EUNIS 2016: Crossroads where the past meets the future
EUNIS 22nd Annual Congress
Book of Proceedings

EUNIS
THESSALONIKI
2016

ISSN 2409-1340

Preface

Dear Reader,
A few days preceding the opening of EUNIS 2016 let me share with you a few thoughts and ideas about how we 've come thus far.

Aristotle University of Thessaloniki has been a member of EUNIS community for more than ten years now. Our involvement in EUNIS activities started to increase during the last three years the moment we decided to adopt one more extrovert business strategy so as to enhance our bonds with the other European Institutions. At this point, I would like to thank personally Jean-Francois Desnos as it was his warm support and encouragement that induced us to announce our candidacy for hosting EUNIS 2016.

Over the last two years, while the Congress was being prepared, we were overcome by mixed feelings. On the one hand, we felt greatly honoured and enthusiastic at having been given such a golden opportunity. On the other hand, however, there were times of fatigue, anxiety and stress just to mention but a few at the thought of carrying on such a tradition passed to us by our honourable predecessors. But in the end and above all, we felt happy and proud that we had been given the chance to be part of a combined effort that strengthened EUNIS collaborative mentality.

This Book of Proceedings, and the Congress in general, is the result of the work of a great number of people as EUNIS Board Members, EUNIS Task Forces Leaders, the members of the Scientific Committee, the Authors and the local organizers have worked in close co-operation to produce remarkable results that will make, as promised, EUNIS 2016 a memorable event. At this point, allow me to express my warmest thanks to all of them for their contribution. Special thanks to our sponsors as nothing could be done without their support.

To conclude, 60 stimulating papers, each evaluated by 3 Scientific Committee Members, that will ignite discussions during the Congress' days, are included in this Book plus one more honorary paper that all together perfectly reflect the theme of this year's Congress: Crossroads where the past meets the future. The selected theme depicts the multifaceted Crossroads (geographical, historical and technological) that you are invited to explore during your stay in Thessaloniki. A Crossroads indeed, where in the universal paths of historic memory, the taste of wine mingles with the smell of cinnamon and the presence of great men and women that shaped our culture still finds visible proof in the countless faces of life in this modern ancient city.

I wish you a good reading.

Looking forward to meeting you face to face in Thessaloniki.

Yiannis Salmatzidis
Chair of the Organising Committee
EUNIS 2016

EUNIS at a glance

EUNIS is the European University Information Systems Organization. It was formed in 1993. It was registered as a non-profit organization in Paris, France in 1998.

EUNIS brings together those who are responsible for the management, development and the policy for Information Technology in Higher Education in Europe. The objective of EUNIS is to contribute to the development of high quality information systems. To achieve this, the aims of EUNIS are:

- encourage exchange, cooperation and debates between those responsible for information systems in higher education or research institutes/organizations within Europe;
- establish relationships with supervisory organizations in charge of information systems in hig her education and in research institutes in each country as well as at European level.

Aristotle University of Thessaloniki at a glance

AUTh is the largest University in Greece covering all disciplines. It is widely recognized as a vibrant center of learning which draws its inspiration from a long tradition of academic achievement. This can be supported, among other factors, by the fact that so much in science, as in the arts and divinity, medicine and technology, it prides itself in its international role. Most of its academic personnel have been trained in reputable Universities in Europe, the United States and as far afield as Australia and Japan. The University has been actively participating in the Erasmus Programme since 1987, accounting approximately one fourth of the total Erasmus mobility in Greece in the frame of Student for Studies Mobilities as well as Staff for Teaching Mobilities.

Nevertheless, mindful of rapid change and progress, we aim to improve our strategy, policies and everyday practices, in order to meet contemporary local and global demands. By assessing our experience, we have been able to determine our strengths and weaknesses, and we have adopted a holistic internationalization strategy, the main objectives of which can be briefly described as follows:

- Strengthen our role in the European and international knowledge community by building upon collective and personal academic achievements.
- Enhance our visibility among the traditionally prestigious academic institutions all over the world, by establishing long-term cooperation schemes at research, education and training level.
- Reinforce our traditional presence as leading education and research institution in Southeastern Europe and Eastern Mediterranean, by building focused strategic partnerships in the area.
- Play a decisive role in academic exchange, good practices dissemination, and knowledge diffusion.
- Support multicultural co-existence, social and cultural cohesion, and promote sustainable regional development.

- Make multilateral, rather than unilateral approach, a core aspect of our work in education, research and administrative level.
- Make our graduates able to think and act across traditional academic boundaries and across national borders. Properly equip them so that they may benefit from international knowledge and experience and support national and local dynamic development.
- Take into consideration global market demands and adjust respectively our educational policies.
- Enhance our cooperation with commercial enterprises abroad in terms of internship offers in order to improve our students' international employability.
- Enhance and reinforce our relation with Greek society.

Despite the financial difficulties, it invests every year remarkable resources in the field of Information Technology recognizing its special role in the daily administrative, educational and research operations and it prides itself in the quality of electronic services that it offers to the academic community.

EUNIS 2016 Congress Committees

Organising Committee

The organising committee was responsible for organizing the Program, budget, contracts, PR, sponsors, coordination of the work of the Scientific Committee, registration process, accommodation, evaluation of the Congress, the day to day Congress operations and logistics.

- **John Murphy**, EUNIS' President, Chair of the Programme Committee
- **Prof. Panos Argyrakis**, Head of the IT Board of Aristotle University of Thessaloniki
- **Yiannis Salmatzidis**, Chair of the Organizing Committee, Technical Manager of IT Center of Aristotle University of Thessaloniki
- **Angeliki Agorogianni**, Head of Administration and User Support Unit of IT Center of Aristotle University of Thessaloniki
- **Dimitris Daskopoulos**, Head of Services Unit of IT Center of Aristotle University of Thessaloniki

Program Committe

The programme committe was responsible for the Track Themes, Keynotes, decisions on review criteria, scheduling papers in thematic sessions. The programme committe was made up of the members of the Organizing committee as well as the following members:

- **Ilkka Siissalo,** EUNIS BencHEIT Task Force Leader
- **Elsa Cardoso**, EUNIS Business Intelligence Task Force Leader
- **Victoriano Giralt**, EUNIS Interoperability Task Force Leader
- **Gill Ferrell**, EUNIS eLearning Task Force Leader
- **Johan Bergstrom,** Eunis Research and Analysis Initiative (ERAI) Leader
- **Noel Wilson,** EUNIS Member
- **Michele Mennielli,** EUNIS Board Secretary
- **Michael Turpie,** Chair of the Organizing Committee EUNIS 2015
- **Jean-François Desnos,** EUNIS Executive Secretary

Scientific Committee

The Scientific Committee, structured with the support of the EUNIS Board and the 5 Congress Track Leaders, namely Elsa Cardoso (Leadership & Management), Victoriano Giralt (ICT Infrastructure & Security), Gill Ferell (Teaching & Learning), Mikael Berglund (Software Development) and Michele Mennielli (OpenX & Interoperability), fulfilled timely an outstanding mission..

- **John Murphy**, EUNIS' President, Chair of the Programme Committee
- **Prof. Panos Argyrakis**, Head of the IT Board of Aristotle University of Thessaloniki
- **Yiannis Salmatzidis**, Chair of the Organising Committee, Technical Manager of IT Center of Aristotle University of Thessaloniki
- **Angeliki Agorogianni**, Head of Administration and User Support Unit of IT Center of Aristotle University of Thessaloniki
- **Dimitris Daskopoulos**, Head of Services Unit of IT Center of Aristotle University of Thessaloniki
- **Ilkka Siissalo,** EUNIS BencHEIT Task Force Leader
- **Elsa Cardoso**, EUNIS Business Intelligence Task Force Leader
- **Victoriano Giralt**, EUNIS Interoperability Task Force Leader
- **Gill Ferrell**, EUNIS eLearning Task Force Leader

- **Johan Bergstrom,** Eunis Research and Analysis Initiative (ERAI) Leader
- **Noel Wilson,** EUNIS Member
- **Michele Mennielli,** EUNIS Board Secretary
- **Michael Turpie,** Chair of the Organizing Committee EUNIS 2015
- **Jean-François Desnos,** EUNIS Executive Secretary
- **Asbjørn Reglund Thorsen,** Oslo University, Norway
- **Raimund Vogl,** EUNIS Treasurer
- **Bas Cordewener,** EUNIS Board Member
- **Ramon Grau Sala,** EUNIS Board Member
- **Mikael Berglund,** EUNIS Board Member
- **Tomasz Szmuc**, EUNIS Board Member
- **Ligia Maria Ribeiro**, EUNIS Board Member
- **Valérie Le Strat**, EUNIS Board Member
- **Malte Dreyer**, EUNIS Board Member
- **Amandine Alehyane**, ERAI's Editorial Committee Member
- **Yves Epelboin**, ERAI's Editorial Committee Member
- **Anna Pacholak**, ERAI's Editorial Committee Member
- **Thierry koscielniak**, ERAI's Editorial Committee Member
- **Jan Madey**, EUNIS past President
- **Spiros Bolis**, GUNET (Greek Universities Network)
- **Panayiotis Tsanakas**, Chairman of GRNET (Greek NREN)
- **Athina Vakali**, Member of the IT Board of Aristotle University of Thessaloniki
- **Georgios Pagkalos**, Member of the IT Board of Aristotle University of Thessaloniki
- **Nikolaos Pitsianis**, Member of the IT Board of Aristotle University of Thessaloniki
- **Susan Grajek, EDUCAUSE**, Vice President, Data, Research, and Analytics
- **Ed Simons,** euroCRIS, President
- **Anne Kealley,** CAUDIT, CEO
- **Peter Tinson**, UCISA Executive Director

EUNIS 2016 Sponsors

Platinum	
CISCO	TelmAco
Gold	
COSMOTE	ORACLE®
Silver	
Extron	
Bronze	
explorance	myday
EUNIS MÜNSTER 2017	Unplag.com® PLAGIARISM DETECTION ENGINE
Panopto™	

Table of Contents

Parallel Session Three – Leadership & Management

Parallel Session Three – ICT Infrastructure & Security

Parallel Session Three – Software Development

Parallel Session Three – OpenX & Interoperability

Parallel Session Four – Leadership & Management

Parallel Session Four – ICT Infrastructure & Security

Parallel Session Four – Teaching & Learning

Parallel Session Four – OpenX & Interoperability

Parallel Session Five – Leadership & Management

Parallel Session Five – ICT Infrastructure & Security

Parallel Session Five – Teaching & Learning

Parallel Session Five – OpenX & Interoperability

The Form of Spirals Carved on Ancient Greek Monuments

Jean-François DESNOS[1], Bruno HELLY[2]

[1] EUNIS www.eunis.org, jfdesnos@orange.fr

[2] Maison de l'Orient et de la Méditerranée, Université Lumière Lyon 2 – CNRS, bruno.helly@mom.fr

Keywords

Spiral, pattern recognition, Ancient Greece

The venue of the EUNIS 2016 Congress in Thessaloniki, Greece, is an opportunity for the authors to revive a study they made in 1980 where they tried to characterize the form of spirals carved on tombstones and colonnades in ancient Greece (from VI^th to III^rd century Before Christian Era) by several "schools" of carvers, using several design techniques.

From a sample of 54 digitized spirals, we have identified three classes of spirals: Archimedes spirals, centres spirals, and logarithmic spirals.

1. Finding three classes of spirals

From the bibliography in Archaeology (Moëbius, 1968), we are expecting spirals drawn, before being carved, by a series of circular arcs. Among them, we have distinguished three classes of spirals:

- **A class** (Figure 1) for Archimedes class: The involution of a circle, drawn by unwinding a string from a circular cylinder (in red on Figure 1). This kind of spiral is very close, and often called, an **Archimedes spiral (in blue on** Figure 1).

  The Archimedes spirals from our sample are mainly of Ionian origin. We can associate these forms with contemporary geometric studies (trying to "square the circle")

Involute of a circle (red)

Archimedes spiral (blue)

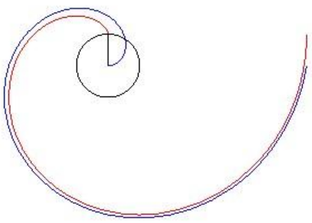


Figure 1

- **C class (centres spirals) are** made by unwinding a string around two points or more (2 centres spiral, Figure 2). For example there are 4 points when unwinding a string around a square cylinder (Figure 3).

  In our sample, these spirals originate very early (VIth century BCE), especially in Attica.

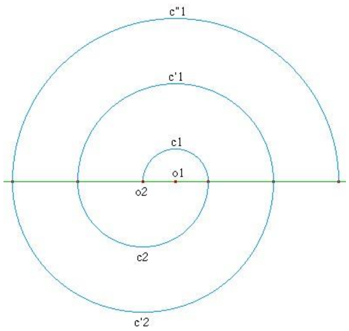


Figure **2**

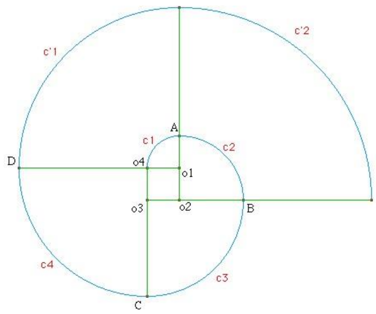
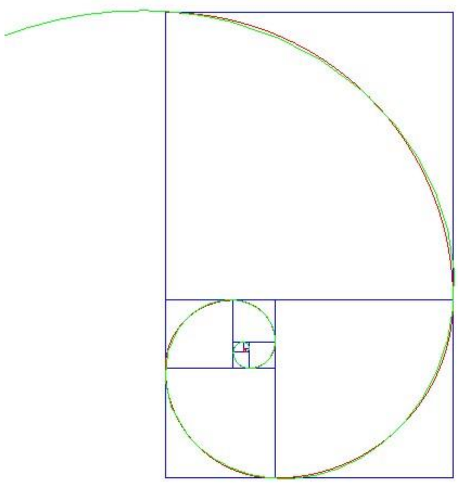


Figure 3

- **L class: logarithmic spirals** (Figure 4). They look like curves found in the nature, (shells, hurricanes, galaxies). We found L class spirals in the Asia Minor coast, Aegean islands including Samos, and later in Athens and other parts. We will discuss the links of these designs with the geometric studies of Thales. These forms can also be approximated by a series of circular arcs. The so-called golden spiral is a logarithmic spiral.



A l**ogarithmic spiral** is depicted in green on the schema. In red we show an approximation using circular arcs.

Figure 4

2. Determining the form

The Pattern Recognition problem then, is the retrieval of the spiral geometric elements. We chose not to study the curves in polar coordinates (r, θ) because their equation depends on the chosen origin of axes. We preferred **to analyse the curvature, which is an intrinsic property**. This point made this research new and innovative (Desnos, 1980).

If the radius of curvature is expressed as a function of the angle that the tangent makes with a fixed direction *Ox,* we notice that the assumed spirals have some remarkable properties:

- For the **A class (Archimedes)**, the radius of curvature grows linearly with the polar angle (involution of a circle).

  It can be described in polar coordinates by the equation $r = a + b\,\theta$

  One other property is that any ray from the origin intersects successive turnings of the spiral in points with a constant separation of the distance.

- For the **C class (centres)**, the radius of the curvature is piecewise constant (circular arcs).
- For the **L class** (logarithmic), the radius of the curvature grows exponentially with the polar angle. This kind of spiral is also quite well approximated by a sequence of circle arcs, of radius 1, kl, $k^2 1$, $k^3 1$, …

  The equation in polar coordinates is $r = ae^{b\,\theta}$ Some more

  properties for the L group are:

- The angle φ between the tangent and the radial line is constant.
- The distance between the turnings increases in geometric progression.
- The radius of the curvature can be written:

$$R = ke^{l\theta}$$

3. Implementation

The software was designed and developed by the authors in PL1 language.

The inputs were done manually by points. The outputs were made on a Benson plotter.

a. The input of a spiral was made by point (Figure 5), with an average of 8 points by π/4.

b. Selecting the first eight points of the spiral, the arc of the circle fitting the set of points using least-squares approximation is determined.

c. The centre of the circle, the radius of curvature, and the tangents at the projection of each point on the arc are deducted. On Figure 5, 4 circle centres are very close 2 by 2.

d. The same procedure is used on the following points until the end of the turnings.

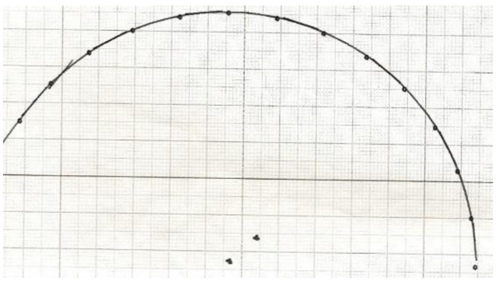


Figure 5 An output on the plotter showing the points and circle arcs that join them

Figure 6 below shows the radius of curvature R (ordinate) as a function of the angle α that the tangent makes with a fixed direction (abscissa). The continuous segments shows the calculated radius of curvature; the dotted lines are the best approximation (least squares), here by constant segments. Here the spiral is shown as having 4 centres in Figure 7.

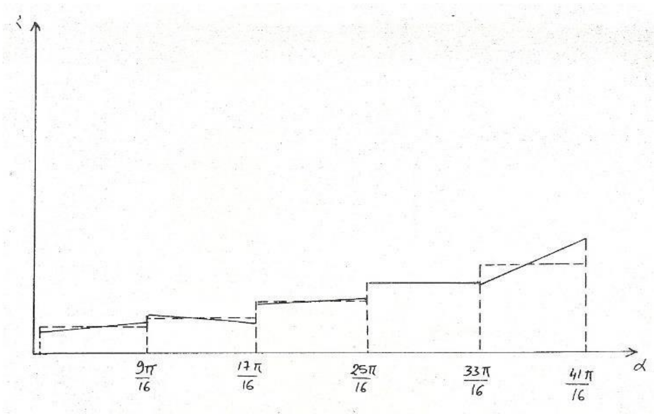


Figure 6

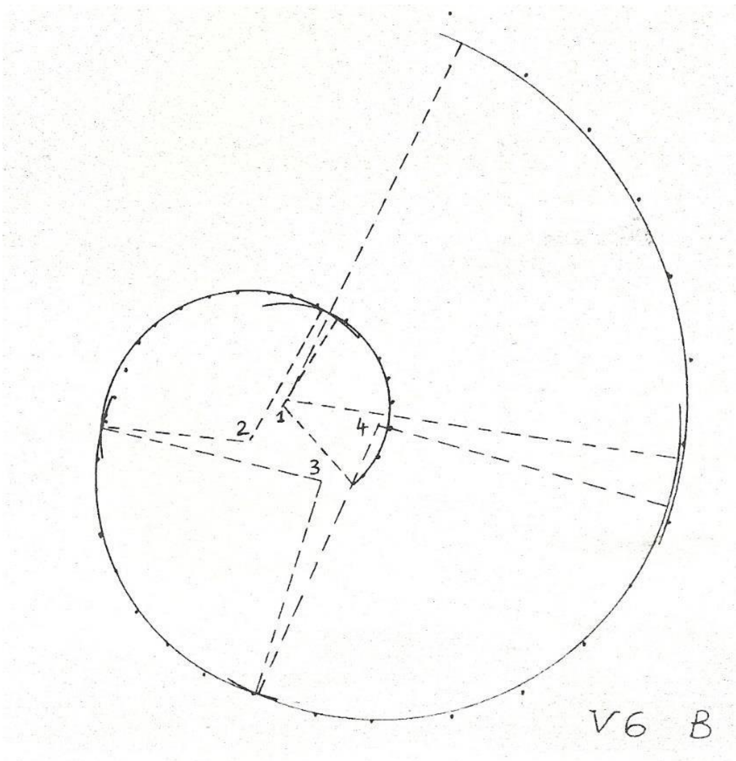


Figure 7: A spiral with 4 centres (the centres are named 1, 2, 3, 4)

Figure 8 below shows an example of a spiral with 2 centres:

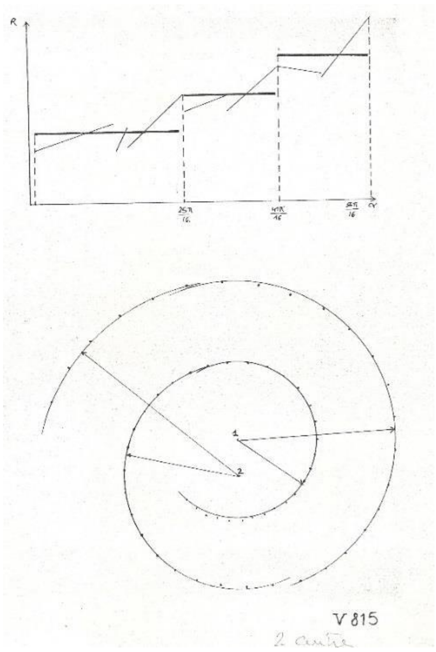
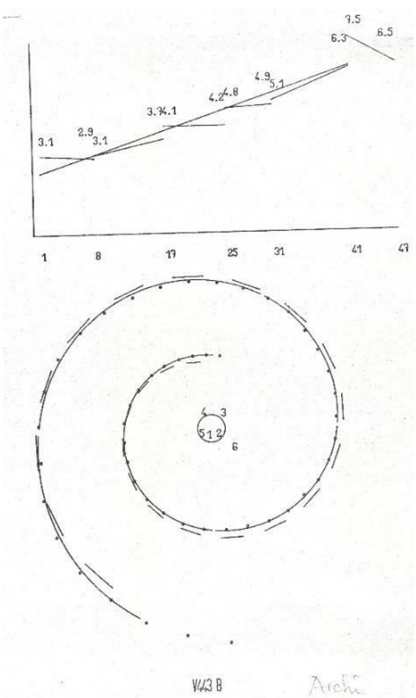


Figure 8: A“2 centres” spiral

Below at the left, Figure 9 represents an Archimedes spiral. On the right, Figure 10 is a photograph of the same carving.



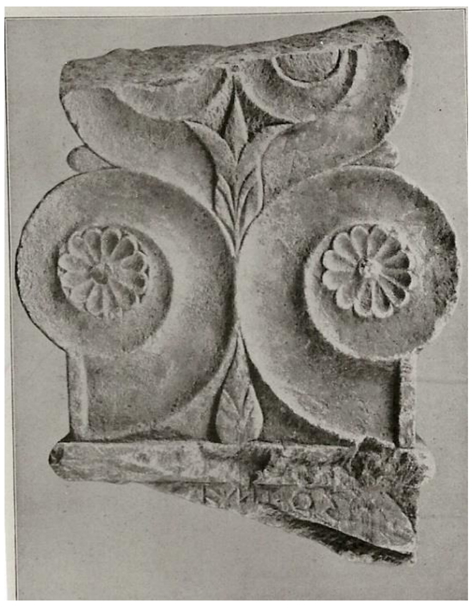
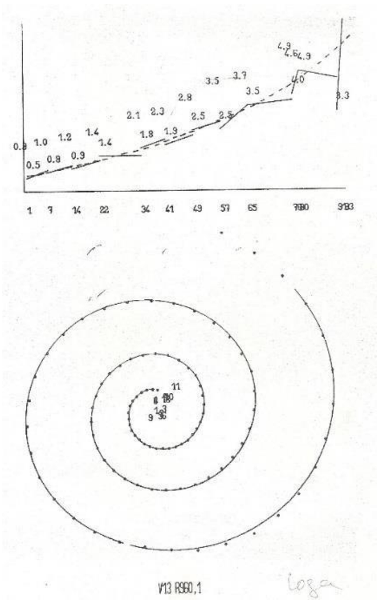


Figure 9 An Archimedes spiral Figure 10

And in Figures 11 and 12, we show an example of (the same) logarithmic spiral:



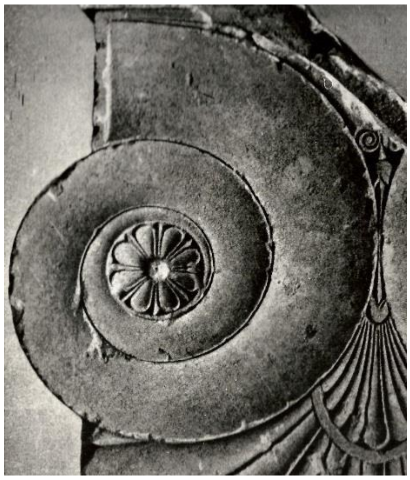


Figure 11 A Logarithmic spiral (Samos VIth BCE) Figure 12

4. Results

We admit that the sample remains small, with spirals chosen for the quality of the craft, in order to minimize the classification errors after processing.

In 1980, the input process was done by points and was very long and tedious. That's why, from several thousands of beautiful photographs taken by our colleague and friend Christoph Wolters (Wolters, 1969), only 54 spirals were analysed. Today, the photographs could be digitized more easily, with a recognition program using a spline or Bézier approximation, which was already discussed in 1980 with Professor P.-J. Laurent in Grenoble (Laurent, 1972).

From these 54 spirals, we could define the form of 21 spirals, which is quite satisfying considering the precision of the carving, photographs, digitization, and approximations used. Among them, representatives of the three classes were determined.

A class Five Archimedes spirals were detected

- from Samos, date 530-520 VIth century BCE
- from Sardis (Asia Minor), date middle VI BCE
- from Amorgos (Aegean island), date middle VIth century BCE
- from Kos (Aegean island), date Vth century BCE
- from Attica (Piraeus), date IV BCE

These are mainly Ionian artworks including Athens and the islands. The design is probably related to geometric problems like squaring the circle (finding a straight line that has a length which is equal to the circle arc).

C class Nine spirals were determined as centres spirals

- a 4 centres spiral from Kertsch (Black Sea), date Vth century BCE
- a 2 centres spiral from Attica, date VIth century (575-545) BCE
- a 2 centres spiral from Attica, date VIth century (550-5525)BCE
- a 4 centres spiral from Sidon, date 430 BCE
- a 4 centres spiral from Athens, date 425-410 BCE
- two centres spirals from Athens Erechteion, date 410-400 BCE
- a 4 centres spiral from Athens, date IVth BCE
- a 4 centres spiral from South Russia, date early IIIth century BCE

This class has early origins, especially in Attica. But on IIIrd century BCE, Demetrius, the king of Macedonia forbade carvers any marble ornaments in the Athens area. Workshops were closed and the carvers moved to other Greek areas.

L class **Seven spirals were classed as Logarithmic**

- one from Troade, date around 550 BC (VIth century BCE)
- one from Samos, date around 530-520 BC (VIth century BCE)
- one from Samos, date around 530-520 BC (VIth century BCE)
- one from Samos, date around early Vth century BCE
- one from Karystos (Euboea), date around 440-430 BCE
- one from Athens, date 365-340 BCE
- an unknown origin spiral…

Mainly designed in the Ionian tradition (Troade, Aegean islands, especially Samos). We expect a relationship between logarithmic designs and the first geometric definitions assigned to Thales.

As a conclusion, we can say that today we have the informatics tools to treat the thousands of photographs preserved at Maison de l'Orient Méditerranéen. Analysing them through modern approximation techniques, it could be possible to associate a large segmentation in classes to the techniques of the carver's workshops, the movements of the craftsmen, the place and dates of the sculptures.

Bibliography

Desnos, J.-F. *Pattern Recognition of Spirals Carved on Ancient Greek Monuments*, 1980 Conference on Pattern Recognition, Oxford, England.

Laurent, P.-J. *Approximation et Optimisation,* Ed. Hermann, Paris, 1972

Moëbius, H. *Die Ornamente der griechischen Grabstele*, um Nachträge und Register vermehrte Auflage, München, 1968.

Wolters, Ch. *Die Anthemien-Ornamente der Grabstelen von Demetrias*, Thesis, Ruprecht-KarlUniversität zu Heidelberg, 1969

The Authors

Dr Jean-François Desnos is a Research Engineer in Applied Mathematics and Informatics retired from Université Joseph Fourier, Grenoble. He is a former President of EUNIS.

Pr Dr Bruno Helly is an Emeritus Research Director in Archaeology at Centre National de la Recherche Scientifique. He has been working for 40 years on ancient Thessaly.

Challenging Dropbox: The Adoption and Usage of New Cloud Storage Service "sciebo" at German Universities

Dominik Rudolph[1], Raimund Vogl[1], Holger Angenent[1], Anne Thoring[1], Andreas Wilmer[1], Christian Schild[1]

[1]Westfälische Wilhelms-Universität Münster, ZIV, Röntgenstraße 7-13, 48149 Münster/Germany, {d.rudolph|r.vogl|h.angenent|a.thoring|a.wilmer|schild}@uni-muenster.de

Keywords

diffusion of innovations· adoption · cloud-storage · project report

1. ABSTRACT

As reported at EUNIS 2015, a large academic cloud storage service was launched in the beginning of 2015 by the majority of the public research and applied science universities in the German state of North Rhine-Westphalia (NRW) under the brand name “sciebo”. One year after the start, we will examine if the predictions made in the preparatory project phase on system performance and on service adoption based on the well-known diffusion model by Rogers apply to reality. This is the first study about the adoption of a specific cloud service at several universities. We identify two factors affecting the speed of diffusion: share of technophiles and the use of marketing measures. Organization size does not seem to influence the speed of diffusion. Regarding system performance and availability, one year of operation shows that the agreed on targets were met.

2. INTRODUCTION

Cloud storage services like Dropbox or Google Drive became quite popular in the course of the last half decade, not least in the academic context among students and researchers, making it possible to easily share documents with others and to synchronize data across multiple devices. Those commercial services are very comfortable in use, but security concerns about their data utilization arise, especially after the Snowden disclosures. In 2013, as a consequence, the majority of the public research and applied science universities in the German state of North Rhine-Westphalia (NRW) formed a consortium to start a jointly operated private cloud service for the academic community. This sync and share storage platform should be free of charge, easy to use and, most importantly, it should be hosted on premise at several university data centers to be fully compliant with German data protection regulations (Vogl et al., 2013). With respect to the software functionality and the required hardware setup for potentially 500.000 users, the system design was grounded on empirical user studies.

A first exploratory survey on the demand for a university operated alternative to Dropbox etc. was conducted among potential users at Münster University in 2012 and extended to a multi-site survey with more than 10.000 participants from three major universities in late 2013 (Stieglitz, Meske, Vogl, & Rudolph, 2014). Both surveys focused on the participants’ intention to use such a university operated cloud service, their demand for storage space and client platforms, the type of content (file types) they intended to store, and the communities they wanted to collaborate with using the service’s file sharing functionalities. The procurement of the software solution as well as the sizing of the hardware platform were based on the adoption and usage estimates derived from these surveys.

In February 2015, after extensive preparatory work done for the funding proposal, the procurement process, and the system setup and commissioning, the sync and share cloud storage service was launched under the brand name “sciebo – theCampuscloud” (sciebo being short for science box) with three university data centers (Bonn, Duisburg-Essen and Münster) hosting the system platforms on premise. Almost exactly one year after the start, it is now the right time to review how the initial expectations on service adoption and usage as well as system performance and availability correspond with reality. After a year of operation (as of Feb 02 2016), exactly 40.000 users from 24 universities (out of 33 in NRW) and one public research center have signed up for sciebo through the self-enrollment web portal.

The case of sciebo is unique because it allows us to observe the diffusion of a technical innovation from the beginning in a well-controlled setting. There is plenty of literature about the adoption of cloud systems in organizations like SMEs (Alshamaila, Papagiannidis, & Li, 2013; Tehrani & Shirazi, 2014; Trigueros-Preciado, Pérez-González, & Solana-González, 2013) or special industries (Cegielski, Allison Jones-Farmer, Wu, & Hazen, 2012; Gupta, Seetharaman, & Raj, 2013; Ivanova & Ivanov, 2010; Khanagha, Volberda, Sidhu, & Oshri, 2013; Lian, Yen, & Wang, 2014; Low, Chen, & Wu, 2011; Moryson & Moeser, 2016; Oliveira, Thomas, & Espadanal, 2014), but only little is known about the adoption behavior of end-users who can decide freely if they want to use a new cloud service or not (Shin, Jo, Lee, & Lee, 2014). Universities are a special case: On the one hand, they are organizations with a quite uniform population and a manageable size. On the other hand, because of the principle of freedom of research and teaching held high in Germany, there is no possibility to command the use of a system, so users have to be convinced.

3. PREDICTIONS

In preparing the sciebo project and applying for substantial funding, reliable predictions on the user adoption of this new service were crucial for the system design and amount of hardware to procure. For the university data centers volunteering to host the platform, estimates of the internet bandwidth to be dedicated to sciebo was important, and for the universities that had to decide if they wanted to join the sciebo project consortium it was necessary to know what quality of service, especially with respect to system availability, they could expect. Thus, based on empirical research, predictions were made on the required storage volume for the sciebo system platform and the required internet bandwidth – both directly connected to the adoption of the new service by its eligible users. System availability scores were estimated based on the analysis of three years of well documented operations incidents at the University of Münster.

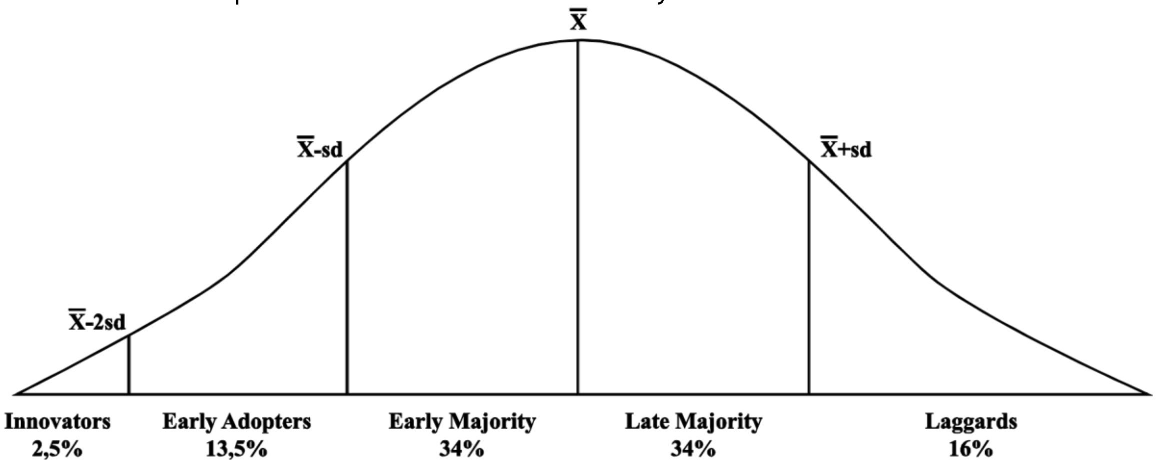


Fig. 1. Adopter Categories according to Rogers [15]

According to Rogers (Rogers, 2003), innovativeness, i.e. the readiness and the degree to which a person or an organization adopts an innovation (i.e. a new product) compared with the other members of his population, follows the Gaussian distribution. He identifies five adopter categories (innovators, early adopters, early majority, late majority, laggards; see Fig. 1) who have different characteristics referring to their innovativeness. If you accumulate the adoption decisions of all those adopters over time, you will get an S-shaped curve, the diffusion curve. The faster the innovation is adopted the more steeply this curve will rise. The speed of diffusion depends on the characteristics of the innovation, in particular its relative advantage compared to other existing products, compatibility with existing values and practices, simplicity and ease of use, trial ability and observable results.

As our data from a large user survey conducted in 2013 (Stieglitz et al., 2014) show, Dropbox is the most used storage service among members of the universities with about 80 percent of market share.

This value recurs in another survey conducted in 2015 at the same universities (unpublished work), so we conclude that Dropbox obviously has reached the saturation of demand five years after its inception in 2007 and two years after the release of the first stable version 1.0 in 2010. Examining Dropbox's worldwide diffusion (see Fig. 2), a flat growth is visible in the first two years and a take-off in the third year.

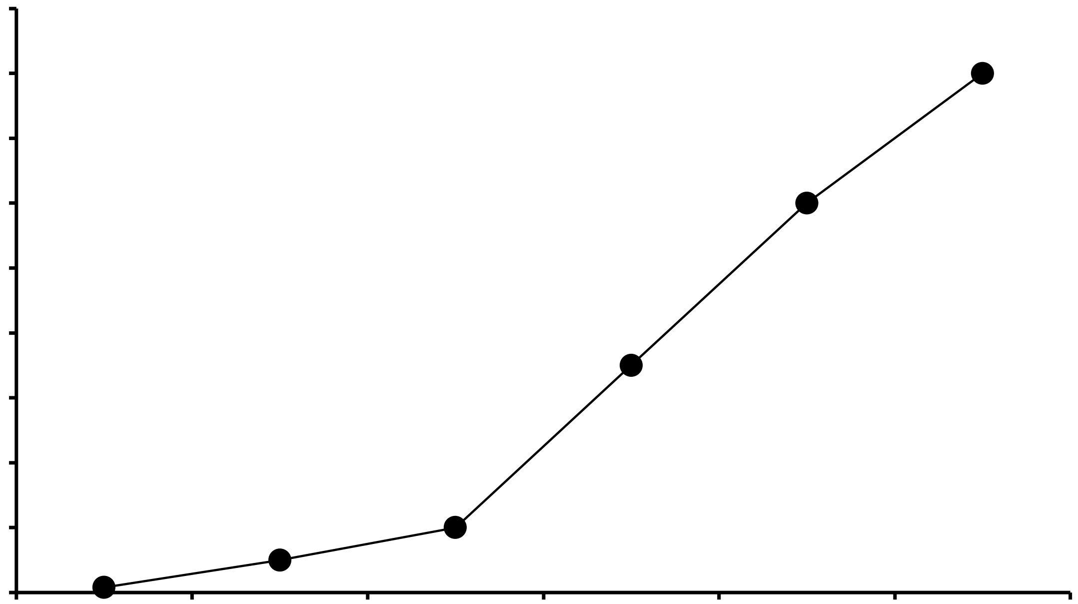


Fig. 2. Diffusion of Dropbox (in mio. users) (Dropbox, 2015)

For sciebo, we predicted an even faster diffusion because the technology is already known from Dropbox. Moreover, sciebo's high security standards and bigger free storage space seem to be significant relative advantages as stated by the participants of a survey in 2013 (Stieglitz et al., 2014). According to Diffusion Theory, market potential is not the total of all potential users (i.e. all members of the participating universities), but the total of all those persons who will realistically use a new service (Kleinaltenkamp & Plinke, 1999). In the survey, 92.5 percent of the participants stated that they wanted to use sciebo. Being informed that their usage authorization would be revoked when leaving university, the count dropped to 65 percent. Thus, 65 percent of all members of the participating universities – that is about 252.000 individuals – constitute the estimated market potential of sciebo.

Based on the distribution of per user storage demands from the survey, we could refine the initial assumption that each user would utilize the planned 30 GB quota to the max and were able to predict an average storage volume of 8 GB (pessimistic scenario) to 16 GB (optimistic scenario) per user and could ascertain that a maximum storage space of 30 GB should fit most users. Assuming that users would switch their academic data from another platform to sciebo in the first days after the registration, we expected a quite linear growth with a 30 percent basis synchronization at the beginning and just small gain of 3 percent a month.

Considering the predictions on service adoption and storage demand, different scenarios were derived to estimate the size of storage systems to be procured and the internet bandwidth required. The total storage volume required for the operation of sciebo in the long term was estimated at 1.7 PB (pessimistic) to 5 PB (optimistic), and the internet connection bandwidth requirement for service operation was estimated at 3 Gbps in the optimistic scenario.

The predictions on system availability (base on three years of incident logs at Münster) resulted in an agreement amongst the sciebo consortium partners that the availability scores have to be 99.5% per year for each of the sites with a minimum of 98% per month.

4. FINDINGS

4.1. User Diffusion

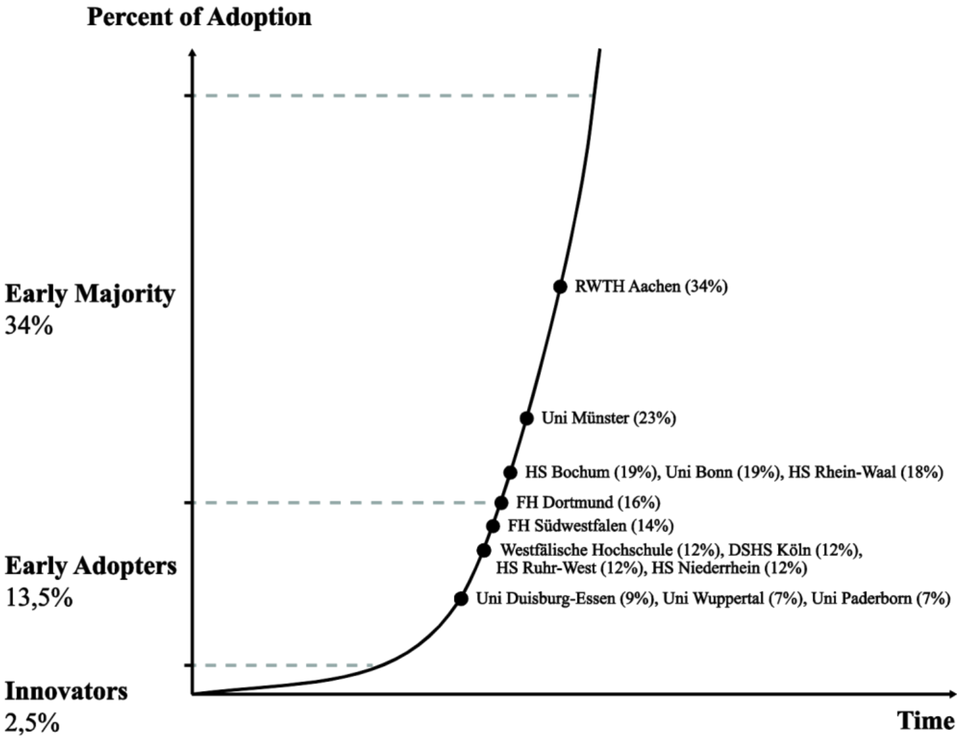


Fig. 3. Diffusion of sciebo after one year (only universities starting in Feb 2015)

Nearly one year after the official launch, sciebo hit another milestone with now 40.000 users – this means an actual market share of 17.3 percent. In terms of the Diffusion Theory, this implies that sciebo's diffusion has already reached the early majority phase.

However, diffusion speed varies significantly at the different universities. Figure 3 shows the state of diffusion at the 14 universities that started sciebo in Feb 2015. The spectrum ranges from 6.7 percent at the University of Paderborn to 33.9 percent at RWTH Aachen. University size might serve as one explanation, as information should flow very fast at a small campus with a manageable number of departments. As stated by Rogers (2003), diffusion can be seen as a communication process: In smaller and spatially closer populations, communication between the members is much more likely and easier than in a complex university with lots of different departments distributed over the whole city.

Though in theory size suggests itself as a reason for the different diffusion speeds, it does not seem to be a good explanation in our case: Comparing same-sized universities – e.g. the Universities of Münster, Duisburg-Essen and RWTH Aachen with about 44,000 to 49,000 members each (see Fig. 4) – the differences in market share are still evident. Results show a remarkable variance of 24.5 percent between RWTH Aachen (33.9%) and the University of Duisburg-Essen (9.2%), with the University of Münster (23.0%) ranking mid.

Taking all universities into account, RWTH Aachen appears to be an outlier with its high market share. Both, the University of Münster (23.0%) and the University of Duisburg-Essen (9.2%), rank much closer to the overall average. One possible explanation for RWTH's high performance is that, unlike the Universities of Münster and Duisburg-Essen, RWTH is a technical university with many technophiles. They resemble the innovators described by Rogers and are the first to adopt new technologies. Logically, a technical innovation like sciebo diffuses faster in a technophilic environment than in other populations.

The low performance of the University of Duisburg-Essen, compared with the same-sized universities and the overall average diffusion, is similarly interesting. A closer look reveals that the universities' commitment in terms of marketing activities might be another decisive factor. While RWTH Aachen and the University of Münster, in particular, performed a variety of marketing activities (i.e. direct mailings to all members), the University of Duisburg-Essen did not to that extent. Therefore it is likely that only innovators and early adopters who are interested in innovations and actively search for information on their own account for their share of sciebo users. Further monitoring will show if an early majority can be reached with no marketing and just word of mouth, or if the number of users will be stagnating. According to some authors there is a gap between the early adopters and the early majority which has to be bridged by marketing activities (Christensen, 2011; Moore, 2014), while Rogers (2003) considers both groups as a continuum.

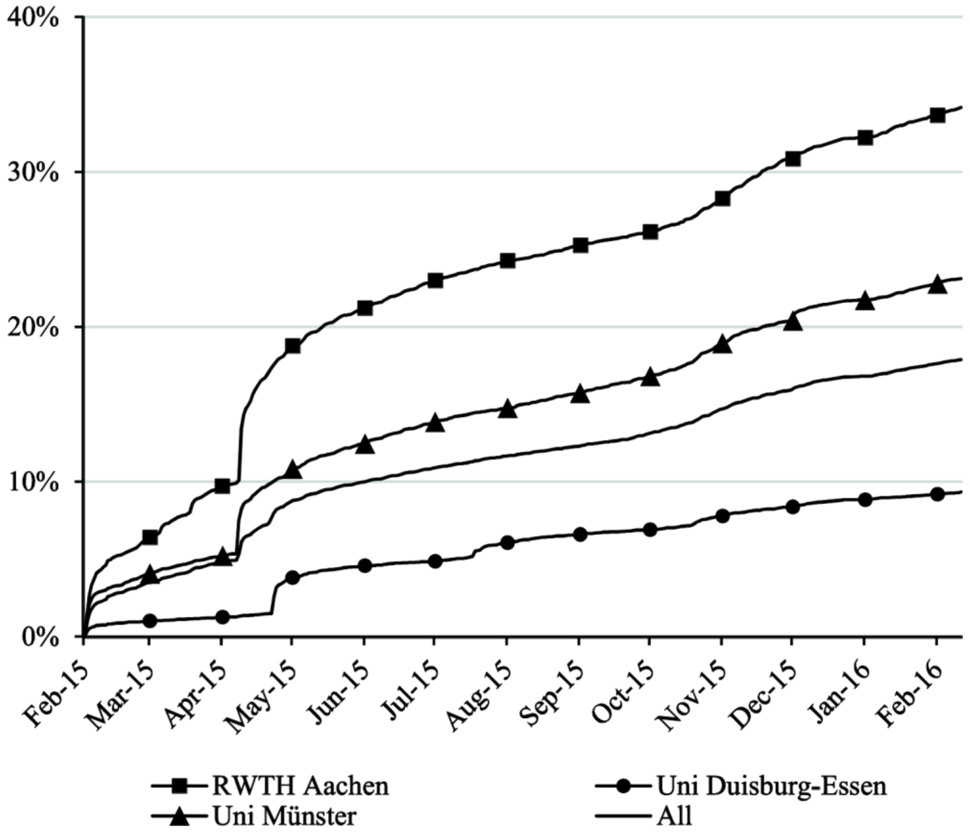


Fig. 4. Diffusion curves of chosen universities with same size starting in Feb 2015

Examining the diffusion curves of the different universities (see Fig. 4), deviations from the ideal Scurve of the diffusion model are clearly visible. Usually, they are caused by special events. The first boost in February 2015 is the official launch of the service. In the run-up we realized a large Facebook campaign with posts in over 400 user groups related to the participating universities. Also, test users were now added to the statistics. The second and largest user increase in April, at the start of the summer term in Germany, is triggered by direct mailing, that most participating universities did send to their members. The diffusion curves of those universities passing up this opportunity show no such steep rise. In October most universities welcome their largest share of new students for the winter term, explaining the next boost. In December, some universities used direct mailing to promote an online survey related to sciebo, again gaining attention and an additional boost for new users for sciebo.

As regards storage space, we initially expected 9 GB (30% of the intended per user quota limit of 30 GB) right after registration and a monthly growth of 3 percent (until the quota limit is reached). Currently, the average volume needed by an active user (i.e. a user who uploaded some data) is 3.3 GB, amounting to a total of 99.8 TB storage space used in sciebo. Those universities which grant access to sciebo only to their staff have a substantially higher storage demand per active user (e.g. Düsseldorf University with 7.4 GB) than most other universities where usually three out of four active users are students (e.g. Münster University with 4.7 GB).

4.2 Data Storage

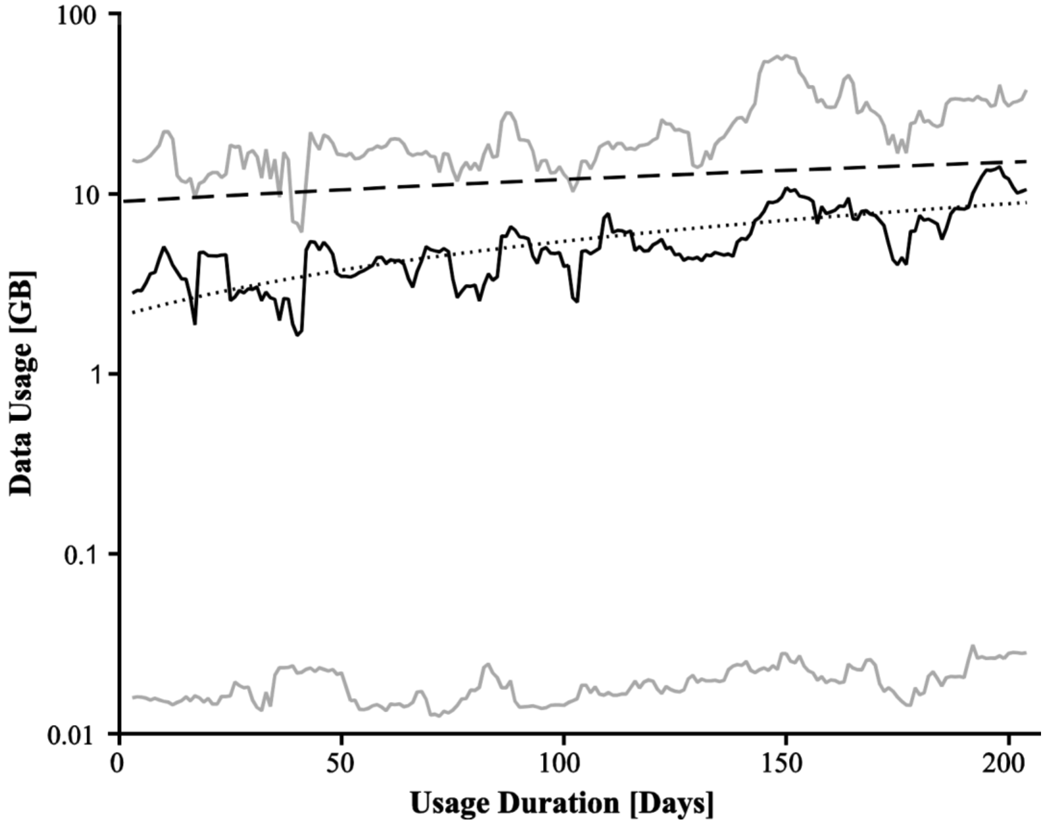


Fig. 5. Storage load on individual user basis per time vs. model (broken line)

In Figure 5 we analyzed the storage load on an individual user basis. In particular, we looked at the dependency between the consumed storage space of a single account and its age. Shown is the mean used disk storage for user accounts in dependency of the account lifetime (solid black line), the 0.05quantile (lower grey line) and the 0.95-quantile (upper grey line) in a logarithmic plot. The broken black line represent the expected and the dotted black line the observed linear model of the user behavior.

Altogether 6,581 user accounts were analyzed on a day-wise basis. The statistical values were computed across an ensemble of user accounts for a specific account age. In addition, two datasets from different time points are independent from each other because accounts were not tracked over time. The analysis was restricted to active accounts with a used storage capacity of more than 10 MB. Thus, inactive accounts from seasonal side effects, such as beginning of a new semester, are excluded from analysis. In addition, a moving average with a window size of 7 days was used to accumulate the number of user accounts for statistical analysis, i.e. in average N=225±92 accounts were analyzed for each day.

We observed two main findings: First, we predicted that on average an account initially requires 30 percent of its full 30 GB quota and grows in a linear fashion with 3 percent of its quota per month. One can rewrite this assumption to a linear equation of the form f(x)=A+Bx with the function f describing the disk usage in dependency of the time x and the coefficient A as the initial off-set, B as the slope of the function, i.e. we expected A_{exp}=9000 [MB] and B_{exp}=29.6 [MB/Day]. However, we observed an offset a_{obs}=2077.1 ± 239.3 [MB] and a slope b_{obs}=33.5 ± 2.0 [MB/Day] with a linear LeastSquares Fit ($p<.001$ and adjusted R-Squared 0.578). The observed results show that on average a user synchronizes less data directly after the subscription than initially expected, but fairly consistent with 30% of the average storage space per user of 8 GB in the pessimistic scenario deduced from the survey findings. However, the growth of the data synchronized is higher than expected.

Second, sciebo has to handle a variety of usage scenarios. In Figure 5 the close distance of the average to the 0.95-quantile indicates a positively skewed underlying distribution, which is caused by an extensive disk usage of some few accounts. This indicates on the one hand that usage scenarios will differ in strong fashion between users and, on the other hand, that sciebo is capable to deal with a wide variety of use cases.

4.3 Bandwidth

The initial estimates of bandwidth requirements were essential to make sure that the internet connection bandwidth of the three university data centers hosting the sciebo platform was not entirely consumed by the new sciebo service. Based on simply models of service utilization (up- and downloads) an overall limit of 3 Gbps sustained for the whole sciebo system, thus approx. 1 Gbps for each of the datacenter sites, was predicted as being sufficient.

One year after the start of operation, this sustained data rate has not been reached by far, but temporary bandwidth peaks at each of the three sites are in the 800 Mbps range (see Fig. 6). With continuous growth of the sciebo user base and storage volume, bandwidth demands will necessarily grow, but negative effects on the internet connectivity of the hosting universities (each currently has a 10 Gbps internet link) are, as initially predicted, not to be expected, especially since traffic policies limiting the bandwidth allocated to individual connection could still be imposed. The mutual data backups between the three sites are schedules in the 12am to 6am timeframe where service utilization is low and thus do not negatively impact the bandwidth budget.

4.4 System Availability

To ensure high system availability for sciebo according to the agreed on availability scores, a set of measures was taken with respect to resilient system design and has proven very effective in the first year of operation. Availability monitoring of the complete sciebo service stack through periodic automated ownCloud file access operations from probes at all three sites checking the respective other two sites with event correlation using NAGIOS and Check_MK show good monthly availability scores even for the initial three months period of operation and for the whole 11 months for which availability data has been recorded up to now (Table 1).

	Site A	**Site B**	**Site C**
Mar 2015	98.50	99.98	100.00
Apr 2015	99.69	100.00	99.93
May 2015	99.92	99.87	99.21
Mar 15 - Jan 16	99.64	99.81	99.80

Table 1. Availability scores (in %) for the three sites hosting sciebo (anonymized)

They are well in line with the availability scores previously agreed on amongst the consortium partners of 99.5% per year for each of the sites and a minimum of 98% per month. These results are also comparable with numbers publicly disclosed on Dropbox, where 99.63% to 99.85% availability (where the lower number includes unconfirmed downtimes) for the service was monitored by independent sources for the July to December 2012 period.

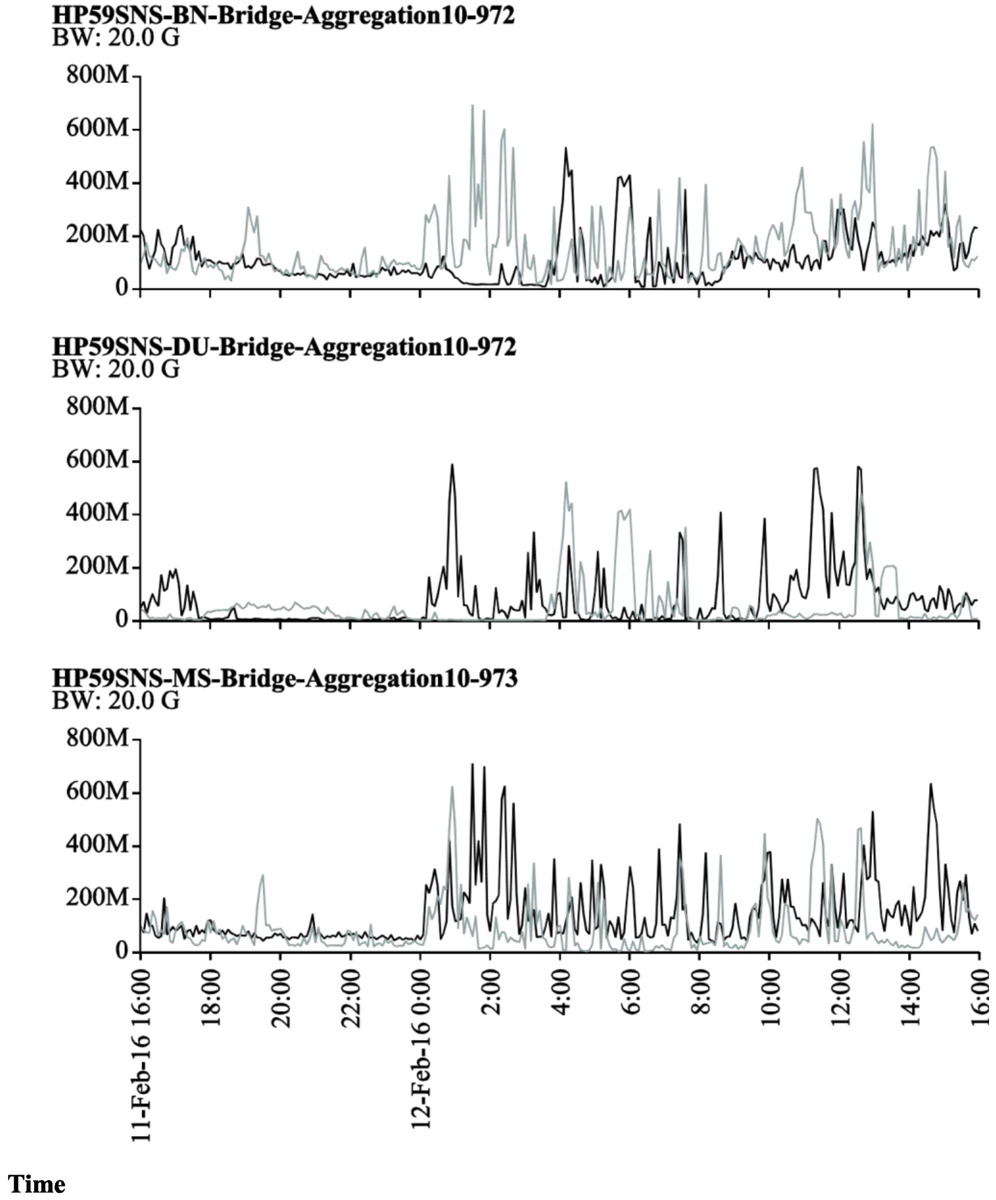


Fig. 6. Internet bandwidth (in=black, out=grey) consumed by the 3 sciebo sites at Bonn (BN), **Duisburg-Essen (DU) and Münster (MS) on a typical day after one year of operation. Correlated in/out peaks between two sites in the 12am – 6am timeframe are due to mutual backup copy operation.**

4.5 Additional Findings

Apart from those findings related to our predictions, some additional outcomes are worth mentioning.
The first finding broaches the issue of user activity: 38 percent of the registered users are inactive, i.e. they have not uploaded any data to sciebo yet. Based on Rogers' Diffusion Theory (2003), this inactivity of a substantial user fraction could be interpreted as either a prolonged phase of decision making or as discontinuance (without having used the service apart from signing up) (Black, 1983; Parthasarathy & Bhattacherjee, 1998). This finding needs further research.
The second finding focuses on the key collaboration feature of sciebo – sharing data with other sciebo users or externals (share via hyperlink). With an overall average of 2.4 shares per active user, this feature is not used very strongly yet. Folders (66.5%) are shared more often than files (33.5%). Approximately 50 percent of all shares are performed via link (primarily intended for external exchange), contrary to expectations from the survey (Stieglitz et al., 2014), where 65 percent of the participants intended to share within their university and only 21 percent intended to share with externals.

5. CONCLUSION

These first results show that the predictions on service adoption and system availability made in the design phase of the sciebo service do well conform to the reality of one year of operation. Especially the prognoses on required system platform parameters phrased in the aftermath of the 2013 survey (Stieglitz et al., 2014) are – up to now – in line with the service's adoption, and, moreover, Rogers' diffusion theory (Rogers, 2003) has proved to be an adequate model. We could identify two factors influencing the speed of diffusion of the sciebo cloud-service:

1. Share of technophiles in the organization
2. Use of marketing measures

Both findings are supported by the diffusion model. As known from the diffusion literature, an innovation is more likely to be adopted if it is not too complex and consistent with known products. Consequently, technophiles who understand a technical innovation much better and usually find it less complex than other people, will be more likely to adopt an innovation quickly. As noted by some authors, there might be a gap – in terms of missing peer-to-peer connections – between innovators and early adopters on the one hand and the early majority on the other hand, because of the significant differences between those groups (Moore, 2014). Marketing measures like direct mailings, Facebook posts, YouTube videos etc. can bridge this gap by informing the early majority about a new service, and thus speed up the diffusion process. According to our data, organization size does not influence the diffusion speed.

Finally, the universities' heterogeneous rate of adoption and the high fraction of inactive users leave a wide field for further research. In the upcoming months, analyzing the reasons for discontinuance of use will be a key focus.

6. REFERENCES

Alshamaila, Y., Papagiannidis, S., & Li, F. (2013). Cloud computing adoption by SMEs in the north east of England: A multi-perspective framework. *Journal of Enterprise Information Management*, *26*(3), 250–275.

Black, W. (1983). Discontinuance and Diffusion: Examination of the Post Adoption Decision Process. *Advances in Consumer Research*, *10*(1).

Cegielski, C. G., Allison Jones-Farmer, L., Wu, Y., & Hazen, B. T. (2012). Adoption of cloud computing technologies in supply chains: An organizational information processing theory approach. *The international journal of logistics Management*, *23*(2), 184–211.

Christensen, C. M. (2011). *The innovator's dilemma: The revolutionary book that will change the way you do business*. New York, NY: Harper Business.

Dropbox. (2015). Stats. Retrieved from https://www.dropbox.com/

Gupta, P., Seetharaman, A., & Raj, J. R. (2013). The usage and adoption of cloud computing by small and medium businesses. *International Journal of Information Management*, *33*(5), 861–874.

Ivanova, M., & Ivanov, G. (2010). Cloud computing for authoring process automation. *Procedia-Social and Behavioral Sciences*, *2*(2), 3646–3651.

Khanagha, S., Volberda, H., Sidhu, J., & Oshri, I. (2013). Management innovation and adoption of emerging technologies: The case of cloud computing. *European Management Review*, *10*(1), 51– 67.

Kleinaltenkamp, M., & Plinke, W. (1999). *Markt- und Produktmanagement: Die Instrumente des technischen Vertriebs*. Berlin: Springer.

Lian, J.-W., Yen, D. C., & Wang, Y.-T. (2014). An exploratory study to understand the critical factors affecting the decision to adopt cloud computing in Taiwan hospital. *International Journal of Information Management*, *34*(1), 28–36.

Low, C., Chen, Y., & Wu, M. (2011). Understanding the determinants of cloud computing adoption. *Industrial management & data systems*, *111*(7), 1006–1023.

Moore, G. A. (2014). *Crossing the chasm: Marketing and selling disruptive products to mainstream customers* (3. ed.). New York, NY: Harper Business.

Moryson, H., & Moeser, G. (2016). Consumer Adoption of Cloud Computing Services in Germany: Investigation of Moderating Effects by Applying an UTAUT Model. *International Journal of Marketing Studies*, *8*(1), 14.

Oliveira, T., Thomas, M., & Espadanal, M. (2014). Assessing the determinants of cloud computing adoption: An analysis of the manufacturing and services sectors. *Information & Management*, *51*(5), 497–510.

Parthasarathy, M., & Bhattacherjee, A. (1998). Understanding Post-Adoption Behavior in the Context of Online Services. *Information Systems Research*, *9*(4), 362–379. doi:10.1287/isre.9.4.362 Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). New York: Free Press.

Shin, J., Jo, M., Lee, J., & Lee, D. (2014). Strategic management of cloud computing services: Focusing on consumer adoption behavior. *Engineering Management, IEEE Transactions on*, *61*(3), 419–427.

Stieglitz, S., Meske, C., Vogl, R., & Rudolph, D. (2014). Demand for Cloud Services as an Infrastructure in Higher Education. In International Conference on Information Systems (Ed.), *ICIS 2014 Proceedings.* Retrieved from http://aisel.aisnet.org/icis2014/proceedings/ISCurriculum/20/

Tehrani, S. R., & Shirazi, F. (2014). Factors influencing the adoption of cloud computing by small and medium size enterprises (SMEs). In *Human Interface and the Management of Information. Information and Knowledge in Applications and Services* (pp. 631–642). Springer.

Trigueros-Preciado, S., Pérez-González, D., & Solana-González, P. (2013). Cloud computing in industrial SMEs: identification of the barriers to its adoption and effects of its application. *Electronic Markets*, *23*(2), 105–114.

Vogl, R., Angenent, H., Bockholt, R., Rudolph, D., Stieglitz, S., & Meske, C. (2013). Designing a Large Scale Cooperative Sync&Share Cloud Storage Platform for the Academic Community in Northrhine-Westfalia. In U. Sukovski (Ed.), *ICT Role for Next Generation Universities - 19th European University Information Systems.* Riga: Riga Technical University. Retrieved from https://eunis2013-journals.rtu.lv/article/view/eunis.2013.008

AUTHORS' BIOGRAPHIES

Dominik Rudolph is a research assistant and executive secretary of the Zentrum für Informationsverarbeitung (the computing center) of the University of Münster (Germany). He received his Ph.D. from the University of Münster, where he also studied communication sciences, economics and modern history. His research focusses on the diffusion of media innovations from the user perspective. Related to the sciebo project he is responsible for marketing and evaluation of the service.

Raimund Vogl holds a Ph.D. in elementary particle physics from the University of Innsbruck (Austria). After completing his Ph.D. studies in 1995, he joined Innsbruck University Hospital as IT manager for medical image data solutions and moved on to be deputy head of IT. He served as a lecturer in medical informatics at UMIT (Hall, Austria) and as managing director for a medical image data management software company (icoserve, Innsbruck) and for a center of excellence in medical informatics (HITT, Innsbruck). Since 2007 he has been director of the Zentrum für Informationsverarbeitung (the university computing center) of the University of Münster (Germany). His research interests focus on management of complex information systems and information infrastructures.

Holger Angenent has studied physics at the Technical University of Ilmenau and the University of Münster (Germany). He worked four years as a research assistant at the institute of Theoretical Physics in Münster. Since 2010 he is a research assistant at the Zentrum für Informationsverarbeitung (the university computing center) of the University of Münster and responsible for high performance computing systems and cloud services. In the sciebo project he is responsible for the technical operations.

Anne Thoring is a research assistant for public relations and marketing at the Zentrum für Informationsverarbeitung (the computing center) of the University of Münster (Germany). She graduated from University College London (UK) and the University of Münster with degrees in communication sciences, publishing and strategic communication. Her research focuses on strategies and tools of corporate communications.

Andreas Wilmer is a research assistant at the Zentrum für Informationsverarbeitung (the computing center) of the University of Münster (Germany). He received his Ph.D. from the University of Münster, where he also studied physics and applied mathemathics. Since 2014 he is part of the sciebo team where he implements new software tools.

C. Schild is a research assistant at the Zentrum für Informationsverarbeitung (the university computing center) of the University of Münster (Germany) and responsible for authentication systems. He studied physics at University of Münster. He was a leading member of the JOIN project at the university of Münster which participated in several european cooperative projects (some ipv6 task forces, 6WIN, 6NET) to develop and propagate the IPv6 protocol.

EUNIS 2016: Hybrid clouds infrastructures in Higher Education Institutions – A proof of concept

Pedro Lopes[1], Francisco Pereira[2], António Costa[3]

[1]Pedro Lopes, ESTGL-IPV, Lamego, plopes@estgl.ipv.pt
[2] António Costa, UTAD, Vila Real, acosta@utad.pt
[3] Francisco Pereira, UTAD, Vila Real, fsp@utad.pt

Keywords
Cloud computing, cloud federation, cloud infrastructure, cloud interoperability, datacentre, academic cloud federation.

1. Abstract

Taking into account recent developments concerning the cloud computing paradigm, the need for integration and interaction between datacenters at the level of higher education institutions, in order to meet growing computing needs, it is relevant to study and apply models of clouds federation to meet these needs. This article establishes the guidelines for a study which is being developed, that are based on the design of a model for a federation between higher education institutions. This work is based on the establishment of guidelines for best practices in the idealization, design and implementation of hybrid clouds federation. This work is presented as a technical approach to the implementation of an Academic Cloud Federation.

2. Introduction

The need to address the growing demand for computing power drives the need for more and more institutions to invest in resources for research purposes, and new organizations for management at resources level but also at the institution organizational level in order to maximise the efficiency (and redundancy) with the support from platforms in the realm of Cloud Computing. A practical example this is the *Conseil Européen pour la Recherche Nucléaire* (CERN), with the implementation of a private cloud based on OpenStack platform, that in less than two months of implementation created a proof of concept (Bell, 2013).
The CERN need for computing power and need to provide this capability to research teams in different areas results in a constantly evolving and engagement to the support platforms used (Sverdlik, 2014). CERN is currently one of the major contributors to the OpenStack community with the release of modules source code blocks for the platform (Verge, 2014).
Since Cloud Computing is a major research area within several international research organizations, a definition of guidelines is relevant, following a logical continuity definition of recommendations for best practices guides following the recommendations of GÉANT that listed a set of standards for the creation of a federation of hybrid clouds at the level of higher education institutions (GÉANT, 2016).

BonFIRE is a multi-site testbed that supports testing of cloud-based and distributed applications (Kavoussanakis et al., 2013). In this facility is offer a federated, multi-site cloud testbed for the users as an homogeneous way to interact with the facility (García-Pérez et al., 2014). This facility is connected to FEDERICA and GÉANT Auto BAHN (Büchli et al., n.d.; “FEDERICA Project,” n.d.; Hume et al., 2012; Rabljenovic et al., n.d.). The FED4FIRE project is have the intention to federate bonfire and all similar facilities used for research and experimentation, facilitating and extending its use for for example research in smart cities, on the top of BonFIRE and other networks (“Federation for Future Internet Research and Experimentation,” n.d.)

3. Conception

The essence of hybrid clouds federation model relies on the integration of several private clouds presents in higher education institutions in order to disclose it as a single cloud with more features and resources. We present the guidelines for a study which is being developed based on the design of a model for Academic Cloud Federation and the subsequent implementation. The core of the model is based on the integration of various private clouds of higher education institutions in order to aggregate private clouds into a single cloud. One pillar in the model is the intrinsic autonomy attributed each institution, which is very important. The other pillar is the model supports for different approaches, taking into account the degree of relationship and integration pursue by each institution. The model gives the possibility of the federation itself or its constituent clouds, each independently, to be interconnect with strategic partners or public clouds. This approach opens paths to versatility and flexibility in the federation level of integration. As more institutions join this federation more resources are likely to be shared as well, providing ground to research in areas such as quality of service policies, administrative security, management and access control or auditing among others.

Table 1 shows the classification for each of the interconnected component which make up the model recommended for this work.

Table 1 - Classification table of the recommended model

Zone Clouds	Clouds of various institutions of higher education
External Clouds	Clouds external to institutions, public or private partners
Connections type A	Connecting links between zone clouds and external Clouds
Connections type B	Connecting links between the various zone clouds

Figure 1 shows as each component is integrated into the model and how they are interconnected to obtain the desirable Academic Cloud Federation.

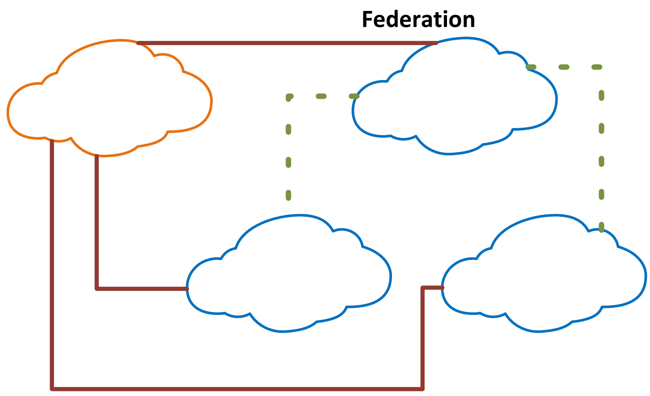


Figure 1 - Model proposed federated Cloud

Connections between each of the institutional clouds or with external clouds always assume the Internet connection of each of the Institutions.

Currently the Foundation for National Scientific Computing (FCCN), a unit of the Foundation for Science and Technology, IP (FCT), has the main mission to plan and manage the operation of the Network for Science, Technology and Society (Rede Ciência, Tecnologia e Sociedade RCTS) (FCT, 2015). The RCTS network is a high-performance network for institutions with higher communication requirements that includes universities, government laboratories and polytechnics (FCCN, 2015a). The connection between the various institutional clouds is performed on a high-performance network, managed by FCCN, with different high access bandwidth, reducing the constraints inherent in the use of internet connections provided by commercial operators (FCCN, 2015b). For the production deployment a dedicated backbone is provided for the implementation of the federation based on RCTS network.

A study by the EMC Corporation in, states that the growing reliance on technology would be the main factor for the increase of business risks (Risks, Availability, & Increasing, 2013). Organizations require new IT models where availability is almost continuous, with more control and visibility of information, establishing a trust-based infrastructure.

Even the National Institute of Standards and Technology (NIST) has released a guide planning and taking contingency plans for information technologies systems (Swanson et al., 2002). Thus it would be necessary to draw a plan in which the system continuity would not be affected by any adverse conditions such as technical failures, dead services, natural disasters (storm or energy interruption for example).

The possibility of using a model for shared resources could allow setting processes, policies and restore critical system procedures following a catastrophic event in a less arduous task. With shared resources, geographically separated, the model will add the advantage for increasing fault tolerance and increased availability of service. The intuitions can think, discuss, analyse, test and implement a global strategy and contingency measures involving the federated academic cloud, increasing and improving the services already provided by each institution to its users.

Randles et al. addresses a comparative study for the implementation of a load balancing algorithm for cloud computing (Randles, Lamb, & Taleb-Bendiab, 2010). This algorithm, coupled with the existence of a geographically distributed infrastructure, thought, designed and engineered to provide high availability allow the development of resilience to the Academic Cloud Federation.

4. Conclusions

At this stage of the study we are testing the proof of concept in terms of a federated structure of higher education institutions. With satisfactory preliminary results but with the awareness of the need for some more research to mitigate a number of aspects in the form of improvements and manage minor implementation problems. The model emphasizes the creation of a strong technological base, supporting all the needs of higher education institutions wherever possible, even at the implementation phase of the Academic Cloud Federation, providing innovation, support, knowledge and confidence. Networking with other institutions presents as guarantee for support at critical moments, when faced with the lack of resources within the own private cloud. This confidence is important for institutions to take their strategic decisions without being limited to their own internal limitations, allowing to be more versatile in the search for new directions. At the same time we will need to consider how to control and aggregate information from logs recorded by the system from different players in the federation. This need arises from the natural shared management of the federation. After an institution of higher education is integrated into the federation, it will naturally to have some sort of federation administration access. In this sense it is urgent to draw up a notebook of good management practices and in parallel, review of knowledge extraction mechanisms from operations' logs made by all stakeholders in the system.

5. REFERENCES

Bell, T. (2013). CERN Uses OpenStack. Retrieved February 2, 2016, from https://www.openstack.org/user-stories/cern/

Büchli, M., Campanella, M., Ivánszky, G., Radoslaw, Krzywania, Peeters, B., … Wilson, D. (n.d.). Deliverable DJ.3.3.1: GÉANT2 Bandwidth on Demand Framework and General Architecture. *Architecture*.

FCCN. (2015a). A Rede Ciência, Tecnologia e Sociedade. Retrieved July 12, 2015, from https://www.fccn.pt/pt/rede-academica/a-rede-ciencia-tecnologia-e-sociedadercts/#!/pt/rede-academica/a-rede-ciencia-tecnologia-e-sociedade-rcts/apresentacao/

FCCN. (2015b). Entidades ligadas à Rede Académica. Retrieved August 16, 2015, from https://www.fccn.pt/pt/rede-academica/entidades-ligadas/

FCT. (2015). Fundação para a Computação Cientifica Nacional. Retrieved July 12, 2015, from https://www.fccn.pt/pt/a-fccn/

Federation for Future Internet Research and Experimentation. (n.d.). Retrieved January 15, 2016, from http://www.fed4fire.eu/

FEDERICA Project. (n.d.). Retrieved April 15, 2016, from http://www.fp7-federica.eu/

García-Pérez, D., Lorenzo del Castillo, J. Á., Al-Hazmi, Y., Martrat, J., Kavoussanakis, K., Hume, A. C., … Margery, D. (2014). Cloud and Network Facilities Federation in BonFIRE. In D. an Mey, M. Alexander, P.

Bientinesi, M. Cannataro, C. Clauss, A. Costan, … J. Weidendorfer (Eds.), (Vol. 8374, pp. 126–135). Berlin, Heidelberg: Springer Berlin Heidelberg. doi:10.1007/978-3-64254420-0_13

GÉANT. (2016). Campus Best Practice. Retrieved February 2, 2016, from http://services.geant.net/cbp/Pages/Home.aspx

Hume, A. C., Al-Hazmi, Y., Belter, B., Campowsky, K., Carril, L. M., Carrozzo, G., … Van Seghbroeck, G. (2012). BonFIRE: A multi-cloud test facility for internet of services experimentation. *Lecture Notes of the Institute for Computer Sciences, Social-Informatics and Telecommunications Engineering, 44 LNICST*(January), 81–96. doi:10.1007/978-3-642-35576-9_11

Kavoussanakis, K., Hume, A., Martrat, J., Ragusa, C., Gienger, M., Campowsky, K., … Margery, D. (2013). BonFIRE: The clouds and services testbed. *Proceedings of the International Conference on Cloud Computing Technology and Science, CloudCom*, 2(257386), 321–326. doi:10.1109/CloudCom.2013.156

Rabljenovic, V., Ivanszky, G., Muyal, S., Camisard, E., Büchli, M., Krzywania, R., … Robles, E. (n.d.). Deliverable DJ.3.2.1: GÉANT2 Bandwidth on Demand (BoD) User and Application Survey, *3*. Retrieved from http://geant2.archive.geant.net/upload/pdf/GN2-05-208v7_DJ3-3-1_GEANT2_Initial_Bandwidth_on_Demand_Framework_and_Architecture.pdf

Randles, M., Lamb, D., & Taleb-Bendiab, A. (2010). A comparative study into distributed load balancing algorithms for cloud computing. *24th IEEE International Conference on Advanced Information Networking and Applications Workshops, WAINA 2010*, 551–556. doi:10.1109/WAINA.2010.85

Risks, T., Availability, T., & Increasing, A. (2013). How Organizations Are Improving Business Resiliency With Continuous IT Availability, (February), 1–8.

Sverdlik, Y. (2014). CERN's OpenStack Cloud to Reach 150,000 Cores by 2015. Retrieved February 2, 2016, from http://www.datacenterknowledge.com/archives/2014/11/07/cerns-openstackcloud-to-reach-150000-cores-by-2015/

Swanson, M., Wohl, A., Pope, L., Grance, T., Hash, J., & Thomas, R. (2002). Contingency Planning Guide for Information Technology Systems. *Nist Special Publication*, *800*(34). Retrieved from http://oai.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=ADA40 4260

Verge, J. (2014). CERN Contributes Identity Federation Code to OpenStack. Retrieved February 2, 2016, from http://www.datacenterknowledge.com/archives/2014/06/30/rackspace-cloud-usercern-contributes-code-to-openstack/

6. AUTHORS' BIOGRAPHIES

Pedro Lopes is in the final research stage to complete the PhD in Computer Sciences in Universidade de Trás-os-Montes and Alto Douro (UTAD). He is System and Network Administrator in Instituto Superior Politécnico de Viseu (IPV), and invited teacher in IPV. He is a Microsoft Certified Professional with MCP, MCSA and MCSA Messaging.

Francisco Pereira is an Assistant Professor at Universidade de Trás-os-Montes lecturing, working e researching in the fields of Operating Systems, Computer Networks and Cloud Computing. He as also publish in the fields of Hardware Architecture, Parallel Computing and Computer Graphics.

António Costa is ICT specialist at the University of Trás-os- Montes and Alto Douro (UTAD) and is responsible for the coordination the areas of core infrastructure and communications, computer security areas, data center, VoIP and communications networks. He collaborates in teaching on different degrees of Computer Courses, as well as in research, extension and development projects. Holds a degree in Electrical Engineering (specialization in Electronics, Instrumentation and Computation) and a post-graduate degree in engineering area. Currently, he is in the final research stage to complete the PhD in Computer Sciences. He made several made courses or specializations which includes the Upper Course Director for Public Administration; Diploma of specialization of the Information Society for Public Administration, SIP Masterclasses and a OpenStack specialization.

SIGMA Cloud
An Open Academic and Research Environment

Juan José Fuentes[1], Jordi Cuní[2]

[1] SIGMA AIE
[2] SIGMA AIE

Keywords

SIGMA, cloud, SaaS, Opennebula

1. ABSTRACT

SIGMA, as many other entities had to face the situation of a datacenter full of servers, a high power consumption, heat diffusion… the migration of the CPD to a Virtual Datacenter was a matter of time, and the time came as so many servers required a large workforce to manage, a large amount of power to fed the servers and to cool the rooms, even the servers were sometimes underused and squandered.

SIGMA as a non-profit organization and a consortium of public Universities has a policy of support and foster open source organizations, and whenever possible implement open source over commercial solutions.

Looking for the solution that best fitted our needs was a hard work, primary due to the many projects that exists over the Internet, some solutions analyzed were Openstack, Proxmox and Opennebula, being the latter the chosen one.

That was our first step into the open cloud world.

2. SIGMA GESTION UNIVERSITARIA CONSORTIUM

SIGMA Gestion Universitaria [1] is a nonprofit consortium established in 1996 by a

group of 8 top level Spanish Public Universities to provide technological solutions to their needs for managing academics, learning, research and organization processes. SIGMA represents 20% of the students in the Spanish university system. The consortium's objective has evolved towards the continuous technological modernization of university management through the development of IT solutions aimed at automating the administrative processes and, as a result, guaranteeing their effectiveness.

Technology and innovation are the backbone of the services and solutions provided, based on a highly open source development and deployment platform for J2EE5 certified application servers compliant on a multi-tier and high performance proven open architecture. Internationalization is also one of SIGMA's top priorities. For years, SIGMA has established relationships with other European universitity consortiums. Lately, SIGMA has open new strategic areas of interest such as SaaS, BI, eLearning and Mobile.

3. Introduction to Open Cloud

There are a lot of projects about cloud management, each one with its own strengths and weaknesses, the first task we faced was to define the main features we need and centered the search on the projects that best could fit those requirements. So to delimit the scope of the project we centered the decision over 3 projects, Openstack[2], Proxmox[3] and Opennebula[4].

Figure 1. Cloud and Virtualization open projects

Openstack is a project with an installed base larger and an extended community, but digging in the requirements it ends to be an overkill project, it involves about 16 subprojects and implement it require a great investment in time and human resources, so for us it doesn't worth the benefits of the great features.

While evaluating Openstack, about three years ago, it was difficult to get all the environment functional, and even once the server was operative it was easy to notice that maintaining upgraded all the modules could be difficult, from the beginning it was clear that manage the cloud infrastructure will be a hard task very error prone.

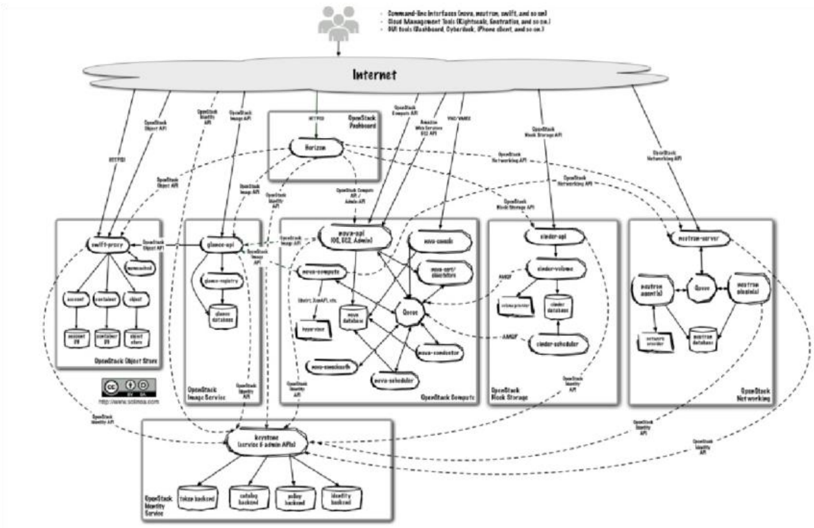


Figure 2. Opentack module interoperability

Proxmox is not really a cloud manager but a server virtualization management software, it could be a limitation to provide real cloud service to the community but as a first approach it could fit the requirements as it has a lot of interesting features integrated, as it manages full virtualization and linux containers, high availability, backups… all integrated in a central management console.

Finally we decided that it's worth to think in the long run and start building our own cloud.

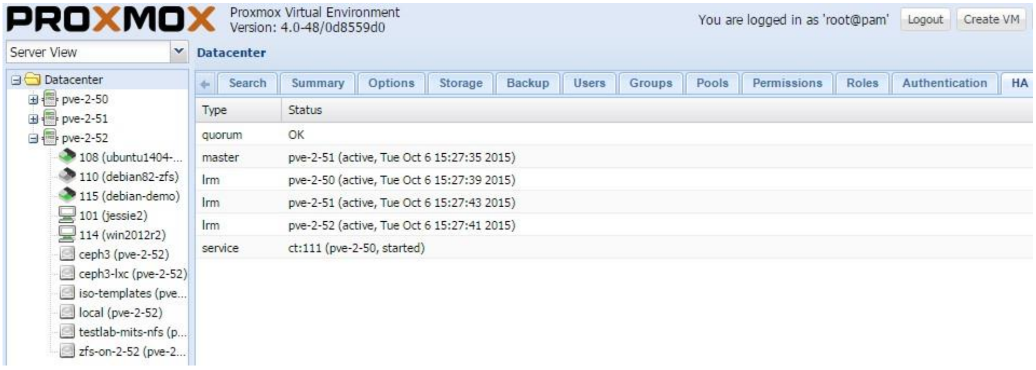


Figure 3. Proxmox console

Opennebula includes some key features that made the decision very easy:

- Fully open source
- Avoid vendor lock-in, platform independent
- Simple, is very easy to install and update
- Mature, since 2008 this project is growing driven by user needs
- Enterprise-class product
- Cloud Bursting, extension of private clouds with resources from remote clouds
- Multiple zones, centralized management of multiple instances for scalability and isolation
- Autoscaling, creation of application flows with auto-scaling policies based on performance metrics and schedule

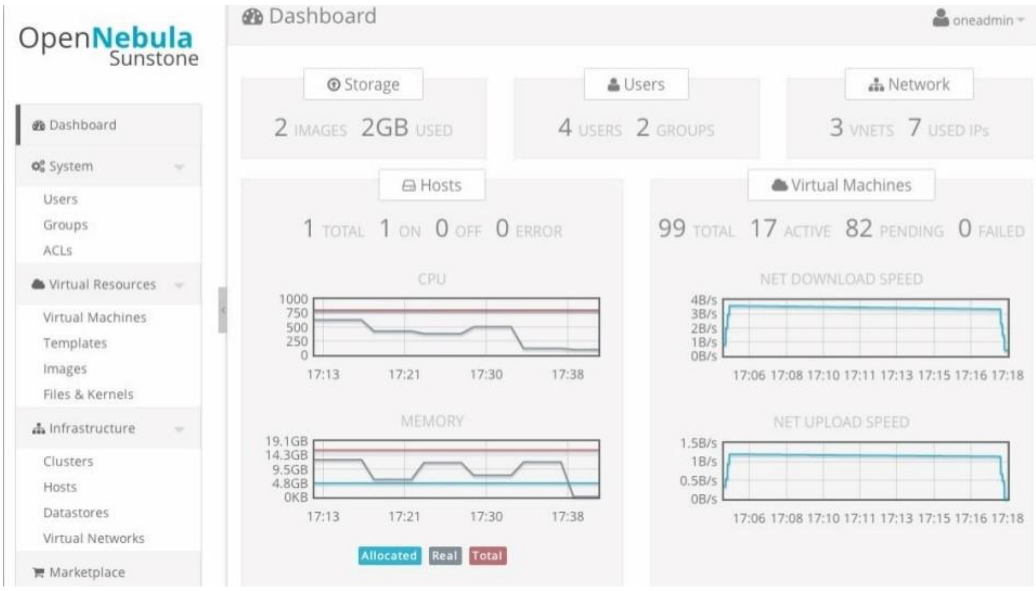


Figure 4. Opennebula GUI Sunstone - Dashboard

4. Architecture

The architecture provided by Opennebula allows us to scale out the SIGMA cloud adding more nodes whenever is needed and even in different geographical zones.

The basic parts are a frontend to centralize the management, a datastore as repository of images and virtual machines, and the worker nodes with the hypervisor:

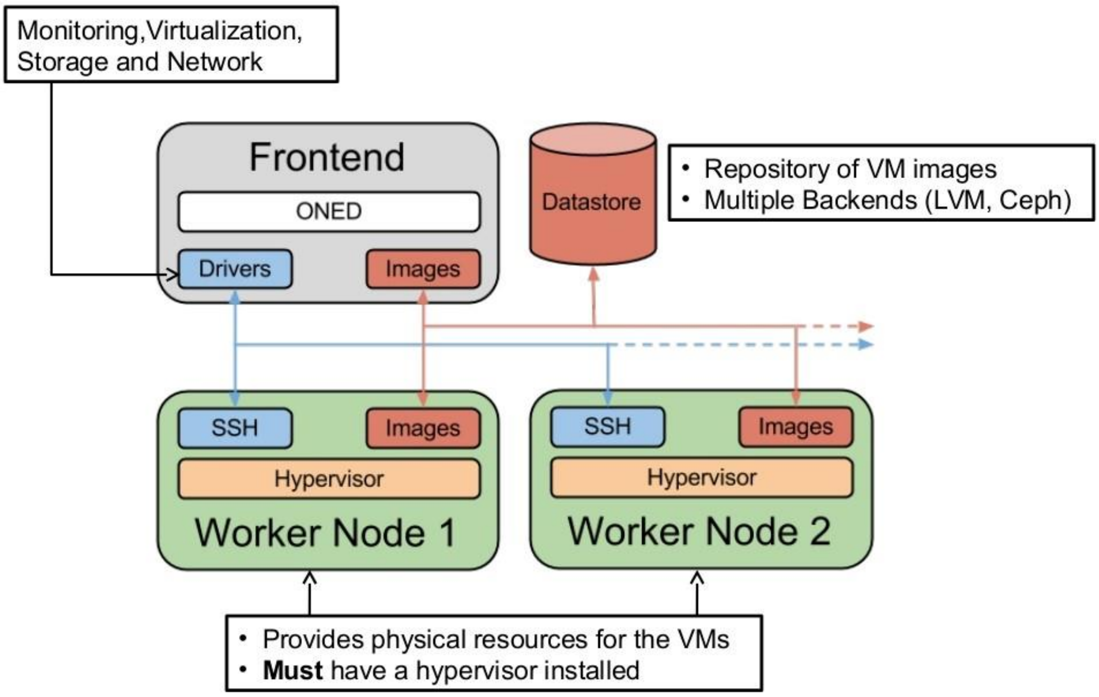


Figure 5. Opennebula Environment

As said before Opennebula is platform independent, so you can choose the hardware that best fits your needs, only requirements to use Linux.

In our case we chose CentOS as our distribution to implement the infrastructure as we have long experience with it. So the frontend and all the worker nodes are CentOS Linux.

To properly work and communicate is necessary the ssl key exchange between all the nodes, also the installation of the hypervisor chosen on each node. Our preference is KVM, we think it has the best performance in the platform we use, in the last versions it has improve performance and security.

Each node will provide the physical resources, memory and CPU, maybe also disk, but this will be conditional on the storage strategy. All this resources will be controlled from the frontend, it can be done in two ways, by command line or from the GUI frontend named Sunstone.

The storage strategy will define the possibility of use some feature or not, like a shared strategy will enable you to use live migration between different hosts without losing service.

From a more general point of view Opennebula offers an open and complete architecture that allows a great level of configuration and customization of our own cloud.

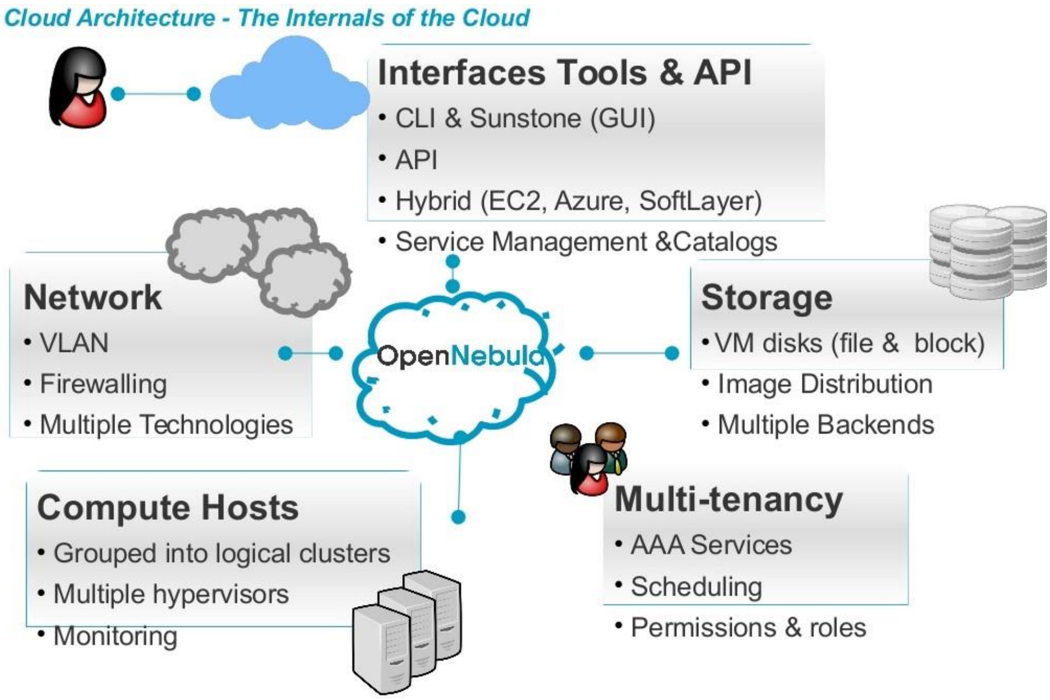


Figure 6. Opennebula Architecture

The API provided allows the private cloud to connect to some other public resources (cloud bursting), we can choose between different network technologies and strategies.

Multi-tenancy capacity enables us to provide isolated environments to different groups of users while sharing resources.

High Availability feature provides fault tolerance in front of hardware issues, in case of a server fault the working images are moved to other nodes.

A cloud Federation allows the ease of management of different geographical VCPD's by centralize the management and delegate administrative tasks in remote offices as shown in the next figure.

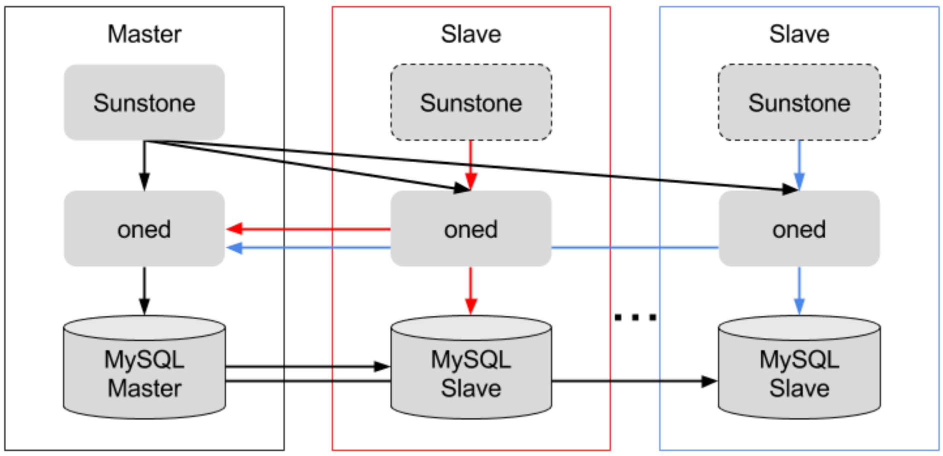


Figure 7. Opennebula federation schema

5. Conclusions

The implementation of an open cloud management infrastructure is a breakthrough that enables us to achieve new objectives, be more competitive and the possibility to offer to our community of partners and users a lot more services while adjusting the budget.

As our business grow we try to use high quality standards and follow international best practices, in this scenario building our own cloud was the more logical scenario to step into.

As many other institutions the great number of possibilities available in the current cloud landscape represents a challenge for us, is easy to take a bad choice, so we try to manage by evaluating, comparing and participating in the cloud community as much as we can.

Using Opennebula has helped us to build our own private cloud in a way that we were able to learn quick, implement fast a basic cloud infrastructure, which we're evolving and expanding, and keeping the budget.

In the next years we've planned to deploy an infrastructure over different geographical locations to expand the SIGMA Cloud ONE thanks to the base we have yet built and taking advantage of the numerous resources and key features we have available.

6. REFERENCES

[1] **SIGMA Helping Universities Succeed** http://www.gestionuniversitariasigma.com/

[2] **Openstack** http://www.openstack.org

[3] **Proxmox** http://www.proxmox.com

[4] **Opennebula** http://www.opennebula.org

AUTHORS' BIOGRAPHIES

Juan Jose Fuentes
IT Manager

Postgraduate in Corporative Networks Design (2005)
CISM (Certified Information Security Manager) 2015

Technical Computer and Software Engineer at Universitat Aut noma de Barcelona (1998 2001). He works for SIGMA since 2001, currently leading the Middleware & Systems area. His role covers a wide range of activities from designing strategy plans for backups, recovery, monitoring and storage to defining and carrying out the design of the CPD provisioning. He maintains and upgrades the backend resources of SIGMA. He gives advice to the company customers in their hardware infrastructures. He took part in the strategic migrations projects such as database migration (Ingres to Oracle), and middleware migrations (Iplanet-Glassfish– Weblogic).
In the lasts year his main effort has been focused on achieving a multi-tenant solution in order to minimize the maintenance cost of the SaaS service that SIGMA delivers to their customers.
He is currently focused on building the SIGMA Higher Education SaaS in a cloud environment.

Jordi Cuní

He was born in 1976 in Barcelona Spain. Computer Science degree at Universitat Oberta de Catalunya (2006 – 2012), Computer and Software Engineer at Universitat Aut noma de Barcelona (1997 – 2000).

He works for SIGMA since 2000, being the current Manager of Architecture Area and Software quality assurance Area. He leads a development team counting on 7 people for those areas.

His role focuses mainly on maintenance and develop the own Sigma framework in order to increase the productivity, define the methodology among the different areas and establish the software development tools for the rest of the company. At last but not least his area takes part on technical and performance support for our customers and helps them in the migration projects of their back-end resources. Previously, he had been project management for developing SIGMA's area for 5 years. His main efforts was focused on develop software solutions on resource planning necessities, stock management of static and mobile resources and physical and on-line surveys.

CIO structures and the success of HE institutions

1st Markus von der Heyde[1], 2nd Andreas Breiter[2]

[1]vdH-IT, Rosenweg 7, 99425 Weimar, Germany, info@vdh-it.de
[2]Universität Bremen, ifib, Am Fallturm 1, 28359 Bremen, Germany, andreas.breiter@ifib.de

Keywords
CIO, Higher Education, IT-Governance, Research Budget, Success Indicators.

1. Summary

The success of higher education (HE) is hard to measure, despite all efforts in national and international rankings. To claim an influence of governance structures and the work of a CIO on this success is even harder. Nonetheless, there is room for discussions. For excellence in academia to happen there has to be a set of institutional habits, which may include appropriate decision structures in general. This paper presents high correlations between success by means of extended research budgets and the formal participation of a CIO on decision domains concerning IT in HE. Whether this can be tracked down to a causal link between successful research and good work of CIO with a top management, is an open question. We will focus on this in the upcoming 2016 CIO study, which takes place in March and April and therefore cannot be part of this submission but will be presented at EUNIS in Thessaloniki.

2. Motivation and methods

One central task for all institutions in higher education is the control and governance of information technology (IT). Based on projects covering almost everything within a university, the rapidly increasing collaboration between universities as well as the everlasting financial pressure, several governance agencies advised: the introduction of an IT-governance model in form of a chief information officer (CIO) or in other ways is mandatory [MA01, DFG06, vdH08, FL09, BK10, GPT11, ZKI12, HRK13]. Following these general advises led to a variety of implementations in Germany which had been extensively analyzed and published [vdH14, ZKI14, HWvL15] and [vB15]. Figure 1 shows the diversity of these implementations.

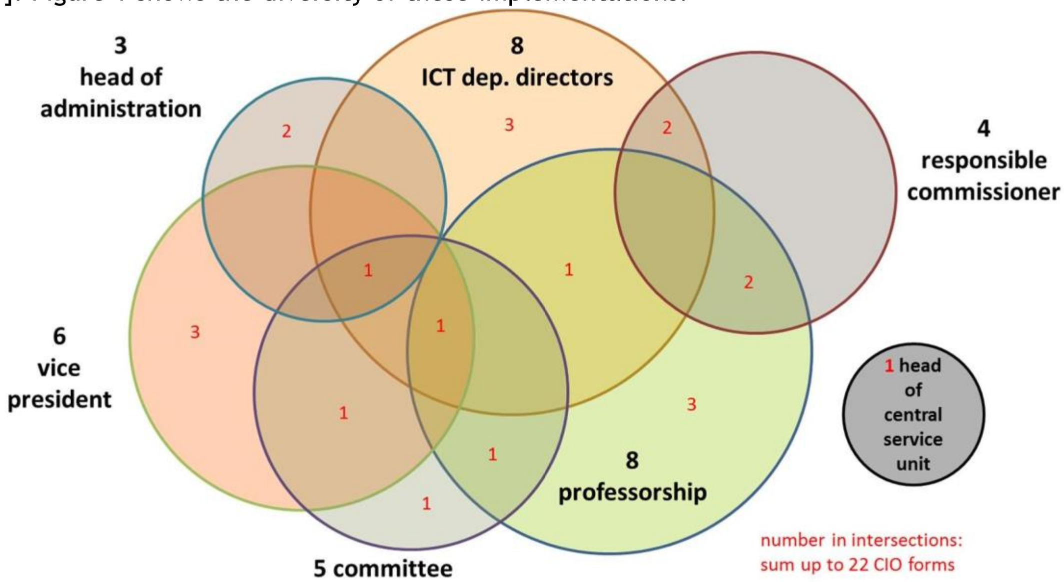


Figure 1: Variations of CIO forms in German HE institutions. Black numbers indicate the occurrence of the primary roles. Red numbers indicate the intersections between those roles. For example there is one CIO who stated to be VP, professor, director of the ICT dep. as well as member of a CIO committee.

At the same time, two studies reported (2014 in [ZKI14, vdH14, HWvL15] with interviews and 2015 in [vB15] with web based questionnaire) the high correlation between the ratio of external research budget and main budget of institutions with several indicators:

1) Number of IT decision domains (as defined by Weill and Ross in 2004 [WR04]) the CIO participates (2014, 2015)
2) Whether the CIO has direct influence on the ICT departments by organizational rules (2014).

3) Participation on the decision on the overall ICT infrastructure (2015).
4) Transparency of IT personal across the institution (2014)
5) The amount of time a CIO spends on actual strategic work and projects (2014).
6) An established HPC service structure (2015).
7) The absolute amount of research budget (2014, 2015).

Apart from many other statistically evaluated indicators, these line up in a certain direction: They all aim at the power of a CIO with respect to the overall decisions on IT. Those CIOs which are limited to verbal power alone seem not as successful with applications on external research funds.

3. Causal links

In the interviews (2014), many CIOs emphasized their role in moderation, coordination and general responsibility for the overall strategic use of IT. Most CIOs also argued for participation on the board of directors. Those CIOs who have a permanent guest or member status in the rectorate or on executive boards emphasized the current value. Those who rely on the contact to a certain member from those councils hypothesized a high value of direct participation.

Three major impacts can be identified: 1) Being part of these councils obviously guarantees early access to valuable information. 2) IT also can provide additional information on value and service being connected to new initiatives. 3) The overall value of IT can be shaped and identified much more effectively by the joint perspectives on the alignment of IT and business.

To gain these advantages, it seems necessary to open up decision processes. Institutions stay behind:

- when transparency for personal budgets is limited,
- when there is only one joint position of operative ICT directors and CIOs,
- when all decision powers for IT stay on the level of the board of directors,
- when there is no delegation of decision competencies to the IT expert (CIO), and
- when there is limited flexibility on the access to joint resources (e.g. HPC services and others).

Up to now, not one single indicator alone but all indicators in a joint approach point in the same direction. The focus on the 2016 study will therefore include more questions to shed light onto this causal link between decisions and success of higher education.

4. Future perspective

Since the actual causal link remains open, and we cannot test in real life the differences between institutions. The 2016 study will additionally focus on:

- Personality of the CIO: Degree of innovation; ability to decide; focus on success and some other factors from psychological frameworks [Ai02].
- Context of the institution: Ability to adopt quickly; flexibility of structures; degree of innovation; focus on governance and strategy and other key indicators from organizational frameworks [ISO08, WR09].
- Application of IT management frameworks: IT maturity rankings, quality of IT services, perceived degree of security and user experiences and other factors from international IT standards may also be correlated to the success and value of IT [BF11].

The correlation of those factors will hopefully help us to learn more about the causal link as well as about the efficiency of the CIOs work within his/her institutional context.

The pure measurement of success indicated by research funds also needs to be extended towards student success and abundance rates. But these factors had been a puzzle for more than half a century for the applied research in Germany and around the world [Sc15].

5. References

[Ai02] Axiometrics International (2002). Validity Studies Of The Hartman Profile Model. Retrieved February 27, 2016, from: http://www.axiometrics.net/AiValidityReport.pdf

[BK10] Bröcker, W., König, F. (2010). Informationsverarbeitung an Hochschulen – Organisation, Dienste und Systeme. Empfehlungen der Kommission für IT-Infrastruktur für 2011–2015. Deutsche Forschungsgemeinschaft 2010. Retrieved February 27, 2016, from http://www.dfg.de/download/ pdf/foerderung/programme/wgi/empfehlungen_kfr_2011_2015.pdf

[BF11] Breiter, A., Fischer, A. (2011). Implementierung von IT Service Management in der öffentlichen Verwaltung. Nationale und internationale Fallstudien und deren vergleichende Analyse. Berlin: Springer.

[FL09] Fernández, A. M., Llorens, F. L. (2009). An IT-Governance framework for universities in Spain. In: Proceedings of the EUNIS 2009 Conference: June 23rd to 26th 2009, University of Santiago de Compostela, 2009. ISBN 978-84-9887-138-8. Retrieved February 27, 2016, from: http://www.gti4u.es/pdf/an_it_governance_framework_for_universities_in_spain.pdf

[GPT11] Görl, S., Puhl, J., Thaller, M. (2011). Empfehlungen für die weitere Entwicklung der Wissenschaftlichen Informationsversorgung des Landes NRW. ISBN: 978-3-8442-0694-4, Köln, 2011

[HRK13] HRK Website (2013). Entschließung der 13. Mitgliederversammlung der HRK am 20. November 2012 in Göttingen: Hochschule im digitalen Zeitalter: Informationskompetenz neu begreifen - Prozesse anders steuern. Published in Beiträge zur Hochschulpolitik 1/2013. Retrieved February 27, 2016, from http://www.hrk.de/fileadmin/redaktion/hrk/02-Dokumente/02-10Publikationsdatenbank/Beitr-2013-01_Informationskompetenz.pdf

[HWvL15] H Hotzel, M Wimmer, M von der Heyde, U Lang (2016). IT-Governance – role of a CIO in German Universities – a Survey by ZKI. In PIK-Praxis der Informationsverarbeitung und Kommunikation 38 (3-4), 121-126, also available as PDF by deGruyter.com

[ISO08] ISO/IEC 38500:2008 "Corporate Governance of Information Technology", ISO/IEC. 2008, from: www.iso.org

[MA01] Mönkediek, J., Arends, P. (2001). Informationsverarbeitung an Hochschulen – Organisation, Dienste und Systeme. Empfehlungen der Kommission für Rechenanlagen für 2001–2005. Deutsche Forschungsgemeinschaft 2001. Retrieved February 27, 2016, from http://www.dfg.de/download/pdf/foerderung/programme/wgi/wgi_kfr_empf.pdf

[Sc15] Schulmeister, R. (2015). Abwesenheit von Lehrveranstaltungen Ein nur scheinbar triviales Problem. Eine Meta-Studie von 300 empirischen Arbeiten. Hamburg. Retrieved February 27, 2016, from http://rolf.schulmeister.com/pdfs/Abwesenheit.pdf

[vdH08] von der Heyde, M., Hotzel, H., Olbrich, S., Stenzel, H., Weckmann, H.-D., Wimmer, M. (2008). Strukturkonzepte für die Informations-und Kommunikationsversorgung von Hochschulen. In PIK-Praxis der Informationsverarbeitung und Kommunikation 32 (3), 167-173.

[vdH14] von der Heyde, M. (2014). CIO-Modelle an deutschen Hochschulen - Netzwerk der entscheidenden Faktoren. Informatik 2014. In Lecture Notes in Informatics (LNI) 232, 1815-1823.

[vB15] von der Heyde, M., Breiter, A. (2015). Wer entscheidet? IT-Governance an Hochschulen. Informatik 2015, in Lecture Notes in Informatics (LNI), in print.

[WR04] Weill, P., Ross, J. W. (2004). IT Governance: How Top Performers Manage IT Decision Rights for Superior Results. Harvard Business School Press. Boston 2004. ISBN 978-1591392538

[WR09] Weill, P., Ross, J. W. (2009). IT Savy - what non-IT executives should know to make IT pay off. Harvard Business School Press, Boston.

[ZKI12] ZKI Website (2012). Treiben oder getrieben werden? - IT-Strategie in Hochschulen. Abschlussbericht des IT-Strategieforums. ZKI. Retrieved February 27, 2016, from http://www.zki.de/fileadmin/zki/Arbeitskreise/IT-SF/webdav/web-public/Publikation/ EndredaktionPapier_120130-final.pdf

[ZKI14] ZKI Website (2014). CIOs und IT-Governance an deutschen Hochschulen". ZKI. Retrieved February 27, 2016, from http://www.zki.de/fileadmin/zki/Publikationen/ZKI_CIO-Studie_final.pdf

6. Author's biographies

Dr. Markus von der Heyde received his PhD in Computer Sciences from the University of Bielefeld for his work at the Max Planck Institute for Biological Cybernetics Tübingen in 2000. His approach is to adopt biological principles into distributed computer applications in order to enhance stability and robustness.

Since 2004 he has worked within ZKI on topics as information security, servicemanagement, strategy and governance. Until 2011 he was ICT director of Bauhaus-University in Weimar. Until today he also focuses on internationalization and supports ZKI, GI, EUNIS and EDUCAUSE and serves as program committee member as well as a proposal reviewer for conferences and the scientific community. In cooperation with various partners he continues to conduct the German CIO studies. Today, he is management consultant specialized on IT topics in higher education.

See further details on https://de.linkedin.com/in/mvdh42

Prof. Dr. Andreas Breiter is Professor for Information Management and Education Technologies at the University of Bremen and Scientific Director of the Institute for Information Management Bremen GmbH (ifib). His main areas of expertise are IT-Management, IT Service Management and IT-Controlling, Information Management in Education, E-Learning-platforms as well as Mediatization. He also chair of working group 3.7 (IT in Educational Management) of the International Federation of Information Processing (IFIP), member of the Association for Computing Machinery (ACM) and also member of the Gesellschaft für Medizinische Datenverarbeitung und Statistik (GMDS). See further details on https://www.linkedin.com/in/andreas-breiter-a0b0711

Re-Engineering Working Culture - How an ICT Project Promotes a University Towards Its Strategic Goals

Lotta Linko, Ari Kuusio

Lotta Linko, Online Communications Manager, Häme University of Applied Sciences, P.O. Box 230, FIN-13101 Hämeenlinna, lotta.linko@hamk.fi
Dr Ari Kuusio, Chief Information Officer, Häme University of Applied Sciences, P.O. Box 230, FIN13101 Hämeenlinna, ari.kuusio@hamk.fi

Keywords
strategy, change, social intranet, cloud services, Office 365, Yammer, agile development, project, ework, digitalisation, collaboration, communication

1. Summary

This case study discusses how HAMK, Häme University of Applied Sciences, has successfully promoted its strategic goals by taking a new approach to an “ICT project”. We have introduced Office 356 within the whole organisation, and at the same time systematically launched a change in the way of working and the culture of thinking. An ICT project has, in addition to gradually changing the everyday actions and applications, grown into a more profound movement around attitudes towards knowledge, collaboration, and communication.

The value of this case lies in showing how information and communication technology and a well managed project can play a major part in changing processes. The key is in seeing ICT as more than a set of technologies: strategically lead, it is tool for rethinking our processes and making them serve our purposes in the changing demands. In our case, the project works at three levels: tools, methods, and culture.

We will describe our change from the strategic leadership and the tactical ICT management points of view, and give an overview to the actions at operational level. We will also list the reasons to this project being different from previous ICT projects.

2. EXTENDED ABSTRACT

The Finnish education system, including regulation and funding, is facing major changes as part of the happenings taking place in the Finnish society. At the same time the state of the economy, the turmoil of the world of work and the rapid development of technologies pose demands for Universities’ curricula, processes, and efficiency. HAMK has been faced with new requirements and has acted by bringing changes into its strategy and management system, as well as the ways and services of studying, teaching, and working. HAMK’s aim as a publically-funded organisation is to act productively, cost-efficiently, and responsibly to the benefit of its stakeholders. One key element to success is digitalisation and collaboration.

The technology used at HAMK was reaching the end of its life phase and also hindered us from changing our working habits and attitudes. Combined with these no-longer-suitable solutions, we had heterogeneous working methods and unsufficient staff competences as a challenge.

HAMK’s new strategy and new management were the starting point for the change. The demand to differentiate from competition in terms of brand and processes, as well as to meet new customer expectations (future millennial students) lead to bold decisions. One of them was advancing digitalisation. The technology change project - from Oracle Portal and separate tools for communication and cooperation to Office 365 platform - included the levels of working habit and communication culture changes.

As the project was aiming at new ways of working, it was carried out in new way, too. The desire for quick results lead to choosing agile methodology as the way to proceed instead of the traditional waterfall approach. In accordance with agile principles, the project was carried out in phases and demand-based releases instead of detailed descriptions of the finalised future entity.

This was the first large-scale agile project carried out at HAMK and it also served as a pilot for future development tactics. Forming future actions into a project ensured documented goals and sufficient resources, and picking change-minded developers and experts from several different units as project participants guaranteed that more than technical or technological viewpoints were taken into account while planning development and delivering quickly-employable results.

The project was a good pilot in testing a new development approach: it taught the participants new and valuable working skills at the same time enabling cross-boundary team-building. The project also pioneered in implementing full-scale cloud services enabling easy e-working, collaboration and communication – this was a major leap in both technology and ideology for an 'old-school' organisation. We have come to realise that the agile development principles and methods applied within the project must be applied among this and other projects. The project has thus given ideas to the new way of HAMK project portfolio management which is underway.

The O365 cloud service in itself forces us to continue to being proactive and carry on development in our working tools and habits. A complex system and changing environment calls for continuously seeking best practices and applications in different work roles. Choosing cloud also made us think of data and information security issues at new level.

The project was a kick-off for a process change: the advancement is no longer carried out as a project but as a natural part of people developing their own work as individuals, teams, units, and all of HAMK. During the project, continuous but comprehensible changes were brought into the everyday work: this paved the way to the change mindset in people which is seen as a fact of the future. The project also invited to looking at and changing the ways of working: different processes have been scrutinised, and in some cases we have been able to make chains leaner.

As a result of the project, the working culture and habits have changed: after one year of use we can clearly see more openness, more collaboration and more communication, which are elements of the strategic goals of digitalisation and collaboration. The changes, however, are not extensive nor final: a lot of work remains to be done in an organisation with 600 employees and 6000 students – with a service which is constantly evolving and changing by nature. From the organisation ICT point of view, we no longer deliver the same perfect set of tools for all users but provide optimal options for different user groups and individual users with their own devices. Choosing cloud is choosing change, and we have to adapt our services and service capability accordingly, and constantly.

3. AUTHORS' BIOGRAPHIES

Biography: Lotta Linko

Education:

Master of Arts, University of Tampere, Finland. Major: English Translation, minors: Finnish language and literature. 1993.

Professional Development further education programme, Tecnichal University (currently Aalto University), Espoo, Finland. 2002.

Work experience:

Manager of Online Communications, Häme University of Applied Sciences. 2003-present.

Communications Officer, Tikkurila Oy (chemical industry). 1998-2003.

Marketing Communications Specialist, Tellabs Oy (telecommunications industry). 1995-1998.

Document Controller, Martis Oy (acquired by Tellabs). 1993-1995.

Memberships:

The Finnish Association of Technical Journalists

The Finnish Association of Science Editors and Journalists

LinkedIn: http://www.linkedin.com/in/lottalinko

Biography: Ari Kuusio

Education:

Master of Science (Economics), University of Jyväskylä, Finland. Major: Information technology. 2004.
Licentiate of Science (Economics), University of Jyväskylä. 2009.

Scientific degrees:

Doctor of Philosophy (Business Economics), University of Jyväskylä. 2012.

Work experience:

Chief Information Officer, Häme University of Applied Sciences. 2007-present.
System Manager, TeliaSonera Oy (telecommunications industry). 1999-2007. Planner, Finnish Tax Administration. 1989-1999.

LinkedIn:

https://fi.linkedin.com/in/ari-kuusio-95868622

EUNIS 2016: IT strategy for a public university – why, what, when and how?

Soren Berglund

CIO

Umea University

Sweden

Soren.berglund@umu.se

Keywords

IT strategy, cloud, IT organization, ROI, CIO

Introduction

This paper discusses the challenges of establishing an IT strategy for a public institution in Higher Education.

As a CIO, you are expected to have an IT strategy for your institution. This is a task that may be done with some regularity, say each 3rd year. Does an IT strategy works that way? Should it be more frequent regarding the rapid changes within ITC? Or should it be the other way around, let the IT strategy be a moving target and go into a never-ending transformation. This paper addresses the challenges with an institutional IT strategy: Why? What? When? How?

Why should you invest in an IT strategy?

Good question! Who cares? Does it help you? Is it worth the endeavor? Yes, it must be worth it, otherwise don´t. It should be your work goals and work plan and your foundation for internal and external acceptance of where you are going with your institutions ITC. You need to have a strategy, and it can be defined, exposed and used in many ways. Without a plan, you are lost !

What is an IT strategy?

Good point! Does it look like a thick book? Is it a sheet of paper? Is it a video? Is it statements with a price tag or is it a storytelling piece of art? Is it in your head, not explicitly shown to anyone? A good strategy is like good rhetoric, it explains what you want to do and why, and it addresses the obvious critique that always exists within our institutions. Is there a difference in being a public university versus another organizational form? In this central section, I´ll go through areas that need to be managed in an IT strategy.

When to release an IT strategy?

Good thinking! Timing is everything. When is the right time to present a shift in motion? I´ll walk through some institutional indicators that can trigger a move or change with current IT strategy. This includes shift in institutional business strategy, changes in central management and changes in the financing model, technology shift and organizational changes.

How to implement an IT strategy?

Good planning! An IT-strategy that is not implemented is worthless and may represent a lot of effort put into nothing. It is important to understand the managerial culture of your institution and how to deal with acceptance and resistance. Should you go all-in and risk your position or wait for collegial support? Know your supporters and your opposition.

The author is CIO for Umeå university since 2009. He has a degree in Computer Science and Business, University of Umeå, 1978. After university studies, employed as System Analyst and Designer for business information systems. Returned to Umeå university for doctoral studies and teaching in Informatics with special focus in System Design and System Development. He has been a Project Manager for several national projects. He has been Head of the Ladok Division at the University of Umea, a large unit specialized in system development and maintenance. He has been a board member of EUNIS and worked as an expert for the European Commission. Current EUNIS publications includes:

Berglund, S and Wallmark, M (2015) Moving a decentralized University to the Cloud. The 21st European University Information Systems Organisation (EUNIS) congress, EUNIS 2015. Dundee, 10-12 June, 2015.

Berglund, S (2015) Procurment of Cloud Services. The 21st European University Information Systems Organisation (EUNIS) congress, EUNIS 2015. Dundee, 10-12 June, 2015.

Berglund, S (2013) Always connected, the Umea university campus and city network approach. The 18th European University Information Systems Organisation (EUNIS) congress, EUNIS 2013. Riga, 12-14 June, 2013.

Berglund, S (2011) Yes, I am a student. Give me a discount! The 17th European University Information Systems Organisation (EUNIS) congress, EUNIS 2011. Dublin 15-17 June, 2011.

Lind, M and Berglund, S (2008), e-Me - the Student's Best Friend. The 14th European University Information Systems Organisation (EUNIS) congress, EUNIS 2008 VISION IT - Visions for IT in Higher Education, University of Aarhus Universitet, Denmark (voted conference best paper)

A secure infrastructure for mobile blended learning applications

M. Politze[1], S. Schaffert[2], B. Decker[3]

[1]IT Center RWTH Aachen University, Seffenter Weg 23, 52074 Aachen, politze@itc.rwth-aachen.de
[2]IT Center RWTH Aachen University, Seffenter Weg 23, 52074 Aachen, schaffert@itc.rwth-aachen.de
[3]IT Center RWTH Aachen University, Seffenter Weg 23, 52074 Aachen, decker@itc.rwth-aachen.de

Keywords
mobile, blended learning, infrastructure, oauth2, caching, SOA

1. ABSTRACT

New trends like The Internet of Things, Wearables and BYOD pose new challenges to existing IT infrastructure and applications. Especially the increasing amount and heterogeneity of devices demands changes on existing IT systems. Further degrees of automation are required to successfully operate existing IT infrastructure and applications. Many students try to individualize the existing services using own software. These changes in student behavior have led us to the creation of an infrastructure designed for secure mobile access. After three years of operation this infrastructure has evolved to deliver far more than only access to legacy systems and is now supporting several blended learning scenarios and other university processes.

2. MOTIVATION

Due to increased mobility and the rising number of students the universities have to standardize existing processes, improve cooperation between institutions, reduce overall costs or increase efficiency. Also the students have changed the demands on their universities and its employees. Previously various processes that are supported by IT infrastructure and applications were introduced to serve this purpose. Not only are IT infrastructure and applications becoming more important to the universities' processes and employees but also the students and their daily life. This leads to increased competition among the universities to present the best and most appealing services to their students.

The Horizon Report is one of the most regarded studies concerning the development of education. In the 2015 report (The New Media Consortium 2015 – The NMC Horizon Report, 2015) the upcoming major developments in the higher education sector are identified as follows:

- Less than a year:
  - Bring Your Own Device (BYOD)
  - Flipped Classroom
- Two to three years:
  - Makerspaces
  - Wearable Technology
- Four to five years
  - Adaptive Learning Technologies
  - The Internet of Things

Both, these developments and the organizational challenges need to be faced by the universities IT infrastructure and applications in the near future to remain operational and meet the expectations of governments, employees and students.

The technical challenges of increasing device heterogeneity and count is accompanied by an increasing urge of individualization. Especially students from technical fields seek to customize, improve and extend the existing means for their personal scenario. Leaving the individualization of certain IT applications to the users themselves may reduce efforts when developing the applications in first place but also needs defined processes, guidelines and interfaces that allow controlled access to the needed data in a machine readable way for every student.

3. GOALS

To better cope with the latest development and fast changing requirements, increased mobility and higher degree of personalization Service Oriented Architectures (SOA) are widely used. However due to the broad fields of application of SOA during the past years a multitude of incompatible standards, formats and architectures have been developed and are now part of virtually any application framework. While choosing the right SOA is a critical step for the short term success it is most important to build a comprehensive and consistent model of the data exchanged between the systems. To generate this common model several processes at the university need to be analyzed in how they use the available data.

In any software system if it is a SOA or a more traditional monolithic architecture a central asset of the collected data is reliability. While in a monolithic environment reliability of the data may be controlled centrally in a SOA other assertions have to be provided. In terms of data security there are three key concepts: confidentiality, integrity and availability. As the SOA will participate in a multitude of processes these need to be strictly enforced by the architecture (security by design).
Further security and reliability needs like authenticity, non-repudiation, accountability or anonymity should also be included into the design of the architecture.

According to the need for reliability and security of the owners and curators of the data, the protection of personal data needs to be enforced. By extending processes and sharing data across system boundaries, data will be accumulated to datasets and may become available to a broader audience. Especially for personal data the general right of personality needs to be protected.

4. CURRENT ARCHITECTURE

Generally the infrastructure was designed to combine different existing source systems already used by the students and university staff for E-Learning, Campus Management, Identity Management and other purposes (Politze & Decker, 2014). Data preparation and data consolidation between these systems and attached apps is done utilizing existing standards: REST, SAML and OAuth2. The data is then rendered on the smart device using client technologies like the Cordova Framework.

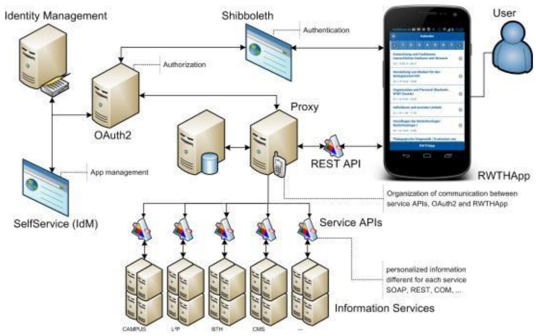


Figure 1 Schema of the Proxy service accessing legacy systems.

The infrastructure designed for RWTHApp consists of two main services shown in Figure 1: (1) The Proxy service forms the central component to make data from legacy systems accessible from smart devices in a secure and consistent fashion. (2) The authorization service (OAuth2) that handles the consent of the users to access their data in the legacy systems.

From an architectural point of view the Proxy service is primarily intended to deliver data to smart and mobile devices. Nevertheless some more traditional web applications are also already taking advantage of the centralized implementation of the services. Even though the Proxy Service centralizes the access to legacy systems it is built using some of the paradigms introduced by micro services: primary the independence of functional units to access the independent legacy systems.

These functional units are then centrally published and appear as a single web service instance using consistent access and naming conventions.

The design of the proxy service also tries to increase availability and speed of the legacy systems by introducing automated and semi-automated caching layers. To increase overall performance and user experience the cache is filled with information a priori using a probabilistic, proactive model to predict future web service calls. For the proactive caching system, all requests are divided into separate user sessions which form an item set. Such an item set then contains all requests made by a single user on a single device within a certain time frame. Association rule mining is then used to find patterns.

The OAuth2 protocol allows secured, personalized access to the web services and handles the authorization from the user without supplying credentials to the app itself. This also paves the way for third party developers accessing the proxy service.

To access the API third party developers have to perform a simple registration process. During this process apart from a contact name and email address the developers have to supply the use cases their app covers and what data is needed from the API to perform these tasks. The register of all applications is publicly visible to all users. The OAuth2 process can then be used by other developers to provide additional functionality that is not covered by existing IT systems and applications themselves.

Furthermore the implemented OAuth2 system is capable of handling authorizations for multiple attached services and therefore cannot only be used for the Proxy service but also for other services running in the university context. Allowing not only the reuse of already established infrastructure but also use OAuth2 authorization for inter process communication.

5. CASE STUDIES

In the field of E-Learning next to a centralized Learning Management System (LMS) several distributed systems are used for additional processes. Thanks to the efforts in the RWTHApp project most of these have been extended by an interface to allow exchange of data across process and system boundaries. Furthermore there is a trend to develop applications for smart and mobile devices supporting very specific blended learning settings. These settings are quite unique it is usually not desired to embed the functionality within RWTHApp.

One of these applications was created by the Department of History at RWTH Aachen University: an interactive guide through archeological sites in the vicinity of Aachen. To support this application a set of flexible and available services is needed. Figure 2 depicts a web interface built upon Microsoft SharePoint that allows the users to compose articles and enrich those using media files such as images and videos. A WYSIWYG editor that renders the articles as they appear on the mobile device is used to conveniently edit the articles. Figure 3 shows a prototype of the mobile application accessing the articles from SharePoint. The integration of SharePoint into the mobile service infrastructure allows simple applications to profit from advanced editing and document management abilities of the platform.

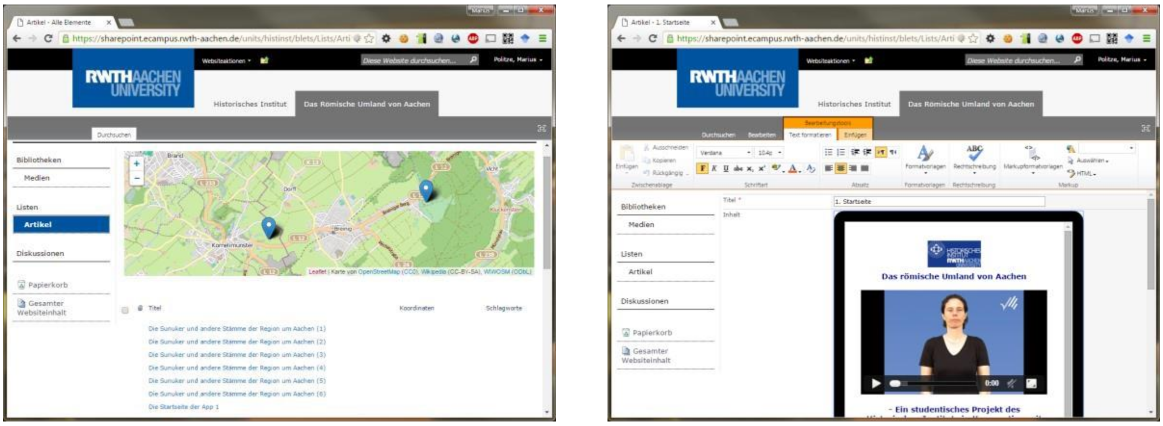


Figure 2 Articles and media can be entered and managed using WYSIWYG editors.

Figure 3 Prototype of the app articles and interactive maps.

Another successful blended learning scenario is the audience response system (ARS) that was developed as part of RWTHApp. In contrast to previous cases completely new processes were implemented both in the application and in the server infrastructure. The ARS supports a variety of different settings and can be used by every teacher at the university according to their wishes (Politze M. , Decker, Schaffert, & Küppers, 2015). Among text and photo messages teachers have the ability to initiate polls. Based on the existing infrastructure the ARS will be further extended to allow more interactions with the students for example using prepared quizzes from the E-Learning system already connected to the infrastructure.

The simple integration of external processes is of course not limited to mobile devices. Using the defined interfaces it is possible to register students into E-Learning course rooms in an automated way. This paves the way for decentralized distribution of classes. This was especially helpful for organizations within the university that do not participate in the regular curriculum (e.g. language classes) but distribute the students manually to the offered classes. Instead of setting up a dedicated LMS using this degree of automation afar from the default use cases allowed the usage of the centralized solution.

The OAuth2 system further allows integration of external systems into the LMS. The external systems are embedded into the LMS website. With an OAuth2 access token these systems can then access the LSM in the context of the current user. This allows external systems that are mainly implemented by the different institutes for their specific teaching scenario to integrate seamlessly and to work with the data stored in the centralized LMS.

To reduce the impact of the security vulnerabilities of Eduroam discussed in (Brenza, Pawlowski, & Pöpper) the creation of device based credentials for Eduroam was also implemented on the infrastructure for mobile services, even though not a blended learning scenario. This risk mainly originates from the fact that Eduroam credentials, that can be retrieved using a man in the middle attack, are mostly the same credentials as for other university services. To reduce the risk of identity theft, credentials can be generated per device and are therefore not usable to access other university services (Decker & Politze, 2015). While the generation of credentials and set up of Eduroam on the device currently requires several manual steps the service endpoints to generate device based credentials have been added to the infrastructure for mobile services. This allows in a future version to automate the setup process using an app directly on the mobile phone.

6. RELATED RESEARCH

Various research groups and projects reduce complexity building SOA by modelling and try to find iterative or partial solutions to some facet of the aforementioned challenges. Generally there are three main areas that contribute with their work to the complex: (1) Business Process Management and (2) Software Architecture delivering general approaches for SOA and (3) Pervasive University delivering more specific insights into the applications at universities.

To overcome the gap between modelled processes and the supporting software Zimmermann et al. propose an integrated service oriented architecture (SOA) that allows adoption to changing business processes and needs (Zimmermann, et al., 2013). Even SOA that are modelled using the same architecture may still be incompatible. This also led Taheriyan et al. to propose a method to integrate traditional SOA with each other using linked data (Taheriyan, Knoblock, Szekely, & Ambite, 2012). Rathfelder et al. introduce a method to evaluate the maturity of a SOA. This model does not only evaluate the technical maturity but also considers the organizational domains like organizational structure, development and governance processes (Rathfelder & Groenda, 2008).

However more specific SOA for smart and mobile devices are being developed. These focus on technologies like web services and cloud infrastructure to compete with the growing and changing market. Micro service architectures as proposed by Namiot et al. are used to reduce dependencies in the software development process often found in monolithic applications (Namiot & Sneps-Sneppe,
2014). Schleicher et al. show that an additional dependency is introduced as virtualization and cloud environments pose different requirements to the deployed software (Schleicher, Vogler, Inzinger, & Dustdar, 2015). While SOA have solved some of the challenges that come up with the increasing number of smart and mobile devices there are still legacy systems that were not designed using SOA. As remarked by Serrano et al. the existing legacy systems are usually not well documented and too expensive rewrite. Therefore it may be desirable to wrap existing systems with a service layer (Serrano, Hernantes, & Gallardo, 2014).

Especially the fields of Education and Research (E-Learning and E-Science) are in focus of several research groups and projects. Barkhuus and Dourish have discussed the different needs of students related to ubiquitous services offered by their university (Barkhuus & Dourish, 2004). While the technological basis has severely changed since the study in 2004, the social roles, relationships and responsibilities of the students are mostly comparable. Juling describes that mobility and ubiquity of information technology and therefore global accessibility, reachability have become part of our daily life (Juling, 2009). Lucke and Tavangarian introduce a model for the pervasive university that takes the heterogeneous existing systems in the field of E-Learning into account (Lucke & Tavangarian, 2009). This model was later extended with a concept to integrate multiple context aware E-Learning services (Lehsten & Tavangarian, 2013). The works of Mincer-Daszkiewicz and Barata et al. show two practical examples of SOA in the field of E-Administration (Mincer-Daszkiewicz, 2014) (Barata, Silva, Martinho, Cruz, & Guerra e Silva, 2014).

7. LESSONS LEARNED

With three years of experience in running an infrastructure for mobile access and blended learning scenarios several conclusions and recommendations can be derived. First of all we could observe tremendous interest by the students but also by employees of the university who wanted to tailor existing systems to fit into their specific scenario. These applications have existed before but were not using officially maintained services resulting in frequent bugs or incompatibilities when source systems changes for example due to updates.

The OAuth2 subsystem implemented in the infrastructure allows fast integration of new backend services as well as the integration of new applications. Also the secure exchange of information between systems using the OAuth2 protocol is now used in several occasions within the IT landscape of the university. As more and more services are able to offer an SOA that can work with OAuth2 tokens the interoperability is increased and it is possible to integrate small subsystems and developments directly based on the needs and requirements of the users. The OAuth2 system is further being used to deliver single sign on functionality between some of the integrated systems.

Since the OAuth2 system and the proxy service have been used to automate certain processes they have become a critical resource in the universities IT services. These processes partially or entirely are based on the newly created infrastructure. The first obvious effect is that errors and failures in these systems cause failures in the relying processes. This can be worked against by introducing redundancy at all levels. The second effect is due to the number of attached legacy systems failures and errors in these systems now attract attention in the proxy service. Due to the architecture much more tracing information is available compared to errors that occur to the users. This makes monitoring and testability easier for some of the legacy systems.

While the first intention of the infrastructure was to provide access to the legacy systems on campus it has shown that many applications require additional more basic services. These are usually less specific like database or storage access. Most of them are available as a service offered by the IT Center already but are not accessible from mobile and smart devices easily. The infrastructure for mobile services therefore needs to be extended by a general purpose object storage service or document store to enable low threshold development of further applications. In our case we will use a SharePoint based solution that extends the existing document library by an Amazon S3 compatible layer. This allows future apps to store small files up to 250MB without the need of implementing specific services.

Table 1 shows the effects of the proactive caching compared to naïve least recently used (LRU) cache on the performance of the provided APIs. The hit rate increased from under 50% to slightly over 70%. This was also the main goal of the implementation and the result shows that the general idea is working. The changes in request durations are caused by the increase of hit rate because a cache hit also leads to a faster response time. It can also be noted that globally, the additional requests caused by the proactive caching do not decrease the performance for the end user, as the average request duration is lower than without proactive caching. The change in dirty read percentage is small enough that it could be insignificant.

Table 1 Effect of proactive caching to overall performance

	LRU-Cache	Proactive-Cache
Hit rate	48.32%	70.89%
Avg. duration	1557ms	1004ms
Requests <700ms	81.03%	87.63%
Dirty reads	2.27%	2.29%

Using the presented infrastructure we are now able to serve 40,000 installations of RWTHApp on 6 different operating systems. During this semester we were also able to serve over 50 courses with our blended learning services in the app. The infrastructure also serves 96 applications from external developers (mostly students) with about 30,000 users that use the provided APIs for more specialized scenarios. Currently 10,000 devices are already connected using device based Eduroam credentials.

Last but not least we were able to observe a speedup in developing new applications on top of the defined services. While it was certainly an investment to build this interface in our current projects we can see that due to better standardization and clear access guidelines the development of all new applications on top of the service layer gets easier, more understandable and more maintainable.

8. FUTURE CHALLENGES

Compared to the structures in E-Learning there is currently no widely used centralized system supporting E-Science processes. However at the university there is an initiative to set up an integrated Research Data Management (RDM) system within the next years. Since the actual implementation of the system is not yet finished the capabilities of the system can yet be influenced to support the efforts towards a more complete university programmable interface. Apart from the integrated system several institutes and organizations have set up their own RDM systems and usually offer only very restricted access to the contained data.

As in the case of E-Learning there are several ideas for applications for smart and mobile devices in E-Science. Again these are usually very specific to certain institutes or organizations and their processes. While most of these applications originate from the local context they often reach out to other organizational processes in the field of E-Administration (e.g. employment status).

RWTHApp will continue to support more processes of the students' daily routines. This functionality can be extended in such a way that students no longer need to actively query the app for information but RWTHApp suggests the most relevant information for the students. This behavior poses additional challenges to the infrastructure as queries to the information systems in the cooperate context are no longer based on the interaction with the users but may be collected automatically.

The device based generation of Eduroam can be published further to be used by students of other universities. This lifts the current implementation from the local to the federative context. Findings from this case study will provide more input of how the infrastructure scales across these contexts.

To evaluate the current case studies a formal definition of the requirements posed on the infrastructure is needed. Based on the current state and related research, these requirements will further disambiguated and show how to measure if the infrastructure fulfils the current and future requirements. To support the continual improvement process the findings of the definition will then be applied to the set of case studies.

The Ultimate goal is to develop a programmable interface for every process of the university. However due to the massive amount and complexity of processes, contributing systems and stakeholders a full implementation is questionable. The presented infrastructure should provide a solid basis for future implementations and adoptions of processes within the university. To verify the resulting goodpractice infrastructure it will then be used as a basis for future case studies that are implemented in the university context.

9. REFERENCES

Barata, R., Silva, S., Martinho, D., Cruz, L., & Guerra e Silva, L. (2014). Open APIs in Information Systems for Higher Education. In *20th EUNIS Congress*. Umea.

Barkhuus, L., & Dourish, P. (2004). Everyday Encounters with Context-Aware Computing in a Campus Environment. In D. Hutchison, T. Kanade, J. Kittler, J. M. Kleinberg, F. Mattern, J. C. Mitchell, . . . I. Siio, *UbiComp 2004: Ubiquitous Computing* (Vol. 3205, pp. 232–249). Berlin, Heidelberg: Springer Berlin Heidelberg.

Brenza, S., Pawlowski, A., & Pöpper, C. (n.d.). A practical investigation of identity theft vulnerabilities in Eduroam.

Decker, B., & Politze, M. (2015). Authentifizierungs- und Autorisierungsschnittstelle für (mobile) Geräte als Komponente des RWTH-IdMs. Heidelberg.

Juling, W. (2009). Vom Rechnernetz zu e-Science. *PIK - Praxis der Informationsverarbeitung und Kommunikation, 32*(1).

Lehsten, P., & Tavangarian, D. (2013). CASA-Ein Konzept zur nutzergetriebenen, kontextbasierten Dienstintegration in Lehr-und Lernumgebungen.

Lucke, U., & Tavangarian, D. (2009). Eine Service-und Kontext-basierte Infrastruktur für die Pervasive University.

Mincer-Daszkiewicz, J. (2014). We Publish, You Subscribe — Hubbub as a Natural. In *20th EUNIS Congress*. Umea.

Namiot, D., & Sneps-Sneppe, M. (2014). On Micro-services Architecture.

Politze, M., & Decker, B. (2014). RWTHApp: from a requirements analysis to a service orieanted architecture for secure mobile access to personalized data. *20th EUNIS Congress*. Umea.

Politze, M., Decker, B., Schaffert, S., & Küppers, B. (2015). Facilitating Teacher-Student Communication and Interaction in Large-Scale Lectures With Smartphones and RWTHApp. In L. Gómez Chova, A. López Martínez, & I. Candel Torres, *EDULEARN 15* (pp. 4820–4828). Barcelona: IATED Academy.

Rathfelder, C., & Groenda, H. (2008). iSOAMM: An Independent SOA Maturity Model. In R. Meier, & S. Terzis, *Distributed Applications and Interoperable Systems* (Vol. 5053, pp. 1–15). Berlin, Heidelberg: Springer Berlin Heidelberg.

Schleicher, J. M., Vogler, M., Inzinger, C., & Dustdar, S. (2015). Smart Fabric - An InfrastructureAgnostic Artifact Topology Deployment Framework.

Serrano, N., Hernantes, J., & Gallardo, G. (2014). Service-Oriented Architecture and Legacy Systems. *IEEE Software, 31*(5), pp. 15–19.

Taheriyan, M., Knoblock, C. A., Szekely, P., & Ambite, J. L. (2012). Rapidly Integrating Services into the Linked Data Cloud. In D. Hutchison, T. Kanade, J. Kittler, J. M. Kleinberg, F. Mattern, J. C. Mitchell, . . . E. Blomqvist, *The Semantic Web – ISWC 2012* (Vol. 7649, pp. 559–574). Berlin, Heidelberg: Springer Berlin Heidelberg.

The NMC Horizon Report: 2015 Higher Education Edition. (2015). Austin, Texas.

Zimmermann, A., Sandkuhl, K., Pretz, M., Falkenthal, M., Jugel, D., & Wissotzki, M. (2013). Towards an integrated service-oriented reference enterprise architecture. In P. Knauber, J. Knodel, & M. F. Lungu.

AUTHORS' BIOGRAPHIES

Marius Politze, M.Sc. is research assistant at the IT Center RWTH Aachen University since 2012. His research is focused on service oriented architectures supporting university processes. He received his M.Sc. cum laude in Artificial Intelligence from Maastricht University in 2012. In 2011 he finished his B.Sc. studies in Scientific Programming at FH Aachen University of Applied Sciences. From 2008 until 2011 he worked at IT Center as a software developer and later as a teacher for scripting and programming languages.

Steffen Schaffert, B.Sc. is a master student at Maastricht University in Artificial Intelligence. He finished his Bachelor's degree in Scientific Programming at FH Aachen University of Applied Sciences in 2013. Since 2010, he works as a software developer at the IT Center RWTH Aachen University.

Dipl.-Inform. Bernd Decker is deputy team lead of the IT process support team at IT Center RWTH Aachen University since 2011. From 2006 to 2009 he worked at IT Center as Software Developer and since 2009 as lead of the development group. His work is focused on IT solutions for processes in the field of E-Learning, E-Services and campus management systems.

Deploying an University App Store with Open Innovation

Jaime Busquets [1], Miguel Macías[2], Raúl Mengod[3], Juan Evangelista[4] and Carlos Turro[5]

[1] ASIC-Universitat Politécnica de València, Camino de Vera 46021 Valencia, busquets@asic.upv.es.
[2] ASIC-Universitat Politécnica de València, Camino de Vera 46021 Valencia, mimaen@upvnet.upv.es.
[3] ASIC-Universitat Politécnica de València, Camino de Vera 46021 Valencia, rmengod@cc.upv.es.
[4] ASIC-Universitat Politécnica de València, Camino de Vera 46021 Valencia, jevang@upv.es.
[5] ASIC-Universitat Politécnica de València, Camino de Vera 46021 Valencia, turro@cc.upv.es.

Keywords

App, Store, Open Innovation

1. Summary

The usual practice of universities when deploying corporate apps for mobile devices is to have it in the official stores of the most common systems and grow it by the addition of services like a corporate webpage. This behavior fails in the sense that don't address both the ways that mobile user consume services and also because calls for a centralized IT service managing all the web app.

The Open Innovation paradigm allows involving internal and external users in the definition and creation of services. The new Strategic Plan for 2015-2020 of the UPV states the "Open Innovation" paradigm as a strategic project for that period. The vision of that strategic project is to develop a methodology of innovative projects that can help a radical improvement of the organization. As a first action, UPV has a pilot project in order to implement a corporate mobile ecosystem, including a corporate App Store and develop applications through a development framework that offer users agile alternatives to perform common functions.

Benefits of this project are increased service, improving the user experience, and also security and confidence that are and inherent risk in traditional stores. UPV App Store is presented to the users in mid- March 2016 containing a dozen downloadable applications.

2. INTRODUCTION

Universitat Politècnica de València (UPV) is a Spanish University with a long history in applying IT technologies to all parts of the learning process and also to University's management services. This path has led to developments like Polimedia (Turro et al. 2010), and also the flipped Classroom experience (Busquets et al, 2015) which have been presented in EUNIS and other conferences. The new Strategic Plan for 2015-2020 of the UPV states the "Open Innovation" paradigm as a strategic project for that period. The vision of that strategic project is to develop a methodology of innovative projects that can help a radical improvement of the organization.

As a first action, UPV has a pilot project in order to implement a corporate mobile ecosystem, including a corporate app store and develop applications through a development framework that offer users agile alternatives to perform common functions. Desirable characteristics of both the portal and the resulting apps is that they are attractive, cross-platform, simple, safe, task oriented, easily configurable, scalable, evolvable and usable.

The document goes as follows: First we will review Open innovation paradigm and its implementation at UPV. Then we will show the case of Corporate Apps deployment and the Ecosystem that UPV has built around it. Finally we will show the current results of the project and the conclusions of it.

3. OPEN INNOVATION AT UPV

Open innovation (Chesbrough 2006) is a paradigm that assumes that companies can and should use external ideas as well as internal ideas, and internal and external paths to market, as the company look to advance their technology. According to some authors like Marcet (Marcet 2008), open innovation can be developed in organizations like public administrations, and by doing so they are able to provide the greatest possible value to its users, and especially in a rapidly changing world like the present.

At UPV, the initiative started with a pilot project in which outside experts, who acted as facilitators in the process, selected about thirty people from very different positions in the organization, all with the common denominator of being able to propose innovative ideas in a dynamic environment exploration.

They worked in the process in successive stages, in which ideas could be discussed, analyzed, and classified, compared with the challenges that an organization like the UPV can have in the immediate future and in a changing environment like the present. There was also opportunity of comparing ideas with companies and external organizations who have had similar experiences in the recent past.

Each round carried a selection of promising ideas, so at the end there was a manageable quantity of them. The selected ideas for further development were:

- Mobile applications (the subject of this paper)
- Virtual Office 24x7x365
- Transparent management
- Learning competences

With them we could move to the phase of product design, always following design methodologies and an associated business model.

The success of the experience, and further work on the selected ideas led to the UPV to propose this methodology to be part of its Strategic Plan for the years 2015-2020.

4. THE CASE OF CORPORATE APPS

The usual practice of universities when deploying corporate apps for mobile devices is to have it in the official stores of the most common systems (iOS, Android and Windows).This common behavior presents some problems, namely:

1. As features are being added in successive versions, the app grows in size and complexity, so browsing behavior within it gets increasingly complex, and at the end it is more difficult to find content inside the app than in the corporate website.
2. Also, as the app becomes more complex, it is more difficult to develop these new features, so the incorporation of them is often delayed.
3. There are different groups of users (teachers, students, technical, administrative, researchers, visitors, alumni, etc.) and within each group different people have different needs.
4. The development of the corporate app can only be done by the main developers group, as any update in the app can potentially harm other features.

So, a single corporate application hardly suits both the long and medium-term requirements and therefore tends to be underrated and scarcely used.

A different approach to solve these problems is to create an ecosystem of independent apps, each with a specific, easy functionality, delegating user administration of the same to user’s device. In this way users can decide what apps to install and how to organize them, depending on his needs or activities. This also allows a faster development cycle, because each app is independent from the others.

A big issue with this approach is that, if those apps are published in the standard app stores, there is no easy way for a user to know what apps are available. Also, given that not all applications are intended for all user profiles, it seems reasonable to consider a profile management so that if the user does not belong to a particular group (teacher, student, etc.) the store shouldn’t recommend applications which do not correspond to that profile.

Another consequence of posting apps on standard stores, is also that there is not an easy way to know if a particular app has been endorsed as safe by the university, because the policies of those stores do not require it. For example, in September 2015 a number of external apps faked as official applications of different Spanish universities. So in those stores there are applications that can fake institutional, through the use of corporate image, and be rated even higher than the official implementation of the institution.

The solution to those problems is to distribute the apps by a own store, conveniently certified, and recommend registered users the applications that can be useful to them, limiting the presence of the institution in official stores to a single corporate application that provides essential information and a link to its own store.

5. UNIVERSITY’S APP ECOSYSTEM

As stated before, several services have been selected as a result of UPV’s open innovation process, being the first the apps project that we describe in this paper. The apps project aims to leverage University’s development capabilities from all members (IT services, teachers, students, etc.) and doing so by creating a development structure that provides users agile services for the implementation of the most common functions.

This structure works around three items, as displayed in figure 1.

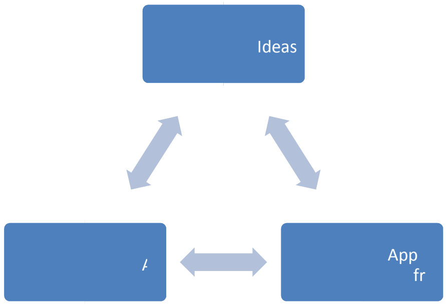


Figure 1. App Ecosystem

5.1 Ideas workshop

The ideas workshop encourages the University stakeholders in participating on the apps project and also to know what resources are available for the developments. It aims to create synergies between the different actors by means of:

- Envisioning Workshops, in which people think about services that could be useful to them and others.
- Challenges, in which the University challenge its members to solve particular tasks.
- Enhancement of previous work, by selecting successful use cases and enlarging their reach.
- Support in the definition of a business model.

5.2 App Store

The app store is a portal where users can browse and download digital objects, particularly apps developed for all major mobile operating systems. There users can also access and work corporate applications from a secure authenticated environment, especially when apps need access to private data.

A required capability of the apps portal is authentication. As the portal have to recognize different user profiles (teacher, student, staff, researcher, visitors, etc.), there is a need to support multiple authentication systems.

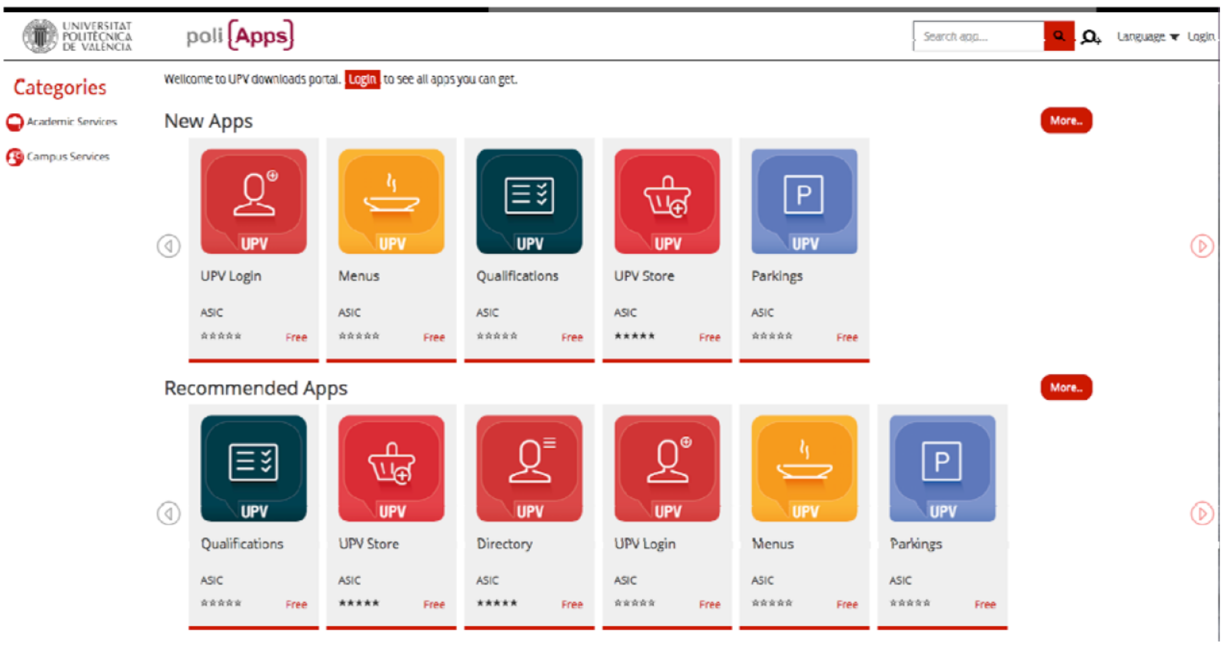


Figure 2. UPV’s App Store

Currently the app portal supports:

• Corporate UPV Simple Sign On.

• Spanish Universities' Federated identity (SIR).

• External identification with users of social networks: Facebook, Twitter, Google+, LinkedIn.

• Local Users registered on the platform.

Once authenticated, the system knows the user's profile, the history of the installed applications, and the preferred language. Based on this information the system will present the applications that are available for the user, hiding those that are not typical of their profile.

The portal has the ability to merge different profiles, so if a user had registered for different systems at different times, from that moment the portal will work with in a single consolidated user information.

The store is shown as a typical mobile portal applications (see figure 3), in which the apps are presented with their icon, name, version, developer and price.

Given that the number of elements that contains the store can grow a lot, the portal support defined categories that allow you to group the apps by their different nature: At this moment they are classified in: mobility, academic services, campus, etc. Apps are displayed in four panels to view them sorted by date, recommendations, number of downloads, or see directly all that are available.

The app portal is developed in a MEAN (Mongo, Express, Angle, Node) environment and is responsive (figure 3). It is designed to be easily adaptable and customizable to other environments or organizations.

Figure 3. UPV's App Store mobile view

5.3 App development framework

Developer support is a key component in this Open innovation project. The way UPV manages this in the apps context is through the establishment of a framework for mobile application development. So this allows a common programming app and export for different mobile OSes, and also to have a library of common components to reuse code and practices between apps.

The developer support is currently implemented around the environment Appcelerator, which allows common developing and export for the two main systems: iOS and Android.

When the developments target UPV resources, which is usually the case, they need to access the business logic through corresponding REST services (see figure 4).

Figure 4. Development framework

6. RESULTS

The first wave of apps were focused on simplicity and expected service numbers, and also trying to improve significantly the way that users consume UPV services. Anyway, as a result of the Open Innovation process, the number of apps and the services covered may vary.

The app list is shown in the app store, and a user can get more information by clicking on it, such as the description of the features offered, some views of the different screens and a help guide. There is also social information, such as valuation by other users, the number of downloads, user recommendations and reviews. The store is presented to the university community in mid-March 2016, and includes a first collection of apps developed, consisting of:

- UPV Store
- Directory
- Live Parking information
- Daily Menus of UPV's cafeterias
- UPV Card services
- Assesment results
- Virtual Campus
- Exam results (Qualifications)

While these apps are ready for the launch of the store, they are followed by the development of another dozen emerged from the envisioning working groups.

7. CONCLUSIONS

The UPV has made in recent years an important effort in the implementation of ICT in all areas of its business, by integrating several open source or commercial solutions, or developing their own tools. As mobility is a key factor in today's society and especially in the university environment, there was a considerable gap between the solutions effectively implemented and the ability to access these services in mobility.

Throughout the past year, following an Open Innovation path, the UPV has added to its capabilities the ability to manage, support and maintain large number of mobile applications, which offer users of the university access many services in an easy and useful way while in mobility.

The store is currently being launched in March 2016, and contain a dozen different Apps and is developing another dozen of them, which will join the store in the coming months.

8. REFERENCES

Appcelerator (2016). http://www.appcelerator.com/

Busquets, J., & Turró, C. Preliminary results from a flipped classroom experience: Getting an insight from the real marks. 2015 EUNIS conference

Chesbrough, H. W. (2006). Open innovation: The new imperative for creating and profiting from technology. Harvard Business Press.

Marcet, X. (2008, September). Open Innovation: A New Paradigm. In Hybrid Intelligent Systems, 2008. HIS'08. Eighth International Conference on (pp. 959-960). IEEE.

Turro, C., Cañero, A., & Busquets, J. (2010, December). Video learning objects creation with polimedia. In Multimedia (ISM), 2010 IEEE International Symposium on (pp. 371-376). IEEE.

9. AUTHORS' BIOGRAPHIES

Jaime Busquets: http://es.linkedin.com/pub/jaime-busquets/

Juan Evangelista: https://www.linkedin.com/in/juanevangelistadavid

Raul Mengod: https://es.linkedin.com/in/raúl-mengod-lópez-176a9611/en

Carlos Turró: https://www.linkedin.com/pub/carlos-turr%C3%B3-ribalta

LARK: Location-Aware Personalized Travel Guide with Rich Knowledge

Bontomitsidis Spyridon[1] (smpontom@ee.auth.gr), Floros Dimitrios[1] (fcdimitr@ee.auth.gr), Manolas Dimitrios[1] (manolasd@ee.auth.gr), Mylonakis Konstantinos[1] (mylonakk@ee.auth.gr), Pitsianis Nikos[1] (nikos.pitsianis@eng.auth.gr)

[1]Department of Electrical and Computer Engineering, Aristotle University of Thessaloniki, Greece

Keywords

Learn, Experience, Tours, Routing, Multimedia, Web, Mobile, Application, Context-aware

1. ABSTRACT

We present LARK, a mobile web application at edu.lark.gr, that provides location-aware information content. LARK is a query-search-optimization engine that serves as a multimedia database, an individually customized tour planner and an on-site tour guide. Technically, LARK consists of a server component to facilitate generation, modification, search of multimedia content that can be related, and adaptive, to physical locations and a mobile app to render and adapt the tours on user's mobile device(s) and interests. LARK provides new possibilities for collecting and sharing specialized knowledge beyond tourism, by presenting tours with high educational and historical significance for its users.

2. INTRODUCTION

LARK is a mobile web application at edu.lark.gr, to provide a new experience with personalized tour planning and on-site guidance. Many modern museums offer visitors audio guides to certain themed sections via provided players, and recently, via mobile web applications. At a much larger scale, with much richer information, offering personalized customization, LARK accompanies and guides anybody with a mobile device, a smartphone or a tablet, to a city or county and enriches the travel experience with enlightening and delightful information.

LARK utilizes synergistically modern technologies and techniques for sensing and processing. Smartphones, or similar mobile devices, can accurately identify location, access the Internet, and playback audio and video content from various sources. LARK acts as both a personalized tour planner and an on-site personal guide to new or familiar destinations facilitating tour plans ahead of time or in the spur of the moment. Aware and adaptive to spatial location, LARK can guide a tourist, an adventurer or a student, on foot or vehicle, not only describing locations and directions, but also providing information on local tales, legends, history, architecture, arts, customs, shopping and services. Everything is done at a personal pace, by personal taste and interests (Figure 1).

The content of a guided tour can be extended and enriched to a variety of themes beyond conventional tourism. Special thematic walks can be accessible at any time and not only when the specialists are

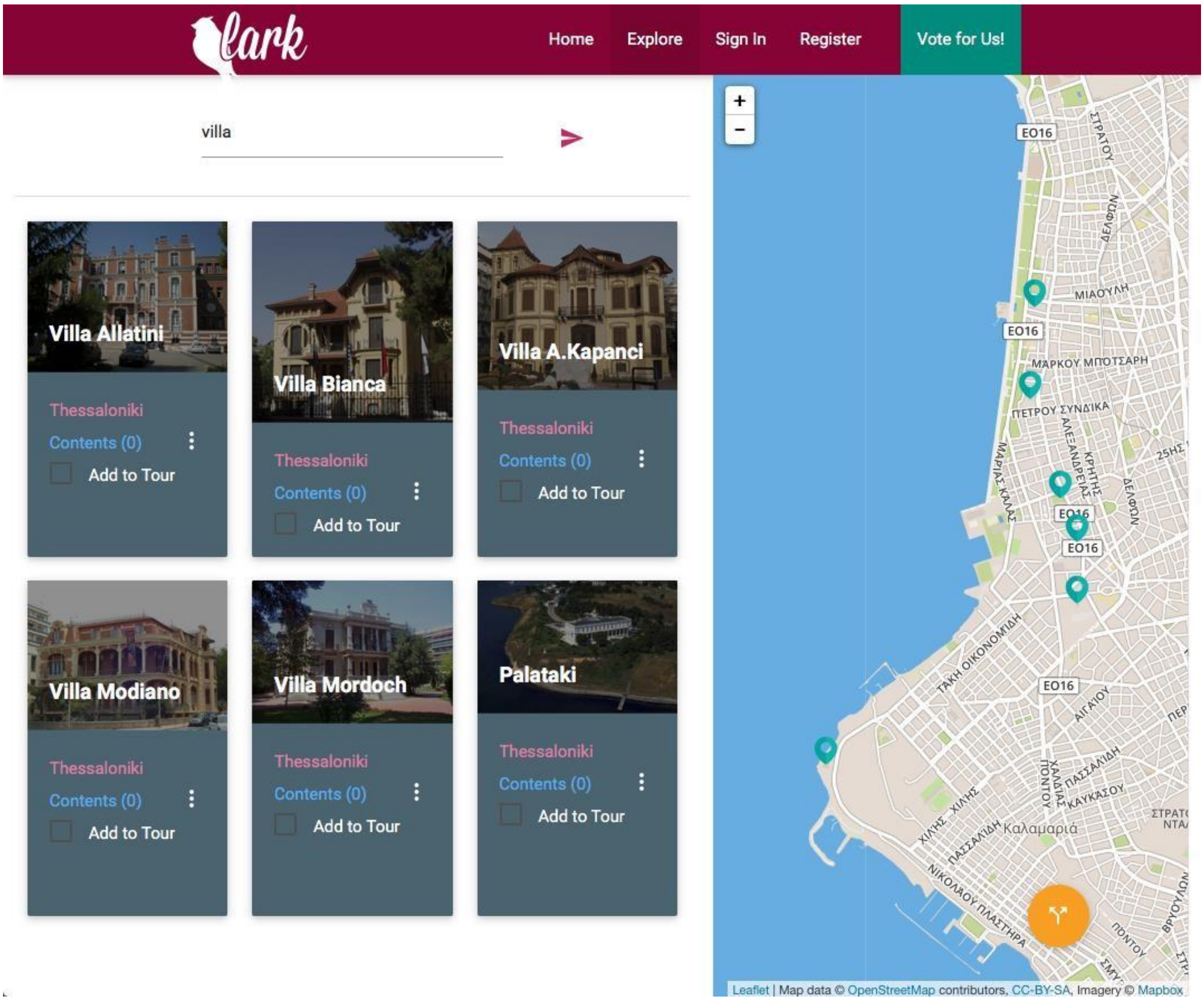


Figure 1: Screenshot of LARK, showing the results of a query. Resulting articles are shown on the left panel and their associated locations are shown on the right map panel.

available. A tour may contain the localities related to the life of a poet, the house she was born, the school she attended, the coffee shop she used to frequent. The audience can trace the poet's steps from place to place, listening to poetry readings along the way and gain new insights to her work. The guided tour may be the audio performance of a play, the non-linear reading of a novel, or even a treasure hunt game, where the action is triggered by the places visited.

3. RELATED WORK

Recent years have seen the emergence of many mobile touring applications that take advantage of the multimedia playback and geocoded information. Among audio guides, *Acoustiguide* (2014) provides multiple mobile phone applications that guide the user through a specific city, or site.

The *Kawamura Memorial DIC Museum of Art* application contains audio recordings that provide explanation to various artworks and introduce the visitor to the history of the museum.

The *Richmond Olympic Experience* (ROX) application consists of a complete audio tour, accompanied by insightful commentary by Olympic and Paralympic medalists, granting knowledge to the tough journey an athlete takes in order to reach the Olympic Podium.

City of Perth iWalk Trails (2015) incorporates three different audio trails, in order to entertain and brief the user about the history and culture of Perth city. Among video guides, *Timetraveler The Berlin Wall Augmented* (2014) tries a different approach. Instead of audio tours, it enables the visitor to revisit and experience historic events by overlaying photos and information on the walls of the buildings and sites, through augmented reality. The traveler can therefore see historic footage of the same locations on their smartphone screen.

Guide content can be enriched in many ways. For example, *Walking Cinema: Murder on Beacon Hill* (2013) provides a mixed reality storytelling mechanism that while presenting and narrating the story of the murder of Dr. George Parkman, it guides the user through geocoded videos that reveal the evidence and the story of the incident. The application acts as an interactive storytelling game, but also explores real locations around historic neighborhoods in Boston, to communicate with the audience in a more direct manner.

Dopios (2015) tries to connect visitors with citizens of the city they are exploring in order to provide specialized tours along multiple landmarks and sites. *Dopios* works as an intermediate channel, so that travelers can find their local guide, who shares their interests and is willing to tour them around the city

Research papers on the making of such guides can be found in related literature. *LifeMap* (2011) and *Cyberguide* (1996) provide a basic infrastructure, regarding context-aware content and multimedia in order to effectively accomplish the creation, storage and redistribution of the application's data to the end user. This is of the utmost importance, since building a framework that will enable the incorporation of previous mentioned features in one unified solution, requires appropriate database abstractions and design.

A study is also carried out on the effectiveness of tour guides via guide-user interaction. A contextaware Tour Guide (2007) studies the impact user feedback can have on the robustness, and investigates, --from a usability perspective--, the differences between context-aware tour guides in contrast to conventional applications.

4. CONTRIBUTION

The purpose of LARK has been to inherit multiple aspects introduced by different applications and to combine them under one user-friendly framework, without losing necessary abstractions. LARK is a unified platform that enables the generation, modification, distribution, customization and rendering of location-aware, information-rich content in the form of self-guided tours. It marks a substantial advance, and a departure from existing tour guides that provide only pre-determined, theme-specific, location-specific, fixed and limited information content, and render content in a fixed form or format.

LARK is easy to access, as a user or creator, without the need to consult programming experts or any requirement to build place-specific applications. Open or copyrighted content can be created and shared with others through LARK by people with little or no technical background. LARK also strives to create and connect user communities to author original material that is hard to uncover otherwise.

The LARK framework is underlaid by a well-designed abstraction and configuration, integrating and implementing the desired features. The technical contributions of LARK are summarized as follows:

- A framework designed and developed to facilitate the generation, storing, distribution and rendering of multimedia, multi-source content, that is associated to geographic locations.
- Automated classification and characterization of landmarks and sites, exploiting information collected via crowd-sourcing.

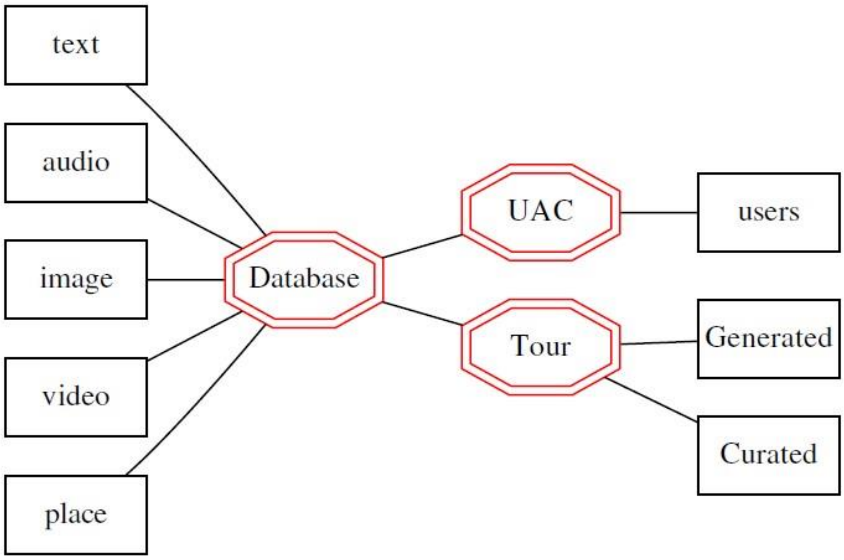


Figure 2: Screenshot of LARK, showing the results of a query. Resulting articles are shown on the left panel and their associated locations are shown on the right map panel.

- Automated generation of mobile tour guides customized to the user's schedule, pace, tastes and interests.
- Collection of direct and indirect user feedback.

5. SYSTEM COMPONENTS

LARK consists of three major components. A multimedia database, a subsystem for managing user access, and an optimizer for tour planning and guide rendering (Figure 2).

The multimedia database with associated locations is the main component feeding all services provided by LARK. The LARK database of multimedia, in addition to text, contains voice narration, music, photographs and video associated with a geographic location or position in an indoor space like a museum. The entries provide information that can be browsed in advance, or just in time during a tour. Audio files with voice narration free the user from having to look at the mobile device. Music selected and timed appropriately prepares the audience for the upcoming point of interest and creates the right mood. This content can either be accessed on-demand or be programmed for automatic playback.

The database also contains categories that can be mapped to information. Points of interest are annotated with multiple category attributes that map them to classes of general or specialized interests like history, architecture, nature and many more that can be defined by the users, directly or indirectly.

The system of user account management is a database of registered and anonymous users. Locations and descriptions can be created, modified, and reviewed by users. Thus knowledge and expertise can be shared with everyone who is interested about a certain place. User annotations are also recorded; these include commentary and grading of existing information, and categorization of entries into classes. User records contain voting history, annotations, editing of entries or tours taken.

The tour optimizer is a special service module of LARK. In its simplest form, the tour optimizer solves a scheduling problem to minimize the distance or time traveled to reach all target locations of a tour. More complicated problems are solved when additional constraints are added. For instance, time windows may be imposed on the tour stops, for example, the time a certain attraction is accepting visitors and the overall duration of the tour is constrained. Traffic conditions and means of transportation may also be taken into account to form an acceptable tour.

Interactive tours can also be generated, based on position, path and the user's recent interactions, resulting to a unique experience. This provides a form of interactive narrative tours, that do not always produce the same final route, but change and adapt, based on user's choices.

6. INTERNAL PROCESSING AND LEARNING

The internal abstraction and processing in LARK are as follows. Locations are denoted by nodes and paths by edges in a graph. Both nodes and edges can be associated with classes and multimedia content. Content assigned to edges is filtered depending on the transportation means. Related content can be triggered according to proximity or similarity criteria.

Advanced computational techniques are used to characterize the nodes, to generate tours and collect feedback from the user. Nodes are automatically classified into multiple classes in order to associate them in different ways and themes. Each node is denoted by a vector in a d-dimensional space, where each dimension represents a different attribute (i.e. historical value). The attributes are elicited or crowd-sourced from user feedback. A k-means classifier is used to categorize each node into classes for node classification and characterization. Neighborhood clusters can be provided as alternative suggestions that might interest the user.

After the classification process, correct labeling of the derived clusters is also very important, in order for the application to provide correct results. The labeling process can be enhanced through the use of the Latent Dirichlet allocation (LDA) algorithm on the content or the reviews of a specific site. LDA can identify common topics along multiple documents that accompany a place and use these to correctly identify each cluster.

The customized tours are spawned through the use of both the user's current location and the classes that best match user interests and subjects queried. The suggested route minimizes the overall distance or time needed to traverse the tour. The scheduler takes into account the distances between places, the form of transportation, real time traffic conditions, probable amount of time spent in each node, opening hours of the places to be visited and the user's available timeline.

LARK collects and learns from the user feedback, without the user's direct involvement or with user's direct feedback or contribution. For instance, the application records whether the tour was completed, how much time was spent en-route and at each location. If a location visit has been prematurely terminated or completely omitted, the user is queried to reconfirm an interest in the subject. The user feedback, direct and indirect is used to better associate attributes to nodes, so that this information can be utilized in future tour planning.

LARK enables and encourages the user to participate in recording and sharing information related to points of her interest.

7. CONCLUSION

Creation of multimedia materials in addition to text, containing voice narration, songs and music, photographs and video related to a location and their reproduction in sequence and on queue for a self-guided tour has become very easy with the ever-expanding capabilities of mobile technology. Combining technologies like the Global Positioning System, Wi-Fi position estimation, and maps with such multimedia can lead to the creation of easy-to-use, high quality, context-aware applications.

LARK interconnects all of these with the appropriate abstractions in order to provide a unified platform for travelers and guides, containing the tools to create, distribute and render multimedia tours around the globe.

By making connections to visitors, LARK aspires to also have positive impact on local communities, on local people in all walks of life, and open new and exciting opportunities to sustain and advance local culture, arts and business.

LARK is available at edu.lark.gr, and accessible from anywhere the Internet reaches.

We thank Prof. Xiaobai Sun of Duke University for her critical comments.

8. REFERENCES

City of Perth iWalk Trails, (2015). Mobile phone audio tour app http://www.perth.wa.gov.au/our-capital-city/things-see-and-do/self-guided-trails

Acoustiguide (2014). Audio - multimedia tours for multiple platforms. http://www.acoustiguide.com/

Chon, J., & Cha, H. (2011). LifeMap: A smartphone-based context provider for location-based services. *IEEE Pervasive Computing*, *10*(2), 58-67. http://doi.org/10.1109/MPRV.2011.13
Gulliver, S. R., Ghinea, G., Patel, M., & Serif, T. (2007). A context-aware Tour Guide: User implications. Mobile Information Systems, 3(2), 71–88.

Abowd, G. D., Atkeson, C. G., Hong, J., Long, S., Kooper, R., & Pinkerton, M. (1996). Cyberguide: A Mobile Context-Aware Tour Guide. Baltzer Journals, 3(September 1996), 1–21.

Burigat, S., & Chittaro, L. (2005). Location-aware visualization of VRML models in GPS-based mobile guides. In Proceedings of the tenth international conference on 3D Web technology (pp. 57–64).

Dey, A. K. (2010). Context-aware computing. Ubiquitous Computing Fundamentals, 321-352.

Schilit, B., Adams, N., & Want, R. (1994). Context-aware computing applications. In Mobile Computing Systems and Applications, 1994. WMCSA 1994. (pp. 85-90).

Untravel Media (2013). Walking Cinema: Murder on Beacon Hill https://itunes.apple.com/us/app/walking-cinema-murder-on-beacon/

Robin von Hardenberg (2014). Timetraveler The Berlin Wall Augmented https://itunes.apple.com/en/app/timetraveler-die-berliner/

Dopios (2015) https://www.dopios.com

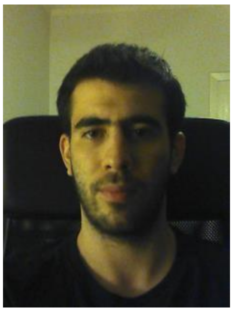
2nd Experimental School (2014). Heritage tours of Thessaloniki monuments http://edutech.mysch.gr/mnimeia/mesopolemou.html

9. AUTHORS' BIOGRAPHIES

Spyridon Bontomitsidis is a graduate (2015) of the department of Electrical and Computer Engineering of Aristotle University of Thessaloniki. His strong interest in software led him to work outside of his degree and gain experience in webprogramming, android developing and algorithms. Adding that with the hardware expertise acquired from the University, he formed a true engineering profile, able combine software and hardware efficiently. He worked for nine months at IMEC, Belgium implementing his thesis, which gave him the opportunity to design professional level hardware and software, adding value to the existing cutting edge research work. In addition, he is part of Meerkat, a developing team, with distinctions in various national competitions on smart applications to improve everyday life and tone up tourism. (LinkedIn: https://gr.linkedin.com/in/spiros-bontomitsidis-1866a484)

Dimitrios Floros is a Ph.D. candidate in Electrical and Computer Engineering at Aristotle University of Thessaloniki, Greece. He received his diploma with excellence from the same institution in 2015, with a thesis on the analysis and design of 3D projection mapping systems. His primary research interests lie in the field of high performance numerical computing. His enthusiasm with software developing led him to become part of an award winning team, Meerkat, developing web-apps as well as mobile applications that help solving everyday live problems. He has also worked for Passias S.A., developing and updating the existing inner-company ERP system.

(LinkedIn: https://gr.linkedin.com/in/dimflo)



Konstantinos Mylonakis is a student of department of Electrical and Computer Engineering of Aristotle University of Thessaloniki. Currently working on his thesis in the field of Fast Multipole Method. Besides his interest in the field of computational physics, he enjoyed to expand his developing skills learning about Web developing and system administration. His enthusiasm for dealing with complex real life problems led him to join the Meerkat team, where he works on back-end and algorithm tasks. He has won three awards as members of Meerkat team for the application Prisma, Aneas and Lark and looks forward to improve the existing projects and deal with new challenges.

(LinkedIn: https://gr.linkedin.com/in/kostasmylonakis)

Dimitrios Manolas is finishing his studies in the department of Electrical and Computer Engineering of the Aristotle University of Thessaloniki. He is presently working on his thesis on energy efficiency through behavioral economics. Dimitrios has channeled much of his engineering problem-solving background into new areas and ventures, taking a strong interest in the managerial and marketing fields. He had the opportunity to develop his competences further by working for 6 months for Procter & Gamble. For the past two and a half years, Dimitrios has also been strongly involved in volunteering, by taking key positions in the Erasmus Student Network, Europe's largest student organization for the advancement of mobility and international higher education.
(LinkedIn: https://gr.linkedin.com/in/dimitriosmanolas)

Nikos Pitsianis is an assistant professor with the department of Electrical and Computer Engineering of the Aristotle University of Thessaloniki, Greece. His research experience and interests are in algorithms and architectures for high performance numerical computing and applications in integrated sensing and processing. He holds a PhD in Computer Science from Cornell University.

Erasmus Without Paper — from the technical perspective

Janina Mincer-Daszkiewicz (jmd@mimuw.edu.pl), Wojciech Rygielski (rygielski@mimuw.edu.pl),

Faculty of Mathematics, Informatics, and Mechanics, University of Warsaw, Banacha 2, 02-097 Warszawa, Poland

Keywords

Erasmus Without Paper, student mobility, Erasmus+, Student Information System, EWP Network, EWP Registry, connectors, GitHub, semantic versioning

1. INTRODUCTION

The **Erasmus Without Paper** (EWP) project [2, 3] aims to create a network supporting the electronic exchange of student data by interlinking the existing Erasmus student databases of Higher Education Institutions (HEIs) with the goal to permanently migrate from the paper world to the electronic world of student data. It is a response to the current needs of the information society, more specifically a large number of potential end-beneficiaries ranging from students, institutional Erasmus coordinators, IRO staff, HEIs at large, national agencies, or even the European Commission. The project addresses the Erasmus+ goal of increasing student mobility and recognition of student achievements (measured in recognized ECTS points). The EWP Network is the first attempt to standardize student data transfer on a European-wide scale. It is important to note that the transfer does not involve documents themselves (e.g. scanned copies) but the data that is contained in these documents, so that they can be used for the generation of various documents, processed automatically and stored in institutional databases. In particular, no data is held centrally.

There are 11 partners composed of public institutions, higher education organizations, and companies from 8 European countries with a dissemination potential to over 400 HEIs from 36 European countries. They are supported by 11 associate partners actively involved in the project.

The project started on November 1st, 2015 and will last for two years (grant number 562264-EPP-12015-1-BE-EPPKA3-PI-FORWARD).

In this paper we present the results of the first half year of the project, mostly from the technical perspective. We want to share some design and implementation decisions concerning the architecture, security, scalability of the EWP Network, data format, API, protocols supporting data exchange, and other technically oriented issues.

2. PROJECT GOALS

The project aims to design and work out a pilot for an integrated communication network supporting the exchange of student data in an electronic form, and to build connecting software modules (connectors) that will allow Student Information Systems (SISs) with built-in mobility modules (part of SIS that takes care of Bilateral Agreements, student applications, Learning Agreements, Transcript of Records and other documents) and/or stand-alone Mobility systems (like MoveON or MobilityOnLine) to exchange data over the EWP Network. In more detail, the main project tasks are the following:

- Describe all possible mobility scenarios.
- Create common data models for the exchanged information and design appropriate document formats.
- Define the necessary transport protocols and standards.
- Take care of identity management (authentication and authorization methods).
- Solve the security and privacy issues.
- Build connector modules (also generic) that allow data handling software to send and receive data over the network.
- Include extra tools to increase performance and usability (e.g. grade conversion).

3. GENERAL PROJECT DEVELOPMENT DECISIONS

The final success of the project depends on the number of institutions joining the network. It is crucial that from the very beginning the software will be designed and developed using an open source approach with the active involvement of the academic community. We have created the official EWP organization on **GitHub** (https://github.com/erasmus-without-paper/). All technically biased project work will be reported on GitHub. We will post there specifications, source code, documentation etc. All developers interested in the work progress or wanted to get involved should subscribe to the chosen projects on GitHub. We have also created a web page for developers involved in the design and implementation of the EWP platform and connectors (http://developers. erasmuswithoutpaper.eu/) with the general overview of the documents and specifications, information on their state, links, tools, etc.

There is a set of repositories for various sections of documentation. Documents posted on GitHub are available for review, change notifications help to keep all informed, built-in issue trackers can be used for asking questions, reporting errors or posting suggestions. GitHub supports formal versioning of documents and source code (we will follow rules of **semantic versioning**). Official versions of data format and **Application Programming Interface** (API) will be approved by the project partners, and — once the APIs are released onto production servers — backward compatibility will be guaranteed. The data format will be defined officially by XSD and a validation tool will be provided to help with formal verification of the produced data files.

We plan to take into account data formats developed by other mobility-oriented European projects, like EMREX-ELMO worked out by the EMREX group [1, 4].

4. ARCHITECTURE AND SECURITY

EWP Network is composed of the **EWP Hosts** and the **Registry** (see Fig. 1). EWP Hosts are groups of HEIs. The EWP project aims on allowing communication between them. In order to join the Network, the Host should publish a valid **Discovery Manifest file** somewhere on its servers and send the URL of this file to the EWP Registry administrator. It will be stored in the Registry allowing partners to identify and verify future requests.

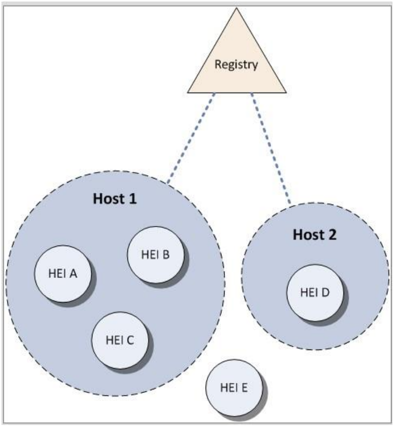


Fig. 1 Main components of the EWP Network

Registry

The Registry is the only centralized part of the EWP Network. It allows all EWP Hosts to access the list of other EWP Hosts. It may also be used for projects unrelated to EWP, as long as these projects have similar architecture. The Registry is being updated **automatically**. It periodically reads all the information which all EWP Hosts provide within their Discovery Manifest files, and these changes are reflected in the Registry responses.

The major advantage of such automatic updating is that the partners *do not need* to contact the Registry maintainer when they want to change some of their Registry entries. Most changes in the Registry can be performed simply by updating the manifest on the partner's server (and the Registry will fetch these changes automatically). This approach supports the scalability of the solution.

EWP Hosts are not required to implement *all* features of the EWP Network. In order to avoid unnecessary requests, the Registry also keeps track of all the implemented APIs.

Some of the APIs are **event listener APIs**. If Host 2 wants to receive change notifications from other hosts, it indicates in its Manifest file that it has implemented a specific event listener API. Now, if Host 1 is able to broadcast such notifications, then it asks the Registry which hosts have implemented the proper listeners, and posts the proper notifications at the listener URLs.

Security

There are two types of certificates involved in the communication:

- **Server certificates** are used by the Host when it **responds** to API requests.
- **Client certificates** are used to **issue requests** within the EWP Network.

Implementers may use the same certificate for both purposes.

API

In order to join the EWP Network, a new partner needs to implement a subset of its APIs. There are many APIs, and each partner will choose which of them he wants to implement. Each partner has to implement Discovery Manifest API:

- It serves to identify the partner, announce the list of HEIs covered by the partner's system, and used certificates while fetching the data from the EWP Network. It's like a simple "business card" of the EWP Host. Its role may be expanded along the project.
- It serves to inform all **other** members of the network about which features (APIs) **the EWP Host** has implemented. This list may include external APIs (unrelated to the EWP project).

The partner needs to host the Discovery Manifest file somewhere on its servers. The Discovery Manifest file is a simple XML file which must conform to the provided XML Schema.

The **Echo API** allows beginner EWP developers to test the security of their EWP Network connections. It doesn't "do" anything, but it requires the developer to implement the core security framework (which will be needed by all the other APIs later on).

The EWP Network specification posted on GitHub describes EWP Network components, establishes common security measures, features, data types and vocabulary, and explains how partners communicate between one another.

5. SUMMARY

The Erasmus Without Paper project has entered the design and implementation phase. The **pilot** we are working on aims to test out the feasibility of the proposed solutions for all HEIs in Europe. In the first step the general architecture of the EWP Network has been designed along with some general discovery services and security mechanisms. The API design is in progress. The development of connectors for local systems will follow. All the specifications, documents, and source code will be hosted on GitHub. We want to share them with the academic community and prospective developers of local connectors. This paper is a call for cooperation, especially directed toward other European projects/groups with the focus on student mobility and student data sharing across borders.

6. REFERENCES

[1] EMREX project. Retrieved in January 2016 from: http://www.emrex.eu.

[2] Erasmus Without Paper (EWP), an Update. Presentation by Valère Meus at 2015 Gröningen Declaration Network Annual Meeting, Málaga, 4-6 May, 2015. Retrieved in January 2016 from: http://www.groningendeclaration.org/erasmus-without-paper-ewp-update

[3] Erasmus Without Paper project. Retrieved in January 2016 from: http://www.erasmuswithoutpaper.eu.

[4] Lindstedt M., Hansen A.B., Ravaioli S., Vangen G., Sidselrud A., Mincer-Daszkiewicz J., Henriksson P. (2015). *Field trial on the impact of enabling easy mobility on recognition of external studies (EMREX)*. EUNIS 2015, Dundee. http://www.eunis.org/eunis2015/wpcontent/uploads/sites/3/2015/04/EUNIS2015_submission_13_P1_TRACK_3_slot_3.pdf

7. AUTHORS’ BIOGRAPHIES

Janina Mincer-Daszkiewicz graduated in computer science in the University of Warsaw, Poland, and obtained a Ph.D. degree in math from the same university. She is an associate professor in Computer Science at the Faculty of Mathematics, Informatics and Mechanics at the University of Warsaw specializing in operating systems, distributed systems, performance evaluation and software engineering. Since 1999, she leads a project for the development of a student management information system USOS, which is used in 47 Polish Higher Education Institutions, gathered in the MUCI consortium. Janina takes active part in many nation-wide projects in Poland. She has been involved in Egracons, EMREX and Erasmus Without Paper European projects.

Wojciech Rygielski graduated in computer science in the University of Warsaw, Poland. He is a senior programmer working on USOS.

He is one of the main developers from Poland in EMREX and Erasmus Without Paper European projects. He is responsible for keeping the EWP specifications clean, up-to-date and backward-compatible.

Supporting Student Mobility with EMREX — a field trial on exchanging student achievement records

Mats Lindstedt[1], Anders Bøgebjerg Hansen[2], Stefano Russo[3], Geir Vangen[4], Janina Mincer-Daszkiewicz[5], Mattias Holmlund[6]

[1]CSC – IT Center for Science Ltd, Finland [2]IT Department of the Ministry of Higher Education and Science (UFM-IT), Denmark [3]KION, Italy [4]FSAT, University of Oslo, Norway [5]University of Warsaw, Poland [6]ICT, Umeå University, Sweden

Keywords

Learning mobility, student information systems, digital result exchange, European policy experimentation, recognition

1. BACKGROUND

The EMREX project, co-funded by Erasmus+, addresses the EU 2020 target that 20% of higher education students should be mobile during their studies. EMREX focuses on the exchange of student achievement records between higher education institutions. EMREX together with e.g. Erasmus Without Paper, FAIR and other similar initiatives is part of a wider set of activities on student mobility by EU. Academic recognition in higher education is seen as a challenge in learner mobility and also as a potential area for the improvement of a more efficient education system in general.

The EMREX field trial aims at testing new ways to make the administration of student mobility easier and thus promoting a higher attainment level to student mobility in higher education and also encouraging more effective recognition of prior learning and avoiding overlapping studies. In the first phase the trial is set up between Finland, Norway, Sweden, Denmark and Italy. Students in these countries may during the field trial log into their student portal at their home university and collect study achievements from the host university. Poland will also utilize the EMREX solution for its internal mobility.

This session aims at presenting the objectives for the EMREX project, demonstrates the solution for exchanging achievement records, and discusses the first preliminary findings from the ongoing field trial.

2. THE EMREX FIELD TRIAL

The tangible outcome of EMREX is a federated solution that supports the exchange of student data on achievements. The solution will be highly scalable and can thus be easily implemented in the whole European community. The field trial will test the hypothesis that the new functionality will lower the burden of administrative tasks laid upon students and lower involvement of the administration.

The solution was developed in 2015 and a live field trial is conducted in 2016. Each partner in the project has set up a National Contact Point (NCP) and a Student Mobility Plug-In (SMP) for the local Student Information System (SIS). Exchange students in the participating countries will use the EMREX solution to electronically retrieve their achievement records from the host HEI. The students, mobility coordinators and administrators will be asked to participate in surveys and the statistics from the exchanges will be collected and analysed. The first findings from the field trial will be presented in this session.

3. THE EMREX SOLUTION

The EMREX solution consists of several components. The idea is that they should be as independent of each other as possible. In this way, it will be easier to add new participants to the network.

Each SIS or institution, depending on local implementation, that wishes to fetch results via the EMREX network, must implement an SMP (EMREX-Client). The client provides the student with a secure login, enables the student to contact the host HEI and provides a way to store the retrieved results in the local SIS.

Each country that wishes to provide results to the EMREX network must implement an NCP. The NCP provides the student with a secure login in the host country and enables the student to select and fetch their results from the host HEI. The EMREX network will use the ELMO format to exchange the results.

The process is initiated by the student, logging into the SMP, which contacts a platform, EMREG register, to check which NCPs are connected and available. The student chooses their host HEI and the student data is verified by the NCP. An electronic transfer of student achievements via the NCP and SMP is performed as soon as the student has approved the course list at the host university.

The EMREX solution will be demonstrated in the session.

EMREX is based on open source code and freely available to all. The solution will be available for all HEIs in Europe from 2017. New countries can join the EMREX network through creating their own EMREX clients and contribute to the network by providing their own NCPs.

4. PRELIMINARY FINDINGS AND FUTURE BENEFITS AND OPPORTUNITIES

The biggest benefit coming out of this policy project will be the increased availability, quality and reliability of information about student records of achievement information. This will make student mobility processes easier, faster and more transparent for students. Students will also benefit from the recognition of previous academic studies and degrees because of increased eligibility, when applying for studies in higher education. The universities will benefit from a reduction of manual work. The field trial also supports the collection of measurable data on the rate of recognition that can then be analysed and used for improving the national policies on student mobility and rules for recognition of previous studies. The data will increase the quality of the learning mobility statistics.

In this session the first preliminary conclusions from the ongoing field trial will be presented and discussed.

Another benefit from the field trial will be the comparison of the transcripts of records in the participating countries. To fully benefit from an electronic transfer there is a need for a common format. The solution will also be evaluated from a technical perspective to smooth the path for newcomers to join the EMREX network.

One of the goals and benefits of the field trial is the peer learning of the authorities involved. The way to support this particular goal is making the results of the development process openly available through open source code. The up-scaling of the EMREX-platform will be provided by applying a decentralised management model: the higher education institutions in the European Community will be responsible for the operation and funding of their own part of the solution. The EMREX-platform will thus not be dependent on being coordinated by a central body or organisation nor on centralised funding, which will secure its sustainability. All institutions of higher education will be able to use the information from countries offering the functionality.

5. BIOGRAPHIES

Mats Lindstedt has a Master of Science in Business Strategy and International Marketing and a Licentiate in Applied Mathematics from the Helsinki University of Technology. He has over 15 years of experience from the ICT industry including program management and R&D development. Since 2012 he work for CSC Ltd in Finland and with developing support for student services. Previously he was the project manager for Tiptop, developing web based support for university students' personal study plans. Currently he is the project manager for the EMREX project.

Anders Bøgebjerg Hansen holds a master's degree in political science from the University of Copenhagen. He has worked with different student information systems at two universities and has 15 years of experience coordinating systems development on the customer side within higher education in Denmark. He is a special adviser at the IT Department of the Ministry of Higher Education and Science (UFM-IT) where he works with contract and project management with relation to the student information system STADS and the application system DANS. These systems are used at all 8 universities and several institutions of architecture and art in Denmark. Anders Bøgebjerg Hansen has been the project manager of many large EU tenders and has for several years been involved in Nordic forums in the area of student information systems.

Simone
of them at
where he
used by

Stefano Russo has more than 15 years experience in developing nationwide software systems. He spent most Kion, the company which is the leader in developing Students Information Systems for the Italian Universities, works as part of the group that manages the mobility module for the student information system "ESSE3" over 60 universities in Italy.

Geir Vangen has more than 20 years experience in developing nationwide systems within higher education in Norway. At USIT, the University of Oslo University Center for Information Technology, he works as development manager for the student information system FS. Geir Vangen is also responsible for architecture and methods for the section within USIT that develops systems for student information (FS), research information (CRIStin), national admission (SO) and data warehouse. He participates in national and international standardization work, and has been a member of the groups developing the MLO and ELM-standards. He is a member of the steering committee of RS3G. He has been member of national committees appointed by the Ministry of Education and Research, and has lead projects on behalf of the Ministry. Geir Vangen graduated from University of Oslo, Institute of Informatics in 1989.

Janina Mincer-Daszkiewicz graduated in computer science in the University of Warsaw, Poland, and obtained a Ph.D. degree in math from the same university. She is an associate professor in Computer Science at the Faculty of Mathematics, Informatics and Mechanics at the University of Warsaw. Her main fields of research include operating systems, distributed systems, performance evaluation and software engineering. Since 1999, she leads a project for the development of a student management information system USOS, which is used in over 40 Polish Higher Education Institutions, gathered in the MUCI consortium. In 2008, she started the Mobility Project with RS3G. Janina takes active part in many nation-wide projects in Poland.

Mattias Holmlund holds an Bachelor of Science in System Analysis from Umeå University. He has been working with IT since 2001 and held the position as Operations Manager of one of three Swedish national SIS-Ladok installations until 2011. He is currently involved in setting up the new operational organization for the next generation of the Ladok-system. In the Emrex project he is technical responsible for the Swedish part of the development and also as a Work package leader in the Erasmus without paper project (EWP).

Paperless mobility in European Higher Education Institutions with Moebius

Stefania Niavi[1], Stauros Argiropoulos[2], Anastasios Selalmazidis[3], Nikos Liolios[4]

[1]AUTh IT Center, PO Box 888, EL 541 24, stniavi@it.auth.gr

[2]AUTh IT Center, PO Box 888, EL 541 24, argiropoulostauros@gmail.com

[3]AUTh Erasmus Office, PO Box 888, EL 541 24, anselal@ad.auth.gr

[4]AUTh Erasmus Office, PO Box 888, EL 541 24, lioliosn@ad.auth.gr

Keywords

Erasmus+, mobility management, student mobility, staff mobility

1. SUMMARY

Erasmus+ mobility procedures have many different phases during the academic year. Each phase involves different people during the application process and administrative handling. The Moebius software is designed to model mobility flow and to organize information at each level in a system where all procedures are completed electronically.

2. BACKGROUND

The Aristotle University of Thessaloniki is the biggest university in Greece, having 60.000 students, 2.500 teaching members and about 1000 administrative and assistance staff. Erasmus+ mobility numbers are also significant at every action: 800 outgoing and 500 incoming students per year for studies and traineeship, as well as 150 outgoing and 160 incoming staff members for teaching and training. These mobility numbers impose a significant overhead for processing and evaluation. Consequently, a new software application was designed in house, firstly to replace the existing, costly and inflexible commercial software and secondly to explicitly serve AUTh needs with online procedures.

3. DEVELOPING AUTH'S MOBILITY MANAGEMENT SYSTEM

Moebius is designed and developed to serve in the framework of Erasmus+ [1], the EU programme for education, training, youth and sport 2014-2020.

The idea raised by the need of Aristotle University Erasmus Office to use an application that simplifies the mobility procedure and fully interoperates with the rest electronic systems of the institution. Thus, the project aims to document and model student and staff mobility procedures and provide electronic solutions to them.

3.1Architecture

The application consists of an online and an offline system, each one built to serve different groups of people.

The online subsystem is a portal designed to gather information from end users. In this subsystem:

- Interinstitutional agreement contracts are completed and signed by the involved members (Higher Education Institutions HEI)
- All incoming and outgoing mobility applications are submitted
- Any pre-mobility process is performed, for example the evaluation of mobility submissions.

The offline subsystem is the main mobility management application, which manages the mobility procedure. This subsystem handles the:

- Submission of nominations
- Management of interinstitutional agreements and mobilities for all types of actions
- File uploads per mobility in order to create the electronic folder case
- Export of reports and certificates for end users
- Statistics on mobility data, graphs and maps for instant overview of mobilities (Figure 2).

The architecture of the system is described at Figure 1.

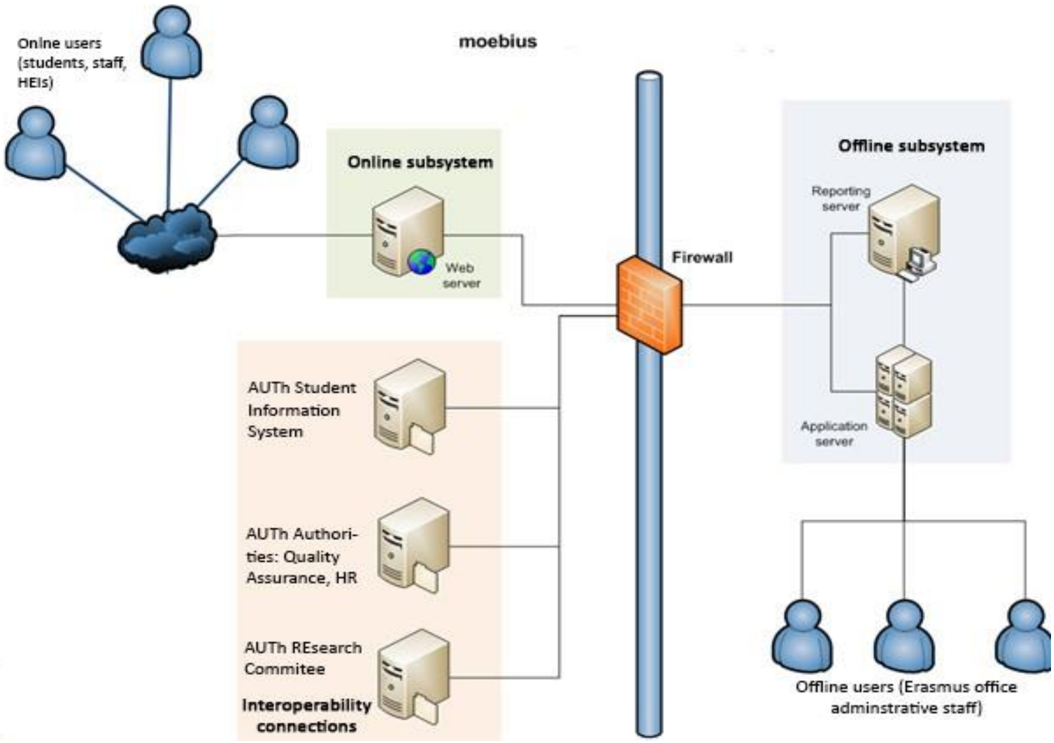


Figure 1: Moebius architecture

3.2 Technologies

Moebius is built using modern technologies and methods. More specifically, the online subsystem is built in Drupal 7. The backend of the offline subsystem developed in CodeIgniter [2] PHP application development framework and its frontend interface uses Ext JS [3], a comprehensive JavaScript framework for building feature-rich cross-platform web applications targeting desktop, tablets, and smartphones. Maps constructed using Google Maps API [4]. Any communication between the Moebius application and other AUTh information systems is done using REST services.

3.3 The roadmap

Moebius was developed in cooperation with AUTh's Erasmus Office, as the main target of the system was to serve and cover Erasmus+ requirements. Therefore, the challenge was to create an application that fulfills AUTh needs but generalize development as much as possible according to the programme.

Another major issue was that student and staff mobility workflows have many bureaucracy points that Moebius tried to simplify by inserting electronic procedures, electronic documents and digital signatures.

The impact was significant to end users (students and staff) as mobility applications and evaluation is quicker and transparent to all AUTh users. In parallel, AUTh Erasmus administrative staff is equipped with a tool that serves as mobility electronic folder case and simplifies their daily job.

3.4 Interoperability

A huge asset of developing an in house application is the high degree of interoperability with existing systems of the university. In this respect, Moebius communicates with:

- The Student Information System, in order to gain access to grade records and ECTS credits of students applying for a mobility experience
- The Authorities of AUTh and provide statistics to the Quality Assurance Information System
- The AUTh HR main Directory, in order to synchronize staff personal data
- The AUTh Research Committee, simplifying the procedure of student payments

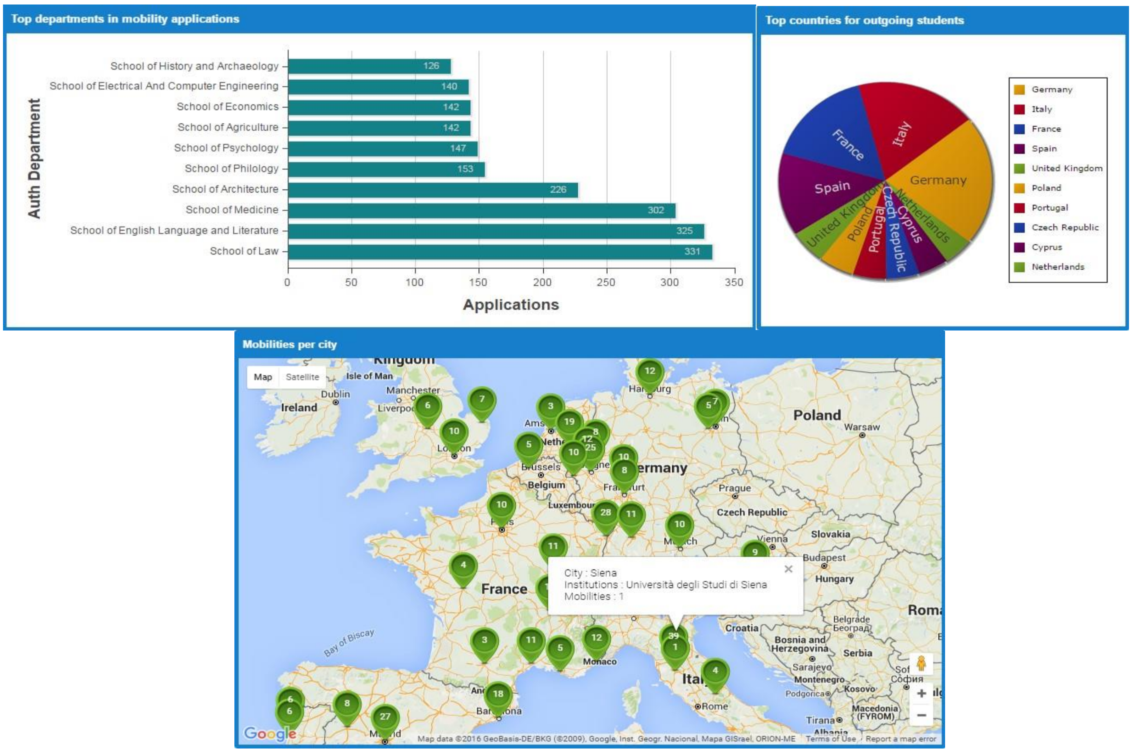


Figure 2: Mobilities per city, per country and per AUTh school

4. FUTURE WORK

Further development is already under way, building new features and customizing the application for AUTh community members. It will employ online monitoring of application status, personalized notifications and post-mobility communication, as well as backend extensions to financial management of the Erasmus+ projects.

5. CONCLUSION

Implementing AUTh's mobility management application is a challenge, as it aims to cover the different aspects of the Erasmus+ mobility procedure in a highly extrovert European university. The expected result is to simplify the mobility experience, facilitating both the person that performs the mobility and the administrative staff that manages the procedures.

6. REFERENCES

[1] Erasmus+, retrieved Feb 25, 2016 from http://ec.europa.eu/programmes/erasmus-plus

[2] CodeIgniter PHP framework, retrieved Feb 25, 2016 from https://www.codeigniter.com

[3] Sencha Ext JS, retrieved Feb 25, 2016 from https://www.sencha.com/products/extjs/#overview [4] Google Maps API, retrieved Feb 25, 2016 from https://developers.google.com/maps/

7. AUTHORS' BIOGRAPHIES

Stefania Niavi http://gr.linkedin.com/in/niavistefania

Stauros Argiropoulos https://www.linkedin.com/in/argiropoulostauros

Anastasios Selalmazidis https://www.linkedin.com/in/anastasiosselalmazidis

Nikos Liolios https://gr.linkedin.com/in/nikosliolios

ERAI 2016: Update

1st Johan Bergström, 2nd Michele Mennielli[2], 3rd Amandine Alehyane[3]

[1]Umeå Universitet, Sweden, johan.bergstrom@umu.se

[2]Cineca, Italy, m.mennielli@cineca.it

[3]Paris Ile-de-France Digital University, France, amandine.alehyane@unpidf.fr

Keywords
Research, analysis, ERAI, Surveys, Collaboration

1. Summary

The ERAI project now has 2 years to its name. When it comes to content and process the project is maturing however there is still alot of work to be done. This presentation will describe previous and current work, results and analysis as well as challenges and call to action. Participate in this session and project to make this a valued component of the EUNIS offering.

2. ERAI

One of the challenges in the ever-faster changing world of technology is how to stay competitive. The need for continuous improvement and agility for higher education IT requires knowledge about in-sector and out-of-sector trends. While organizations like Gartner are excellent resources for pushing out our field of vision to garner knowledge about out-of-sector trends EUNIS started the EUNIS Research and Analysis Initiative (ERAI) to provide a platform for IT leaders to understand the uses and trends of IT for the European Higher Education system. The overall mission of EUNIS is "to help member institutions develop their IT landscape by sharing experiences and working together."

3. Previous and current work

There are a number of previous as well as upcoming projects that will be described. Both from a process perspective but also when it comes to results.

- ERAI/Eunis and Eurocris collaboration – The state of CRIS in Europe
- Benchmarking – joining the different initiatives in Europe
- CIO – top ten
- CLOUD Computing

4. Journal

Last year ERAI published three issues predominantly focused on the congress. The goal of 6 publications were therefore not reached. However, ERAI has been able to grow some traction and this has given the journal a position in which we can provide the platform to our partners. Both GEANT and EuroCris have shown interest in using the Journal as a means to publish their congress' full papers.

In order to further make the work around the Journal more efficient we will set up a repository, hosted by EuroCris to store publications coming from ERAI/EJHEIT. This will move us closer to the goal of making the journal Open Access.

5. AUTHORS' BIOGRAPHIES

Johan Bergström, Msc Computer Science, is working as an International

Business developer for ICT Services and System Development (ITS) - Umeå University. Johan was the congress organiser of the 20th annual EUNIS congress in 2014. Johan is also a programme committee member the Terena Networking Conference in 2015 and 2016 as well as a Senior Reviewer ERO

(Educause Review Online). https://www.linkedin.com/in/johanbergstrom

Michele Mennielli is working as an external Relations and International Affairs Manager for CINECA, Italy. His primary focus is on Research Informations systems. He is also a board member of both EUNIS and EuroCris, two paneuropean organisations focusing on IT for Higher Education. https://www.linkedin.com/in/michelemennielli

Amandine Alehyane is a Project Manager at The Digital University Paris, France where she focuses on research and analysis on the higher education sector in France. Predominantly in the field of cloud computing.

All three authors were involved in the creation of the Eunis Research and Analysis Initiative (ERAI) in 2014.

ERAI-paper-template.doc

State of Enterprise Architecture practice in Finnish Higher Education sector

1st Nestori Syynimaa, 2nd Patrik Maltusch, 3rd Esa Suominen

[1]Enterprise Architect, CSC – IT Center for Science, Espoo, Finland, nestori.syynimaa@gmail.com
[2]Head of Enterprise Architecture team, Aalto University, Helsinki, Finland, patrik.maltusch@aalto.fi
[3]Enterprise Architect, Helsinki Metropolia University of Applied Sciences, Helsinki, Finland, esa.suominen@metropolia.fi

Keywords
Enterprise Architecture, maturity, capability

1. ABSTRACT

Enterprise Architecture (EA) has been practiced in Finnish Higher Education (HE) sector for several years. In 2011 the Finnish parliament ratified an act mandating all public sector organisation to adopt EA by 2014. Despite the Act, several studies have shown that the maturity of EA is low in Finnish public sector. To support the development of EA practice in Finnish HE sector, an EA Special Interest Group (EA-SIG) was founded in 2012. To shed light to the current state of the EA practice in Finnish HE sector, this paper reports the findings from a recent EA maturity study conducted by EA-SIG. The findings indicate that currently only half of the Finnish HE institutions have achieved the "defined" level of EA maturity. According to the study, the other half will achieve this level in two years.

2. INTRODUCTION

Enterprise Architecture (EA) has been practiced in Finnish Higher Education (HE) sector for several years. Officially the history of Finnish HE sector EA started in 2009 when eleven Finnish Higher Education Institutions (HEIs) started an EA-pilot as part of the RAKETTI-initiative. The pilot participants got a head start to prepare for the Act on Information Management Governance in Public Administration, which was ratified in 2011 (Finnish Ministry of Finance, 2011). The Act mandates all Finnish public sector organisations, including HEIs, to adopt EA by 2014. The report from 2014 revealed that the EA maturity in Finnish HE sector was low, even among the HEIs participating to the EA-pilot (Kella, 2014). Several studies has shown that the EA is not properly understood in Finnish public sector (Hiekkanen et al., 2013; Lemmetti & Pekkola, 2012; Pehkonen, 2013; Tuomola, 2014). According to two recent PhD dissertations this is one of the main reasons for the low EA maturity (Seppänen, 2014; Syynimaa, 2015).

Finnish HE sector consist of Universities and Universities of Applied Sciences (UASs). Currently there are 15 universities and 25 UASs in Finland. To support the development of EA practice in Finnish HE sector, HEIs have founded an EA Special Interest Group (EA-SIG) in 2012. EA-SIG has provided general EA training and peer support for EA practitioners in Finnish HE sector.

In order to shed light to the current status and maturity of EA practice in Finnish HE sector, this paper presents findings from a recent EA maturity study conducted by EA-SIG in the end of year 2015. In the future, the study will be conducted annually.

The rest of the paper is organised as follows. The research methodology of the paper is described in Section 3 and results in Section 4. Section 5 concludes the paper by summarising the findings of the paper and by providing some suggestions.

3. RESEARCH METHODOLOGY

The EA maturity study was conducted as a web questionnaire. The questionnaire was based on the EA maturity model of KARTTURI, The Guide for Developing Higher Education Enterprise Architecture (CSC, 2013). KARTTURI EA Maturity Model (KEMM) consists of eight EA domains and five maturity levels as seen in Table 1. Maturity levels of KEMM are based on CMMI (see http://cmmiinstitute.com) and TOGAF (The Open Group, 2009).

Table 1: KARTTURI EA maturity model (KEMM) matrix

Domain/Level	Initial	Partial	Defined	Managed	Strategic
EA descriptions					
EA method					
Governance processes					
Development and implementation					
Organisation					
Knowledge					
Substance support					
Interoperability					

As the KARTTURI is available only in Finnish, we will briefly introduce the maturity levels and domains of KEMM in English. On the Initial level EA related processes and EA organisation are not clearly defined. On the Partial level part of the architecture management processes, organisations, or tools are used. On the Defined level organisation's architecture descriptions are produced following standardised processes and templates, and activities are organised. On the Managed level usage and effectiveness of architecture descriptions and architecture management processes are regularly monitored. The results are analysed and corrective actions taken as required. On the Strategic level EA is a tool for organisation's strategic leadership and planning. In the EA descriptions domain the existing EA descriptions are assessed in terms of how they are stored and distributed. Also the level of how the EA descriptions can be utilised and the update processes are assessed in this domain. In the EA method domain the architecture methods and frameworks of the organisation are assessed. Similarly, in Governance processes domain, the governance processes related to EA are assessed. In the Development and implementation domain, the level of how the development of EA is organised and guided are assessed. Also the methods how the EA descriptions are implemented and published are assessed. In Organisation domain the organisation structure, roles and responsibilities of the EA practice are assessed, including the role of top-management in EA development. In the Knowledge domain, the level of knowledge of EA and related concepts of organisation's specialists, management, and other key stakeholders are assessed. In the Substance support domain, the level of how EA is integrated to HEI's substance activities and processes (i.e. teaching and researching) are assessed. Also the levels of how EA's support to substance is monitored and evaluated are assessed. Finally, in the Interoperability domain, the compatibility of HEI's internal architecture with the HE-sector reference architecture and other relevant reference architectures are assessed. (translated from CSC, 2013).

The questionnaire was organised in three parts: background questions, EA maturity assessment, and EA capability maturity assessment. Background questions of the questionnaire can be seen in Table 2.

Table 2: Background questions

Question	Options

Type of the organisation (required)	• University • HEI • Vocational institution • Vocational college • Other
HEI	• <list of HEIs> • Other
Name of the respondent	• N/A
Role of the respondent (required)	• Enterprise Architect • CIO • Substance executive • Other executive • Other specialist
Estimation of EA work (FTE)	
Number of full-time architects	
Annual EA budget (€)	
Interoperability	
Estimate the influence of EA in your organisation	Scale: weak (0) – strong (5)

The maturity model related questions were organised in a matrix so that all questions for each domain were in one page as seen in Figure 1. Questions were in the form of claims which were derived from the KEMM (for details see CSC, 2013, part V). Each level consists of one or more claims representing the status of the particular level. Each level might be achieved currently, in the future (6, 12, or 24 months), or it might not be relevant at all.


FIN EA-SIG

EA maturity assessment for Higher Education Institutions

Domain 1: EA descriptions

Which kind of EA descriptions (blueprints) your organisation have?

	Currently achieved	+ 6 mo.	+12 mo.	+24 mo.	n/a
Level 1: Initial - EA documentation is informal or non-existent.					
There are some individual descriptions or drafts, which do not necessarily follow any agreed models.					
Level 2: Partial - Architecture documents are partly based on agreed models.					
There are organisation-wide architecture descriptions and technology standards produced at least partly using agreed models.					
The need to gather descriptions to a central place is identified and started.					
There are descriptions for both current and target state of the organisation.					

Figure 1: Example of maturity model questions

The EA capability maturity were assessed by placing each of the eight domains in a quadrant seen in Figure 2. There were two axles: urgency and significance, which represented the current status of EA capability maturity in respondent’s organisation.

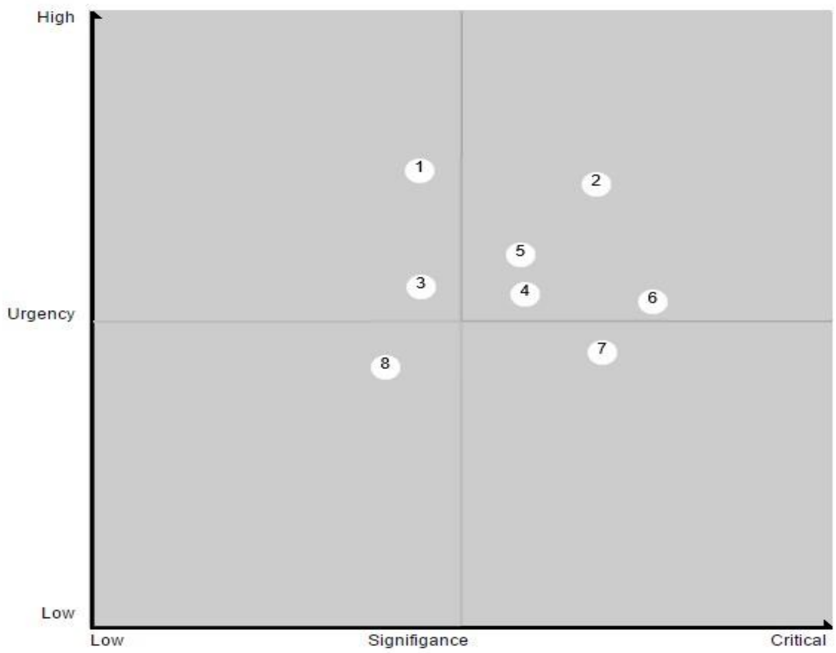


Figure 2: EA capability maturity assessment profile

4. RESULTS

In this section the results of the questionnaire are presented and analysed. The questionnaire was sent to all CIOs of Finnish HEIs and other interest parties.

4.1 Background information

Total number of 19 responses were received in time (see Figure 3). The quarter of the respondents (26%) were from universities and half (53%) from other HEIs. Most of the respondents were either Enterprise Architects (37%) or CIOs (37%).

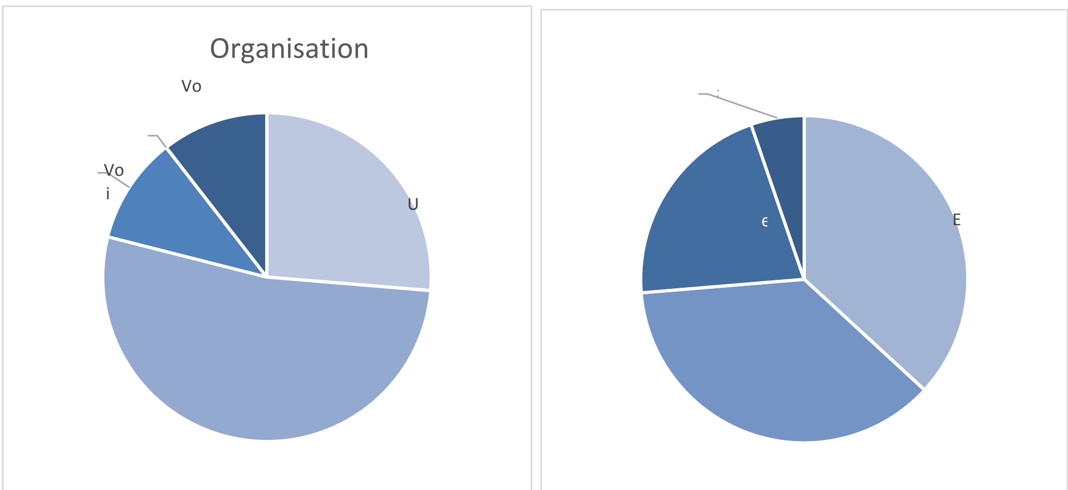


Figure 3: Respondents' roles and organisation types

The estimation of annual EA work were 2.75 FTE (n=19) and number of full-time EA personnel 0.47 (n=18). Assessment of the significance of EA work can be seen in Table 3. Most of the respondents (7) regards significance of EA work relatively weak and only one respondent as strong.

Table 3: Significance of EA work

(weak) 1	2	3	4	(strong) 5	*n*	$\bar{x}$
0	7	4	5	1	17	3

4.2 Enterprise Architecture maturity

As seen in Figure 1, there are one or more questions on each maturity level. We are interested on the maturity levels instead of individual questions. Therefore, the answers were summarised per maturity level as follows. If there was only one question on the maturity level, that was also the value of the particular maturity level. For instance, the initial level in Figure 1 would get its value from the answer for the first question. If there was more than one question, the value for the maturity level was the mode of the answers. For instance the partial level in Figure 1 would get the value which has the most occurrences in questions 2 to 4, i.e., if the second question would be assessed as current and two remaining as +6 months the value of the partial level would be +6 months. In case of two modes, the strongest would be selected, i.e. if there is two current and two +6 months answers the value would be current.

KEMM is similar to the other capability models in terms that in order to achieve a certain maturity level also the requirements of all lower levels needs to be fulfilled. For instance, in order to reach the partial level, one must first fulfil the requirements of the initial level. However, as it can be seen in the following figures, there might be more HEIs for instance on partial level than there are on initial level. This is caused by the design of the questionnaire, as the respondents have stated their own perception of the maturity on each level.

The current EA maturity of Finnish HE sector can be seen in Figure 4. The figures represent the percentage of the HEIs on each level. As it can be noted, practically all HEIs have achieved the initial level. Also the partial level is achieved by all HEIs except for the EA method and governance and implementation domains. These two domains also have the lowest maturity. EA knowledge domains on the other hand has the highest maturity. This clearly demonstrates that the investments made to EA training during the last few years have been valuable. It should also be noted that there are some HEIs that have achieved the strategic level at least in one domain. Interoperability domain is an exception, as none of the HEIs have achieved the strategic level.

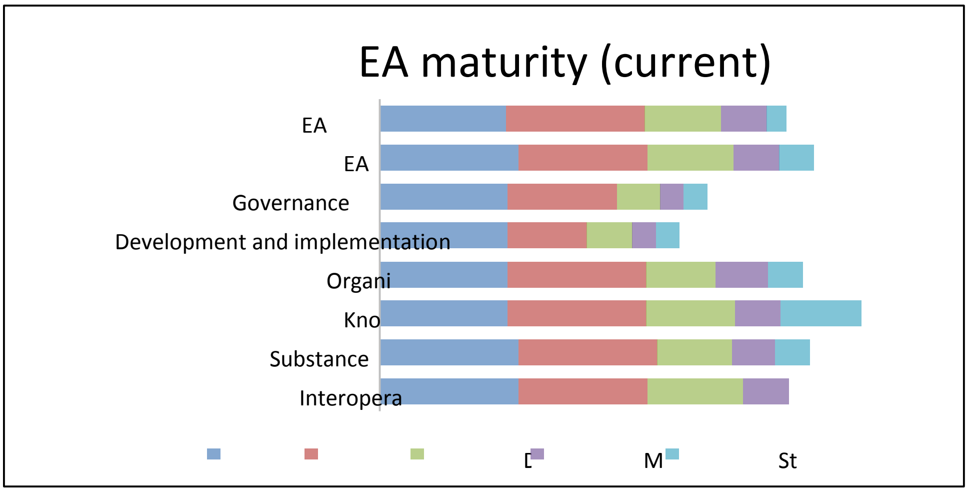


Figure 4: Current EA maturity (percentage)

During the next 6 months HEIs are focusing their efforts to increase the maturity of EA method and governance and processes domains (Figure 5). Some attention is also given to Development and implementation and Interoperability domains.

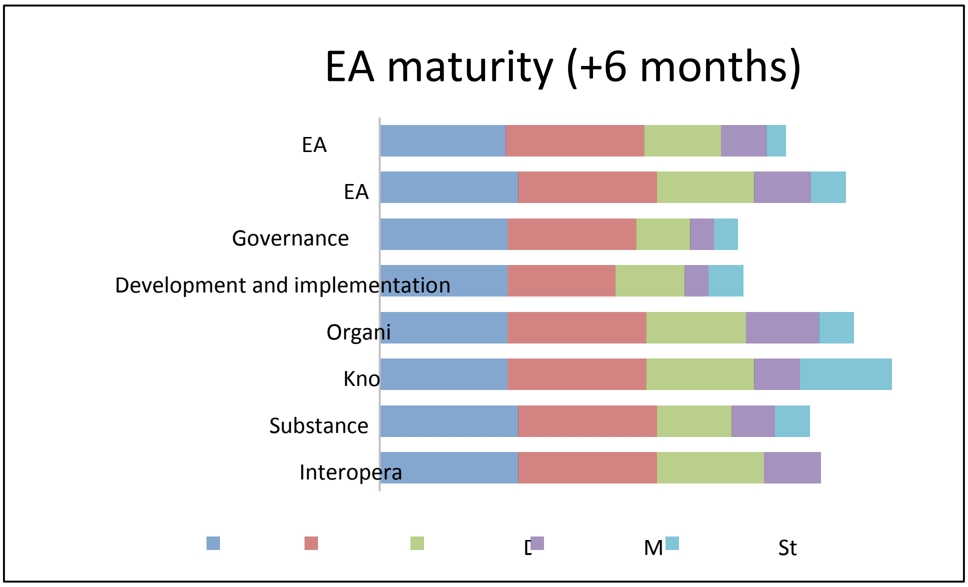


Figure 5: EA maturity after 6 months (percentage)

During the next 12 months the maturity of the different domains are levelling, except for the development and implementation (Figure 6). At least 25% of the HEIs will achieve the strategic level maturity in one or more domains.

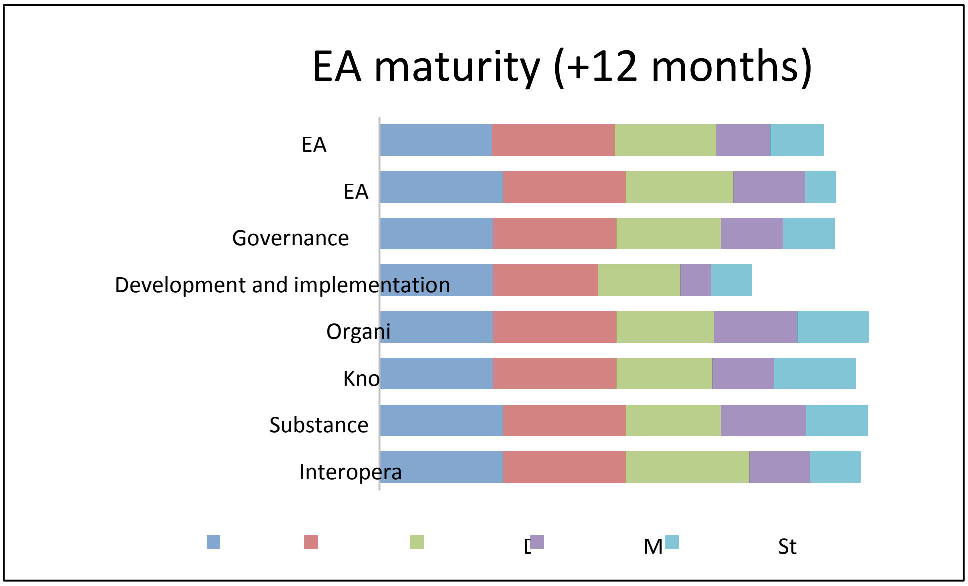


Figure 6: EA maturity after 12 months (percentage)

In 24 months the EA maturity will be on high level. Substance support domain will have the highest maturity, as all HEIs will achieve the managed level and 75% the strategic level (Figure 7). This indicates that HEIs are working with the issues which are relevant to their core-business. Besides the information security, optimising education technology and student success technologies are the top IT issues in 2016 (Grajek, 2016).

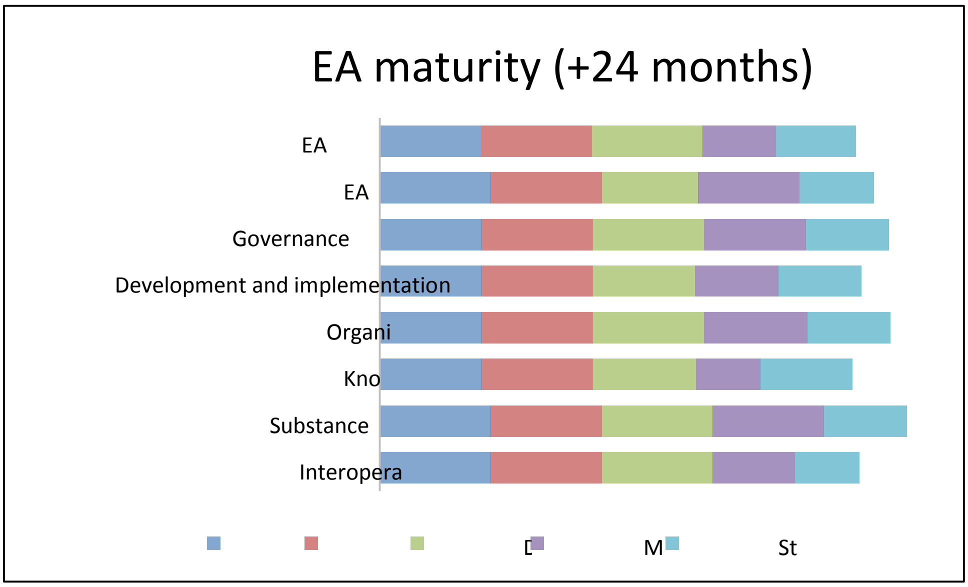


Figure 7: EA maturity after 24 months (percentage)

The overall development of EA maturity is illustrated in Figure 8. The percentage of HEIs achieving the defined level is raising steadily from 50% to 100% during the next 24 months. Also the percentage of organisations on the managed level and strategic level are increasing.

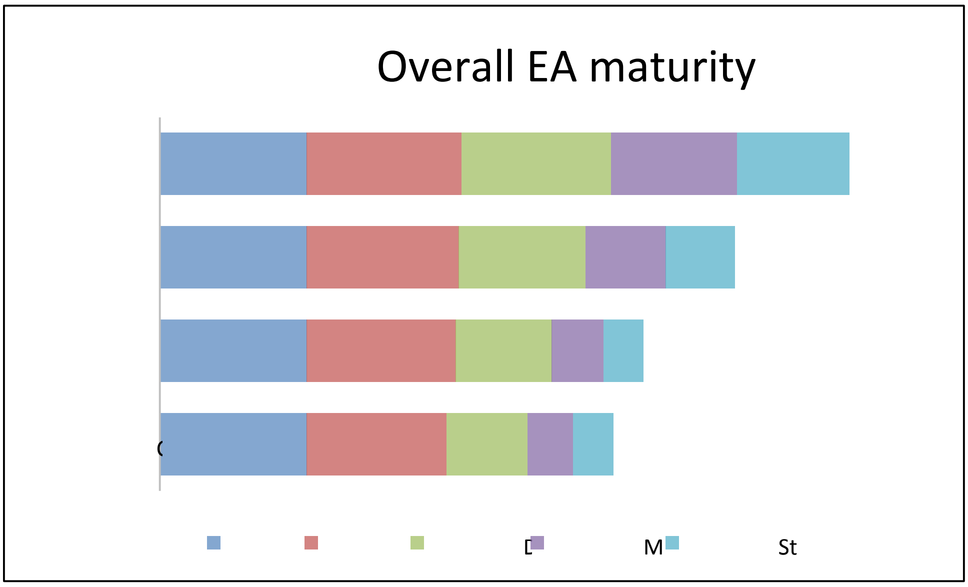


Figure 8: Development of overall EA maturity

4.3 Enterprise Architecture capability maturity

The maturity of EA capability refers to the levels of urgency and significance of each KEMM architecture domain. In other words, how critical and urgent each domain is to HE sector. The maturity of EA capability is illustrated in Figure 9. As it can be seen, Substance support is the most significant and urgent maturity domain. Another domain with high urgency is the Knowledge domain, which is interesting, as it is currently the most mature domain.

The average of all significance assessments is 2.97 which is in line with the background question average seen in Table 3.

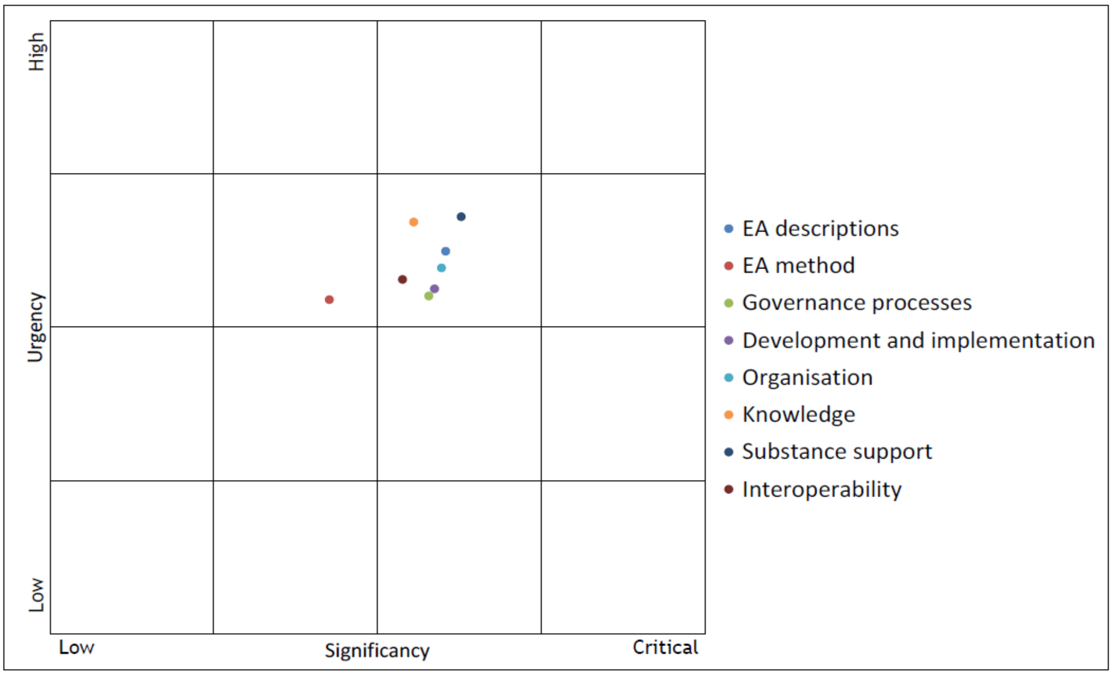


Figure 9 Enterprise Architecture capability maturity (*n*=17)

5. DISCUSSION

This paper presented findings from a recent EA maturity study conducted among Finnish HE sector. As the results indicates, the current EA maturity in Finnish HE sector is still low. Practically all HEIs have achieved the *partial* level but only 50% of the HEIs have achieved the *defined* level. The results are in line with the overall EA maturity of the Finnish public sector (Finnish Ministry of Finance, 2015). According to respondents, the *defined* level will be achieved by all HEIs during the next two years. Time will show whether this estimation is too optimistic or not.

According to the results, Finnish HE sector should focus on increasing the significance of EA work, which is currently relatively low. One way to increase the significance is to increase the awareness of EA and its benefits among the top-management. Also the maturity of *Governance processes* and *Development and implementation* domains should be given attention to. EA training focusing on these domains might help to achieve higher maturity levels.

This paper has some limitations which authors would like to express. The number of the respondents (*n*=19) is too low to make definitive statistical conclusions. There are 40 HEIs in Finland, so, at best, the respondents represent 47.5% of the Finnish HE sector. Therefore, the results and conclusions should be regarded as indicative.

Authors encourages other European HEIs to conduct similar studies to explore the current and future maturity of EA. European wide research would allow HEIs to benchmark their performance against peers and plan their development activities accordingly.

6. REFERENCES

CSC. (2013). *KARTTURI 2.2 - Korkeakoulujen kokonaisarkkitehtuurin menetelmäopas. (Enterprise Architecture method guide for Higher Education Institutions)*. (Vol. 2nd). Helsinki: CSC Tieteen tietotekniikan keskus Oy.

Finnish Ministry of Finance. (2011). Act on Information Management Governance in Public Administration (643/2011). Retrieved from https://www.vm.fi/vm/en/04_publications_and_documents/03_documents/20110902ActonI/Tietohallintolaki_englanniksi.pdf

Finnish Ministry of Finance. (2015). *Tietoja valtion tietohallinnosta 2014. Valtiovarainministeriön julkaisuja 27/2015. (Facts on information management of Finland 2014. Publications of the Ministry of Finance 27/2015).* (Finnish Ministry of Finance,). Helsinki: Ministry of Finance Retrieved from http://vm.fi/julkaisu?pubid=6408.

Grajek, S. (2016). Top 10 IT Issues, 2016: Divest, Reinvest, and Differentiate,EDUCAUSE review (pp. 10-63). Retrieved from http://er.educause.edu/~/media/files/articles/2016/1/erm1611.pdf.

Hiekkanen, K., Korhonen, J. J., Collin, J., Patricio, E., Helenius, M., & Mykkanen, J. (2013, 15-18 July 2013). *Architects' Perceptions on EA Use -- An Empirical Study.* Paper presented at the Business Informatics (CBI), 2013 IEEE 15th Conference on.

Kella, T. (2014). Kokonaisarkkitehtuurin tila ja periaatteet Suomen korkeakouluissa. Retrieved from https://confluence.csc.fi/download/attachments/31819654/KA-ty%C3%B6n+ja+periaatteiden+status+20140218.pdf

Lemmetti, J., & Pekkola, S. (2012). Understanding Enterprise Architecture: Perceptions by the Finnish Public Sector. In H. Scholl, M. Janssen, M. Wimmer, C. Moe, & L. Flak (Eds.), *Electronic Government* (Vol. 7443, pp. 162-173). Berlin: Springer.

Pehkonen, J. (2013). *Early Phase Challenges and Solutions in Enterprise Architecture of Public Sector.* (Master's Degree Programme in Information and Knowledge Management), Tampere University of Technology, Tampere. Retrieved from http://dspace.cc.tut.fi/dpub/bitstream/handle/123456789/21449/Pehkonen.pdf

Seppänen, V. (2014). *From problems to critical success factors of enterprise architecture adoption* Vol. 201. *Jyväskylä Studies in Computing* (pp. 250). Retrieved from http://urn.fi/URN:ISBN:978-951-39-5941-8

Syynimaa, N. (2015). *Enterprise Architecture Adoption Method for Higher Education Institutions.* (pp. 262). Retrieved from http://www.gerenios.com

The Open Group. (2009). *TOGAF Version 9.* Zaltbommel, Netherlands: Van Haren Publishing.

Tuomola, J. (2014). *Establishing Enterprise Architecture as a Part of Management and Development: the Field of Health and Welfare.* (Master's Degree Programme in Information and Knowledge Management), Tampere University of Technology, Tampere. Retrieved from http://dspace.cc.tut.fi/dpub/bitstream/handle/123456789/22744/Tuomola.pdf

7. AUTHORS' BIOGRAPHIES

Dr. Nestori Syynimaa MBCS CITP works as an Enterprise Architect for CSC - Finnish IT Center for Science, as a freelance trainer for the leading Finnish ICT-training company Sovelto Plc, and is the founder of Gerenios Ltd. He is also a member of the Finnish EA-SIG. His is experienced trainer in Enterprise Architecture and Office 365. Previously he has worked as CIO, CTO, and senior consultant in ICT industry since 2000. He holds BBA from Seinäjoki University of Applied Sciences and M.Sc. (Econ. & BusAdm with major in CS) from University of Vaasa, Finland. He received his Ph.D. from Henley Business School, University of Reading, UK. His second Ph.D. dissertation on EA is under pre-examination in University of Jyväskylä, Finland. He also holds several industry certificates including TOGAF, ITIL, Microsoft Certified Trainer, Microsoft Certified Educator, and MCSA (Office 365).

Patrik Maltusch is the head of EA architecture team at Aalto University, Finland. He is also chairman of the Finnish EA-SIG and one of the lead educators who have coached administration staff in the national Higher Education EA schooling program. Past experience include working as a customer service instructor for nearly ten years and further fifteen years as network architect and business owner for internal infrastructure design in a global Telco company. Patrik is also a distinguished and accredited security professional, risk manager, system auditor and a certified Higher Education Enterprise Architect. As entrepreneur and start up facilitator Patrik understands what staying practical means for business. For Patrik interoperability is the key to success in an ever growing and more complex and complicated ecosystem landscape. Something that can be achieved using EA methodology in a more visualized way.

Esa Suominen works as an Enterprise Architect at Helsinki Metropolia University of Applied Sciences. He is also secretary of the Finnish EA-SIG. He has long experience in IT sector at HE Institute. He has worked as Team leader at Information System Development group, Project Manager, IT Manager and in IT Support. He holds M. Sc. from University of Lappeenranta, Finland. He is interested in to implement Enterprise architecture and Project Portfolio Management in practical way at organisations.

The Future of IT Management: A Longitudinal Qualitative Review

Noel Wilson[1] and Johan Bergström[2]

[1] BALLYMENA, Northern Ireland, BT42 2BT, e28533@btinternet.com
[2] ICT Services and System Development (ITS), Umeå University, 901 87 Umeå, Sweden, johan.bergstrom@umu.se

Keywords
IT Management, IT Leadership, IT Strategy, CIO

1. Summary

This paper is a sequel to the 2015 paper "EUNIS Congress' 21st Birthday: A Historical Perspective on its Proceedings". Its focus is on IT management activities as interpreted from information available in the "EUNIS Proceedings repository". Papers on non-technical aspects of IT management are a small percentage of those presented over the Congress' 21 year history; they fall under several tracks, however by "drilling down" into abstracts and keywords an indication of "hot topics" is possible.

IT management foci have seen paradigm shifts from emphasis on operational and service management through customer relations and strategic management, then governance and 'top table' participation. Technological advances are impacting significantly upon society, with the pace of change being rampant. With the socialization of IT and the personalization of "smart" devices are we confronting a future where current IT management emphasis needs to change in terms of an ability to keep pace with an agile environment? What skills are necessary if IT leadership is to be in tune with institutional requirements and capable of delivery so as to maintain competitive advantages? Is the successive reliance on conventional management practices agile enough in the present time? Are we at a crossroads where present management emphasis is at variance with a need to be an innovative leader identifying and devising technology-rich environments that are abreast of our student generation? Some challenges and approaches to them are outlined in response to these questions, calling upon research elsewhere in the Higher Education (HE) sector and in business literature.

2. IT MANAGEMENT: HISTORICAL CONTEXT

IT managerial skills and experiences have changed considerably since the early establishment of centralized computer departments, say, from the late 1950s onwards. "Early days" managerial competencies focused on "running hardware" with little attention given to users, apart from researchers and their compute requirements. Considering this era as "first generation management"; the emphasis was on technical and operational knowledge and experience where the management function often resided with persons whose experience was gained through direct use of the technology. Over the past 50 years a transition from a technical specialist to board-level strategist has evolved.

As the application of computing diversified to encompass non-scientific and non-engineering disciplines the need to recognize support requirements arose. Also, administrative computing began to develop, often as a separate organizational unit. The emergence of early organizational structures included a "user support" function sitting alongside, typically, a "systems" and "operations" function, however managerial oversight remained predominately a technical responsibility.

In the 1970s, as organizational structures developed those who held responsibility for functional areas became eligible for promotion to managerial positions. Concurrently, user bases were expanding with undergraduates now using computers and the presence of mini and microcomputers bringing about a broader spectrum of support services. The transition from a technical specialist manager towards an appreciation of wider service needs began. Their departmental subordinates were the "technical brains" who helped steer technical and operational needs. Relationships with peers in finance and staffing completed the portfolio of senior managerial requirements commensurate with the era.

With the 1980s came further managerial developments, including mergers of library and IT departments as information in digital formats became de rigueur. In a number of UK institutions the merged department came under the leadership of persons with a librarianship background, indicating transition towards user centric strategic developments. Moving to the next decade, the ubiquity of IT was evident with major changes in the types of applications used in the academic world, demands for new management information systems to support the academic function, personal devices routinely used by students and digital networking pushing physical boundaries for IT use. Then, IT management became a boardroom level function due to its criticality to institutional competitiveness, as management information systems became the life blood of the business. Consultancy assignments replaced or complemented major in-house developments as a way of injecting new thinking and new knowledge into projects, perhaps indicating a more "open" approach to human resource provision.

The new millennium heralded further changes with many novel applications being harnessed, especially by the Y-Generation who were now in tertiary education as technically savvy Information Age students. The habitual use of social media, mobile devices and an ever increasing range of relevant freeware served to further delineate what should, and should not, be the strategic direction of centralized departments. As the millennium progresses so has the constraints on budgets due to the economic downturn and the increasing dependency on IT to support the institution's business. Availability of commercial software and consultancy services alongside the ever-evolving "in the cloud computing" opportunities are impacting the HE sector as institutions seek to keep pace with information requirements. Can internal human resources and the corresponding knowledge base alone sustain the needs of a progressive tertiary education sector? Emerging technologies is a buzz phrase that succinctly encapsulates the paradigm within which IT seems to now be permanently seated. On the other hand, and against strong external pressures, the sector is confronting flexibility and sustainability issues as a constant demand. What can be achieved? Today emphasis is focused more towards strategic and leadership matters than technology; the capability to deliver business value using technological platforms with lowest 'total cost of ownership' is a greater challenge than an exclusively technological one. The continuing decline of government funding, especially in the UK but also elsewhere, coupled with increased competitiveness and the constant need for information services see the Chief Information Officer's (CIO's) roles extend far beyond the technology; they contribute to a vision for institutional change and act as a catalyst to bring about these changes.

3. MANAGERIAL CHALLENGES

Myriad phrases populate the literature when the pace of change in IT is discussed. Today's business emphasis focuses on information and data including analytics, privacy and security aspects and "the cloud" with its many ramifications for how IT is provided and managed. The proliferation of mobile devices pushes the "technology everywhere" agenda whether for staff or students. Mobility is but one dimension of the "internet of things", with cloud computing presenting opportunities not even conceived a few years previously. These technologies are the tip of an emerging technologies iceberg. Looking at the UK's UCISA "Strategic Challenges for IT Services" report (2013) we note that effective governance, choice of appropriate delivery model, use of consultancy, process improvement and 'corporate data issues' inhibiting value optimization from Business Intelligence applications are some of the key challenges. Educause's 2016 "Top 10" list (2016) promotes "divest, reinvest and differentiate" as key themes; *divest* from what can be provided by others, *reinvest* in the workforce skills and structures and *differentiate* by adopting technologies, processes and services that align with the institution's most strategic priorities.

Agility within a leadership context seems to balance with emerging technologies within an IT business support context. To achieve flexibility, sustainability and a competitive edge mandates a sound and agile leadership culture. An ability to keep abreast of new developments affords the opportunity to examine their relevance and business worth to a progressive institution. An important question is "What level of technical knowledge is appropriate to appraise new developments and their suitability for addressing aspects of an IT Strategic Plan and how best can this knowledge be achieved?" With the prevalence of emphasis on management performance, whether using Balanced Scorecards, Key Performance Metrics or Service Agreements, the need to take "right" and "timely" decisions is critical.

The senior IT manager, along with their departmental team, is a critical link in the university's overall decision making process. This collective resource needs to focus on a common goal; their capability to 'add value to the business.' Restructuring of organizational units is common, especially in UK universities, though perhaps predicated by a requirement to reduce operational costs rather than as a method of strategic realignment of skill sets. For example, customer focused developments whilst necessitating sound technical domain knowledge also mandates a persona with capability of building and maintaining successful human-human relationships. 'Back of organization' specialist teams may not possess the social and technical skills to be members of a 'front of organization' team. Similarly, retraining and the pace of retraining necessary to keep pace with the contemporary technological world, is predicated on an aspiration to interact widely and to possess a positive attitude towards ‘learning from others’, with less effort directed towards ‘learning by doing’. A recent Deloitte report on “Higher Education is Evolving” (2011) discusses the roles of the CIO within Canadian Universities, stating that “Higher education CIOs today often see themselves engaged in campus-wide discussions and decisions that have little to do with technology.” This assertion is likely to adequately describe the European as well as the US situation. For example, EDUCAUSE’s article by Berman et al (2014) on “Challenge Accepted! Why CIO Is the Best Job on Campus” cites several CIOs roles, many indirectly technology-related and many others at the very heart of institution’s vision and strategy.

4. A REVIEW OF EUNIS CONGRESS PRESENTATIONS

A qualitative review of Congress contributions associated with non-technical managerial level issues is challenging given the nature of information available. In general terms, Eunis Congresses tend to focus on technical matters and in its formative years there were several contributions from within the research community. Even today technical contributions continue to feature heavily, including several that are presented under a leadership theme given their “pushing new approaches and technologies” nature. Whilst technical leadership is acknowledged, nevertheless the focus is upon the higher tiers of leadership; those involved in the wider horizon gazing and actively contributing to how the overall institution is being positioned within the higher education arena.

Using track titles and undertaking amalgamations where there are similarities across years, for example tracks where “leadership” or “strategy” is in the track title are combined into a generic “leadership” or “strategy” title respectively, the distribution of what may be perceived as “Csuite” presentations is as shown in Table 1. The total of these presentations represents approximately 35% of all Congress presentations over the past 21 years. Examining when particular tracks were introduced provides some indication of when a topic became important. For example “changing roles of computer centres” featured in years 1997 and 1998 whereas “IT Governance” didn’t feature until 2004, “leadership” and “strategy” in 2005 and “new challenges” in 2010.

Table 1: Generic Track Titles

Generic Track Titles	Count
IT Strategy	84
IT Leadership	77
IT Governance	119
IT Management	61
Changing Roles/Structures/Challenges	64

An examination of paper titles, abstracts (where available) and tracks provides a generalized synopsis of management-related issues. In line with the paper’s title, effort has been made to identify contributions that evidence an evolution of the role played by centralized IT departments.

As early as 1997, in the UK, Information Strategies (IS) were becoming topical; also in the USA the relevance of environmental screening to strategic planning highlighted the pace of change within the HE sector. Rothery and Hughes (1997) in discussing IS conclude that the role of central IT/Computing Services whilst not central to the Information Strategy process, is essential in implementing IT developments contained within it, thus reinforcing the department’s institutional commitment. The authors reinforce the importance of an IS as opposed to the technology, highlighting a significant departure in how computing/IT is viewed. The era brought about a new emphasis, one of wider institutional needs not only technology per se. Central IT departmental leadership needed to grasp that subsidiary or subservient nature of an IT Strategy to the Information Strategy; their capacity to function strategically as opposed to technologically and managerially became more centre stage. Foster (1997), in discussing environmental screening, advised that “technology is no longer the limiting factor. Now, more often than not, institutional culture and practice are the inhibitors or catalysts for change”. Her remarks indicate a transition of emphasis towards “the greater good of the institution.” Reid (1998) provides insight to changing roles of central IT departments. He mentions strategy- and policy-related roles. Strong indications of mergers with libraries and the need to more closely IT align with the core business of the university are articulated. His work highlights matters requiring leaders who could identify with trends and who had the ability to operate at board level in the interest of ensuring the salient aspects of their organizational units were understood and protected.

In 1999 Congress’s focus turned towards technological innovations. Whilst “IT Strategy” and interuniversity collaboration featured nevertheless these presentations adopted a stance around technologies. The topic of “University Management” featured in 2000 though presentations focused on technologies including knowledge management and national networking initiatives. Similarly in 2001, the tracks “Changes in University

Organisation and Structure” gave consideration to technology, for example the use of the internet to support “anytime-anywhere support services”. This was the only topic that clearly provided opportunity for strategic leadership contributions. The 2002 event’s programme continued with themes broadly aligned to those in the preceding three years though Law’s (2002) keynote presentation on “Planning and designing IS for university management” provided that higher level of non-technical leadership focus. Furthermore, as a keynote presentation, it reinforced the continuance of importance of IS’s from their emergence some five years earlier. Amsterdam’s Congress, in 2003, heavily featured the “e-topics” (e-Learning, e-University and e-Science), with the Gartner keynote presentation on “Higher Education: the state of the technology”. The first decade of Eunis Congresses concluded with the 2004 Congress theme of “IT Innovation in a Changing World”. The tracks addressed continued to feature aspects of transactional leadership with grid computing, various applications of commercial products to “e-scenarios” and IT governance much to the fore.

By 2005, tracks included “Strategy” and “Governance and Leadership” headings alongside technologyrelated topics including middleware, e-learning and information systems. 2006 continued with “Strategy” and the introduction of a session on “Leadership: Effective Management” complemented by tracks comparable to the immediate past Congresses. Regrettably abstracts are unavailable to ascertain the nature of paper contributions though paper titles indicate discussions around leadership and IS developments, the role of IT in shaping an organization, customer focus and leading and managing. Apart from a track incorporating “IT governance and strategy” the 2007 Congress track list returned its attention to technologies including implications associated with mobile device use, IT support for the Bologna process, identity management and security and “e-themes”. 2007’s keynote address, by Zastrocky, titled “IT leadership and the Role of the CIO” identified the upcoming shortage of IT leaders and the role and requirement for Chief Information Officers (CIOs). His research on CIO roles reinforces a 21stC requirement for these persons to be “full spectrum” contributors to the organization’s most senior executive team (Zastrocky, 2000). In 2008 three tracks featured “management”, namely “managing processes”, “Managing IT projects” and “Managing IT Infrastructure and Data Centres”. Based on the associated abstracts, each paper focused on what may be considered to incorporate elements of organizational leadership; leadership incorporating strategy execution and the facilitation of change based around adoption of new technologies and new processes. For example data centre virtualization, standards adoption e.g. associated with ITIL ® and COBIT ®, podcasting and various software technologies were discussed. Moving to 2009, technologies, identity management, e-learning, security and web-based solutions dominated, with “IT Governance” the only observed track providing a strategic and potentially pan-national approach to governance (Fernández and Llorens, 2009). A similar suite of tracks featured in 2010, with the introduction of a “New Challenges” track serving to capture papers discussing the potential value of specific technologies to learning, teaching and administration. The 2012 Congress saw “Leadership” return to the track list where associated contributions focused on the academic realms of the university. Moving to 2013, “Leadership and Governance” was a track within which benchmarking, departmental reorganization and approaches to IT governance based around the ISO Standard featured. The role of Chief Information Officers (CIOs) first featured in a track title; “CIO and IT Management”, in 2014. The associated papers, similar to in 2012, featured technologies (e.g. Microsoft Lync and cloud computing) apart from Wilson’s (2014) where changes within HE and Institution’s IT demands impacted upon central IT department’s roles and organizational structures. Last year’s Congress (2015) featured a track titled “Leadership, Management and Governance (Surveys).” Hotzel et al (2015) provided an interesting survey of CIO types within the German University sector; other papers within the track focused on technologies with enterprise architecture, based around COBIT, being used to assess the value that IT adds to an institution (Westerlund, 2015).

The synopsis illustrates the substantial variability perceived to exist across the history of the Congress, yet where presentations indicative of “C-suite” matters arise it is interesting to note the ebb and flow of key issues. Changing roles and structures within IT departments featured from 1997 to 2001; IT governance was evident during the period 2004 to 2009; IT strategy during 2005 to 2012 and IT Leadership from 2005 through to 2015. Whilst each track did not feature in each year of the time intervals nevertheless an indication of the prevalence of the topic is acquired.

5. WHAT IS THE FUTURE FOR LEADERSHIP AND MANAGEMENT?

Positions that fall within the “C-suite” classification, such as the CIO or “IT leader”, vary in their responsibility portfolios and some smaller institutions may not incorporate the word “chief” in senior IT titles. Hopkins and Clarke (2013) provided a thought-provoking glimpse at how institutional IT roles could change, quoting Jon Madonna, “Nothing stops an organization faster than people who believe that the way you worked yesterday is the best way to work tomorrow.” The emphasis on changes of skills and competencies is strongly stated. In

2014, Eriksson focused on managerial attributes relevant in today's agile world. Both contributions touch upon technological, political, financial and social changes as they influence the environment within which the successful IT leader operates. Moving forward over the next few years it is likely to be the case that "change will be a constant" whether technologically or otherwise. Quoting, from George Orwell, "If people cannot write well, they cannot think well, and if they cannot think well, others will do their thinking for them", the latter part of his expression ably sums up the criticality of effectiveness for leaders and managers. However, can we expect a university to recruit, retain and develop the portfolio of skills necessary to keep ahead of the changes it faces? "Probably not" for many institutions however a culture of acceptance of consultancy, reports from trusted community sources (e.g. Educause, EUNIS, and UCISA) and networking/partnering with fellow institutions may help alleviate the skills and workforce pain.

Considering the initial question "Are we confronting a future where past and current management emphasis needs to change?" indications are that the answer is "Yes" and that change does take place, whether through restructuring, role changes or approaches to service provisioning. For example, the maturity of modern ubiquitous technologies, the socialization of IT and the personalization of "smart" devices serve to demystify the technical aspects with resulting changes in demand on support services. The management of the IT support function is on a transition towards customer service, quality and performance management, and "any-time any-where" access. Strategic opportunities to avail of offcampus support from providers such as NorMAN and UniDesk are outsourcing options. In the UK the Joint Information Systems Committee (JISC) provides a contemporary and comprehensive portfolio of services to support institutions, whether by analyzing IT expenditures, providing access to a shared data service framework or producing a comprehensive suite of "state of the art" reports across a range of issues relevant to technology and its implications for teaching and learning, research and administration. The "X as a Service" (XaaS) model, of which the preceding examples are part, is sufficiently mature to become an alternative to in-house provision. The capacity to evaluate, select, implement and then successfully manage XaaS developments mandates expertise such as contract management, relationship management and negotiation. Whilst these skills are not a new requirement, nevertheless they are likely to be the skillset of key persons if an institution pursues the displacement, for example, of aspects of data centre services with an "IT as a Service" (ITaaS) provider. An appetite for retraining may be needed. Change is inevitable within management practices; no longer is it timely, economic or strategic to expect to have oversight of key business needs and concurrently devise and implement bespoke solutions. The future of effective management resides in the territories of collaboration, business partnerships and the effective transformation of staff skills and aspirations towards enhanced social networking, greater acceptance of solutions already proven elsewhere and the internal dissolving of technical organizational barriers. The preceding comments relate to "within organizational unit" strategic matters however the leadership role to evolve change must be in tune with "board level" requirements and be capable of delivering change within their scope where the action underpins competitive advantages for their institution. Conventionally the identification of managerial and leadership skills has been based on theoretical models of the "quadrant type" or "personality trait assessment tools". These approaches compartmentalize persons based on perceived strengths however agile environments may blur boundaries to mandate greater levels of risk taking, greater flexibility in terms of roles, responsibilities and decision making and more frequently dealing with business and technological issues that are beyond one's "comfort zone" of knowledge and experience. Transformational leaders are needed in an agile environment, those with a vision, a capability to inspire others and to contribute to cultural change. Findings of the Educause report "Todays Higher Education IT Workforce" (2014) are pertinent regarding non-technical skills and appetites to reskill for "non-managerial" staff.

Regarding the question concerning "level of technical knowledge appropriate to appraise new developments and their suitability for addressing aspects of an IT Strategic Plan", the answer should have cognizance of what aspects will be in-house and necessitate local business intelligence, for example those associated with information management and business intelligence. Analytical skills coupled with a capability to effectively interact with other senior business unit staff are required.

Keeping pace in an agile environment encompasses government policy, the institution's student catchment and the execution of the university's mission statement. IT leadership that demonstrates acuity in this wider context, a strong track record of 'horizon scanning', the ability to identify need for change and execute change, adapting aspects of the business to achieve "best fit" with other changes and the authority, and respect of board-level personnel, to identify IT projects to achieve and maintain competitiveness are necessary "C-suite" capabilities. An Accenture report "Traits of a Truly Agile Business" (2014) states a comparable set of competencies for the continued success of large multi-national business organizations, based on its survey of "C-suite" executives. Hayes, in her JISC blog (2014), reinforces the need to "develop the skills in our current, and likely future CIOs, to keep pace with the ever-changing landscape and organizational expectations for IT." For an institution to maintain competitive advantage the skills and experience of the CIO must be incorporated within executive decision making; as an effective communicator and collaborator, the CIO, will ensure the viability of IT solutions to business needs and identify how IT can effect transformations.

Traditional managerial practices and scope of influence have changed and are likely to continue to change as the environment within which the “C-suite” IT executive performs. “Knowledge of IT” is less important than “knowledge about IT and its capabilities”; an appetite for change in a broad sense is essential since the prominence of IT management, or leadership, has gradually risen through institutional hierarchies, reaching to the highest tier of management.

6. CONCLUDING COMMENTS AND OBSERVATIONS

Weaknesses and limitations exist in this survey and the opportunity to draw specific conclusions is limited. For example, the type of information available is inconsistent across the review period; in some instances only the Congress Programme is available and in other instances there is access to Abstracts. It must be recognized that the observations made are based on those universities whose staff have contributed to EUNIS Congresses; they may be unrepresentative of the wider European University sector. Furthermore, senior management positions are likely to assume various portfolios of responsibility dependent upon, for example, the size of the organization, its type (e.g. principally research focused, mainly undergraduate taught courses etc.), the range of disciplines covered (e.g. liberal arts, technological, business or hosting a medical faculty) and the primary funding source (e.g. government, private, research or hybrid funding models). Todd, in her doctoral thesis “Leadership in Higher Education: The CIO Role and the Leadership Team” (2011) provides a comprehensive review of responsibility and role differences associated with CIOs drawn from “mid-size 4-year private US Colleges”. Her work helps to substantiate the need to be attentive to “influencing variables” when seeking to state generalizations. The choice of keywords and the positioning of papers within tracks is open to interpretation; track titles vary across years with papers with similar focus appearing under tracks with dissimilar titles. The eclectic mix of factors involved in the study coupled with the authors’ interpretations are critical and must be considered in any observations made.

Generally speaking, the principal thrust of Congress presentations as measured by frequency of occurrence of track titles, is that of “technology as an enabler” whether for information management, teaching and learning, research or other administrative purposes. The associated leadership, or management, roles are varied with several corresponding to “C-suite” activities; those that enable strategic decisions, those that reside at the centre of an organization’s business direction and those that streamline and add value to processes. Positions in the HE sector and similar positions in the public sector have many “soft” skills and roles parallels, as evidenced from the literature referenced elsewhere, however there are also several characteristic differences between, for example, income sources, impact of government policies and outputs.

Given the significance of IT “C-suite” roles within universities it is timely to consider an initiative whereby the European HE community could be surveyed, examining opportunities to collaborate in identifying developmental opportunities for the future “CIO” within EU HE institutions. EDUCAUSE’s work in education and development programmes is acknowledged and made readily accessible to the Eunis community. The work of Leslie and van Velsor (1998) may highlight factors of contemporary relevance, for example in the areas of cultural heterogeneity and cross-national team working factors. Co-operation from within the Coalition of Higher Education Information Technology Associations (CHEITA) would be distinctly advantageous in facilitating American and Australasia involvement.

7. REFERENCES

Accenture (2014. “Traits of a Truly Agile Business”). Retrieved April 25, 2016, from: https://www.accenture.com/us-en/insight-traits-truly-agile-businesses.aspx

Berman, M. et al. (2014). Challenge Accepted! Why CIO is the Best Job on Campus. EDUCAUSE review online. Retrieved April 25, 2016, from: https://www.educause.edu/visuals/shared/er/Extras/2014/Good2bCIO/default.htm

Bichsel, J. (2014). Today’s Higher Education IT Workforce. Retrieved April 25, 2016, from: https://library.educause.edu/resources/2014/1/todays-higher-education-it-workforce

Clarke, M. and Hopkins, P. (2013). *Altruism is dead! The Perfect Storm: BYOD + CLOUD meet MOOCs*. EUNIS (2013). *Papers and Abstracts*. Retrieved April 7, 2016, from http://www.eunis.org/eunis2013/sites/default/files/upload/Paul%20Hopkins%20and%20Mark%20Clark%20(Altruism%20is%20dead-%20The%20Perfect%20Storm%20%E2%80%93%20BYOD%20CLOUD%20meet%20MOOCs).pdf

Deloitte (2011).Higher Education is Evolving: As the business model changes, the governance model must too. Retrieved April 25, 2016, from: http://www2.deloitte.com/content/dam/Deloitte/ca/Documents/human-capital/ca-en-humancapital-higher-education-evolving.pdf

Eriksson, L. D. *The new manager - a gardening type!* EUNIS (2014). *Papers and Abstracts*. Retrieved April 7, 2016, from http://www.eunis.org/eunis2015/wp-content/uploads/sites/3/2015/06/Parallel4-Track-5-Paper-34-The-new-manager-a-gardening-type.pdf

Fernández, A. and Llorens, F. An IT Governance Framework for Universities in Spain. EUNIS (2009). Abstracts and papers. Retrieved April 25, 2016, from: https://app.box.com/files/0/f/2623206251/1/f_22373429353

Foster, S. J. Managing the Crisis in Information technology Support in US Higher Education. EUNIS (1997). *Papers and Abstracts*. Retrieved April 25, 2016, from: https://app.box.com/files/0/f/2613731093/1/f_22299903125

Grajek, S. (2016). Top 10 IT Issues, 2016: Divest, Reinvest, and Differentiate. EDUCAUSE review (online). Retrieved April 25, 2016, from: http://er.educause.edu/articles/2016/1/top-10-it-issues-2016

Hotzel, H. et al. CIOs at German Universities – a Survey by ZKI. EUNIS (2015). *Papers and Abstracts*. Retrieved April 25, 2016, from: http://www.eunis.org/eunis2015/wpcontent/uploads/sites/3/2015/04/EUNIS2015_submission_54_P1_TRACK_2_slot_3.pdf

Law, D. Planning and designing IS for university management. EUNIS (2002).*Papers and* Abstracts. Retrieved April 7, 2016, from: https://app.box.com/files/0/f/2615473715/1/f_22313890493 [Note: Congress Programme only available]

Leslie, J. B. and Van Velsor, E. (1998). A Cross-National Comparison of Effective Leadership and Teamwork: Towards a Global Workforce. Centre for Creative Workforce publication. ISBN 1-882197-34-8

NorMAN Helpline, University of Northumbria. Retrieved April 7, 2016, from http://www.outofhourshelp.ac.uk/

Reid, T. A. The Changing Role of University Computing Centres. EUNIS (1998). *Papers and Abstracts*. Retrieved April 25, 2016, from: https://app.box.com/files/0/f/2613771771/1/f_22299959983 Rothery, A. and Hughes, A. Information Strategy: A Tool for Institutional Change. EUNIS (1997). *Papers and Abstracts*. Retrieved April 25, 2016, from: https://app.box.com/files/0/f/2613765885/1/f_22299893849

UCISA Report 2013: Strategic Challenges for IT Services. Retrieved April 25, 2016, from: https://www.ucisa.ac.uk/~/media/Files/publications/surveys/Strategic_challenges_for_IT_Services_2013_FINAL

Todd, N. (2011). Leadership in Higher Education: The CIO Role and the Leadership Team. Unpublished doctoral thesis. Retrieved April 25, 2016, from: https://libres.uncg.edu/ir/uncg/f/Nicolet_uncg_0154D_10808.pdf UniDesk. Retrieved April 7, 2016, from: http://www.unidesk.ac.uk/

Westerlund, K. Setting goals and measuring the value of Enterprise IT Architecture using the COBIT 5 framework. EUNIS (2015). *Papers and Abstracts*. Retrieved April 25, 2016, from: http://www.eunis.org/eunis2015/wp-content/uploads/sites/3/2015/04/eunis2015_submission_14_P4_TRACK_2_slot_3.pdf

Wilson, N. Information Technology - In Transformation: Organizational Structure Implications? EUNIS (2014). *Papers and Abstracts*. Retrieved April 25, 2016, from: http://www.eunis.org/eunis2014/papers/

Zastrocky, M. R. and Schlier, F. (2000). The higher education CIO in the 21st century. EDUCAUSE Quarterly, 23(1), 58–59.

8. AUTHORS' BIOGRAPHIES

	Noel Wilson holds a Master in Mathematics from Ulster University. He is a Chartered IT Professional and a Fellow of the British Computer Society. His career in the HE sector spanned 41 years, with 35 spent in various managerial roles. In July 2005 the University awarded him a Distinguished Learning Support Fellowship for his contributions to IT and media service developments. His LinkedIn reference is: http://www.linkedin.com/pub/noel-wilson/15/476/91a
	Johan Bergström manages the EUNIS ERAI project. He is employed as a Project Manager and International Business Co-ordinator at the University of Umeå. He graduated from Uppsala University with a Bachelor in Computer Science and Linguistics. He has held various positions in industry and higher education. Johan's expertise includes project management, consulting, business analysis, coaching and training. His LinkedIn reference is: https://www.linkedin.com/profile/in/johanbergstrom

EUNIS 2016: Enter the mindset of a hacker. Why? Because to protect against hackers, you have to think as one!

1st Asbjørn Reglund Thorsen

FSAT, Fridtjof Nansens vei 17, 0369 Oslo, a.r.thorsen@fsat.no

Keywords
Security, hackers, live-demos, mindset, dark-web, tor-browser

1. Summary

Even the best security researchers can fall for hackers trickery, so how on earth should you expect an ordinary person to make good enough security precautions? To protect against hackers you have to think as one. In this talk the speaker will show with several live demos how hackers might attack you in the every day life and how easy it is to get hacked.

2. ABOUT THE EXTENDED ABSTRACT

A good hacker has both great skills and great tools to compromise you as a target. In this talk the presenter will show, by examples, how hackers easily can pinpoint you or your company with easy to use tools and some cunning techniques.

This talk has several live demos and all of them should be quite easy to understand and several possible precaution tips will be shown.

One demo shows how an attacker easily can become man in the middle without the victim even touching the computer/tablet/pad/mobile. Another demo will show how a hacker can plant a device in your company's network and easily get access from the internet.

The audience will be walked through several methods of hacking and a tour deep into the dark web where hackers buy and sell credit cards, personal information, usernames and passwords etc. This market place provides hackers and others with basically everything money can buy.

This talk is for everybody that wants to dive quickly into the world of a hacker to understand what's out there and that hacking is big business.

3. REFERENCES

Tor browser: https://www.torproject.org/projects/torbrowser.html.en Hak5 gadgets: http://hakshop.myshopify.com

4. AUTHORS' BIOGRAPHIES

Asbjørn Reglund Thorsen is group leader and head of development at group Delta at FSAT, responsible for maintaining and developing applications for the national admission services in Norway. He also works as a pen-tester, speaker and is a co-founder of Awareness Security AS. He is board member of Open Web Application Security Project (OWASP) in Norway and has specialized in web application security both as a pentester and course instructor, he also likes to play with wifi pineapple and other gadgets. Linkein profile: https://www.linkedin.com/in/reglund

University ict security certification

Ciclosi F.[1], Mauri M. [1], Polzonetti A[2]

[1]Computer Center University of Camerino

[2]ELIOS srl. Spin Off University of Camerinos

Keywords
Security, Certification, ISO 27001, ISMS

1. ABSTRACT

Information security management is a key aspect in the good governance of ICT. Due to the evolution and widespread about the Internet, organizations are easier to attack on the information technology systems. Given the above background, the University's IT Services and Systems Centre (CINFO) decided to respond to external requests by trying to manage the change in such a manner that would imply giving up an old approach, based just on technology update, and directly aiming at managing the procedures concerning security issues. In this paper we discute the certificate process at Camerino University and the results obtained.

2. INTRODUCTION

In the last few years, the University of Camerino has been tackling a number of challenges concerning ICT security, both in order to comply with the increasingly stringent regulations for Italian Pas [1], as well as to respond to sudden changes (not just the technological ones) that have been affecting service infrastructures during the current transition from a client-server paradigm to a new functional one. Being based on a cloud system and on software defined networking, the new paradigm is providing the basis for a global interconnection model involving heterogeneous and 'smart' devices that are typical of the so-called 'Internet of Things' [2].

Given the above background, the University's IT Services and Systems Centre (CINFO) decided to respond to external requests by trying to manage the change in such a manner that would imply giving up an old approach, based just on technology update, and directly aiming at managing the procedures concerning security issues.

Within such a scenario, starting from 2012, an in-depth work has been done to gradually redefine all the IT processes, so that they could be provided under stable operating conditions, in compliance with rules and arrangements (not just technical ones), so that confidentiality, integrity and availability requirements could be guaranteed, even though in a general although quantifiable manner .

The final decision to start a virtuous route that, by using the ISO 27001 certification as operating gearing, could lead to a redefinition of internal organizational processes, was made in response to the issues originating from the 'Studio di Fattibilità Tecnica' (Technical Feasibility Study) [3], as per Art. 50-bis ('Continuità Operativa' (Operational Continuity)) of the 'Codice dell'Amministrazione Digitale' (Digital Administration Code) (Legislative Decree No. 82/2005, and as amended through Legislative Decree No. 235/2010) [4].

3. THE CERTIFICATION PROCESS

The certification process included the following macro activities, which were not necessarily performed individually and consequentially:

- Definition of ISMS (Information Security Management System) perimeter
- Establishment of a shared ISMS policy
- Applicability statement (Annex A)
- Redefinition of the organizational structure
- Implementation of a risk analysis method

- Implementation of a risk management strategy developed through improvement actions
- Definition of control effectiveness indicators
- Definition of an audit and review plan

In particular, the process started with a study and investigation phase in order to define the perimeter of the ISMS pertaining to CINFO, including the field of application, as well as limits and exclusions [5]. The outcome of this study phase enabled us to define the certification scope in the following object statement: ‘Supply of connectivity, email, web portal, telephone, hosting and management services to the University and to customers that may request them.’

Therefore, an in-depth analysis of the main services supplied by the University on behalf of CINFO was carried out, especially focusing on their organization, infrastructures, data, devices, networks and support technology.

In particular, an asset tree was developed for every service (BS - Business Service), in order to map out its layout. The asset tree includes the following information units:

- IF (Information)
- SW (Software)
- HW (Hardware)
- COM (Communication devices)
- L (Locations)
- P (People – Human Resources)

Likewise, the various parties that are interested in supplying/using such services were also identified and divided into the following groups: students, teaching staff, technical-administration staff, external staff, public parties, private parties and external users. Then a set of guidelines was also developed to specify the structure’s features and the requirements set forth by the University’s policies concerning IT security. Such guidelines were conceived by keeping in mind that they could also be applied, at a later stage, to methods and tools used for information management. The work devoted to this phase facilitated the rise of a new kind of awareness as regards the meaning of information security, where information started being considered as an essential resource that is needed to carry out the University’s business activities. Hence, given its value, it deserves to be properly regulated and protected.

The document infrastructure set up to support the certification process is composed of regulations, roles and rules that specify how resources, including sensitive information, are to be managed, protected and distributed within the University. In particular, each document tackles a single security topic by describing it from any possible points of view and according to any interests it may have for different users [6]. The documents were divided into the following categories:

- DS – System Documents;
- PO – Organizational Procedures;
- PT – Technical Procedures;
- IO – Operating Instructions.

The classification of every single document is made by indicating a chronological number that univocally identifies it within the corresponding category. Moreover, for the benefit of human users, a title explaining the document’s contents is also provided. Therefore, the whole documentation was made available to all the interested parties that were authorized beforehand, through publication on a special web portal with limited and controlled access.

The following step saw the development of a matrix that helps to establish a correlation between the control objectives and the controls specified in the Annex A enclosed to the ISO 27001:2005 standard [7], and its applicability to the perimeter of the above-mentioned system (see Figure 1). Within such a context, the current state of implementation by CINFO of the indications set forth for the various controls was also identified and detailed.

Annex A – Control Objectives and Controls	Current state	Applicable	Notes

A.5 Information security policies					
A.5.1 Management direction for information security *Objective: To provide management direction and support for information security in accordance with business requirements and relevant laws and regulations.*					
A.5.1.1	Policies for information security	Control A set of policies for information security should be defined, approved by management, published and communicated to employees and relevant external parties.	DS 02 – ISMS Policy	SI	NOT NEW
A.5.1.2	Review of the policies for information security	Control The policies for information security should be reviewed at planned intervals or if significant changes occur to ensure their continuing suitability, adequacy and effectiveness.	Annual Review	SI	NOT NEW

Figure 1 - Example of how the Control Objectives and Controls matrix (see Annex A) should be completed.

This work tool, that features a peculiar, intrinsic dynamism, was and still is regularly updated so that it may reflect at all times any ISO developments (e.g. the transition from the 27001:2005 version to the new 27001:2013 one [8]), as well as any changes that may occur within the University's ISMS.

The management of the security 'process' also required a redefinition of CINFO's organizational structure. This lead to the development of three functional areas (Systems, Networks, Applications) reporting to the Technical Management and supported by two staff (Secretarial Services and Help Desk). Detailed specifications concerning roles, connections, hierarchical reporting, duties and responsibilities were defined for each functional area.

Then, a customized strategy for risk analysis and an assessment was also defined and implemented. Although it was developed starting from concepts discussed in literature [9], nevertheless the strategy in question was adapted to the peculiar ISMS perimeter being used.

In particular, the method adopted was the Magerit one [10], which was implemented through the PILAR software tool [11]. Such an approach includes five, well defined steps, which are summed up here following and that are repeatable when risk management operations are carried out.

- Step 1 – Assets
- Step 2 – Threats
- Step 3 – Countermeasures
- Step 4 – Impact
- Step 5 - Risk

When tackling Step 1, the assets that are important for the University are defined through an analysis of the main ones [12] – i.e. those that are made of data and processes that transform them into information. That's why the concept of 'assets interdependence' (i.e. the measure in which an asset from a higher level is affected by a security accident involving a lower level asset) is quite important. So, assets were divided into five levels in order to formalize their dependence and make the calculation of cumulative or consequent risk easier. As regards asset value, a qualitative ranking system was opted for (with a 0-10 range), to allow for a quicker positioning of each asset's value in relation to the others, even when the final risk outcome is not expressed in financial terms, but according to a conventional order of magnitude.

When dealing with Step 2, first of all, all the threats that were considered relevant to every asset type were identified. Then the asset groups and the relevant threats were matched together.

That was done because not all the threats affect all the assets. Moreover, even when an asset is affected by a threat, it may not be concerned by all the threat's dimensions and in the same way. Finally, once it was defined which threat may damage a given asset, the latter's vulnerability level was established by considering the frequency value (how many times a year the threat occurs) and damage value (average value, as a percentage, of the damage suffered when the threat occurs).

During Step 3, the impact and risk that may theoretically concern the assets were calculated, as a cautionary measure, in the worst possible case, i.e. as if there was no protection in place. Therefore, such an approach would show what may happen if none of the countermeasures were activated. Generally, the countermeasures may be included in the risk calculation either by reducing the threat frequency (preventative countermeasures), or by limiting the damage caused (containing countermeasures).

When working on Step 4, the impact that threats may have on the systems was calculated by considering both the asset value and the damage level that, in theory, such threats may cause. During the process, special attention was devoted to the dependence relation between the various assets, keeping in mind that whereas the IT system value is based on the services offered and on the data processed, however, threats do tend to affect the means used. Two types of calculations were chosen: the cumulative impact and the reflected impact ones.

During Step 5, the last one, the actual calculation of the risk value was carried out [13] [14], by considering the impact of threats and their occurrence frequency. Using a given asset as reference, the single risks were combined or grouped in different ways, as it had already been done for the impacts, until a global value was obtained and expressed by using a ranking system.

The single risks, related to a given asset, may realistically combine or group in different ways, just as it may happen with impacts, as described in Step 4.

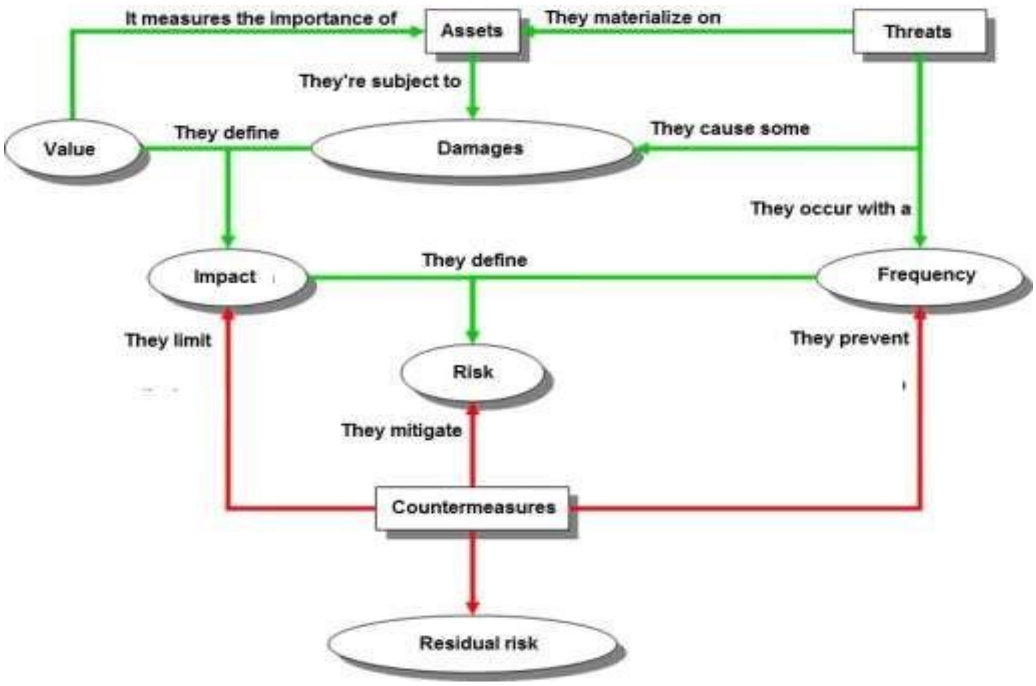


Figure 2 - The steps of the risk analysis and management method adopted.

At the end of the risk analysis, the global risk value related to a single asset is, therefore, expressed according to its level of criticality by using an eight-point ranking system:

- {0} := Negligible
- {1} := Low
- {2} := Medium-low
- {3} := Medium

- {4} := Medium-high
- {5} := High
- {6} := Critical
- {7} := Very critical

where two threshold values were defined beforehand, that are:

- alert threshold – no further countermeasures need to be taken below such a value;
- action threshold - if such a value is reached, then suitable countermeasures need to be immediately identified to bring the risk value back to acceptable levels.

Within such a perspective, it was decided to accept the consequent residual risk value if the latter is lower than the action threshold value.

Once the identification phase concerning existing risks was concluded, such risks were tackled through a method based on the improvement actions to be taken, in order to reduce their associated value. (see Figure 3). By considering a continuous improvement process based on the Deming Cycle, the implementation status of the proposed actions recorded in the Improvement Action Registry is constantly monitored and works as an input for every new risk analysis and management process that is constantly carried out, at least on an annual basis. Within such a perspective, the evidence detected also provides an opportunity to indirectly monitor the effectiveness of actions that were undertaken.

#	Source	Ref. Doc.	Point ISO27001	Weakness	Action
1	AR	DS-05, § 6.3.1, countermeasures [AUX6]	9.2.3	cabling is not completely protected and identifiable	Configuration errors, interferences and data interception may easily occur if cabling is not checked

Consequences	Priority	Responsibilities	Resources	By	Evidence status on 25 June, 2015	%
Labelling all the cables related to the systems. Separating power cables from data cables. Checking that unauthorized interception of data traffic is impossible by accessing the cabling.	Medium	Mr. Rossi	Internal	31 Dec, 2015	PT-20 – Security and cabling schema.docx - V.0 del 18/11/2013	100

Figure 3 - Example of how a record should be set up in the Improvement Action Registry

Within the ISMS adopted by CINFO some special indicators were defined in order to continuously monitor the effectiveness of activated controls, and were also properly associated to the related regulations [15]. A special card was created for every indicator, along the lines of ISO/IEC 27004:2009 [16], where the most important features of the indicator in question are summed up.

Such indicators and the ISMS get continuously into contact through the implementation of decision criteria. In particular, the acceptability thresholds define whether a given value may or may not be considered risky, and potential improvement actions may be triggered. On the other hand, the desirability thresholds define whether a given value may or may not be considered acceptable and, in the latter case, an alert message to the system administrators may be activated.

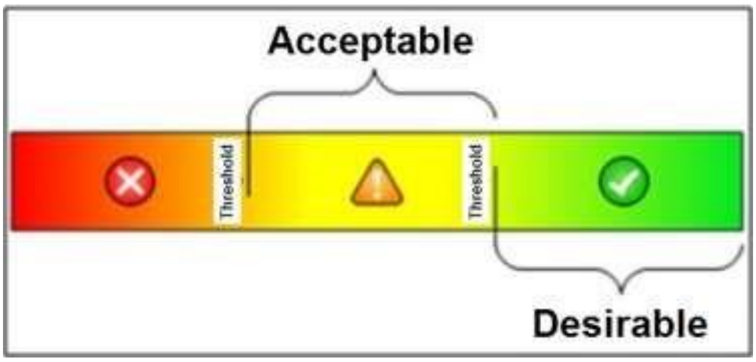


Figure 4 - Diagram of a decision criterion

The values resulting from the effectiveness measurements, or the values associated to all the indicators that were defined based on the frequency identified for their detection, are gathered through a special table-like form that helps to check the trend of what has been detected, compared to previous years and to the minimum (acceptable) or recommended threshold values (desirable).

ID	*Description*	*Detection rate*	*Annex A point*	*2013*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*2014*	*Desirable*	*Acceptable*
I27	Password quality	6m	A.11.3.1	3			4			4			5			5	**5**	**2**	**4**

Figure 5 - Example of how a record should be completed in the Table for Effectiveness Indicators of Activated Controls

The system continuous improvement is guaranteed by setting up a 3-year program for internal auditing [17]. During the auditing, all the requirements set forth by ISO regulations are carefully analyzed. If anything unacceptable is detected, the implemented procedure specifies that a corrective action is to be immediately entered in the Improvement Actions Registry.

Point	Requirement	Objective Evidence	Detection
4.2	Understanding the needs and expectations of interested parties	DS13 (Context and scope) – DS01 (SGSI Perimeter) – DS04 (ISMS Organization)	NO

Figure 6 - Example of how a record should be entered in the Internal Audit Report

In addition to the internal auditing, an annual review of the whole ISMS should also be carried out. During the review, all the incoming and outgoing elements that may be useful to perform a proper assessment of the system are gathered, in order to ensure that the system is effective, adequate and suitable on an ongoing basis. At the same time, any improvement opportunities and amendment needs are also evaluated, including what needs to be done for the information security policy and its objectives.

4. TRANSITION TOWARD THE NEW ISO 27001:2013

The transition and adjustment process concerning the new ISO 27001:2013 [18], which has already been carried out last year, required that some changes (not particularly expensive ones) had to be made within the ISMS, in order to adjust both the regulatory references and the structure of some documents to the new requirements set forth by the ISO standard.

For example we have revisioned our system documents in order to substitute the Deming Cycle (Plan-Do-Check-Act) with the new but equivalent ‘Framework for managing risk’ (DesignImplementing-Monitoring/review-Continual improvement) introduced by the standard ISO/IEC 31000:2009.

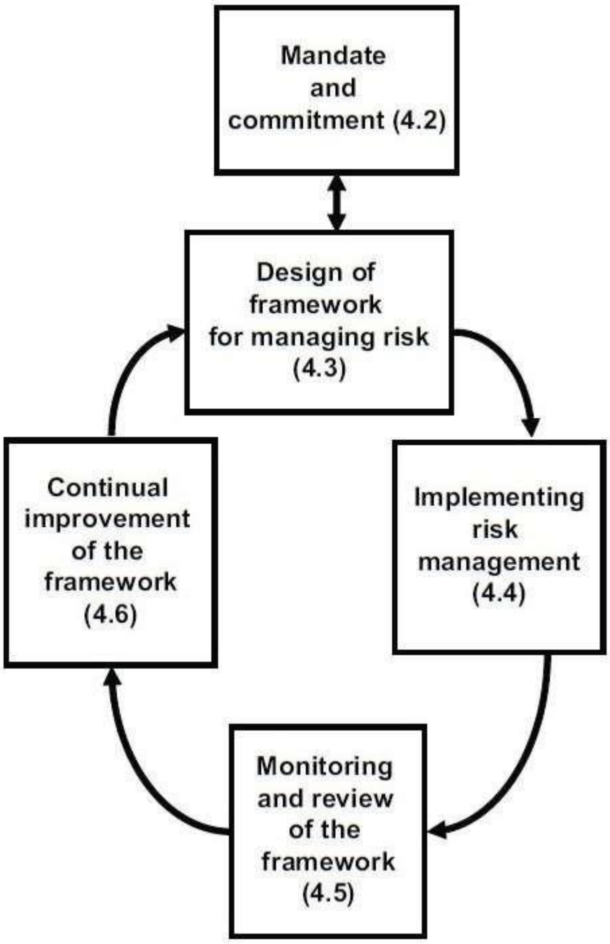


Figure 7 – The Framework for managing risk by the ISO/IEC 31000:2009 Clause 4

From an organizational point of view, no special arrangements were required, since over the years the system has been organized in such a manner that would facilitate a linear transition toward a new version of such a standard.

5. RESULTS OBTAINED

In order to comply with the requirements specified in the ISO 27001 standard, in the year 2013, CINFO has got a new tool dedicated to the management of security incidents called CIM (CINFO incident management). It is a web application used by all employees for the registration and management of events or security incidents.

The implementation of the CIM system has been fundamental and throughout the years has allowed the CINFO to collect a large amount of data, used as an input for the indicators table, for the corrective actions definition, as well as for the internal audits and the annual review.

As an example of the results of this virtuous cycle we’ll illustrate how from the analysis of data collected in the CIM it has been possible to identify the cause of some anomalies and then to proceed to their resolution. We will present two examples: the first relating to the reduction of the data center services downtime and the second relating to the backup jobs management.

5.1 Reducing the services downtime in the data center

About the first aspect, the data recorded in CIM during the year 2013 saw a significant downtime time in some services housed at the university data center. The analysis of these data allowed us to identify the cause of the problem, due to the presence of two particularly obsolete SAN and to the inadequate air-conditioning system (this situation became especially critical during the summer, when outdoor temperatures were higher). In the first quarter of 2014, we renewed the data center's air conditioning infrastructure and then we proceeded to the obsolete SAN replacement.

The outcome of these actions has guaranteed an immediate decrease in the downtime of services in the data center from 2.1% in 2013 to 0.08% in 2014. After that it has constantly maintained its level below the threshold level (set at 1%) in the following years too. In fact, the 2015 total value was 0.58% and the one detected in the first quarter of 2016 was 0.02%.

Table 1 - Comparison of different downtime data center services rate in the period 2013-2016 (first quarter)

Year	ID	Description	Detection rate	Annex A point	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Desirable	Acceptable
2012	I31	Uptime datacenter services (%)	1m	A.14	0,0%	0,3%	0,2%	0,0%	0,5%	0,0%	1,0%	0,3%	0,5%	0,2%	0,7%	0,2%	0,3%	1%	3%
2013	I31	Uptime datacenter services (%)	1m	A.14	0,0%	0,0%	0,5%	0,6%	0,8%	0,0%	10,3%	0,7%	0,7%	10,8%	0,7%	0,0%	2,1%	1%	3%
2014	I31	Uptime datacenter services (%)	1m	A.14	0,1%	0,1%	0,0%	0,0%	0,0%	0,00%	0,52%	0,00%	0,00%	0,00%	0,00%	0,26%	0,08%	1%	3%
2015	I31	Uptime datacenter services (%)	1m	A.14	0,00%	0,30%	0,07%	0,14%	2,89%	0,07%	0,13%	0,40%	0,14%	0,00%	2,78%	0,00%	0,58%	1%	3%
2016	I31	Uptime datacenter services (%)	1m	A.14	0,00%	0,00%	0,07%										0,02%	1%	3%

5.2 Backup management improvement

About the second point from the analysis of the types of incidents recorded in CIM, it has been possible to identify the inadequacy of backup procedures using obsolete hardware and heterogeneous software platforms. In order to solve this critical situation the following corrective actions have been implemented:

- logical and operational organization of the first and second level backup systems, including the consolidation and/or replacement of hardware equipment;
- the update of the technical procedure called 'backup', by better specifying the information to be saved, the media handling and the backup job instances recording management.

The outcome of these actions has guaranteed an immediate increase in the percentage of the backup successfully managed from 88,13% in the fourth quarter of 2014 to 98.47% in the first quarter of 2015. In general by comparing the data on an annual basis, there was a significant increase, rising from 90.26% in 2014 to 98.38% in 2015. These data are also confirmed by the first detection in 2016 which, in March 31, showed a successful rate in the first quarter, amounting to 96.09%.

Table 2 - Comparison of different backup success rates in the period 2013-2016 (first quarter)

Year	ID	Description	Detection rate	Annex A point	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Desirable	Acceptable
2016	I10	% Backup successfully	3m	A.10			96,09%										96,09%	85%	75%
2015	I10	% Backup successfully	3m	A.10			98,47%			97,45%			98,91%			98,70%	98,38%	85%	75%
2014	I10	% Backup successfully	3m	A.10			90,96%			88,42%			93,53%			88,13%	90,26%	85%	75%
2013	I10	% Backup successfully	3m	A.10			98,30%			99,40%			99,46%			99,5%	99,17%	85%	75%

5.3 Final conclusion

To sum up, the choice made to follow the ISO27001 certification route revealed to be far-sighted, since it drove the ISMS toward a method change based on the management of the security 'process'. Therefore, an actual change of route has taken place, one that has led to designing (or redesigning, in many instances) the systems for distributed services provided by the University. Special attention was devoted to security issues considered in a holistic manner and not just from a technology point of view anymore. Therefore, we can definitely state, without a shadow of a doubt, that, apart from the unquestionable prestige and proven quality level of our University, the main benefits obtained through the certification process are to be found in the cultural change that has been introduced, one that represented a real quantum jump and marked a clear cut with the past.

6. REFERENCES

[1] Agenzia per l'Italia Digitale website (2014). *Linee Guida per il Disaster Recovery delle Pubbliche Amministrazioni ai sensi del c. 3, lettera b) dell'art. 50bis del Codice dell'Amministrazione Digitale*. Retrieved April 27, 2016, from http://www.agid.gov.it/sites/default/files/linee_guida/linee-guida-dr.pdf

[2] Ciclosi, F. (2015). *Implementare il paradigma SDN con OpenFlow Switch Protocol. Guida teoricopratica di riferimento*. Roma, Italia: published by the author.

[3] Iacono, G., Marzano, F., Medaglia, C. M., (2012). La continuità operativa negli Enti locali. Guida pratica alla gestione del Piano. Dogana, Repubblica di San Marino: Maggioli Editore.

[4] Art. 50-bis D.Lgs. 7 marzo 2005 n. 82.

[5] ISO (2013). *ISO/IEC 27002:2013, Information technology -- Security techniques -- Code of practice for information security controls.*

[6] ISO (2016). *ISO/IEC 27000:2016, Information technology -- Security techniques -- Information security management systems -- Overview and vocabulary.*

[7] ISO/IEC (2005). *ISO/IEC FDIS 27001:2005(E), Information technology – Security techniques – Information security management systems – Requirements.*

[8] Wings2i IT Solutions Pvt. Ltd. Website (2014). *Comparison of Controls between ISO/IEC 27001:2013 & ISO/IEC 27001:2005*. Retrieved April 22, 2016, from http://www.wings2i.com/pdfs/Differences%20between%2027001%202013%20Vs%202005.pdf

[9] Chavas, J. P., (2004). *Risk Analysis in Theory and Practice*. San Diego, USA: Elsevier Academic Press.

[10] PAe portal administracion electronica website (2012). *MAGERIT – version 3.0 (English version) Methodology for Information Systems Risk Analysis and Management. Book I: method*. Retrieved April, 21, 2016 from http://administracionelectronica.gob.es/pae_Home/dms/pae_Home/documentos/Documentacion/Metodologias-y-guias/Mageritv3/MAGERIT_v_3_-book_1_method_PDF_NIPO_630-14-1620/MAGERIT_v_3_%20book_1_method_PDF_NIPO_630-14-162-0.pdf

[11] EAR / PILAR website (2014). *Report Templates*. Retrieved April, 21, 2016 from http://www.pilar-tools.com/doc/v54/ReportTemplates_en_e_2014-01-30.pdf

[12] Freund, J., Jones, J. (2015). *Measuring And Managing Information Risk - A FAIR Approach*. Waltham, USA: Elsevier Inc.

[13] ISO (2009). *ISO/FDIS 31000:2009(E), Risk management – Principles and guidelines.*

[14] International Electrotechnical Commision (2009). *IEC/FDIS 31010:2009(E), Risk management – Risk assessment techniques.*

[15] ISO (2011). *ISO/IEC 27035:2011, Information technology -- Security techniques – Information security incident management*.

[16] ISO (2009). *ISO/IEC 27004:2009, Information technology -- Security techniques -- Information security management – Measurement*.

[17] ISO (2011). *ISO/IEC 27007:2011, Information technology -- Security techniques -- Guidelines for information security management systems auditing*.

[18] ISO (2013). *ISO/IEC 27001:2013, Information technology -- Security techniques -- Information security management systems – Requirements*.

7. AUTHORS' BIOGRAPHIES

Francesco Ciclosi is a twenty years experience analyst and trainer, responsible for designing distributed systems services. He is graduated in computer science and has achieved several professional certifications such as: Cisco CCNA, Microsoft MCSE, MCT, MCSA, MCTS and VMware VCA-DCV. He's the author of many articles about computer security and of the books "Implement the paradigm with SDN protocol OpenFlow switch" and "S.A.T.A. traveling to the System of Access to Administrative Transparency ". He has worked with many government agencies, private companies and universities, in the framework of national projects, such as the Italian electronic identity card project. Currently he's working at Camerino University as Information Security Management System manager and cloud computing, server virtualization and storage platform administrator. He's also working as "Computer Science" contract professor at Macerata University. He has previously worked at "Asur" CEO office, at Nestor, the experimental safety laboratory of Tor Vergata University in Rome and at Siemens Informatica "Security Data Networks". Further information is available at https://www.linkedin.com/in/francesco-ciclosi-a0668062

Using Honeypots in Network Intelligence Architectures - The University of Trás-os-Montes e Alto Douro case study

José Bessa[1], Hugo Coelho[1], Pedro Monteiro[1], José Brito[1], António Costa[1]

jmiguelbessa16@gmail.com, *coelho.hu@gmail.com*, *monteiro.p@outlook.pt*, *jbrito@utad.pt*, *acosta@utad.pt*

[1]University of Trás-os-Montes e Alto Douro, Quinta de Prados, 5000-801 Vila Real, Portugal

Keywords

Network Intelligence Architectures, Business Intelligence, Big Data, ETL, Honeypots, Security, Intrusion Detection Systems, Monitoring.

1. ABSTRACT

Organizations have increasingly data that needs to be processed to produce information and knowledge in a timely manner. To assist this, Information Systems in the decision-making processes have been developed, which are the case of Decision Support Systems and the Business Intelligence architectures. Many of the organizations' services are supported by communication infrastructures and it is necessary to guarantee that these are prepared to ensure the proper functioning and availability of services and applications. According to this, there is a lot of data being produced indicating their operational status in order to monitor and track their performance.

Considering the Information's importance to organizations, security and confidentiality of the data needs to be assured, therefore Intrusion Detection Systems are an integral part in systems management, with particular importance on safety and infrastructure's reliability and the business data supported by them. This case study was conducted to assess the contribution that Honeypots can have in the creation of security intelligence. The use of Honeypots, Decision Support Systems and Business Intelligence architectures in the organizations' network infrastructures allows to build Network Intelligence Architectures for management and more efficient protection.

With the NIA built for the case study of the University of Tras-os-Montes e Alto Douro, IT and Communications Services have greater insight into their network infrastructure, allowing them to take informed and consented decisions based on the service and security indicators provided by the NIA and create policies to protect the infrastructure.

2. Introduction and Scope

Nowadays, Information, Knowledge and Intelligence represents a key to the success of an organization, and allows it to gain competitive advantage and gives the best possible way to manage the business. In order to achieve these levels of abstraction, first it is necessary to consider the data from the organizations daily activity. Given the exponential growth of data, there is a need to streamline its treatment, which has encouraged the use of Information Technologies (IT) to support the organization's Information Systems (IS). These systems do not work isolated and they need to be integrated, which involves the use of communication infrastructures and support systems, particularly when organic units are geographically dispersed. More and more organizations use communication infrastructures to support their business, and as such it is important that they are monitored and managed so they can sustain in the best way the various activities of organizations, not only for their normal operation, but also for strategic activities (Taylor, Gresty & Askwith, 2001).

Monitoring is crucial for the management operations, as it allows to early on identify trends and patterns in data traffic, network devices' behavior (anomalies, performance issues), in order to ensure infrastructure's reliability, robustness, high productivity and quality of service to those who use it (Avizienis et al., 2004). After handling the data generated by IT, which is part of the network infrastructure and its systems, it is possible to get knowledge about it. In order to know their behavior, a tailored SI such as a Decision Support Systems (DSS), can be used to enable informed and consensual decision making.

The use of DSS and Business Intelligence (BI) architectures to obtain Knowledge on management and monitoring network infrastructures, can be associated to the concept of Network Intelligence. On the other hand, the Computer Security issues are closely linked to the performance of these infrastructures. Therefore, it is important to use mechanisms to assess whether it is safe and vulnerability free, including them in a Network Intelligence Architectures (NIA) (Russell & Cohn, 2012).

In order to reduce the risk of compromising information, security policies should be created to ensure business continuity in its normal flow. These policies should be regularly reviewed so that there is a constant evaluation. They must ensure that the information is accessed only by authorized entities and that is always available, while the data is real and consistent. Additionally it is necessary that vulnerability and threat detection methods are present in the infrastructure. This will help to improve the security policies already established. Thus, it becomes possible to calculate the risk that the compromised Information may cause to the organization (Ahmed, Mahmood & Hu, 2016).

One of the mechanisms used to increase IT Security is the use of Honeypots. A Honeypot is another security tool, which along with other tools of this kind, helps in network intrusion detection, giving network and system administrators the necessary knowledge to treat these network security incidents, either by detection and prevention of attacks, or to its reaction. If then, this Knowledge of the intrusion is integrated into a Knowledge Management platform, it is possible to create a DSS, able to assess on creating standards and security policies to be applied to the infrastructure, so they remain in a stable state of security (Spitzner, 2002).

This work aims to demonstrate the applicability of probes based on Honeypot models for intrusion detection in an attempt to improve the Security Information strategy carried out by the University of Trás-os-Montes e Alto Douro's (UTAD) IT and Communications Services (SIC-UTAD), given the considerable number of detected intrusion attempts this institution receives. These, in successful cases, could compromise their services and consequently their reliability.

This paper is divided into four sections: in section 2 it is provided the scope of the paper and in section 3 a conceptual aproach around some of the key concepts that can be associated with Network Intelligence architectures. In the 4th section the case study is explained, the identified needs that led to the execution of this work, the proposed Network Intelligence architecture to UTAD and the used technologies. The paper ends with a section of tests and achieved results, as well as some final considerations and perspectives for future work.

3. Conceptual Aproach

The development of a NIA that make feasible the intentions of SIC-UTAD for the management of the network infrastructure, required the necessity to understand the concepts/technologies that can be applied over the data generated by the network, to obtain Knowledge and Intelligence, namely (Russell & Cohn, 2012): the DSS and BI architectures (focusing on Extract-Transforme-Load processes and Data Visualization). On the other hand, assuming data security as essential, there was a need to understand the Intrusion Detection Systems (IDS) and, in this article, the application of Honeypots to ensure this assumption, allowing its incorporation in this type of architectures.

3.1. From Big Data to Managing and Monitoring Network Communication Infrastructures

Nowadays, a great number of organizations have network communication infrastructures to support their several activities. In this way, many organizations can only support their business and activities, if they have an infrastructure of this kind (Sterbenz et al., 2010).

Given the importance of the network infrastructures mentioned above, it is important to manage and monitor them. Monitoring is crucial for the management operations, since it allows to early identify trends and patterns in data traffic, behavior of network devices (anomalies, performance issues), in order to ensure the reliability, robustness, high productivity of infrastructure and quality of service for those who use it. Monitoring represents a key element in network management, being this composed by activities, methods, processes and tools that support the operation and maintenance of the network infrastructure (Lee, Levanti & Kim, 2014).

Similar to what happens with remaining organizational data, also data from the network infrastructure have exponentially grown, being this phenomenon associated with the concept of Big Data. This concept have appeared from the need to improve the management of large volumes of data, expediting the decision-making process.

Big Data is applied to the organization's ability to manage, store and analyze data. The data storage process is one of the most important aspects contemplated in this concept, hence it is necessary to create new ways to do that, given that the traditional ways fall outside this new paradigm. On the other hand, it is essential that not only the data is stored but also used in the organization routines, in order to speed up and sustain their activities (Chen & Zhang, 2014).

With Big Data it is possible to identify the most important customers and their needs to strengthen relationships, maximize profits and sales, mining data associated to clients in order to generate new marketing campaigns, analyze data from media and banking to detect new socio-economic market trends, analyze data from social networks, among others. (Bolón-Canedo, Sánchez-Maroño & AlonsoBetanzos, 2015).

When it comes to Big Data it is critical to consider the 5V's that allow to realize their essence and relevance that there is a concept explaining this phenomenon, which are: Volume, Variety, Velocity, Value and Veracity. Explaining each of these "V's" (Hashem et al., 2015.):

- **Volume** is associated with the large amounts of data in multiple formats, from different sources, internal (e.g. internal IS) and external (e.g. newspapers, Internet, partners IS, social networks), and it is still constantly growing. The greater the data volume is, the greater the ability to detect hidden patterns and optimize analytical models;
- **Variety** closely associated with the data format irregularity, since these may be structured (e.g. relational databases), semi-structured (e.g. XML, RDFS) or without structure (e.g. SMS, tweets, audio, video, images), which it is expected given the variety of data sources (e.g. sensors, mobile data, operational IS);
- **Velocity** refers to the transmission of data, its handling, delivery and availability in the data storage structures. This factor is important so that the availability of data is made in a timely manner, which is becoming real-time, since the dynamics of organizations requires that the time for decision-making becomes shorter;
- **Value** is the factor that explains the importance of data for relevant business information to be identified and extracted, as well as standards for defining action strategies and to influence the creation of new products/services;
- **Veracity** of data is required so that when analytical models are applied, decisions can be made based on real and consistent data, not creating ambiguities, fraud, questions, inconsistencies or incoherencies in these management activities.

Despite the current adoption and exploration of the concept of Big Data in the organizational environment, simple data collection by itself is no guarantee of competitive advantages. The data are mere representations of real facts, and only have value when contextualized and delivered to whom can interpret, for generate Information. For process management it is of interest to achieve a higher level of abstraction, namely Knowledge, passing through the analysis and extraction of conclusions from the Information (Kebede, 2010).

In order to manage the network infrastructure is important to have Knowledge and Intelligence (crossing Knowledge with the personal experience of those who use it) to take consensual and timely decisions. Thus, we can say that the NIA are architectures that in its genesis include mechanisms to obtain Knowledge and later Intelligence from network infrastructures.

A NIA contemplates the use of DSS to facilitate the processes of obtainment, retention and management of Knowledge and Intelligence enhancing and maximizing organizational resources (Scheibe et al., 2006). DSS belong to the class of information systems that are designed to facilitate decision-making processes, and have advanced analytical capabilities. They are often tailored to the person or group that uses them, so they should be flexible, interactive and dynamic (Vizecky & ElGayar, 2011). Its main tasks consists in the production and dissemination of information, hence they can be considered an information system.

This type of systems have other features such as the creation of Intelligence and organizational Knowledge, through the use of analytical data models with possibility of simulation scenarios and friendly interface with users over the creation of dashboards that represent graphically the data complexity using Data Visualization (DV) techniques (Grierson, Corney & Hatcher, 2015). Dashboards created in these kind of systems, in this case for the manage and monitor network infrastructures, use the DV techniques, which allow the application of analytical models and statistical functions, whose results are presented visually through interactive dashboards composed by tables, diagrams, graphs, histograms, maps and pilot panels (Janvrin, Raschke & Dilla, 2014).

The decision-making implies that there is organizational intelligence, that involves gathering information, analyze it, disseminate it (to who knows the business), get new opportunities, react in time and adapting. Everyday, this capacity should be an integral part of any organization, for business decision-making to be appropriated and have quality. However, with organizations storing increasing amounts of data, there is a need for the use of IT to its storage, delivery and processing to extract organizational intelligence. In order to fullfil that need, the concept of BI emerged (Ramakrishnan, Jones & Sidorova, 2012).

The concept of BI can be understood as a set of techniques and tools used to extract intelligence from a data set. Related to BI is a set of concepts, methods and processes to improve business decisions, which uses data from multiple sources and applies the experience and assumptions to develop, in a accurate way, knowledge of business dynamics (Petrini & Pozzebon, 2009).

Given the importance of the concept of BI to organizations, this has been exhaustively studied and defined by several authors. For this work, we assumed the definition of BI developed by the authors Sharda, Delen & Turban (2013), in which it is said that BI is an aggregator concept that combines architectures, tools, data sources, analytical tools, applications and methodologies. Integrates data analysis with decision support systems to provide information for all persons in the organization, who need to make tactical and strategic decisions. With the development of an appropriate BI architecture, an organization may be able to develop intelligent decision support systems for competitive advantage in the industry in which it operates (Wu, Chen & Olson, 2014).

The ability to combine business activities, IT and analytics, should be on the focus of the organization's work, with the creation of an adequate infrastructure that will achieve the organization's goals and allowing it to take competitive advantages; agility in decision-making processes; ability to handle sensitive information; identify patterns, trends or hidden behavior in the organization's data that may represent propitious situations related to customers and/or new business opportunities (Chen, Chiang & Storey, 2012).

A BI architecture must be aligned in the global infrastructure of the IS of an organization. Typically a BI architecture consists of (Olszak & Ziemba, 2007): internal data sources (data from operational systems) or external, Extract-Transform-Load (ETL), data storage source (e.g. database, Data Warehouse, Data Marts, ad-hoc queries), analytical tools for data processing (e.g. OLAP servers, Data Mining) and front-end applications where the data analysis results will be presented (e.g. dashboards, reports, graphics).

The ETL tools are a fundamental part of BI systems, since they are used to simplify and standardize the data migration process. In this work, this process has a particular focus, given the complexity and variety of data formats of the systems used in this case study. This module, aims to gather several data from heterogeneous platforms of the organization in a standard format that can be used by DSS, and at the same time should be able to integrate and standardize data. Also, it must be flexible because the requirements can be changed and the dynamics of databases should be considered as well (Guo et al., 2015).

The ETL concept, as the name suggests, involves three steps (Prema & Pethalakshmi, 2013): **Extraction**, where a copy of the new data is obtained since the last application of ETL tools, which are present in the various data sources (which may have different shapes and structures); in **Transform**, data is processed into information, a task consisting in the translation of encoded values; application of this process to certain categories of rows and/or columns; merge (merging) or aggregation of data in order to create a uniform structure which can be stored in the database. Finally the **Load** is done, which consists in the activity of populate the target tables present in the database, which can be a simple step, namely, rewrite new data over the oldest, or a more complex process in which data is held for historical purposes, keeping all records of all changes made.

Scalability is one of the most important factors to consider when this type of modules are constructed, since in some situations, the ETL modules have to process millions of data and update databases with millions of records. The exponential growth of data (Big Data) and the increasing data sources require that the ETL technologies become more advanced and flexible (Karagiannis, Vassiliadis & Simitsis, 2013).

3.2. Security

When we are talking about IS in organizations and Big Data, it is also necessary to take into account the policies and computer security mechanisms that prevent systems and organizational data of being accessed by unauthorized entities, ensuring their integrity. In this sense IDS emerged, which as the name suggests, are designed to detect and prevent intrusions (Liao et. al, 2013).

To understand the applicability of such systems it is necessary to understand what an intrusion is. An intrusion consists of a set of activities with the goal of misrepresent and/or compromise the integrity, confidentiality and availability of a resource. This type of illegal action comes from an attack or set of attacks and may or may not distort the data in a permanent way (Zuquete, 2013).

IDS try to assess this type of illegal activity and can detect intrusions from an early stage of trial or suspicious activity, to the consummation of this act. They act independently of the mechanisms that support the correct use of the systems in which they are applied, and to build an intrusion profile, they collect data on the various activities associated with a System allowing to conclude on likely past, present or future intrusions, this being a dynamic and constantly updated process (Jaiganesh, Mangayarkarasi & Sumathi, 2013).

Regarding intrusion reaction, this systems may be of two types: passive or active, whereas the former only react with alerts and reports to a specialist in this area to apply defensive measures, the latter have automatic response mechanisms to intrusions (Sekhar et. al, 2015). Despite the benefits of these systems, IDS like any other system, have limitations such as: false positives by false alarms and false negatives when an intrusion is not detected, which can lead to loss of trust in these systems; overhead on the network and its systems; a lack of standardizationon on the specification of intrusions and attacks; outdated attack databases, since all days new attacks are created; High technology requirements to support their action mechanisms(Spathoulas & Katsikas, 2010; Corona, Giacinto & Roli, 2013).

With the use of IDS for information security, illusion systems have been created, which is the case of Honeypots. Although there are several definitions of what a Honeypot is (Pouget, Dacier & Debar, 2003), the most consensual explains that this is a security resource without production value and whose true value lies in being probed, attacked or compromised, thus obtaining various information about the attackers and will allow to create preventive measures against attacks (Spitzner, 2002). In other words, a honeypot is a resource on the network, that although it is not a production system, has the ability to seem like one and to look vulnerable.

As a direct consequence of the definition, any traffic directed to a Honeypot is considered abnormal. This assumption means that, unlike the Network Intrusion Detection Systems (NIDS), the data collected is of great value and private of noise (Briffaut, Lalande & Toinard, 2009). On the other hand, the monitoring is isolated, making a Honeypot unaware of other network behavior, proving the need for other security tools, as wel as the creation of Honeynets (Curran et al., 2005). This simplicity in how a honeypot works, allows its support systems to not require large computational resources.

By logging and analysing adverse events, a Honeypot be used for the treatment of security incidents it captures, allowing preventive actions (resource deterrence), detection (event alerts), reaction (attacker data) and research (increase Knowledge). The fact that there are worldwide research Honeypots allows the information obtained by them to be correlated, identifying attack patterns (West-Brown et al., 2003). These patterns can then be crossed with the information obtained by prevention and reaction Honeypots existing in the organization networks, leading to security policies being created and applied in other network resources, such as traffic filtering policies applied to Firewalls, based on previously detected events (Spitzner, 2002; Pouget, Dacier & Debar, 2003).

Honeypots can be classified in three ways that are directly related to how an attacker interacts with it:

- **Low Interaction:** These Honeypots are easier to deploy and configure, since they only simulate services with which the attacker can interact and their importance is based on the detention of unauthorized scans and connection attempts (Briffaut, Lalande & Toinard, 2009). The risk of this type of honeypots is very low, since an operating system (OS) is not given to an attacker to interact with, but only a set of services configured to operate in a predetermined way (Spitzner, 2002);
- **Medium Interaction:** These consist of isolated subsystems monitored in real systems, giving the attacker the ability to interact with an OS that is pre-configured to not expose all the features expected from a real system, reducing the risk of being compromised (Honeynet Project, 2004). The information

given by these honeypots are more extensive, having the ability to record the behavior of attackers,viruses and worms after they take over the System;

- **High Interaction:** Although these honeypots give us the most information about the attacker, they are very complex in their implementation and maintenance, and become a high risk (Briffaut, Lalande & Toinard, 2009), because the more complex a system is the greater is its probability of failure. This type of honeypots provides a real system to the attacker without any restrictions, being important the controlled environment in which they are placed (Honeynet Project, 2004).

In summary, the greater the level of interaction, the greater the freedom of the attacker and the produced information, however the risk is also bigger.

For a honeypot to be efficient producing relevant data to improve security, it is important that it is implemented in a way it is not identified (signatures problem), and is placed pertinently in the network infrastructure, since the location will determine its value. A common location for placement of honeypots is the Demilitarized Zone (DMZ), since that is where public production systems of a organization are usually located. In the DMZ, a honeypot will be able to monitor and capture external attacks targeted at the public infrastructure of the organization (Salimi & Kabiri, 2012).

Honeypots for research purposes are placed directly in contact with the public so that they can record all kinds of information regardless the organization. Another possible location is the organization's internal network. When placed in the same network as the user devices it will allow the detection of internal attacks, i.e. it will know what devices may be compromised and are possibly being used as a source of other attacks (Pham & Dacier, 2011).

4. Proposed Architecture

4.1. Instituition and Needs

UTAD is a public Portuguese university, established in 1973 in the city of Vila Real, and is one of the leading institutions promoting the development of this region, both by its scientific and technological contribution, and by encouraging the entrepreneurship. This institution consists in several organic units, and the one directly addressed in this work, is SIC-UTAD. This unit is responsible for all technological support of the information and infrastructure systems as well as the Internet access of UTAD having the responsibility to monitor and manage both the equipment that make up the infrastructure and the traffic passing through UTAD's network.

Within the decision-making processes of these services, a set of requirements related to the IT infrastructure has been identified, which led to the composition of an NIA, which allow acquire Knowledge and Intelligence of the network infrastructure. As with any system, it is also necessary to ensure its safety and integrity and so, for the intrusion detection, came the need to install a Honeypot on the network infrastructure and assess its contribution in the NIA. Therefore, the considered NIA data sources will be support services such as DNS, RADIUS, DHCP, SNMP, Firewall. Given the extensiveness of this work and given the importance of implementing a Honeypot in NIA, only the results from the implemented Honeypot will be presented.

4.2. Deploying the Technologies on Network Infrastructure

A prerequisite for the implementation of this NIA was the need to use technologies that follow the Free Open Source Software (FOSS) philosophy, to ensure that not only the monetary implications that could come from the implementation are reduced, but also to make use of the documentation and support communities that are often associated with these technologies. The fact that these technologies are open source allows a better understanding of its operations. Thus, technologies used in this case study and their respective support systems follow this philosophy.

The architecture proposed in this section for the UTAD's network infrastructure management (**Figure 1**), took into account all the aspects mentioned in the third section of this article, respecting the NI architectures principles. This architecture is divided into four levels / layers: data, ETL, DV and Knowledge / Intelligence, the latter being the highest level.

In order to build a robust NIA and manage the communication infrastructures and its systems, there was a need to create and implement a tool that allows to obtain operating logs from honeypots and other systems that constitute the communication infrastructure and other UTAD systems (e.g. RADIUS, DHCP and DNS) as well as their processing, storage in a uniform data structure with the ability to produce visual metrics (via dashboards). Given the complexity of the situation in question, it was used the Elastic stack composed by ElasticSearch (for data storage), Logstash (for acquisition and processing of data) and Kibana (for building dashboards and obtaining Knowledge).

The ELK® stack (ElasticSearch, Logstash and Kibana) was installed on several virtual machines in a data center server. At the ETL level, each data type has a virtual machine (keeping them isolated), using the Linux operating system Ubuntu 14.03 Server and each have installed: ElasticSearch (database engine), Logstash (used to filter the data and populate the database) and shield (used for database security). Before using this stack of technologies, the logs go through a cleaning script that is designed to create a uniform structure, which can be used in Logstash filters. In the DV level, the technologies used (and operating system) are the same that the ETL level uses, with the addition of Kibana used for data analysis and consequent construction of views (dashboards) and also the installation of plugins for managing visual form of databases (and ElasticSearch), Kopf and HQ.

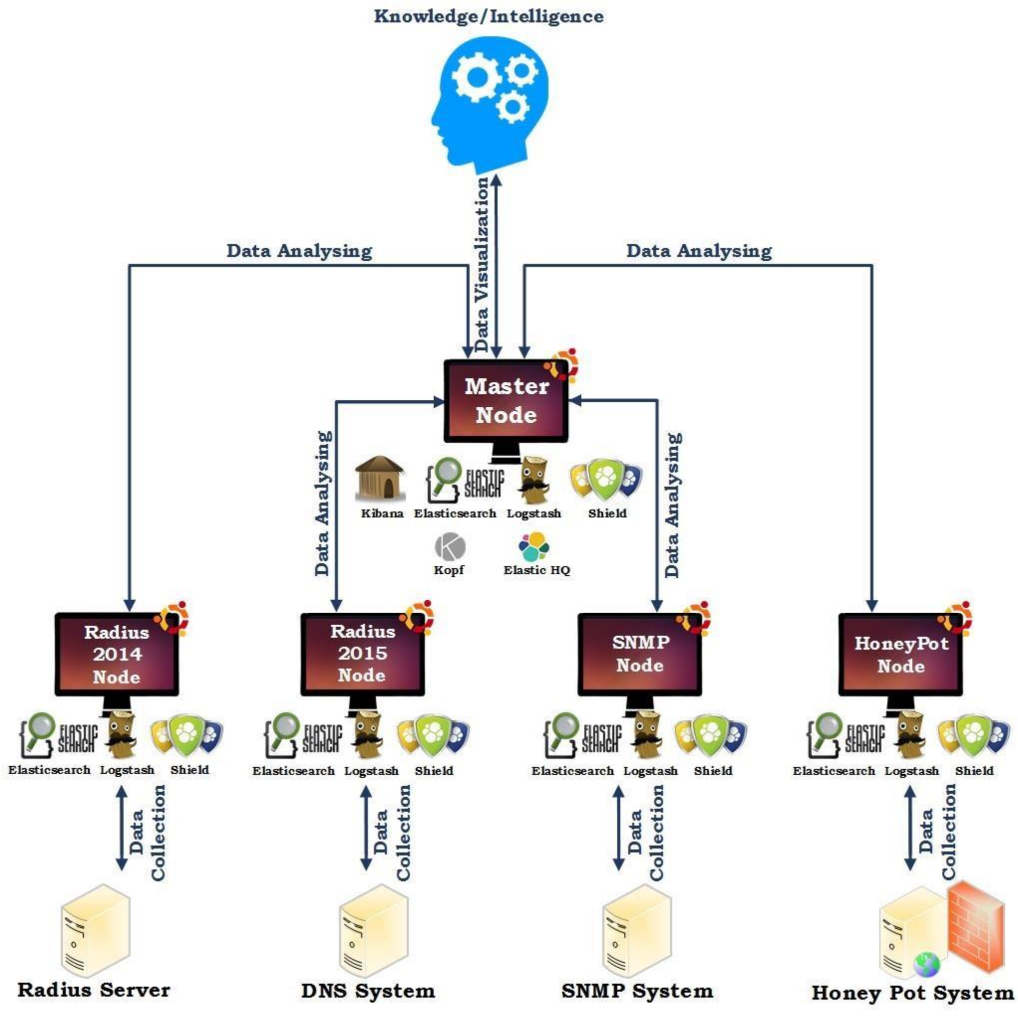


Figure 1 – NI architecture proposed to UTAD's network infrastructure

Focusing on the Honeypot node, the solution used for detection and prevention of the attacks was the HoneyD framework as a Honeypot. This product has shown to be the right one for the needs of the institution and in this case study, one of the most stable honeypot solutions recognized nationally and internationally. In addition, it is a scalable tool, highly customizable with the ability to simulate a complete network architecture and able to act as low and medium interaction Honeypot.

In this case, the HoneyD was installed to behave as a low interaction honeypot by opening some common TCP ports in order to register connections, as is the case of ports 22 (SSH) and 21 (FTP). Other ports such as 80 (HTTP) and 23 (TELNET) were configured in medium interaction mode, by associating scripts that simulate these services' behavior. While in the first case only connection data is obtained, in the second you can record some of the attackers behavior. HoneyD is also configured to respond for all Internet Protocol (IP) that are not used in the network in which it is deployed. The **Figure 2** briefly shows the place where the HoneyD server is in the network.

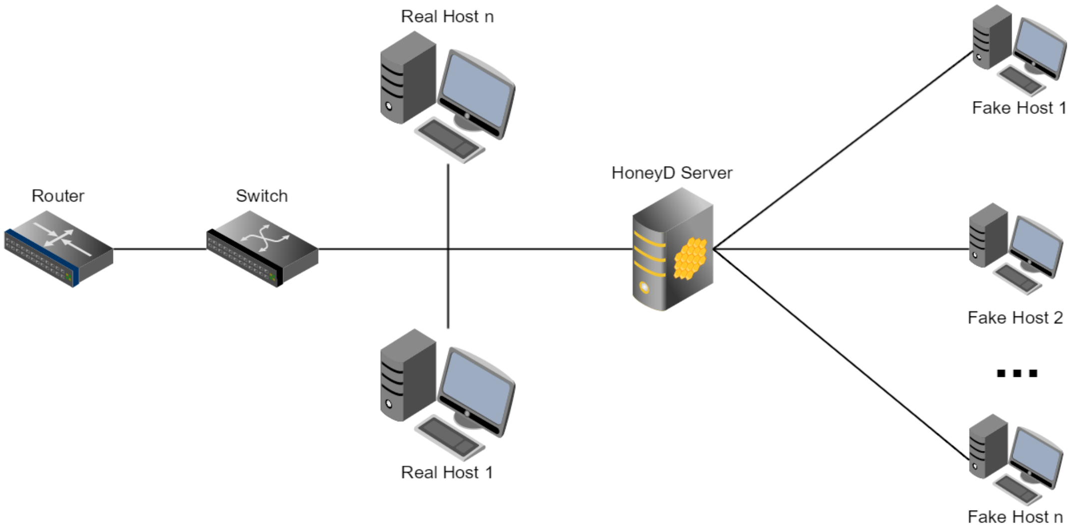


Figure 2 - HoneyD server on the network

5. Results, Final Considerations and Future Work

The proposed architecture, already serves the staff responsible for managing the IT infrastructure in their operational management activities, and also serves to support the strategic planning of the entity object of the case study. For the visual presentation of the results obtained, a set of dashboards were created that reflect more quickly and intuitively the necessary information to streamline decisionmaking processes, considering the systems mentioned in the proposed architecture.

Regarding the security systems (Honeypot and Firewall) discussed in the practical component of this work, they allowed to identify which infrastructure machines/IS have more attack attempts, the zones of the world where most attacks come from (China, Indonesia, Hong Kong, United States, South Korea, Vietnam, Turkey and Russia), and which are the operating systems used by the attackers (Linux for Asian countries, Russia and Ukraine, and Windows to the North American continent, Africa and Central Europe), allowing to adapt the firewall that filters the traffic, aiming for maximum protection of the infrastructure and also proposing new security measures.

In order to test the security solution implemented in the proposal NIA, the logs obtained from Honeyd in the period of **12/09/2015** to **16/12/2015** were considered. In **Figure 3**, we can see the number of connections per protocol and as a result we can see that the majority of attempted attacks are from the ICMP and TCP protocols having some from the IGMP and UDP protocols. Given the amount of ICMP and TCP connections, these will be seen in greater detail through the dashboards observed in **Figure 4** and **Figure 5**, respectively.

Fig Attack frequency by protocol

The analytics produced, allows assessing some information about the intrusions in the UTAD's network. The **Figure 4** shows a dashboard with some visualizations of the ICMP protocol, where it can be seen that, in the said time period, the Honeypot received 594.172 ICMP connections, and considering the timeline, the daily average was of 3,500 connections, maintaining a constant behavior, without high peaks. The biggest source of this kind of scans was the Southeast Asian region, the main countries were China, Hong Kong, Singapore and Japan. At the Americas quadrant, we found the United States and Canada as major sources of attacks, and at Europe the largest representatives of this type of illicit activity are the United Kingdom and Russian Federation. It is also possible to acquire some knowledge about the operating systems used by the attackers, it has been observed a great use of Windows XP, especially for the attackers from France, Russia, the Netherlands, China and the United States.

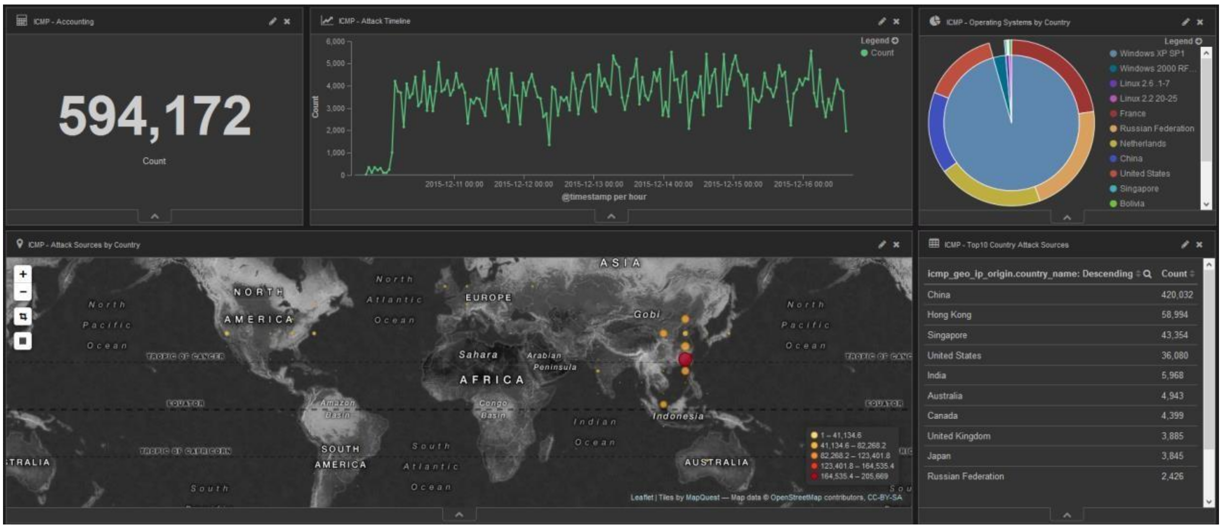


Figure 4 – ICMP - Total of attacks, number of attacks by day, operating systems used, geolocation of source attacks, top10 countries by number of attacks

In the case of TCP (**Figure 5**), the honeypot registered about 4,050,000M anomalous connections, a number greater than any other protocol. The port with more received intrusion attempts was the Telnet service port (23), with over than 75% of connections. In this protocol, there is a greater geographical focus of the attacks from Asian countries such as China, Hong Kong, Singapore and India, included in this Top10 are the United Kingdom in Europe, the United States in North America and Australia in Oceania. Unlike the ICMP protocol, with the TCP protocol, the main operating system used for the attacks execution was Linux. Analyzing the timeline, in the first two days of the period of evaluation, the number of attacks increased, maintaining a constant behavior in the remaining period of time.

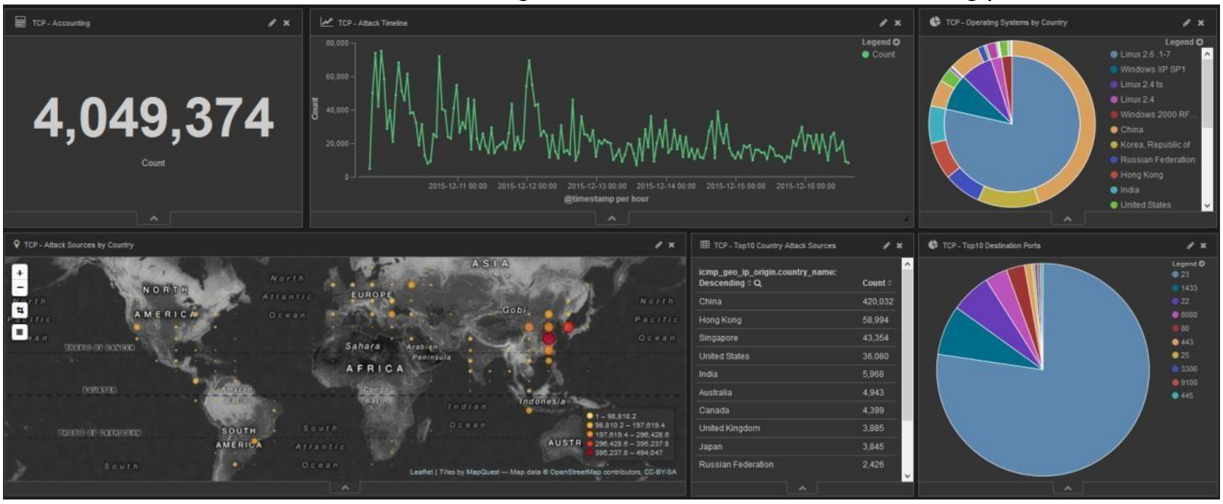


Figure 5 – TCP - Total of attacks, number of attacks by day, operating systems used, geolocation of source attacks, top10 countries by number of attacks, top10 destination ports

Nowadays, the network communication infrastructures are essential to support the activity of organizations, and thus, it is important that they are monitored and managed in the best possible way in order to guarantee quality of service to those who use them. This context is applied to UTAD and to the management areas of SIC-UTAD, hence the need to create an architecture that would allow to get

Knowledge and Intelligence from the network infrastructure, that makes use of concepts associated with NIA above referred in the conceptual approach of this article. On the other hand, the organizations data is of great value to them, since it is part of their private property and so it is of most importance to ensure their protection and assure damage prevention in risk situations.

In the network infrastructure was introduced a security mechanism that allows SIC-UTAD to have a better perception of anomalous traffic flowing on the network infrastructure of the university. Beyond this detection of attack attempts, the honeypot installed allowed dissuasion of production resources, decreasing the probability of them to be attacked, and also allowed adapt Firewall rules which filters the traffic of university, based on the generated security indicators. Until now, the results are very positive, since it is possible to obtain knowledge of the generated data by the infrastructure services, previously described, allowing SIC-UTAD to have a proactive approach in the monitoring and management of UTAD's network infrastructure, having been made some adjustments in it.

Regarding future work, it is intended to continue research in this area of Network Intelligence, given the development that have been made in this. It is also intended to create new dashboards for decision support and adapt the proposed architecture to all data sources used in UTAD's network infrastructure. Associated to the Honeypot it is intended to optimize the data treatment process, in order to make it more robust, efficient and fault-tolerant. In addition to this optimization, it is expected to expand the applicability of this mechanism through the creation of several honeypots in the various university's subnets allowing a holistic view of the intrusions and attacks in the entire infrastructure.

6. REFERENCES

Ahmed, M., Mahmood, A. & Hu, J. (2016). A survey of network anomaly detection techniques. *Journal of Network and Computer Applications*, 60, 19-31.

Avizienis, A., Laprie, J., Randell, B. & Landwehr, C. (2004). Basic concepts and taxonomy of dependable and secure computing. *IEEE Transactions on Dependable and Secure Computing*, 1(1), 1133.

Bolón-Canedo, V., Sánchez-Maroño, N. & Alonso-Betanzos, A. (2015). Recent advantages and emerging challenges of features selection in the context of Big Data. *Knowledge-Based Systems*, 86, 33-45.

Briffaut, J., Lalande, J. & Toinard, C. (2009). Security and results of a large-scale high-interaction Honeypot. *Journal of Computers*, 4(5), 395-404.

Chen, C. & Zhang, C. (2014). Data-intensive applications, challenges, techniques and technologies: A survey on Big Data. *Information Sciences*, 275, 314-347.

Chen, H., Chiang, R. & Storey, V. (2012). Business Intelligence and analytics: From Big Data to big impact. *MIS Quarterly*, 36(4), 1165-1188.

Corona, I., Giacinto, G. & Roli, F. (2013). Adversarial attacks against intrusion detection systems: Taxonomy, solutions and open issues. *Information Sciences*, 239, 201-225.

Curran, K., Morrisey, C., Fagan, C., Murphy, C., O'Donnell, B., Fitzpatrick, G. & Condit, S. (2005). Monitoring hacker activity with a Honeynet. *International Journal of Network Management*, 15(2), 123-134.

Grierson, H., Corney, J. & Hatcher, G. (2015). Using visual representations for the searching and browsing of large, complex, multimedia data sets. *International Journal of Information Management*, 35(2), 244-252.

Guo, S., Yuan, Z., Sun, A. & Yue, Q. (2015). A new ETL approach based on data virtualization. *Journal of Computer Science and Technology*, 30(2), 311-323.

Hashem, I., Yaqoob, I., Anuar, N., Mokhtar, S., Gani, A. & Khan, S. (2015). The rise of "Big Data" on Cloud Computing: Review and open research issues. *Information Systems*, 47, 98-115.

Honeynet Project, The. (2004). *Know your enemy: Learning about security threats* (2ª ed.). Boston: Addison-Wesley.

Jaiganesh, V., Mangayarkarasi, S. & Sumathi, P. (2013). Intrusion detection systems: A survey and analysis of classification techniques. *International Journal of Advanced Research in Computer and Communication Engineering*, 2(4), 1629-1635.

Janvrin, D., Raschke, R. & Dilla, W. (2014). Making sense of complex data using interactive data visualization. *Journal of Accounting Education*, 32(4), 31-48.

Karagiannis, A., Vassiliadis, P. & Simitsis, A. (2013). Scheduling strategies for efficient ETL execution. *Information Systems*, 38(6), 927-945.

Kebede, G. (2010). Knowledge management: An information science perspective. *International Journal of Information Management*, 30(5), 416-424.

Lee, S., Levanti, K., Kim, H. (2014). Network monitoring: Present and future. *Computer Networks*, 65, 84-98.

Liao, H., Lin, C., Lin, Y. & Tung, K. (2013). Intrusion detection system: A comprehensive review. *Journal of Network and Computer Applications*, 36(1), 16-24.

Olszak, C. & Ziemba, E. (2007). Approach to building and implementing Business Intelligence systems. *Interdisciplinary Journal of Information, Knowledge and Management*, 2, 134-148.

Petrini, M. & Pozzebon, M. (2009). Managing sustainability with the support of Business Intelligence: Integrating socio-environmental indicators and organisational context. *The Journal of Strategic Information Systems*, 18(4), 178-191.

Pham, V. & Dacier, M. (2011). Honeypot trace forensics: The observation viewpoint matters. *Future Generation Computer Systems*, 27(5), 539-546.

Pouget, F., Dacier, M. & Debar, H. (2003). *Honeypot, Honeynet, Honeytoken: Terminological issues*. Boston: Addison-Wesley.

Prema, A. & Pethalakshmi, A. (2013). Novel approach in ETL. In *Pattern Recognition, Informatics and Mobile Engineering (PRIME), 2013. International Conference on, Salem: India* (pp. 429-434). IEEE.

Ramakrishnan, T., Jones, M., Sidorova, A. (2012). Factors influencing Business Intelligence (BI) data collection strategies: An empirical investigation. *Decision Support Systems*, 52(2), 486-496.

Russell, J., Cohn, R. (2012). *Network Intelligence*. Wisconsin: Book on Demand.

Salimi, A. & Kabiri, P. (2012). Avoiding Cyber-attacks to DMZ and capturing forensics from intruders using Honeypots. *Journal of Advances in Computer Research*, 3(1), 65-79.

Scheibe, K., Carstensen Jr., L., Rakes, T. & Rees, L. (2006). Going the last mile: A spatial decision support system for wireless broadband communications. *Decision Support Systems*, 42(2), 557-570.

Sekhar, M., Tulasi, K., Amulya, V., Teja, D. & Kumar, M. (2015). Implementation of IDS using Snort on bayesian network. *International Journal of Computer Science and Mobile Computing*, 4(4), 790-795.

Sharda, R., Delen, D. & Turban, E. (2013). *Business Intelligence: A managerial perspective on analytics* (3ª ed.). New Jersey: Prentice Hall.

Spathoulas, G. & Katsikas, S. (2010). Reducing false positives in intrusion detection systems. *Computers & Security*, 29(1), 35-44.

Spitzner, L. (2002). *Honeypots: Tracking Hackers*. London: Addison-Wesley.

Sterbenz, J., Hutchison, D., Çetinkaya, E., Jabbar, A., Rohrer, J., Scholler, M. & Smith, P. (2010). Resilience and survivability in communication networks: Strategies, principles, and survey of disciplines. *Computer Networks*, 54(8), 1245-1265.

Taylor, M., Gresty, D. & Askwith, R. (2001). Knowledge for network support. *Information and Software Technology*, 43(8), 469-475.

Vizecky, K. & El-Gayar, O. (2011). Increasing research relevance in DSS: Looking forward by reflecting on 40 years of progress. In System Sciences, 2011. *HICSS'44th Hawaii International Conference on, Hawaii: United States*, (pp. 1-9). IEEE.

West-Brown, M., Stikvoort, D., Kossakowski, K., Killcrece, G., Ruefle, R. & Zajicek, M. (2003). *Handbook for Computer Security Incident Response Teams (CSIRTs)* (2ª ed.). Pittsburgh: Software Engineering Institute.

Wu, D., Chen, S. & Olson, D. (2014). Business Intelligence in risk management: Some recent progresses. *Information Sciences*, 256, 1-7.

Zuquete, A. (2013). *Segurança em Redes Informáticas* (4ª ed.). Lisbon: FCA.

7. AUTHORS' BIOGRAPHIES

José Bessa is an Information Systems student at University of Trás-os-Montes e Alto Douro (UTAD), Vila Real, Portugal, where he got his bachelor's degree in 2013 and is now completing his master's degree in Computer Science. He is currently researching Information Systems Architectures and Network Communications. Besides this, implements Business Intelligence (BI) and Self- Service BI solutions at UTAD. Further information is available at www.linkedin.com/in/jmiguelbessa.

Hugo Coelho is currently studying Computer Science at the University of Trás-os- Montes e Alto Douro (UTAD), Vila Real, Portugal, where he acquired his bachelor's degree in 2015 and he is now completing his master's degree. He is also researching the applications that a security information and event management have in the context of the university that he attends. Further information is available at www.linkedin.com/in/coelhohu.

Pedro Monteiro is a Computer Science student at University of Trás-os-Montes and Alto Douro (UTAD), Vila Real, Portugal, where he got his bachelor's degree in 2015 and is now completing his master's degree. Besides studies he is currently researching security information and event management systems and their applications in the context of the university he attends. Further information is available at www.linkedin.com/in/monteirop.

José Brito is a Computer Science student at University of Trás-os-Montes and Alto Douro (UTAD), Vila Real, Portugal, he is currently researching security information, IoT, Big Data and Data Visualization Services and their applications in the context of the university he attends. Further information is available at www.linkedin.com/in/josepedrobrito.

António Costa is a ICT specialist at the University of Trás-os-Montes e Alto Douro (UTAD), Vila Real, Portugal, and is responsible for the coordination the areas of core infrastructure and communications, computer security areas, data center, VoIP and communications networks. He collaborates in teaching on different degrees of Computer Courses, as well as in research, extension and development projects. Holds a degree in Electrical Engineering (specialization in Electronics, Instrumentation and Computation) and a post-graduate degree in engineering area. Currently, he is in the final research stage to complete the PhD in Computer Sciences. He made several made courses or specializations which includes the Upper Course Director for Public Administration; Diploma of specialization of the Information Society for Public Administration, SIP Masterclasses and a OpenStack specialization. Further information is available at www.linkedin.com/in/ariocosta.

A browser-based digital signing solution over the web

Fotis Loukos[1], Charalampos Tsipizidis[2], Dimitris Daskopoulos[3]

[1]Aristotle University of Thessaloniki IT Center, PO Box 888, EL 541 24, fotisl@it.auth.gr
[2]Aristotle University of Thessaloniki IT Center, PO Box 888, EL 541 24, tsipizic@it.auth.gr
[3]Aristotle University of Thessaloniki IT Center, PO Box 888, EL 541 24, dimitris@it.auth.gr

Keywords
Digital Signing, Document and Grade Signing, Certificates, Web Extensions, Native Messaging API.

1. INTRODUCTION

The ability to digitally sign documents or pieces of information for submission over the web is an area of work that concerns all major organizations and governments. Educational institutions have the typical needs of document signing, as well as assuring that the grade submission process and long term archival of grades is not exposed to risk. Typical solutions so far have involved hardware cryptographic devices that guarantee a higher level of security for safekeeping of the signer's personal certificate. This makes it harder for web browser applications to access these non-standard devices for signing and most existing solutions resort to Java applets loading proprietary libraries. With Java being plagued by so many vulnerabilities, maintaining a working, let alone secure, setup on end-user machines has become a major challenge for organizations. Furthermore, Oracle has already announced that the Java Plugin for browsers will be phased out in the near future (Oracle, 2016).

2. PROPOSED SOLUTION

In order to overcome the aforementioned problems, a pure Javascript solution should be deployed. Currently, Javascript supports the Web Crypto API (Sleevi & Watson, 2014) which allows cryptographic operations such as hashing, encrypting and signing. However, to ensure the privacy of the end users, the Web Crypto API does not support cryptographic operations using cryptographic devices which can be used to identify the user. Thus, a different approach is required.

Google Chrome Native Messaging (Google, 2016) is a technology which allows developers to create native applications, called *Native Messaging Hosts*, which can be executed by the Google Chrome browser, and communicate using a message passing interface with Google Chrome extensions and apps. Hence, a native application which uses the PKCS11 API (RSA Laboratories, 2004) can be used to sign any message in cooperation with an extension that implements the communications with the browser.

2.1 Architecture

The proposed solution consists of two major components, the Native Messaging Host and the Native Messaging Application. The Native Messaging Host is the OS native program that uses the cryptographic interface to communicate with a hardware cryptographic device and digitally sign the payload. On the other hand, the Native Messaging Application is a pure Javascript implementation running in the web browser having the form of a Web Extension Plugin. It initiates the signing process, by passing the payload to the Native Messaging Host and retrieves the results.

2.2 The Native Messaging Host

The Native Messaging Host is launched by the Web Extension Plugin and receives a JSON formatted message at its standard input. The message consists of a payload to be signed and a number of different options. Currently, the host can accept messages in various encodings, such as base64, which allows users to sign arbitrary binary data, and can apply a hash function to the input message. By loading any known PKCS11 libraries, it searches for attached hardware devices and signs the payload when it finds an appropriate certificate.

With multiplatform support being a prerequisite, the program should be written in a portable scripting language, and Python 3 was the authors' programming language of choice.

In order to interface with PKCS11 libraries, the PyKCS11 Python module (Amato & Rousseau, 2016) was used. It is based on the SWIG framework and implements a Python wrapper around any standard PKCS11 library. It has been successfully tested with the Gemalto Classic Client and the Safenet eToken Client under Windows (x86 and x64 architectures), Linux (x86 and x64 architectures) and Mac OS X.

2.3 The Native Messaging Application (Browser Plugin)

The Native Messaging Application initiates the signing procedure when the user triggers a DOM element inside a specific webpage. The extension then crafts a JSON message containing parts of the webpage to be signed and forwards it to the Native Messaging Host. The extension also registers a callback function, triggered when the Native Messaging Host responds, to embed the signed data back into the webpage and inform the user of the successful signing. After the end of the signing process the data can be sent to the web server for storage.

The Google Chrome extension is available for installation through the Google Chrome Web store. Users can be guided to either preinstall the Plugin, or the webpage can prompt installation by clicking at an element in the related website (inline installation). The latter makes the procedure more transparent.

3. CONCLUSION

We have implemented a low maintenance solution for digital signing based on personal certificates stored on hardware devices. So far, this solution is only available to Google Chrome users. Similar functionality will be made available to Mozilla users with the WebExtensions API which is expected to be released in Q2 2016. The installation procedure is simple and is not affected by the security updates of Java or other third-party software. It allows organizations with a large employee basis to function on wide scale digital signing projects with the maximum of security, that is personally stored digital certs.

4. REFERENCES

Amato, G. & Rousseau, L., *PyKCS11 - PKCS#11 Wrapper for Python*. Retrieved February 18 2016, from: https://bitbucket.org/PyKCS11/pykcs11.

Google (2016). *Native* Messaging. Retrieved February 18 2016, from: https://developer.chrome.com/extensions/nativeMessaging.

Oracle (2016). *Moving to a Plugin-Free Web*. Retrieved February 18 2016, from: https://blogs.oracle.com/java-platform-group/entry/moving_to_a_plugin_free.

RSA Laboratories (2004), *PKCS #11 v2.20: Cryptographic Token Interface Standard*. Public Key Cryptography Standards PKCS#11-v2.20.

Sleevi, R., & Watson M. (2014), *Web Cryptography API*, W3C.

5. AUTHORS' BIOGRAPHIES

Dr Fotis Loukos is working for the Computing Infrastructure and Systems Administration Department of the IT Center of Aristotle University of Thessaloniki where he focuses on Network and Information Security. He is the PKI Administrator of the Hellenic Academic and Research Institutions Certification Authority (HARICA), a Certification Services Provider included in most major Root CA programs (Mozilla, Microsoft, Apple) and in the EU TSL. He is also an external contractor for the European Network Information Security Agency (ENISA). He holds a Doctor of Philosophy in Computer Science from the Department of Informatics of the Aristotle University of Thessaloniki. His interests include Network and Information Security, Cryptography and Public Key Infrastructures.
https://gr.linkedin.com/in/fotisloukos

Charalampos Tsipizidis works as a software developer at the IT Center of the Aristotle University of Thessaloniki. His work experience and interests lie in web conferencing systems (both Flash and WebRTC based), web development with numerous PHP frameworks, Linux system administration, load balancing and information security.

https://gr.linkedin.com/pub/charalampos-tsipizidis/3a/822/2b7

Dimitris Daskopoulos holds a Master's degree in Computer Engineering from Penn State University. He works at the IT Center of the Aristotle University of Thessaloniki, as Head of the Services Unit, a line of work he still finds immersive after 20 years. His interests are in web development, authentication/authorization, and DevOps practices for university applications.

Engaging students in building better digital services

Pauliina Kupila[1], Ulla Lehtonen[2]

[1]University of Helsinki, P.O. Box 53, 00014 University of Helsinki, Finland, pauliina.kupila@helsinki.fi
[2]University of Helsinki, P.O. Box 53, 00014 University of Helsinki, Finland, ulla.m.lehtonen@helsinki.fi

Keywords
Innovation, technology, mobile application, student-centred, social theory of learning

1. Summary

University students use a number of Social Network Sites (SNS) in their everyday life (Usuel et al. 2009). For example Facebook and WhatsApp are used to create own circles and groups to help in connecting with other students. The University of Helsinki does not recommend educational use of Facebook since we cannot require the students to sign up for user accounts in SNSs.

The Digital Teaching and Learning Environment project of the University of Helsinki develops new teaching and learning services in order to create a uniform and user-friendly learning environment. The services are developed using the agile approach and with the attitude "mobile first". Both teachers and students are engaged in planning and testing of the services.

As a new way to catch ideas and feedback from students we have invited students to participate in a Student Panel, which meets about three times a semester. The incentive to participate in the panel is the chance to influence on the planning of new digital services. The panel members will serve as early adopters of our services.

Before launching the Student Panel, we organized a student workshop for innovating new digital student services. One of the ideas presented was the Opinder. It is a mobile application, which helps students to communicate with other students in the same courses. The Opinderis connected to the student information system (SIS) and it shows the courses a student has registered to. Students can create events, and invite other students from their courses to join the events. As students get to know each another, they can create own groups and make direct invitations to the groups. Students can also chat with one another.

2. STUDENT-CENTRED APPROACH

The Digital Teaching and Learning Environment project's focus is on students, and we are very interested in students' opinions on the new services. We take part in student events and co-operate with the student union. As our working method is agile, we test our services on students continuously. We carefully follow their feedback on improvements and possible missing details in our services. This student-centred approach is also one of the top priorities in the new strategy of University of Helsinki (2017 – 2020). (2016)

2.1 Student Panel

The purpose of the Student Panel of the University of Helsinki is to let students guide our development of digital services. At the same time, we want to challenge ourselves and the University to try out new approaches to the teaching and learning environment.

The Student Panel has 15 members from different faculties. The panel members will provide the project with feedback on upcoming digital services, and brainstorm new digital student services and mobile applications. The Student panel has the power to change our plans and priorities on developing digital services. The Student Panel gathers about three times in semester, and so far it has met five times.

In the very first panel meeting we introduced My Studies, the new digital service we had developed. At that point My Studies provided the student with a list of upcoming lectures and an ability to add them to his calendar. Our question to the Panel was, is this enough or should there be a calendar view. Contrary to our expectations, the students saw the calendar view as an important feature. With that in mind, we implemented it in our next development sprint. According to our user tracking the calendar view is more frequently used than the list of lectures; thus, the Student Panel had a right instinct on the needs of the students.

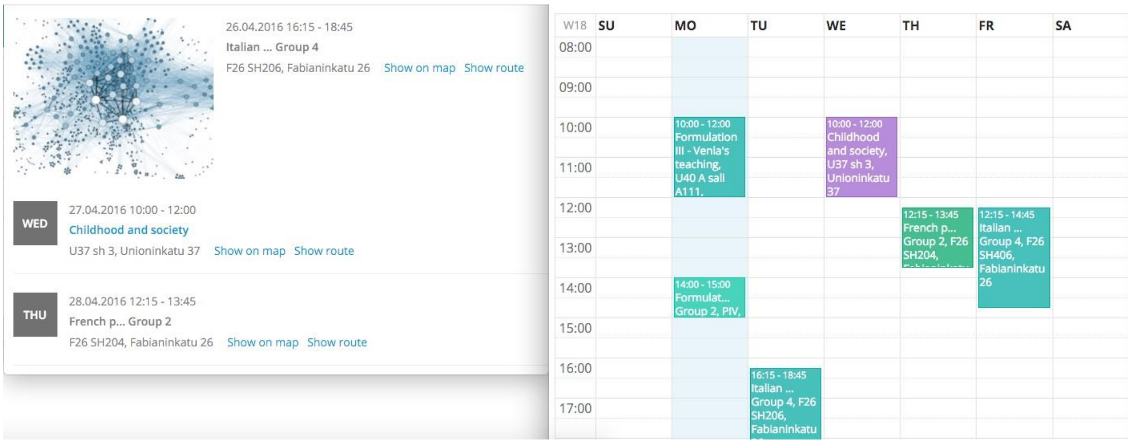


Figure 1. The list of upcoming lectures and the calendar view

In the future we hope the Student Panels receives an even more stable position in the development of our digital services. The ideal student panel would have its own budget and a power to decide which services will be developed and which will be put aside.

2.2 Opinder

As stated, the idea of the Opinder was picked up from a student workshop as one of the new digital student services. We decided to test the idea, and our first step was an interactive prototype. We showed the prototype to students on our four campuses and asked for their opinion. Since the students welcomed the idea of the Opinder, we started developing the application in June 2015 with an ambitious goal to come out with Opinder in September at the beginning of the academic year.

The Opinder Beta was launched at the Opening Carnival with limited features: Opinder allowed the students to create events and invite other students to join the events. Again, the students were excited about the idea, but the use of the Opinder remained scarce. We had an interesting product idea, however it had too few features available to attract actual users. Thus, we were at the crossroads: either to develop the Opinder substantially or end the whole project.

Figure 2. Product Owner and a group of students discussing the concept of the Opinder

In order to find out whether our efforts in developing the Opinder were worthwhile, we started a pilot study with the Faculty of Social Sciences in February 2016. The students used the Opinder for a month and we gathered afterwards to discuss its pros and cons (Figure 2). The students still believed in the idea of the Opinder, but they felt that the current service wasn't good enough. The biggest lack was the inability to communicate with other students.

Based on the feedback, we agreed on adding a chat feature to the Opinder. This feature will be published in May and piloted by the Faculty of Medicine and the Open University. If the pilot is a success, we will continue our development in order to finally publish Opinder 1.0. Table 1 summarizes the feautures of Opinder prototype, beta and 1.0.

Table 1. Opinder features

Opinder prototype (mock data)	• Search for students and teachers by courses and location • Create events, invite others to join (by course and individual user) • Offer tutoring events to students (for teachers)
Opinder beta September 2015	• Search for students and teachers by courses • Create events, invite individual students to join
Opinder beta May 2016	• Search for students and teachers by courses • Create events, invite individual students to join • Chat with individual users
Opinder 1.0 (future plan)	• Search for students and teachers by courses and location • Create groups, add users to groups • Create events, invite others to join (by course, group and individual user) • Chat with groups and individual users • Offer tutoring events to students (for teachers)

As we have involved students in the development of the Opinder, we will make use of them by conducting a survey and interviews. We will adapt the questionnaire used by Arteaga Sánchez et al. (2014) to conduct a survey about Facebook usage in academic purposes. We have changed the focus of the questionnaire on the Opinder and translated it into Finnish. We foresee that the Opinder will support informal learning through increased communication, and facilitate the students in creating communities of practice (Wenger 2009).

3. CONCLUSIONS

Engaging students by several ways helps us to improve the digital services of the University of Helsinki. We will get new ideas and useful feedback that students need and desire. After conducting the survey on the use of the Opinder we will make decisions on further development based on our findings and conclusions. Our hypothesis is that the use of the Opinder will support the students in connecting with other students and in building networks. These social networks will support the students in information discovery and sharing.

As the code of our digital services will be published open-source, we hope to see university students, staff and partners in cooperation also internationally to develop functionality of service.

4. REFERENCES

Arteaga Sánchez, R., Cortijo, V., Javed, U. (2014). Student's perceptions of Facebook for academic purposes. *Computers & Education 70(2014)*, pp. 138–149.

University of Helsinki website (2016). *Strategic Plan of the University of Helsinki. Global impact in Interaction 2017 – 2020*. Retrieved February 15, 2016, from: http://strategia.helsinki.fi/en/#landing.

Usluel, Y. K., Mazman, S. G. (2009). Adoption of Web 2.0 tools in distance education. *Procedia Secial and Behavioral Sciences 1(2009)*, pp. 818–823.

Wenger, E. (2009). *A Social theory of learning. Contemporary theories of learning*, pp. 209–218.

5. AUTHORS' BIOGRAPHIES

Pauliina Kupila is a Master of Social Sciences and a qualified teacher. She has been working as educational technology specialist at University of Helsinki since 2000. During that time her main duties have been teacher training, project management and development. Currently she is the product owner of Opinder and My Studies in the Digital Teaching and Learning Environment project.

(LinkedIn: https://fi.linkedin.com/in/pauliinakupila)

Ulla Lehtonen is a Master of Science (Tech) and a Bachelor of Social Sciences. She has worked at the University of Helsinki for a decade as educational technology specialist, head of academic affairs and planning officer. Thus her main duties have varied from teacher training to administration, student admissions, quality management, and project management. Currently she is the product owner of My Teaching and a number of smaller services in the Digital Teaching and Learning Environment project.

(LinkedIn: https://fi.linkedin.com/in/ullalehtonen)

User Support 2.0 – New Communication Channels in the IT-ServiceDesk at RWTH Aachen University

Sarah Grzemski[1]

[1]RWTH Aachen University IT Center, Seffenter Weg 23, 52074 Aachen, grzemski@itc.rwth-aachen.de

Keywords
Service desk, chat support, blog, multi-channel communication, omni-channel communication

1.Summary

The world we live in is increasingly becoming mobile. Smartphones and tablets act as our daily companions. As a result, our communication habits have changed. At the same time, the demand for quick answers to questions and requests is rising. Telephone and e-mail experience competition from chats and web portals while blogs with corresponding communities as well as information portals enjoy increasing popularity. Looking at the annual user satisfaction survey conducted by the RWTH Aachen University IT Center, the results of 2014 confirmed this trend for the customers of the IT Center. Regarding the survey results and against the backdrop of the above mentioned developments, the ITServiceDesk conceptualized scenarios for additional future-oriented communication channels that have been implemented in 2015. Hence the IT-ServicDesk that was recently based on telephone and e-mail communication has step by step advanced to a multi-channel service provider. This was a necessary precondition to establish an omni-channel system in the future.

2. IT CENTER OF RWTH AACHEN UNIVERSITY AND ITS IT-SERVICEDESK

The IT Center is a central organization of RWTH Aachen University that supports crucial IT processes of the university, provides and distributes approx. 34 basic as well as individual IT services for other organizational units of the university and external partners. As a provider of IT services, the IT Center has to analyze the wants and needs of its customers. The implementation of IT Service Management in 2008 already showed that a central contact for users of the IT services provided by the IT Center is essential to bring a high-quality approach to the increasing user requirements. The IT-ServiceDesk (ITSD) is responsible for accommodating any concerns the user may have and for directly processing 1stlevel support queries. Additionally, the IT-SD organizes and structures the communication between the user and the various specialist departments of the IT Center in the event of more complex issues. The variety and complexity of the services and the heterogeneity of users pose a significant challenge to the IT-SD supporters, their knowledge and communication skills. These communicative competencies include a very broad range of content knowledge and expertise on the one hand and allow the IT-SD staff to operate in a particularly professional and customer-oriented way on the other hand. In order to better and more sensitively respond to customer needs and hence to increase customer understanding, the IT-SD has been conducting annual user survey since 2011. The user survey of 2014 indicated that the customers of the IT Center are requesting new and modern contact channels.

3. IT-SERVICEDESKS WITH NEW COMMUNICATION CHANNELS

The self-conception of the IT Center as a modern IT service provider and changing communication habit of the users affected the IT-SD to intensively discuss and deal with new, modern communication channels. We started by looking at other outstanding universities (TU9 and Idea League). The analysis revealed that except for the Delft University of Technology none of the above-mentioned universities offered e.g. a chat support or a blog with community for their support teams, helpdesks or information centers. Issues concerning work organization, staff workloads as well as implementation scenarios were subject of intensive discussion. Initial experience with our ticket portal (live since January 2015) that allows the user to check the status of their inquiry online and at any time proved helpful in this matter. We had also gained experience of posting information via the Facebook account of the RWTH Aachen University. Against this background and with the wish that our customers would open up to new, modern communication channels, the IT Center blog with its support community, the web chat available via the website of the documentation portal as well as the support chat of the RWTHApp were designed as a multi-channel solution. Multi-channel means having various channels available for customers to submit requests: email, chat, social media, etc. This implies that the customer support department has to run 5 or even more applications to manage all of those customer interactions. For the customer, there is no connection between the systems, so there is no information flow between different requests. There is also no connection for the supporter due to the non-integrated information about the customer history. Despite of this challenges the implementation of a multi-channel system was an appropriate step forward. From the perspective of the user the diversity of communication channels -that had been realized in the short term- is highly convenient and allows an individualized communication behavior. Otherwise the IT-SD and its staff gained organizational and individual experiences in dealing with the new channels. Hence the IT-SD met the requirements of its customers, upgraded its communication system and created a positive image as a modern service provider.

3.1 Chat Support via RWTHApp and Web Chat

Owing to the pre-existing functionalities of the audience response system, integrated in the RWTHApp, the integration of the support chat in the RWTHApp was not a real issue. The integration on the documentation portal website could also be implemented rapidly. What proves more challenging is the development of a suitable, user-friendly backend for both use cases. It had to be ensured that the chats are integrated in the requirement of the existing reporting rules (number, duration, time of reception etc.). Additionally, it was necessary to test how many chats are to be processed by the staff and how many staff members are basically required to realize a swift and high-quality chat support. Questions e.g. how quickly a chat had to be responded, how users should be addressed and what questions were even suitable to be processed and answered via the communication channel chat had to be answered beforehand. “Go live” was in November 2015 and at present it can be stated that the prudent procedure of not promoting the support chat via the IT Center blog and not yet releasing a Facebook post gives us time to deal with this new additional communication channel and to learn what our customers will expect from this channel.

3.2 IT Center Blog and its Community

The IT Center blog was designed as a modern information platform that provides weekly, target-groupspecific posts. A defined process that regulates what posts are released at what time and how, allows the authors to “produce to stock” and backlog posts but also to permit guest commentaries. As a result, we have succeeded in consistently releasing at least one post each week, since July 1, 2015. The objective is to involve users in moderated discussions so that finally support communities will emerge. Contests and quizzes are intended to encourage users to participate actively in the creation of the community. Experience from networking groups of student dormitories have shown that there is a great deal of readiness to act as supporters on the user side.

4. CONCLUSION & OUTLOOK

Today it´s self-evident that users communicate via chats, web portals, apps and Facebook beside the conventional contact channels. This diversity of communication opportunities is already established in business. The IT Center followed this development through the implementation of a communication strategy including chats and blog. Along with major challenges, the progressive digitization also presents a wide array of possibilities to intelligently control customer inquiries, prevent calls and enhance the benefits for the customer. However, the implementation of new channels must be closely coordinated and tailored to the individual customer target groups. It has to be taken into account what channel is really needed and what technical support possibilities can be integrated accordingly. Securing a fully integrated reporting that spans across all channels should also be considered. The impact of the changing communication behavior on the staff has to be taken into consideration. E.g. the level of flexibility and the willingness to communicate with the customers on a multitude of channels will increase. The aim is to synchronize and integrate various communication channels at the IT Center in a way that will eventually ensure a special user experience and at the same time reduce the staff’s workload. In this system of omni-channel communication all customer information and contact points are cross-linked through various applications. Specifically, this represents that the advantages of digital and conventional communication and distribute/sales channels are seamlessly tied together, guiding the customer from the initial information search through contacting and up to the order process, irrespective of when and, in particular, which channels were utilized for the individual steps. The strategic vision of IT Center is to become an omni-channel service provider.

5. AUTHORS' BIOGRAPHIES

Sarah Grzemski studied Economic Geography, Geography and Economics. She received her Master's degree from RWTH Aachen University in 2002. Until 2007, she worked as a research assistant in the Department of Economic Geography of Services. Her main research focus were employees in call and service centers. Since 2007 until today, she has been employed at the IT Center of RWTH Aachen University. Initially, she worked for the division of Process IT Support. Since 2010, she is the head of the division IT-ServiceDesk. In this role, she assumes responsibility for the staff and the strategic development of the IT-ServiceDesk, particularly with regard to customer support and service.

Electronic management of assessment: business processes, system requirements and institutional capability

Dr Gill Ferrell[1], Lisa Gray[2]

[1] Consultant to Jisc, One Castlepark, Tower Hill, Bristol, BS2 0JA, UK, gill@aspire-edu.org [2]Jisc, One Castlepark, Tower Hill, Bristol, BS2 0JA, UK, lisa.gray@jisc.ac.uk

Keywords

Assessment, business processes, digital assessment, electronic management of assessment, integration, life-cycle, online submission, online marking, process review, self-assessment, system requirements.

1. ABSTRACT

This paper reports the final outcomes of a programme of work looking at the electronic management of assessment (EMA) that was carried out in collaboration with UK universities, national agencies, system suppliers and the EUNIS membership.

Collaboration via the EUNIS e-Learning Task Force has allowed cross-fertilisation of ideas and sharing of resources at the European level. We report on some of the outcomes of this work and suggest how individual universities can use the resources to build capacity in their own institution.

2. INTRODUCTION

This paper is the fourth in a series looking at enhancement of assessment and feedback practice in UK universities and the lessons to be learned for the wider EUNIS community. The first paper (Ferrell & Sheppard 2013) presented a landscape review which showed that, although assessment and feedback lies at the heart of the learning experience, it remains the single biggest source of student dissatisfaction with the UK higher education experience. Subsequent papers (Ferrell & Stewart 2014 and Ferrell & Gray 2015) analysed the problems from both institutional and systems perspectives and looked at tools and approaches that were being successfully applied to tackle all of these issues.

This paper reports the final outcomes of this programme of work carried out in collaboration with UK universities, national agencies, system suppliers and the EUNIS membership. We have amassed a significant amount of knowledge and guidance about good practice. The goal now is to help universities make effective use of the available guidance in their own context.

Throughout this paper we use the term electronic management of assessment (EMA). This describes the way technology can support the management of the entire life cycle of assessment and feedback activity, including the electronic submission of assignments, marking, feedback and the return of marks and feedback to students.

3. FINDING COMMON GROUND

At first sight it seemed as if we were tackling issues too diverse and complex to make any sense of them in a single university let alone deliver solutions that were applicable UK wide and ultimately useful to all EUNIS members.

The first big step forward came when, building upon the work of EUNIS Elite Award winners 2014 Manchester Metropolitan University (Stubbs 2014), we were able to define an academic model showing a high level view of the academic processes involved in assessment and feedback. The assessment and feedback lifecycle shown below was found to have widespread applicability across UK higher and further education and work with the EUNIS e-Learning Task Force revealed that it was similarly useful in the wider European context.

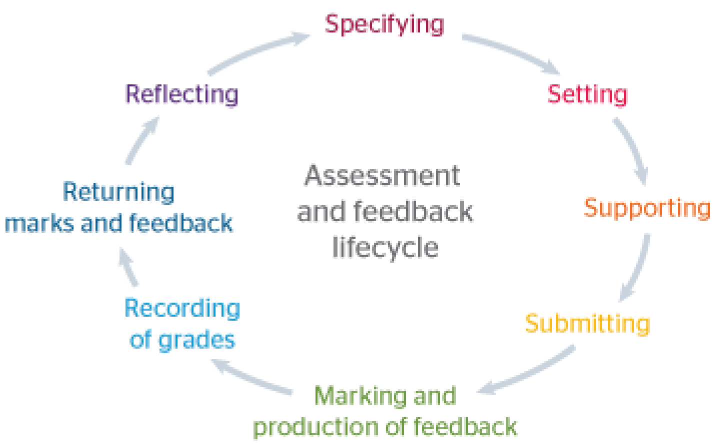


Figure 1. The assessment and feedback lifecycle
(adapted from an original by Manchester Metropolitan University) CC BY-NC-SA

The lifecycle model offers a ready means of mapping business processes and potential supporting technologies against the key academic stages. Use of this approach allowed us to have conversations about common issues with business processes and systems within a shared frame of reference that transcends institutional differences.

Through surveys. workshops and working groups we identified and prioritised the key issues (for more on this see Ferrell & Gray 2015) and implemented series of solution finding projects. The main outcomes of this work are:

- An online guide Transforming assessment and feedback with technology
- An online guide Electronic management of assessment (EMA) in higher education: processes and systems
- A generic set of system requirements (developed in collaboration with EUNIS member UCISA) and responses to those requirements from many suppliers
- A self-assessment tool to support capacity building with regard to the electronic management of assessment (to be launched for EUNIS 2016)

Through our collaboration with the EUNIS e-Learning Task Force, we discovered that a national project in Norway to review the process of managing digital exams in universities was taking an approach very similar to our own. They used the Archi modelling tool, originally developed by Jisc, to develop a series of process maps defining the steps universities need to take to move from current practice to a desired future state that cuts out unnecessary manual actions. As with our lifecycle model and generic process maps they concentrate on essential tasks for all universities and identification of the role responsible for each task rather than the sequencing of workflows that varies between institutions.

As a result of this work Norway now has a model IT architecture for digital assessment that is platform independent and based on recognised international standards:

- The Norwegian report on ICT architecture for digital assessment (Melve & Smilden 2015) complements the Jisc resources

The EUNIS e-Learning Task Force connection also brought us into contact with complementary work being carried out in the Netherlands by SURF:

- The Dutch Digital Testing project site has many useful resources

4. UNDERSTANDING THE BUSINESS PROCESS

Using a similar approach to the Norwegian project, we reviewed the business processes associated with assessment and feedback - particularly those around submission, marking and feedback which our research showed were the most problematic areas of the lifecycle. We produced a set of visualisations to describe the main academic practices and the key variables that influence decisions thus reducing the ‘noise’ around differences and focusing on what is pedagogically significant. Figure 2 shows our model of the core tasks carried out by all UK universities.

We invited universities to compare our model against their own practice and ask the following questions:

- Are you doing additional tasks - if so, why?
- Are the tasks being done by the right people eg do you have academic staff undertaking administrative duties that do not require academic judgement?
- Do you have systems that could carry out some of the tasks you are doing manually?
- Do you have multiple ways of performing the same task - if so, why?

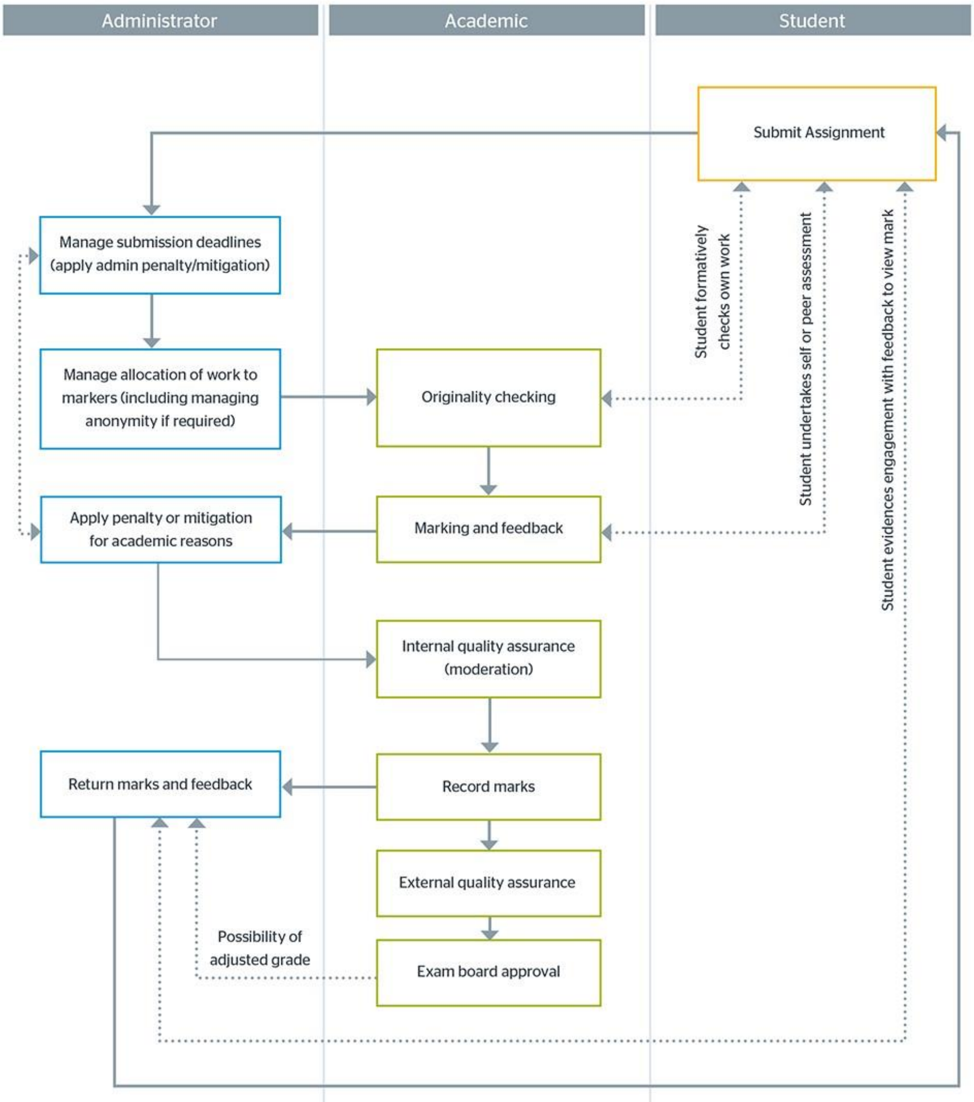


Figure 2 Submission, marking and feedback process ©Jisc and Bonner McHardy CC BY-NC-ND

5. DEFINING SYSTEM REQUIREMENTS

As well as supporting process improvement, the generic overview allowed us to work with universities and UCISA to define a set of system requirements that are representative of UK wide needs.

The generic overview was broken down into a more detailed view of the submission process and the marking and feedback process showing the system requirements for each task. The system requirements are also available as a template that can be used as the basis for universities to adapt in an Invitation to Tender (ITT).

A range of system suppliers completed the template comparing their product features against the requirements and these have been published on the Jisc EMA blog to aid universities and colleges better understand the ways in which particular systems can support their needs and to see how particular combinations of systems might work together. Interestingly the EUNIS connection prompted interest from suppliers across Europe some of whom are not currently operating in the UK market.

6. INDICATORS OF EMA MATURITY

As a result of this body of work, we were able to identify a series of key factors that universities need to think about in relation to their assessment practice and these became the indicators of institutional EMA maturity.

6.1 STRATEGY/POLICY AND QUALITY ASSURANCE

A key indicator of maturity is the extent to which institutions have moved towards ensuring that electronic management of assessment is enshrined in their formal strategy, policies and procedures. Responsibility for assessment and feedback policy and procedure is often devolved to local level within institutions so it can take some time for good practice involving new use of technology to become normalised. During the early stages of adoption there will be many pilot projects but for these practices to become embedded such that they are the normal way of doing things requires a more directive approach. As institutions become more confident in the benefits of EMA they tend to offer fewer possibilities of 'opting out' of the digital approach.

The persistence of organisational myths surrounding policy and quality assurance processes is actually a significant barrier to change. The tendency to do things the way they have always been done can often be perpetuated by a belief that this is somehow enshrined in policy. Academics are often surprised to find that many characteristics of existing processes are matters of historic choice rather than regulatory issues. They are often surprised at how few regulations there actually are or how easy it is to make changes to perceived barriers in the regulatory frameworks. Variation in how staff apply assessment policy across an institution is thus often down to such myths about what actually constitutes the policy in the first place.

6.2 CURRICULUM DATA

Good quality data about the academic curriculum and how it is assessed is essential. Simply having easy access to information about what learning outcomes are being assessed, how they will be assessed and when feedback and marks are due, can greatly improve student satisfaction. Assessment remains an area where much information is still paper-based. Having information in digital format can facilitate the transfer of data between systems and cut out manual entry. The corollary of this is that the more technology is used, the more errors and inconsistencies in data become visible.

Many institutions operate ineffective assessment regimes because they simply do not have sufficient information about what is being assessed. Basic analytics on assessment practice can help avoid a range of issues such as assessment 'bunching' impacting staff and student workload, over-assessment or assessing certain learning outcomes many times whilst ignoring others. Good information management is a very significant indicator of institutional capability.

6.3 PROCESSES AND WORKING PRACTICES

Many institutions struggle to get the most out of their information systems due to the variety and complexity of their business processes. Large universities rarely have a single, institution-wide, business process for a given function. Different faculties, schools, departments and programmes each have their own way of doing things and this variation can prevent them from achieving the efficiencies and benefits possible through EMA technology.

Any organisation with many different ways of carrying out the same activity is likely to need a series of time-consuming and cumbersome workarounds to adapt their information systems to these bespoke approaches. We found that standardisation of business processes is necessary before universities can move beyond large scale pilots to institution-wide implementation of EMA.

6.4 TECHNOLOGY

The capability of existing commercial systems to meet institutional requirements is often voiced as a concern. However, we found that data and business processes are equally, if not more, relevant issues. Participants in our research frequently commented on the extent to which new technologies are 'bolted on' to old processes without people really taking the time to stand back and consider what the process is really intended to achieve. All of the issues noted above make it difficult to get the most out of existing technologies.

Universities that operate in a very decentralised way often allow individual parts of the business to choose their own software tools which means they end up with multiple tools that can all do the same job. In IT terms it makes sense to streamline this complexity and give preference to tools that integrate well together to reduce duplication/data entry.

6.5 CULTURE

Institutional culture is a complex area. Factors that can make it difficult to improve assessment practice include: the decentralisation of decision making and, hence, the diversity of practice already noted and the culture of universities that reward research excellence to a far greater extent than excellent teaching. Risk aversion is also a significant issue as neither staff not students want to take risks with something as important as assessment.

6.6 STUDENT EXPERIENCE

There is a wide spectrum of approaches to student engagement in assessment practice and the extent to which the culture promotes assessment literacy and student understanding of the processes involved in making academic judgement. An example of such a difference is whether a university uses text matching tools (such as the Turnitin or Urkund products) as plagiarism detection support for academics or as a formative tool for students to support the development of academic writing skills.

Some universities still take a view that good students will inevitably succeed and a few will need remedial support. Others realise that assessment literacy is a skill to be developed (by both students and staff) and have their students actively involved in changing academic practice. There is also variation in the extent to which assessment is used to develop employability skills by using assessment types (such as group work and peer review) that reflect the world of work more closely that more traditional methods such as essays and closed book exams.

7. MEASURING EMA MATURITY

In response to demand from UK universities we developed a self-assessment tool that EUNIS members are welcome to use or adapt for their own purposes. We recognise five levels of EMA maturity:

Researching	You are at an early stage of EMA. You do not seem to have a comprehensive view of organisational activity overall; policy, process and systems seem fragmented. Ensure you have senior management support to undertake further investigation. Start by defining the principles that underpin assessment and feedback in your organisation and find the areas of good practice you can build on.
Exploring	You are probably aware of pockets of good practice but have not really begun to try to scale this up. You will need to be clear about expected benefits in order to effect the cultural change needed.
Embedding	You are at a tipping point where fairly widespread experimentation is close to becoming mainstream practice. A key issue will be ensuring that business processes are sufficiently consistent to support a more holistic approach.
Enhancing	You are probably already supporting the core of the assessment and feedback life cycle with technology. You are looking to fill gaps and find more elegant solutions to existing workarounds.
Pioneering	You are looking to go beyond automation, standardisation and efficiency gains to ensuring that EMA has a truly transformative impact on learning and teaching in your organisation. Your organisation is probably a provider of many of the resources in our accompanying guide but we can still provide some inspiration and support.

Completion of the self-assessment questions generates a report rating the respondent at one of the five levels against each of the key indicator headings: strategy/policy and quality assurance; curriculum data; processes and working practices; technology; culture; student experience. The report gives a set of suggested actions intended to help build on strengths and address limitations. It also provides links to resources that might help you carry out the suggested actions.

8. LESSONS LEARNED FROM SELF-ASSESSMENT PILOT

We piloted this approach at the end of 2015 with twelve universities (including three EUNIS members) which provided valuable lessons.

Overall the participants reported that the outcomes matched their own understanding of their strengths and weaknesses and that the suggested actions fitted with their experience of how to make progress in each of these areas.

8.1 LEVEL OF GRANULARITY

During the pilot however it became clear that our focus on the whole institution was too broad. Universities with very decentralised structures, and those at the early stages of EMA maturity, tend to exhibit very different profiles in different parts of the institution. These institutions need their action plan and supporting resources at a level of granularity individual to each of their component business units.

We thus redesigned the self-assessment to work at different levels. Respondents are now asked to define what happens in their 'organisation' in many of the questions. Organisation in this case refers to the coherent entity on behalf of which they are responding so it may be a programme team, a department or the whole institution. We also ask about consistency across your 'component areas' and practices at 'local level'. At institutional level component areas/ local level will generally be schools or faculties, at department level they may be programmes of study and at programme/ course level they may be individual modules.

8.2 MOVING BETWEEN LEVELS

Our five level scale reflects the increasing use of EMA bringing further benefits for students and institutions. Our pilot showed that it should however be viewed with a number of caveats.

The scale is not a simple linear one. The first two levels are quite similar in terms of the user experience. You may correspond to the researcher level because your institutional practice is disjointed and people do not have a clear idea what others are doing. However, the overall user experience may not be significantly different to that of institutions at the explorer level.

Institutions have also reported that the amount of effort needed to move between levels is not equally distributed. The most significant amount of effort is needed to get from the early stages to the embedding and enhancing levels. Once there, further progress is proportionately easier to achieve.

Progress through the levels is associated with evidence of greater benefits but that is not to say that every institution will necessarily be aiming to reach the highest level. In some cases institutions may provide an excellent student assessment experience in spite of constraints on how much they can invest in supporting information systems.

8.3 DATA VALIDITY

In many cases it may not be possible for an individual to answer all the questions. Indeed, we suggest that the self-assessment should be done as a group exercise because the dialogue that ensues is the first stage in the change process.

There will always be some concerns about the validity of data from a self-reporting exercise such as this. Different people may have a different interpretation of some of the questions and responses and it is only through dialogue that such differences can be explored and enhance the institutional knowledge base. Most of those involved in the collaborative development of this tool found the dialogue instigated by the self-assessment process to be the most valuable aspect of the activity. We therefore suggest the tool is best suited to supporting continuous improvement rather than any kind of benchmarking.

Whether your approach to developing EMA capability is top-down or bottom-up and whether you are a policy maker or a practitioner, you will probably find that you want to compare results from different parts of your institution. This will help you target staff development, select areas to pilot new approaches and identify good practice that can be built upon.

9. SUMMARY

Assessment lies at the heart of the learning experience and universities right across Europe are trying to get to grips with moving traditional practice into the digital age. The drivers for this are both the need for efficiency and the need to meet the expectations of students who have grown up in that era and who need university to prepare them for a digital future.

Collaboration between members of the EUNIS e-Learning Task Force has shown that, even with a topic as complex as this, we can find common ground and benefit from sharing experience. Find out more from:

Jisc guide: Transforming assessment and feedback with technology

Jisc EMA blog: http://ema.jiscinvolve.org/wp/

10. REFERENCES

Ferrell, G & Sheppard, M (2013) Supporting assessment and feedback in practice with technology: a view of the UK landscape. Paper presented at EUNIS 2013: Riga, 12-14 June 2013. Retrieved February 29, 2016, from: https://eunis2013-journals.rtu.lv/article/view/eunis.2013.025

Ferrell, G. and Stewart, A (2014) Technology supported assessment and feedback: tackling the issues of pedagogy, process & people. Paper presented at EUNIS 2014: Umea, 11-13 June 2014.

Ferrell, G. and Gray, L. (2015) 5/10 'Must try harder': applying technology to the management of assessment and feedback. Paper presented at EUNIS 2015: Dundee, 10-12 June 2015. EUNIS Journal of Higher Education 2015 Congress Issue. Retrieved February 29, 2016, from: http://www.eunis.org/erai/2015-3/

Melve, I. & Smilden, B. (2015) ICT Architecture for Digital Assessment: best practice document. Retrieved February 29, 2016, from: http://services.geant.net/cbp/Knowledge_Base/Campus_Networking/Documents/CBP-44_ICTarchitecture-for-digital-assessment_published.pdf

Stubbs, M. (2014) Transforming the Student Experience: Manchester Metropolitan University's EQAL Project. Retrieved February 29, 2016, from: http://www.eunis.org/wpcontent/uploads/2014/06/Stubbs-MMU-UK.pdf

AUTHORS' BIOGRAPHIES

Gill has teaching and research experience and has held senior management positions in a number of university administrative functions as well as directing a UK support service enhancing the use of ICT in further and higher education. She acts as a consultant to universities and national agencies in both the UK and Europe and has been an invited speaker at many national and international events. Current interests include: data and information management, technology enhanced learning, assessment and feedback and learning space design. She was a EUNIS Board member from 2010-2015 and is currently leader of the EUNIS eLearning Task Force.

http://uk.linkedin.com/in/gillferrell

Lisa is a Senior Co-Design Manager within the Student Experience team at Jisc, providing leadership on the use of technology-enhanced learning and teaching in Higher and Further Education. For 10 years she has led a range of innovation and change programmes on the themes of technology-enhanced assessment and curriculum transformation. Lisa has spoken widely on the many ways that technology can enhance assessment and feedback and on the use of e-portfolios to support learning, and has orchestrated a range of highly regarded activities in these areas including the development of advice and guidance materials and a series of national workshops.

https://uk.linkedin.com/in/lisagray1

E-learning advancements in the academic foreign language teaching

Anna Pacholak[1], Monika Galbarczyk[2]

[1] University of Warsaw, Centre for Open and Multimedia Education, ul. S. Banacha 2c, 02-097 Warsaw, Poland, a.pacholak@uw.edu.pl

[2] University of Warsaw, Centre for Open and Multimedia Education, ul. S. Banacha 2c, 02-097 Warsaw, Poland, m.galbarczyk@uw.edu.pl

Keywords e-learning, Higher Education, e-course, foreign languages, on-line teaching, life-long learning, MOOC, SPOC.

1. ABSTRACT

Among the initiatives undertaken within the 2020 Bologna Process strategy for Higher Education, focusing on the development of innovative life-long learning systems and the mobility, multilingualism and employability empowering, an on-line foreign language teaching project was launched (in 2006) at the University of Warsaw. It was implemented by the University Centre for Open and Multimedia Education and realized with the use of an IT educational Moodle platform and the extensive application of e-learning EFL methodology. The paper presents the ways in which the concept of online foreign language teaching has been expanding and growing within the University for 10 years now. Progressively, multi-level and multi-purpose e-courses together with on-line placement tests have been created and the number of the languages taught increased to 14, reaching over 5 000 users in 2015 and more than 37 000 course participants since the very beginning of the project. The paper also describes the major challenges and the future prospects of computerbased foreign language teaching at the University.

2. Introduction and background

Developing an ICT-skilled and knowledge-based society is the priority of the European Union. However, according to the EU 2015 Joint Report on education and training (ET 2020), 25% of adult EU citizens still represent low levels of digital skills and only 10.7% take part in life-long learning process (EU ET2020, 2015). The strategy which enhances the EU goals fulfillment is the 2020 Bologna Process strategy implemented by the European Universities. The integral part of this policy is the development of life-long learning systems as well as the empowering of the mobility, multilingualism and employability. Its main aims focus on the improvement of the learning environment and removal of the study barriers by introducing, among others, student-oriented programmes, enhancing innovation and exploiting the potential of digital technologies.

Hence, the implementation of the innovative and modern didactics is an important goal in the universities development strategies, which is also the case of the University of Warsaw. One of the forms of reaching this objective is the inclusion of the ICT into the didactic process. This expectation is met, among others, within the ICT supported courses at the university. It lets students encounter various forms of learning and introduces them to life-long learning process which in turn makes them more competitive on the labour market and increases their employability.

Among the initiatives undertaken within this policy, an on-line foreign language teaching project was launched (in 2006) at the University of Warsaw. It was based on the existing IT infrastructure - an educational platform and an e-learning methodology worked out by the University Center for Open and Multimedia Education.

3. Virtual Learning Environment (VLE) tools and advantages

Continuous improvement of computer literacy skills within the academic community and easy access to the Internet fostered the development of computer-assisted e-learning courses at the University of Warsaw. As a basic technical tool for embedding the e-courses, an open source educational Moodle platform was set under the supervision of the Centre for Open and Multimedia Education (COME) UW. The enthusiastic feedback from the academic community, which was delivered after the first edition of the e-courses, led to their development in various fields of knowledge covered at the University (Wieczorkowska, Madey,2007). This success, together with the experience gained at the time of the creation of the first e-learning courses (from various fields), opened the door for the development of the computer-assisted language teaching at the University, being in line with the Bologna strategy for Higher Education.

The tool used i.e. the Moodle platform, perfectly meets the expectations for online foreign language teaching. First of all, it allows students to access all necessary sorts of language teaching materials (audio, video, graphics, and text files) in one environment. It also allows for a variety of knowledge testing ways and ensures immediate automatic feedback (which decreases the risk of inappropriate language learning habits). Additionally, it helps students to identify gaps in their knowledge that needs to be revised with greater care. What is also of importance is that this method of learning corresponds with the psychology of individual differences, taking into consideration that every student needs different amount of time to practise and revise particular sections of the online material depending on their background and skills.

The on-line materials can be easily combined with in-class teaching via blended learning, as it was the case of the first courses created. Not surprisingly, they were highly appreciated both by the students and the lecturers, which resulted in the creation of other language courses making the elanguages idea expand. The materials are also accessible on mobile devices making the didactic process even more flexible for users (Bednarczyk, Krawczyk, 2009).

Additionally, the plug-in integrating the University students' management system with the Moodle platform enrolment was launched to make life easier for all students, teachers and the administration staff.

4. Language on-line services developed

The first attempt to introduce online foreign language teaching at the University of Warsaw (via the educational platform) was made in 2003 by the Centre for Open and Multimedia Education, UW. It was assumed that students participating in online courses would need skills of two types: on the one hand, they needed to show computer skills to be technically able to move within an online course, carry out tasks and submit assignments, and on the other hand – sufficient language skills, which led to the conclusion that the language level of the courses offered should not be lower that B2 (according to the Common European Framework for Languages). Two courses in English were launched initially. They were: *Writing summaries in English* and *The language of group discussions*.

These courses were the starting point for a big project initiated for the whole university by COME UW in 2006 called "E-lektoraty" (Language e-courses), covering mainly the courses in English, but with time including the ones in German, Russian and Croatian.

As in every process of development, there were a few interweaving variables that decided about the current shape of online language courses at UW (Rudak, Sidor, 2008).

In 2005, the Senate of the University of Warsaw issued a Resolution on equal access to the languages didactic offer for both stationary and extramural students. There were some organizational challenges though. Due to an insufficient number of classrooms and a shortage of teachers and lecturers meeting the requirements of online education, it turned out to be quite difficult to achieve satisfactory teaching and learning outcomes within the amount of teaching hours set in the curriculum. The students' needs were growing too as the number of students and student groups was increasing, new types of courses and new levels of advancement were introduced, the access to classrooms was getting limited as a result of the above mentioned growth. Therefore, in 2006, steps were taken to introduce e-learning within the field of foreign language teaching at the University, with a particular focus on the English language.

The concept of online foreign language teaching has been expanding and growing within the University for 10 years now. Progressively, multi-level and multi-purpose e-courses together with online placement tests have been created. There are more languages available on the platform, more levels of advancement and more course types to choose from (general language e-courses, placement tests, remedial language courses, mock language certification courses). The number of languages offered increased to 14, exceeding 5 000 users in 2015.

4.1. Placement tests

The question of testing and assessment of the students' level of advancement in foreign languages and ways of group assignment became of importance due to the increasing number of students. To facilitate the process of testing and to help students find out about their language skills and choose the most appropriate course, a set of six online placement tests in English, German, French, Russian, Italian and Spanish (Figure 1.) was prepared to be placed on an educational Moodle platform (maintained by COME UW) and used in an interactive manner to obtain immediate results and instant feedback on the suggested choice of a course. The placement test result was a kind of passport which opened doors to chosen online language courses for both stationary and extramural students.

Figure 1. Number of placement tests attempts in 2015.

For about 10 years now these placement tests have been gaining great popularity among the university students. Table 1. shows the quantitative participation of students in the placement tests in the chosen languages in the years 2006-2015.

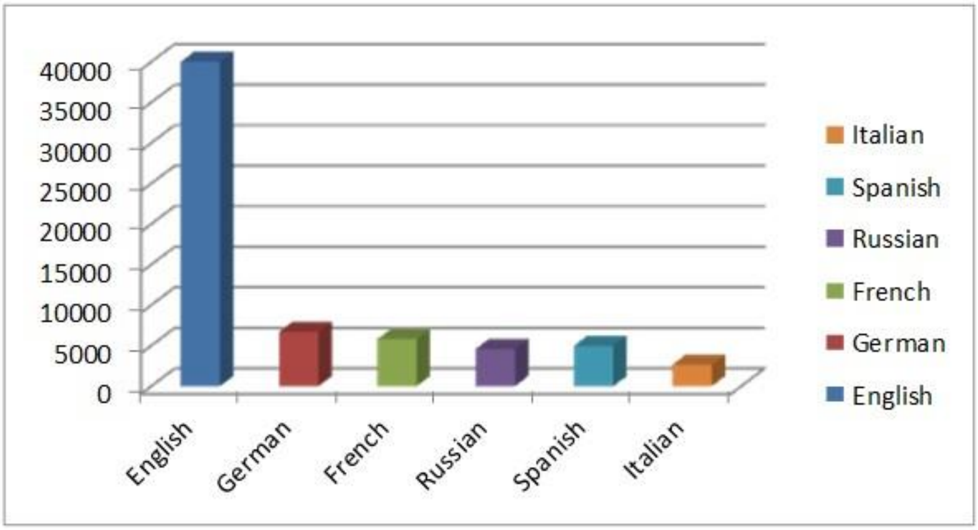


Table 1. The quantitative participation of students in the placement tests in the chosen languages in the years 2006-2015.

It is worth mentioning that online placement tests have served their purpose well for both the students themselves as they may access them at any time and place (on condition they have access to the Internet) and for the University itself since there is no need to organize in-class placement testing which would have to be done during the holiday season and would also require the engagement of the teachers and the administration staff.

4.2. General language e-courses

The next step to incorporate online language courses into the university education was the introduction of the large project "Creating curricula for distance learning in the Faculty of Information Technology – the English language component". Contracted by COME UW, the expert ELT methodologists from the English Teacher Training College in the Centre for Foreign Language Teacher Training UW worked out the concept and methodological assumptions together with both the overall and the detailed syllabi for the four Project modules (Galbarczyk, Walewska, 2006a).

Over 10 years now, these courses have undergone a number of changes resulting from the teachers and students' needs and feedback. And so today, they take the following form:

The modules provide language practice at two levels of advancement: B1 (two modules) and B2 (two modules). Each of the four modules covers 60 teaching hours (a teaching hour = 45 minutes) and is organized the blended learning way with 45 hours realized on the educational platform and 15 hours – in a classroom. Each module consists of 10 thematic chapters. Every thematic chapter contains interactive exercises developing language skills: listening comprehension, reading comprehension, writing, as well as language sub-systems: grammar, vocabulary, functions and pronunciation (Figure
2.).

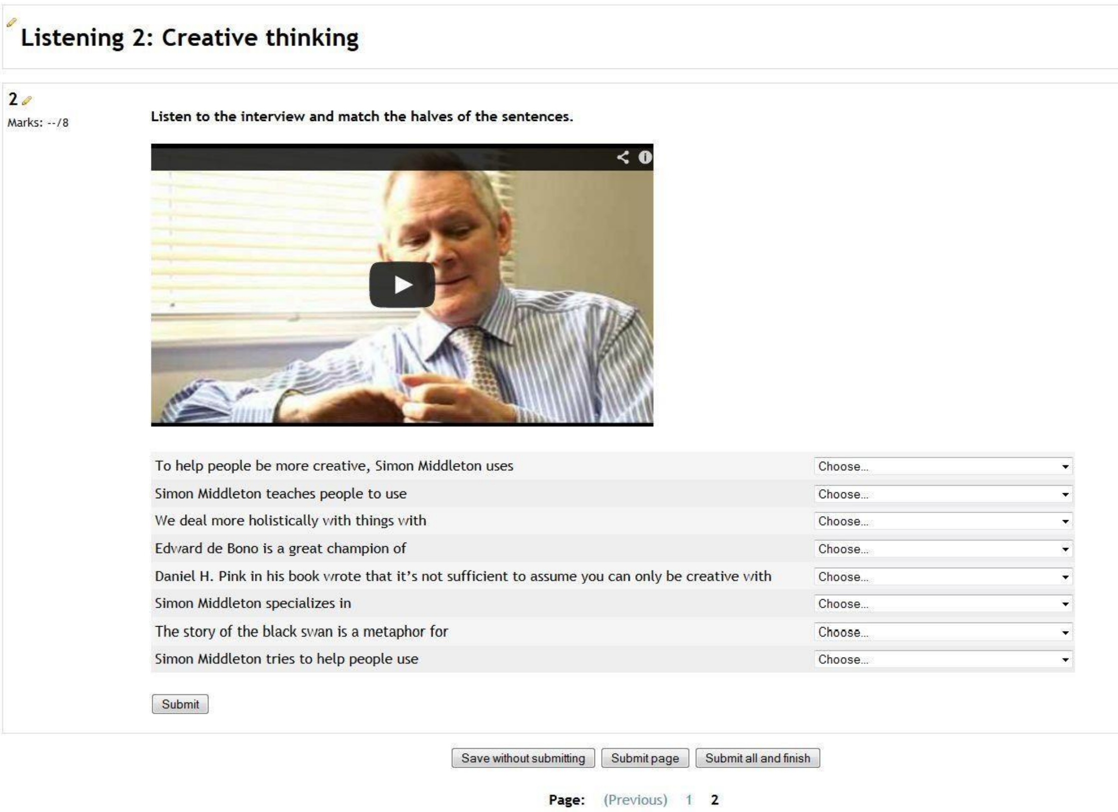


Figure 2. An example of an on-line listening task in a general English language e-course at B2.

The structure of each thematic chapter (Galbarczyk, Walewska, 2006b) reflects the most natural scheme applied in a real-life classroom – it begins with an open-ended warm-up task (usually in the form of a forum) introducing the theme and asking for students' initial reaction and sharing of experience. Then there follow tasks to practise the language skills and sub-systems (in the form of interactive closed-ended quizzes). The chapter ends with an open-ended follow-up activity (in the form of a forum or an online/offline assignment, often including an academic writing task) (Figure
3.).

Every second thematic chapter contains a revision and a test section. They take the form of a quiz with closed-ended tasks, evaluated automatically by the platform.

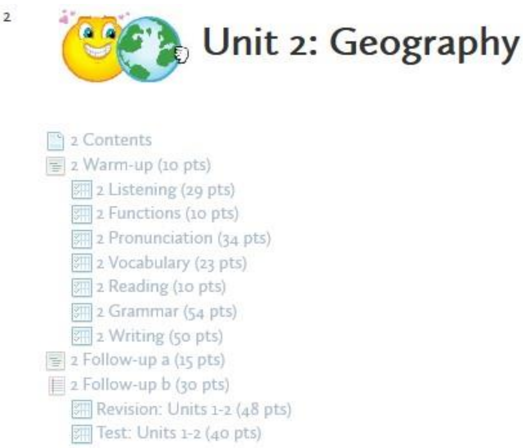


Figure 3. An example of an on-line module structure in a general English language e-course at B2.

The skill of speaking, quite difficult to be practised online due to asynchronous communication, is dealt with during the in-class meetings. The e-teachers, as they become known under this name, are supported with specially prepared stationary lesson scenarios, placed on the platform within a separate course for e-teachers - a kind of repository of teaching materials. The scenarios contain sets of photocopiable exercises (for individual work, pairwork and groupwork) which develop the ideas from particular thematic chapters and give room for the spoken language practice in class. Obviously, e-teachers are entitled to add their own tasks to the ones available on the platform (Figure 4.).

Figure 4. An example of an interactive assignment in a general English language e-course at B1.

The online English language courses received good working reviews during the pilot study (600 people took part in it), from both the e-teachers and the students who were truly interested to continue their language studies this way.

The online English language courses have served as a model for other courses. Namely, they gave a start to the *General English Course at C1*, the so-called specialist courses above B2 level in *Business English Communication*, *Writing summaries in English* and *The language of meetings and conferences* (though these ones are run without in-class meetings), and online full semestre courses (60 teaching hours per semestre) in other languages like Croatian, Czech, German and Russian. It is important to add that though learning takes place mainly via the educational platform, the certification in every course is carried out in class. Today, students of all faculties and types of studies may freely participate in a chosen online course (Figure 5.). They also have a chance to express their opinion on the courses completing the online evaluation forms placed within every course.

Figure 5. Number of virtual classes and students for General Language e-courses in 2015.

As for the e-teacher preparation and responsibility for the courses they run, they are offered free trainings provided by COME UW experts, developing the e-teachers' ICT didactic and technical skills. They are also equipped with necessary online guide books placed in a separate course for eteachers, and supported with the online courses helpdesk.

4.3. Mock language certification e-courses

Finishing their language studies, the UW students are obliged to take a certification exam in a chosen foreign language at B2 level. Since 2013, to help students get acquainted both with the format and content of a language certification exam, COME UW has been offering short preparatory courses in 6 languages (English, German, French, Russian, Italian and Spanish). They contain descriptions of the written and spoken parts of the certification exam and provide an online mock test copying the form and content of an in-class paper test which students take during exam sessions. These tests are available without time limits set. So far, over 1500 students have already enrolled in the certification courses.

4.4. Remedial language e-courses

In case a student fails a certification exam twice, they are required to take a remedial course in a foreign language. COME UW offers remedial 10 hour courses in 14 languages at three levels of advancement: A2, B1 and B2 (English, French, Greek, Georgian, Hindi, Japanese, German, Russian, Spanish, Italian, Chinese, Persian, Turkish, Croatian) (Figure 6 and 7.).

Figure 6. Number of languages for the remedial language e-courses in 2015.

Figure 7. The example headers of the on-line remedial language e-courses.

Some challenges encountered during the Eastern languages embedding on the platform (like Hindi, Georgian, Japanese, Chinese) as a special sort of fonts was necessary to be applied for the students to be able to read the texts in these languages and some of the languages are read and written from the right to the left (like Persian, Hebrew, Arabic). This imposed the need of adding new functionalities and advancements to the platform (elaborated by the COME UW programmers)
(Figure 8.).

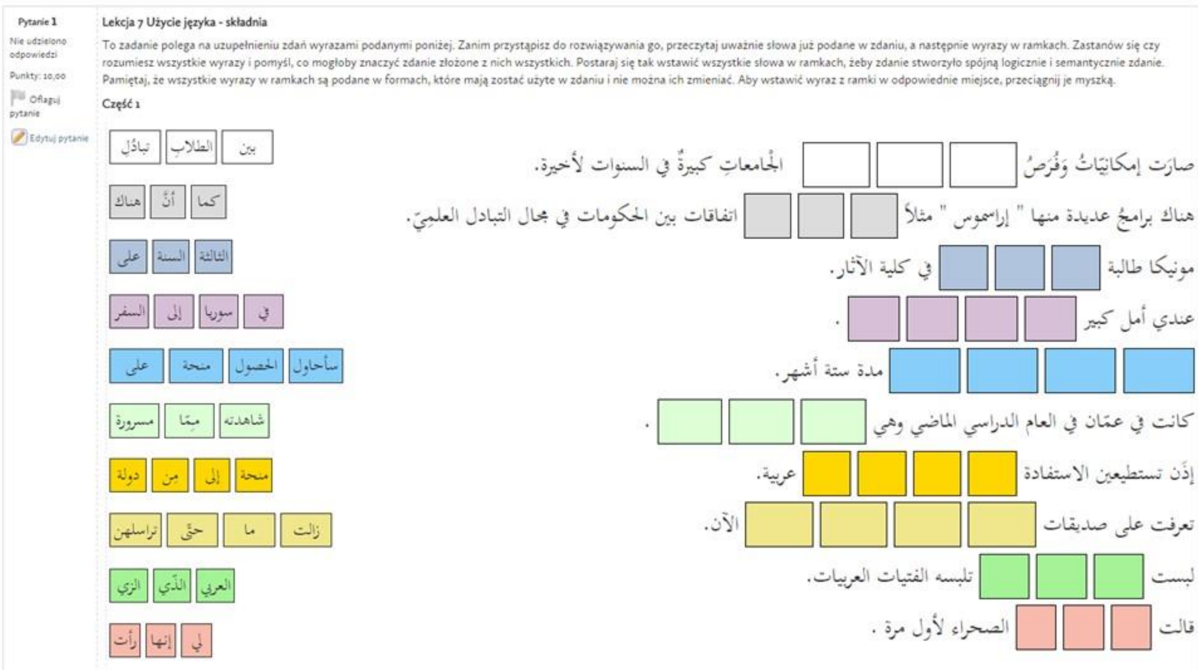


Figure 8. The example exercise of the on-line remedial language e-course in Arabic B1.

5. Language e-courses benefits

The process of introducing new forms of teaching foreign languages at the University of Warsaw let both stationary and extramural students have equal chances to master their linguistic competence.

The added value and the additional benefit from language e-courses is the University's students and teachers' ICT skills increase, which closely relates to the University of Warsaw innovative and modern didactic policy. Moreover, the methodological guidelines and teaching materials available on the educational platform can be used by any language teacher who would like to run classes on-line.

From the administrative point of view, the proposed e-languages' solutions save time (in comparison to the administration of paper tests and their checking) and mean less work for teachers thanks to automatic online assessments. Due to the IT advancements, the tests results migrate automatically to the University Students Management System (USOS), which again facilitates the administrative work. And finally, it reduces the overall costs.

A valuable advancement is student-oriented methodology of language teaching. It helps students to identify the gaps in their knowledge within the learning process. It also facilitates the teacher supervision over the individual student's activity on the platform and lets them briskly react and fully motivate the students in order to make their efforts most effective.

6. Further directions

Some new functionalities are still being developed on the platform. Among them, a tool for recorded speech submission is being tested. This tool will make it possible to work on the skill of speaking in greater detail, allowing students to make audio and video recordings of their spoken performance and letting e-teachers evaluate the students' performance in the same manner.

The existing on-line language courses and tests have their say in spreading the target group outside the university, reaching, for example, the Erasmus exchange students. Thanks to the Polish language (local mother tongue) placement tests and e-course development (in preparation), they are able to learn Polish and prepare themselves for studying in Poland beforehand, while still in their own countries.

The foreign language placement tests have already been used by the University staff (both administrative and academic) in order to qualify for language trainings, and in this way they serve well for the university internal purposes.

The achievements reached can be easily implemented for a broader scope of students and other academic target groups for any language taught at the University of Warsaw. They already function as internal academic MOOCs or SPOCs (small private online courses) (Epelboin, 2014, 2015, Fox, 2013). Once created, they serve thousands of students: already in the course of studies and the newcoming ones.

7. Summary and conclusions

The Bologna strategy, adopted by the European universities, emphasizes the important role of mobility, multilingualism and life-long learning. Moreover, life-long learning implies that qualifications may be obtained through flexible learning paths. Student-centred learning requires the empowerment of individual learners, new approaches to teaching and learning, effective support and guidance schemes and a curriculum focused clearly on the learner. All the above requirements are met within the University of Warsaw project on on-line language courses and interactive tests. The concept has been growing along the two collateral ways: one, regarding the form of services (specific kind of courses or tests for different levels of language advancement: general language ecourses, remedial e-courses, mock certification e-courses, placement tests) and the other, regarding the increase in the number of languages taught via this method. As a result, the on-line materials for 14 languages have been created and there are more than 200 virtual classes run annually on the COME educational platform with the engagement of over 40 well-trained e-teachers. In 2015 academic year, the number of e-courses users exceeded 5 000 (comprising more than 37 000 students taught from the beginning of the project). Thus, it may be stated that the e-courses play a role of internal academic SPOCs (small private online courses), being a form of MOOCs (massive open online courses) (Epelboin, 2014, 2015, Fox, 2013).

The value added of the project is the ICT skills increase in the university students and teachers, which is in line with both the University of Warsaw innovative and modern didactic policy and the European Union strategy on ICT society development. The additional benefit is a significant administrative costs reduction.

Finally, the question on whether the University of Warsaw's achievements in the field of language eteaching may be applied in other universities is a complex one. The technical aspects depend a lot on the infrastructure already set and developed at a university, the structure of a university itself, its policy and the number of students. This means the benchmarking may apply only to some aspects of the solutions presented above, nevertheless, it still should bring benefits for students, teachers and university administrative staff.

8. REFERENCES

1. *2015 Joint Report of the Council and the Commission on the implementation of the Strategic framework for European cooperation in education and training ET2020.*, (2015). Retrieved Feb 28, 2016 from http://ec.europa.eu/education/documents/et-2020-draftjoint-report-408-2015_en.pdf

2. Bednarczyk, I., Jonatowska, J., (2008). *E-angielski na UW* w: E. Gajek, & D. GoltzWasiucionek (Red.), Kształcenie komplementarne a dydaktyka języków obcych, Wydawnictwo Uczelniane WSG, Bydgoszcz, pages 51-60

3. Bednarczyk, I., Krawczyk, T. (2009), *E-nauczanie języków obcych na Uniwersytecie Warszawskim*, Zeszyty Naukowe Wydziału ETI Politechniki Gdańskiej, no. 7, pages 21-27. Retrieved Jan, 28 2016 from https://www.come.uw.edu.pl/sites/default/files/mainfiles/tresc/metodologia/elektoraty.pdf

4. Epelboin Y. (2014), *MOOC 2014: should universities enter the competition?* EUNIS Journal of Higher Education IT, Issue 2014-1. Retrieved Jan, 28 2016 from http://www.eunis.org/erai/2014-1/

5. Epelboin Y. (2015), *MOOCs and pedagogy: where are we heading?*, EUNIS Journal of Higher Education IT, Issue 2015-3. Retrieved Jan, 28 2016 from http://www.eunis.org/erai/2015-3/

6. Fox A., (2013), *From MOOCs to SPOCs*, Communications of the ACM, Vol. 56 No. 12, pages 38-40, doi 10.1145/2535918. Retrieved Jan, 28 2016 from http://cacm.acm.org/magazines/2013/12/169931-from-moocs-to-spocs/abstract

7. Galbarczyk, M., Walewska, A. (2006a). *Koncepcja i założenia metodyczne kursu języka angielskiego dla studentów informatyki w ramach projektu „Opracowanie programów nauczania do kształcenia na odległość na kierunku studiów wyższych INFORMATYKA*". Retrieved Jan, 28 2016 from http://osilek.mimuw.edu.pl/images/a/a2/Koncepcja_kursu_po_recenzji.pdf

8. Galbarczyk, M., Walewska, A. (2006b). *Program ramowy kursu języka angielskiego dla studentów informatyki w ramach projektu „Opracowanie programów nauczania do kształcenia na odległość na kierunku studiów wyższych INFORMATYKA"* Retrieved Jan, 28 2016 from http://wazniak.mimuw.edu.pl/images/5/5c/Program_ramowy_po_recenzji.pdf

9. Marciniak, Z., Chmielecka, E., Kraśniewski, A., Saryusz-Wolski, T., (2014), *Report of the National Qualifications Framework for Higher Education*, Eduactional Research Institute, Warsaw.

10. Rudak, L., Sidor, D., (2008). *Taksonomia e-kursów* w: Praca zbiorowa (Red: Zespół Ośrodka Kształcenia Na Odległość OKNO PW), Postępy e-edukacji, Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa, pages 211 – 219.

11. Wieczorkowska, G., Madey, J. (2007), *Dekalog edukacji internetowej*,in: P. Wiemann, & G. Domańska-Żurek (Red.), VI konferencja Uniwersytet Wirtualny: model, narzędzia, praktyka, Wydawnictwo PJWSTK, Warszawa, pages 10-17.

9. AUTHORS' BIOGRAPHIES

Anna Pacholak, MSc, works in the Center for Open and Multimedia Education, University of Warsaw. She has been engaged in various educational projects involving e-learning such as Doctorates for Mazovia (e-course: *Basics of knowledge commercialization*), Ministry of Regional Development e-courses on projects' evaluation, Audiovisual and Media Education Programme (PEAM), Warsaw School of Data Analysis. Her main scope of interest is open access education, e-learning involvement in teaching and learning, motivation aspects in learning process, new technologies for education. She is a member of the Editorial Board of the EduAction open access online journal and the EUNIS Journal of Higher Eduaction IT.

Academic ELT methodology teacher and teacher trainer at the University of Warsaw since 1994 (The University College of English Language Teacher Education; The Centre for Foreign Language Teaching); author/co-author and editor of ELT coursebooks for primary and secondary education in Poland. Currently works for the Centre for Open and Multimedia Education, the University of Warsaw: in charge of online foreign language courses; also deals with online course design, testing and evaluation. Interests: effective communication in a foreign language, self-awareness and self-monitoring in language learning, language differences as a source of development of communicative competence; blended learning, new technologies in e-learning.

Active teaching and learning: stimulating students' engagement at Paris Descartes University

Xavier Coumoul[1], Anne Laude[2], Pierre Buffet[3], Ludivine Alvarez[4], Marion Harent[5], Stéphanie Lehu[6],

Thierry Koscielniak[7]

[1234567] Paris Descartes University, Sorbonne Paris Cité University
45 rue des saints-pères, 75006 Paris, France
[1] Professor of Biochemistry and Toxicology, Bio
medical Sciences College
xavier.coumoul@parisdescartes.fr
[2] Professor of Law, Dean of Law College
anne.laude@parisdescartes.fr
[3] Professor of Medecine, MD, Medecine College
pierre.buffet@parisdescartes.fr
[456] Instructional Designer, Digital Pedagogy Office
ludivine.alvarez@parisdescartes.fr
marion.harent@parisdescartes.fr
stephanie.lehu@parisdescartes.fr
[7] Executive Director, Digital Pedagogy Office
thierry.koscielniak@parisdescartes.fr

Keywords
eLearning, game-based learning, social learning, gamification, BYOD

1. Summary

In this presentation we will examine six concrete examples that will demonstrate how student's engagement can be stimulated by different kinds of online activities at Paris Descartes University. We will demonstrate innovative ways to use Moodle forum before, during and after a lecture. You will hear feedbacks from teachers and students on several interactive, game-based or social learning activities.

2. Outcomes

- Learn how to perform easy to use interactive online activities before, during and after lectures
- Explore how online activities enhance learning experiences
- Exchange on feedbacks from students and teachers

3. Extended Abstract

Six examples of innovative teaching and learning activities will be demonstrate. Most of the values comes from mixed experiences online and during lectures.

1- Interactive BYOD sessions with LMS Moodle during lectures .This activity has been described at EUNIS 2014 conference. Results and further developments will be described.

2- Students are co-writing an article on Law during Master courses. They use a pad application which permits synchronous writing under the supervision of the professor. The resulting article is copied on Wikipedia at the end of the group work.

3- After a series of Medecine lectures, final Q&A sessions are organized using an online forum. More than 1500 students could prepare questions three days before the session. Answers are given in the theater. Ranking of questions is possible via a « like » feature.

4- « Chemist jeopardy » and « Cell signalisation Grand Slam » are activities based on the same model of online quizzes with rewards.

5- « Campus life »: students may ask online a question after each lecture. The most liked get a reward badge and is answered during the next lecture.

6- « Game of Throbes » A trivial pursuit like game which is performed live with students groups. A lot of fun and emulation on a very serious subject: infectious diseases.

4. REFERENCES

Emery, S. (2012). *Factors for Consideration when Developing a Bring Your Own Device (BYOD) Strategy in Higher Education*. Retrieved February 14, 2016, from: https://scholarsbank.uoregon.edu/xmlui/bitstream/handle/1794/12254/Emery2012.pdf?sequence=1 Fang, B. (2009). *From Distraction to Engagement: Wireless Devices in the Classroom*. Retrieved February 14, 2016. From: EDUCAUSEreview http://www.educause.edu/ero/article/distractionengagement-wireless-devices-classroom. Badeau-Mahmoud et al. (2014) *Interactive lectures with Moodle and students' devices: BYOD at Paris Descartes*. Retrieved February 14, 2016. From : EUNIS international congress 2014. http://www.eunis.org/download/2014/papers/eunis2014_submission_19.pdf

5. AUTHORS' BIOGRAPHIES

Thierry Koscielniak is Executive Director of the Digital Pedagogy Office of Paris Descartes University, France.

www.parisdescartes.fr

He is a member of the EIRA (**EUNIS Research and Analysis Initiative**) editorial committee and EUNIS E-learning task force.

He is member of the French association of Digital Education Departments in Higher Education (www.anstia.fr).

As a member of the IT Strategic Steering Board of his university, he plays a role in strategic planning and policy development for information system, infrastructure and programs.

His department is in charge of the LMS Moodle, of the e-portfolio management system Mahara and of the university social network based on Elgg: http://carnets.parisdescartes.fr

Thierry completed his Ph.D. in Computational Chemistry at Pierre et Marie Curie University.

https://www.linkedin.com/in/tkoscielniak twitter : @tkoscielniak

EUNIS-2016-koscielniak.doc

The social university: delivering business benefit through online networking

Dr Gill Ferrell[1], Anna Mathews[2]

[1]Aspire Ltd, Le Chay 47360, St Sardos, France, gill@aspire-edu.org
[2]UCISA, University of Oxford, 13 Banbury Road Oxford OX2 6NN, UK, execsec@ucisa.ac.uk

Keywords
Academic freedom, benefits realisation, cyber bullying, cyber crime, esafety, governance, legal compliance, policy, service delivery, service design, social media, social networking, strategy.

1. ABSTRACT

This paper encourages senior management teams to adopt a strategic approach to university use of social media.

Social media tools have a user base of millions and are increasingly used by universities but often in an *ad hoc* fashion. There are examples of good use of social media for business activities including student recruitment, induction, learning and teaching, research, delivering IT customer service, alumni relations and other areas.

However, universities have not yet been able to embed pockets of good practice into more strategic approaches that meet particular needs. Many have been swept along by a global trend without being clear what they want to achieve using social media. There are more HE courses on developing a social media strategy than there are university social media strategies!

The time is right to be more visionary in approach and more tactical in the use of particular tools. Senior management teams need understanding of the opportunities and risks to provide leadership and ensure this type of engagement delivers the desired benefits.

A strategic approach doesn't mean your university's social presence will become bland and corporate but rather that you can use new tools to enhance the core activities of a scholarly community.

2. INTRODUCTION

This paper outlines the need for senior management teams to adopt a strategic approach to the use of social media by their universities.

Social media is a general term for a range of internet-based applications that allow people to create, co-create, share and interact with information. The scale of use of these tools is phenomenal with the most popular applications having many millions of active users worldwide. Use of such tools within universities is already common and is increasing. However, awareness of the benefits and risks associated with use of such tools is generally lowest amongst senior staff who have responsibility for corporate governance.

The paper draws on guidance in a Toolkit published by UCISA in 2015 for UK universities (UCISA 2015). The Toolkit recognises that good use of social media requires effective collaboration across many different functional areas of the institution including: senior management; marketing; IT; learning and teaching; legal and student support and, hence, the full Toolkit contains specific guidance for different types of user. Here we look specifically at the key messages for senior management teams.

The paper is specifically concerned with the higher education context and how this differs from the use of such tools in other types of organisations. It looks at social media from a perspective of corporate governance in higher education thus it is not a guide to the use of specific tools and nor is it limited to the use of such tools for learning and teaching purposes.

3. MAKING THE MOST OF THE OPPORTUNITIES

There is strong evidence that the effective use of social media is delivering considerable benefits across all aspects of university activities. To take but a few examples:

- Students are making contact with their peers through university networks before arriving on campus, and in some cases even prior to application, aiding recruitment and retention.

- Researchers are engaging in action research and communicating about their research using such tools.
- Students are using the tools to develop and demonstrate their competence in skills required for the world of work.
- Universities are using the tools to reach, interact, and work collaboratively with a range of audiences and using such public engagement to show the value of their activities in relation to the wider economy and society.
- Social tools are changing the nature of internal communications between university services and their customers.
- Social media tools are being used effectively to enhance learning and teaching practice such as examples of their use to support peer review, peer support, collaborative working and enhancing learning in large group settings.
- Social networks offer another channel to engage with university alumni.

There are short case studies on all of these types of benefits in our Toolkit.

The cultural trend implied by use of such tools is a significantly different and more social relationship between higher education providers and their stakeholders. The university is more of a knowledge hub than an ivory tower. Communications are likely to be more rapid and less formal. In using social media as part of your official channels of communication you will need to ensure you can both manage and meet user expectations.

With current tools it is very easy to innovate and experiment, but it is worth investing a little time in understanding the spirit of each tool's user community. Much authentic engagement will evolve quite naturally and organically, and you may indeed take the community in new directions, but managing a corporate presence does require a certain degree of planned effort and dedicated staff time. Such communications can be very cost effective but they do need to be resourced. You cannot expect staff to engage in social media communications on top of everything else they already do.

4. PRACTICAL APPROACHES

4.1 Defining a strategy

We suggest the use of social media is a strategic issue that requires senior level commitment but do you actually need a social media strategy?

The answer is that you probably don't need a separate strategy so long as you are thinking strategically and know how the use of social media fits with your institutional mission. Ensure the senior management team discusses the role that social media could play in underpinning your institutional values and supporting your particular mission. Also ensure that your use of these tools is aligned with other important institutional planning documents. For example have your overarching information and communications strategies been updated to take account of these new forms of communication?

However, if your institution is taking its first steps with social media, then you might find it useful to a separate (possibly short-term) strategy and action plan to make the most of the opportunities and clarify how you will measure that benefits realisation is actually taking place.

4.2 Defining a policy

In order to meet your responsibilities with regard to corporate governance you will need some form of policy on the use of social media by your staff and students.

Many universities have social media policies and they vary considerably in their approach – possibly because different universities have given different departments responsibility for this area. Such policies may be 'owned' by departments of marketing, communications and external relations; human resources; or information services. You need to think about who has the expertise to devise such a policy and also the role of policy as an ***enabler*** versus a means to deal with misconduct.

Smithers (2012) discusses the issues associated with university social media policies being developed by people with backgrounds in other industries, who have been brought in for this purpose, and who do not really understand how scholarly communities operate. He suggests this results in policies that are developed without enough vision for what could be achieved and which are taking protectionist and damage-limitation approaches, restricting the opportunities to innovate and collaborate.

Universities employ a wide-ranging body of staff many of whom have legitimate reasons to use social media in support of their professional practice. In other cases, however, staff may spend an excessive amount of work time on social media activity that is not work-related or exhibit behaviours that would seem incompatible with the pastoral care of students. Too much emphasis on penalising misconduct can result in a policy that is negative in tone and discourages staff from making the most of opportunities.

A practical approach is to indicate the level of social media activity you might expect a particular job role to entail – a spectrum might range from neutral (not expected to participate on behalf of the business) through to encouraged (not a requirement but can be beneficial and guidance available) to expected (a normal part of the role).

The message here is the need to ensure that policies act as enablers to delivering the benefits of social media as well as effectively managing the risks. It may be a good idea to frame your policy to be as much about institutional values as about rules. It is also beneficial to involve a range of stakeholders in drawing up/reviewing the policy in order to gain buy-in and help determine what is reasonable in different contexts (bearing in mind that different departments may have different cultures within a single university).

Our Toolkit contains a lot of good practice guidance on this topic.

4.3 Choosing the right tools

The choice of which tools to use is a significant one. There are many tools available and fashions change rapidly. Particular tools often appeal to a certain demographic so in order to interact effectively you need to understand how the social media channels you adopt are perceived by your target audience(s). You also need to consider what type of interactions your students will feel it appropriate to have with a learning provider via social channels. The higher education student and staff population is a very diverse community and it would be overly simplistic to stereotype attitudes to social media.

Universities also need to consider the international dimension of their activities. Social networks and other tools that are popular in Europe may be little used, or even banned, in some key target overseas markets such as China and other parts of Asia.

Currently there is a lot of thought being given to reputation management on social media but less evidence of effort being put into looking at how information flows via social networks support all aspects of the student lifecycle. The ad hoc addition of tools in an organic fashion can lead to confusion on the part of staff and students about which tools to use for which purposes. The difficulty at an institutional level is therefore getting the right balance between tools that are readily available to you (and possibly already familiar to your staff) and tools that your students prefer to use, bearing in mind that you may have a diverse student population and a set of younger users whose habits and preferences change quite frequently.

A few practical suggestions:

- View social media as part of service delivery – think about your stakeholders and their needs and preferences. A service design approach and the use of individual user stories or personas can help (see Baranova *et al* 2010).
- Look at the fit with IT infrastructure – consider the possible tools in relation to their compatibility with your other infrastructure.
- Solve real world problems – for example, consider whether social media tools might address issues due to students not reading email?
- Be inclusive – ensure that the tools you use are accessible to the widest possible range of potential users.
- Look at total cost of ownership – consider the total cost of the various options available, bearing in mind that tools free at the point of use may require chargeable customisation and that some tools may have cost implications in terms of the guidance and/or training needed.

4.4 Staying legal

At first sight the range of legal issues that need to be considered when using social media is quite daunting. In practice however there is nothing significantly new about any of this. The relevant legislation has been in place for some time and universities already have well established procedures for ensuring compliance in other areas of their activity. The basic need is to undertake a review of your policies and guidance. Ensure that they take account of the use of social media and include relevant examples to help clarify the issues for staff and students. Simply having policies and guidelines is not enough, however – in order for them to be effective you must communicate them well to all of your users.

Our Toolkit takes you through a few examples where less familiar issues may arise including:

Copyright and intellectual property rights (IPR) Universities are generally very well aware of their responsibilities in these areas but issues can arise due to the ease of capturing and sharing information on social media. Copyright and IPR do exist in the virtual world and the laws are basically the same but they are easier to infringe and to detect! In some cases, the issues can be quite complex e.g. a single piece of multimedia content may actually consist of a number of different layers with different ownership and there may be multiple contributors to content on blogs and wikis. It can often be quite difficult to determine who owns content and in which country's jurisdiction the content was generated. There is also a lack of clarity of what may be permitted under exceptions to copyright because of a lack of suitable case law e.g. in the field of data and text mining.

Our advice is to apply common sense and existing good practice. When using content produced by staff you need to think about whether or not the content was produced as part of their duties of employment, and when using content produced as part of an inter-institutional project you need to think about having a consortium agreement that defines how that content can be used. You may also wish to use the student-generated content on social media, either as learning resources or to showcase other aspects of the student experience, and you should ensure that you have the appropriate consent to do so. Note also that whilst reproduction by a student as part of their learning may fall within a copyright exemption, reproduction of the same material by the institution as part of their marketing may not.

Data protection and privacy Particular care needs to be taken with regard to the sharing of images and video clips where individuals are recognisable, as this may infringe on an individual's right to privacy (as defined by Article 8 of the European Convention on Human Rights) as well as data protection legislation. Personal data must be fairly and lawfully processed and learners should be informed about all uses of their personal data and consent to that use. Institutions should also be aware that individuals captured on audio or video undertaking activities such as singing, dancing, acting, miming, reading aloud or even simply giving a lecture may be covered by performers' rights and their explicit consent will be required to publish the video clip or podcast. The Web2Rights project established that even avatars recorded in virtual worlds can acquire performers' rights.

Most European countries have stringent data protection laws. The UK Data Protection Act makes special provision in relation to sensitive personal data: this comprises data about a person's religious beliefs as well as personal data relating to racial or ethnic origin, political opinions, membership of trade union organisations, physical or mental health, sexual life and offences or alleged offences. Whenever processing sensitive personal data, explicit consent is required and additional safeguards should be in place. Social networks that support student societies may therefore process sensitive personal data. The ease of combining data from different sources may also mean that personal data or sensitive personal data, whilst anonymous in its original source, can be aggregated with other data such that individuals are identifiable.

International law Many social media tools are available worldwide and support for international recruitment and international research is indeed part of their appeal for universities. This does however mean that if content infringes a law in another country then those making the content available could be sued in that other country. As an example, copyright materials that could be made available under the US fair use provisions may fall foul of UK copyright law where the boundaries are more narrowly drawn. As an example it is possible for a wiki to be built up by a number of contributors across the world: each may have diligently followed local laws but some may have ended up doing things that would have been illegal in UK law.

It is illegal to import something from another country which would be infringing copyright had the act in question been carried out in your country. Thus a wiki host could be liable for illegal content that was incorporated in good faith by a third party in another country. Defamation laws may also vary from country to country. Whilst the risks are real, actual examples of cross-border cases going to court are extremely rare (one of the most notable examples was the French state blocking the sale of Nazi memorabilia via Yahoo).

Research ethics Another area that is specific to our particular environment is the opportunities offered by social media to help in carrying out research. Universities should provide guidance on the use of social media in research and ensure that ethics policies are updated to cover research conducted using social media.

Our Toolkit offers common sense guidance on all of these issues and other areas such as the posting of inappropriate content by students or staff.

4.5 Academic freedom

Given the nature and values of the higher education environment, it is unsurprising that matters relating to academic freedom and freedom of speech are particularly prevalent and contentious in relation to the use of social media. From the university perspective the issues relate to the extent to which the institution might be held legally responsible for the actions of its staff and students in the 'virtual world' and the extent to which such actions reflect on the image of the institution.

Situations where online behaviours go beyond the bounds of normal acceptability to the extent they are illegal and/or constitute harassment of others should be covered by statute and policy. There are however many more grey areas, where the right to express certain opinions using certain social media channels is more contentious.

Academic blogging, and other forms of commentary via social media, is one of the more contentious areas. Debates about academic freedom are nothing new, but potentially controversial opinions that were previously restricted to a limited journal readership now have a much wider audience and frequently receive considerable media attention, as do comments made by academics about universities.

It is a moot point to what extent institutions would wish to control the use of social media by staff and students. Attempts to do so may simply drive criticism underground to other channels or behind the screen of anonymity. There is a need to clarify where professional ends and private begins, and to be clear about what constitutes inappropriate behaviour. It is equally clear that promoting and supporting examples of good practice is as important as defining what will not be tolerated.

Our Toolkit looks at the issues in more detail and provides guidance including:

- Define your context – relate your approach to social media to your existing position in an institution that has a legal responsibility to promote freedom of speech and academic freedom.
- Be value-driven – emphasise your institutional values in guidance for staff and students.
- Keep it simple – if you choose to have a policy, do not make it complicated — a simple policy of advising people not to say or do anything online that they would not do offline can suffice as guidance, as for example in these quotes from UCISA (2014) Model Regulations:

"*Real world standards of behaviour apply online and on social networking platforms, such as Facebook, Blogger and Twitter.*"

"You must not cause needless offence, concern or annoyance to others."

"The way you behave when using IT should be no different to how you would behave under other circumstances. Abusive, inconsiderate or discriminatory behaviour is unacceptable."

4.6 DEALING WITH PROBLEMS

Despite the enormous benefits of social media in many aspects of everyday life, the tools, like so many others, have the potential to be misused. The BBC in June 2014 reported that 50% of calls passed on to front-line police now involve crimes originating from misuse of social media. Other forms of cybercrime are also on the increase (and are indeed opening up as a whole new subject area in many universities). Universities need to understand the issues and be proactive about preventing them.

Behaviours that may constitute bullying or harassment can take a variety of forms. Various terms have been coined to describe behaviours that specifically relate to the use of social media: creeping, stalking, trolling and ratting are all discussed in our Toolkit. Online bullying and harassment is often carried out by the same types of perpetrators and for the same reasons as in the physical world. In the digital world however the choice of victim may be more random and people can be subject to this type of persistent behaviour from complete strangers.

Awareness of bullying and harassment is probably strongest in terms of its association with young people but anybody can be affected. Social media use is increasing the extent to which teachers and tutors are subject to abuse. Criticism on sites such as Ratemyprofessors.com and The Student Room can often overstep the bounds of acceptability. There are a number of celebrity academic cases but this issue is something that many academics on social media may encounter.

Universities have a duty of care so as an institution you need to think very carefully about how best to protect your staff and students from cyber bullying without inadvertently accepting liability for matters beyond your control.

In 2013 UCISA was involved in helping UK universities deal with the appearance of a series of social media sites with names such as Spotted:<institution>. In this case users were asked to post descriptions and/or images of people spotted in institutional libraries causing some students to state that they no longer felt safe in the library. UCISA issued guidance to members about using existing procedures to require hosts to effect a takedown of such pages, focusing particularly on the visibility of university insignia and the lack of subject consent.

Simple steps to help your university discharge its duty of care include:

- Define limits – have a clear policy and guidance on what constitutes acceptable and unacceptable behaviour: this can take the form of a specific social media policy or may be handled by the IT acceptable use policy and other documents such as the student charter and staff conditions of employment.
- Be consistent – have a clear and consistent approach to dealing with inappropriate posts on university official social media channels.
- Offer guidance – support staff and students in the effective use of social media using the suggestions outlined in our Toolkit.
- Help keep your users safe – alert staff and students to the dangers of misuse of social media and point them to sources of advice and help (you can find many sources referenced in our Toolkit).
- Act quickly and only when you need to – be wary of overreacting to ill-considered remarks but be prepared to alert the relevant authorities if an individual appears to be facing real risk.

Our Toolkit offers further guidance on these topics and preventing other forms of cyber crime perpetrated via social media.

5. SUMMARY

A few of the main pointers for corporate users are highlighted here. You will find further information and good practice guidance spread throughout each section of our online Toolkit:

- **Know why you are doing this** – be clear about what benefits you want to achieve.
- **Be consistent** – have an appropriate combination of strategy/policy/guidelines to communicate your approach to all users. This does not need to be complicated — focus on how your use of social media supports your core principles and values rather than on defining a detailed set of rules about what can and cannot be done.
- **Understand your users** – think about using approaches such as service design to better understand how social media can improve the experience of interacting with your institution. This will help you choose the right tools and design effective processes to support their use.
- **Be visible and accessible** – make sure your users can find you by clearly signposting links to your social media presence on the home page of your website. Make sure the tools you choose are accessible to the widest possible range of users.
- **Create a strong digital identity** – you will have corporate branding and communication guidelines but finding your corporate voice in social media channels can be more of a challenge. Your style should maintain professional standards although it is likely to be less formal than other types of communication. Where you have a group of staff contributing to corporate communications do not be afraid to let them have individual identities.
- **Be current and relevant** – by setting up a social media presence you are committing to keeping it up-to-date and relevant to the target audience. You may want to consider splitting a channel into different identities for different audiences if topics are becoming mixed or, conversely, amalgamating groups that are similar and have limited activity. You also need to ensure that dormant accounts are closed down.
- **Ensure adequate resourcing** – ensure that official channels of communication have an active presence at all reasonable times. What is likely to meet user expectations may vary depending on the purpose for which a particular communication channel is set up. One or two people doing this in their spare time is not likely to generate effective engagement. A certain amount of dedicated resource may be needed in a number of key areas of the institution.

- **Engage your users** – keep your social media channels social and do not use them simply to broadcast information. As part of offering meaningful engagement you will need to decide how best to encourage discussion and the exchange of ideas whilst finding appropriate ways to respond to criticism and views you do not agree with. As an institution you need to find your own voice and create your own image as a place of stimulating and thoughtful debate.
- **Protect your users** – a duty of care to both staff and students demands pro-activity about esafety and about sources of advice in cases of cyber bullying or harassment whether or not this takes place through official institutional channels.
- **Protect your institution** –ensure that your institution operates within the law and follow our guidance to mitigate the risk of legal liability or reputational risk should any of your users break the law.
- **Keep an eye on trends** – social media is here to stay but is a fast-moving environment so you need to keep an eye on what your users are doing (and saying) and also look out for new developments that might offer opportunities for you to innovate and differentiate.
- **Measure success** – think about what meaningful success measures look like for your institution and measure the things that matter.

By following our simple, common-sense guidelines you can ensure that your university is free to innovate in this new digital environment and use social tools to deliver benefit in many aspects of activity.

6. REFERENCES

Baranova, P., Morrison, S. and Mutton, J. (2010) *Service design in higher and further education: a briefing paper*. Retrieved February 11, 2016, from: http://wiki.cetis.ac.uk/images/8/82/Service_Design.pdf

Smithers, M. (2012) *Universities and social media: Academics need to be bold in our use of social media and not outsource digital dissemination to widget gurus*. LSE Impact Blog. Retrieved February 11, 2016, from: http://blogs.lse.ac.uk/impactofsocialsciences/2012/10/03/smithers-universitiessocial-media/

UCISA (2014) *Model regulations for the use of institutional IT facilities and systems*. Retrieved February 11, 2016, from: www.ucisa.ac.uk/modelregs

UCISA (2015) *Social Media Toolkit: a practical guide to achieving benefits and managing risks*. Retrieved February 11, 2016, from: www.ucisa.ac.uk/socialmedia

7. AUTHORS' BIOGRAPHIES

Gill has teaching and research experience and has held senior management positions in a number of university administrative functions as well as directing a UK support service enhancing the use of ICT in further and higher education. She acts as a consultant to universities and national agencies in both the UK and Europe and has been an invited speaker at many national and international events. Current interests include: data and information management, technology enhanced learning, assessment and feedback and learning space design.

http://uk.linkedin.com/in/gillferrell

Anna is Head of Policy and Projects at UCISA. She drafts UCISA's consultation responses and represents the Association at meetings and events. She works in collaboration with UCISA's special interest groups and leads the annual statistics survey. She has previously been a programme manager at the University of Oxford and has worked in support of medical research. www.ucisa.ac.uk/contact

UCISA publications, case studies and event materials (presentations, streamed content and other post-event resources) are freely available to colleagues across the UK and internationally at www.ucisa.ac.uk

Creating an IT plan is more than words on a page

Karoline Westerlund[1]

[1]Umeå universitet, SE-901 87 Umeå, Sweden, karoline.westerlund@umu.se

Keywords

IT plan, IT governance, Security, Risk analyses, Shadow IT

1. Summary

This paper presents an approach making awareness of security issues further out in the organization by creating an IT plan for one department at our university. The IT plan provides a structure to help organize and define roles and responsibilities, an enabler. The IT plan should be communicated, understood and accepted.

2. ABSTRACT

I was contacted by the Head of Administration at one of our departments asking what authority their IT support group had when it came to IT resources and security issues.

I thought it would be interesting to share their experiences and work together with them. I invited myself to the group and we started a one year long journey meeting once a month which resulted in an IT plan as Dean signed up. For me it was interesting to see what issues they were facing and what local solutions they had developed instead of using our central IT services. Trust was important and I decided not to lecture them. Instead I asked questions about their choices of solutions, hopefully making them rethinking.

The objective was to provide a structured methodology to help the IT group developing and implementing an IT plan for governance and planning of IT resources at their department. The outcome was to define decision rights and liability frameworks for desired behavior regarding IT usage. The department needed to understand and commit to the plan and for that we needed full commitment from the department's leadership.

The IT group supported 170 employees and 2000 students. Together, they used a variety of IT services and managed a large amount of information. They had a mixture of centrally provided services and local solutions developed and managed by the IT group.

The IT plan had to align with the university's governance policies and regulations and supplement with local rules that were unique to their needs. I wanted to point out the most important areas to cover, keep it short so people actually took part of it and put some more detailed documents in an appendix, see figure 1.

1. Responsibility and Roles
2. IT resources – Services and Equipment
3. Security – Risk management
4. Permissions – Access rights
5. Software and Licences
6. ToDo – need to improvement

Figure 1 Areas covered in the IT plan

Every meeting covered one of the areas. I put up the frame and questions and the first thing we did was to identify the key responsibility roles and assign people to the roles. We used the RACI matrix, responsibility assignment matrix, to visualize. We determined the key points of the responsibilities and mandates they had.

We identified the support they gave to the most commonly IT services used on a daily basis and what areas they covered. Standard specifications were set for workplaces for different roles. The most important security issues related to behavior were highlighted. Here we are talking about information security, backup, password, phishing mail and virus.

It is important to have control over higher permissions to the applications. We set up a matrix of applications, persons connected and what kind of permission.

Software and licenses is a complicated area. To maintain control you must established procedures for purchasing and installation of software. We developed a description of various software normally available and pointed out one responsible person in the group.

During the year we identified areas that needed improvement. A new matrix describing activities, expected results and responsible appointed person was prepared. One important security issue was that they had their own backup solution and the hardware placed in a room in the basement with no security classification. A new lesson had to be learned – how to identify risk factors and classify the information. Another lesson learned was that what is not documented is not – you have to understand the need of documentation and know where you will find it.

When we started our work we agreed upon that the Head of administration is to be responsible for the IT plan, keep it alive and update it with the IT group and communicate it to everyone in the department. When the IT plan was approved by the Dean the Head of Administration called for an all staff meeting presenting the IT plan and pointed out the most important security issues they had to relate to.

This kind of work did not come easy for the group. They had a lot of information but needed help to transform it to an IT plan.

3. REFERENCES

Westerlund, K (2015) *The importance of having a disaster recovery planning process* EUNIS (2015) ISSN 2409-1340 http://www.eunis.org/eunis2015

Westerlund, K (2015) *Setting goals and measuring the value of Enterprise IT Architecture using the COBIT 5 framework* EUNIS (2015) ISSN 2409-1340 http://www.eunis.org/eunis2015

Westerlund, K (2013) *One way to communicate the value of Enterprise Architecture – maturity levels for IT applications*, EUNIS (2013) ISBN 978-9934-10-433-6 http://eunis2013.rtu.lv/content/program Westerlund, K (2012) *How we built an Enterprise Architecture framework meeting our needs*, EUNIS (2012), www.eunis.pt/images/docs/abstacts/P2C1.pdf

Westerlund, K (2011) *On Budget is Not Enough – Lesson Learned Leaving an Email System from the 90s*, EUNIS (2011), www.eunis.ie/papers/On-Budget-Is-Not-Enough_KarolineWesterlund_Paper.pdf

4. AUTHORS' BIOGRAPHIES

K. Westerlund. I work as an IT-strategist at Umeå University since 1997. I am a part of the IT Office and we have a mandate from the University Management to take strategic responsibility for all common IT at the university. Between the years 1994 to 1997 I worked as a project manager and was responsible for the development of an IT system supporting human recourses, named Primula, for higher education in Sweden. At the beginning of the 90s I worked as a development strategist at Umeå University and in the sector. During the years 2006 to 2012 I was a member of the Ladok Board. I have studied informatics, economics and law at Umeå University. I have the strategic responsibility for IT security. On an annual basis, I give a number of seminars in various fields such as Enterprise Architecture, Governance, Management and Information Security.

The Digitization of the Higher Education Enterprise - Making Higher Education Affordable, Accessible, and Relevant for All

Author
Dr Malcolm Woodfield

SAP Labs Silicon Valley
Palo Alto, USA
m.woodfeld@sap.com

Keywords
Digitization, Re-imagine, Transformation.

1. Summary

Over the last decade we have become familiar with the term “Digitization”, applied mainly to the conversion of analog and paper assets for learning and research. The next decade will see a dramatic escalation in Digitization applied to the whole University enterprise. This will produce enormous challenges but also enormous opportunities to make Higher Education globally more affordable, more accessible, and more relevant.

2. ABOUT THE EXTENDED ABSTRACT

Higher education script

1.	We are facing an unprecedented demand for education across the globe. There are forces – economic, political, technical, and cultural – converging in a perfect storm to increase demand for higher education. How we respond to this demand will do nothing less than shape the future of our world. Hello, I’m Malcolm Woodfield, global vice president of higher education and research for SAP. Today I’m going to talk about how providers of higher education are reimagining their future and achieving unprecedented transformation through the adoption of digital technologies.
2.	What are these forces that I’m speaking of? Here are some examples:
3.	Demand for online learning content is massive – and innovators are using digital platforms to reach this growing audience. For example, in 2012, Harvard University and MIT founded edX, a Massive Open Online Course platform offering free content from some of the world’s best universities and institutions. edX now serves over 5 million learners.
4.	Another driver of demand is the growth of the nonpermanent or contingent workforce. These are your contract laborers, freelancers, and temporary workers. This new workforce will require not one skill set but several that need to be continually refreshed and retooled.

5.	Thirdly, the tremendous rise of the middle class. By 2030, the middle class is expected to grow by 177% to reach 5 billion people. The majority of growth is in emerging economies that place a high value on the power of education. Couple these figures with estimates for the contingent workforce, and you can see that there will be tremendous demand for continuing education.
6.	These are just some of the pressures that are driving a seismic shift in education – in who is taught, how they learn, and who provides that education. However on the supply side, there is a challenge.
7.	Supply is limited by high cost, by technology, and by the legacy practices of how education is delivered.
8.	The future of higher education – and to some extent, the future of our world – depends upon how we respond to this challenge – and in particular – how we use technology to respond to this challenge. How do we create the best possible future for higher and continuing education?
9.	By using digital technologies to transform how education is managed and delivered. That means:
10.	Reimagining how the academic enterprise is run – how the business is run: how you teach, who you teach, how you are funded, and how the whole operating model works.
11.	That in turn will require a change in the business processes and practices of those institutions, many of which have been in place for many years.
12.	Thirdly, then, who will implement these changed models? The workforce of the future will be drawn from the students of the present – and this workforce will have new working methods, patterns, and values.
13.	In other words, the digitization of education will affect every related activity, every interaction, every transaction, and every outcome. How do we navigate this transformation successfully?
14.	Providers of education need to reevaluate their operations and focus on three areas in particular:
15.	They need to simplify to be more agile.
16.	They need to harness the massive amounts of data being generated by digital technologies.

17.	And they need to run on a real-time basis. You and your students live in a real-time universe. Your operations should run in real time, too.
18.	Today we have the platforms for running simple, running data, and running in real time.
19.	The modern digital business framework, can turn this imagined future into reality by transforming how providers of learning run at their core. For example:
20.	Student engagement The student experience is changing dramatically. Students come from a generation that uses mobile devices constantly. They expect a consumer-like experience and service. Our technology helps you meet those expectations.
21.	New workforce engagement software helps develop traditional staff – but also transform how you cultivate talent and manage contingent employees. You need the infrastructure to manage this changing and complex workforce.
22.	Supplier networks When it comes to “bricks and mortar” campuses, they are like small towns. Beyond education, they have medical services, housing, food services, transportation, sports, entertainment, security . . . These are provided and supported by a network of suppliers. Digital technologies facilitate supplier collaboration and cost control across all of these expenses.
23.	That brings me to the last point – Big Data and the Internet of Things. The campus infrastructure is becoming a platform for the Internet of Things – with its individual pieces connected through sensors and software in a network. This “connected campus” will produce tremendous amounts of data – data that can drive real-time insights and inform decisions. Decisions like which students to admit, which faculty to hire. Whether to invest in a particular area of medical research. These decisions will be based upon data and predicted, measurable outcomes. Our digital framework helps enable this decision making.
24.	Let me give one example. La Trobe University, based in Melbourne, educates 36,000 students throughout Australia and Southeast Asia. • La Trobe set out on a mission to achieve digital transformation that is enabling it to run Simple, run data, and run in real time. • It’s running simple by moving all on-premise its core applications to the cloud hosted from a local data center.

25.	It's using data to gain an immediate view into student performance, Mitigating costly attrition rates while improving student retention and performance through better insight into student behavior. It's focusing its researchers' time through instant access to data related to grants.
26.	And it's running in real time. By simplifying financial operations, La Trobe was able to consolidate over 70 unreliable custom reports to five standard reports containing accurate, realtime data.
27.	By bringing its operations into the cloud, La Trobe University has been able to simplify operations, increase productivity, and foster innovation.

AUTHOR'S BIOGRAPHY

https://www.linkedin.com/in/malcolm-woodfield-57631a1?trk=hp-identity-name

Dr. Malcolm Woodfield was born in England and educated at Cambridge

University where he obtained his Ph.D., which was subsequently published by Oxford University Press. After a successful career as a teacher and widely-published researcher (at Cambridge University and University of Chicago), Dr. Woodfield joined SAP Labs Silicon Valley in 1997.

Dr. Woodfield leads the Global Business Unit for SAP's Higher Education and Research. As such he is responsible for worldwide business development and product development of SAP's portfolio of solutions for Higher Education.

He is responsible for advising SAP regarding technology trends and requirements in the School, Higher Education, and Workforce Development sectors, and for managing relations with approximately 8,000 Schools, Universities, companies, and Ministries of Education using SAP technology for teaching, research, and administration. His team has ultimate responsibility both for SAP business and product strategy, but also for the success of all SAP projects in Higher Education and Research worldwide.

The Campuscard System: An innovative multifunctional smartcard solution for higher education institutions

Dr. rer. nat. Tamas Molnar

[1]Project Manager Campuscard Berlin, Humboldt University Berlin, Unter den Linden 6, 10099 Berlin, tamas.molnar@cms.hu-berlin.de

Keywords
Smartcards, Mifare, Self-service Terminals

1. Introduction

The Campuscard system is an innovative, integrated card system for universities and colleges, which is introduced as joint project of six universities and colleges in Berlin for over 100 000 students. The system is designed to incorporate multiple card types, from student cards, which are being currently introduced at six institutions, to employee and visitor cards with multiple services included:

- Identification (optical and electronic)
- Electronic payment system (canteens, cafeterias, copy and print services)
- Use of the library (electronic identification and payment of fees)
- Optical and electronic ticketing for public transport
- Access control (employee cards only)

The system is based on Mifare DESfire EV1 cards and is compliant with ISO/IEC 14443 (NXP Semiconductors N.V., 2010) , which can be considered secure. (Oswald & Paar, 2011)

2. The challenge of issuing cards to 100 000 users

The system was created as a solution for a problem, which most institutions face when issuing smartcards for their students: The traditional distribution processes of card systems are either time consuming or connected to high costs. There are approximately 150 institutions in Germany as of 2016 with a student card system in operation, which integrates the most common functions relevant for the users.

The card issuing is however the most complex and most expensive process of these systems as it either relies on a high number of employees or on costly card placement machines to enable a postal shipment of the cards to the users.

We have found that institutions try to solve this problem by selecting one of two common solutions to the card issuing problem:

- Several universities (i.e.: University of Konstanz) issue cards with direct personal contact. This process involves the production of the cards from previously uploaded information by the student, either in-house or outsourced by an external card production partner.

  This procedure enables to produce a larger number of personalised smartcards in advance of the issuing process and offers a relatively trouble free procedure.

  The main disadvantage of this solution is however the reliance on a high number of staff for the card issuing itself. An institution with 20 000 to 30 000 students has to issue approximately 5-8 000 cards every other semester by hand, requiring the high number of employees at peak times for a speedy process, but does not require them in the other eleven month of the year. In addition the card replacement means that even in case of outsourced card production, an in-house system has to be used in parallel.

- An alternative solution used by institutions in Germany (i.e. University Jena) is issuing by mailing the cards to the user. Similar to the first option, this can be done by in-house printing or outsourcing, and enables a relatively cost effective way of issuing a large number of cards. There is however a limitation, batches which are smaller than approximately 1000 cards cannot be produced, which means that replacement cards need a different procedure.

3. The solution

We have solved this problem by integrating the different workflows into an identical process, which is almost independent from the cause of issuing. Identical procedure can be used for Initial cards and replacements, with both using a minimum of staff through the use of self-service terminals.
Users receive a one-time QR-code, which allows for printing a single personalised card.
The terminals scan the QR-code, can take a picture of the user and print a dual sided personalised card in approximately 1:10 Minutes.
The kiosk systems have been produced in cooperation with an industry partner. The devices feature the hardware for the card issuing process by integrating all essential components into a single selfservice device. The units are built around an Evolis KM500B (Evolis, 2016) thermo-transfer card printer with a card capacity of 500 blanks. This enables to reduce the service cycle as the unit is able to produce 500 student cards on its own, without the need for service personnel. The system is designed with a multilingual touch interface based on a usability study carried out between 20102014 (Molnar, 2014). The units also feature a trackball and are ISO 18040 certified for disabled users, by featuring a wheelchair compatible design and a complete multilingual speech output. The integrated wide lens camera system is able to take photos of users between of the height of 130 cm to 190 cm.

The system itself runs on a modified Ubuntu Linux and features remote administration of the device further reducing the needed manpower.

The cards feature a rewritable area (Thermo-ReWrite), which can display the validity of the card, and enables a revalidation every semester.

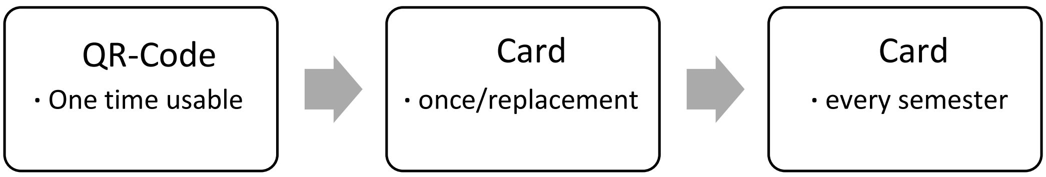


Figure 1: Card issuing process

The system is built upon a card management application (KMS) developed in-house with interoperability in mind, as the integration of different institutions required a flexible solution, which was not available commercially. The KMS is a modular java application for Apache Tomcat, using RESTful connection for communication with the terminals and a Talend based link to different campus management system as a data source. The KMS works currently with products of the HIS eG, SAP CM and Campusnet, but other products can also be integrated.

The modular approach enables us a tailoring of the KMS to the requirements of the institutions without the need to modify the core of the application. The KMS core is therefore identical at every institution enabling us a fast rollout of new features and bug fixes, thereby offering a high reliability and security for the system.

4. References

Evolis. (2016). *Evolis.fr.* Von Evolis Product Leaflet KM500B: http://fr.evolis.com/sites/default/files/atoms/files/kb-ksm1-160-fre-a4_rev_a1_0.pdf abgerufen

Molnar, T. (2014). *Improved Usability of electronic Government Services for the ageing Population.* Berlin: HU Berlin.

NXP Semiconductors N.V. (2010). Mifare DESFire EV1 Specifications. Netherlands.

Oswald, D., & Paar, C. (2011). Breaking Mifare DESFire MF3ICD40: Power Analysis and Templates in the Real World. In B. Preneel, & T. Takagi, *CHES 2011* (S. 207-211). Nara, Japan: Springer.

Author´s Biography

Dr. Tamas Molnar is the head of unit of the Service Centre Campuscard since 2015 and project manager for the Campus card system since 2011.

Education

Primary and Secondary Schooling – Some in Germany

2001 Completed with Final Examination

09/2001 – 07/2003 University of Technology Budapest – Studies: Electrical Engineering

09/2003 – 07/2008 Corvinus University Budapest – Studies: Business Information Systems Focus: Electronic Government

2007 - 2008 University Potsdam, Exchange Student Informatics

2008 Degree Business Informatics (Grade: Good)
In cooperation of the University Potsdam and the Corvinus University Budapest

05/2009 - 04/2014 Humboldt-University Berlin – Ph.D. Program

Focus: Software Usability in Electronic Government Systems

2014 Ph.D. in Software Usability (Grade: Magna Cum Laude)

Work Experience

09/2005 – 01/2006 Teaching Assistant, Corvinus Universität,

Chair of Theoretical Informatics, Focus: Oracle Database Systems

09/2006 – 10/2007 Project Team Member, Auda GmbH.

Focus: Multimedia Systems in education

10/2007 – 03/2008 Work on the Usability Project of the State Chancellery Brandenburg

01/2009 – 10/2010 Consultant/Project Lead, Brandenburg State Forestry Institute Focus: IT-Security Projects

Since 01/2011 Project Manager, Humboldt-University Berlin
Focus: Smartcard based identification systems

Since 06/2015 Head of unit, Service Centre Campuscard, Humboldt-Univeristy Berlin

Dr. Tamas Molnar, Humboldt-University Berlin tamas.molnar@cms.hu-berlin.de, +49 30 2093 70136

Automated User Information Conversion to improve Identity Federation Scalability

Daniela Pöhn[1] and Wolfgang Hommel[2]

[1]Leibniz Supercomputing Centre, Bavarian Academy of Sciences and Humanities,
Boltzmannstraße 1, D-85748 Garching n. Munich, Germany, daniela.poehn@lrz.de
[2]Universität der Bundeswehr München, Computer Science Department, D-85577 Neubiberg, Germany, wolfgang.hommel@unibw.de

Keywords
Federated Identity Management, Inter-Federation, SAML, User information, Attribute conversion.

1. ABSTRACT

Many European higher education institutions (HEIs) have joined an identity federation, which is typically run by their national research and education network (NREN). For example, the German NREN DFN operates the so-called authentication and authorization infrastructure (AAI) DFN-AAI. By being part of a federation, each HEI makes use of federated identity management (FIM). FIM allows users to use the account at their home organization, also called identity provider (IDP), when accessing a service, run by a service provider (SP). By applying FIM, each user account is maintained at a single place, which reduces the required effort for identity & access management and improves the overall quality of user data.

Security Assertion Markup Language (SAML) is the predominant standard for FIM within the higher education. It introduces the closed-trust-boundaries paradigm, which is realized by mostly static national federations and, as research is not limited to geographic boundaries, inter-federations. The biggest inter-federation within the higher education environment is eduGAIN, operated by GÉANT (GÉANT, 2016). In order to be part of a federation or inter-federation, IDPs and SPs need to run a FIM software. Examples of widely deployed FIM software suites are Shibboleth and SimpleSAMLphp.

In order to let the user access a personalized or access-protected service, the SP requires certain user information, called attributes, from the IDP. These attributes can be, e.g., a unique ID, the user's real name, or an email address. The IDP sends such attributes in an assertion statement to the SP, while the SP indicates beforehand the required attributes in its so-called metadata. Metadata is one key element of SAML, which describes an entity (i.e., IDP or SP) with, among other information, the technical communication endpoints (URLs), contact information, and information about the attributes.

Before the attributes are sent to the SP by the IDP, they eventually need to be transformed into the data format understood by the SP. After resolving and filtering all the required attributes, this is done via attribute conversion rules. Federations have created so-called schemas to have a standardized vocabulary of attributes, i.e., they specify attributes with their names, unique identifiers, syntax, and semantics. For example, the German federation DFN-AAI uses the `dfnEduPerson` schema (DFN-AAI, 2009), which extends the international schema `eduPerson` (Internet2, 2013). Additionally, another international schema, `SCHAC` (REFEDS, 2015), exists, while projects and research communities can establish further individual schemas.

If no suitable conversion rule is available at the IDP, the IDP administrator has to implement and manually deploy a new conversion rule to the IDP software configuration. This workflow is typically triggered when a user contacts the IDP administrator complaining that a service does not work the way it should. As different FIM software use different programming languages and different conversion methods, the situation gets even more complicated.

Therefore, in this article we present an approach based on a generic user attributes conversion rule repository, extending our previous work in (HMP, 2014). We first discuss the motivation for generic conversion rules and elicit the required functionality. We then design an architecture and workflows for this generic conversion rule repository, which is then explained based on a thorough example. We conclude this article with a summary and provide an outlook to our future work.

2. MOTIVATION FOR GENERIC CONVERSION RULES

Setting up an IDP software the first time requires a connector to the local identity and access management (I&AM) system, which is typically implemented using a leightweight directory access protocol (LDAP) server or relational database management system. The I&AM system authenticates the user and provides the user attributes in an IDP-internal format. Due to historical reasons and HEI-specific individual I&AM requirements, the IDP-internally used schema often differs from the schemas used nationally and internationally. Similarly, especially commercial SP services may require user data in proprietary formats that are not compatible with the schemas used in FIM federations. Therefore, attribute conversion rules are needed.

The German schema `dfnEduPerson` includes, for example, the attributes

- `dfnEduPersonCostCenter`,
- `dfnEduPersonStudyBranch1`,
- `dfnEduPersonFieldOfStudyString`, and
- `dfnEduPersonFinalDegree`.

Typical attributes for the schema `eduPerson` are the following:

- `eduPersonAffiliation`,
- `eduPersonScopedAffiliation`, `eduPersonEntitlement`, and
- `eduPersonPrincipalName`.

Other common attributes, according to `inetOrgPerson`, are, e.g.:

- `cn (CommonName)`,
- `displayName`,
- `givenName`,
- `sn (Surname)`,
- `o (OrganizationName)`, and
- `mail`.

`SCHAC` comprises further attributes, for example:

- `schacHomeOrganization`,
- `schacMotherTongue`, `schacDateOfBirth`, and
- `schacCountryOfCitizenship`.

Other federations may have yet again different schemas. In order to send the raw attributes from the I&AM to the SP, the IDP operator has to transform them by adding conversion rules. Within the FIM software Shibboleth, the conversion is done in a multi-step workflow:

- Fetch the raw user data into the ID
- P software (DataConnector)
- Define the attributes (AttributeDefinition)
- Filter the attributes (AttributeFilter)
- Send the attributes (AttributeRelease)

Other FIM software use similar steps, but with a different configuration format and step denomitations.

Typical conversion rules are:

- Renaming, e.g., from `DateofBirth` to `schacDateOfBirth`,
- Merging and Splitting, e.g., `sn` and `givenName` to `displayName`, and
- Transforming, e.g., different date formats.

For these conversion rules, Shibboleth and other FIM software have pre-defined conversion types, which still need to be applied manually by the IDP administrator.

Therefore, a new attribute at an SP requires the IDP administrator to add the definition, the conversion, and the filtering manually to the IDP configuration. As the user first has to inform the administrator, the administrator needs to gather all the required technical information and then adds the conversion rule; this results in waiting time for the user before she can actually make use of the desired service.

In order to enable automated conversion of attributes, a centralized conversion rule repository needs to be established. This repository stores the information for a conversion from format A to a format B using a generic syntax, which can then be transformed, e.g., to Shibboleth or SimpleSAMLphp conversion rule implementations. In contrast to the conversion rule repository described in (HMP, 2014), the generic conversion rule repository uses a generic format, enabling the re-use of conversion rules by different FIM software suites.

Therefore, an IDP administrator can upload her newly written conversion rule to the repository. If another IDP needs the same conversion rule, but uses another FIM software, it searches the repository based on the source and target attributes; the generic rule is transferred to the IDP and automatically integrated into its FIM software configuration by an IDP extension. This enables the full automation of IDP-SP setup procedures and enables the user to immediately make use of a service.

3. FUNCTIONALITY OF THE GENERIC CONVERSION RULES REPOSITORY

The centralized generic conversion rule repository can be seen as a trusted third party (TTP) for the re-use of conversion rules. The TTP can be operated, for example, by a federation or interfederation. An extension of the IDP software downloads and integrates the generated conversion rules. This helps IDPs to reduce the workload, while, at the same time, reducing the waiting time for the users, and helping SPs to receive the required attributes.

Instead of the manually written and added conversion rule after a notification from the user, the extension searches for an appropriate conversion rule. The generic conversion rule is adapted for the FIM software and integrated locally. Although this approach is straight-forward, no such service is operated currently.

By making use of a generic conversion rule repository with a relational database for conversion rules, the setup is automated:

- First, the IDP software extension detects that the IDP does not have the necessary attributes for the SP available. The SP requirements are stated in the SAML metadata and required for the automation to work. The IDP attributes can be found within the configuration of the IDP software. By a simple comparison, the missing attributes can be identified.
- By having the required attributes and all the attributes the IDP can offer, the extension queries the TTP. The TTP uses an application programming interface (API) for the communication with the IDPs. The TTP searches a generic conversion rule suited for the IDP.
- If a generic conversion rule is found of a simple conversion, the rule is downloaded and a specific format generated by the IDP software. More complex conversion rules with scripts should be stored IDP software specific and manually downloaded by the IDP administrator.
- If no generic conversion rule is found, the IDP is returned an error. The IDP operator then writes a new conversion rule, which should optionally be uploaded to the TTP. The TTP extracts the generic rule by applying the templates. The generic rule is saved in the database.

• After downloading the conversion rule, the generated specific rule is integrated into the IDP's local configuration. As the conversion rule is now available, the IDP sends the required attributes to the SP and the user can make use of the service.

Therefore, a specific and generic conversion rule can be re-used, speeding up the setup of IDP-SP relationships by reducing the efforts needed for conversion rules. As the TTP is not needed for further communication, it cannot become the bottleneck of a federation or inter-federation and does not introduce any privacy issues. As scripts are not integrated automatically, this also increases the security, while the conversion rule management is lightweighted.

4. ARCHITECTURE AND WORKFLOWS

In order to explain the TTP with the generic conversion rule repository in more detail, the management workflow is shown first, before the generic conversion rule syntax is described.

a. Management Workflow

The basic management workflow for conversion rules, described in (HMP, 2014), can be re-used, as seen in Figure 1. After a new conversion rule is created, it is uploaded to the TTP. At a later date, an IDP operator can delete or update the conversion rule. When a conversion rule is updated or deleted, all IDPs, which re-use the conversion rule, must be notified.

An update of a conversion rule is, e.g., important, if the conversion rule includes a mistake. Even though the TTP validates the conversion rule after the upload, not all cases can be covered.

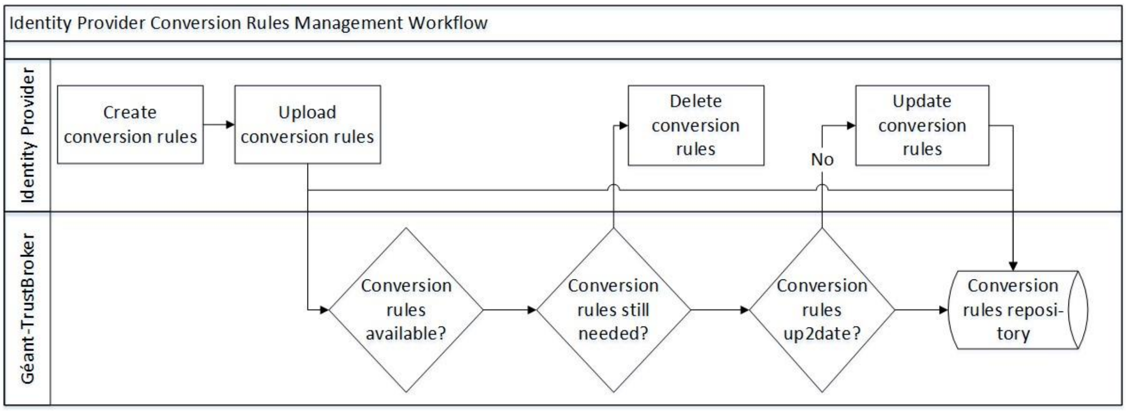


Figure 1: Conversion Rule Management (HMP, 2014)

All generic conversion rules are stored in the database.

b. Architecture

The centralized generic conversion rule repository has a web application, which enables the interactive management of conversion rules. Alternatively, the API can be used for the management of conversion rules. The backend consists of a simple logic of the application, while the necessary data for the conversion rule including permissions is stored in a simple database.

The database has the following tables:

• `ConversionRule`: Conversion from one or more attributes into another attribute.
• `ConversionKeyword`: Inserts keywords for specific conversion rules.
• `ConversionAttribute`: Information about source and target attributes for a conversion rule.

This minimalistic design allows the lightweighted storage of generic conversion rules, which is then translated into the FIM software specific format at the IDP. This basic architecture is shown in Figure 2.

The TTP stores the generic conversion rules in a database. The generic rule is downloaded, converted and then inserted into the configuration. If a new conversion rule is written, it is translated into a generic format, if no scripts are included, and then uploaded to the TTP.

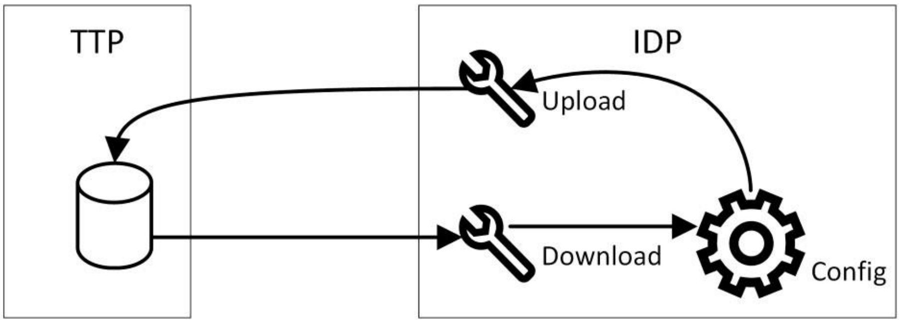


Figure 2: Architecture of Generic Conversion Rule Management

In order to design a generic format of simple conversion rules, the conversion within the FIM software needs to be reviewed in detail. Shibboleth uses different pre-defined operations, for example the following:

- Renaming by mapping of attributes.
- Splitting and other definitions with regular expressions.
- Merging can make use of the template attribute definition, which is written in the Velocity template language.
- Scoping by scoped attribute definition.
- Principal name by principal name attribute definition.
- Furthermore additional scripts can be used.

This shows that mapping can be re-used easily, while splitting and merging needs more information. More complex transformations can be implemented via scripts.

The following pre-defined conversions of SimpleSAMLphp are relevant for the generic conversion rule repository:

- `core:AttributeAdd`: adds an attribute to the response.
- `core:AttributeAlter`: searches and alters the value of an attribute.
- `core:AttributeMap`: renaming of attributes.
- `core:PHP`: modifies attributes by applying PHP code.
- `core:ScopeAttribute`: scoping of attributes.

This listing shows that renaming and scoping are relatively easy, while transformation, splitting, and merging are more complex to implement.

The open source FIM software PySAML2 uses a python dictionary to map attributes. Identifiers describe the supported name formats. `To` and `fro` statements then contain the actual mapping of the attributes. Therefore, renaming is possible out of the box. For all other conversions, Python language functionalities need to be used.

Active Directory Federation Services (ADFS) is becoming more popular. Although ADFS supports SAML, it uses terms from the WS-Federation world. Claim rules describe which claims (attributes) are sent to the relying party, which equals an SP. As claims are not available in the schemas described above, they need to be transformed by the ADFS 2.0 Custom Rule Language. This is done via an administration tool.

An API is supposed to be available in the future. As a result, the generic conversion rule repository can only send the names of the attributes and the type of conversions in this specific case.

In order to fully automate the conversion, the following information is needed:

- sort of conversion,
- source attributes,
- target attribute, and
- additional information, like regex.

By mapping the pre-defined conversion rules, the following keywords are extracted, which are needed to allow the automated generation of FIM software specific conversion rules:

- `source`,
- `target`,
- `targeturn1`,
- `targeturn2` as well as the transformations
- `regex` respectively `pattern` and
- `conversion`.

The generic conversion rule is described as follows.

```
source={source1, source2, ...};
transformation = [renaming, merging, regex, conversion];
target={target, targeturn1, targeturn2}; source(transformation) =>
target;
```

A simple renaming can be described as the following generic code:

```
source;
transformation = renaming;
target={target, targeturn1, targeturn2};
```

In order to transform the generic conversion rule to a FIM-software-specific conversion rule, templates with the keywords are necessary at the IDP side. Shibboleth uses extensible markup language (XML) code to configure the software and, therefore, transform user attributes. The renaming template for the FIM software Shibboleth is the following:

```
<resolver:AttributeDefinition
xsi:type="Simple" xmlns="urn:mace:shibboleth:2.0:resolver:ad"
id="{{ target }}" sourceAttributeID="{{ source }}">
 <resolver:Dependency ref="{{ source|resource }}" />
<resolver:AttributeEncoder xsi:type="SAML1String"
xmlns="urn:mace:shibboleth:2.0:attribute:encoder"
name="{{ targeturn1 }}"/>
  <resolver:AttributeEncoder xsi:type="SAML2String"
xmlns="urn:mace:shibboleth:2.0:attribute:encoder"
name="{{ targeturn2 }}" friendlyName="{{ target }}" />
</resolver:AttributeDefinition>
```

The FIM software SimpleSAMLphp is written, as the name indicates, in PHP. The renaming template is therefore different:

```
'authproc' => array(
      50 => array(
            'class' => 'core:AttributeMap',
            '{{ target }}' => '{{ source }}',
      ),
)
```

PySAML2 uses a python dictionary for the mapping of attributes, resulting in the following template:

```
MAP = {
    "identifier": "urn:oasis:names:tc:SAML:2.0:attrname-format:basic",
    "fro": {
        '{{ target }}': '{{ source }}',
        },
    "to": {
        '{{ source }}': '{{ target }}',
    }
}
```

These templates can be filled in with the values, when generating specific conversion rules. As long as a template exist, a specific simple conversion rule can be generated.

5. EXAMPLE

In order to illustrate the generic conversion rule repository, an example with the IDP Leibniz Supercomputing Centre (LRZ) is given. The IDP LRZ uses the FIM software Shibboleth, which enables simple conversion rules, like renaming and scoping; Transformation and other conversion rules including scripts need to be downloaded manually. Besides the national federation DFN-AAI, LRZ is also member of the international inter-federation eduGAIN.

Let us assume that the DFN-AAI operates such a conversion rule repository. Therefore, the IDP operator of the LRZ configured the IDP software extension in such a way that simple conversion rules of the DFN-AAI are automatically downloaded and integrated, while other conversion rules need be manually processed. Although this manual step results in waiting time, it is important for the trust in and acceptance of conversion rules. As additional feature, the user is sent an email automatically once the service is usable.

An employee of the LRZ wants to make use of a new service. In this step, the IDP software extension determines the required conversion rules. As the service specifies two attributes, which are not known by the LRZ yet, the IDP software extension queries the TTP.

For one attribute, `mailName`, a generic conversion rule can be found. The conversion rule consists of the target `mailName` and the source attributes `sn` and `givenName`.

```
source={sn,   givenName};   transformation   =
merging;
target={mailName, targeturn1, targeturn2};
```

As the conversion rule includes a script, the conversion rule is manually downloaded after a brief check and then integrated.

```
<resolver:AttributeDefinition     id="mailName"     xsi:type="Script"
xmlns="urn:mace:shibboleth:2.0:resolver:ad">     <resolver:Dependency
ref="sn" />
    <resolver:Dependency ref="givenName" />
    <resolver:AttributeEncoder xsi:type="SAML1String"
xmlns="urn:mace:shibboleth:2.0:attribute:encoder"
name="{{ targeturn1 }}"/>
    <resolver:AttributeEncoder xsi:type="SAML2String"
xmlns="urn:mace:shibboleth:2.0:attribute:encoder"
name="{{ targeturn2 }}" friendlyName="mailName" />

<Script><![CDATA[        importPackage(Packages.edu.internet2.middleware.shibboleth
.common.
          attribute.provider);        mailName = new BasicAttribute("mailName");
merge   =   sn.getValues().get(0)   +   "   "   +   givenName.getValues().get(0);
mailName.getValues().add(merge);
    ]]></Script>
</resolver:AttributeDefinition>
```

For the second attribute, `personalDisplayName`, no conversion rule is found. Therefore, the IDP operator is informed via email about that problem. The administrator manually writes the needed conversion rule and uploades it to the TTP. The user is informed via email and can make use of the service right afterwards.

```
<resolver:AttributeDefinition                       xsi:type="Simple"
xmlns="urn:mace:shibboleth:2.0:resolver:ad"  id="personalDisplayName"
sourceAttributeID="displayName">                 <resolver:Dependency
ref="{{  source|resource  }}"  />          <resolver:AttributeEncoder
xsi:type="SAML1String"
xmlns="urn:mace:shibboleth:2.0:attribute:encoder"
name="{{ targeturn1 }}"/>
    <resolver:AttributeEncoder                xsi:type="SAML2String"
xmlns="urn:mace:shibboleth:2.0:attribute:encoder"
name="{{ targeturn2 }}"      friendlyName="personalDisplayName" />
</resolver:AttributeDefinition>
```

The specific conversion rule is uploaded to the TTP and stored in the database.

```
source={displayName};    transformation    =
renaming;
target={personalDisplayName, targeturn1, targeturn2};
```

The federation operator of the DFN-AAI receives an email about this new conversion rule, which can be validated so other IDPs can make use of it in a fully automated manner.

When another user of a different IDP wants to use the same service, the IDP can re-use the newly added conversion rule, reducing the waiting time for the user and the manual workload of the operator.

6. CONCLUSION

The generic conversion rule repository has been described in order to improve the conversion rule repository for Shibboleth (HMP, 2014). Therefore, it extends the proof of concept implementation of the GÉANT-TrustBroker by the on-the-fly attribute conversion between IDPs and SPs with different schemas and FIM software. This generic approach with the use of templates for the FIM software allows the re-use of shared conversion rules independend of the FIM software. Therefore, it speeds up the setup of IDP-SP relationships, helps SPs to receive the needed attributes, and reduces the waiting time for users. As scripts can be used within conversion rules and different FIM software uses different scripting language, a generic way to describe scripts should be found.

In the next step, this generic conversion rule repository is tested with different engaged parties within the GÉANT project. The experiences gained testing the generic conversion rule repository will be used to improve the repository, extend it to support further FIM software suites, and help to support IDPs in eduGAIN.

7. ACKNOWLEDGMENT

The research leading to these results has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 691567 (GN4-1).

The authors wish to thank the members of the Munich Network Management (MNM) Team for helpful comments on previous versions of this paper. The MNM-Team, directed by Prof. Dr. Dieter Kranzlmüller and Prof. Dr. Heinz-Gerd Hegering, is a group of researchers at Ludwig-MaximiliansUniversität München, Technische Universität München, the University of the Federal Armed Forces, and the Leibniz Supercomputing Centre of the Bavarian Academy of Sciences and Humanities.

8. REFERENCES

Hommel, W., Metzger, S., Pöhn, D. (2014). *Géant-TrustBroker: Simplifying Identity & Access Management for International Research Projects and Higher Education Communities*. 20th congress of the European University Information Systems Organisation (EUNIS 2014)

DFN-AAI (2009). *dfnEduPerson Schema 1.0.* Retrieved February 15, 2016, from: https://www.aai.dfn.de/fileadmin/documents/attributes/200811/dfneduperson-1.0.schema.txt

GÉANT (2016). *eduGAIN Homepage*. Retrieved February 15, 2016, from: http://services.geant.net/edugain/Pages/Home.aspx

Internet2 (2013). *eduPerson Object Class Specification (201310)*. Retrieved February 15, 2016, from: http://software.internet2.edu/eduperson/internet2-mace-dir-eduperson-201310.html

REFEDS (2015). *SCHAC Releases*. Retrieved February 15, 2016, from: https://wiki.refeds.org/display/STAN/SCHAC+Releases

9. AUTHORS' BIOGRAPHIES

Daniela Pöhn received a university diploma degree in Computer Science from the University of Hagen, Germany, in 2012.

She was engaged in the IT industry as a full-time software developer during her studies, before she joined LRZ as a Ph.D. candidate in September 2012.

She is involved in the identity management research activity of the GÉANT project since April, 2013, leading one task about the TrustBroker approach. The focus is mainly on interoperability within federated identity management.

Wolfgang Hommel has a Ph.D. as well as a postdoctoral lecture qualification from Ludwig-Maximilians-Universität in Munich, Germany, where he teaches information security lectures and labs.

His research focuses on information security and IT service management in complex large-scale and inter-organizational scenarios

Digital Identity for University People

G. Gentili,[1] F. Ippoliti[2], M. Maccari[1], A.Polzonetti[3]

1 Computer Center University of Camerino Italy

2 School of Science and Technology University of Camerino Italy

3 ELIOS srl. UNICAM Spin Off Via le mosse,22 62032 Camerino (MC)

Keywords

Digital Identity, Smart Card, Electronic .

1. ABSTRACT

Identity management is a set of technologies and processes supporting identity information. Its adoption in Public Administration, in particular in the domain of university, maintains organization autonomy giving at the same time students and staff support to access the services that are delivered. In this paper, we present a project lead by University of Camerino with the Italian Banking Group UBI. The project consists in the issue of Enjoy my UniCam card allowing users to have, on a single physical card, several functionalities about facilitated banking account, university services and digital signature certificate. First results about the testing phase are presented.

2. INTRODUCTION

Over the time, managing personal identity on-line has become a serious issue. It has become increasingly important in terms of personal security, partly because organizations are now highly networked when it comes to information. Digital Identity (ID) is spread among different organizations. Small amounts of information cannot reveal enough about people to impact on us in a negative way but, when using the internet extensively, we can find several more information than expected [1]. So, depending on the context, person may be represented by different “partial identities”. For example, a person may use one or more partial identities for work and others in spare time, e.g., with the family, doing sports, or dealing with companies like a bank, an Internet service provider, or a supermarket [2] [3] [5].

The project is based on a prepaid card named “Enjoy”, that made possible the creation of a project leaded by University of Camerino (UniCam) in collaboration with the Italian Banking Group UBI and the Namirial Certification Authority. This initiative has also made possible the creation of a digital scenario “Enjoy Ecosystem”, resulting from a collaboration of five Italian universities and many UBI local branches. Aim of the paper is to present the UniCam experience in digital identity management. The goal is to create a card for students, faculty and administrative staff that allow you to have, on a single physical card, several functionalities such as bank services, academic services and digital signature, letting the owners to save time and increase their satisfaction toward the university. The “all-in-one” solution has been chosen to guarantee safety, privacy and trust. [6]

In order to complete the project, several issues have been addressed and solved. From the political point of view, the project is a valuable means of bringing innovation in UniCam. About the legal point of view, it also allowed the adoption of the Italian Digital Administration Code. For what concerns the organizational issues, an agreement was signed among UniCam, Italian Banking Group UBI and Namirial Certification Authority; it regulates terms and conditions in order to achieve the whole project objective. Finally, about the technical aspects, a new system was implemented. It is integrated with all the other existing infrastructures in the university, supporting different technologies. For instance, to set data flows among stakeholders, some web services have been implemented and SFTP (Secure Shell File Transfer Protocol) server has been integrated. Finally, from the administrative point of view, the use of Enjoy My UniCam card allows a remarkable simplification of the paperwork.[10]

Section 3 discusses the whole Enjoy my UniCam card project, with a deep description of actors, system architecture and processes. Section 4 describes the services available with Enjoy my UniCam card. Finally, Section 5 concludes the paper.

3. ENJOY MY UNICAM

3.1 Overview

Even if the paper focuses on the role of Enjoy My UniCam card, it is important to have a wider point of view considering the whole Enjoy My UniCam card project in Fig. 1. Every UniCam user can be identified and authenticated by the Enjoy My UniCam card. In this way, it is possible to benefit of the various services making available directly by UniCam. The basic idea allows establishing a trust federation, respecting the SAML 2.0 standard, between UniCam Identity Provider and Idp of other organizations. The infrastructure is based on Shibboleth: an open-source project that provides Single Sign-On capabilities and allows sites to make informed authorization decisions for individual access of protected on-line resources in a privacy-preserving manner. The Shibboleth software implements widely used federated identity standards, principally OA- SIS' Security Assertion Markup Language, to provide a federated single sign-on and attribute exchange framework. By doing so, users of an organization can use the services offered by the new federated organization and vice versa. All data are managed in full compliance with current privacy policies. Some personal information are exchanged between different actors.

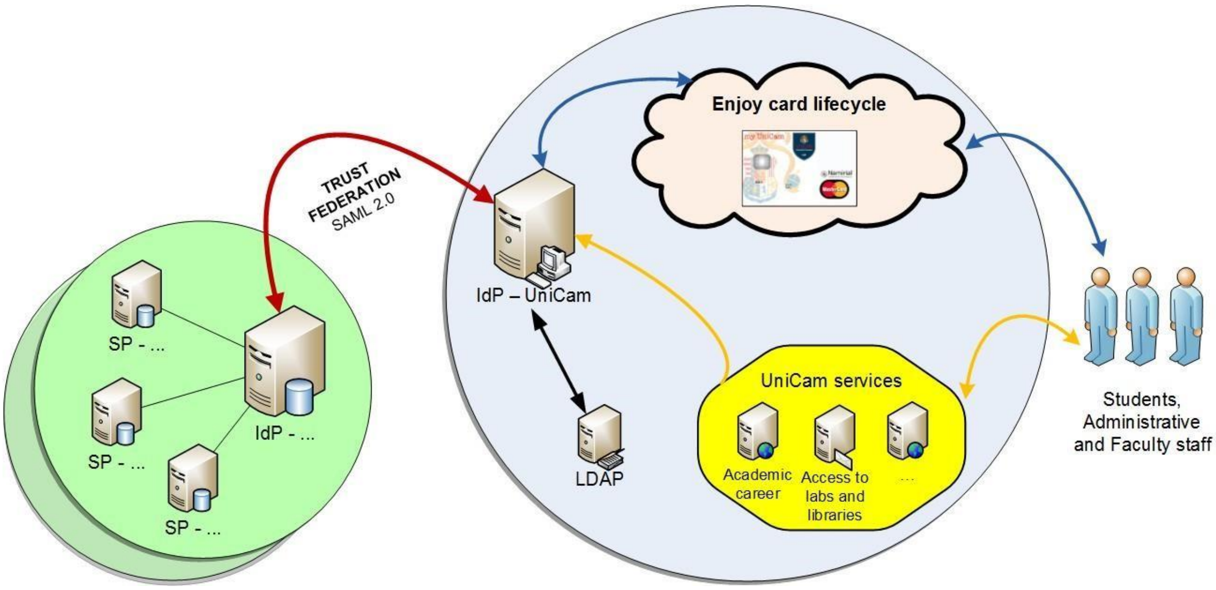


Figure 1 The whole Enjoy My UniCam card project.

3.2 Stakeholders

Following we sum up the main stakeholders involved in the project.

- University of Camerino is the services and cards provider, it manages control and data flow.
- UBI is a banking group which has a wide coverage, with about 1,800 branches,
- on the whole national territory. It assigns an International Bank Account Number (IBAN) to each person requesting Enjoy My UniCam card, offering its banking services. The group is also responsible for the emission of the card. About control and data flow management, UBI performs some operations in order to obtain and exchange data flows with UniCam and Oberthur.
- Oberthur is a company and it deals with the creation and issuance of personalized cards, according to the explicit applicant request and after obtaining the confirmation that the applicant has the right to get the card.
- Namirial Certification Authority is a computer company and web engineering that has found its own specific place in the field of IT and it is one of Certification Authority recognized by Italian Public Administration. In the project, Namirial is responsible for the issuance, management and termination of the digital signature certificates.

The stakeholders exchange information between their systems, according to the architecture represented in Fig. 2, where it is possible to see also the components diagram of the system.

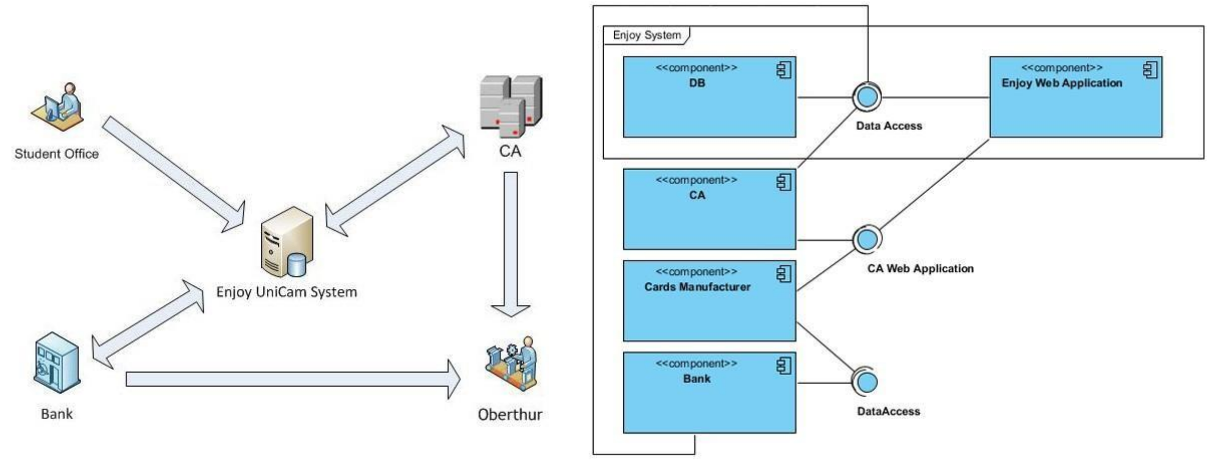


Figure 2 Enjoy My UniCam system architecture and component diagram

3.3Implemented process

Following the main business process supported by Enjoy My UniCam, in Fig. 3 we provide the use cases diagram of every processes about the process to obtain the card.

Request of the card - Student Office. For the students interested in the Enjoy My UniCam initiative, Student Office collects the student data and their pictures to be used for the card production. During the registration phase, UniCam uses the Namirial web portal to insert the student data, which performs the necessary checks of formal correctness. Based on these data, Namirial produces digital signature certificates and makes them available to Oberthur. Finally, the Student Office issues a voucher to present to the bank, which proves to be eligible for the card request. UniCam and UBI recognize the voucher like an official document.

Request of the card - Bank branch. The student goes to a branch authorized to issue cards, presenting the voucher given to him/her by UniCam during request phase. The bank employee collects the voucher and performs the following tasks:

- Identification of the users and insertion his/her data in the system;
- Request of the card in the system;
- Ask the student to subscribe the necessary contracts;
- Notifies the student when approximately the card will be ready and that he/she will receive an envelope containing the Personal Identification Number (PIN) and the invitation to come to the branch to get the card.

Every day, via the SFTP server, UBI provides UniCam a file with a list of requests for cards issuance. UniCam acquires via SFTP the file, completes with the additional information and for each record includes a photograph to be printed on the card. According to UBI needs, UniCam adds in the photograph file properties the information about the fiscal code and the IBAN assigned to the holder.

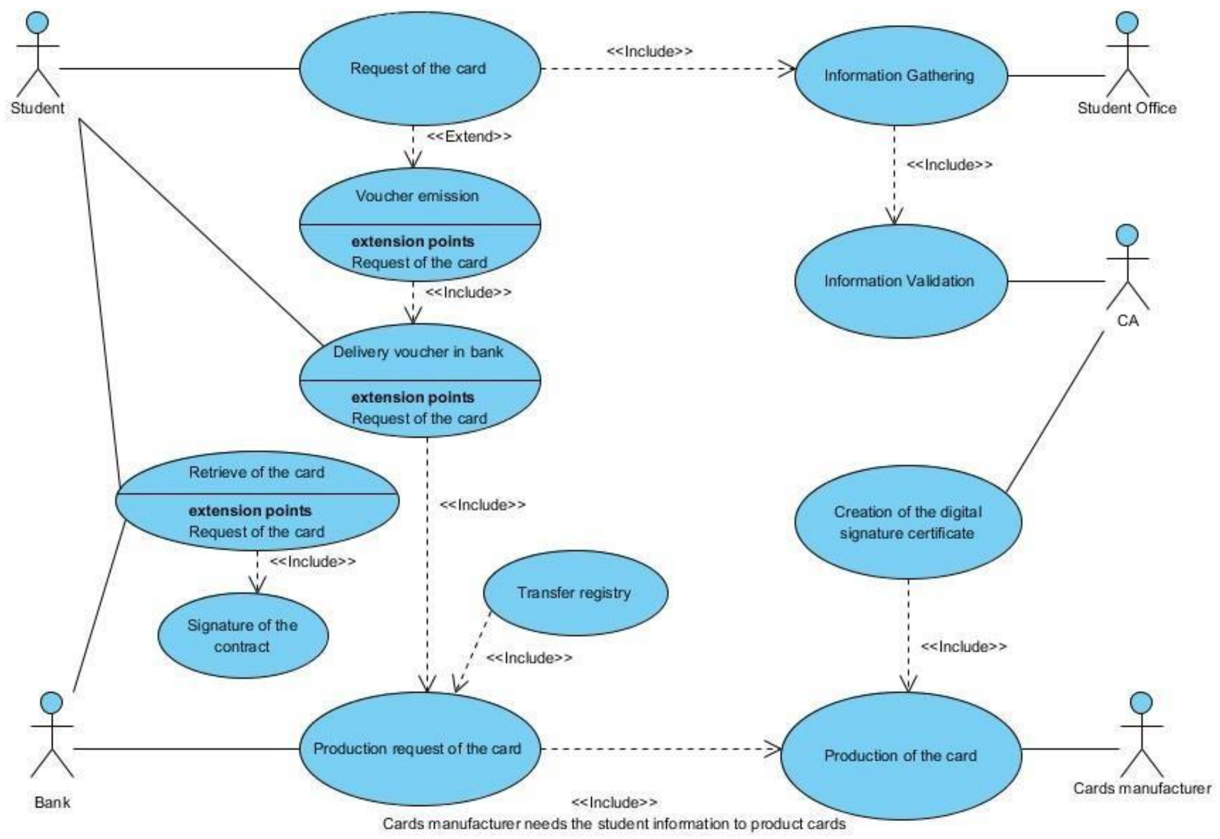


Figure 3 Use cases diagram about request, emission and delivery of the card.

Production of the card. UBI transmits the requests, the personal data necessary for the production of cards and photographs of the owners to Oberthur, which performs the following activities:

- Customization with UniCam logo, Namirial logo and photo of the owner;
- Insertion of digital signature certificates in the cards, which are available on the Namirial web portal.
- When the card is produced, on behalf of the UBI shipping office, Oberthur sends:
- The cards to the bank branches from which the request was made;
- The envelopes containing the PIN and the notification that the card is avail- able in the bank, to the students' home address.

Activation of the digital signature certificate. The issuance process of digital signature certificates involves the following steps:

- Namirial concludes a LRA agreement (Local Registration Authority)[1] with UniCam for the issuance of signature devices;
- Namirial provides UniCam of its web portal, with which a UniCam application refers to validate the data of the applicant;
- After the UniCam registration is complete and, data has been validated from Namirial web application, digital signature certificates are made available for Oberthur, without UBI participation;
- Oberthur loads the digital signature certificates on the cards, realizing the customization and sends them to the UBI branches.

---

1 An LRA (Local Registration Authority) is an agent of the Certifying Authority who collects the application forms for digital signature certificates and related documents, does the verification and approves or rejects the application based on the results of the verification process

Delivery of the card. When the card and PIN have been produced, the student receives at his/her home address the PIN and the invitation to go to the bank branch to receive the card. When the student is at the office, he/she was handed the envelope containing the card and the delivery device signature module. The student signs the module and UBI sends it via mail to Namirial. Every day Namirial will call a procedure to communicate to UniCam the information acquired. At this point Namirial sends directly to the students' home address PIN and Personal Unblocking Key (PUK) of the digital signature certificate.

Reissue of the card. In case of theft or loss of card, the student must:

- Request the freezing of money services in the way specified in the contract documents: that is calling the customer service or going directly to the bank branch;
- Request the freezing of digital signature certificate, as specified by Namirial in the documentation attached to the envelope containing PIN and PUK;
- Go to the Student office to request the release of a new voucher with which to present the replacement request of the card at the bank branch, in order to maintain the same IBAN;
- Go to the bank branch where the student originally requested the issuance of the first card, showing the new voucher. In this way, the replacement request is processed as a standard procedure for a new Enjoy My UniCam card.

The process then follows the normal process of issuing a card. The voucher is a prerequisite, without which the student cannot request the card. It's the only document obtained from the Student Office, certifying the students have the right to become cardholders.

Early extinction of the card. If a student loses the right to ownership of the card (e.g. in the case of drop-out), the Student office must inform the student that, before closing the relationship with the University, he must go to the bank branch to return the Enjoy My UniCam card, according to the usual banking regulations about the extinction of the cards.

4. SUPPORTED SERVICES

The card allows the students to have, in a single physical device, several functionalities, in different areas: bank and university services.

- Bank services. The card is technically a prepaid card with an associated IBAN. It is valid for 5 years and it has not fixed fee. It allows you to make the usual banking operations, with special facilitations, such as paying anywhere displaying the MasterCardTM symbol in Italy and abroad, making free withdrawals at every Bancomat cash machines in Italy, making and/or receiving transfers using home banking, paying bills and making RID payments and so on.
- UniCam services. The card allows the student to be recognized in UniCam facilities giving the possibility to access to laboratory and library, pay the meal at the canteen, register for exams, display and summary of the academic career, and require internships and thesis, enrollment to university sports center.
- As already mentioned, the card contains a digital signature certificate, with legal value, with which you can digitally sign documents. In order to use the UniCam services about the request of particular documents or, for example, to require thesis, it is possible to fill the document directly from your laptop and then, finally, sign it with digital signature certificate. In this way, the document will have official and legal value.

UniCam also participates in the IDEM Federation. So organizations in IDEM become Identity Provider: identities of own users can be exchanged, providing appropriate safeguards and always respecting the privacy of users [7][8][9]. With Enjoy my UniCam card, it will be possible, in every university or organization participating to IDEM, to access to any service available such as libraries, logging in in computer labs, connecting to universities Wi-Fi networks, which are often present in squares and public areas of faculties, and so on.

5. CONCLUSION

In this paper, we present the experience of the University of Camerino about the multi-services card. The adopted solution presents several advantages. On one hand, it avoids the possibility to have many and many cards to benefit different services. On the other, in term of identity federation it is part of community making advantages of related benefits.

Enjoy My UniCam card obtained good results during the testing phase, delivering over 2330 cards in the first 21 months. The waiting time between the request and the final delivery has been about 15 days, which is a nice result considering the processing. In the next future, UniCam is going to activate several more services such as paying photocopies, coffees or snacks at the vending machines and about public transport service aiming to build up a smart campus.

6. REFERENCES

1. Al-Khouri, A. M. (2012). *PKI in government digital identity management systems*. European Journal of ePractice, 4, 4-21.

2. Jensen, J. (2012, August). *Federated identity management challenges*. InAvailability, Reliability and Security (ARES), 2012 Seventh International Conference on (pp. 230-235). IEEE.

3. Bour,I.(2013). *Electronic Identities in Europe - Overview of eID solutions connecting Citizens to Public Authorities.* Technical report, Transaction Security

4. NIST (2001). *Security requirements for cryptographic modules*.Technical report, National Institute of Standards and Technology.

5. Eve Maler, D.R.(2010) *The Venn of Identity: Options and Issues in Federated Identity Management*. Technical report, European Commission

6. Gaedke, M., Meinecke, J., Nussbaumer, M.(2005) *A modeling approach to federated identity and access management*. WWW '05 Special interest tracks and posters of the 14th international conference on World Wide Web.

7. Carota, S., Corradini, F., Falcioni, D., Maggiulli, M.L., Marcantoni, F., Piangerelli, R., Polzonetti, A., Re, B., Sergiacomi, A.(2012) *FedCohesion:*

Federated Identity Man- agement in the Marche Region. In: EGOVIS/EDEM. (2012) 112–124

8. Morgan, R., Cantor, S., Carmody, S., Hoehn, W., Klingenstein, K.(2004) *Federated Security: The Shibboleth Approach*. Technical report, EDUCAUSE Quarterly (2004)

9. Baldoni, R.(2012). *Federated Identity Management Systems in eGovernment: the Case of Italy*. Electronic Government, an International Journal, 9(1), 64-84.

10. Falcioni, D., Ippoliti, F., Marcantoni, F., & Re, B. (2013). *Digital Identity into Practice: The Case of UniCam*. In Technology-Enabled Innovation for Democracy, Government and Governance (pp. 18-28). Springer Berlin Heidelberg.

Towards a distributed research data management system

M. Politze[1], F. Krämer[2]

[1] IT Center RWTH Aachen University, Seffenter Weg 23, 52074 Aachen, politze@itc.rwth-aachen.de
[2] IT Center RWTH Aachen University, Seffenter Weg 23, 52074 Aachen, kraemer@itc.rwth-aachen.de

Keywords
RDM, distributed systems, PID, metadata, RDF

1. SUMMARY

At RWTH Aachen University a project aims at improving the support and technical infrastructure for Research Data Management (RDM). In this project the need was identified to provide researchers with a tool to simply register and store metadata corresponding to their files. Our solution enables researchers via a web interface to register and identify their data with PIDs as well as store metadata in a standardized form. To account for confidentiality concerns data and metadata can optionally also be stored in a file locally. The solution will be deployed and evaluated in March 2016.

2. BACKGROUND

There is an initiative to set up an integrated Research Data Management (RDM) system within the next years at RWTH Aachen University. A project group focuses on consulting and training as well as on the development of technical solutions for RDM. Since managing data requires extra effort from researchers, usability and seamless integration into existing workflows are key to establishing an integrated RDM. Technical solutions need to cover all domains of the research process: private and collaborative domain, in which researchers actively work with the data, as well as the archive and publication domain, in which data is accessed less frequently. Registering metadata is the prerequisite for re-discovering and re-using data, but requires extra effort from researchers. However, this task is the easier the earlier it is performed since the context of the data generation is more present to the researcher. We therefore want to offer a tool for the registration of metadata that works independently from the local IT environment of the researcher, allowing every researcher to document metadata as soon as research data is produced. It also needs to be flexible regarding the storage of data as well as metadata since many institutes have their own IT infrastructure and sometimes strong privacy and confidentiality concerns regarding even meta-information about their research. Furthermore, structure and format of metadata need to be standardized to allow for a seamless transition to the archive or publication domain and for the data to be found and re-used later. The RDM project closely cooperates with a number of pilot users, which will test the solution throughout the development process.

3. OUR SOLUTION

Our first step towards an integrated RDM system is to offer a distributed solution that allows the usage of an integrated service layer (ISL) as well as any private services already available to the researcher.

Researchers log on to a web interface where they can register their data to a PID (persistent identifier) service. They can choose from a number of predefined metadata schemas that use Dublin Core as a basis, and fill it in. Depending on the user's institutional context it is also possible to preset a metadata schema. To achieve maximum re-usability the metadata schemas and presets are defined in RDF format. The link between data and metadata will be established using the registered PID. Via a REST API it will also be possible to automatically provide metadata from local systems such as test stations or measurement devices. Storage of the data and metadata can be realized in two different workflows depending on the researcher's preferences.
(1) Private Workflow: Formalized metadata is stored together with the research data in the private archive. Metadata is provided in an RDF file. To ensure retrievability data and metadata are linked by a PID service. (2) Integrated workflow: Formalized metadata is stored in the integrated metadata store. With the number of users and disciplines the available metadata schemas will be continually expanded. The storage concept for metadata still poses a challenge. For the first version a generic RDF triple store will be used. The researcher also has the option to transfer the research data into the integrated archive service. A PID links data and metadata, regardless of where the data is kept. Already existing metadata can be directly imported into the metadata

store as long as it is formalized and the metadata schema is known. This process can be further automated using the REST interfaces to update and copy metadata in the ISL. The interface also allows updating links stored in the PID service in case of server migrations (private to private, private to integrated, integrated to integrated).

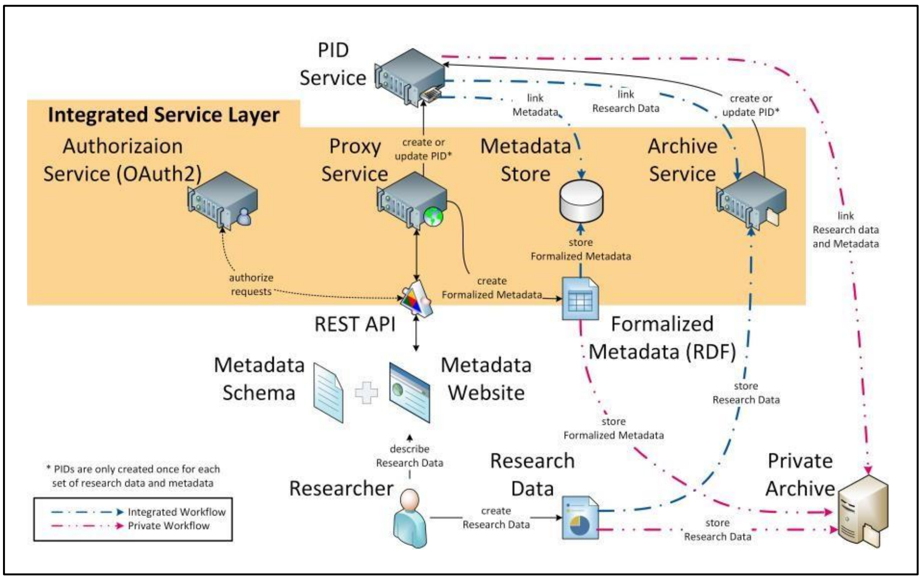


Figure 1: Architectural overview of the first stage

The Web Page uses W3C recommendations for defining metadata schemas and generates a user interface to enter the metadata. The formalized metadata is stored in RDF for mat to ensure longterm usability.

4. CONCLUSION AND OUTLOOK

The shown architecture allows multiple integrated and private archives which help supporting (1) different archive types in the integrated layer e.g. short- vs long-term or high vs low latency and (2) the gradual adoption by researchers of the ISL systems instead of their own infrastructure. Also this allows the ISL systems to slowly grow and meet the expected functionalities. Automation features are a key feature for adoption by power users with lar ge data volumes.

In the world of IT long-term storage of ten or more years is quite challenging. Storage of formalized metadata in RDF format ensures long-term usability and facilitates migration between successive systems and retrievability using advanced search algorithms. However, this requires the specification and usage of existing metadata standards.

As a minimum set of metadata DublinCore is used. Finding the right discipline specific metadata schemas has turned out to be difficult. Discipline specific metadata schemas have yet to be analyzed and evaluated together with data curators from the university library and researchers from the discipline.

The current solution will be deployed in March 2016 and evaluated by users from different disciplines. According to the user feedback it will be adapted and further extended to meet all requirements currently posed by the researchers.

5. AUTHORS’ BIOGRAPHIES

Marius Politze, M.Sc. is research assistant at the IT Center RWTH Aachen University since 2012. His research is focused on service oriented architectures supporting university processes. He received his M.Sc. cum laude in Artificial Intelligence from Maastricht University in 2012. In 2011 he finished his B.Sc. studies in Scientific Programming at FH Aachen University of Applied Sciences. From 2008 until 2011 he worked at IT Center as a software developer and later as a teacher for scripting and programming languages.

Florian Krämer studied Political Science, Economics and Linguistics and received his Master of Arts from RWTH Aachen University in 2010. After working as a research assistant in the Institute for Political Science he joined the IT Center in 2011. Here his tasks first included support and training, he was responsible for the online documentation and worked on different projects including knowledge management and research data management. Since 2015 he is responsible for the coordination of the activities concerning RDM within the IT Center and a member of the RWTH project group on RDM.

New university erp for studying, teaching nd administration - past, present and future of the peppi

1st Tuomas Orama, 2 nd Jaakko Rannila, 3 rd Mika Lavikainen, 4th Lauri Stigell

1st, Development manager, Helsinki Metropolia University of Applied Sciences, Bulevardi 31 PL 4000,

tuomas.orama(at)metropolia.fi

2nd, Project manager, Helsinki Metropolia University of Applied Sciences, Bulevardi 31 PL 4000,

jaakko.rannila(at)metropolia.fi

3rd, Project manager, Helsinki Metropolia University of Applied Sciences, Bulevardi 31 PL 4000,

mika.lavikainen(at)metropolia.fi

4th, Lauri Stigell, CEO, Edumate Consulting Ltd, lauri.stigell(at)edumate.fi

Keywords

Student Information System (SIS), Enterprise Resource Planning (ERP), Service oriented architecture (SOA), Enterprise Architecture, Enterprise Service Bus (ESB), Administrative Model, Consortium

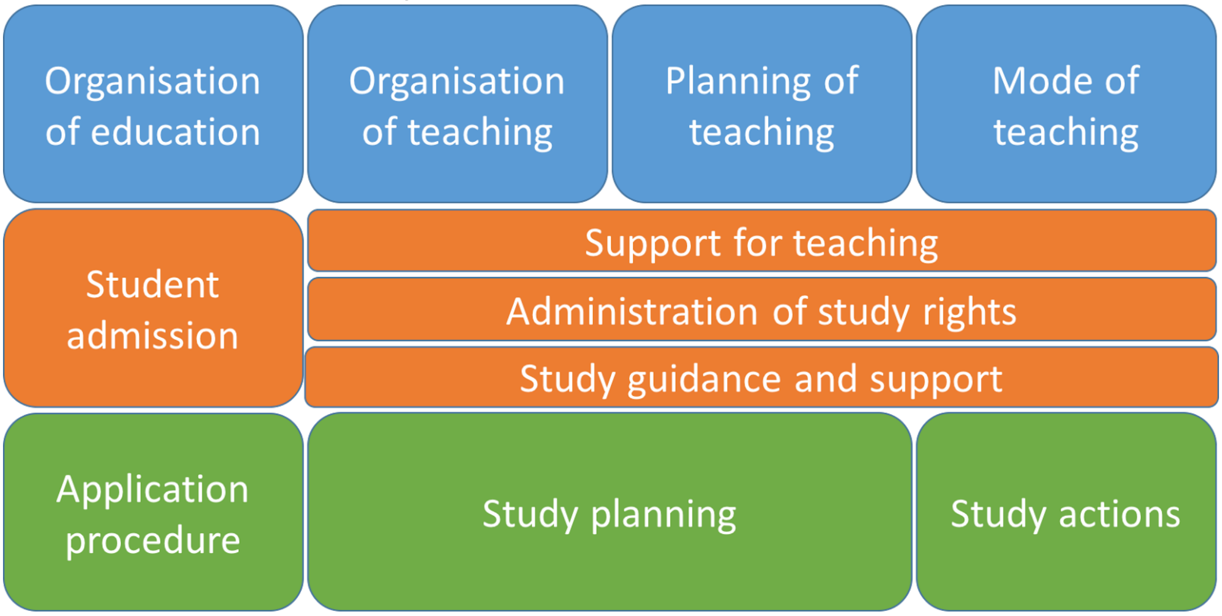
1. INTRODUCTION

It has been over a decade in Finland since the latest new Higher Education Institution (HEI) student information system (SIS) was released. At the moment, there is more or less only two prevailing ecosystems in Finland. Those two are Oodi in universities and Winha in universities of applied sciences (MINEDU 2016). Both of them are made in the late 90's.

HEI's woke up into the situation of renewing ecosystems in 2005 when ProAMK (PROAMK 2007) project was started. Its goal was set high - to create one ecosystem for every university of applied sciences in the areas of education and research. In 2007, the project was closed down because of lack of belief and courage. In 2009 new project started by the ministry of education. It was called RAKETTI and one of its goals was to create or acquire a new student information system for the whole sector. In 2010 the project excluded that goal from the project - because of lack of belief and courage. Instead, the project refocused on the architectural specifications, definitions of definite national services and some reference projects (RAKETTI 2014).

Picture 1 (SYNERGIA 2015) illustrates the agreed education process areas within Finnish HEI's. Gradually the understanding was reached which process areas would be covered by national solutions (student admission, application procedure) and which by the HEI's themselves.

Picture 1: Process areas in the Finnish Higher Education



Before the understanding, the situation in the early 2010s was expectant. Everybody was hoping that the national projects would create new systems covering all process areas to replace the old systems. When they didn't, two Universities of Applied sciences started their own project using their own money at their own risk. The goal was to create a whole new ecosystem with totally different system architecture for the usage of whole education sector. The goal was set even higher than before with fewer resources.

2. THE GOALS OF THE PROJECT

Helsinki Metropolia University of Applied sciences with Tampere University of Applied sciences started the developing programme "Renewing student administration systems" with a project called Peppi in 2010 (PEPPI 2010). It was followed by student dashboard (PAKKI 2014) and student information system (PERUSREKISTERI 2014) projects (2014 - 2016). The goal in every project was to create an ecosystem of services created in Service oriented architecture (SOA) fashion. One of the goals was - as expected - to replace old systems with new services. But far more ambitious goal was to renew the Enterprise Architecture (EA) on it's all levels:

- Business
- Information
- System
- Technology

One remarkable aim was also to create an ecosystem of services so that other HEI's could start using this ecosystem in their organisations. The big picture was that there would nationally be at least one product family that could respond to most of the needs that HEI's have in order to cope with the ever changing business environment. In addition, it was crucial that the product family would be affordable and still be constantly developed accordingly to the HEI specific requirements.

It was also clear that user interfaces should be modernized to modern standards. Both student and staff users are digital natives in today's world. Users demand high standard usability from HEI's systems and this was a high-priority requirement from the day one.

3. The environment

Finnish HEI environment

As mentioned above, Finnish HEI environment consists of universities and universities of applied sciences. The number of institutions is relatively high although there have been several mergers during the last decade. At the moment there are 14 universities and 24 universities of applied sciences but it is expected that there will be more mergers in becoming years. More interestingly, there is also deepening cooperation between the two higher education sectors, and some commentators have even suggested that it could fade out the lines between the sectors. However, the official dogma is still the current separate model.

The other trend within the HEI environment is decreasing funding. The HEI's are almost entirely government funded, and due to ongoing weak economic growth, the cuts have been considerable, even 15 % in the area of information management, in recent years. That has already lead to dismisses in many institutions. This has great impacts to HEI's resources and the capability to make investments for the future. However, cutbacks haven't been all that bad. The flip side and the positive effects of the cutbacks are that HEI's had to think things differently. They had to simplify many decisions and they also had to cooperate with each other. This has had very positive effects for the whole sector. Due to these positive effect many think that acquiring ecosystem IPR's and distributing the ecosystem owned by HEI's consortium which governance is very lightweight makes sense. In addition, self-owned ecosystem cuts yearly licence fees dramatically.

Establishment of the project

In late 2000s, Finnish HEI sector had various projects, discussions, and investigations about current student information systems and their current state (PROAMK 2007, HAUTAKANGAS & al. 2007, STIGELL & al. 2008). There were also inquiries about emerging of new SIS's on the market. Various interpretations were made about which out-of-the-box system would be the silver bullet for the whole Finnish institutions. Despite all the fuss, none of these actions didn't lead to concrete results; steps towards national student information system were never taken.

In order to succeed with the goals in our projects, we utilized the experience and results gathered from previous national projects. In those projects, we encountered some challenges with multi-organizational requirement specifications. It was challenging to match all requirements specified in a variety of working groups. Partly this was due to the methods that working groups used - members were not participating full-time and some specifications overlapped between working groups. Later it was hard to refurbish these requirements and agree on how to proceed. In addition, this method (although it was democratic) was too time consuming considering our schedule.

On the other hand these projects generated personal and organisational networks that have been highly beneficial in later projects. Also, many of the results in earlier national projects have been utilized in our projects during years.

We concluded that the most efficient way to implement our project was to proceed with two steps:

1. Develop the system for limited amount of organisations (in our case 2 biggest Universities of applied sciences in Finland)
2. Publish the system as is for other HEI's and continue development through consortium We used this model in our first big SOA project (Peppi) which succeeded over expectations. That is why we have continued to use this method also in later projects that have extended the Peppi ecosystem.

Financial constraints

Our development programme had it's financial resources exclusively from the owner institutions. That leads to two things. Firstly, there was no confusion of who is making the decisions: we had the money, we made the decisions without a need to negotiate in a democratic - yet usually a necessary - process. Secondly, and more importantly, the amount of money did not allow us to waste time: the high quality results were urgently needed in a limited time. Table 1 describes the key figures of the development programme between 2010 and 2016.

Table 1: Development programme in numbers

Programme members	Budget (2010 - 2016)	Documentation so far (in pages)	Estimation of man-days used in the project	Estimation of code lines created in the project

over 100	5-6 million €	1000-1200	10000-15000	450 000 - 650 000

Technical environment
The Finnish public sector's system architecture has been focusing on these principles during the last decade:

- Interoperability - service interfaces ● Enterprise Architecture
- National Enterprise Service Bus
- Mobile services
- Open data
- Open source software

As we started our own project we wanted to have an answer to every principle mentioned above. First of all Peppi ecosystem is made using an only open source software. It is made in SOA fashion which means that all the thing you can do in a user interface can be made through service interface (REST/JSON or SOAP/XML). All the services run in ServiceMix 5 which is ESB product. This pretty much answers all the interoperability issues. These solutions also answer the issues of integrating the services to national ESB because of the usage of standard interfaces. Peppi ecosystem is also designed by the principles of EA and all the aspects of it have been taken into account. All Peppi user interfaces are made with responsive web design. This covers the part that all services can be used with wide range of mobile devices. Also, native applications can be made because all the services can be accessed through back end application interfaces (REST/JSON). (PEPPI 2016a)

4. THE RESULTS

At the end of 2016 Peppi ecosystem covers all the needed functionalities in the areas of studying, teaching, and the student administration. As a result, the system architecture is better organized, master data management and integration management is controlled and well documented, large-scale reporting is enabled and the organizations have been able to get rid of the obsoleted systems. Most importantly the new services are user-friendly and the system itself has reduced the need for manual work.

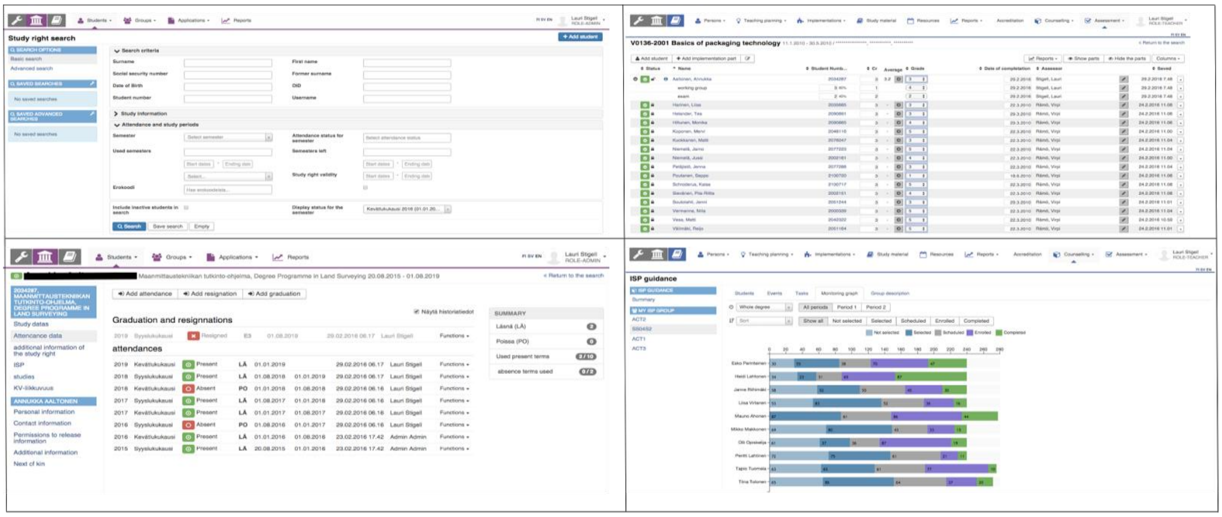
As mentioned, Peppi ecosystem has been developed in different projects. Here are explained projects and services within Peppi ecosystem in short

- Peppi project (2013)
    - Enterprise resource planning
        - Curricula
        - Course planning / management
        - Schedules / room reservations
        - Organisation management eg. teacher resourcing
- Student registry project (2016)
    - Student information system (SIS)
        - Student registry
        - Assessment / Accomplishment registry
        - Code management
        - Reports (eg. printed certificates and statistical reports)
- Student dashboard project (2016)
    - Personal curriculum management
    - Personal assessments / accomplishments
    - Personal reports
    - Enrollments
    - Personal information management
- Intranet / integrated dashboards project (2016)
    - Intranet
    - Course workspaces
    - Dashboard integrations
- Numerous smaller projects ie. (2013 - 2016)

- Study-plan service
- Schedule machine
- Application management service (eg. for different certificates)
- e-Signature service ○ ...

The services are collected to the role-based dashboards (Picture 2). Currently, there are five different dashboards in production: student, teacher / counsellor, planner, student administration and administrator.

Picture 2. Role-based dashboards



5. THE STATE OF DEVELOPMENT

The Finnish HEI's have defined a nationally agreed process map of the education process phases (illustrated in chapter 1). The process map (Table 2) added with our projects describes the overall coverage of the current Peppi ecosystem.

Project	Education and Curricula Planning	Student Application and Admissions	Study Right Management	Teaching	Studying	Studying Support Services	Alumni
Enterprise resource Planning (Peppi)							
Student registry (Perusrekisteri)							
Student dashboard, PSP (Pakki)							
Integrated dashboard							

Table 2. Process areas covered by different projects

The table shows that the current ecosystem covers almost all of the defined process areas. Of course, there are some sub-processes within these main processes that are to be covered but the overall coverage is high. The gap in the second process phase (application and admission) is covered with separate national service so there is no need to cover that part in the Peppi ecosystem, although we have running integrations also with the mentioned national service. The last process phase is meant for post-study alumni and we currently don't have any plans to integrate it with Peppi ecosystem since there are several other products on the market to support that.

As a conclusion of current development, we could say that Peppi ecosystem now covers all the currently desired educational process steps. The consortium is now concentrating on the deployment of recent results in various HEI's as well as laying emphasis on further development of existing services.

6. THE FUTURE

The future looks bright for the consortium and the Peppi ecosystem. At the moment Consortium is implementing new services every year. At the moment, development ideas presented for the current roadmap include:

- Integrations to cloud services (Drive, O365, Moodle, Optima etc.)
- Integrations to national application system (studyinfo.fi)
- New planning and optimization tools for scheduling

Consortium and development

The results of the Peppi ecosystem projects have been rapidly taken into use in different universities. The distribution is managed through the Peppi Consortium which - at the end of February 2016 - covers about 50 % of the Finnish universities and universities of applied sciences (PEPPI 2016b).

- 13 universities of applied sciences
- 4 universities
- 1 vocational school
- 8 company members

All the members can influence and/or participate in the ecosystem development. The structure of the consortium is kept quite light consisting at the moment only 3 groups.

- Steering group
- Business and information group
- System and technical group

Business and information group is the main group when considering the ecosystem development. It makes the proposals for the ecosystem roadmap and for improved features. Steering group holds no content expertise so they don't intervene on the content development. Instead, they decide on the bigger guidelines how the consortium should extend and what are the fees. System and the technical group are responsible for the integrity of used technologies. They make requirements which technologies and techniques should be used in the ecosystem development.

Consortium commits the members into development by collecting yearly fees based on the number of full-time equivalent students in HEI. These annual fees are used for the ecosystem development.

The consortium members gather requirements and development ideas. They then present those ideas to other consortium members and suggest changes to the ecosystem roadmap. When a joint understanding is achieved the ideas will be developed in the version agreed jointly.

7. SUMMARY

Finnish universities of applied sciences, Metropolia, and TAMK, started renewing their student information systems using service orientated architecture in 2010 when the first project Peppi was launched. Peppi project brought large-scale services for university resource planning. The successful project was followed by several other projects expanding the Peppi ecosystem to cover all educational process areas except the application and admission phases which were decided to be nationally supported.

The educational sector in Finland has gone trough major cutbacks in funding as well as structural changes. This change in the environment demands new ways to cope with the changes. We need more efficient and affordable systems, flexible system development and more cooperation between HEI's. In this paper, we have described one IT-solution bundle that responds to these demands.

Peppi system has been both efficiently implemented and rapidly taken into use in many institutions in Finland. Currently, about a half of the HEI's have joined Peppi Consortium thus having access to Peppi services. The consortium expects that a number of member organizations continues to grow in becoming years among the HEI's as well as upper secondary and vocational schools.

The intriguing challenge is how we can keep on developing current and possible new services while consortium is still in a strong expanding phase. Thus far we have been able to do that, but it is clear we will continue evaluating both development method and administrative practices regularly in order to answer the needs of growing community. If - and when - we can do that, the future looks successful for the Peppi ecosystem.

8. REFERENCES

HAUTAKANGAS, Sami; SAARINEN, VESA: Yliopistojen opintohallinnon tietojärjestelmäselvitys, Minedu 2007.

MINEDU 2016. The higher education in Finland is based on the two-pilar system consisting of traditional universities and universities of applied sciences (former polytechnics). University Education in Finland. Retrieved 29.2.2016, from http://www.minedu.fi/OPM/Koulutus/yliopistokoulutus/?lang=en

PAKKI 2014. Retrieved 29.2.2016, from https://wiki.metropolia.fi/display/Pakkiprojekti/Pakkiprojekti

PEPPI 2010. Retrieved 29.2.2016, from https://wiki.metropolia.fi/display/peppi/Peppi+-+Vaihe+2

PEPPI 2016a. Retrieved 29.2.2016, from http://www.peppi-konsortio.fi/tekninen.html and https://wiki.metropolia.fi/display/peppi/2.+Arkkitehtuuri

PEPPI 2016b. Retrieved 29.2.2016, from http://www.peppi-konsortio.fi/konsortio.html

PERUSREKISTERI 2014. Retrieved 29.2.2016, from https://wiki.metropolia.fi/display/perusrekisteriprojekti/Perusrekisteriprojekti

PROAMK 2007. Retrieved 29.2.2016, from https://www.proamk.fi/

RAKETTI 2014. Retrieved 29.2.2016, from https://confluence.csc.fi/download/attachments/40568204/OPI-loppuraportti_2014-03-25_Lopulline n.pdf

STIGELL, Lauri; SORMUNEN, Marko; AUVINEN, Jussi: Opintohallinnon tietojärjestelmäselvitys 2008, University of Kuopio, 2008.

SYNERGIA 2015. Retrieved 29.2.2016, from https://confluence.csc.fi/download/attachments/51895485/process%20areas_english.png

9. AUTHOR'S BIOGRAPHIES

Tuomas Orama works as development manager and is the head of the development unit in Metropolia University of Applied Sciences in Helsinki, Finland. He graduated as an industrial designer from Kuopio Academy of Design. He has studied also in Institute of Design and Fine Arts in Lahti university of applied sciences and in università per stranieri di Perugia. His work experience includes dozens of IT-projects for more than a decade. He has worked in several expert positions in national IT-projects in HE-level.

Jaakko Rannila works as project manager at Metropolia University of Applied Sciences in Helsinki, Finland. He has bachelor's degree in science (Industrial Engineering and Management, Helsinki Stadia polytechnic, 2006). His work experience includes several IT-projects varying from SOA-projects to fully tailored software projects as well as a large national project involving Education IT-management. In addition, he has experience in developing ERP systems and search engine systems in Higher Education, renewing qualification criteria to upper secondary education in degree programme of

Mika Lavikainen works as project manager at Metropolia University of Applied Sciences in Helsinki, Finland. He has master's degree in science (Industrial Engineering and Management, Lappeenranta University of Technology, 2005). His work experience includes several IT-projects varying from CRM-projects to fully tailored software as a service projects as well as large EU Framework six projects. In addition to IT-based projects he has experience in developing advanced collaborative working environments (including augmented reality prototyping), Collaborative Networked Organizations (CNO's) and virtual organizations.

Lauri Stigell in an entrepreneur and owner of Edumate Consulting Ltd. He has master's degree in arts (General History, University of Turku 2003). His work experience includes educational politics, learning and studying development and several national and university IT-projects.

Research Software Sustainability is essential to Open Research Recommendations and an update on developments

Simon Hettrick[1], Matthias Katerbow[2], Bas Cordewener[3]

[1]The Software Sustainability Institute (SSI), Edinburgh, United Kingdom, simon.hettrick@software.org
[2]Deutsche Forschungsgemeinschaft (DFG), Bonn, Germany, matthias.katerbow@dfg.de [3]Knowledge Exchange (KE), Bristol, United Kingdom, bas.cordewener@jisc.ac.uk

Keywords
Research, software, sustainability, preservation, re-usability, reproducibility, infrastructure, European coordination

1. Summary

A recent Knowledge Exchange workshop on software sustainability recommended a number of technical and societal changes and the overall need to raise awareness of researchers' reliance on software. The importance of these findings and first steps to explore European coordination and cooperation of national initiatives will be addressed in the presentation.

2. Abstract

Without software, modern research would not be possible. We tend to marvel at results rather than the tools used for research, which means the fundamental role of software in research has been largely overlooked. This puts at risk the reliability and reproducibility of research and its results. The practices of software sustainability minimises these risks and help to increase trust in research results, increase the rate of discovery, increase return on investment and ensure that research data remains readable and usable for longer.

A recent Knowledge Exchange workshop on software sustainability recommended a number of technical and societal changes and the overall need to raise awareness of researchers' reliance on software. It also led to steps to explore European coordination and cooperation of national initiatives.

The presentation will explain the value of sustainable software to research, the measures that can support the sustainability, and the steps currently explored to establish a Software Sustainability Initiative in each European country and to have these initiatives linked to share knowledge and expertise through a European Software Sustainability infrastructure. Most of the content of this presentation can be found in a report on the workshop issued by Knowledge Exchange[1]

3. Author's biographies

[1] Hettrick, S. (2016). Research Software Sustainability Report on a Knowledge Exchange Workshop. Knowledge Exchange. Retrieved May 10, 2016, from http://www.knowledge-exchange.info/event/software-sustainability

Simon Hettrick is the Deputy Director of the UK's Software Sustainability Institute. He is responsible for the Institute's policy team which investigates the use of software in the research community and campaigns for changes that will improve the software that is used in research. He has a particular interest in the people who develop software in academia - Research Software Engineers - and has been a passionate advocate for greater recognition and reward for this group.

Before working for the Institute, Simon conducted research into waveguide lasers, worked as a patent attorney and then moved into communications. He still considers himself a physicist, but can no longer do maths.

Dr. Matthias Katerbow is working as a Programme Officer at the "German Research Foundation" (DFG) and he is responsible for the funding programme e-Research-Technologies. He is also representing the DFG in the "Knowledge Exchange" initiative. He has a particular interest in the development of information infrastructure, IT services for science and humanities as well as enabling of Open Scholarship.

Before working for the DFG, Matthias has worked as a linguist at the research center "Deutscher Sprachatlas" at Marburg University. He received his doctoral degree from the Marburg University for his work on Language Acquisition and Language Variation. He studied Linguistics, Phonetics, Informatics and Linguistic Engineering. He is still concerned with research, but without being a researcher.

Bas Cordewener is the Coordinator of Knowledge Exchange, an initiative in which DEFF (Denmark), DFG (Germany) SURF (Netherlands), Jisc (United Kingdom) and CSC (Finland) work together. Engaged in establishing, funding and policy development of IT Infrastructures for Higher Education and Research, Knowledge Exchange partners focus on Open Access, Research Data and Open Scholarship.

Before working for Jisc (who host the Knowledge Exchange office), Bas worked for SURF in several management positions addressing IT related educational innovation, innovation of research and international collaboration.

Identify to simplify: improving interoperability at a national level with the ORCID HUB

1st Michele Mennielli[1], 2nd Andrea Bollini[2], 3rd Josh Brown[3], 4th Susanna Mornati[4]

[1] Cineca, Via Magnanelli 6/3, 40033 Casalecchio di Reno (BO), m.mennielli@cineca.it

[2] Cineca, Via dei Tizi 6/B, 00185 Roma, a.bollini@cineca.it

[3] ORCID, 10411 Motor City Drive, Suite 750, Bethesda MD 208171st, j.brown@orcid-eu.org

[4] Cineca, Via R. Sanzio 4, 20090 Segrate (MI), s.mornati@cineca.it

Keywords

Open Source, ORCID, Interoperability, Standards, DSpace, DSpace-CRIS, IRIS, CRIS.

1. Summary

The ORCID HUB is an open source infrastructure implemented by Cineca that simplifies the integration of multiple ORCID applications. The Hub is designed originally for national initiatives, but it can also be adopted for institutions with numerous and complicate applications to be integrated with ORCID. The Hub provides a dashboard for single researcher to authorize and monitor the applications to communicate with her ORCID profile. Massive data updating and Reporting are provided for administrators and managers to easily have an up-to-date and panoramic view of ORCID data.

2. The ORCID HUB

Italy is home to a remarkable project linking 80% of researchers, including doctoral students, and their publications, institutionally and in national infrastructures, using ORCID iDs. The project allows better identification of all Italian researchers and simplifies crucial processes within the research ecosystem.

In April 2015 Cineca released the first CRIS/ORCID integration for its open source solution DSpaceCRIS. This was the first (technological) step towards national ORCID adoption. In May 2015 the Italian Agency for the Evaluation of Universities and Research (ANVUR) announced that they would use ORCID as the researcher identifier for the National Research Evaluation exercise (VQR), starting in the Summer of 2015.

ANVUR, with the institutional support of CRUI (the Conference of Rectors of Italian Universities) and the technological support of Cineca, then founded the I.R.ID.E Project (Italian Researcher Identifier for Evaluation) to deliver this. In June 2015 Cineca signed a consortium agreement with ORCID, to allow all Italian member Institutions to access ORCID services.

For this project, Cineca created an ORCID Hub, released as an open-source software in July 2015. By October 2015 there were over 50,000 ORCID iDs linked to the ORCID HUB and more than 50 applications connected (including the national publication database, IRIS installations, and thirdparty legacy CRIS systems).

This open-source project has demonstrated the power of the implementation of a unique identifier for researchers at a national level, generating network effects and showcasing the value of collaboration between community-led organisations at scale. As a unique identifiers, ORCID provides a way to distinguish each researcher from every other one and, through integration in key research workflows, supports automated linkages between researchers and their activities and outputs. The Hub is a registry that stores all Italian researchers' ORCIDs and the authorisations for applications to interact with the researcher profile, allowing to register once and get ORCID stored both in the national database and institutional repositories.

At the moment the Hub is serving the Italian research community but it can be adopted by any other nation or grouping seeking to embed identifiers in national or large infrastructures. Also single institutions can benefit from this technology where they can integrate multiple applications with ORCID in one go.

Before the end of 2015, Cineca made functionality available in DSpace-CRIS to update ORCID profiles using local data and implemented the full integration of the Cineca's extended CRIS platform (IRIS) with ORCID. At the beginning of 2016 Cineca added to DSpace-CRIS the feature to import locally the biographic data from the ORCID Profile. In the coming months Cineca will upgrade to the ORCID API v2, define the compliancy with the PTCRIS synchronization framework and add the possibility to collect information on publications and projects, besides biographic data.

Among the features offered with the ORCID HUB there are:

- Auto-Update functionality for Italian researchers (or any researchers associated with ORCID through the HUB): data provided by 1 researcher are automatically added to its collaborators (e.g.: co-author, co-investigator, etc);
- Easy import/export of ORCID information (Biography, Works, Funding) from CSV format;
- The researcher can authorize at once different applications to interact with ORCID (local CRIS, a national database, etc.)
- A central database matching "local/national ID" and ORCID which can be accessed with REST (Data As a Service)

The ORCID hub takes advantage of the functionality of the ORCID member API, but even a subset of these functions would be a significant benefit to any repository or research management network.

3. CONCLUSION

ORCID is becoming an essential infrastructure in the research ecosystem. It is open and free to researchers and its wide adoption will enhance the interoperability of information and the fluidity of workflows interconnecting different systems. The potential for new, exciting services is getting higher.

Sustainability provided by institutions and other players will guarantee that ORCID will remain in the control of the community of scholars. Cineca's ORCID Hub is released as open-source software and it can be freely adopted by countries and large communities, thanks to impressive team work between Cineca and ORCID technical staff, representing a contribution to the success of a free, open, interoperable infrastructure to help illuminate the world of research.

4. REFERENCES

ORCID-HUB: https://github.com/Cineca/OrcidHub

DSpace-CRIS: http://cineca.github.io/dspace-cris/

IRIS: http://www.cineca.it/en/content/iris-institutional-research-information-system

PTCRIS: Mendes Moreira J, Cunha A and Macedo N. An ORCID based synchronization framework for a national CRIS ecosystem [version 1; referees: 2 approved, 1 approved with reservations]. F1000Research 2015, 4:181 (doi: 10.12688/f1000research.6499.1)

5. AUTHORS' BIOGRAPHIES

Michele Mennielli works for International Relations and Business Development at Cineca, the Italian Consortium of University. He is Board Member and Secretary of EUNIS, Board Member Executive for External Relations at euroCRIS and Member of the DSpace Steering Group.

Andrea Bollini is Deputy leader of International Business Development and Head of Open Source & Open Standards Strategy at Cineca. He has been responsible for software design and development of IT solutions for several projects since 2004. He has achieved an extensive experience in setting up repositories with DSpace software and has been a DSpace committer since January 2007. He is member of the euroCRIS CERIF Task Group and of the Architecture Task Group. He is now the responsible for the relation with the open source community and domain communities to preserve and improve the Cineca positioning, assuring the adherence of Cineca solutions to best practice and standards.
Education: Master Degree in Applied Mathematics at the University of Rome La Sapienza (Italy) and Postgraduate Master, II level, in Information & Communication Technology Management at the University of Milan II (Italy), Sun Certified Java Programmer, Sun Certified Web Component Developer and Sun Certified Business Component Developer.

Josh Brown directs the operations of ORCID EU and project manages ORCID's work on the THOR project. Before ORCID, Josh was consortium and operations manager for SCOAP3, programme manager for digital infrastructure at Jisc, and project officer for SHERPA-LEAP at University College London. His background is in academic libraries.

Susanna Mornati is Head of International Business Development and she is also leading the Solution for Institutional Research Department in Cineca. She has been responsible for IT projects and services for research since 2010. She holds a strong experience in project and program management in complex environments. She participates as an expert in the activities of several committees and serves on a number of international scientific boards. She writes and lectures on various aspects of IT management for research. Main previous positions: Responsible for e-publishing and digital repositories services at CILEA (2003-2009), Vice Director of Libraries at the University of Insubria (2002-2003), Director of the Physics Library at the University of Milan (1996-2001), Associate at CERN Scientific Information Service, Geneva, Switzerland, (1994-1996). Education: Master Degree in Linguistics at the University of Milan, Postgraduate Master, II level, in Information & Communication Technology Management at the University of Milan Bicocca, Diplôme de Langue de l'Alliance Française, English Certificate of Proficiency.

Interoperability between Information Systems of Portuguese Higher Education Institutions

Lígia M. Ribeiro[1], Rui H. Pereira[2], Osvaldo Pacheco[3], Mário Bernardes[4], Ricardo T. Martins[5]

[1] Universidade do Porto, Faculdade de Engenharia, R. Dr. Roberto Frias, 4200-465 Porto, Portugal, lmr@fe.up.pt [2] Instituto Politécnico do Porto, ISCAP, Portugal, rhp@iscap.ipp.pt [3] Universidade de Aveiro, Departamento de Electrónica, Telecomunicações e Informática, Campus Universitário de Santiago, 3810-193 Aveiro,Portugal, orp@ua.pt [4] Universidade de Coimbra, Serviço de Gestão de Sistemas de Informação e Infraestruturas de Comunicação R. Arco da Traição, 3000-056 Coimbra, Portugal, mjb@uc.pt [5] Universidade de Aveiro, Serviços de Tecnologias de Informação e Comunicação, Campus
Universitário de Santiago, 3810-193 Aveiro, Portugal, ricardo@ua.pt

Keywords

Interoperability platforms, information systems, cloud computing, electronic administration

1. ABSTRACT

The main thrust of this work is to present an interoperability platform between information systems of higher education institutions in Portugal and the main advantages and benefits its use has already allowed within an academic community of about 100,000 users. This interoperability platform, running on a cloud computing environment, was a major result of a project called "IES+Perto", meaning "Higher Education Institutions Closer", involving some of the most prestigious Portuguese universities and the largest polytechnic in the country. It was developed with a unifying but not intrusive perspective, so that each institution would continue to be solely responsible for the organization and delivery of its information.

A common mobility strategy for digital content supported by an application for mobile devices, and a set of services for electronic data transfer between institutions for the academic processes of student national mobility and joint courses of study, have been developed using the interoperability platform.

The project IES+Perto and the interoperability platform in particular have contributed very positively to innovation, administrative modernization and electronic management of the institutions involved, creating conditions for the extension of services to other higher education institutions, as has already happened by supporting new initiatives that the project IES+Perto proponents and other higher education institutions submitted for funding under a new application to the National Administrative Modernization Support System, which were approved.

2. OVERVIEW OF THE PROJECT IES+PERTO

The project IES+Perto was a collaborative and resource sharing project between four Portuguese higher education institutions (HEI), financed with 1.7 million euros by the National Administrative Modernization Support System (SAMA). The project provides 87,000 students, 6,000 professors and researchers and 3,500 other employees from the universities of Porto, Aveiro, and Coimbra and the Polytechnic Institute of Porto with new information technology (IT) services, exploring the benefits of interoperability, open standards and cloud computing, to advance a development strategy headed for administrative modernization and rationalization of costs in the higher education context.

The project was able to create important synergies not only between the actors directly implicated in carrying out the project, but also among employees of different departments of the organizational structure of the partner institutions that have made significant contributions to the objectives to be achieved, besides other national bodies such as the National Foundation for Scientific Computation (FCCN), a branch of the National Foundation for Science and Technology (FCT), and the National Security Office (GNS).

The results of the project highlight a federated cloud computing environment interconnecting existing private clouds of the partner institutions and, built on top of the federated cloud, an interoperability platform which enables access, communication and interaction with the information provided by the information systems of each institution. This interoperability platform enabled the development of common applications and services in a fast and efficient way, despite the deep differences in the implementation of the information systems of each institution.

Taking advantage of the interoperability platform, a common strategy to explore academic information through mobile devices was designed, resulting in the development of an application that includes a set of features to facilitate easy access to services of the partner institutions. It was used furthermore to implement interfaces to enable the electronic data transfer between institutions for national student mobility programs and joint courses of study. Aiming for the complete dematerialization of academic processes, an application library was developed for digital signature with the Citizen Card, looking after the innovativeness of administrative services and the confidence of stakeholders. Some preliminary results of the project IES+Perto have been presented in a previous work (Ribeiro & Valente, 2015).

The developments were carried out using open and interoperability standards to minimize maintenance costs and future licensing needs and facilitate interconnection with other applications for higher education.

An inter-institutional cooperation agreement between the partner institutions was established to ensure governance and shared management of the federated cloud and the interoperability platform, as well as applications and services it supports or will be supporting in the future, creating conditions for the extension of services to other higher education institutions beyond the four already implied, as is already the case.

3. DEVELOPMENT OF AN INTEROPERABILITY PLATFORM

3.1 Context

A consortium of higher education institutions or other sister organizations responsible for delivering information systems and academic applications for higher education does not exist in Portugal. Only FCCN, the Portuguese NREN (National Research and Education Network), provides connectivity services and related applications and services to the academic community. It follows that each institution develops or acquires its own tailored information system, although there are specific agreements for the use of information systems developed in the context of a single institution by other institutions. The existing information systems are very different in scope, integration capabilities and standards compliance. This scenario does not favor the ability to share information and services automatically between institutions. However the demands on higher education have been changing fast, much as a result of the global economic and financial background, but also due to the rapid pace of technological advancement. In particular, student mobility and the use of mobile devices are the “new normal” of operations that challenge higher education IT services.

Aiming to increase the level to which technology is leveraged for the benefit of the academic community, the partners of the project IES+Perto decided strategically on developing an interoperability platform between their information systems, bearing in mind its applicability to other institutions of higher education.

3.2 Overall architecture and integration

Considering on the one hand the significant differences existing between the information systems and related applications of the various higher education institutions, and, on the other, the need for each institution to organize and freely manage its information space, and given the growing need for HEIs to share information and create common services, an interoperability platform was designed in the context of the project IES+Perto as a means of integrating and transforming information existing on local HEIs' information systems to support data exchange and the build of conjoint applications.

This interoperability platform aims to expose the HEIs' information systems to their stakeholders as a unique and standard REST/SOAP-based service. The platform architecture follows the Enterprise Service Bus (Chappell, 2004) paradigm in order to provide information consumers with a consistent view of several heterogeneous data sources. These service standardization requirements are beyond interfacing issues and data mappings, because complex adaptations based on business logic rules are required.

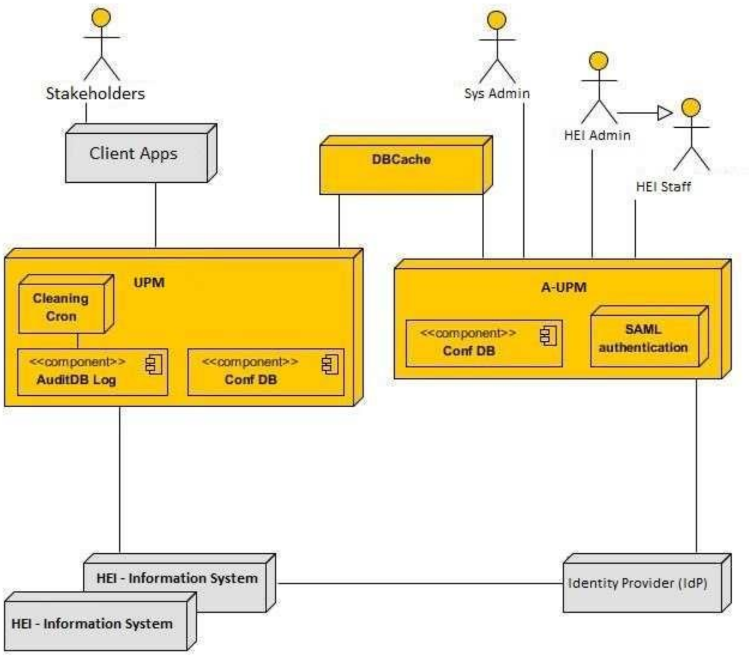


Figure 1 Platform architecture

The platform architecture was conceived with scalability in mind. The system is composed by two types of main module: (1) A-UPM (Admin - Ubiquity Provider Module) and (2) UPM (Ubiquity Provider Module). Additionally, other subsystems such as cache, database of configurations and logs, complete the system. The A-UPM provides a user interface for system administration tasks. These tasks are performed by HEI staff for administrating their services, as well as a main system administrator. On the other hand, the UPM modules are engines without direct human interaction that receive the client requests and support service mappings. In Figure 1, we present how these two types of module and subsystems are interconnected. The UPM modules were developed in order to be added to a cluster, enabling redundancy and load balancing. Besides the overall capacity of the system being very scalable, it is also flexible, because these cluster nodes can be geographically dispersed according to the service consuming needs.

Concerning the system performance, two levels of cache were introduced in the UPM modules: (1) C1 caches the output results of the platform; (2) C2 caches the data gathered from the HEIs' information systems. The C2 cache policy is based on a TTL (Time to Live) parameter, which is related to the HEIs' service. Notice that some services are very static, such as students' personal data. On the other hand, the students' grades data are very volatile, especially at the end of the semester. In our tests, this simple approach proved to be very efficient. However, more complex cache policies could be implemented in the future.

At the C1 cache level, the policy is very similar. The invocations submitted to the platform are also cached according to a TTL parameter. However, additional mechanisms are required in order to guarantee that wrong users do not gain unauthorized access to cached data. Thus, this cache level has separated contexts for each access authorization. That is to say, if one user performs exactly the same request as another, the cached data is not used. In this case, only the data cached at the C2 cache level will be used, thus introducing high performance gains.

In order to enable business logic rules in the service mappings, the platform allows that special modules, the Handlers, can be introduced into the system in order to extend its base adaptation mechanisms. These Handlers are written in Java programming language and use an API provided by the platform. The API provides abstraction regarding the technical details when invoking the HEIs' services, as well as transparent caching mechanisms.

Figure 2 depicts one example of a sequence of interactions between an external client and HEIs' information systems being handled by the platform. In this figure, one can observe a stakeholder invoking a service which triggers the execution of the Handler. The platform deals with client invocations and forwards each request to the appropriate Handler using the identifiers received in the request.

Invocations to the platform require four mandatory arguments: (1) bsUIID—an identifier of the operation to be executed; (2) an identifier of the HEI; (3) an API key that enables access control of client applications; and (4) a container that contains all arguments of the requested action. This container is, indeed, the input source of arguments passed to the Handler. The first and second identifiers together permit the platform to find which Handler must be applied in the requested action.

The mechanism processing starts by searching for the requested data in the C1 cache. In the example presented in Figure 2, no cached data is found. Hence, the request is delivered to the Handler. In the former step, the Handler gets data (Obj1) from the HEI's information system using the programming API of the platform. Notice that the use of the C2 cache is transparent to the Handler. After getting Obj1, the Handler performs some data processing based on the specific business rules of the target HEI for which it was written. At the next execution step, it invokes another web service in order to obtain additional data (Obj2) for completing its task. Finally, the result is delivered to the platform and recursively to the client.

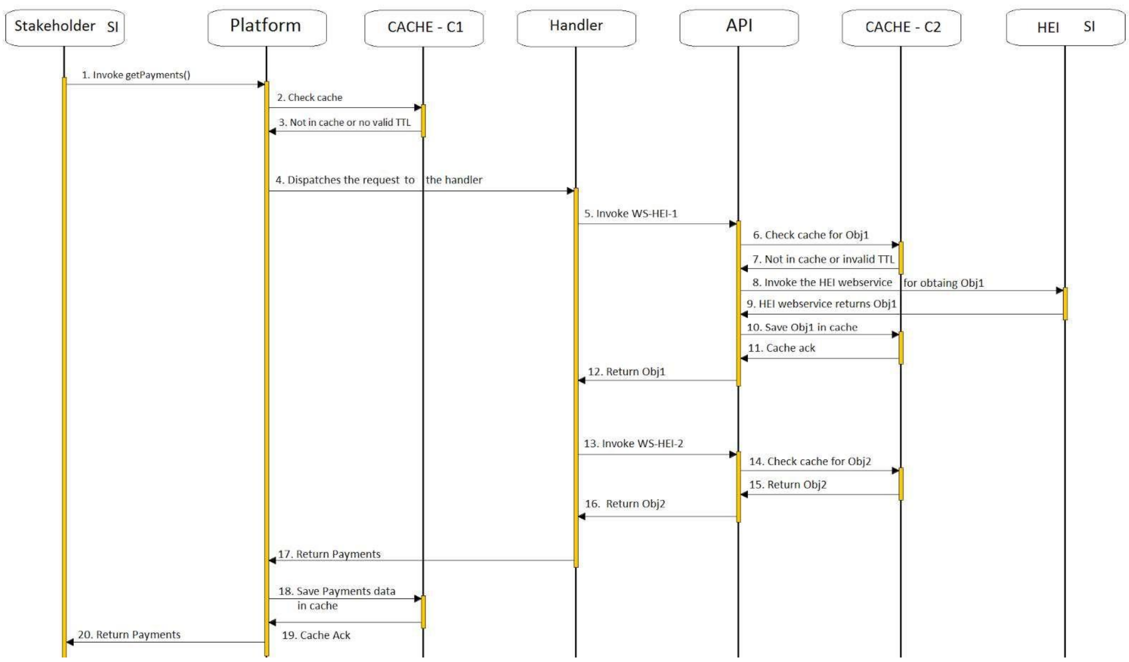


Figure 2 Handler invocation

Due to the use of a programming language and the platform programming environment, these Handlers are able to manage high levels of complexity regarding the adaption problem, business logic rules and data sources' heterogeneity. During the implementation phase of the services, many variations were observed in the HEIs' data models and concepts. Without this versatility of the platform, it would have been impossible to achieve our goals.

3.3 Deployment in a community cloud

After identifying the architecture of the interoperability platform, another important step was the definition of a computational and network model to support it, with adequate capacity in terms of performance, availability and future growth. This section briefly describes the approach followed by the HEIs and the implementation carried out in the context of the project IES+Perto.

The adoption of a common strategy by the involved HEIs for cloud computing implementations in order to share solutions, and build a knowledge base and a community cloud was among the main objectives of the project IES+Perto. This infrastructure allows appropriate response to the requirements for supporting the interoperability platform.

Considering the previous experience in the field of the HEIs involved, it was decided to adopt OpenStack software (OpenStack, n.d.) to create the private clouds and KVM (Kernel-based Virtual Machine) as the virtualization solution. Hence a community cloud named cloud4IES was built and is now a distributed platform that interconnects HEIs' private clouds over the national research and educational RCTS network (Network for Science, Technology and Society), managed and operated by FCCN.

To extend each private cloud beyond its own data center to the other HEIs data centers, FCCN deployed three VLANs (one for each cloud) using private addressing (RFC 1918). These VLANs are implemented overs RCTS+, a RCTS service for applications needing high performance switching connectivity without Internet access (FCCN, *RCTS Plus*, n.d.). Figure 3 shows the private clouds of the universities of Aveiro (UA), Coimbra (UC) and Porto (UP) connected through the RCTS+ VLANs. To support the interaction between components of the interoperability platform, a fourth VLAN was added.

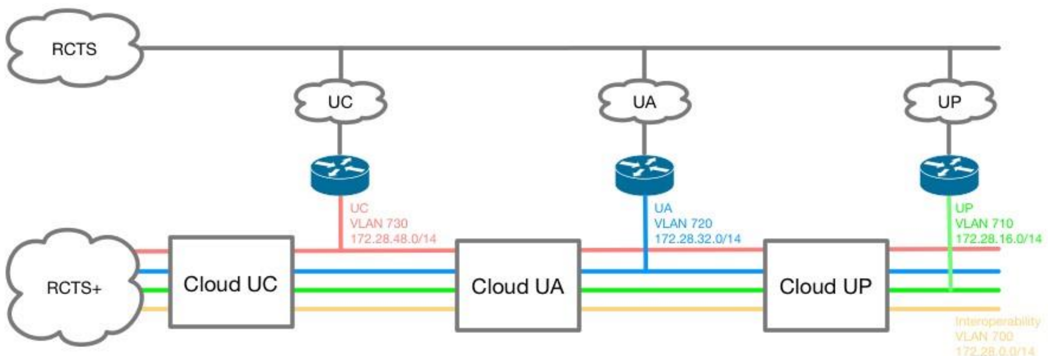


Figure 3 Cloud4IES VLANs interconnection

This was an efficient approach because it permitted the interconnection of the universities' private clouds in a very short time over the NREN that already connected them, profiting from a generous amount of bandwidth. With this solution, a HEI can easily host equipment from another university, providing that each institution manages its own address space and the security policies of its private and distributed cloud. Further, in future, private clouds' interconnection over RCTS+ will enable the integration of cloud4IES with external operators and public clouds.

Over this platform, the virtual data center VDC-PI4IES was implemented, allowing the sharing between all the HEIs of a replicated and synced infrastructure that enables redundant and high availability services for the interoperability platform, providing ubiquitous access to local universities information systems (see Figure 4). If the load increases, load balancing between more instances of the interoperability platform modules UPM and A-UPM may be easily configured.

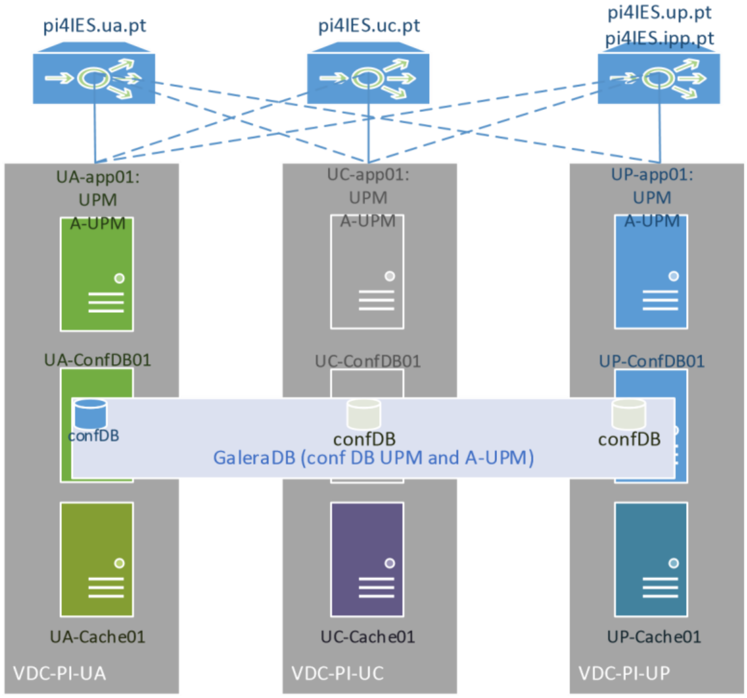


Figure 4 VDC-PI4IES architecture

The last step in the cloud4IES implementation was to provide a way for cloud administrators to manage their remote resources hosted in another university. This was achieved through the federation of all the private clouds' dashboards, a graphical interface to access, provision and automate cloud-based resources. Each private cloud is configured with a Shibboleth Service Provider (SP) and integrated with the national infrastructure for authentication and authorization (RCTSaai) (FCCN, *RCTSaai*, n.d.) that connects the Shibboleth (Shibboleth, n.d.) Identify Provider (IdP) of each university.

4. EXPLORING THE INTEROPERABILITY PLATFORM FOR COLLABORATIVE SERVICES

A set of broker services is available on the interoperability platform for supporting a mobile app for the academic community and the transfer of student data between HEIs for national mobility programmes and joint courses (see Figure 5).

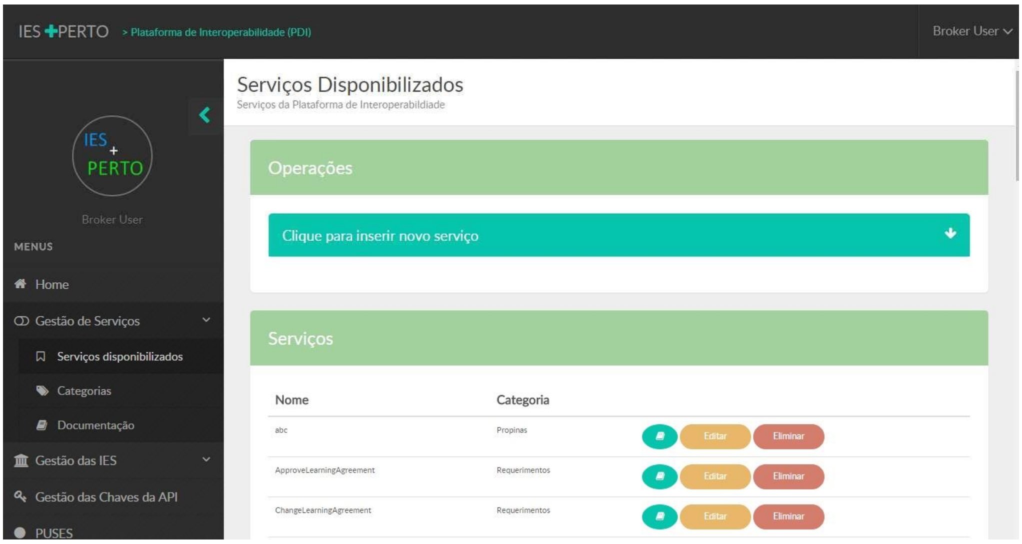


Figure 5 Interoperability platform services

The mobile application is customizable to each institution and adapts to the services available through the interoperability layer provided by the interoperability platform. The app was developed using open source technologies with support for iOS and Android platforms. It supports the authentication of users via Shibboleth and data access authorization via OAuth protocol (OAuth, n.d.). Communication between the mobile application and PI4IES takes place via HTTPS, no personal information being sent unencrypted over the network.

The app was developed for all members of the academic community and includes a set of features for each category of members. For instance, for students it includes features regarding academic information, the student's current account—allowing the student to generate ATM references for payments—or more general features such as those related to canteens, with reservation possibilities, or the possibility of requesting notifications in advance concerning the status of queues in different institutional services (see Figure 6).

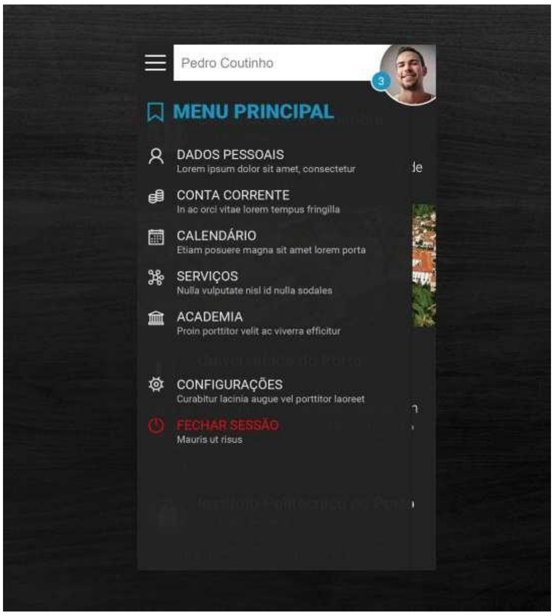


Figure 6 IES+Perto Mobile APP

Over the last decades, and in particular from the beginning of the current century, the substantial increase in the number of foreign students in higher education (ICEF Monitor, 2015) raises the need for digital student data portability, as recognized by the Groningen Declaration on Digital Student Data Depositories Worldwide "… digital student data portability and digital student data depositories are becoming increasingly concrete and relevant realities, and in the years to come, they will contribute decisively to the free movement of students and skilled workers on a global scale" (Groningen Declaration, 2012).

In Portugal, national student mobility is also real and present and, together with students' enrolments in joint courses, justifies enabling simplified access to student data by the institutions involved. In the context of the project IES+Perto, the interoperability platform was therefore used to implement student data transfer between the partner institutions cooperating in national mobility programs and joint courses. Besides the development of the necessary Handlers on the interoperability platform, local service layers were also developed to make the interconnection of each HEI information system with the interoperability platform services layer. Services supported included student enrolments, learning agreements and transcripts of records, both individual and group search, payment plans and status of current accounts in respect to joint courses. A pilot phase involving the academic and the international relations services to validate the student data portability is now starting.

Together with the development of an application library for digital signature with the national Citizen Card and a data repository with features of digital preservation of electronic documents, a significant improvement of information security, specifically in the preservation and availability of documents, was introduced.

5. EFFECTS AND IMPACT

5.1 Administrative modernization and electronic management

The project IES+Perto has allowed the achievement of a set of initiatives that embody significant improvements to the academic community of the four participating institutions, already being extended to other higher education institutions in Portugal, with additional added-value.

The interoperability platform was a major achievement of the project, allowing high levels of technological integration with the information systems of each institution, being developed according to a non-intrusive unifying perspective, so that each HEI continues to be responsible for organizing its own information. This makes possible the fast and smooth further development of common applications and services for HEIs.

The application for mobile devices built on top of the interoperability platform allows the interaction of the academic community with the respective institutional services, thus obviating travel needs at a physical counter. Furthermore, the design and implementation of targeted services for mobile platforms, exploiting open standards and interoperability, entail immediate benefits to all the national academic community, including the approximately 300,000 students in public higher education. Apart from these, the solution will also provide obvious benefits to third parties with which the HEIs interact.

As far as we are aware, the electronic transfer of student data implemented using the interoperability platform for national mobility programs and joint courses was the first effort of electronic transfer of data between higher education institutions in Portugal for academic purposes, translating into efficiency gains in service to the community.

In addition, the application library implemented a digital signature with the national Citizen Card, contributing to the dematerialisation of processes, this being a main driver for improvements in the quality of service to the community and the increase of the confidence of stakeholders.

Therefore the results achieved have a significant impact on the internal services of the HEIs. This impact is realized in a further simplification and dematerialisation of processes by exploiting new service models supported by IT, linking the virtual and face-to-face service channels.

5.2 Innovation and best practices

The interoperability platform developed in the context of the IES+Perto project is the result of an innovative initiative that, at the same time, implemented several best practices. In fact, it is the first time in Portugal that four HIEs gathered to form a consortium not for research purposes, but for building a platform that is intended to address common needs. To ensure the future management of the platform, the involved HIEs signed a protocol that creates an administrative board to produce regulation and evaluate new members, and also a technical board, formed by specialists of each institution. This way, no extra costs will be involved in the management of the platform.

The interoperability platform, completely implemented with open source tools and following open standards, also constitutes a useful case in the adoption of several best practices. First, the optimization resulting from sharing computational resources in a cloud computing environment should be highlighted. Secondly, the sharing of human resources and their expertise has also led to substantial benefits, integrating technical teams and enabling collaboration in the development of new projects.

Finally, by running business processes over the interoperability platform, there is a clear improvement in the quality of service of the involved institutions, dematerializing the exchange of information and reducing overall operational costs.

In the context of ICT, interoperability is commonly accepted as bringing innovation, although the correlation between interoperability and innovation is complex, interoperability being a very context-specific concept (Gasser & Palfrey, 2007). We argue that the interoperability platform developed in the context of project IES+Perto actually conveyed innovation because it allows seamless data integration and transmission between academic institutions, facilitating the development of new services to the users. In particular, it allows the promotion of new services aimed at mobile platforms, offering up a distinctive application that reveals a competitive advantage not only in the public context but also the private. Also, both the use of open source technologies and standards and the agreement established between the partner institutions to maintain and develop further the federated cloud and the interoperability platform built on top of it assure the sustainability of these resources and the prospect of the innovation continuum. To the extent that cloud interoperability is a challenging issue and many obstacles still exist (Toosi, Calheiros, & Buyya, 2014) we can also say that the operation of a federated cloud environment between the partner organizations was itself innovative.

6. CREATING COOPERATION NETWORKS

The exchange of knowledge and experiences between the technical teams of the four partner institutions was a key benefit of this initiative. An active and open sharing of knowhow allowed a better and efficient response to the challenges that arose in the reorganization of the data centers and virtualization environments, as well as defining and implementing the cloud computing model and connectivity that supports it. These synergies also included the academic and external relations services, to define requirements for the electronic data exchange between institutions.

This teamwork, performed with great motivation and commitment, translated into added benefits for directly involved employees and for institutions, allowing for cross-analysis and joint improvement of processes and procedures. Therefore, in terms of inter-institutional cooperation, a

network of contacts was established, materialized in the teams involved which worked together, sharing problems, solutions and knowledge.

The above mentioned network of cooperation has already borne fruit, namely the successfully submission of a new joint project involving additional partners. This new project, called “IES em Rede”—meaning “Higher Education Institutions in Network”—is financed with three million euros by the National Administrative Modernization Support System; it starts in March 2016 and joins two other universities, Beira Interior and Trás-os-Montes e Alto Douro. With the project “IES em Rede”, the HEIs will develop new user cases for the interoperability platform.

The eGovernment Action Plan 2011–2015 (Digital Agenda for Europe, n.d.) defines administrative burden reduction as a key priority for achieving the “efficient and effective government” objective. The European Council Conclusions on October 2013 state that: "Efforts should be made to apply the principle that information is collected from citizens only once, in due respect of data protection rules”. The “once only” principle states that citizens and businesses must have the right to provide information only once to a public authority. Offices of public administration should be able to take steps to share this data internally, while respecting data protection rules, so that no additional burden falls on citizens and businesses.

Another effective strategy is to produce default digital services that are so compelling and easy to use that all those who can use them will choose to do so whilst those who can’t are not excluded. Although the concepts of the “once only” principle, “digital by default” and making electronic procedures the dominant channel for delivering e-government services can be easily understood, their practical implementation encounters many obstacles, such as policy, legal and technological issues, as well as data protection requirements.

According to the Study on eGovernment and the Reduction of Administrative Burden (SMART 2012/0061) (Digital Agenda for Europe, 2014), more than 70 percent of EU countries have undertaken initiatives to put into practice the “once only” principle. The “once only” principle was transposed into Portuguese law in May 2014. Two of the most important areas of application of the “once only” principle in the HEIs are academic information exchange (certificates and contextual information) and research information management.

Figure 7 presents a proposal for information system architecture to support the application of the “once only” principle in academic area. This architecture integrates the PI4IES, the interoperability platform of public administration (iAP) and payroll management platform, simplifying the process of interaction between the information systems of HEIs and iAP. The presentation layer is composed of the Citizen Portal, the Portal for Higher Education and other applications that may be developed in the future.

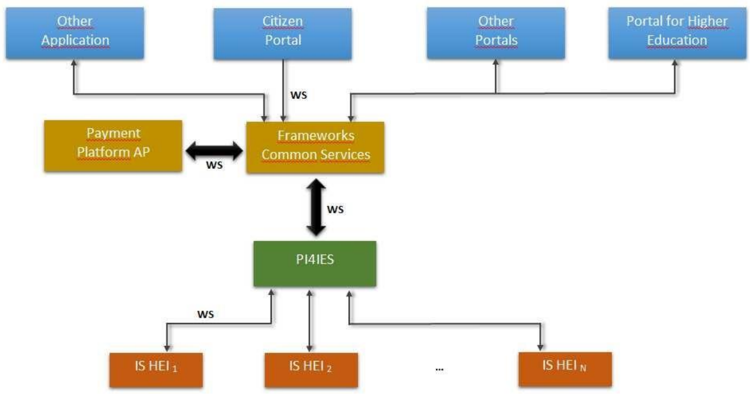


Figure 7 Proposal architecture for supporting the “once only” principle

7. CONCLUSION

The project IES+Perto was a very successful project, the interoperability platform and the federated cloud that supports it being the most impressive results accomplished. An agreement was therefore established among the partner institutions to enable the sustained operation of these resources and their further development, including the extension of use to other higher education institutions, and that has already happened.

The interoperability platform allows the easy, non-intrusive and integrated provision of electronic services for the academic community across multiple higher education institutions, allowing efficiency and productivity gains, fostering both internal and cross-institutional collaboration, being an important instrument for the modernization and innovation of higher education institutional services, taking advantage of information and communication technologies.

Acknowledgement

This work has been supported by the Portuguese Administrative Modernization Support System (SAMA) of the Operational Program Competitiveness Factors, COMPETE, under the National Strategic Reference Framework (QREN) and the European Union (EU).

8. REFERENCES

David A. Chappell (2004). *Enterprise Service Bus*. O'Reilly Media, ISBN 0-596-00675-6

Digital Agenda for Europe (n.d.). *European eGovernment Action Plan 2011-2015*. Retrieved February 4, 2016, from https://ec.europa.eu/digital-agenda/en/european-egovernment-action-plan2011-2015

Digital Agenda for Europe (2014). *Final report: Study on e-government and the reduction of administrative burden (SMART 2012/0061)*. Retrieved February 4, 2016, from https://ec.europa.eu/digital-agenda/en/news/final-report-study-egovernment-and-reductionadministrative-burden-smart-20120061

Gasser, U., & Palfrey, J. (2007). *Breaking down digital barriers: How and when ICT interoperability drives innovation*. Berkman Publication Series. The Berkman Center for Internet & Society, Harvard University. Retrieved February 3, 2016, from https://cyber.law.harvard.edu/interop/pdfs/interop-breaking-barriers.pdf

Groningen Declaration (2012). *Full text of the Groningen Declaration*. Retrieved January 27, 2016, from http://www.groningendeclaration.org/full-text-groningen-declaration

FCCN (n.d.). *RCTS Plus: Connectivity and infrastructure: Services*. Retrieved January 26, 2016, from https://www.fccn.pt/en/services/connectivity-and-infrastructure/rcts-plus/

FCCN (n.d.). *RCTSaai Federation: Connectivity and infrastructure: Services*. Retrieved February 5, 2016, from https://www.fccn.pt/en/services/connectivity-and-infrastructure/rctsaaifederation/

ICEF Monitor (2015). *The state of international student mobility in 2015: Market intelligence for international student recruitment*. Retrieved January 27, 2016, from http://monitor.icef.com/2015/11/the-state-of-international-student-mobility-in-2015/

OAuth Community Site. (n.d.). Retrieved February 5, 2016, from http://oauth.net/

OpenStack Open Source Cloud Computing Software. (n.d.). Retrieved February 5, 2016, from https://www.openstack.org/

Ribeiro, L. M., & Valente, L. (2015). Using cloud computing to foster closer links between higher education institutions. In *EUNIS 21st Congress Book of Abstracts - The Journey to Discovery* (pp. 330-332). Dundee, UK: Abertay University. Retrieved February 12, 2016, from http://www.eunis.org/wp-content/themes/eunis/assets/EUNIS2015_Book_of_Abstracts.pdf

Shibboleth. (n.d.). Retrieved February 5, 2016, from https://shibboleth.net/

Toosi, A. N., Calheiros, R. N., & Buyya, R. (2014). Interconnected cloud computing environments: Challenges, taxonomy, and survey. *ACM Computing Surveys*, *47*(1), 7:1-7:47. doi:10.1145/2593512. Retrieved February 5, 2016, from http://www.cloudbus.org/papers/InterCloud-ACMCS.pdf

9. AUTHORS' BIOGRAPHIES

Lígia Maria Ribeiro has been Principal Researcher at the Faculty of Engineering of the University of Porto since 2002. She received her degree in Applied Mathematics in 1977 from the Faculty of Sciences of the University of Porto and holds a PhD in Engineering Science from the University of Minho. She was prorector at the University of Porto between 2006 and 2014, being responsible for ICT. Between 2004 and 2006, she was President of EUNIS, after being VicePresident for two years. She is presently a member of the EUNIS Board of Directors.

Her main research areas of interest are computer simulation, high performance computing, information systems, electronic administration and informal learning spaces. pt.linkedin.com/in/ligiamribeiro

Rui Humberto Pereira is Invited Assistant Professor at the Polytechnic Institute of Porto - ISCAP since 1998 and is software development team leader at the Polytechnic Institute of Porto. He received his degree in Electrical and Computer Engineering in 1997 at the Faculty of Engineering of the University of Porto and holds a PhD in Software Engineering from the University of Vigo. He has developed his research activities in the areas of information systems, decision support systems, interoperability and database systems, having participated in various national projects. He is author of several articles published in national and international journals.

Osvaldo Pacheco has been Assistant Professor at the Department of Electronics, Telecommunications and Informatics of the University of Aveiro since 1996 and is a researcher at the Institute of Electronics and Informatics Engineering of Aveiro. He has been pro-rector at the University of Aveiro since 2010, being responsible for ICT. Over recent years, he has developed his research activities in the area of information systems and in the area of decision support systems, having participated in various national and international projects. He is author of several articles published in national and international journals and of a book.

Mário Bernardes is currently ICT director at Coimbra University, where he has been developing activity in system and network administration for more than thirty years. His educational experience dates from 2004, through the teaching of several curricular units in Internet technologies and information systems at the Faculty of Economics and Faculty of Humanities at master's level. He is member of the Institute of Electrical and Electronics Engineers and co-author of two books, "TCP, Teoria e Prática" and "Administração de Redes Informáticas".

Ricardo Martins is IT Engineer at the University of Aveiro since 1997. In the past decade he was responsible for directing the IT Support Team at the same University and for the execution of several projects in Datacenter, Communications, Security and Systems areas. Now, and since 2013, he is the ICT Director at the University of Aveiro.

Interoperability + semantics = check!
Smart and Cost Effective Data Modelling and Tools of the Future

Suvi Remes1, Miika Alonen2, Patrik Maltusch3, Mikael af Hällström4

[1] CSC – IT Center for Science, Keilaranta 14, FIN-02101 Espoo, suvi.remes@csc.fi

[2] CSC – IT Center for Science, Keilaranta 14, FIN-02101 Espoo, miika.alonen@csc.fi

[3] Aalto University, PO BOX 11000, FIN-00076 Aalto, patrik.maltusch@aalto.fi

[4]Finnish Tax Administration, PO BOX 325, FIN-00052 Vero, mikael.afhallstrom@vero.fi

Keywords
semantic interoperability, terminological theory, linked data, metadata, data modelling

1. SUMMARY

The more we rely on digitalisation in our transaction and businesses, the more we need to ensure that machine to machine communication can take place at high speed. Still, interoperability of information systems and the lack of shared semantics, both between humans and machines, is an internationally recognised issue. Information systems in the Finnish higher education sector, in the field where decentralisation of information systems is preferred, are not an exception. Semantic interoperability will enable higher education institutions wide cost benefits in relation of 1:38 at the national level.

In Finland we are in the process of implementing information systems and harmonising the legacy data models in the way that makes use of the shared semantics, standards and other best practices according to the common architectural vision. This basic infrastructure for information management is built by combining terminological theory, linked data and adaptable data modelling practices.

2. SMART AND COST EFFECTIVE DATA MODELLING AND TOOLS OF THE FUTURE

When you "talk the talk" you need to "walk the walk" it's a common phrase you hear. The new approach we have to data management and interoperability is a mix of some existing elements with previously untapped potential, e.g. use of semantic technologies and linked data in the Finnish higher education sector. It forms a structured, common architecture frame connecting conceptual modelling of business, services and processes to defining and maintaining controlled terminology and further to constructing data models for information systems.

Many efforts have been made trying to define best practices and guidelines for interoperability; one of the most effective being RAKETTI-project (*Information Services as Part of the HEIs' Structural Reform*) during the years 2008-2014. The results, however, support mainly data storage, data collection and reporting activities based on a strictly normalised data model. Typically architecture of higher education information systems is based on traditional databases which have their own data models and terminology and moving the data from one information system to another requires high cost expert labor work.

The modelling process of any information system should start from conceptual modelling. What is usually missed at this stage is a systematic and formalised method for concept defining. It is not that we do not have them, it is that we have not fully recognised the value of humanistic terminological theory (ISO, 2009). We argue that the concepts we use in business and operations of agencies (e.g. *Vocabulary of Education,* (OKSA, 2016), typically in cross-human communication situations, should form the solid foundation also for semantics of data models used in information systems. The controlled, methodologically intact terminology should be openly available both in human and machine readable formats, such as SKOS (W3C, 2012). In Finland, SKOS vocabularies will be published in the *Finnish Ontology Service* (FINTO, 2016), maintained by the Finnish National Library.

Terminology work takes no role in defining logical data structures, such as classes, properties and part-of relations. For this purpose a so called *Semantic Interoperability Model* is needed. It connects the concepts and logical data models together and pass the shared semantics to every implementation that re-uses its components (Figure 1). The Semantic Interoperability Model, actually a linked data vocabulary, identifies the re-usable information components with URIs (Uniform Resource Identifiers), and enables creation of *application profiles* for specific use cases. Application profiles are data models constructed and documented in human and machine-readable formats following the guidelines from DCMI (DCMI, 2009) and rethinking the metadata specifications developed by CEN (CEN/TC 353). These profiles re-use the descriptions and mappings and make it possible to transform the re-usable components into different standard technical formats, such as XML or JSON schemas.

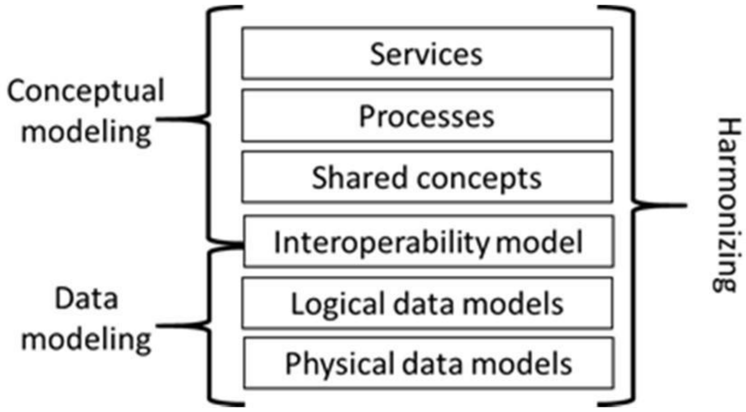


Figure 1. Common architecture frame connecting conceptual and physical modelling.

One of the goals of our work has been to build a prototype for collaborative online tool for creating linked data vocabularies and application profiles — instead of documenting terminology and data model descriptions, as usual, in e.g. separate wiki pages or spreadsheet. This work has proceeded and we are proud to present the solution: *IOW - Interoperability Workbench* (CSC, 2016). It is an open source IT software and as a modular implementation it enables further development, as linkages e.g. to existing Code Services.

The Semantic Interoperability Model and IOW is being developed by the Ministry of Education and Culture for supporting the needs of institutions of higher education and research, but the work will in future form the basis for a wider *National Metadata Service* and be a part of the *National Service Architecture* (Ministry of Finance, 2015). We argue that this approach to interoperability and semantics of information and digital services has potential also in the context of international cooperation.

3. REFERENCES

CEN/TC 353. European Learning Standards. Retrieved from www.cen.eu/work/areas/ICT/eEducation

CSC. (2016). *IOW - Interoperability Workbench*. Retrieved from http://iow.csc.fi

DCMI. (2009). *Guidelines for Dublin Core Application Profiles. Retrieved from http://dublincore.org*

FINTO. (2016). *Finnish Ontology Service*. Retrieved from http://finto.fi

ISO. (2009). *Terminology work -- Principles and methods (ISO 704: 2009)*

Ministry of Finance. (2015). *National Architecture for Digital Services*. Retrieved from http://vm.fi/en/national-architecture-for-digital-services OKSA. (2016). *Vocabulary of Education*. Retrieved from http://confluence.csc.fi/display/TIES/Sanastotyo

W3C. (2012). *SKOS Primer. Retrieved from http://www.w3.org/TR/skos-primer*

AUTHORS' BIOGRAPHIES

Suvi Remes is working as specialist in information management and semantic interoperability at CSC – IT Center for Science and has experience in developing information and data management and architecture on different levels of abstraction and operations.

She leads as project manager the service development of *IOW - Interoperability Workbench* and coordinates its introduction and implementation in the field of higher education and research but also on a national level together with strategic co-operation partners. She is a member of the Ministry of Education and Culture led working group for *Vocabulary of Education*, and co-coordinates the language translations for the terminology. She is also a member of a national-level terminology working group which guides and develops the terminology work and its processes for the public sector in Finland.

Suvi is also working for the *Open Science and Research Initiative (ATT)* which the Finnish Ministry of Education and Culture set out to promote research information accessibility and open science. Suvi chairs the *ATT Metadata Working Group* which has studied possibilities to improve interoperability, especially semantic interoperability, in metadata management focusing on research data and datasets. She also, from time to time, coaches the research administration terminology working group. She has experience in working in various international networks, including standardisation work both in the national and the international bodies, e.g. CEN and ISO.

Suvi holds a M.Sc. in Cultural Geography and she has since deepened her understanding of semantic theories studying further Linguistics and Literature. Her interest lies in the terminological theory and its applications in information management and different communication situations.

Previously Suvi has worked few years in a private sector company in industry coordinating and developing information management processes. She has also work experience from study administration, focused that time on international student mobility and admissions.

Miika Alonen is working as interoperability architect and specialist in semantic interoperability at CSC – IT Center for Science. He is the chief architect and also active developer in the service development of *IOW - Interoperability Workbench* and participates in various national networks in the implementation process of this new architecture approach.

Miika has a strong IT background and experience in projects focusing in semantic interoperability. He holds a M.Sc. in Software Engineering and is currently, on the side of his full time job, doing his postgraduate studies at Aalto University in

the field of Semantic Computing.

LinkedIn profile:

https://www.linkedin.com/in/miika-alonen-67500b21

Patrik Maltusch is heading the EA architecture team at Aalto University. He is also acting member and chairman of the Finnish National Enterprise Architecture Special Interest Group and one of the lead educators who have coached administration staff in the national wide Higher Education EA schooling program. Past experience include working as a customer service instructor for nearly ten years and further fifteen years as network architect and business owner for internal infrastructure design in a global Telco company. Patrik is also a distinguished and accredited security professional, risk manager, system auditor and a certified Higher Education Enterprise Architect. As entrepreneur and start up facilitator Patrik understands what staying practical means for business. For Patrik interoperability is the key to success in an ever growing and more complex and complicated ecosystem landscape. Something that can be achieved using EA methodology in a more visualized way.

Experience per domain:

Software Security 5+ years, Hotel & Restaurant 10+ years, Information Security 10+ years, ICT Service Management 15+ years, Project Management 15+ years, Business Management 15+ years, ICT Networks 20+ years, IT Systems 30+ years.

LinkedIn profile:

https://fi.linkedin.com/in/maltusch

Publications:

Maltusch, Patrik & Nieminen, Virpi (2015). *Business and Dynamic Change: The Arrival of Business Architecture. Applying Architecture to Business Transformation and Decision-making: Case Aalto University*. Future Strategies Inc. http://futstrat.com/books/BusinessandDynamicChange.php

Mikael af Hällström works as senior advisor at Finnish Tax Administration. He has been working in different cross-governmental projects since the mid–2000s, mainly focusing on developing interoperability, including national controlled terminologies and vocabularies, information architecture modeling frameworks, nationally harmonised code lists and classifications and XML schema conformance. Mikael chairs several national level working groups with connection to these themes and he is also a member of steering groups directing development of procedures and actions on interoperability in the public sector in Finland. He holds a Master's degree in Law.

Putting the CHEITA Global Complexity Index to the test

1st Johan Bergström[1], 2nd Anne Kealley[2], 3d Leah Lang[3], 4th Lori MacMullen[4], 5thMichele Mennielli[5], 6th Paul Sherlock[6], 7th Peter Tinson[7], 8th, Markus von der Heyde[8]

[1] Umeå Universitet, Sweden, johan.bergstrom@umu.se
[2] CAUDIT, Australia, anne.kealley@caudit.edu.au
[3] EDUCAUSE, USA, llang@educause.edu
[4] CUCCIO, Canada, lori.macmullen@cuccio.net
[5] CINECA, Italy, m.mennielli@cineca.it
[6] University of South Australia, Australia, paul.sherlock@unisa.edu.au
[7] USICA, UK, execsec@ucisa.ac.uk
[8] vdH-IT, Germany, zki@vdh-it.de

Keywords
benchmarking, CHEITA, Complexity Index, CIO, IT management, trends, comparison

1. Abstract

In 2015 The Coalition of Higher Education Information Technology Associations (CHEITA), a collaboration between higher education it associations across the globe, identified that in order to facilitate cross-border comparisons appropriate for the global higher education business it would be necessary to establish a way of comparing individual institutions. The CHEITA Benchmarking Working Group was created to explore the viability of and to identify a way to undertake benchmarking of IT in higher education on a global scale.

The working group decided, after a lengthy process, to use the model developed in Australia called Complexity Index. It is a methodology to identify and index institutional complexity. The original model was adjusted (leaving out number of campuses) to become The CHEITA Complexity Index. The index is calculated using 3 components:

Element	Minimum	Maximum
Number of students (EFTSL)	0	45,000
Number of staff (FTE)	0	18,000
Research income ($)	0	$750,000,000

This is then compared to the IT spend of a specific institution to provide a data point where the institution can be plotted. For a more detailed description of the Complexity index see the full paper published by CHEITA[1]

Benchmarking IT benefits institutions by giving the institution the possibility to compare with peer universities. By using the CHEITA Complexity Index, benchmarking IT can be extended internationally and enable comparison with institutions from other countries. This serves a purpose to provide more members of a peer group and in some cases, where an institution does not have any peers within its country, an actual peer group.

The concept of trans-national comparison using the Complexity index to create peer groups has not yet been put to the test. The CHEITA Benchmarking working group has the ambition to create a discussion between IT leaders from different parts of the world, seemingly of the same complexity. This discussion will shed light on both the validity of the Global Complexity Index as well as the value of benchmarking in general. This presentation will include a discussion on the process and concept behind both the Complexity Index as well as the discussion group. If available at the time of the EUNIS2016 congress, a presentation on key findings will also be presented.

2. REFERENCES

1. Bergström, Johan, Eden Dahlstrom, Pekka Kähkipuro, Anne Kealley, Leah Lang, Lori MacMullen, Michele Mennielli, Paul Sherlock, and Peter Tinson. Benchmarking IT: A Global Approach. CHEITA, July 15, 2015. (http://www.cheita.org/wp-content/uploads/2015/08/CheitaBM.pdf)

3. AUTHORS' BIOGRAPHIES

Johan Bergström, Msc Computer Science, is working as an International Business developer for ICT Services and System Development (ITS) - Umeå University. Johan was the congress organiser of the 20th annual EUNIS congress in 2014 and currently the manager of Eunis Research and Analysis Initiative.
https://www.linkedin.com/in/johanbergstrom

Anne Kealley, Dip. Teach, B Bus, Grad. Cert. O&G Engineering, is the CEO of the Council of Australian University Directors of Information Technology (CAUDIT). Anne is a member of the Organising Committee for the THETA 2017 conference, a proposal reviewer for the EDUCAUSE 2016 conference and a member of the Scientific Community of the EUNIS 2016 Congress. https://au.linkedin.com/in/annekealley

Leah Lang leads EDUCAUSE Analytics Services, a suite of data services, products, and tools that can be used to inform decision-making about IT in higher education. Leah has a B.S. in Statistics from Penn State and an M.S. in Survey Methodology from the University of Maryland.

Michele Mennielli, Michele Mennielli is working as an external Relations and International Affairs Manager for CINECA, Italy. His primary focus is on Research Informations systems. He is also a board member of both EUNIS and EuroCris, two paneuropean organisations focusing on IT for Higher Education.
https://www.linkedin.com/in/michelemennielli

Paul Sherlock is an Officer (Library & IT) at the University of South Australia (UniSA) where he is responsible for the strategic direction and operational management of the University's IT and Library services. Paul has previously been President of the Council of Australia University Directors of Information Technology (CAUDIT). During Paul's presidency CAUDIT was incorporated and international ties with South Africa were established. Paul led the development of the CAUDIT complexity index which is been adapted for use
internationally by the CHEITA benchmarking working group.
https://au.linkedin.com/in/sherlockpaul

Dr. Markus von der Heyde received his PhD in Computer Sciences from the University of Bielefeld for his work at the Max Planck Institute for Biological Cybernetics Tübingen in 2000. His approach is to adopt biological principles into distributed computer applications in order to enhance stability and robustness.
Since 2004 he works within ZKI on topics as information security, service-management, strategy and governance. Until 2011 he was ICT director of Bauhaus-University in Weimar. Until today he also focuses on internationalization and supports ZKI, GI, EUNIS and EDUCAUSE and serves as program committee member as well as proposal reviewer for conferences and the scientific community. In cooperation with various partners he continues to conduct the German CIO studies. Today, he is management consultant specialized on IT topics in higher education. See further details on https://de.linkedin.com/in/mvdh42.
.

Peter Tinson is Executive Director of UCISA. Peter has worked for UCISA since 2005. His responsibilities include representing the UK Higher Education IT community in discussions with Government departments and other bodies on the development and implementation of legislation and policy.

Lori MacMullen is the Executive Director of the Canadian University Council of Chief Information Officers (CUCCIO). Representing 57 Canadian Universities CUCCIO serves as the national voice for IT-related issues in Canadian universities and provides a forum for members to share ideas, best practices and advance collaboration across the sector. Ms. MacMullen holds a Business Administration degree from the University of New Brunswick. In addition to her formal education, Ms. MacMullen has also attended the Program for Public Executives at Queen's University and has participated in a number of international, national and provincial committees aimed at advancing IT related issues in both the public and academic sectors.

BENCHEIT – Benchmarking Higher Education IT An Update on the Work of the EUNIS Bencheit Task Force

1st Ilkka Siissalo[1], 2nd Yiannis Salmatzidis [2], 3rd Angeliki Agorogianni[3], 4th Yvonne Kivi[4]

[1] University of Helsinki IT Center, PO Box 28, FI-00014 University of Helsinki, Finland,ilkka.siissalo@helsinki.fi

[2] Aristotle University of Thessaloniki, University Campus, 54124 Thessaloniki, Greece, jsal@it.auth.gr

[3] Aristotle University of Thessaloniki, University Campus, 54124 Thessaloniki, Greece, aagorogi@it.auth.gr

[4]University of Helsinki IT Center, PO Box 28, FI-00014 University of Helsinki, Finland, yvonne.kivi@helsinki.fi

Keywords

benchmarking, BencHEIT, CIO, IT management, costs

1. Summary

BencHEIT is a free of charge yearly survey with the aim of establishing a comprehensive knowledge of how cost efficiently IT works in European universities, and universities of applied sciences. The BencHEIT Task Force gathers the data and generates an analysis for the CIOs to use in comparing the organization´s IT costs and volumes to their peer´s numbers. It also provides them with tools to start more detailed discussions how to improve the performance of institute's IT services. Analysis gives some perspective to common development within the higher education IT.

Data is collected in three dimensions

1. Organizational level: centralized IT, other centralized units, distributed units e.g. faculties and research centers. This way participating organization can see how (de)centralized their IT is in comparison to others.
2. Account level: financial data is divided in hardware, software, staff, facilities, outsourcing and other costs.
3. Services: all costs and also some of the volume data is collected within different IT services e.g. infrastructure, workstations, business applications.

The initiative was started as a country-wide Finnish project, and in the year 2012 it was opened to all interested European HEIs. The number of participants have increased every year since we started the project in its current form in 2012. In the last round we had 49 participants, from Finland, Sweden, Denmark, Norway, Germany, Greece and Slovenia.

Every year for the past four years, the Task Force together with EUNIS has hosted a workshop day somewhere in Europe (Münich, Paris, Bologna and Barcelona), for everyone interested in benchmarking. One of the topics has been finding possible common indicators for comparing results from other similar studies at hand. This will also be one of the topics discussed in the pre-congress workshop in Thessaloniki 7th June 2016. The Task Force is also planning a workshop in Trondheim,

Norway in the fall 2016.

Bencheit is one of the EUNIS official task forces. This presentation is an update on what the project is doing at the moment, and what is new for the year 2016. The presentation aims to explain how the project works, and what the benefits of participating are, also for someone who has never heard about it before.

We will hear from Yiannis Salmatzidis and Angeliki Agorogianni, telling us about the University of Thessaloniki´s experiences and benefits as a fairly new participant.

2. AUTHORS' BIOGRAPHIES

Ilkka Siissalo is the CIO of University of Helsinki, EUNIS Vice President and chairman of the Bencheit steering group. Ilkka holds an M.Sc degree in biochemical sciences as well as a bachelor level degree in marketing. Ilkka has acted as the IT leader in various research related institutions both within the private sector and academia for over 25 years.

Yiannis Salmatzidis is the Technical Manager of the IT Centre of Aristotle University of Thessaloniki, the largest university in Greece. He is also a member of the EUNIS Board and a member of the Bencheit steering group. Yiannis graduated from the Department of Electrical Engineering at Aristotle University. He holds a Master's Degree in Electrical Engineering, from University of Maryland at College Park, USA. He is a Fulbright Fellow.

Angeliki Agorogianni is the Head of Administration and User Support Unit at the Information Technology Center of Aristotle University of Thessaloniki since 2013. Between the years 1997-2012 she worked at the Telecommunication Center of Aristotle University as administrator of the voice network and the videoconferencing infrastructure of the university. She holds a bachelor's Degree in electrical engineering from Aristotle University and a Master's Degree in Business Administration. Since 2014 she leads the annual Bencheit survey for Aristotle University.

Yvonne Kivi is an IT specialist at the University of Helsinki and the project manager of BencHEIT. She holds a B.Sc degree from Arcada university of applied sciences. Yvonne is the key contact person to most of the institutions that participate in the Bencheit work.

EUNIS-2016-paper-template.doc

Finding the holy grail of IT Benchmarking

1st Johan Bergström[1], 2nd Rens van der Vorst[2], 3d Michele Mennielli[3], 4th Yvonne Kivi[4], 5th Teemu Seesto[5], 6th, Ole Langfelt[6], 7th Jose Pascual Gumbau Mezquita[7], 8th Antonio Fernández Martínez[8], 9th Vicente Andreu Navarro[7], 10th Paco Sampalo[9]

[1]Umeå Universitet, Sweden, johan.bergstrom@umu.se
[2]Fontys University, The Netherlands, r.vandervorst@fontys.nl
[3]Cineca, Italy, m.mennielli@cineca.it
[4]University of Helsinki, Finland, yvonne.kivi@helsinki.fi
[5]FUCIO, Network of Finnish Universities' Chief IT officers c/o University of Turku, teemu.seesto@utu.fi
[6]Norwegian University of Science and Technology, ole.langfeldt@ntnu.no
[7]Universitat Jaume I, gumbau@uji.es, andreuv@uji.es
[8]Universidad de Almeria, afm@ual.es
[9] Universidad Polytechnica de Cartagena, paco.sampalo@si.upct.es

Keywords
benchmarking, BencHEIT, CIO, IT management, trends, comparison

1. Abstract

There are a number of benchmarking initiatives throughout Europe. Together, these are covering a fairly large number of institutions. The goals of these initiatives are to get a full picture of the state of IT at an institution with a purpose of facilitating a comparison between institutions. At the BencHEIT meeting in Barcelona an idea was put forward to find a number of common indicators from these benchmarking surveys. A goal of this work is to provide a possible overview of the situation of IT in Higher Education in Europe.

Ensuring good benchmarking with secured data points over region, countries or even continents is the holy grail of benchmarking. The BencHEIT initiative in Europe is a good example of a well managed and ambitious endeavor to make this happen. However, this is within the scope of a specific survey, where the definition of each data point is discussed and decided (still there is always the risk of misunderstanding the intent of a specific collection point).

When it comes to analyze the different benchmarking initiatives from different regions, countries or continents it becomes more difficult. A group of representatives from three different benchmarking projects have engaged in trying to find this holy grail.

The project, called "Trans-national Benchmarking", is trying to find a path to this holy grail. Instead of comparing and encompassing all aspects of the benchmarking work the groups is working to define the common denominators between the 3.

The first step is for each one of us to go through these documents to try to find commonalities, starting with the Context indicators. A quick overview of these indicators show that you can pair them into three different areas.

- Basic data or Context indicators about the institution. This is more or less mandatory to facilitate some kind of comparison.

- Indicators that we believe or look like they are comparable. These will then have to be defined more closely to ensure they are actually asking the same questions (and thus getting comparable answers).
- Indicators that we would like to have, based on the needs of the institutions (what indicators they are using to run their business and influence stakeholders).

This presentation will focus on describing this set of indicators that are comparable between different benchmarking projects. The project has identified the indicatiors and will move on to providing a pilot where these indicators will be put to test. This will also outline the constitution of the transnational benchmarking community.

The project is not yet finished but the results will be available before EUNIS2016.

2. AUTHORS' BIOGRAPHIES

Johan Bergström, Msc Computer Science, is working as an International Business developer for ICT Services and System Development (ITS) - Umeå University. Johan was the congress organiser of the 20th annual EUNIS congress in 2014. Johan is also a programme committee member the Terena Networking Conference in 2015 and 2016 as well as a Senior Reviewer ERO (Educause Review Online).
https://www.linkedin.com/in/johanbergstrom

Michele Mennielli, Michele Mennielli is working as an external Relations and International Affairs Manager for CINECA, Italy. His primary focus is on Research Informations systems. He is also a board member of both EUNIS and EuroCris, two paneuropean organisations focusing on IT for Higher Education.
https://www.linkedin.com/in/michelemennielli

Teemu Seesto has M.Sc. in economics from Turku School of Economics. He has been a teacher of information systems science for twenty years. Seesto was the CIO of Turku School of Economics during 2006-2010. He is currently the IT general secretary of FUCIO, the Network of Finnish universities' CIOs. Teemu is a member of the Bencheit steering group.

Yvonne Kivi is an IT specialist at the University of Helsinki and the project manager of BencHEIT. She holds a B.Sc degree from Arcada university of applied sciences. Yvonne is the key contact person to most of the institutions that participate in the Bencheit work.

Ole Langfelt IT architect and IT security manager at the Norwegian University of Technology.

Rens van der Vorst has a degree in Economics & Law and Political Science. He works for Fontys University (45k students) as head of IT innovation. His most recent projects are the Quantified Student (a Runkeeper App for Students), CitizinOne (a life long portfolio), an IT benchmark for higher education in the Netherlands. Rens is very active in Dutch community SURF and European community EUNIS.

Jose Pascual Gumbau Mezquita Director of Office for Planning and IT Forecast at University Jaume I.

Vicente Andreu Navarro has a degree in Computer Engineering. He works at University Jaume I as Senior IT Innovation Specialist. He is in charge of IT security management and personal data protection. He is also involved in IT organization and governance and has been the leader of the academic pilots in STORK and STORK2.0 projects on electronic identity, co-funded by the European Commission.

Antonio Fernández Fernández Martínez

Paco Sampalo

Challenges of Supporting Education and Research to Make Use of eduGAIN

Ioannis Kakavas[1,2]

[1]GRNET S.A. Athens, Greece, ikakavas@noc.grnet.gr participant of the
[2]GÉANT 4 Project, Cambridge, United Kingdom

Keywords eduGAIN, federated identity management, collaboration, research

1. Summary

eduGAIN, a service developed within the EC-Funded GÉANT Project, interconnects SAML2-based identity federations around the world, simplifying access to services and resources for an international research and education community. In this technical presentation, a short overview of eduGAIN is provided along with a summary of the work that the GÉANT Project has done for and together with various research communities. The benefits of joining eduGAIN for universities and researchers are outlined and a set of challenges that universities and campus IT need to address in order to allow their researchers to make better use of eduGAIN is discussed, along with suggestions and best practices for how to address them.

2. eduGAIN introduction

An (identity) federation is a group of organizations that agree on a set of common standards, policies and practices to issue and accept identity assertions. Identity assertions are issued by an Identity Provider (IdP) that authenticates a user (e.g. by password). The Identity assertions then are consumed by Service Provider (SP), which uses the attributes of that assertion to perform access control and to provide the user attributes to the web applications it protects.

eduGAIN's main purpose, as an interfederation service, is to interconnect academic identity federations around the world, simplifying access to content, services and resources for the global research and education community. eduGAIN thus enables the trustworthy exchange of information related to identity, authentication and authorization (AAI) by coordinating the federations' technical infrastructures and providing a policy framework that controls this information exchange.

More than 35 national federations currently participate in eduGAIN. This amounts to more than 1500 Identity Providers worldwide allowing their users federated access to more than 1000 Service Providers offering their services in eduGAIN.

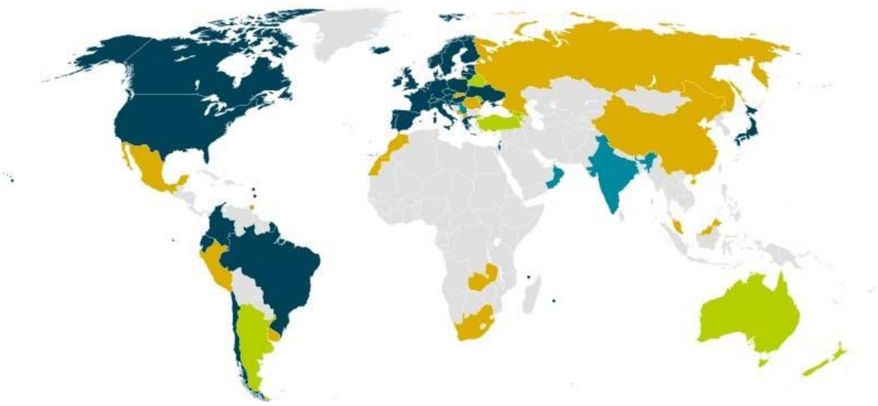


Figure 1: Map of national federations participating in eduGAIN

3. Benefits of joining eduGAIN

Through eduGAIN, universities and their researchers and students can access a great range of services, operated in the member federations in a collaborative environment. Researchers are able to use their local university accounts to access any service connected to eduGAIN that might otherwise be unavailable and without the need to create and manage additional, service specific accounts. Research communities and their services gain exposure to a wide international academic audience while avoiding the cost of user management and user support.

4. Challenges for eduGAIN participants

While eduGAIN offers considerable benefits both for researchers and for services addressed to them, these benefits come associated with a certain cost and additional challenges. Operational cost burdens mainly universities since interfederation adds an extra complexity layer to their existing identity management solutions. Participation in eduGAIN also unveils new administration and policy dilemmas for campus IT. They are now responsible for ensuring that the privacy of their users is respected while at the same time releasing enough information for them to access services in meaningful manner. The presentation offers recommendations, stemming from the experience of the GÉANT Project, on how campus IT can mitigate some of these issues in order to better support their researchers getting access to eduGAIN enabled services.

5. eduGAIN collaboration with research communities

Research communities, driven by their need for fine-grained access management for research data, have produced a paper entitled 'Federated Identity Management (FIM) for Research Collaborations' in which they detail their requirements for federated identity management identify issues that pose challenges for the wider adoption of FIM technologies offered by national federations and by eduGAIN. The GÉANT Project, addressing these requirements and issues, has worked closely with a number of research communities with the end goal of assisting them to satisfy their use cases. Namely, it has worked closely with CERN, DARIAH, ELIXIR, UMBRELLA, ESA and other research communities in order to allow them to:

- Enable researchers to access data sets that cannot be publicly disseminated using a federated identity model that ensures sufficiently reliable authentication and proper authorization.
- Expose their services to international and cross-organization groups of researchers via eduGAIN, offering proper authentication and authorization in user friendly way and at the same time taking away the burden of a complex user management infrastructure
- Simplify the access to their web-based service offerings for researchers by allowing them to use their existing - now federated- university credentials instead of obliging them to create service specific accounts.

The presentation provides an insight of the work that has been completed in collaboration with some of the aforementioned research communities, of the key outcomes and conclusions and explores how these are used to structure guidelines and best practices for the benefit of the rest of the research community.

6. REFERENCES

Broeder, D., Jones, B., Kelsey, D., Kershaw, P., Lüders, S., Lyall, A., Nyrönen, T., Wartel, R., Weyer, H. (2012). *Federated Identity Management (FIM) for Research Collaborations*

7. Author Biography

Ioannis Kakavas holds a degree in Electrical and Computer Engineering from National Technical University of Athens and a M.Sc. in Information and Communication Systems Security from the Royal Institute of Technology (KTH) in Sweden. He has been with GRNET S.A. since 2014, working with Identity and Access Management, Identity Federation and Security. He is a member of the team that operates the national identity federation and the security officer for GRNET. Ioannis participates in the Geant Project, and specifically in the Enabling Users task, collaborating with international user communities to assist them to increase their usage of AAI infrastructures.

Towards Pan-European Cloud Services

Branko Radojević[1], Andres Steijaert[2], Lars Fuglevaag[3]

[1]CARNet / GÉANT, J. Marohnića 5, Zagreb, Croatia, branko.radojevic@carnet.hr
[2]SURFnet / GÉANT, Moreelsepark 48, Utrecht, Nederlands, andres.steijaert@surfnet.nl [3]UNINETT / GÉANT, Abels gate 5, Trondheim, Norway, lars.fuglevaag@uninett.no

Keywords
Clouds, NREN, services, research, education.

1. Summary

Cloud services really make users the choosers by using the services they want, in easy and often economically attractive manner. European NRENs (National Research and Educational Network) have recognized the need for a common, systematic approach to cloud services, and have joined forces in the GÉANT4 Clouds activity. This paper gives an overview of the challenges and possibilities associated with cloud services in research and education, and how the European NREN community is responding to these. It outlines the result of the NREN collaboration through GÉANT so far, specifically addressing the ongoing procurements and its implications and benefits for a wide number of European R&E institutions.

2. Working together empowers our position toward vendors

Cloud services really make users choosers. They empower users to select and use the services they want, in an easy and often economically attractive manner. Research and education organizations can become more agile and provide their users with a wider range of relevant IT services. Cloud services offer great potential but also pose challenges. Research and education institutions as a rule need to know that their data are secure. Procurement regulations and billing are factors that complicate the use of commercial cloud services as well as the growth of "shadow IT" where the IT department is bypassed by users.

European NRENs have recognized the need for a common, systematic approach to cloud services, and have joined forces in the GÉANT4 Clouds activity. The NRENs are working together to aggregate demand and work with vendors in a community effort to bring cloud services to European research and higher education. The goal is ambitious; to deliver cloud services that meet the requirements of the sector to institutions across Europe, and to establish a delivery ecosystem for such services that can keep feeding new services to the community in the years to come.

The initial work was done in previous project (GÉANT3plus) where the team has worked with the NRENs to set common set of goals to be achieved through negotiation process with the commercial vendors. A number of documents were prepared and released and one of the most important is the *Indicative list of requirements for CSPs* (Cloud Service Providers) that on one side harmonizes the list of requirements between the NRENs, and on the other side shows a baseline of joint requirements to the vendors. This step resulted in a number of vendors applying for the self-assessment based of this document that shows their commitment toward community needs and lists that clearly in the now published GÉANT Cloud catalogue.

Following this achievement the team decided to move to the next step: to make a joint procurement for the cloud services. The first area of cloud services to be handled by the activity is Infrastructure as a Service (IaaS). Six of the NRENs are working specifically to do a European tender for IaaS services that will make the procurement of cloud services easier for institutions. Major international IaaS providers have been approached and have expressed their interest. Now the tender is in progress, and NRENs and universities can expect to benefit from the results in the summer/autumn of 2016.

During this year GÉANT Clouds team will continue work together with interested institutions and all major cloud vendors from Europe and beyond to prepare new services beyond IaaS tender. This approach opens possibility to work on to work on other services to provide direct discounted access for research and education users all across Europe without need to do formal procurements, but also to investigate which services are most attractive to our potential users on a larger scale and to prepare future procurements for those services.

The benefits of the joint approach are numerous, but one of the most important is the ability to share knowledge between members of the European NRENs family, which generally lacks experts in the procurement field. And the possibility to approach commercial vendors together already showed its strength, since it was already possible to achieve agreements that a single NREN or a smaller group of NRENs could not achieve. The work in that direction is continuing and it looks very promising.

3. AUTHORS' BIOGRAPHIES

Branko Radojević has worked as Deputy CEO at CARNet since 2005, and is leading the computer & data infrastructure team in CARNet. He has more than 20 years of experience in managing information systems in academic, research and education area. Since 2007 he gained a lot of international experience through the work in GÉANT 2, 3, 3plus and now in GÉANT 4. He is currently leading the Service delivery efforts that includes vendor management and cloud brokerage though the work in GÉANT 4.

Andres Staijert is a Program Manager at SURFnet since 2001, and a initiator and member of the SURFtaskforce Cloud where he coordinates and contributes to the SURF cloud first strategy and support higher education and research organizations in their joint adoption of the cloud. Since 2013 he is leading the GÉANT Cloud team with primary objective of ensuring that the research and higher education community in Europe is optimally positioned to benefit from cloud computing and cloud services. GÉANT Cloud team works on cloud strategy, standards, interoperability, cloud brokerage, vendor management and cloud integration.

Lars Fuglevaag has worked as Head of Communications at UNINETT since 2008, and is leading the team for communications and customer relations in the service department of UNINETT. He has close to 30 years' experience within marketing and communications in both the public and private sector. He has substantial international experience through the NORDUnet communications group, the TF-CPR task force and the GÉANT PR Network, and is currently work package leader for communications and NREN support in the GÉANT Clouds Activity (GN4 SA7 Task 4).

A brief overview of the Information System for Science and Higher Education in Poland

Jarosław Protasiewicz, Marek Michajłowicz, Mikołaj Szypke

National Information Processing Institute, Warsaw, Poland

Keywords
information system; higher education and science; decision support system

1. Summary
The article is aimed to introduce the Information System for Science and Higher Education in Poland briefly. The system acquires data concerning universities and research institutions, analyzes these data, and supports decision-making processes of governmental bodies.

2. INTRODUCTION
The Information System for Science and Higher Education (POL-on) is the integrated and centralized information system [1], which supports the Ministry of Science and Higher Education as well as other Ministries and institutions related to science and higher education. Its primary task is to create a global database of scientific institutions, universities, and Polish science. Collected information supports the decision-making processes. Moreover, some data stored in the system are publicly available. Although the system is designed only for Poland, the cooperation with other countries may be established. We have to note that there are interesting and well-grounded international initiatives concerning scientific data like the CERIF data model supported by Current Research Information System [2], Open Access Infrastructure for Research in Europe [3], Digital Repository Infrastructure Vision for European Research [4], etc. The paper is structured as follows: Section 3 briefly explains how the data are collected, Section 4 discusses the primary business processes, and Section 5 shows some technical details. Finally, conclusions are presented.

3. DATA ACQUISITION AND VALIDATION
The Polish universities and research units are obliged by the law to provide various information and store it in the central system, i.e. POL-on. The information concerns their educational and scientific activities, namely students, researchers and academic teachers, academic degrees and titles, faculties and studies, diploma theses, projects, patents, publications, conferences, awards, laboratories and their equipment, properties, investments, etc. The data can be transferred to the system by using tools of mass import or may be manually entered via the web interfaces. However, the automatic import is available only for limited kinds of data, mainly information regarding students and researchers. Regardless of the method data delivery, all records are validated according to the rules based on the law and the best practices.

4. BUSINESS PROCESSES
The system contains data regarding almost all Polish universities and research units as well as their students and researchers. These data are necessary for the government to manage the area of higher education and science properly. Among many business processes that the POL-on supports, there are several that are especially important. These are, namely:

- verification of the granting of financial aid to students;
- supporting the division of public grant;
- controlling the quality of higher education and particularly suitable employment structure of academics teachers and researchers;
- monitoring the careers of graduates by using the administrative data;
- sharing public data – a practical implementation of the policy of open data/ government;

- Implementation of remote processes of financial and statistical reporting;

- evaluation of scientific research institutes; plagiarism detection of diploma theses.

The POL-on system provides the greatest resources of public records in the Polish administration [5].

5. TECHNICAL ARCHITECTURE

The POL -one was developed using a three-tier client-server architecture. The data are stored in a database, a lightweight container of web applications processes the data, whereas a browser presents data and allows to send requests to an application server. The application is implemented in Java using Spring framework, Hibernate, and Java Server Faces. The system is composed of several modules, which are responsible for the realization of particular processes. Moreover, there are five cooperating systems, which are tightly coupled with the main system (Figure 1).

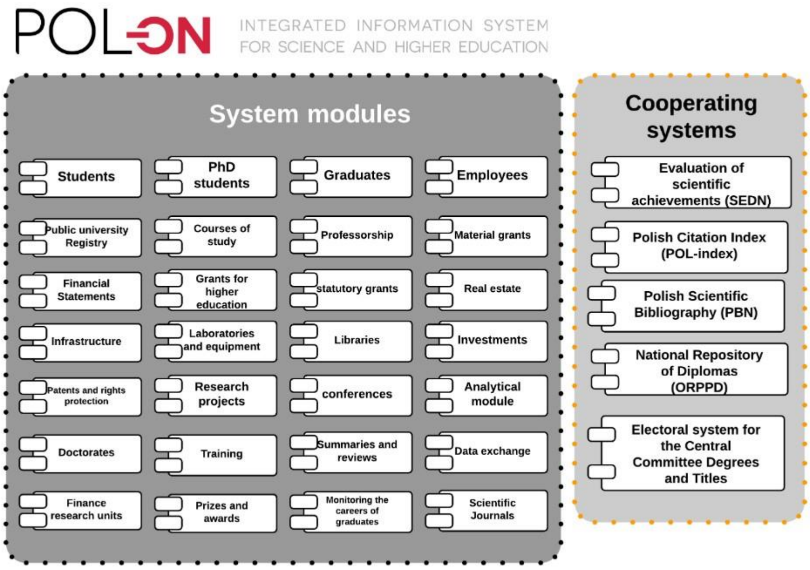


Figure 1. The architecture of the Information system for science and higher education (POL-on).

Current work is focused on design and implementation of RESTful API[6] to enable integration with IT systems of universities and research units. Currently over 20 microservices are deployed.

Further plans include API development and management[7] integration with other systems depicted on Figure 1 using Enterprise Service Bus and integration with National Service Bus (Krajowa Szyna Danych), a solution interchanging data between public domain's systems.

6. CONCLUSIONS

The project POL-on has been developed since 2011. Nowadays, it is the mature and fully deployed system; however, there are still ongoing modifications and improvements. The system significantly helped to manage the area of science and higher education in Poland. The further development may include integration with other Polish governmental systems as well as some European systems [2-4].

7. REFERENCES

[1] POL-on website (2015), https://polon.nauka.gov.pl

[2] euroCRIS website (2015), http://www.eurocris.org

[3] OpenAire website (2015), http://www.openaire.eu

[4] Driver website (2015), http://search.driver.research-infrastructures.eu

[5] https://danepubliczne.gov.pl/en

[6] Garriga M. et.al. (2015). RESTful service composition at a glance: A survey, *Journal of Network and Computer Applications, Volume 60, January 2016, Pages 32-53* [doi:10.1016/j.jnca.2015.11.020]

[7] Brajesh, D. Rajesh D. (2016) API Management, *Apress*

8. AUTHORS' BIOGRAPHIES

Jarosław Protasiewicz (Ph.D.) – he is an assistant professor at the National Information Processing Institute and the head of the Laboratory of Intelligent Systems. He received the Ph.D. degree in computer science at the Systems Research Institute of the Polish Academy of Sciences. His areas of interest include agile project management, software design and development, big data and map reduce, machine learning, bio-inspired algorithms. In the period 20112013 he was the project manager of the POL-on project.

E-mail: jaroslaw.protasiewicz@opi.org.pl

Marek Michajłowicz (MSc) – he received the Master degree in Sociology at Cardinal Stefan Wyszyński University in Warsaw and the Bachelor of Engineering (B.E.) in computer science at Warsaw School of Information Technology under the auspices of the Polish Academy of Sciences. He has several years of professional experience related to business and system analysis. Currently, he works as the project manager of the POL-on system in the National Information Processing Institute.

E-mail: marek.michajlowicz@opi.org.pl

Mikołaj Szypke (MSc) – Analyst/Designer at the National Information Processing Institute. He received the Master degree in computer science at Maria Curie-Skłodowska University in Lublin. He has over ten years of experience in system analysis and development. His professional interests are systems' integration and machine learning.

E-mail: mikolaj.szypke@opi.org.pl

Turning AUTh into e-University

Pinelopi Giovanitsa

Aristotle University of Thessaloniki, IT Center, PO Box 888, EL 54124,

pgiovani@it.auth.gr

Keywords learning management systems, moodle, blackboard, eclass

1. ABSTRACT

Among other universities, AUTh is nowadays facing the need to accommodate new technologies in its learning process. Therefore, AUTh uses learning platforms such as moodle, blackboard and eclass to provide its educators, students and administrators an integrated system to create personalized learning environments. Learners of our university and worldwide, have the ability to take courses entirely on-line through downloading the course material, chatting with the instructor, taking exams and watching the lectures on demand or in real time, only by using a web browser at home without any cost.

2. INTRODUCTION

In the mid-2000s, AUTh decided to use centra, eclass and blackboard as its main learning management systems. It was at 2010 when those systems were mature and the users of the university were really familiar with the idea of online learning. In 2013 due to the cost of the usage and the administration of those platforms, AUTh decided to turn into open source learning management systems and moodle was chosen as the best solution to merge all the courses in one platform. In fact, moodle was chosen as the main learning platform only for members of the university and alongside, for the project called “Open Courses”, eclass was chosen as the platform for all freely accessible and available to everyone institutes’ courses over the internet.

3. REPLACING BLACKBOARD WITH MOODLE

When the decision was made to move from blackboard to moodle, one of the main concerns for the two centers involved, IT and Central Library, was to limit the burden that the teachers or the students might experience while using this new learning management system. Therefore, 92 instructional meetings, took place from the staff of the Central Library, educating more than 1200 users, both teachers and students, to our new platform. Alongside, the same staff created and distributed 19 manuals with guiding tools and how-to questions to help the users of the university. It is important to mention that guiding the teachers and organizing new instructional meetings are daily duties of the Central Library staff.

The main issues, raised by users, that both centers had to answer, was the transition and the enrollment of the students in particular courses, the upload and the distribution of the course material, the creation of new courses and the use of the new tools that moodle offers. In general, our users did not experience much difficulties while using this new system. Most of the teachers have the experience to use that kind of platforms and there is also the support staff in both centers that they can always turn into. Respectively, our students are familiar with learning management systems and the do not put so much effort to learn how to use a new one. Furthermore, there are a lot of comments from students who want all of their teachers to participate in this central learning systems.

3.1 Issues and considerations behind the process

While choosing the moodle platform as the central management system, issues about the philosophy of the LMS, were raised. We had to take into consideration what tools our users want, what features they like and what data instructors need to guide and support student learning. Furthermore, the choice of compatible browsers, languages supported and active user community were very significant. In addition, we had to check what migration and conversion tools to use in order to eliminate the possibility to lose any course material that had to be created from scratch. Also, one of the main aspects we had to focus on, was the security provided from the LMS as far as online testing, plagiarism and grading were concerned. The technical aspects that we had to answer were the hardware, software, network and staff requirements, the features of backups provided and the storage capacity that was needed.

3.2 Taking with numbers and similar experiences

In 2014, prior the replacement of the commercial learning management system blackboard with the open source moodle, the number of users was nearly 50.000, the number of courses was 2.246, the cost of the license was approximately 70.000 euros and 4 people were needed to support the users and manage the platform.

Nowadays, moodle supports more than 54.448 users (among them 46.788 students and 1.260 teachers) and 4.340 courses. 3.714 of them are active and 32.048 students logged in the past six months to view the courses they participate in. The total amount of the courses in moodle comes from the old ones that were migrated from blackboard, the new ones that were asked to be created from scratch and the number of courses from all the independent platforms from various faculties who decided to get merged in the central learning management system. This merge, made the educational process much easier for the users as their need to participate in all of their courses from one placed was fulfilled. In addition, with the use of moodle there is no need for any licensing cost and 5 people work on the platform only at the 75% of their time.

In comparison with other universities or colleges that experienced the migration from blackboard to moodle, in Aristotle University of Thessaloniki six months were needed to complete the process. University of Dar-es-Salaam (UDSM) had 415 courses, with 73 of them active, and 19.528 users. It took two active years to migrate from blackboard to moodle. Beaufort Country Community College (BCCC) had 250 courses per semester with more than 1.000 users and needed two and a half years to migrate. University of Alberta had 15.000 courses, 8.400 academic and faculty staff, 6.500 support staff, 51.900 users and seven years were needed to fully migrate from one LMS to the other.

4. ECLASS ONLY FOR OPEN COURSES

As mentioned before, IT center uses the open source platform called “eClass” for hosting its open courses. There are 385 courses with 279 of them available for anyone around the globe, 189 teachers and approximately 21.383 learners. There is no cost in using the platform and only 2 people are needed to support the users and manage the system.

5. CONCLUSION

There is no doubt that turning AUTh into an e-university has many benefits. It is not only the cost that was decreased but also the administration and management time that is now spent. AUTh community has understood the significance of elearning and Information Technology Center is adopting all the new techniques to provide this service worldwide.

6. REFERENCES

Μιχάλης Γερόλιμος, Νίκη Καλιακούδα, Τάνια Κάργα, Δέσποινα Παπαδάκη (2015), «*Από το Blackboard στο elearning: η εμπειρία της Υπηρεσίας Ηλεκτρονικών Μαθημάτων της ΒΚΠ*».

IT Center (2015), *"Survey about the services provided by IT Center for all the users of the university"*.

Nadjia Soldatic (2014), "Migration from BB to Moodle", https://prezi.com/sz99wvi99qnc/migrationfrom-bb-to-moodle/

7. AUTHORS' BIOGRAPHY

Pinelopi Giovanitsa https://gr.linkedin.com/in/pinelopi-giovanitsa-914034a6

EUNIS 2016: Creating Virtual Learning Environment for Higher Education Institutions

Zvonko Martinović, Sandra Kučina Softić, Vedran Mušica

University of Zagreb, University Computing Centre, Croatia, zvonko.martinovic@srce.hr University of Zagreb, University Computing Centre, Croatia, sskucina@srce.hr
University of Zagreb, University Computing Centre, Croatia, vedran.musica@srce.hr

Keywords
VLE, Moodle, Mahara, Adobe Connect, IT infrastructure, user support.

INTRODUCTION

University of Zagreb, University Computing Centre (SRCE) has a central role in the systematic implementation of e-learning not only at the University of Zagreb but also at other higher education institutions in the Republic of Croatia.

Providing a stable and rich Virtual Learning Environment (VLE) for a large number of teachers and students is an extensive and challenging task. The process of setting up and maintaining a VLE consists out of three important components: software, infrastructure and user support. Each of these components is essential for a smooth running system and providing good user experience.

In this paper we will present our experience in building and maintaining a VLE at the University of Zagreb, University Computing Centre SRCE since 2007.

THE E-LEARNING CENTRE AT SRCE

The E-learning Centre (ELC) was established at the University of Zagreb, University Computing Centre in 2007 and today is a focal point for systematic take-up and supporting e-learning across the higher education institutions in Croatia. Some of the activities that the Centre engages in are supporting teachers and students in use of e-learning technologies, cooperating with and supporting local elearning teams and groups, ensuring a generally accessible e-learning platform (LMS/VLE), maintaining a network (of professionals, teachers and students) for sharing knowledge and experience in e-learning but also promoting the use of new technologies in education. Creating a positive environment and raising awareness of e-learning within the academic community is one of the priorities as well.

Within the Centre, we try to provide a multidisciplinary support and recognize specific needs of our users. For that reason the team consists of people with a wide variety of skills such as software development, instructional design, pedagogy, graphical design etc.

VLE MERLIN - SOFTWARE

Throughout the years, Moodle has established itself as the leading open source Learning Management System in education. It is widely used in higher education around the world and provides a reliable system that brings new features and improvements with every new version. Also, since Moodle is open source software with large community, number of great extension plugins and good online user and developers documentation. These were some of the main reasons why Centre chose Moodle for the LMS as well. The first installation was made in 2007 and has been continuously upgraded and developed since then. The present installation translated is in Croatian language, with number of adjustments and improvements made by the Centre team based on the needs and requirements of the teachers. The e-learning platform, together with e-portfolio system, system for webinars and connection with Information system of Higher Education Institutions (ISVU) builds the VLE for Higher Education Institutions.

Providing a sustainable and easily accessible VLE for over 40 higher education institutions (universities, faculties, polytechnics and professional schools) requires a system that will satisfy very diverse needs. Currently, the VLE Merlin hosts over 4,700 e-courses, used by over 2,100 teachers and 28,000 students in the current academic year, with over 12,200 archived e-courses and over 75,200 users in total.

Moodle version 2.9 has been installed for the academic year 2015/2016 and it provides users with modern and contemporary LMS. Installation of additional modules, development of new ones as well as modification of existing code enables fitting Moodle to the specific user needs. Integration of Moodle with Mahara (e-portfolio system) extends the e-learning environment with a tool for student-centred learning. The e-portfolio system can be used as a single tool or in conjunction with Moodle enabling an export of data or grading students' e-portfolios as an assignment. Real-time communication with rich presentation and meeting control features is provided through webinar system based on Adobe Connect. Version 9.4, which is presently hosted, enables customization and integration with Moodle. Integrated and extended systems can enable a different kind of e-learning and comply with the specific teacher/student needs. VLE can be used for blended learning courses or organization of the fully online studies.

The VLE at SRCE is titled Merlin (http://merlin.srce.hr) and is connected with other information systems like ISVU and MojOblak (remote storage system based on ownCloud) further extending system usability. All systems are accessible using Single Sign-On (SSO) for authentication and authorization through AAI@EduHr infrastructure. AAI@EduHr is the Authentication and Authorization Infrastructure of science and higher education in Croatia. Technically, AAI@EduHr is a hub-and-spoke federation with centralized login service. Each Identity provider (institution) maintains its own LDAP directory and related IdM software. For SSO implementation at AAI@EduHr Security Assertion Markup Language (SAML) 2.0 is used.

Since study programmes in Croatia usually last for five years, Merlin is organized in such a way to enable students to access their courses throughout their entire study. For each academic year, a separate Moodle installation is used. Teaching and classes are organized within the Merlin system for the current academic year, while previous courses are archived and still accessible for teachers and students.

Integration with ISVU is very important as it provides significant benefits in organization of e-courses but also in management of teachers and students. It is possible to open courses on Merlin directly from ISVU as well as enrol and synchronize students and teachers and divide students into groups. Moodle by itself provides great features with integration with many remote storage systems like Google Drive, Dropbox etc. but to use these systems, users need to create new accounts. Also, storing learning materials or sensitive research data on remote systems always involve security issues. Having that in mind, SRCE established the service titled MojOblak which provides a large storage space (100GB for employees and 20GB for students) to all academic members (researchers, teachers and students). MojOblak is available within Moodle as any other repository and is accessed using SSO.

With the increased use of mobile devices and importance of timely notifications from the systems, Moodle Mobile capabilities are used. Customized application called Merlin Mobile is available for users with Android mobile devices enabling receiving of nearly instant push notifications. Using Merlin Mobile application it is possible to access online courses using a smartphone, participate in many activates and send or receive messages and notifications.

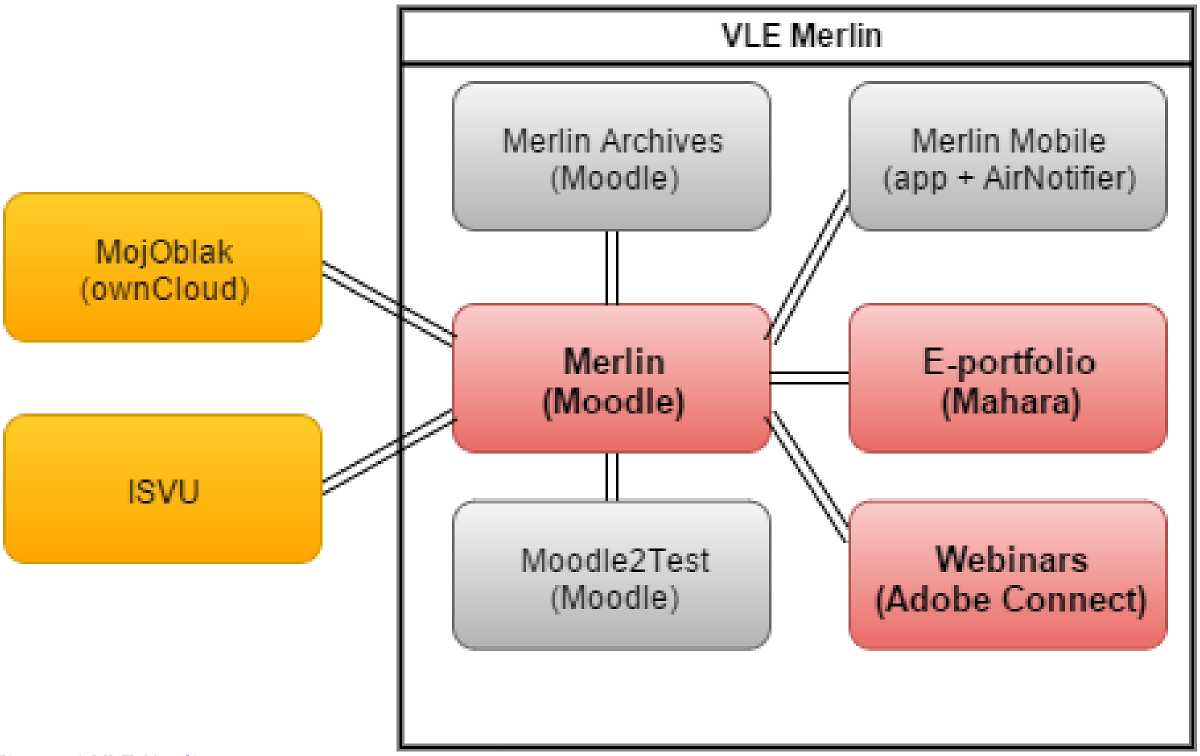


Figure 1 VLE Merlin

VLE MERLIN - INFRASTRUCTURE

To ensure efficient work of the system, it must be set up on good foundations. Computer infrastructure should have high performance to support a large amount of users at any task they might be performing. For VLEs such as Merlin, which is used in higher education in Croatia, it is crucial that the system is available to users 365/24/7. It is important to ensure availability and accessibility of the system at any time and from anywhere. Students should be able to access their learning materials or participate in the scheduled activities whenever they need without any restrictions. Teachers should be able to access their e-courses in order to prepare new learning materials, set new tasks for students, to evaluate their work and to communicate with students at the time they prefer. An important issue is also reliability of data as every piece of data (like exam results) needs to be stored and available at any time. Scheduled backups are essential for data recovery purposes. For this purpose, each server is backed up on daily basis as well as the user data and databases. As mentioned previously, online courses on Merlin are available for five academic years. The older courses are backed up on tapes and can be easily restored if needed.

All servers at the SRCE run on hypervisor. Virtualization systems provide hardware fault tolerance as servers can be migrated to a different host as needed but also provide high performance as computer resources are allotted where and when needed. Multiple servers organized in clusters and accessed through load balancer provide high performance through distribution of load evenly on all servers in the cluster, but also high availability, as the system will continue to work as long as there is still at least one active node in the cluster.

VLE Merlin is organized on two separate clusters as different technologies are used. Open source systems like Moodle and Mahara are installed on CentOS Linux systems. Six web servers running Apache+PHP are available to users through HaProxy load balancer that is installed of two separate physical machines running FreeBSD. Two machines are used to eliminate single point of failure. On one web server cron jobs are enabled performing different scheduled tasks in Moodle and Mahara. PostgreSQL is used as a relational database management system and is set up on two servers in masterslave configuration using Streaming replication. NSF provides shared storage for all web servers is installed on primary database server. VLE Merlin also uses two additional servers - VPL server and AirNotifer server. The VPL server enables compilation and execution of programming code through

Moodle activity and AirNotifier provides push notification to Merlin Mobile application. On a daily basis, VLE Merlin is uses by over 8.000 unique users with peek average of over 200 concurrent users. Infrastructure can provide sufficient performance for over 700 users simultaneously taking exams in Moodle with no significant performance degradation.

Since Adobe Connect is Windows application, additional cluster is organized to provide webinar system to the users.

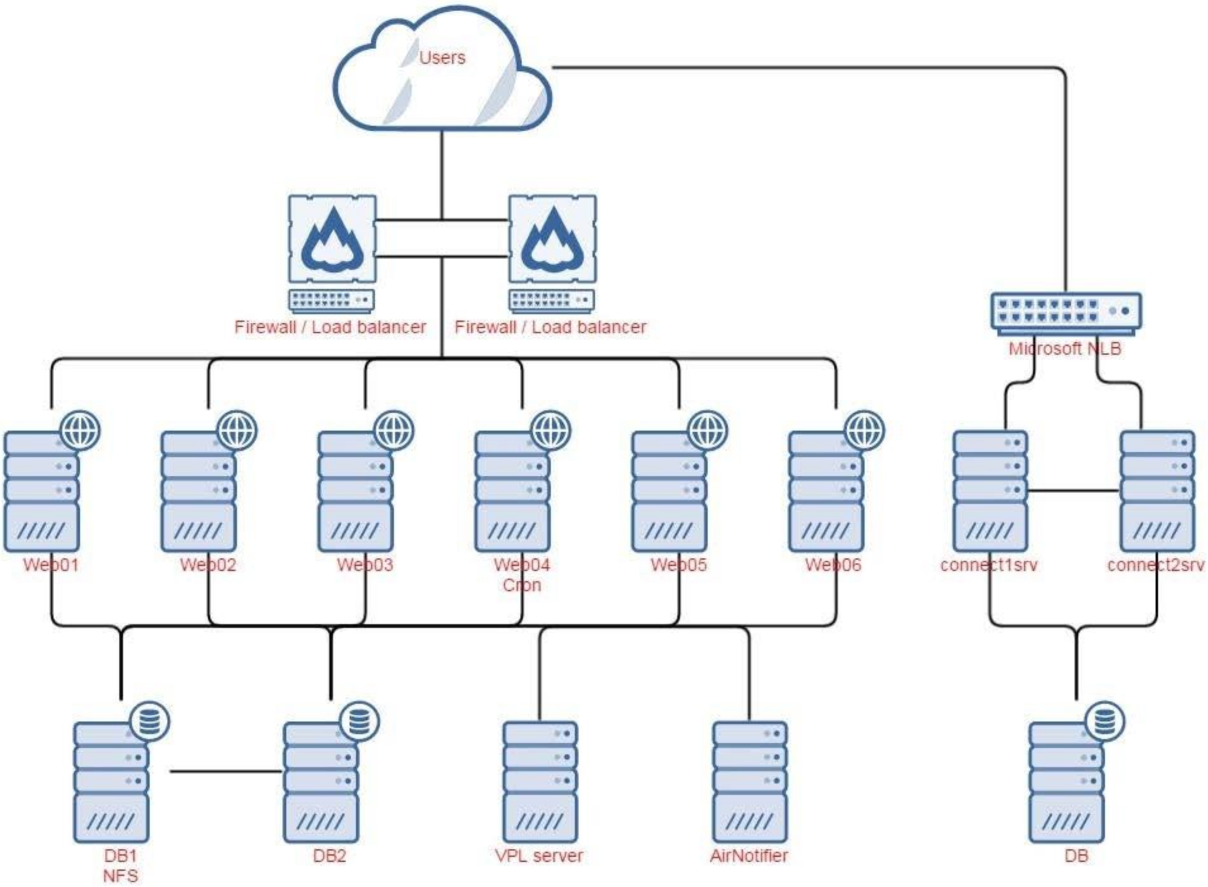


Figure 2 VLE Merlin infrastructure

USER SUPPORT

The use of e-learning technologies is much easier with organized and sustainable support and teachers and students are less reluctant to try them. The Centre has organized helpdesk and consultations, prepared user manuals, animations and training courses (online and face-to-face) in order to ensure that every user gets the most appropriate way of support they need.

The installation of new software versions requires all materials to be up-to-date and verified for new systems.

All user materials are regularly updated and prepared to match the actual version of the software (LMS, e-portfolio, webinars…). The Centre maintains a number of user manuals for all embedded systems as well as a number of short flyers, instructions, FAQs and animations on software usage topics.

Choosing the right tool for the task is probably the most important aspect of teaching because the quality of the final result depends on it. Using e-learning technologies and tools just for the sake of using them will have negative effect on students and their learning experience. The E-learning should support learning process and enrich it so using the right tools the right way is very important. A great effort is made at SRCE to train and support teachers to use e-learning technologies. The Centre is very active in organizing events, workshops and lectures in order to disseminate information about elearning and raise teachers' awareness on advantages of e-learning and available support.

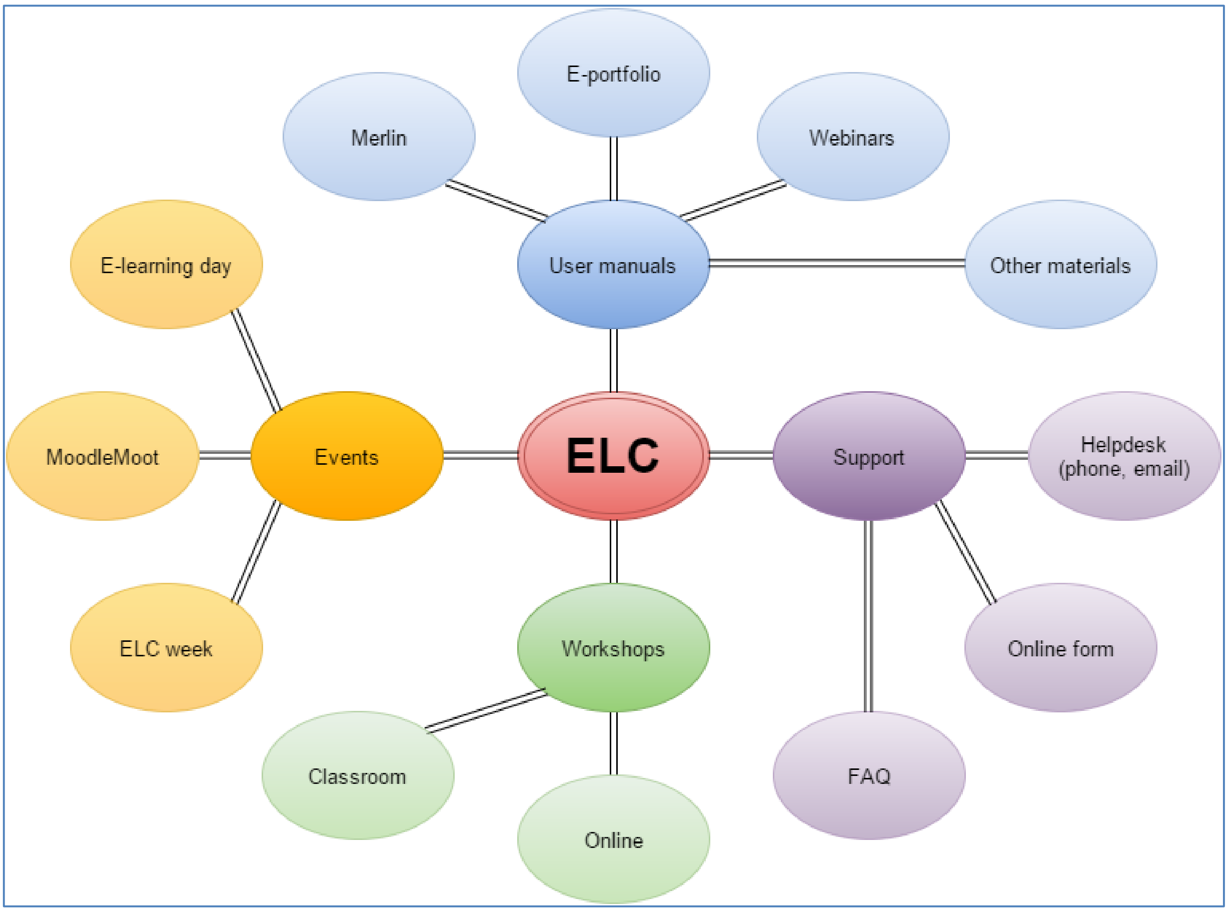


Figure 3 User support at the E-learning Centre (ELC) at SRCE

CONCLUSION

Implementation of ICT and e-learning technologies in teaching and learning process in higher education has become a standard component. But as courses multiply, institutions have to face the issue of providing a good, sustainable support resources to address this issue. Adequate and reliable technical infrastructure to support learning activities is of great importance. Even if using open source software can reduce virtual learning environment implementation costs, maintenance, development and user support will require funds, not only for hardware infrastructure but also for user support. At SRCE, VLE Merlin is considered a vital infrastructure so significant effort is made in all aspects of maintaining and improving it.

Many tasks are still being made to further enhance all aspects of VLE mentioned in this paper. Creating new workshops and learning materials provide better support for growing number of users. Keeping track with new software versions and upgrades is a continuous work as well as upgrading infrastructure. The special emphasis is given to eliminating single points of failure and this process will continue in the future. Current plans for infrastructure improvements involve implementation of database connection pooling, load balancing and automatic failover. Also, by distributing IT resources on two different remote locations, disaster avoidance and/or recovery can be implemented. In this aspect the SRCE has established a second computing location and it is planned that VLE Merlin takes the full advantage of this new infrastructure this year.

REFERENCES

Bekić, Z. & Kučina Softić, S. (2006). Proceedings of the EQIBELT Workshops. University of Zagreb, University Computing Centre, Croatia.

Kučina Softić, S. (2010), Enhancing E-learning Implementation with Organized E-learning Support, EDEN Annual Conference 2010, Valencia, Spain

SRCE website (2016). *Srce: E-learning Centre*. Retrieved February 26, 2016, from: http://www.srce.unizg.hr/en/elc/.

VLE Merlin homepage (2016). *Merlin 2015/2016*. Retrieved February 26, 2016, from: http://merlin.srce.hr/.

E-portfolio system homepage (2016). *Početna stranica - e-portfolio*. Retrieved February 26, 2016, from: https://moodle.srce.hr/eportfolio/.

Webinar system homepage (2016). *Sustav za webinare*. Retrieved February 26, 2016, from: https://connect.srce.hr/.

Moodle website (2016). *Moodle - Open-source learning platform | Moodle.org*. Retrieved February 26, 2016, from: https://moodle.org/.

Mahara website (2016). *Home - Mahara ePortfolio System*. Retrieved February 26, 2016, from: https://mahara.org/.

Adobe website (2016). *Webinar software solution and services | Adobe Connect Webinars*. Retrieved February 26, 2016, from: http://www.adobe.com/products/adobeconnect/webinars.html.

AUTHORS' BIOGRAPHIES

First Author

Zvonko Martinović, M.Edu., Computer Science and Pedagogy Head of unit at University of Zagreb University Computing Centre Zvonko Martinović is currently a head of unit at University of Zagreb, University Computing Centre SRCE. Zvonko has worked at SRCE for 7 years. Within his role he is responsible for administration, maintenance and development of e-learning systems at SRCE. Zvonko has expertise in software development and is involved in development and integration of e-learning systems. Previously Zvonko worked at Valicon d.o.o. as software developer.

Zvonko graduated at the University of Rijeka, Faculty of Humanities and Social Sciences.

Second Author

Sandra Kucina Softic is the Assistant Director for the Training and User Support at the University Computing Centre SRCE. She is also Head of the E-Learning Centre at the University Computing Centre of the University of Zagreb and the Office for E-Learning at the University of Zagreb, central support units for the implementation of e-learning in higher education. She works on e-learning promotion and implementation at the University of Zagreb, monitoring and coordination of the implementation and providing support as well as advising institutions, teachers and students in implementation of new technologies in learning and teaching processes.

In 2011 she received the Rector's award for successful and motivated work on the development and systematic implementation of e-learning at the University of Zagreb.

In 2013 she was elected the EDEN Executive Committee member and in 2014 she received EDEN Fellow Award.

In 2014 she finished a Master's Programme in Digital Education at the University of Edinburgh, UK.

Third Author

Vedran Mušica, bacc. ing. techn. inf., Computer Science Moodle Administrator

Vedran Mušica is currently Moodle Administrator and developer at University of Zagreb, University Computing Centre SRCE, and works at SRCE for last 8 years. He is part of CEU team and is responsible for administration, maintenance and development of Moodle systems at SRCE.

Vedran has expertise in software development and works as a part of the team for development of e-learning systems. Previously Vedran worked at Večernji list d.d. as journalist, webmaster and web developer.

Vedran graduated at Veleučilište Velika Gorica.

Bestr: Open Badges and SIS to empower Lifelong & Lifewide Learning

Matteo Bertazzo[1], Chiara Carlino[2], Federico Giacanelli[3], Simone Ravaioli[4]

[1] Cineca, via Magnanelli 6, Casalecchio di Reno (BO) Italy, m.bertazzo@cineca.it

[2] Kion, via Magnanelli 2, Casalecchio di Reno (BO) Italy, c.carlino@kion.it

[3] Cineca, via Magnanelli 6, Casalecchio di Reno (BO) Italy, f.giacanelli@cineca.it

[4] Kion, via Magnanelli 2, Casalecchio di Reno (BO) Italy, s.ravaioli@kion.it

Keywords

Open Badges, Lifelong Learning, Non-formal Learning, skills, Student Information System, credentialing, recognition.

1. Summary

Everybody is a learner, everybody learns all the time. University students also learn outside university. How can technology help turning the nowadays need for constant learning into growth opportunities – for learners, for universities and for the job market? Bestr is a web-based platform, leveraging Open Badges to valorize Lifelong & Lifewide learning. Integrated with the Student Information System and as open as Open Badges are, it aims at bridging the gap between learning inside and outside university, between learning and working, between working and living.

This paper presents the brand new integration between Bestr and ESSE3 – the Student Information System used by 80% of Italian universities –, and how this lets universities recognize informal learning in their formal paths, maintaining the full control over the quality of such learning experiences and their value according to the student's path inside university.

2. OPEN BADGES TO VALORIZE SKILLS

Lifelong learning is not a pretty slogan anymore: it has become mandatory for every professional to keep growing, to build his/her own unique professional path, capable to keep pace with the ever changing requirements of the job market. The large amount and immediate availability of learning resources online have also made even more common for learning to take place everywhere – especially outside learning-dedicated environments: reading articles, watching videos, engaging in specialized communities. All this learning is a learner's valuable asset, but misses to be properly recognized as it doesn't include an official certification.

On the other hand, employers are eager to find people with specific skills – especially soft skills, which are not usually part of a formal curriculum studiorum: McKinsey's data about skills gap and skills perception is quite significant and prompts all players (learners, employer, learning providers, assessment providers, public administrations) in taking a step towards bridging the (perceived) skills gap and taking into account EU's recommendation on the validation of non-formal and informal learning.

2.1. Bestr

Bestr is a web platform where skills are represented as Open Badges: any organization can issue Badges through Bestr, provided that it carefully describes the skills, achievements or membership the Badge represents, and the criteria used to assign it to a learner. This means that every experience can be valorized: an internship, a language course, a volunteering activity, a hobby – as long as an organization is defining and verifying it in a clear fashion, it can become a Badge, and a learner can claim it.

Once made visible through Badges, skills become real: learners decide to get them, so they can expose them in ePortfolios and digital resumée; companies and organizations can endorse them, learning providers can suggest learning paths to gain them, assessment providers can verify them. These are the actions allowed and encouraged by the Bestr platform.

Through Open Badges, Bestr aims at giving visibility to all skills: the ones desired by companies, the ones owned by learners and the ones developed by learning providers.

3. ENDORSEMENT TO RECOGNIZE VALUE

The “openness” of Open Badges has become even more effective with the release of the *endorsement* extension in Open Badges Specifications v1.1 in May 2015: with endorsement external organizations – i.e. organizations not involved in the process of designing, assessing, or issuing a Badge – can express their endorsement for a given Badge, at any point of the Badge’s life. Endorsement thus becomes the way of expressing the broader trust network that crystallizes around a given skill - aka Badge – and gest to play a big part in the process of adding value to the Badge: the Badge value is now defined by the trust and value recognized to the issuing organization plus the trust and value recognized to the endorsing organizations.

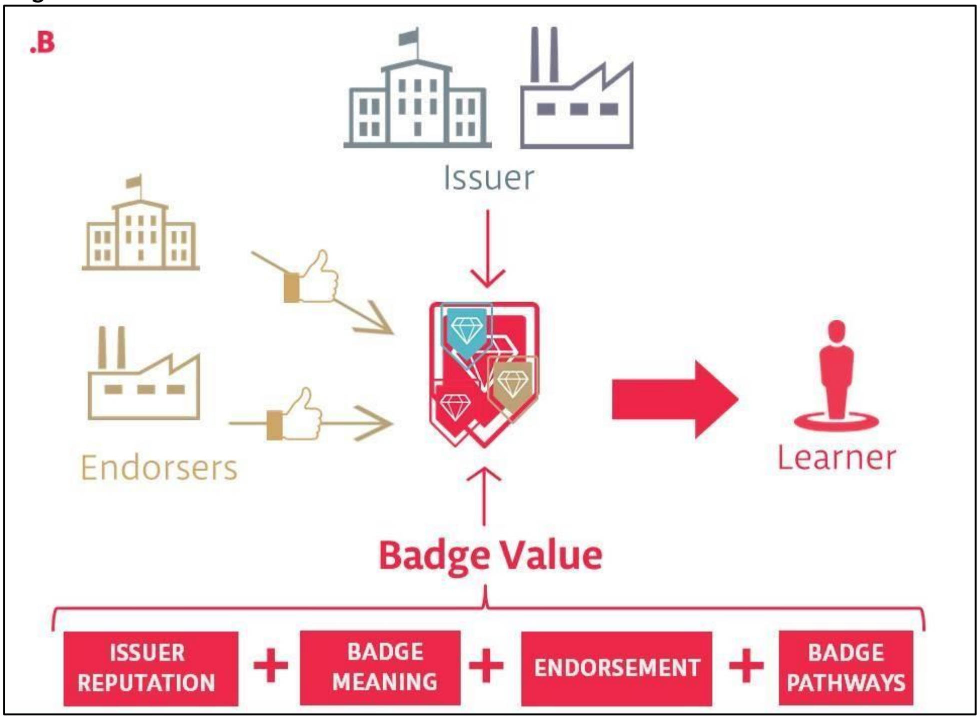


Figure 1

4. FROM OPEN BADGES TO CREDITS: INTEGRATION WITH SIS

For the learner, a Badge endorsed by an employer might mean more chances to get a job, and a Badge endorsed by a learning institution might mean a chance to have his/her learning recognized within a formal learning path.

So, Open Badge endorsing – if properly integrated within Student Information System - could also be a shortcut for Universities to digitize the recognition of non formal and informal learning – whether it happened inside or outside university – into credits or admission points, and include it in the Diploma Supplement.

By interacting directly with the Student Information System used by 80% of Italian universities (ESSE3), Bestr encourages this process and provides universities with digital automation tools capable of allowing a quick and paperless recognition of non-formal learning activities, while still maintaining the control over what gets recognized, keeping up to the high standards typical of a university and making sure that recognition happens coherently with each student’s course of study.

4.1. Bestr and ESSE3: how it works

The endorsement of a Badge is a completely free operation for a University on Bestr: through endorsement, the university expresses a positive approach towards the Badge, and this can also be publicly motivated with a brief statement. ESSE3 allows the operator in the university administration to view all the Bestr Badges recognized as valid by that University, including Badges issued by the University and those which have its endorsement. For each Badge, the University can establish whether any, or how many, credits may be recognized for students who hold them, depending on their degree course and didactic activities.

Through ESSE3, a university can view which of its students have – on Bestr – obtained the Badges it approves. In accordance with rules laid down for each degree course and didactic activity, credits are recognized for students holding the Badges. For example, a student who holds a badge corresponding to an active educational experience, relevant to his degree course and supported by a final examination of a standard which has been checked in advance by the University and confirmed with an endorsement, may have the whole of that didactic activity recognised. For the same Badge, but for a student following a degree course that is less relevant, recognition may still be conferred as extra-curricular didactic activity, potentially as an extra amount, for which credits, area, type of activity and discipline will be defined.

5. CONCLUSIONS

With this implementation, Cineca's aim is to provide Universities with a digital instrument to implement rapidly, and in an innovative way, something that is already a long established idea of university teaching: recognizing the value of a language certificate obtained through an experience abroad, or an internship that has developed competencies that are complementary to a degree course, and so on. The disruptive element does not lie just on the technological side, making recognition easier, faster and more transparent for all the operators, but also in the fact that, by making use of Open Badges, recognition can be activated for competencies that, until a very short time ago, were not identified in a sufficiently structured way to be taken into consideration by a University.

The integration between Bestr and ESSE3 has been released in April 2016; the first universities involved are the University of Milano Bicocca and the members of EduOpen Network, a new Italian MOOC platform providing Open Badges through Bestr as attendance certificates for its courses.

6. REFERENCES

McKinsey (2013), http://www.mckinsey.com/client_service/public_sector/mckinsey_center_for_government/education_to_employment

European Council Recommendation of 20 December 2012 on the validation of non-formal and informal learning, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2012:398:0001:0005:EN:PDF

Open Badges Specifications, https://openbadgespec.org/

Bestr, https://bestr.it/

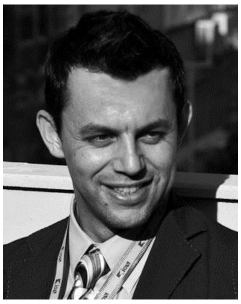
Eduopen, http://eduopen.org/en/

7. AUTHORS' BIOGRAPHIES

Matteo Bertazzo holds a Master Degree in Computer Science from Ca' Foscari University of Venice, Italy. After a research fellowship in Location-based Services from the National Research Council he works as web developer and technical project manager. He currently works as Solution Designer and PMP® certified Project Manager at CINECA InterUniversity Consortium. He has been involved in a number of Education and Digital Humanities projects, both for the consortium's members and for EU-funded projects. He currently leads the development of Bestr, the Italian Open Badge platform. See Linkedin profile at https://www.linkedin.com/in/mbertazz

Chiara Carlino takes care of the online and offline communication for the Bestr project, as well as for Kion and its offer. With a literary background and a bachelor in Philosophy (2005), she works at the intersection between humans and technologies: from semantic web to digital communication, from web analysis and monitoring to user interfaces, from functional requirements to technological applications capable of changing social interactions - such as Open Badges. Chiara already presented at Eunis 2010 (Warsaw) and 2011 (Dublin), and is co-organizer of the 14th Epic Conference (http://openepic.eu). See Linkedin profile at https://it.linkedin.com/in/carlinochiara

Federico Giacanelli fell in love with Physics first, getting a Master Degree in Theoretical Physics from the University of Bologna (1993) then a Physics PhD from the University of Torino (1998). He then fell in love with the Internet and the Web, dedicating the rest of his life to networking administration, Multimedia and streaming services, Ontology based portals, Blogs and CMSs at CINECA InterUniversity Consortium. He loves exploring digital human interactions so he works on web application design, from gathering functional requirements to UX design. He is currently responsible for Bestr UX development. See Linkedin profile at https://it.linkedin.com/in/fedgiaca



Born and raised in Italy, **Simone Ravaioli** holds a Bachelor and Masters Degree in Management Information System from Loyola University Chicago.

After a corporate experience in the US he returns to Italy in 2006 through CINECA, the leading consortium of Italian Universities dedicated to developing software for HE. He currently holds the position of International Affairs Manager and Country Manager Turkey. Simone is founding member of RS3G - an international group of HE implementers focusing on data exchange standards. He also represents RS3G in the European Standardization Committee (CEN). In 2010 he is appointed Chair of the first EAIE Task Force called DSDP - Digital Student Data Portability. In 2014 the epiphany with Open Badges turned him into the Chief Dreamer of Bestr, the first Italian badging platform and with that a deep involvement with the international community. Simone is a Slow Food activist and considers himself a "FreeMover" and a Conversation Instigator.

Next-Generation Digital Learning Environments: Closer Than You Think!

Bruce Maas[1], Rob Abel[2], Jack Suess[3], John O'Brien[4]

[1]Univ. of Wisconsin, Division of IT, Madison Wisconsin, Bruce.Maas@wisc.edu
[2]IMSglobal, 801 International Drive, Lake Mercy Florida 32746, rabel@imsglobal.org
[3]University of Maryland Baltimore County, Division of IT, Baltimore Md. 21250, Jack@umbc.edu [4]EDUCUASE, 282 Century Plaza, Louisville Co. 80027, jobrien@educause.edu

Keywords
NGDLE, Unizin, personalization, interoperability, accessibility, caliper, analytics.

1. Summary

EDUCAUSE, with support of the Bill and Melinda Gates Foundation, ran focus groups in 2014 looking at digital learning environments and what was missing that would allow them to better support teaching and learning. What came out of these discussions has been named next-generation digital learning environments (NGDLE). This abstract and the accompanying session will focus on what the essential requirements are for NGDLE and give an update on one consortium of universities, named Unizin, that is working to implement and deploy an advanced digital learning environment.

2. Introduction

The web-based learning management system (LMS) was first introduced approximately twenty years ago. The EDUCAUSE Center for Applied Research, in a study on faculty and student usage of technology, found that 85 percent of faculty and 83 percent of student use the LMS regularly[1]. As a mainstream educational technology service, few technology products have so quickly reached this level of adoption. Despite this high adoption rate, just 41% of faculty that were surveyed report using the LMS to promote interaction outside the classroom.[2]

In the report "The Next Generation Digital Learning Environment,"[3] it was noted that the LMS has been highly successful in *enabling* the *administration of learning* but less so at enabling learning itself. In addition, the design of most LMS products has been course- and instructor-centric and not designed for students to create customizable pathways.

In 2013, Jack Suess, Malcolm Brown, and Rob Abel wrote an *EDUCAUSE Review* article titled "A New Architecture for Learning."[4] They proposed that today's learner is in a position to integrate a wide array of personal connections, resources, and collaborations – both local to and external to the institution – in order to construct the pathways needed to meet personal educational goals. They noted that many refer to this type of learning as connected learning. Similarly, instructors have an unprecedented number of options for how they design and execute a course.

The authors note that as the LMS became more essential to *course administration*, IT organizations develop a production mindset to the operation of the LMS and don't encourage adoption of innovative new products without months of testing. As a result, there is little incentive to explore new applications and services, let alone encourage personalization. The result is that this productionmentality often serves as an impediment to academic innovation by faculty.

3. Next-Generation Digital Learning Environment (NGDLE)

The NGDLE report[5] describes an environment that doesn't replace the LMS, but augments it, to focus on five dimensions of core functionality: (1)interoperability and integration;

(2)personalization; (3) analytics, advising, and learning assessment; (4) collaboration; and (5) accessibility and universal design. The report notes that some dimensions are further along and better defined; however, all five must be built out to meet the vision.

The report encourages our higher education community to envision the NGDLE as something akin to a *Lego Set*. They note two benefits from this approach, if we standardize how the pieces fit together, then we can build this over time and leverage many parts available today. Second, this approach readily allows for personalization.

4. Interoperability and Integration

Interoperability is the lynchpin of the NGDLE. As noted in the report, much of the proposed plans is built from standards developed by IMS. IMS was founded in 1995, as a project within the National Learning Infrastructure Initiative of EDUCOM (now EDUCAUSE). In 1999, IMS became an independent organization with a mission to advance technology that can affordably scale and improve education participation and attainment. IMS now has 350 members (55 from higher education) that participate in activities around standards creation, innovative use of technology, and the large-scale deployment to achieve learning impact.

IMS has four major efforts that align closely with the NGDLE, these include: accessibility – the IMS standard Access for All[6]; analytics – the IMS Caliper Analytics standard[7]; interoperability – the IMS LTI2 standard[8]; and collaboration and personalization – the IMS Community App Sharing Architecture (CASA) project[9].

5. Unizin Project

Unizin is a consortium of twenty-two higher-education institutions, educating over 700,000 students, that is facilitating the transition toward collaborative digital education with the goal to improve learner success. Founded in 2014, their mission is to improve the learning experience by providing an environment built on collaboration, data, standards, and scale.

Unizin leverages standards and has focused heavily on creating NGDLE *Lego blocks* in the areas of collaboration; analytics, advising, and learning assessment; and interoperability and integration. Examples of these projects include content tools for eText and course design, analytics tool, and support tools for faculty and staff.

6. Summary

Through work such as the NGDLE, higher education is creating a shared vision for the creation of connected-learning environments that focus on personalized learning. These environments are critical for using technology to affordably scale and improve education. While there has been much work in collaborative research between Europe and the United States, this has been less so when it comes to educational tools. We hope that through our session we will begin a dialogue that can help both regions work closely together towards our common goals of improving education.

7. References

[1] Eden Dahlstrom and Jacqueline Bichsel, ECAR Study of Undergraduate Students and Information Technology, 2014, research report (Louisville, CO: ECAR, October 2014).

[2] Eden Dahlstrom, D. Christopher Brooks, and Jacqueline Bichsel, The Current Ecosystem of Learning Management Systems in Higher Education: Student, Faculty, and IT Perspectives, research report (Louisville, CO: ECAR, September 2014).

[3] Malcolm Brown, Joanne Dehoney, Nancy Millichap, The Next Generation Digital Learning Environment, research report (Louisville, CO: ELI, April 2015).

[4] Rob Abel, Malcolm Brown, and John Suess, “A New Architecture for Learning,” *EDUCAUSE Review* 48, no. 5 (September/October 2013), http://er.educause.edu/articles/2013/10/a-new-architecturefor-learning.

[5] Brown, Dehoney, Millichap, The Next Generation Digital Learning Environment
[6] https://www.imsglobal.org/activity/accessibility
[7] https://www.imsglobal.org/activity/caliperram
[8] https://www.imsglobal.org/lti-v2-introduction
[9] https://www.imsglobal.org/activity/community-app-sharing-architecture-casa

<table>
<tr><td></td><td>Bruce Maas is the Vice Provost for Information Technology and CIO at the University of Wisconsin-Madison, a position he has held since August of 2011. He has served the University of Wisconsin System in a diversity of roles over a career of more than 38 years

Bruce has served as the Director and a faculty member of the EDUCAUSE Leadership Institute, and as chair of the EDUCAUSE Midwest Regional Conference. He is serving a 4 year term on the EDUCAUSE Board from 2012 to 2016, and is currently the Board Chair after serving as Treasurer for 2 years. He is also a member of the Internet2 Program and Priorities Committee, External Relations PAG, Co-Chair of the 2016 Internet2 Global Summit Planning Committee, and is the co-PI for two NSF infrastructure grants. In addition, Bruce is a member of the Board of Directors of Unizin and is serving a three year term on the Board of Directors of IMS Global.</td></tr>
<tr><td></td><td>Rob Abel is an education industry leader focused on the role of technology in enabling transformation to new educational models. In February 2006 he was appointed Chief Executive Officer of the IMS Global Learning Consortium, a non-profit organization that provides advocacy for advancement of technology to improve access, affordability and quality of education worldwide. IMS is also a leading technical standards setting body in the global education and learning segment. IMS has grown over 4x and created the annual Learning Impact program under Rob's leadership.

Rob also previously founded the Alliance for Higher Education Competitiveness to research best practices that enable transformation. He was previously Senior Vice President of Client Services and Chief Marketing

Officer at Collegis (later Sungard Higher Education and Ellucian). Prior to his work at Collegis Rob was Senior Director of Online Learning products and serrvices at Oracle. Rob spent 20 years as a leader in the silicon valley high tech segment. He has degrees from Fielding Graduate University, Stanford University, USC and Carnegie-Mellon University.</td></tr>
<tr><td></td><td>Mr. John "Jack" Suess is Vice President of Information Technology and Chief Information Officer (CIO) for the University of Maryland, Baltimore County (UMBC). As Vice President, he provides university leadership for information technology at UMBC and serves on the executive leadership team of the university and is responsible for providing information technology services in support of teaching and scholarship, research computing, and administrative support.

Since 2000, Mr. Suess has been very active nationally in the areas of cybersecurity, identity management, analytics, and cloud computing and has served in a number of national information technology leadership activities with EDUCAUSE, Internet2, IMSglobal, and InCommon.</td></tr>
<tr><td></td><td>Dr. John O'Brien serves as the president and CEO of EDUCAUSE, a nonprofit association whose mission is to advance higher education through the use of information technology. The current membership comprises over 1,800 institutions and 300 corporations.

Throughout his 25-year career in higher education, John has deeply engaged with the IT and educational technology sectors. Most recently, John served as senior vice chancellor for academic and student affairs at Minnesota State Colleges and Universities (MnSCU), the fifth largest higher education system in the country. In this position, he was dedicated to ensuring student success and implemented strategic changes to help MnSCU adapt to the changing needs of higher education.</td></tr>
</table>

EMREX in Poland supporting internal mobility

Janina Mincer-Daszkiewicz (jmd@mimuw.edu.pl), Wojciech Rygielski (rygielski@mimuw.edu.pl),

Faculty of Mathematics, Informatics, and Mechanics, University of Warsaw, Banacha 2, 02-097 Warszawa, Poland

Keywords
EMREX, internal mobility, admission system, Learning Agreement, Transcript of Records, USOS API, Federated IdM, Erasmus Without Paper

1. ABSTRACT

EMREX [1, 3] is the ERASMUS+ Key Action 3 project (grant number 388499-EPP-1-2014-2-FI-EPPKA3PI-POLICY) which aims at building a platform for an effective transfer of mobile students' achievements between partner institutions and thus promoting higher attainment level to student mobility in higher education. Five countries, Finland, Norway, Sweden, Denmark and Italy, agreed to add student mobility plug-ins (**SMP**) to local student information systems (**SIS**), set up national contact points (**NCP**) at country-level through which partner institutions may get access to data on student achievements, and run field trial. Poland is the evaluation body which is responsible in the project for the evaluation of the impact of the EMREX platform on the student mobility and the quality and scalability of the solution from the technical perspective.

To avoid legal issues of data privacy, the partners in the project decided that in EMREX data transfer will be initiated by data owners, i.e. mobile students. Student will log in to SIS of home institution, with help of SMP be directed to the NCP of the country of the host institution, be authorized by the SIS of the host institution, and trigger transfer of achievements.

The EMREX platform seems to solve a well recognized problem in a simple and elegant way. Development of the software components needed to join the network does not seem like a difficult task. The designed solution looks attractive from the perspective of the main stakeholders, mobile students and university administration.

Poland has a rich program of internal mobility, called **MOST** (Polish word for bridge), see [5]. In academic year 2015/2016, 534 students from 28 higher education institutions (**HEI**) spend semester or two in other Polish HEI. 15 of these institutions belong to **MUCI** consortium [6] and use the same SIS, called **University Study-Oriented System** (**USOS**, [7]). If the Polish partner integrates USOS with the EMREX platform mobile students from these institutions will be able to easily transfer their transcripts of records from USOS installation at host institution to USOS installation at home institution. The effect of scale will be immediate. If the system proves useful internally, going international will be an easy next step.

In the paper we describe EMREX solution for Poland internal mobility from the technical and organizational perspective.

2. INTRODUCTION

EMREX [1, 3] is the ERASMUS+ Key Action 3 project which aims at building a platform for more effective transfer of mobile students' achievements between partner institutions and thus promoting higher attainment level to student mobility in higher education and also encouraging more effective recognition of prior learning and avoiding overlapping studies. Five countries, Finland, Norway, Sweden, Denmark and Italy, agreed to develop student mobility plug-ins (SMP) to local student information systems (SIS), set up national contact points (NCP) at country-level through which partner institutions from other countries may get access to data on student achievements, and run field trial. Poland is the evaluation body which is responsible in the project for the evaluation of the impact of the EMREX platform on the student mobility and of the quality and scalability of the solution from the technical perspective.

To avoid legal issues of data privacy, the partners in the project decided that in EMREX data transfer will be initiated by data owners, i.e. mobile students. Student will log in to SIS of home institution using SMP, be directed to the NCP of the country of the host institution, be authorized by the SIS of the host institution, and trigger transfer of achievements.

The EMREX platform seems to solve a well recognized problem of timely delivery of student achievements in a simple and elegant way. Development of the software components needed to join the network does not seem to be a difficult task. NCP is (possibly) one per country, SMP is one per software developer of SIS, and there is also one central registry with binding information. The designed solution looks attractive from the perspective of main stakeholders, mobile students and university administration.

Poland has a rich program of internal mobility, called MOST (Polish word for bridge), see [5]. It is based on the rules similar to Socrates/Erasmus but is limited to students of Polish HEIs who want to spend one or two semesters at other Polish HEI. Program is coordinated by **UAC** (University Accreditation Commission) established in 1998 by the Conference of Rectors of Polish Universities. In academic year 2015/2016, 534 students from 28 HEIs spend semester or two in another Polish HEI.

There is a central admission system for MOST (called IRK-MOST) run by the University of Warsaw. The system also supports exchange of documents such as Learning Agreement and Transcript of Records; however the program coordinators and partner institutions have not yet decided to deploy that functionality.

USOS [7] is a student information system developed by the consortium MUCI [6] of 47 Polish HEIs. 15 of these institutions are involved in MOST. IRK-MOST, like USOS, was developed by MUCI, by the same development team which also takes part in the EMREX project. If the Polish partner integrates USOS with the EMREX platform mobile students from these institutions will be able to easily transfer their transcripts of records from USOS installation at host institution to USOS installation at home institution. The effect of scale will be immediate. If the system proves useful internally, going international will be an easy next step.

More challenging than software development are changes in institutional administrative procedures. Testing them internally can be a useful proof-of-concept.

Polish team decided to extend its role in the project and build EMREX components for Polish institutions using USOS. In this paper we present EMREX solution for Poland internal mobility from the technical and organizational perspective. Program MOST and its organization inside Poland is described in more detail in chapter 3. EMREX goals and the network architecture are explained in chapter 4. Chapter 5 contains description of EMREX for Polish HEIs from MUCI consortium and is the main chapter of this paper. Final thoughts are presented in chapter 6.

3. PROGRAM MOST

MOST (Polish word for bridge) is a mobility program for Polish students. It is based on the rules similar to Socrates/Erasmus+ but is limited to students of Polish HEIs who want to spend one or two semesters at other Polish HEI. Program is coordinated by UAC (University Accreditation Commission) established in 1998 by the Conference of Rectors of Polish Universities. The main goals of UAC's activity are:

- creation of an accreditation system of courses of studies at universities,
- creation and implementation of the standards of the education quality at universities,
- enhancement of the education quality,
- recognition of the HEIs ensuring high quality of the education,
- promotion of student mobility both in a national and international dimension.

Program MOST is carried since 1999. It involves 20 Polish public universities, members of UAC, and 8 associated HEIs. It covers over 400 fields of studies. Over 6000 students took part in the program since its start. Statistics for academic year 2015/2016 give some idea of the scope of the program:

- 2967 study offers,

- almost 1000 students registered in the admission system,
- 501 students qualified for studies at I and II level, 33 students qualified for doctoral studies.

Since May 2010 students register for MOST at one central admission system (IRK-MOST) available at http://most.uka.uw.edu.pl (see Figure 1), run by MUCI and located at the University of Warsaw. From the technical perspective the software has been based on the student admission system (IRK) developed by MUCI for Polish HEIs but was extended with additional functionalities [8]. IRK-MOST supports federated identity management, which means that students from HEIs which have central identity management system can log-in to IRK-MOST using their university credentials. Extra attributes may be sent from HEI's SIS during log-in, like student surname, name, citizen identity number, e-mail. Admissions are run twice a year. Students browse study offers from all participating institutions, select up to 3 study programs, make a priority list and wait for the final decision. Coordinator from UAC with the help of coordinators from partner institutions qualifies students for the mobility. Student's data can be transferred electronically from IRK-MOST straight to local USOS installation.

Figure 1 IRK-MOST — admission system for student mobility inside Poland

As is the case of Erasmus+ program, before the mobility students prepare Learning Agreements (LA) which have to be approved by coordinators from the home and host institution. After the mobility students obtain Transcripts of Records (TR) which have to be delivered to the student office at the home institution. IRK-MOST supports handling of these two documents. IRK-MOST may be integrated with HEI's course catalog (which is part of the ECTS guide), so when composing LA student can browse courses and transfer (upload) codes of those selected to LA. When LA is ready a special token may be sent to home and host coordinators giving access to LA in IRK-MOST. LA may be approved either straight in the system by the authorized person or the scanned version of the signed document can be uploaded into student's account and than its originality confirmed. After the mobility student may himself add grades to LA which is then converted into TR. Such TR has to get approval of the host coordinator. The signed and scanned document can also be uploaded to student's account. Whatever document is generated electronically from IRK-MOST it is signed with the application certificate. An electronic document contains PDF file to be read by human and XML equivalent which may be processed electronically by another application. Information about the current status of the document is attached (was it approved/confirmed by the authorized staff member of the involved HEI).

Handling of LAs and TRs is available in the system from its deployment in 2010. Various scenarios of information transfer between involved institutions are possible, more or less automatic. IRK-MOST can be regarded as one central point for exchange of documents on student mobility between participating HEIs. However this functionality is not used and documents are still exchanged mostly on paper.

What are the reasons? May be in 2010 university administration was not yet ready for such changes in the procedures? May be staff was not appropriately trained or convinced about benefits of the new way of document handling? Or may be administration prefers to stick to local SIS used daily, whereas IRK-MOST is more 'external', dedicated rather to MOST coordinators, not staff of student offices at faculties?

These or other reasons suggest that the simpler scenario, implemented in EMREX, where student himself is responsible for transfer of courses and grades from the host to the home SIS, might be a reasonable alternative. We decided to perform a proof-of-concept.

4. EMREX

Key components of the EMREX network are the following (see Figures 2 and 3):

1. EMREX-ELMO

   EMREX-ELMO is a standard for data exchange on the EMREX platform. It allows for description of home and host HEI, mobile student, courses, grades, credits, and other achievements. It is based on other European standards, like MLO-AD, EuroLMAI. All versions of the XML Schema are available on GitHub: https://github.com/emrex-eu/elmo-schemas/releases.

2. EMREG — EMREX Register

   This is the only central component of the EMREX network. For the lifetime of the project it is hosted in Norway and updated manually, but eventually may be hosted by some European organization (similarly to the EWP Registry, see [2]). There is only one service available — returning a list of all countries and their NCPs, for each NCP a list of all institutions it is responsible for and this NCP's public key. There is also a parameter saying whether a particular country has a separate NCP for each institution. In that case, after the country has been selected, the student is presented with a list of all NCPs registered for that country.

3. NCP — National Contact Point

   It is the entry point to the country's repository of achievement data. It must support secure login, result fetching and data transfer. Log-in service is either the federated identity management at the country-level or authorization at the HEI-level. The results can be fetched from a central repository or from a particular HEI. In the first case a student may in one step fetch results obtained in all institutions located in that country. NCP may give the student a possibility to select a subset of results to be transferred. It may also depend on the local solution whether failed courses are available for fetching. NCP generates the ELMO document in the XML format with attached PDF version optionally signed with the application certificate. XML is signed with the private key of the NCP.

4. SMP — Student Mobility Plug-in

   EMREX Client calls SMP each time it needs a list of institutions to choose from. The Client can cache the list for a certain period of time, as we don't expect the list to change too often. SMP may be implemented as a stand-alone web service.

5. EMREX Client

   EMREX Client can be built as a stand-alone application or as part of the existing SIS. It must implement secure log-in. It uses SMP to fetch the NCP list from EMREG, present the list to the student, forward the student to the selected NCP, and handle the response from the NCP. At that stage the Client should verify that the student logged into the local SIS is the same whose results are fetched from the NCP (by comparing some of the student data). The Client also sends to NCP a session ID and obtains it back in the response for the verification. It should display fetched results, give access to a signed PDF for download or printing. Eventually it should provide a way to store the results in the local SIS.

Security of the solution is obtained through login at the Client and NCP, HTTPS protocol used to transfer data over Internet, signing XML, validating a student at the Client.

Implementation is partly based on the existing infrastructure (student authorization, data repositories). Reusable parts of the implementation are open-sourced, available on GitHub (https://github.com/emrex-eu).

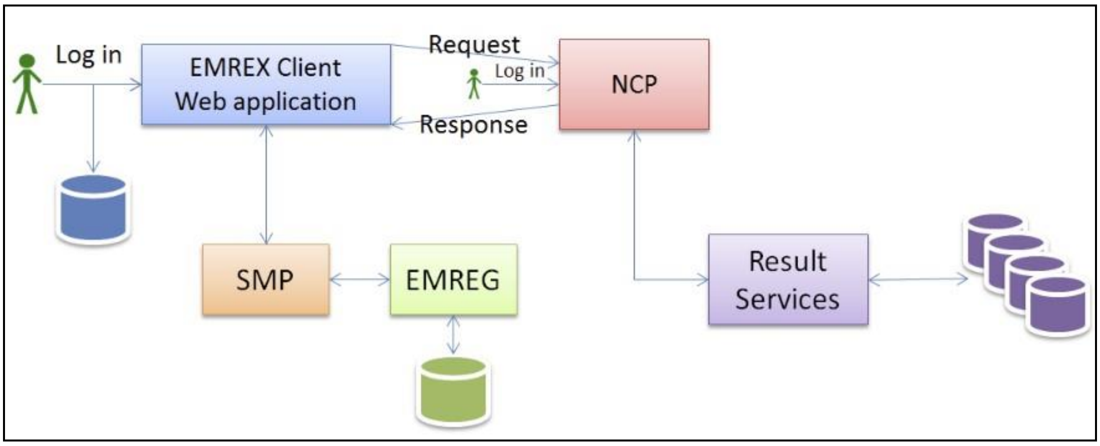


Figure 2 Main components of the EMREX network (from resources of the EMREX project)

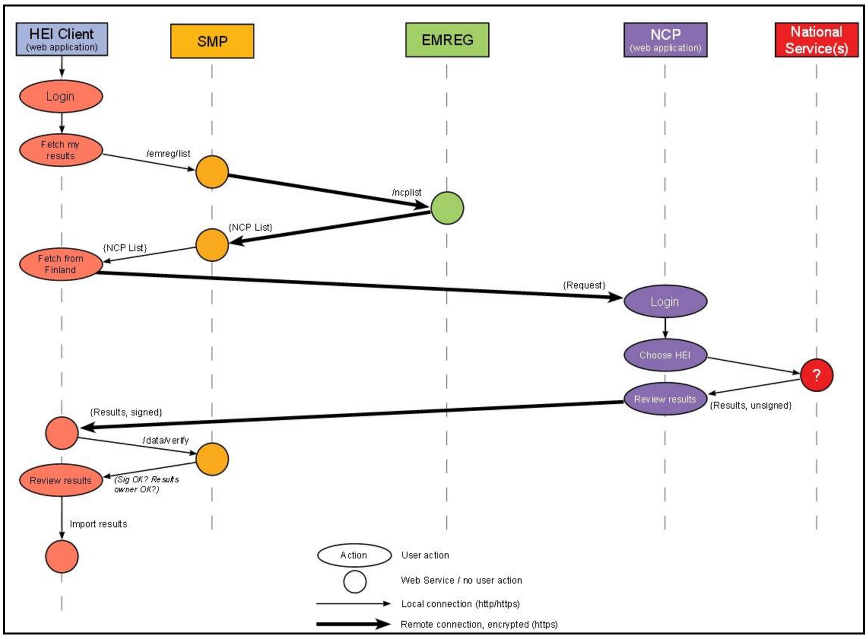


Figure 3 Scenario of data exchange via EMREX network (from resources of the EMREX project)

5. EMREX IN POLAND

In Poland, every HEI has a separate authentication system. There is also no central repository of student achievements. Having multiple NCPs, one for each HEI, seems to be the most appropriate option. This is yet to be decided how the list of NCPs will be updated in EMREG (PUSH or PULL).

5.1. Implementation of NCP

5.1.1. USOS API and USOSweb

Implementation of EMREX in Poland, developed by MUCI, is spread across two USOS subsystems:

- USOS API – a collection of web services, written primarily in Python, publicly documented in English, and designed for use by external consumers (see [4]),
- USOSweb – a web portal used by all students and staff members in their daily academic activities, written primarily in PHP (see [7]).

As stated before, every HEI in Poland which runs USOS has its own installation of both USOS API and USOSweb subsystems. For reference, you might take a look at the installation set up in the University of Warsaw:

- USOS API – https://usosapps.uw.edu.pl/developers/api,
- USOSweb – https://usosweb.uw.edu.pl.

5.1.2. Processing the NCP request

NCP endpoints are implemented in USOS API installations.

When an NCP request is received it is first validated. If it is correct, a unique identifier for this request is generated, and all the details of the request are stored in a database entity related to this identifier. These details may include request headers, IP addresses, etc. and are stored primarily for debugging purposes.

Once this is done, the user is redirected to the USOSweb subsystem.

5.1.3. User signs in and selects the courses

We have received the request, but we still don't know who the user is. Once the user accesses the NCP-related USOSweb web page, he is asked to sign in (see Figure 4).

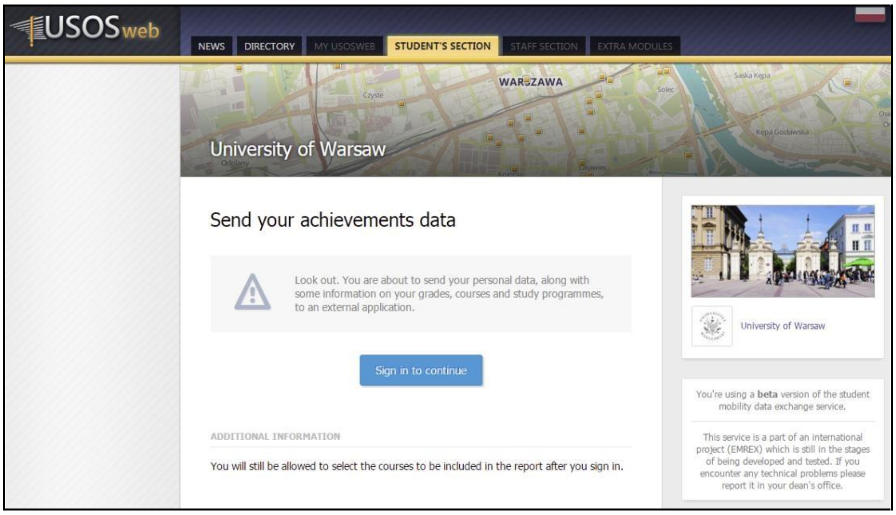


Figure 4 Logging to the NCP of the University of Warsaw

Once he does, the NCP request gets bound to this user (user ID is stored in the request entity). This relationship is permanent (if the user signs out and signs in as a different user, he won't be able to access this NCP request anymore).

Then the user is presented with the list of his courses and he is allowed to select any subset of them (see Figure 5).

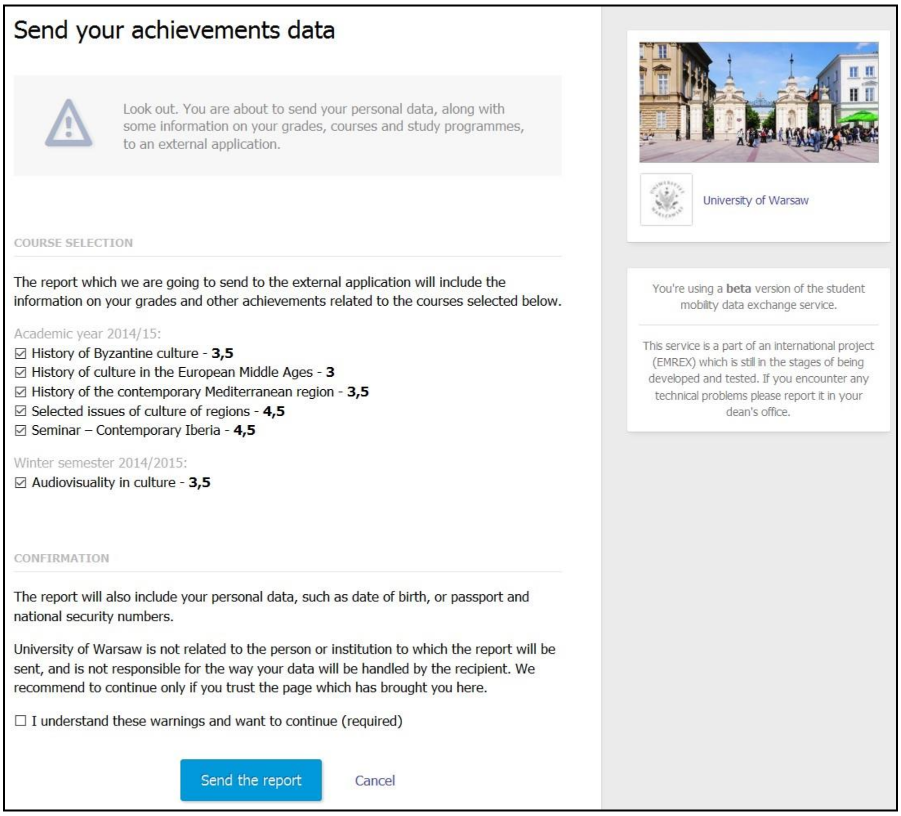


Figure 5 Selecting results at the NCP of the University of Warsaw

5.1.4. The response is sent back to the Client

When the user clicks the **Send** button, the appropriate NCP response with the EMREX-ELMO document is constructed. Internally, parts of it are generated in the USOS API subsystem, but the end user will not see it, as all the communication is done in the background. Different subsystems need to be queried along the process, so this may take a couple of seconds (a user is presented with a standard “loading” icon during this time).

Immediately after the documents are ready, a POST request is being sent directly from the user’s browser to the EMREX Client.

5.2. Implementation of the EMREX Client

At the time of writing, the implementation of the EMREX Client is under way (scheduled to be finished in May 2016).

As with the NCP server, the Client’s implementation will be spread across two subsystems: USOS API and USOSweb.

A user initiates the EMREX exchange on a dedicated USOSweb page. USOSweb fetches the list of NCP servers via USOS API (USOS API is also responsible for caching EMREG responses). The NCP request is not sent directly from USOSweb, USOS API is used as a mediator. The student selects the NCP server on the USOSweb page, and then USOS API method is called with the server’s URL. A unique ID is generated for this request (session Id) and a database entity is stored to track it. Then the user is redirected to the NCP URL with the return URL parameter referring back to a proper **receiver** USOS API **method**.

Once the student selects the courses and is redirected back to the receiver method, the underlying entity is updated and the received EMREX-ELMO document is stored and verified. The user is redirected to the home USOSweb subsystem and presented with the results of the EMREX-ELMO processing. If the verification process goes well, and the local system is able to understand the data in the document, then it may additionally allow the student to select the courses which he would like to store locally (this being an extra option).

Suspicious import requests would need to be approved by an authorized staff member (the attached PDF document should be useful in this case).

5.3. Other issues

The solution will first be made available for testing on the USOS DEMO server. It is a test bed of USOS based applications, with anonymised data, fully functional, available for testers, training, and also for external companies which integrate their products with USOS.

A student who wants to transfer results from one HEI to another should log-in to both systems. Federated identity management for Polish HEIs would substantially help in solving the problem of student authorization. MUCI will recommend HEIs to join the federation. There is also a problem of the validity of a student account in home and host institutions after students leave the institution. It seems reasonable to keep these accounts active indefinitely, not only to assist students in accessing their data in the university repository but also to encourage them to maintain contact with their Alma Mater.

Electronic data exchange is a first step in the process of automatic recognition of student achievements, probably the easier one. Up to now it was the task of the local Erasmus coordinator to translate student achievements expressed in the context of regulations and culture of the host institution to that of the home institution. This translation also involves grade conversion. What was done by the human should be done automatically by the system. The system has to acquire the knowledge and experience of humans. This problem is yet to be recognized and worked out with the strong involvement of all interested stakeholders from European higher education institutions.

6. SUMMARY

Implementation of the EMREX Client and NCP for USOS will be made available for Polish HEIs from the MUCI consortium in June 2016 as part of the official distribution of USOS version 6.2. This means that the platform will become available to almost 50 HEIs in Poland after regular annual upgrade of the student information system, at no extra cost. Depending on the schedule participants of the program MOST will be able to get their results from host institutions starting from the summer semester 2015/2016. Important aspect of the scenario supported by EMREX is that the initiative is on the side of the students and also the students are the potential benefactors. This may be the key to successful deployment.

As our experience shows, IT solutions should be tailored to needs/expectations/capabilities of the organization at its current stage of development. If the EMREX scenario proves useful it may open the door for more sophisticated scenarios, like the ones supported by the Erasmus Without Paper (EWP) Network. EWP project [2] aims to create a network supporting the electronic exchange of student data by interlinking the existing Erasmus student databases of HEIs. In EWP scenario data exchange will be under control of the administration, mostly staff of International Relations Offices. EMREX is the first step towards paperless world which is the goal of the EWP project.

7. ACKNOWLEDGEMENTS

EMREX project is supported by the ERASMUS+ Key Action 3 grant from EACEA (grant number 388499EPP-1-2014-2-FI-EPPKA3-PI-POLICY). EMREX is the joint work of project partners — thank you all.

8. REFERENCES

[1] EMREX project. Retrieved in January 2016 from: http://www.emrex.eu.

[2] Erasmus without Paper project. Retrieved in January 2016 from: http://erasmuswithoutpaper.eu.

[3] Lindstedt M., Hansen A.B., Ravaioli S., Vangen G., Sidselrud A., Mincer-Daszkiewicz J., Henriksson P. (2015). *Field trial on the impact of enabling easy mobility on recognition of external studies (EMREX)*. EUNIS 2015, Dundee. http://www.eunis.org/eunis2015/wpcontent/uploads/sites/3/2015/04/EUNIS2015_submission_13_P1_TRACK_3_slot_3.pdf

[4] Mincer-Daszkiewicz J. (2012). *USOS API — how to open universities to Web 2.0 community by data sharing*. EUNIS 2012, Vila Real. http://www.eunis.pt/index.php/programme/full-programme.

[5] MOST program (http://most.amu.edu.pl) and MOST admission system (http://most.uka.uw.edu.pl). Retrieved in January 2016.

[6] MUCI consortium. Retrieved in January 2015 from: http://muci.edu.pl.

[7] *University Study Oriented System*. Retrieved in January 2015 from: http://usos.edu.pl.

[8] Ziemiański G. (2010). *Exchange of Students Data Between Higher Education Institutions in Poland*. Master thesis, University of Warsaw (in Polish).

9. AUTHORS' BIOGRAPHIES

Janina Mincer-Daszkiewicz graduated in computer science in the University of Warsaw, Poland, and obtained a Ph.D. degree in math from the same university. She is an associate professor in Computer Science at the Faculty of Mathematics, Informatics and Mechanics at the University of Warsaw specializing in operating systems, distributed systems, performance evaluation and software engineering. Since 1999 she leads a project for the development of a student management information system USOS, which is used in 47 Polish Higher Education Institutions, gathered in the MUCI consortium. Janina takes active part in many nation-wide projects in Poland. She has been involved in Egracons, EMREX and Erasmus Without Paper European projects.

Wojciech Rygielski graduated in computer science in the University of Warsaw, Poland. He is a senior programmer working on USOS.

He is one of the main developers from Poland in EMREX and Erasmus Without Paper European projects. He designed and developed EMREX Client and NCP for USOS.

Looking back at the EUNIS repository data using text mining techniques

Elsa Cardoso[1], Ricardo Ribeiro[2]

[1]ISCTE- Instituto Universitário de Lisboa and INESC-ID, Av. das Forças Armadas, 1649-026 Lisboa, Portugal, elsa.cardoso@iscte.pt
[2]ISCTE- Instituto Universitário de Lisboa and INESC-ID, Av. das Forças Armadas, 1649-026 Lisboa, Portugal, ricardo.ribeiro@iscte.pt

Keywords
Text mining, topic modelling, EUNIS repository

1. Summary

Topic modelling algorithms can be applied to a large collection of documents to uncover themes and their relationship, thus adding an automatic semantic layer to the archive of documents. In this work, topic modelling has been applied to the collection of papers published at the EUNIS (European University Information Systems) annual congresses from 1997 until 2015. Drawing on the initial work of (Wilson and Bergström, 2015), this paper extends the historical analysis of the conference proceedings with the application of text mining techniques to analyse the original texts. The performed analyses include the automatic identification of the most relevant topics and their evolution throughout the years for European University Information Systems, and the quantification of the degree of internationalization and cooperation of the EUNIS annual conference.

2. EUNIS repository analysis

The mission of the European University Information Systems organization (EUNIS) is to help member institutions to develop their information technology (IT) landscape by sharing experiences and working together. EUNIS was created in 1993, and currently has approximately 120 member institutions. Several activities and events are periodically organized. The most significant events are the annual conference or congress (hosted by a member institution) and the Rectors conference. Task forces (TF) have been created to foster a deeper collaboration and sharing of experiences between members with similar interests. Presently, there are four task forces established: BencHEIT (focused on benchmarking IT major costs), business intelligence, e-learning, and interoperability. Task forces also organize separate events, like the BencHEIT annual event (since 2012) and the Business Intelligence TF event in Hannover and Paris, in 2011 and 2013 respectively. More recently, the EUNIS Research and Analysis (ERAI) initiative has been launched with the purpose promoting the EUNIS research outcomes, being responsible for the editing of an e-journal, the EUNIS Journal of Higher Education IT (EJHEIT). The first issue of this e-journal was published in the fourth quarter of 2014.

In 2015, the ERAI team performed the first analysis of the existing set of publications (Wilson and Bergström, 2015) focusing on the papers published in the annual congresses. This exercise was very insightful, sharing light on some publishing trends. Since EUNIS does not currently have a data repository, the proceedings of the annual conferences have been stored in the original conference web sites, maintained by the member institutions that hosted the events. The ERAI team performed an extensive web search, to assemble, as much as possible, all the published papers. Key findings from (Wilson and Bergström, 2015) were: (1) a set of comprehensive records exist only from 1997 onwards; (2) the congress tracks are inconsistent across years; and (3) authors vary in their interpretation of keywords (i.e., keywords are also inconsistent across years).

Three major trends were identified by Wilson and Bergström's analysis. First, 2001 up to 2009 was identified as the most popular period for paper presentations, with 2007 achieving the highest value of paper publication in congresses. Second, United Kingdom (UK), Portugal, Germany, and Spain constitute the top-4 countries of paper authors. Finally, the most popular themes identified by the authors were e-issues, leadership and management, infrastructure and security, and information management.

The goal of the present work is to expand the data analysis of exiting EUNIS congress publications, applying business intelligence (BI) and text mining techniques. The motivation for this work emerged from the need to have a comprehensive view of the evolution of information systems development in Higher Education Institutions in Europe. BI and text mining enable the automatic extraction of reliable sematic information from unrestricted text, such as papers' full text and congress programmes. The end result complements the knowledge gained from a standard statistical analysis. In order to achieve this goal, a thorough data cleaning process has been developed. This data preparation stage constituted a very intensive and time-consuming process, since contextual information about each congress is scattered (across different web sites and books) and sometimes insufficient. A multidimensional model has been designed to facilitate the analysis of paper submissions to EUNIS congresses. The multidimensional analysis was implemented using Microsoft Excel power pivots, applying standard Data Warehouse techniques. The output of this stage enabled the computation of several generic data repository indicators for the dataset of publications from 1997 until 2015, such as:

- total number of papers
- papers with keyword definition (number and %)
- papers with abstract definition (number and %)
- papers without author definition (number and %)
- papers with authors from different countries (number and %)
- papers without track definition (number and %)
- number of countries represented
- average number of authors per paper
- number of papers per track (average, min, max)
- number of congress tracks

Text mining techniques, and topic modelling algorithms in particular, can be applied to a large collection of documents to uncover themes and their relationship. The main goal of this work is to use different topic modelling algorithms to define an automatic semantic layer to the archive of EUNIS congress papers published in the time period of 1997 until 2015. The initial set of research questions outlined for this project is:

RQ1. Which are the most relevant topics in the area of European University Information Systems?
RQ2. How did this set of topics evolve throughout the years?
RQ3. How did the number of represented countries evolve throughout the years?
RQ4. How did the number of papers with authors from different countries evolve throughout the years?
RQ5. How did the ratio number of published papers versus number of conference tracks evolve throughout the years?

In order to answer the first two research questions, topic modelling algorithms were applied to automatically identify the most relevant topics and their evolution throughout the years for European University Information Systems. RQ3 has an impact on the analysis of the degree of internationalization of annual conferences. As previously mentioned, one of the main objectives of EUNIS is to establish an international Higher Education community to collaborate and share experiences among members. To this end, RQ4 will enable an analysis of the degree of cooperation between countries.

3. Topic modelling

Topic models allow us to explore large collections of (textual) documents in an unsupervised manner. The intuition behind this type of models is that by collecting statistics about the distributional properties of the words occurring in the documents of a given collection it is possible to uncover its latent topics. "Words with similar distributional properties have similar meanings" (Sahlgren, 2006).

In general, topic modelling approaches can be divided in probabilistic approaches and nonprobabilistic approaches. The main difference between these approaches is that the relationships between words and topics and documents and topics in probabilistic models, like Latent Dirichlet Aloocation (Blei, Ng, and Jordan, 2003), are modelled using probability distributions, while in nonprobabilistic approaches, like Latent Semantic Analysis (Landauer and Dumais, 1997), such restriction does not exists (Steyvers and Griffiths, 2007). However, as mentioned by Blei, Ng, and Jordan (2003), the main advantage of (generative) probabilistic models is their modularity and extensibility. In terms of performance, both types of approaches show similar performance when used for classification, with probabilistic models inducing better quality topics (Stevens et al., 2013). Moreover, as probabilistic modules, this kind of approaches can be easily integrated in a more complex model.

One of the most well-known probabilistic topic models is Latent Dirichlet Allocation (LDA). Given a fixed number of topics, LDA considers that each topic is characterized by a probability distribution over the vocabulary of the collection and that documents are mixtures of topics. LDA is a generative model, so it assumes that each document of the collection is generated from a topic distribution and each word of the document is generated from the distribution over the vocabulary corresponding to a topic randomly selected from the topic distribution.

One of the limitations of this model is that it assumes a fixed number of topics, required to train the model. This choice can have a strong impact on the results: a small number can lead generic topics, while choosing a large of number may lead to low quality topics. The hierarchical Dirichlet Process (HDP) (Teh et al., 2007) can be seen as an extension to LDA that allows an unrestricted number of topics. HDP can estimate the number of topics of a given collection by using a sampling method.

In this work we explored both approaches to determine the right amount of topics that better explains the collection of documents (i.e., EUNIS papers). To this end, several experiences were conducted with different algorithms, leading to different sets of topics. In the end, the final set of topics is always a choice of the analyst. The rationale is to perform a sufficient number of experiences to aid the analyst in the selection of the most relevant and recurrent topics. The inferred models are used to analyze the evolution of topics through time.

4. Conclusions

Preliminary results allowed us to better understand the main themes of the EUNIS conferences, as well as the evolution of such themes over the last 20 years.

An important aspect of this work is data visualization. The generic conference paper indicators are simple data visualization, characteristic of business intelligence projects. However, topic modelling visualization is still a research topic and hence constitutes a challenge to this work. The goal is to provide a sufficiently rich albeit simple text visualization of the evolution of themes in the context of the EUNIS conferences.

5. REFERENCES

Wilson, N., and Bergström, J. (2015) EUNIS Congress' 21st Birthday - A Historical Perspective on its Proceedings. In Proceedings of EUNIS 2015, Dundee, UK, 10-12 June, 2015

Landauer, T. K. and Dumais, S. T. (1997), A Solution to Plato's Problem: The Latent Semantic Analysis Theory of Acquisition, Induction and Representation of Knowledge, in *Psychological Review, 104* (2) , 211–240

Sahlgren, M. (2006), *The Word-Space Model*, PhD Thesis

Teh, Y., Jordan, M., Beal, M., Blei, D. (2007), Hierarchical Dirichlet processes, *Journal of the American Statistical Association,* 101(476), 1566–1581

Blei, D., Ng, A., Jordan, M. (2003), Latent Dirichlet allocation, *Journal of Machine Learning Research* 3, 993–1022

Steyvers, M., and Griffiths, T. (2007), Handbook of Latent Semantic Analysis, chap. Probabilistic Topic Models, 427–448. Lawrence Erlbaum Associates

Stevens, K., Kegelmeyer, P., Andrzejewski, D., and Buttler, D. (2012), Exploring Topic Coherence over many models and many topics. In Proceedings of the 2012 Joint Conference on Empirical Methods in Natural Language Processing and Computational Natural Language Learning, Association for Computational Linguistics, 952–961

6. AUTHORS' BIOGRAPHIES

Prof. Dr. Elsa Cardoso. Assistant Professor, Director of the Master in Integrated Business Intelligence Systems at ISCTE – University Institute of Lisbon, Portugal, and leader of the Business Intelligence Task Force of EUNIS (European University Information Systems organization). She is also a researcher at the Information and Decision Support Systems Group of INESC-ID Lisboa, Portugal.

She has a PhD in Information Science and Technology, with a specialization in Business Intelligence. Her research interests include business intelligence and data warehousing, big data analytics, performance management, balanced scorecard, business process management, applied to Higher Education, Healthcare, and IT service management. She is a member of: Institute of Electrical and Electronics Engineers (IEEE), Association for Computing Machinery (ACM), Portuguese Institute of Business Process Management (IPBPM), Portuguese Quality Association and the vice-representative of ISCTE-IUL at CS03, the commission of IPQ (Instituto Português da Qualidade) for Quality in Information Technology.

https://pt.linkedin.com/in/elsa-cardoso-88092215

Prof. Dr. Ricardo Ribeiro has a PhD (2011) in Information Systems and Computer Engineering and an MSc (2003) in Electrical and Computer Engineering, both from Instituto Superior Técnico, and a graduation degree (1996) in Mathematics/Computer Science from Universidade da Beira Interior. From 1999 to 2011, he was a Lecturer at the Lisbon University Institute (ISCTEIUL), where he is now an Assistant Professor and the Director of the Computer Engineering undergraduate programme. Since 1996, he has been a researcher at INESC-ID Lisboa, Portugal, working in speech and language processing. He is a member of the Spoken Language systems Laboratory of INESC-ID since its creation in 2001. His current research interests focus on the following areas: high-level information extraction from unrestricted text or speech, and improving machine-learning techniques using domain-related information. He has participated in several European and Nationally-funded projects, organized several scientific events and was a member of the program committee of several others, and edited a book on the computational processing of Portuguese.

Central IT Organizations and How They Support Research in the U.S.

Central IT Organizations and How They Support Research in the U.S.

1st Gregory D. Palmer1

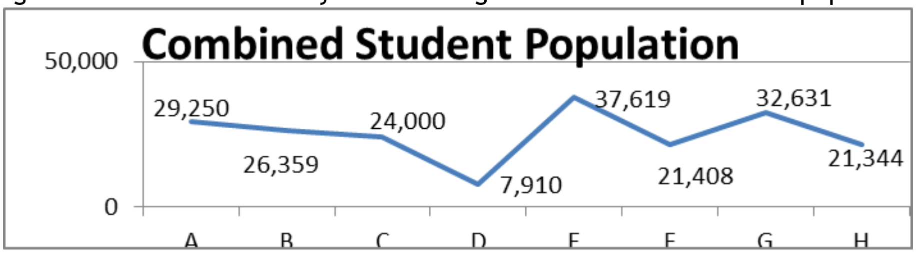
[1]University of Pennsylvania, 3401 Walnut Street Suite 221-A, Philadelphia, PA 19104-6228, gpalmer@isc.upenn.edu

Keywords
IT, Research, Support, Services, Computing, Data Center

ABSTRACT Central IT Organizations and How They Support Research in the U.S.

Since information technology became a centralized function at universities in the U.S. the primary role was considered to be focused on communications and administrative computing. The IT needs of the research communities were generally considered too specialized for the campus-wide organization and fulfilling the hardware, software, storage, and computing requirements became the responsibility of the individual researcher, their department, or the specific faculty. Recently, however, Presidents, Provosts, and Research Deans have given the direction to their Chief Information Officers that they must provide more centralized support for those conducting research while creating economies of scale, (lower costs) across the entire university. The demand for advanced on-campus data centers, high performance computing and networking, and the skilled labor necessary to operate research intensive computing and analytic software has been a great challenge to central IT organizations. It becomes even more difficult when the outcomes are expected to be more cost effective than the current distributed methods.
This paper is the result of extensive interviews with eight universities classified as "research intensive". It analyzes the objective and subjective components of the strategic plans of the central IT administrators, and concludes with financial and operational recommendations taken from the successful models.

I.0 - Institutional Demographics - (Background)
This section is intended to provide general demographics of the institutions surveyed. Of the 8 universities, 4 are considered private and 4 are considered public. In the search for correlations, faculty populations become relevant only when compared to the number of IT staff available to support them.
Population statistics were requested in the following categories:
Undergraduate – Full time registered students
Graduate – Full and part-time registered students
Faculty – Full time faculty
1.1 Total Student Population – Participants range from 7,910 to 37,619 enrolled undergraduate and graduate students for the 2014-2015 academic year **Figure 1** represents the stated number of students during the interview. University E ranked highest in combined student populations.



1.2 Undergraduate, Graduate, and Faculty Populations – In **Figure 2** we see the comparative breakdown in student and faculty populations. No correlation is made at this time, however in 3 cases, graduate students enrolled in private universities outnumbered undergraduates. While this does not seem to have any relevance to research expenditures, history reveals that the greater the number of graduate students at an institution, the higher the likelihood that research initiatives will not draw upon the resources of central IT since they are fulfilling the technology functions.

Given the aforementioned trend towards assigning undergraduates majoring in the sciences with research requirements, access to data both on and off campus will no doubt dramatically increase in the short term. This will affect computing capabilities, network infrastructure, and most likely storage capacity as well. Those universities with large undergraduate populations that are not prepared for the additional demand may find themselves unable to meet the needs of the whole university.

Figure 2 – Comparison of Undergraduate, Graduate, and Faculty Populations

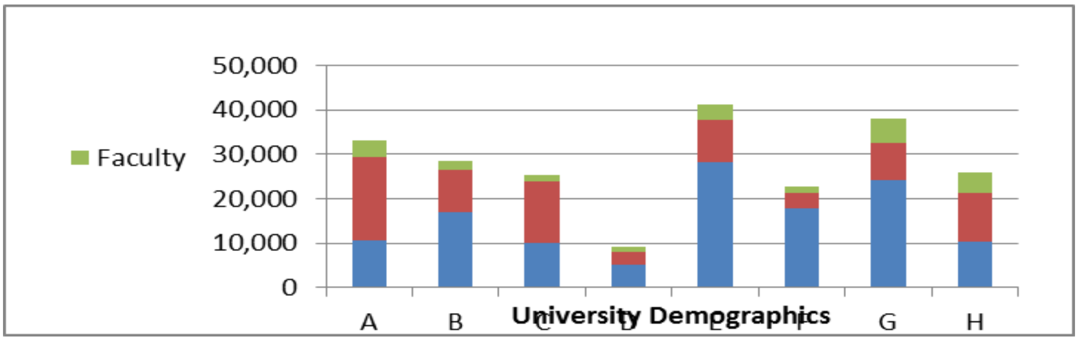
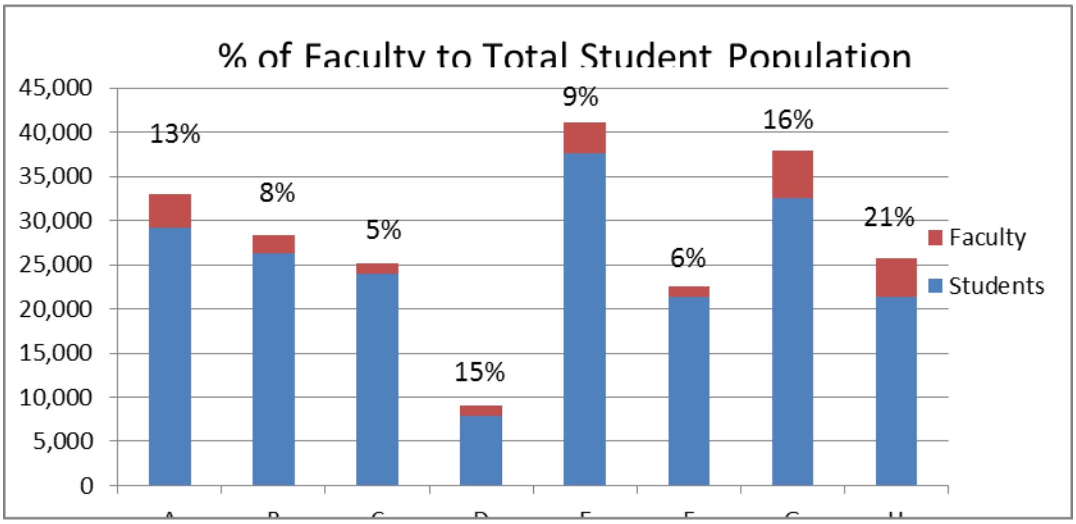


Figure 3 – Percentage of Faculty to Total Student Population



1.3 Faculty-Student Comparison – **Figure 3** looks at full-time faculty for each institution and determines a percentage against total student population. This data may be interpreted as:

- Schools with faculty comprising less than 10% of the total population may have greater teaching responsibilities and less time for research
- Where the graduate student population exceeds the undergraduates, (Figure 2), faculty percentages above 10% are consequently more likely to be involved in research initiatives

2.0 Overview of Central IT Organizations

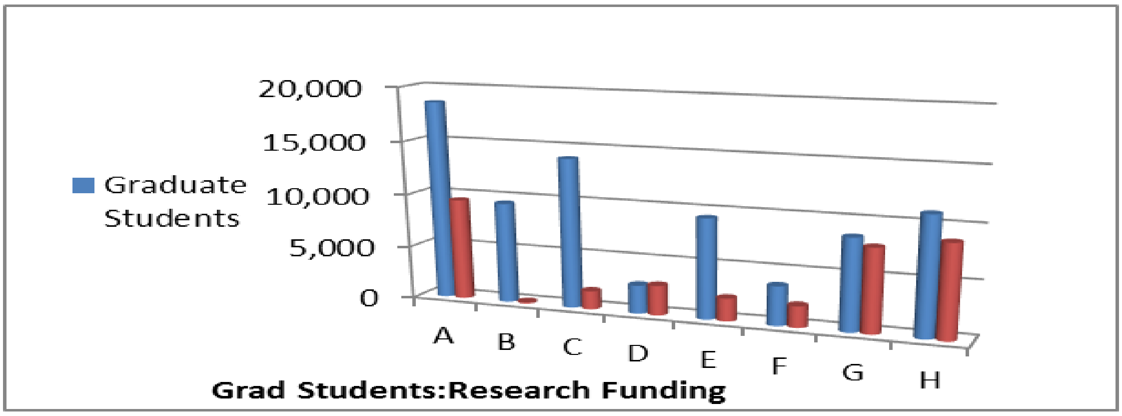
In this section we are looking at the responses from the participants about the general makeup of their IT organization. The intent was to discover both the current and potential capabilities of the organization to support their respective researchers. The information gathered gives us some insight into the balance of administration and full-time staff and the students, faculty, and research initiatives they serve.

An attempt was made to normalize the comparisons so as to minimize differences in the size of the institution. Did the size of the IT organization have any effect on research funding? Does the ratio of

IT staff to faculty have a positive effect on the institution's ability to receive grants? While the size of the unit and its proportion to students and faculty varies by institution, we begin to see some relevance between the availability of IT support and the amount of funding received by the research community.

Figure 4 compares the level of funding with the number of graduate students. At the time of the survey, University A showed the highest level of external funding and the largest population of graduate students, but equaled University E in the ratio of central IT staff to faculty. Given that other schools also had varying levels of staff to faculty ratios it seems that the comparison is irrelevant to research funding and central IT support. The argument can be made however that a higher concentration of graduate students minimizes the dependency on IT support staff. My experience has shown that system administration and other IT functions used in research are most often performed by graduate students and not a dedicated IT employee, whether in central IT, a school, or in the lab itself. The critical factor is how the resources are allocated.

Figure 4 – Graduate Student Population vs External funding



We will see as we progress in this report that the more important trend is how central IT allocates their existing staff resources, not just the total number of FTE's. When we compare total staff to total faculty and see how that stands up to their funding, the greatest staff: faculty ratio, (University D), ranks 4th in overall funding.

Table 1 Central IT Staff to Faculty, Ranked by Total Research Funding

Rank	Name	Funding	Ratio	Rank	Notes	Notes
1	University A	$ 950,000,000	1:12.3	4	Most Funding	Most FTEs
2	University H	$ 870,000,000	1:16.3	6		
3	University G	$ 781,000,000	1:25	8	Highest Ratio	Most Faculty
4	University D	$ 279,000,000	1:3.7	1	Lowest Ratio, Least Students	Least Faculty
5	University E	$ 214,000,000	1:12.5	5	Most Students	
6	University F	$ 200,600,000	1:7.5	3		
7	University C	$ 172,000,000	1:6	2		
8	University B	$111,000,000	1:20	7	Least FTEs	Least Funding

2.1 CIO Divisions and Staffing for Research Support

During the interview process, each institution volunteered information about anticipated changes in their organizational structure. With the number of divisions reporting to the CIO ranging from 3, (University B) to 10, (University G), all universities had either already consolidated or were planning to consolidate the number of groups that reported directly to the CIO. Two universities are currently undergoing major reorganizations, (University H and University D), with the objectives of finding synergies within their staff and re-allocating duplicate processes and resources into a more efficient and balanced model.

Four universities included Research Support as a division, but only one had a staffing level greater than 2 individuals, and one participant counted their general purpose system administrator as a "research division". Of these, the staff members "float" between researchers across all disciplines and provide support only in reaction to requests with little or no proactive attempt to discover areas where they could provide a positive effect. Ticketing systems for service and trouble requests are prevalent in all the participants, however only one differentiated between standard IT requests and the more specific research challenges.

While 3 institutions were planning on dedicating an FTE to an individual academic unit with the greatest research activity, how to equitably fund that person is still an issue. This becomes more complicated when schools and centers have their own, dedicated IT staff separate from the central IT organization. Everyone admitted that while the research community can have very customized needs according to their projects, synergies and economies of scale are generally lost when working in a decentralized IT environment. In all cases, the central IT group and the diverse IT organizations have defined their separate roles over time. Central IT generally has the stigma of being responsible for desktop support, voice systems, and cabling infrastructure. And even though Internet, Internet2, and wide area network connectivity is generally assumed to be the domain of central IT, there are still many cases where Individual PIs, schools, and centers pursue their own negotiations for external connectivity. Those universities with medical schools **all** report a strong IT group specifically for healthcare. While there is some level of cooperation, the domains are clearly separate.

Table 2 gives a general view of trends in staff and process realignment. Senior administration such as the Executive Vice President and the Vice President for Research are realizing that inefficiencies in a distributed environment are costly and non-productive. Changes are planned over an extended period, generally 3-5 years, but the culture of ownership is difficult to overcome.

Table 2 Current and Future Trends in Staffing/Funding

Name	Research Division?	Future	Research Support Allocation	Future	Funding	Future
University A	Yes	Yes	Float	By School	Direct Charge	Long Term Contracting,
University B	No	Yes	Dean's Request	By Tracked Usage	Centralized Fee	"Tax" by School
University C	Yes	Yes	Float	By School	Hybrid	Contracting, direct
University D	Yes	Yes	Float	By School	General Operating	Some contract
University E	No	?	Dean/VPR Request	?	Allocated "Tax"	Same
University F	No	?	Dean/VPR Request	?	Allocated "Tax"	Restructuring!
University G	Yes	Yes	Dean/VPR Request	By Most Visible	Centrally Funded	Hybrid

University H	No	Yes	Dean/VPR Request	By School	Direct Charge	Hybrid

3.0 Central IT Infrastructure

The ability to provide researchers with the necessary infrastructure to analyze, store, access, and transmit the collected data involved with their projects is a necessary function of any IT group. Whether part of the central organization or a local, standalone department, delivering these capabilities is the key to receiving successful grant awards. Funding agencies like NSF and NIH are questioning applications from PIs at institutions that have insufficient campus backbone capacity or access to high performance networks like Internet2, ESnet, or N-Wave. For Big Data projects they are increasingly critical of undersized infrastructure. Since "Big Data" initiatives are outstripping the budgets of central IT, the National Science Foundation has programmatically made available millions of dollars for improving cyberinfrastructure in higher education.

3.1 Campus Networks

In questioning the participants about their infrastructure both on campus and off, it was interesting to note how many of the institutions actually knew very little about their off-campus connectivity. In those instances where the individual interviewed was a member of the central IT divisions devoted to research, it was necessary for them to call the network group to get the correct answer to such questions as to what their campus backbone, Internet, and Internet2 capacities were.

The backbone capacity on their campuses for all participants was 10G, or multiples of 10G. In three cases, the university received NSF CC-NIE grants which gave them the ability to bring in 100G links to Internet2 either through their regional provider, or direct from Internet2. In only one case was the "Science DMZ" actually completed. This would allow the university to provide big data initiatives direct access to the national R&E network without traversing multiple firewalls and routers. When questioned about on-campus connectivity between science laboratories and the backbone, nearly all responded that 100% of the labs had at least 1G of connectivity. On further questioning, these circuits were frequently shared across multiple data collection sites within the same building, thereby making them subject to congestion and latency.

3.2 Data Centers

All universities have some form of a data center. At one end of the scale, a university has a tier 3 facility complete with generators, diverse power sources, diverse network connections, and a "green" HVAC system. Other sites have varying levels of data center infrastructure. Medical schools and other high volume research centers have separate facilities. Connecting these school-specific centers to central IT resources is present but generally the infrastructure is not equal to the demand.

Loosely defined, a data center can be as little as a room or closet with a single rack that houses the collected data and potentially some analysis computing capacity, or it can be a full blown tier 3 facility equal to any commercial offering. As part of an NSF panel in 2012 that included IT administrators from the top 10 research institutions in the U.S., I was amazed to discover that none of the participants were able to account for the number of servers on their campuses. The NSF was attempting to measure on-campus computing capacity, but the ability to centralize such information was impossible due to the decentralized nature of each institution. As the interviews progressed, this lack of information became apparent across every university.

3.3 On-Campus Data Centers vs Cloud Services

The proliferation of computing and storage cloud services continues to gain popularity. Central IT CIOs are attempting to understand the balance between building or expanding their existing facilities or becoming the contract coordinator with companies like AWS, Glacier, or a host of startup organizations. Of the 8 participants, 4 institutions have multiple cloud service contracts distributed across individual schools, 2 institutions use central IT as the contract coordinator, 1 university completely controls a contract through Internet2's "Net+" program, but has no statistics for usage as each account is paid separately, and 1 university has no policy regarding cloud services. The researcher, in an effort to minimize costs and increase the number of services, will gravitate to decisions that based on these two criteria.

4.0 Central IT Research Support Services

In this section we look at specific services offered by central IT in support of their research communities. This is where we begin to see trends in staffing changes that recognize the importance of shared resources and the economies that will bring to the entire university. These economies are realized not just in dollars, but in efficiency and productivity.

4.1 Relationship Management

Proactively discovering the needs of the research community is a process still in its infancy across those universities interviewed. 5 of the 8 participants are reactive as opposed to actively reaching out to deans and department heads. The decentralized nature of IT on campuses and the lack of specialized staff known as relationship managers have led the vast majority of investigators to look externally for solutions involving data storage and computing capacity. Since research requests are not tracked separately and often fall into the same queue as telephone change orders, it requires "knowing the right person" to get something accomplished in a timely fashion and in many cases where there is not any type of introduction to IT for new faculty, it simply does not occur to the individual researcher to contact central IT.

Universities C, D, and H are experimenting with Client Relationship Managers. These individuals are focused on building relationships within research intensive areas. They become knowledgeable about the largest grants that are currently active and proactively look for opportunities to assist schools and departments with their technological challenges. At the same time, they work with the local IT staff and bring their campus-wide knowledge to reveal synergies that create cost and productivity efficiencies. The results have been greater than anticipated, and two of these schools are planning expansions in RM staffing to narrow the scope of responsibility. University H has just begun their RM program and it is too early to quantify the impact.

4.2 Internal Staff Contracting

Also in the preliminary stages is the concept of contracting central IT staff directly to the researcher. Currently at Universities A, C, and D a researcher may contract directly with central IT for specific job functions. The individual remains an employee of central IT but reports on a daily basis to the laboratory they have been assigned to. Using grant funds to pay for this service, the investigator discovers that his graduate students are now free to work on the project and not system administration or programming. This becomes a tremendous productivity enhancement which ultimately results in real dollar savings as well since those functions are now fixed costs instead of variable. The contract period may be task oriented or run the length of the grant period.

4.3 Internal Communications

All participants reported regularly scheduled meetings with the office of the VP for Research, (VPR). These were generally high level administrative meetings with occasional requests for specific researchers considered high profile. The perception is that strategic planning at the individual PI level takes second place to administrative functions at these meetings. The office of the VPR is primarily concerned with grant applications and budget accounting so the involvement of central IT is frequently focused on software modules that improve the business process and rarely on the scientific processes.

In decentralized environments there are efforts within the private universities to coordinate activities with the IT administrators at the various schools and centers. Those few IT organizations that have instituted a Relationship Management Program have reported that the outlook is promising but given the historical lack of communication, the new credibility has the potential to overwhelm the RM.

4.4 Central IT Offered Services

While every central IT organization provides a list of services to their campus community, the most widely known offerings are for students. **Table 3** lists those services that would be most attractive to researchers with an x indicating that the service is available and used. In those cases where the participant responded with "informal", (by request only), it was recorded as not being available. It must be noted that every participant admitted that there is no marketing plan other than the listing of the offered services on a website and, occasionally, how they will benefit the client. A description of the service and any additional information garnered during the interview follows.

4.5 Grant Writing – Grant applications are commonly based on the collection and analysis of preliminary data. Funding agencies are increasingly requiring collaborative efforts across two or more institutions. This increases the potential for success and distributes the award rather than concentrating on a single school or center. Other than research in the areas of computer science and communications networking, it is highly likely that the primary investigator will not design the most efficient process for collecting, archiving, analyzing, and distributing data sets or findings. Central IT is a logical resource for assisting the PI in developing an actual data management plan and providing the text for their grant application.

4.6 Hardware and Software Purchasing – When researchers submit their grant applications they will include equipment listings in their budgets. In most cases these are solicited directly from vendors and may or may not include the volume discounts available at the university level. There is a potential for economies of scale if central IT made the purchases in combination with their own and other units across the campus. The perception is that the highly specialized nature and sophistication of certain hardware is beyond the understanding of central IT. If a central purchasing resource is made available it must be flexible enough to comply with customized configurations and document possible synergies across departments.

4.7 Contract Help – As noted above, some schools are offering central IT employees as contractors to a research project for the duration of the grant. The objective is to remove those who are involved in analysis and reporting from IT tasks and thereby increase performance and productivity. When asked if this service was offered, responses were not always “yes” or “no”. Table 3 reflects only those schools that offer this service on a regular basis. In one other case a very high profile research project warranted this kind of attention but it was the exception rather than a regularly offered service.

4.8 Technical Compliance – For non-IT primary investigators, this service will review the data management design and processes to determine that the outcome will function as desired. Not to be confused with Consulting, Institutional Compliance, or Funding Agency Compliance, this was explained as a design review only, with recommendations.

4.9 Computing Capacity, Individuals – Small research projects or initiatives that require infrequent or low-end processing capability may be resolved with in-room hardware. Cost would be a major issue for this category of research. The question was posed to determine if central IT would provide or purchase computing capacity that may be part of a cluster, cloud, or shared data center infrastructure and would provide configuration support. The researcher would have the benefit of support but not the cost of an entire system.

4.10 Computing Capacity, Shared – Research computing requirements are generally sporadic, ranging from 4 times a year to daily computational analysis of very large data sets. There are many options for the investigators including supercomputing centers, cloud services, on-campus clusters within a school, and central IT provided computing centers. While all the participants offered some form of campus central computing functionality, the models varied based on funding and staff availability.

4.11 Data Center Infrastructure – As mentioned above and reflected in Table 3, all participants offer space in a data center managed by central IT. However, services will vary according to the type of data center and the requirements of the researcher at each institution. There is only 1Tier 3 data center among those surveyed. The power outputs are commonly AC and only occasionally DC. Diverse power sources and network pathways are rare. These limitations have pushed many investigators to cloud services, usually unbeknownst to central IT.

4.12 Technical Consulting – This occurs when central IT goes beyond a simple design review and actually works with the researcher prior to the grant submission to maximize the efficiency of the IT data management plan. This may occur through a relationship manager or in combination with central IT staff members. While 4 participants labeled this as a valid service offering, it is predominantly available upon request only.

4.13 Wide Area Connectivity – In some cases, the investigator may have a requirement for direct connections to funding agencies or collaborators off the campus net. Given the cost and management components this occurs only with “Big Data” projects that are well funded and have a high frequency of transmissions. The examples most often used include Internet2, the National Institute of Health, NOAA, and the Department of Energy. Of the 3 universities listed as offering this service, one has an isolated case but is receptive to more if the circumstances require it. Another university will guide assist the researcher, but will not assume responsibility for the connection. The third university also has the regional Internet2 interconnect as part of the central IT organization and is able to facilitate these special cases to suit the requirements. While such requests are rare, reduced costs and increased capacity needs show a trend for more off-campus connectivity.

4.14 ERP - Enterprise Resource Planning (ERP) is business management software—not typically a suite of integrated applications that an institution can use to collect, store, manage and interpret data from many academic, business and research activities, including: budget planning, cost analysis, or service delivery. While all but one participant provides some form of ERP system, one university is faced with multiple home grown software platforms in a decentralized environment. Efforts there are underway to consolidate and make consistent the process whereby the institution manages research budgets and reporting functions.

4.15 Project Management – This service encompasses central IT taking responsibility for a component of a research initiative or in very few cases the entire data management plan of a project. Those that offer this function admitted that there was room for improvement and the knowledge base necessary to adequately perform such duties was time consuming and therefore very costly. The benefit to the researcher is that they will be able to totally devoid themselves of such IT functions as configurations, implementations, etc. and devote their resources to the research project.

4.16 Institutional Compliance – 6 of the 8 universities interviewed conducted design reviews in one form or another to ensure that the equipment, applications, and data management would not disrupt the campus infrastructure. The remaining 2 institutions left the detailed reviews to the decentralized IT groups and made recommendations only when called upon. Involving central IT in such design reviews would minimize issues with implementations that do not consider the impact in such areas as security or backbone capacity on the university as a whole.

4.17 Funding Agency Compliance – distinct from other areas mentioned above, researchers may be required to ensure that their projects comply with federal and state standards for data management and security. This is most common with healthcare and patient data but also is relevant to many other facets of the university's mission regarding research and education. It is most often left to the decentralized IT organization to assume responsibility for ensuring that standards are met. In very few cases was central IT responsible for agency compliance and then only when called upon.

4.18 Relationship Management – Still in its infancy, the relationship managers are rapidly showing their value to the research community. Working across schools and centers they are able to identify cost saving synergies and act as facilitators between individuals and laboratories. It is rare that different departments interact, creating a loss of economy for the university as a whole. The relationship manager can be instrumental in bringing the research community together.

Institution	Grant Writing	H/W Purchasing	Contract Staff	Technical Compliance	Computing, Individual	Computing Shared	Data Center	Technical Consulting	WAN Connect	ERP	Project Management	Institutional Compliance	Agency Compliance	Relationship Management	Faculty Recruit Retain
Univ. A		X	X			X	X	X		X	X	X			
Univ. B						X	X			X		X			
Univ. C			X	X	X	X	X	X	X	X	X	X	X	X	X
Univ. D	X	X		X		X	X	X		X		X		X	X
Univ. E						X	X			X		X			
Univ. F	X	X				X	X			X					
Univ. G						X	X	X	X			X	X		
Univ. H					X	X	X		X	X	X			X	

4.19 Faculty Recruitment and Retention – When asked if the central IT organization was engaged in assisting the Provost or VPR in the recruitment of faculty from other institutions 6 of the 8 responded, "no". According to an Educause review in 2012, it is important that the IT functionality of an institution be described as a benefit when soliciting well known faculty with large grants from other universities. The same holds true for retaining faculty that have received IT intensive awards that the institution may not be able to accommodate. It is not unusual for faculty members to become disgruntled upon arrival or to leave a university for better lab space, bandwidth, or services available from central IT.

Table 3 Central IT Offered Services

5.0 Funding Mechanisms

The model to fund supporting IT in the research communities has not yet matured in any of the universities interviewed. In the past individual investigators were largely self-sustaining, itemizing in their grants those components necessary to gather data and analyze it. The trend towards eliminating the stand alone laboratory and become more collaborative have complicated the funding of projects since budgets now include 2 or more institutions. Staffing, equipment, computing, and storage budgets need to allocate expenses as if they were multisite companies. The business aspect of research now requires a more in depth management of procurement, space allocation, and human resources. Business development and facilities management are facets that researchers are generally not accustomed to.

In an effort to reduce costs, investigators are considering cloud service providers as an attractive alternative to campus facilities since they allow easier access across distances and between collaborators and minimizing what could be long lead times before their needs are realized by the university. This is a challenge for the central IT organization because it shifts the focus from facilities based computing and storage to offsite companies thereby increasing the need for higher bandwidth connections. Investment decisions to build or expand data centers have a high degree of risk because the total cost could easily exceed the return over the estimated lifespan of the technology.

5.1 Allocated Expenses versus Cost Recovery

Of the 8 respondents to the survey, 5 universities recover their costs through an allocated charge levied against schools and centers. Also known as a "tax" the methodology used is based on various factors, most frequently headcount; total student plus faculty or student, faculty and staff. A percentage of the estimated operating budget for central IT is applied to each school or center and becomes the published revenue base for the entire department. In some cases, only those services that are common to the entire university such as Internet, voice, and cabling are included in this model, while programming and new wiring projects are based on quotations and charged directly to the school. While this process is common, it means that the special needs of the research community are in conflict between available funds and grant budgets.

In **Table 4** we see that with the exception of voice, the common services are paid for through an allocated charge. Maintaining the campus backbone in two instances is covered by a port fee that varies by the capacity requested. With a 1G connection being fairly standard and 10G interfaces are available, but only by request.

Table 4 Key Common Services funding Source

Name	Internet	Internet2	Campus Backbone	Voice
University A	Allocated	Allocated	Allocated	Direct
University B	Allocated	Allocated	Allocated	Direct
University C	Port Fee	Allocated	Allocated	Bundled
University D	Allocated	Allocated	Allocated	Direct
University E	Allocated	Allocated	Allocated	Direct
University F	Allocated	Allocated	Allocated	Direct
University G	Allocated	Allocated	Allocated	Direct
University H	Allocated	Allocated	Port Fee	Direct

In **Table 5** the services that are most applicable to the research community are reviewed. A description of the categories:

5.2 Specialized Campus Circuits – When a request is received for a network connection, either directly to the border router or a campus point-point to another location, a fee may be charged.

Researchers may also request a circuit to the Internet2 interface and thereby bypass the campus backbone. In some cases, two departments on the same campus are collaborators.

5.3 Specialized Off Campus Circuits – There have been occasions when a high profile researcher has requested a direct link to the funding agency or analysis site. Only one institution has that service capability and fees will vary according to capacity and remote location.

5.4 Shared Computing – In cases where central IT provides a computing resource, some schools use the allocated cost for recovery of basic expenses such as electric and HVAC, but will charge for usage accordingly. However, the formula for determining usage varies widely.

5.5 Data Center Space – Most universities charge researchers for full or partial rack space in their central data centers. This ranges from electric only to a full service; installation, administration and maintenance suite of services. In cases where the funding source is derived from allocated fees, expansion requires a request to the administration and may be difficult to obtain or delayed beyond the need. This has made cloud services more attractive.

5.6 Budget Management – The question was presented as a service whereby central IT will manage the IT budget aspects of a researchers grant. Only one institution offers this and even then on rare occasions. In decentralized environments this may be offered by a school or center. In all cases, the office of the VPR plays a role in managing budgets associated with research.

5.7 Project Management – Does central IT provide a service for managing the IT components of a research project? With one exception, the answers were “no”. This would include the installation, configuration, and initial testing of IT related h/ware for grants already awarded. The assumption here is that such expenditure was accounted for in the initial grant budget.

5.8 Grant Overhead – The percentages listed account for space, utilities, and a variety of general university services in support of funded research initiatives. This information is simply provided as a fact, but in 3 instances the person interviewed shared that central IT did not receive any funds from this fee.

Historically, funding for centrally provided IT services is an issue for all institutions but particularly for the public universities. Constraints on purchasing processes and dependencies on government funding made it difficult for IT organizations at public institutions to maintain state of the art facilities which in turn limited their ability to attract high profile investigators. I thought that the answers to the final question of the interview put to the 4 public and 4 private institutions spoke volumes about their view on current funding models. The question was:

Do you feel your current funding model is:

A. Inadequate to meet the needs of the research community

B. Adequate for current needs?

C. Adequate but needs revision for the future

D. Inadequate in general

In order:

4 answered "D", inadequate in general

3 answered "C", adequate but needs revision for the future

1 answered "A", Inadequate for their research community

Table 5 Research Support Services

Name	Specialized Campus Circuits	Specialized Off-Campus Circuits	Shared Computing	Data Center Space	Budget Mgt.	Project Mgt.	Grant Overhead
Univ. A	Not Offered	Not Offered	Direct	Allocated	Not Offered	Not Offered	60%
Univ. B	1G-Standard 10G-Direct	Not Offered	Minimal Offering	Varies	Not Offered	Not Offered	unknown
Univ. C	1G-10G Allocated	Not Offered	Usage Fee	Direct	Not Offered	Not Offered	52.5%
Univ. D	1G-10G Allocated	Not Offered	Allocated	Allocated	Not Offered	Not Offered	62%
Univ. E	Not Offered	Not Offered	Not Offered	Direct	Not Offered	Not Offered	56%
Univ. F	Not Offered	Not Offered	Basic is Allocated + Usage	Direct	Not Offered	Not Offered	Varies
Univ. G	1G Standard 10G-Direct	Not Offered	Offered by Schools	Direct	Not Offered	Not Offered	51%

Univ. H	Direct	Direct	Not Offered	Direct	Direct	Direct	60%

6.0 Summary and Conclusions

Much has changed since the ECAR report of 2012. University Presidents and VPRs are placing a greater emphasis on recruiting and retaining high profile investigators, while Provosts and Deans include more undergraduate research requirements in the curriculum. This puts additional strain on CIO's to provide staff and infrastructure resources without necessarily receiving more funding. While central IT organizations struggle with ways to improve their support of their respective research communities, new trends in service offerings are surfacing that increase the value of internal organizations.

6.1 Challenges Still to Overcome

Perhaps the greatest challenge comes from the culture that has evolved in a decentralized environment. When central IT was perceived as the unit that was primarily responsible for voice, building-building cabling, dormitories, and administrative systems/applications it was necessary for schools and centers to develop their own resources to deal with the research needs that were very often highly customized. Most often, knowledge sharing between schools and even within the same department is nonexistent. Attempts by central IT to reverse or modify such an established culture generally meet with resistance with the attitude of "Don't touch my stuff!" taking precedence over efficiency and economies of scale. If universities are to improve their competitiveness and provide investigators with a suite of reasonably priced services then there must at least be a close cooperation, if not mergers, whereby the technology skill sets are available across the traditional boundaries of fields of study.

Another perception of central IT that must be overcome is the sense that they are so entrenched with processes and standards that they are unable to accommodate the needs of a research community that requires a flexible and oftentimes dynamic environment. Central IT is by nature process oriented and necessarily so, in order to facilitate the normal operation of the institution. Finance, student systems, and the like are assumed to be stable environments in order to ensure that daily operations continue uninterrupted. However research, by nature, deals with new protocols, formats, and technologies that are inconsistent with standard operating procedures. If IT organizations are to gain credibility and trust it must be receptive to non-standard processes.

Last, but certainly not the final challenge is the ability to create an infrastructure that is balanced between cost and demand. The average researcher assumes that because they are paying for overhead it will include all or most of the services mentioned in section 4. Unfortunately, research demand is difficult to forecast, and particularly difficult when creating a budget for additional storage, computing capacity, and bandwidth. Frequency of the service is also an issue. The "Big Data" project that requires high capacity networks for transmission to agencies or collaborators may only run four times a year. The university may not be able to cover expenses for circuits that are available 24x7x365. Fortunately, relatively new layer2 services are able to provide temporary direct connections, and computing/storage hardware is modular and easily scalable.

6.2 Trends That Show Promise:

The communications process between central IT and the VPR was excellent in some cases and very informal in others. While regularly scheduled meetings are held between the CIO and the VPR, the impression was that central IT is still more reactive than proactive. Meetings with the PIs to determine service needs are rare unless directed to do so by the VPR or requested by the PI.

But 3 institutions have implemented Client Relationship Managers, (CRM). These individuals are charged with proactively reaching out to department heads and act as liaisons between central IT, local IT organizations, and the research/academic groups on campus. The results have been immediately positive even to the point where the CRM is now deluged with meeting requests. This has put a new strain on central IT and created a backlog of work orders and capital projects, but the mere fact that IT is listening to the needs of the community has at least temporarily created a good image.

The sustainability of the CRM will depend on whether or not the organization has the resources to satisfy the demand.

Another positive trend is the provision of temporary IT staff to the researcher for the length of the grant. The person reports to central IT on the organization chart but is "embedded" in the researchers lab and works either part time or full time for the P.I. The grant covers the fully loaded cost of the employee and can be paid to central IT via a budget transfer. Arrangements are made prior to the grant submission where the skills are specified and the financials are a fixed rather than estimated cost.

The benefits of this program include the having the advanced skill and knowledge sets that an IT professional can offer, presumably at competitive rates, and the separation of duties between graduate students and IT staff means that the student is focusing on the research and not on programming or system administration. While this concept is new enough that the initial embedded staff members are still on their first assignment, when the research project is complete, the person will be returned to the pool, awaiting their next placement.

Centralized computing which is shared across the university and available to researchers was claimed to be an offered service by all the participants. While the funding models vary, most of the initiatives are pilot programs, but growing. Most of the research communities still prefer to have their system analysis done on site but the "server under the desk" is still prevalent. Everyone admits that the unknown systems are only hidden until they stop working, at which time either the central or departmental IT unit is called upon. By providing community access to centralized computing, central IT eliminates a number of potential issues; security, standards compliance, backup and restoration, cost economies of scale, access to high performance networks, and proper trouble ticket reporting. One additional advantage is that the university IT department becomes a viable option for the investigators when determining the cost, data availability, and security of their research.

Three of the universities have created research divisions within the central IT organization that report directly to the CIO, (a 4th is in progress, but with only 1 person). The reported benefits reveal this to be an excellent decision. Not only is the interaction between IT and the research community vastly improved, but the link between services requested and services offered has reduced response times and increased trust and credibility. Funding for the additional staff is generally provided through a combination of direct charges and allocations.

6.3 Areas for Improvement:

While the above improvement trends are showing positive results there is still the issue of vertical communications across the organizational charts of an institution. The Relationship Manager can play a key role in acting as the research ombudsman if they are given the authority to interact at all levels. They can be a valuable source of information for both the VPR and the CIO. Frequent meetings with PIs will lead to the discovery of service needs and these can be passed on to local IT organizations or central IT whichever is more appropriate.

One element that was particularly lacking was the marketing of current or new services by central IT. While improvements are being made in inter-campus communications there does not seem to be a cohesive effort to make the research community aware of the services being offered. Central IT is frequently in competition with commercial providers and it is not unusual to discover that an available service or product was awarded to an outside company simply because the investigator was not aware the need could be filled internally. Some universities have established working groups consisting of research deans, a representative from the VPR's office, and central IT. This is one good avenue for making options available as long as it doesn't come across as a "hard sell".

Commensurate with the marketing concept is the provision of an ROI. With the exception of very large labs with assigned business managers, most researchers are not business oriented and will make IT decisions based on traditional procedures. The perfect example is when data will be sent to a collaborator or funding agency by shipping hard drives via commercial carrier. If damage occurs, (and it does happen on occasion), the rest of the data can be useless. Using the connection to the advanced network can be faster, more reliable, and more secure. What the research community needs to know is ***why*** they should use central IT services. What is the payback in terms of cost and productivity? This may be an additional role for the research relationship manager or the project manager, but the resource can quickly be funded if the money spent on an outside provider is channeled through central IT.

In a decentralized environment establishing a bi-directional trust relationship with school/center IT Directors and their staff is essential to the success of a cooperative work environment whereby both organizations realize a benefit. Achieving this allows the university to react more quickly to the researchers service needs. This generates more productive outcomes on grant objectives which

The last example I will speak to is the inclusion of central IT in the overhead charge levied against grants, (See Table 5, page 16). In very few cases does this funding seem to find its way into supporting IT services. This is one possible source of funding for the research Relationship Manager.

While this paper should be considered an individual's opinion relevant to facts gathered from a small sampling of universities, and in no way is a research initiative comparable to the ECAR report of 2012, it is nonetheless a statement about the current trends and conditions relevant to how central IT organizations are dealing with the growing demand to support their research communities.

Based on interviews, external readings, and personal observations as the Director of a regional research network and connector for Internet2, I can safely say that 3 important trends are taking place across the U.S. IT organizations are becoming more proactive, more client centric, and treating themselves as a business within the university. I can only hypothesize that the impetus for these trends is brought about by Presidents, VPRs, and Deans that see research as; 1.) a means of improving the human condition, 2.) the expansion of knowledge about our universe, 3.) good business, and 4.) national and global recognition. Order these in any sequence you see fit.

REFERENCES

Bichsel, Jacqueline (2012) "Research Computing, The Enabling Role of Information Technology", (Research Report), Louisville, CO: EDUCAUSE Center for Applied Research, November, 2012, http://www.educause.edu/ecar

Dirks, Nicholas B., (2015) "Rebirth of the Research University", The Chronicle of Higher Education, April 2015, http://chronicle.com/article/Rebirth-of-the-University/229585/?cid=at&utm_source=at&utm_medium=en

National Institute of Health (2014) "NIH Data Book", (U.S. Government Web Publication), Washington, D.C.: U.S. Department of Health and Human Services, http://report.nih.gov/nihdatabook/

National Science Foundation, "Campus Cyberinfrastructure - Network Infrastructure and Engineering Program (CC-NIE)", (Program Solicitation), Washington, D.C.: Office of Cyberinfrastructure, October 2012 http://www.nsf.gov/pubs/2013/nsf13530/nsf13530.htm see also: https://www.nsf.gov/attachments/123382/public/CCNIEThomp.pdf

National Science Foundation, "A Timeline of NSF History", (U.S. Government Web Publication), Washingotn, D.C., https://www.nsf.gov/about/history/overview-50.jsp

Williams June, Audrey, "What it Means to Reach for Carnegie''s Top Tier", *The Chronicle of Higher Education*, April 27, 2015, http://chronicle.com/article/What-It-Means-to-Reachfor/229651/?cid=at&utm_source=at&utm_medium=en

Use the "APA Reference format" for references – that is, a list at the end of the paper, ordered alphabetically and formatted accordingly: http://apastyle.apa.org/. The references are also in 10point Trebuchet MS font (format: Body text – EUNIS 2). References should be published materials accessible to the public.

Gregory D. Palmer, Biography

Education

- **Bachelor of Science**, **Business, Operations Management** **1988**
- Co-authored, Statistical Analysis of Small Business Behavior
- Cum Laude graduate

Honors

- Invited Speaker, EUNIS Congress, Riga, Latvia - 2013
- Invited Speaker, Caribbean Knowledge and Learning Network, Port of Spain, Trinidad/Tobago
- Invited Speaker, Wharton School of Business, University of Pennsylvania – Executive Masters in Technology Management Speaker Series - 2003
- Invited Speaker, University of Texas/Dallas – 2002

Awards

- University of Pennsylvania Models of Excellence – 2010
- Keystone Initiative for Network Based Education and Research - Achievement Award – 2009 – 2010
- University of Pennsylvania Models of Excellence – 2006

Experienc e

MAGPI Exec. Director , Univ. of Pennsylvania November, 1999 – Current

- Established regional high performance network in PA, NJ, and DE in support of research and education
- Created a unique business model for the construction of fiber optic, dense wave division multiplexing
- Successfully contracted with government laboratories for high capacity transport circuits
- One of 6 co-authors for the successful $99.6 M Broadband Technology Opportunity Program, (ARRA stimulus funds for the Pennsylvania state network, PennREN)
- Original programs developed in education and professional development for students and faculty in grades K-20
- Co-PI for the first Digital Humanities grant award, “Digital Corinth” - 2008
- Chairman, Internet2 Africa Regional Interest Group – 2008 – 2013
- Board Member – Pennsylvania Council for International Education, 2007 – 2011

- Advisory Council Member – Asian Studies Collaborative, 2009 – 2012
- Board Member – Hi-Tech Healthcare Annual Symposium – 2010 - 2013

Director of Global IT Operations, Christian Dalloz, Ltd. 1998 - 1999

- Global LAN/WAN infrastructure development for 42 sites worldwide
- SAP servers, EMC storage Management
- Y2K integration on all systems and desktops
- Distributed backbone built for 6 countries in Europe plus the U.S.

Director of Campus Computing, Drexel University, 1995 - 1998

- Awarded NSF grant for participation in the Vbns research and education network
- Completed campus re-wiring project
- Initiated the first wireless pilot project
- Transitioned mainframe computing to centrally administered server farm
- Implemented Digital Northern Telecom PBX to replace Centrex voice service

Telecommunications Manager, Okidata 1985 - 1995

- Collaborated with parent, OKI Japan, to implement multi-nation X.25 packet network
- Digital PBX with 5 digit dialing to 5 locations in North America
- First Local Area Network Ethernet installation
- Digital Voice Trunking over T-1 connections
- Videoconferencing to 5 North American sites via ISDN

Academic IT support for Data Science

Simon Price

Advanced Computing Research Centre, IT Services, University of Bristol, Beacon House, Bristol BS8 1QU, UK, simon.price@bristol.ac.uk

Keywords
Data Science, Big Data, Research Data Management, Research Software Engineering

1. Summary

Globally, over 500 universities now offer data science courses at undergraduate or postgraduate level and, in research-intensive universities, these courses are typically underpinned by academic research in statistics, machine learning and computer science departments and, increasingly, in multidisciplinary data science institutes. Much has been written about the academic challenges of data science from the perspective of its core academic disciplines and from its application domains, ranging from sciences and engineering through to arts and humanities. However, relatively little has been written about the institutional information technology (IT) support challenges entailed by this rapid growth in data science. This paper sets out some of these IT challenges and examines competing support strategies, service design and financial models through the lens of academic IT support services.

2. THE DATA SCIENCE LANDSCAPE

There is currently no universally agreed definition of "data science" and, much like the related term "big data", the term "data science" has been adopted by different communities to refer to substantially different concepts. In industry, data science is frequently associated with data analytics, data engineering and big data technologies such like Hadoop or NoSQL. These associations are also found in the university sector, where data science courses have emerged from an eclectic range of academic departments (Swanstrom 2016). However, research-intensive universities tend to emphasise the established academic disciplines of applied statistics, machine learning and computer science over specific technologies. Despite 52% of data scientists on LinkedIn having only earned the title in the past four years (RJMetrics 2015), a well founded academic claim has been made that data science as a practical applied discipline is at least 50 years old (Donoho 2015).

Setting aside industry's and academia's differing views on the core competences of a data scientist, few would argue against the multidisciplinary nature of data science nor that its impressive range of applications is entirely dependent on IT. Given the major investment in data science research and education by governments and industry, right across the spectrum of academic disciplines, this might seem like good news for financially hard-pressed academic IT support services.

The Alan Turing Institute, the UK's national centre for Data Science, was launched in January 2015 with an initial £52m (€67m) investment from government and industry (ATI 2015). Headquartered at The British Library and further funded through the UK's Engineering and Physical Sciences Research Council (EPSRC), the five founding partner universities of Cambridge, Edinburgh, Oxford, UCL and Warwick have each committed to major recurrent investment in Data Science within their institutions. In the United States, universities such as UC Berkeley, NYU, MIT and Stanford have major Data Science programs and the universities of Rochester and Michigan have both individually made investments on a similar scale to the UK's initial ATI investment.

Why then, with all this inward investment, is this not necessarily good news for the traditional university IT Services division?

3. IT CHALLENGES OF DATA SCIENCE

One challenge lies in the fact that effective research IT support, and data science research in particular, demands more than just the standardised, centralised, corporate-style IT support that universities have increasingly moved their IT divisions towards, albeit with worthy intentions of reducing operating expenditure by exploiting economies of scale. That 21% of the data science courses listed in (Swanstrom 2016) are delivered online suggests that this corporate approach to education IT might be working as well for data science as for other disciplines. However, research IT support for the application of data science across multiple disciplines is far more challenging. Research data comes in a broad range of data types and formats from heterogeneous sources, including laboratory equipment, scanners, medical devices, sensors networks, digital collections or the web; it is processed through computational pipelines and scientific workflows; it is analysed and visualised using data science methods that may also require considerable time investment to gain an understanding of the data and domain together. The specialist IT knowledge required to support such involved and domain-specific work is more likely to originate from staff (or students) embedded in the research group itself rather than from generalist IT support staff working centrally.

In other words, the traditional academic IT Services division is highly unlikely to have enough staff with either a background in each specific research domain nor with up-to-date experience working as an applied data scientist. It is therefore not surprising that the money flowing into universities to develop data science research is being channeled into the operational expenditure of the research groups themselves rather than into IT Services. However, the irony is that the research groups do not have, and will never be able to afford, enough people with this rare combination of skills either.

4. CO-DESIGNING IT SUPPORT FOR DATA SCIENCE

In 2015, the University of Bristol started designing a data science institute, following its established model for multidisciplinary university-wide institutes. While its existing institutes address specific grand challenges, such as climate or health, the new one concerns a set of widely applicable methods, tools. A process of co-design between academics and professional services is exploring a broader model, the Data Institute, builds on Bristol's existing strengths in research data storage and management, advanced computing and research software engineering (Gardiner et al. 2012). The main challenge Bristol or other universities in providing world-class support for data science research is to find economically sustainable ways of developing and bringing together teams of people, for the right period of time, who collectively have the right mix of skills to support academic IT aspects of data science embedded within research groups. From the IT side, a survey of all 190+ IT Services staff skills provided an up-to-date profile of relevant skills to inform training and future recruitment needs. On the academic side, a variety of staffing, advocacy and costing models are being considered to bridge the data science skills gap that neither academic IT nor the Data Institute can achieve alone. Options currently being explored include shared posts, facility-based versus fractional posts as a means of cost recovery from grants - to fund people and equipment. Also, potential synergies with corporate data storage, management and analytics are being examined: can we apply our data science expertise from research to bring wider benefits to the organisation.

5. REFERENCES

ATI website (2015). *The Alan Turing Institute - the UK's national institute for data science*. Retrieved February 12, 2016, from: https://turing.ac.uk/.

RJMetrics website (2015). *The State of Data Science*. Benchmark Report Series. Retrieved February 12, 2016, from: https://rjmetrics.com/resources/reports/the-state-of-data-science/.

Donoho, D. (2015). *50 years of Data Science*. Tukey Centennial Workshop, Princeton, NJ, September 18, 2015. Pre-print, Version 1.00, September, 18, 2015, Stanford University.

Gardiner, C., Gray, S., Price, S., Boyd, D., Knight, V., Steer, D. & Cregan, B. (2012). *Towards sustainable, enterprise-scale Research Data Storage and Management*. Digital Research 2012, University of Oxford.

Swanstrom, R. (2016) DataScience.Community website. *College & University Data Science Degrees*. Retrieved February 12, 2016, from: http://datascience.community/colleges.

6. AUTHOR BIOGRAPHY

Dr Simon Price is the Academic Research IT Manager for the University of Bristol and a Visiting Fellow in Computer Science, with research interests in Data Science, e-Science, e-Research and Digital Humanities. He leads the Research IT group in the Advanced Computing Research Centre, a joint venture between IT Services and the Department of Computer Science. Over the last two decades years he has led a wide range of academic IT projects and services at the University of Bristol, including strategic institutional projects like the data.bris Research Data Service, IT Services R&D, the Institute for Learning and Research Technology (ILRT), the Learning Technology Support Service, as well as the Bristol Online Surveys (BOS) national service as well as numerous academic software development projects. https://uk.linkedin.com/in/snprice

Future Trends in Higher Education and Research in Finland

Outi Tasala

Coordinator at CSC – IT Center for Science, Keilaranta 14, Espoo, Finland, outi.tasala@csc.fi

Keywords
HEI's, future, trends, education, research, national perspective

1. Summary

There is an endeavor in the higher education sector in Finland to identify and predict the future trends that will have the most impact on the sector within the next 5 to 10 years. The aim is to provide a national outlook on what is to come; to convey one possible picture of what the future of the Finnish HEI's, and perhaps also the international higher education and research communities, will hold. The work is done with the goal of helping the institutions in finding a common ground when planning ahead, thinking anew their ecosystems, and in identifying possibilities for working together.

2. ABSTRACT

The field in which the institutions of higher education in Finland operate in is in flux, partly due to the recession. The institutions have to cut back, but at the same time there is a need to invest in digitalization, as this is seen as a way to ensure growth in the future.

A common understanding of the possible future changes is needed to steer the strategic decisions for the future. Thus, it is important to know what the vital areas are where change is imminent, and what to focus on in the long run.

In the higher education sector in Finland there is an endeavor to identify and predict the trends that will have the most impact on the field within the next 5 to 10 years. The starting point for gathering information was Educause 2015 conference, on the basis of which the representatives of the HEI's in Finland have compiled a list of the future trends in higher education and research. Finnish HEI's student administration staff, support services, experts on pedagogy, digital education and learning, and experts on research administration are now processing the list further, and adapting and localizing it to better suit Finland and the European higher education area. The results from this will be presented in the Finnish rector's ICT meeting in September 2016.

Future changes are inevitable and preparing for them well in advance is crucial. Work like this has been done already, mostly from an IT perspective. Indeed this analysis builds on Educause and the work by Gartner, among others. However, a local perspective is needed, especially in a small market like Finland. The aim for this work is to provide a national outlook on what is to come; to convey one possible picture of what the future of the Finnish HEI's, and possibly also the international higher education and research communities, will hold.

The work is ongoing and the final paper is expected by the end of 2016, but the results available now already give good grounds for discussion in an international context. The early results show that in the future even some of the core tasks may be outsourced and acquired from organizations outside the institutions' traditional ecosystems. Cooperation within the institution and faculties, but even more importantly between the institutions, will make a greater success factor in a small market. Business intelligence thinking is inserting itself in the Finnish HEI's, and academic and learning analytics will be utilized to a greater degree. There is also some indication that the core structure of the institutions is changing, affecting the roles of staff in various ways.

This analysis hopes to serve as a toolkit for the rectors of the HEI's in Finland; identifying the key issues and making predictions for the future may help the institutions in finding a common ground when planning ahead, thinking anew their ecosystems, and in identifying possibilities for working together.

3. AUTHOR'S BIOGRAPHY

The author currently works as a coordinator at CSC – IT center for Science, an organization governed by the Ministry of Education and Culture in Finland. The work at CSC aims at helping the HEI's in their efforts in digitalizing the processes and services in the field of education, mainly by facilitating the work of different interest groups. The author has a Master of Arts degree from the University of Helsinki. More information about the author can be found on LinkedIn: https://fi.linkedin.com/in/outitasala

How Application Virtualization improved the student and staff IT experience at Odisee University College

Cloud computing, collaboration, standardization.

Jan Van Calster

1. SUMMARY

Odisee is a Flemish University college, based close to Brussels, Belgium, and a member of the KU Leuven Association. The university was created on January 1, 2014 through the merger of Hogeschool-Universiteit Brussel (HUB) and the Katholieke Hogeschool Sint-Lieven (KAHO, Ghent).. Odisee currently has an enrolment of 11,000 degree programmes along with 9,500 postgraduate programmes covered by 1,100 administration and academic staff across 6 Clusters. At campuses in Brussels and Ghent, Odisee also service KULeuven University students (7000 enrolments) and Academic staff (750 members). The University College currently employs Microsoft System centre more commonly known as SCCM to distribute applications to the 4000 PC's situated in a mixture of Labs, open access Labs and staff/administrative desktop and laptops. All of these machines are required for the Universities main function in bringing mainstream applications to the students, teaching staff as well as applications necessary to deliver the day to day working of a successful University.

2. THE PROBLEM

Odisee is committed to 'Improving the Student IT Experience' and as part of this program the proactive management of the software estate and innovative ways of delivering software to users would contribute positively to an all-around improvement in IT delivery.

Odisee had reached a point where the infrastructure for managing software delivery needed to be brought in line with students expectations for modern software application delivery – anytime, anywhere on demand.. One particular problem to remedy - the completion of a new request for a software application by a user - was impacting on the ability of the IT team to meet SLA's. With lots of software applications to release, the ongoing testing and release cycle was consuming more and more resource. This is could have contributed to user dissatisfaction with their IT Service and was a key area to improve.

Distributing software in the 'old' way also created very large distribution packages. Like most universities it is difficult to predict in advance in which classroom needed what software packages In some cases an average of 140 software titles were installed on classroom PC's. Managing this many applications across 1000's of PC's could cause further issues; applications not working as they should, incompatible software packages, conflicting requirements etc.

Moreover, to facilitate planning of computer classrooms, the installation of software titles in more classrooms than actually needed could result in either violation of licensing agreements or in extreme instances buying more licenses than actually needed.

Some software titles could be licensed to certain groups of students (e.g. ICT students) and installed in dedicated labs However, this could restrict them from using this software in open labs environments or in BYOD situations. It was clear that challenging the way the university delivered software to students could provide an enhanced student experience

3. APPLICATIONS ANYWHERE, ANYTIME AND ANY DEVICE

In the field of education there is much diversity between institutions. There is no standard of software delivery with most university IT teams adopting their preferred method of software delivery. The needs of the university and requirements of the student need to be considered more comprehensively in the age of Bring Your Own Device (BYOD). BYOD is commonplace nowadays but for many this has sometimes stopped at providing WIFI access to student and staff's own devices.

Historically, the idea of Universities collaborating to share packages were applicable has been difficult because of the vast array of different technologies that are used.

The project, which sought a new technology to meet the correct requirements was funded by the University to find the most efficient way of delivering applications to students and staff without the need for physical installation of the software package. This was made all the more important due to complex license models and the inflexibility of moving licenses around the University IT estate. *Maximizing benefits of Application Virtualisation*

4. AMBITIONS

The project was designed to deliver many ambitions the University had when it came to delivering software to staff and students. The most important ones being:

- Use IT to improve the student experience
- Deliver applications to the desktop quickly and efficiently
- Reduce log on times and IT administration
- Improve timetabling and asset management
- Reduce software license costs
- Easily support applications on campus and BYOD
- Focus on proactive student support
- Remove the need for multiple and/or large desktop images.

With a focus on the student experience; the solution needed to efficiently deliver applications to the university managed estate, and the students unmanaged devices in a way that enabled tight control over licenses.

High performance on machines using CAD/GIS/STEM was essential, as Odisee required a method of delivery with no compromises, where the application could be locally executed on the device making use of some of the powerful hardware already purchased for labs that required heaver weight applications.

Another key requirement of the solution was to enable more informed decision making of

- what software titles were being used
- who was using software;
- the ability to structure software purchases more efficiently by knowing how many of software application were being used and in what quantity.

Finally, an easy way for students and staff to access this large array of software without the need for complicated installation on a University owned device. Likewise the solution needed to be user friendly on a student/staff owned device (on or off campus) whilst giving IT control of offline access and license control.

5. SOLUTION AND IMPLEMENTATION

An evaluation began and some investigation of the market in 2014 and after discussion with teams in the Faculties, a project proposal came together that would see all 4 faculties join forces with the aim of implementing a managed software delivery service that would be centrally run from IT.

The team agreed that the following requirements were crucial for a modern software management and delivery infrastructure:

- Quick turnaround of packaging an application (hit more SLA's)
- Simple console for ad-hoc deployment of apps
- Ability to add set list of applications to unattended PC install
- Web-based self-service kiosk for users (AppStore)
- Delivery of software to unsupported workstations (BYOD)
- Offline access; users must be able to use software when away from campus with no connection
- Support for legacy applications on newer operating systems
- Security (applications must be managed to adhere to licensing regulations)
- Easy to update/patch applications (software kept up to date smoothly)

The contenders

- Citrix ZenApp – Discounted as out of budget range
- Microsoft App-V – Discounted as failed to meet all technical challenges
- Numecent/Software2 Application Jukebox – Finalist through to POC

The Application Jukebox system provided an advanced application virtualisation technology, arguably offering Odisee greater flexibility than other application virtualisation products on the market. It had already been implemented and used extensively at some of the Europe's largest universities with significant results.

Application Jukebox provides a mechanism to deliver, manage and virtualize applications to a client machine from a centrally administered server. Odisee aimed to reduce the cost of application delivery, while improving service levels, simplifying management, and improving reliability and user experience.

With Application Jukebox, Odisee student could access and work on their applications as if they were installed locally. There are no reported performance issues and no complicated proprietary web interfaces they would need to navigate. Once activated, the university software applications appear in their Start Menus or on their desktop – just like local applications.

Applications are now delivered to end-user machines across their networks, meaning students can access the applications anywhere, whether on campus, at home or on the move. Critically, for the IT team, applications still remain centrally controlled and can be revoked at any time.

The main anticipated benefits of the App J (Application Jukebox) system would include:

- **Faster software installation and more reliable PCs**
  Reimaging of PCs is currently taking at least 6-8 hours. This is mainly down to the size of the image(s) and the amount and size of the Software applications available on the PCs. Using the application virtualisation software, PCs could be re-imaged in much less time than before, with a more reliable build.
- **Better and faster PC performance / running of applications**
  PC performance is improved as software packages do not have to be installed on the PC image. Software would be deployed on-demand, which means that PCs would be running quite lean, compared to the huge number of current applications that are currently sitting on the PC.

Traditionally, the more applications you install locally, the more bloated the registry and system folder will get. This makes the computer slower and increases the risk of failures. Application virtualization leaves the registry and the system folder untouched. Moreover, the application still behaves as if it was locally installed, and there's generally no compromise on performance, so users can make full use of 3D graphics, HD content, high-CPU performance and any other local resources. Advanced configurable virtualisation means the user experience remains the same without any conflicts with the end machine.

- **Improved speed and flexibility of software deployment.**
  Currently the image is agreed for each academic year, making if difficult to deploy new software or version upgrades etc. within the academic year. Application Jukebox would allow new software/versions to be easily deployed throughout the academic year, ensuring a more flexible response to teaching /academic needs.
- **Improved software license purchasing decision process**.
  By using Application Jukebox's reporting tools, it is possible to see what software application has been used. Application usage is metered within the system on a 'per user per second' basis, so a wealth of data is available for analysis. This data is then fed into Software2's Hub, where management dashboards are created with up-to-the-minute application usage information.
- **Enhanced student experience;**
  Improved student experience – potentially any Windows application to any managed machine. In addition, software applications could be found in a consistent way, across the whole University.
- **Full License Management leading to the maximisation of software resources**
  Administrators can keep track of exactly how many licences are being used at any given time and redistribute them where necessary. By maintaining a central pool of licences and allowing users to take from the pool wherever they are, as and when they need them, resources can be maximised and vast amounts of money saved. For example, expensive licences that are needed for teaching in School computer labs can be easily switched to other areas, such as the LRC, when the computer labs are closed.
- **Secure remote access to applications / Support for the Universities BYOD strategy**
  Applications are delivered to end-user machines across their networks, meaning users could eventually access applications anywhere, whether at home or on the move. However, applications still remain centrally controlled and can be revoked at any time. A self-service portal could therefore, longer term, make it easy for students to access the software they need on their own devices and laptops.

6. CONCLUSIONS

Application Jukebox has vastly improved the way we are delivering applications to;

- Odisee end users

- Odisee Students on university devices

- Odisee Students on their own devices

- Odisee Staff and administration desktops

Odisee now have the ability to stream any Windows application to any compatible device and have vastly improved performance against SLA's in the process.

7. AUTHOR'S BIOGRAPHY

Jan Van Calster – has a masters degree from the University of Leuven in Mathematics and applied Computer Sciences and has worked for HUB and now Odisee as they are now known as since 1983. Jan has taken on two roles in that time period serving as a member of the teaching staff; teaching networking courses up until 2004 where after that period he took on the new role of ICT Manager and now serves at the ICT Service Desk Manager.

His Linkedin profile can be found here : https://be.linkedin.com/in/janvc

EUNIS 2016: You are leaking metadata!
Abstract

Asbjørn Reglund Thorsen

FSAT, Fridtjof Nansens vei 17, 0369 Oslo, a.r.thorsen@fsat.no

Keywords
Hacking, metadata, automation, collection, analyzing, making, tool, harvest, google, dorking, bigdata

1. Summary

A lot of people know that a document may contain information they don't want to share with the world. But did you know that metadata in your pictures might have GPS coordinates embedded? Did you know that your powerpoint presentation might contain your username, IP addresses and other stuff that you might not want to share with the world. It's smart to check what information google, bing and others have collected about you and/or your business. It's also smart to have a *remove metadata* strategy so that you have control over your data.

2. ABOUT THE EXTENDED ABSTRACT

Each time you upload a picture, office file or something else to the internet, do you know what metadata these files contain? Do you wash the files before you upload them?

Google, Bing and other search engines indexes all commonly available web site on the internet. This presentation will in detail show how a hacker can use these search engines to harvest open data files like ppt(x), doc(x), pdf, excel, odt, gif, jpg and a lot of other files. People often do not know or think about that all files contain metadata and what information the metadata contains. Metadata may contain information like names, usernames, passwords, IP adresses to the internal network, GPS data, software versions used to create the document and much more. A hacker can use e.g Google to scope searches to pin point certain files from certain companies to harvest information. It is possible to automate such searches, and in this talk the presenter will walk you through how to make your own tool to harvest data of interest. This talk includes several live demos and will be an eye opener for people and/or companies, and will hopefully raise awareness of this topic. This talk is both for technical and non technical people.

3. REFERENCES

Reglund.com. Security blog with code examples. Retrieved February 13, 2016, from: https://www.reglund.com/youre-leaking-data-without-knowing-it/.

Reglund.com. Security blog with code examples. Retrieved February 13, 2016, from: https://www.reglund.com/metadata-in-pictures-embedded-in-docx-files-2/.

4. AUTHORS BIOGRAPHY

Asbjørn Reglund Thorsen is group leader and head of development at group Delta at FSAT, responsible for maintaining and developing applications for the national admission services in Norway. He also works as a pen-tester, speaker and is a co-founder of Awareness Security AS. He is board member of Open Web Application Security Project (OWASP) in Norway and has specialized in web application security both as a pentester and course instructor, he also likes to play with wifi pineapple and other gadgets. Linkein profile: https://www.linkedin.com/in/reglund

Democratizing (certified) video conferencing

George Kougioumtzakis[1], Savvas Anastasiades[2]

[1] Aristotle University of Thessaloniki IT Center, PO Box 888, EL 541 24, gkougiou@it.auth.gr
[2] Aristotle University of Thessaloniki IT Center, PO Box 888, EL 541 24, sanastas@it.auth.gr

Keywords
Video conferencing decentralization, modernization, optimization, regulatory compliance.

1. Summary

An overly expansive view of legal/regulatory restrictions, coupled with an outdated perception of the cost and complexity of modern video conferencing implementations, have for some time prevented our institution from taking full advantage of video conferencing in its academic and administrative functions.

Addressing this, we have created a framework to further the deployment of small-to-moderate scale video conferencing services, i.e. with sessions involving 3-6 points of up to ten persons each, in a coordinated, decentralized and cost-effective way. We have seen substantial positive results while gaining insights that may be of use to institutions facing similar scenarios.

2. CONTEXT

Since 2011, Greek law grants collective bodies of Greek academic institutions the ability to conduct their official meetings via video conference, provided that the infrastructure exists to ensure participants' identity as well as data confidentiality and integrity.

This provision, along with a concurrent change in the composition of a particular class of collective bodies (faculty election and advancement committees) created an immediate need for compliant ("CVC" - certified video conferencing) solutions to facilitate both hosting and participating in Greek academic institutions' official meetings.

Initially, only one CVC capable installation was fully operational in our institution, with two more on limited availability. Unsurprisingly, demand surged and was poised to reach unsustainable levels, despite our scrambling to setup additional video conferencing points in our central facilities. In response, a goal was set to decentralize the CVC service, ideally setting up an independently operated installation at each department of our university.

We faced several challenges pursuing that goal; this is an outline of those that may be of interest to non-Greek institutions. The term **CVC** may hereafter be interpreted as "**Video conferencing involving 3-6 points of up to ten persons each**".

3. CHALLENGES

3.1. Clearly define your aim

Video conferencing encompasses a broad range of scenarios and corresponding implementations, making it easy to lose sight of your target. Clearly defining and prioritizing your aims can save deployment time, effort and cost.

In our case, the focus was a baseline implementation that each of our institutions' departments could deploy swiftly and at minimal cost to address their CVC needs. At the same time we pursued versatile and expandable implementations with an eye towards eventually addressing other video conferencing scenarios.

Affordability (including the ability to repurpose existing hardware), versatility and expandability made personal computers the most compelling platform to build around. Our baseline was nothing fancier than pc + projector + speakerphone + PTZ "pan-tilt-zoom" camera (we actually had to wait for the market to provide performance pc video conferencing equipment at a comfortable pricepoint before proceeding). We have since complemented this implementation with more sophisticated ones (always pc-based), to accommodate a broader spectrum of use-cases.

3.2. Develop comprehensive and tailor-made propositions

To be convincing, our proposition had to leave no blind spots and be able to stand up to minute examination. A clear road map to implementation with time and cost estimates has been essential. We found that, even if they were not strictly our responsibility, leaving pertinent aspects unaccounted for made our proposition significantly less compelling. Items we had to consider include:

- Technical and administrative workflow design
- Law and regulatory compliance (and misinterpretations thereof)
- Room configuration, including furnishing, lighting and soundproofing
- Equipment specifications, suggestions and possible vendors
- Equipment testing and setup
- Additional tools for scheduling and coordination
- Staff training
- Support and backup

At the same time, while based on a template, our approach had to be flexible enough to accommodate (and, where possible, take advantage of) the specific situation and needs of every department. As an example, we came across six separate instances where departments had invested in dedicated video conferencing equipment but never came around to deploying it. In four of them, it was possible to incorporate this equipment in our implementation and help them recover their investment.

3.3. Practice what you preach

Initially, our central video conferencing facilities operated dedicated video conferencing (H.323) equipment and we soon found that advocating for one platform while using another weakened our argument. Also, faculty and administrative staff were often biased against a personal computer based setup, usually from personal experience with sub-par equipment.

In response, we procured and deployed our proposed baseline personal computer based implementation as the primary/default in our central facilities (pre-existing equipment was kept online as backup, as well as for psychological reasons).

Further, we visibly adopted our proposed tools and workflow, so organizers and participants of every meeting would experience a live functioning demonstration of our complete proposal. These participants often included people holding key positions in the decision making of their respective departments.

Feedback from daily interaction has shown that this has been a very effective way to clear misconceptions about the adequateness and efficiency of our proposal. Additionally, it has encouraged the administrative staff de-mystify and engage in the CVC organization process, making it easier for them to eventually take over and operate independently.

3.4. Do not antagonize peripheral operators

This is especially important if you intend to offer your central facilities as backup for peripheral CVC points. By cultivating your services to an ever-higher standard, you may be discouraging efforts to replicate and decentralize them. In extreme cases this may even result in departments reverting from their already established CVC points, to yours.

To encourage decentralization, focus on a consistent level of service across every CVC point, (including your own) and always seek to propagate any improvements you introduce.

3.5. Keep everyone in the loop

Open lines for communication with CVC points' operators present you with an opportunity to benefit from their feedback and help towards consistent CVC operations throughout your institution. This is also valid for inter-institutional cooperation.

4. RESULTS

Table 1: Active CVC installations at the Aristotle University of Thessaloniki

	2012	2015
H.323 based	3	7
Personal computer based	0	9
Total	3	16

The additional four H.323 implementations operating in 2015 are formerly inactive equipment which has since been activated. All CVC equipment procured since 2012 has been personal computer based.

Table 2: CVC decentralization

	2012	2015
Schools with access to an active local installation capable of hosting a certified video conference	3/41 (7.3%)	22/41 (53.7%)

While far from complete, the level of decentralization we have reached has eased the pressure on our central facilities, which are at the moment (and, barring dramatic regulation changes, for the foreseeable future), operating under a sustainable load.

5. AUTHORS' BIOGRAPHIES

George Kougioumtzakis: https://gr.linkedin.com/in/kougioumtzakis

Savvas Anastasiades: http://users.auth.gr/sanastas/CV-Anastasiades_en.doc

MOOCs: searching for a viable business model

Yves Epelboin[1]

[1]Professor Emeritus, university P.M. Curie (UPMC Sorbonne Universités), Paris, France yves.epelboin@impmc.upmc.fr

Keywords
MOOC, SPOC, e-learning, online course, business model

1. ABSTRACT

MOOCs are a new form of online learning different from the well-know distance learning, which exists since many years. The novelty is in the fact that they are opened to a general public and written for people working alone from a distance. All teachers, who have been involved in such projects, agree that the courses must be completely rebuilt. One cannot just accommodate old documents to a new means of distribution of the information. Moreover, MOOCs being accessible all around the world, documents of poor quality, acceptable in the theater and a small class, must be completely redesigned. Thus MOOCs are complex and expensive objects, which, contrary to ordinary courses, require a full team, to be created. The pioneers were enthusiastic teachers and support staff and did not count their efforts and time. But there is a large gap between building and delivering a few MOOCs and systematically transforming a conventional teaching into MOOCs. Being expensive any long-term project, based on MOOCs, cannot be launched without a business model and all MOOCs creators, all MOOCs providers face the same dilemma: how to subsidize a pro-MOOCs politics? We will first recall the environment needed to build a MOOC and explain why most universities cannot define a business model by their own since they do have neither the finances nor the manpower to systematically transform their teaching and massively create MOOCs. Cooperation among universities, donators, special funding and other sources of income are needed. MOOCs providers must also find their own business model, which differs from the possible ones for the creators, and do not have other choice than to work together and find complementary business models. In a last part we will show, through some examples, emerging business models for both the providers and the creators. The future of MOOCs and online learning is closely linked to the consolidation of these business models.

2. MANPOWER NEEDED FOR A MOOC

Building a MOOC has been, in the beginning, the work of teachers, pioneers and volunteers, who did not count their time, who had decided, for various reasons to jump in this new venture. This is why the time to build a MOOC, i.e. its cost has been systematically underestimated.

In a conventional course, the teacher stands alone in front of his/her students. The preparation and writing of the course, therefore, are essentially solitary tasks. A certain part of the preparative work may be done collectively, but ultimately, the teacher alone is in control of what he/she delivers to the students and documents are judged more by their contents than by their form. But building a MOOC is not just assembling a number of already existing documents and notes and quickly shooting some videos. It is much more demanding because all documents will be available worldwide and judged by numerous people. Quality has become an important matter (Butcher and Wilson-Strydom 2012) and online learning has been the first to profit from this momentum. The reputation of the institutions as well as the authors might be at risk if this is not taken into account (Parr 2014). In brief, to become a MOOC, a course must be rebuild from scratch.

A MOOC is a project, which requires the skills of very diverse people, as we will explain later. Like any team project, it requires a project manager to run it. As one may imagine, most teachers are unlikely to be willing to add this to their existing workload. They do not all possess the necessary skill and must be helped. MOOCs belong to a new manner of working, at all stages, when building the MOOC as well as when delivering its contents to thousands of students. This is quite revolutionary!

2.1. Contents design and pedagogical support

Teachers are the project masters: they define the objectives of the course and its scenario. They define which documents will be used. The costs are very depending on their objectives: writing new documents is more expensive than using open source, scientific documents with formula and graphics need more work than just ordinary writing. The time needed to build the contents of a MOOC may drastically vary according to the disciplines. The use of OER should be encouraged whenever possible but, at the same time, MOOCs authors are often more interested in their own writing than reusing other ones. Teachers must also build quizzes and exercises, whenever required. In most MOOCs they appear in the videos and, according to the individual skills and ease in front of a camera, the time devoted to the shooting and the work needed to edit the videos might be astronomically long! In some cases actors are substituted but this dramatically increases the price of the videos: not only additional staff must be paid but the teachers must completely write the discourse, which may be an additional burden when, often, notes suffice for an oral presentation delivered by the author himself.

In most cases teachers are not expert in online learning and the skills of an instructional designer are required. Except in a few cases, where the teachers have already a good practice of online learning, the participation of an instructional designer is mandatory. The instructional designer must be trained in the use of the Learning Management System (LMS), which will be used to distribute the MOOC. He/she coordinates the work of the support staff with the teachers and the MOOC's distributor. It is a hybrid role, lying in the intermediary zone between teaching and digital engineering.

Same additional workforce is needed to test a MOOC before opening. Otherwise accidents may occur, which may seriously damage the success of the course: misjudgment of the workload per week, errors in exercises and quizzes, technical errors such as missing or wrong links… A MOOC is a one shot story and the short history of MOOCs is already full of small catastrophes! See for instance Barshay (2013). A good advice is to recruit and to pay doctorate or master students. When the MOOC is running, exchanges among the students must often be solicited, which is the role of community managers experts in the field. The same students can be called together with the teachers. As we will see the cost of this additional workload is not very high but it must be taken into account.

2.2. Support staff

The success of a MOOC is very depending on its videos. Not only the contents and the charisma of the presenter are key factors but also the quality of the recording and editing is an essential criterion in the evaluation of a MOOC. A course may contain up to one hour of videos per week, divided in short sequences. It has been shown that the human attention span decreases very greatly (Guo 2013) beyond 9-12 minutes. Thus, the design of the course must be divided in sequences so as to conform to the format of the videos, that the people are used to watch on YouTube.

Recording and editing the videos requires not only trained staff but also the equipment. The editing of an hour requires up to thirty hours or more. This time could be reduced, but to the detriment of the quality. Soliciting the in-house video department is cheaper than outsourcing but in many cases there will not be another choice either because the local skills do not exist or because they are overbooked.

A graphic designer is needed any time a course contains graphics and pictures. Depending on the nature of the textual documents, the work is extremely variable, ranging from simple formatting for an ordinary document to the drawing of graphic diagrams and illustrations. Certain complex illustrations may require more than a day of work, others an hour or less; for the scientific domain, the writing of documents with complicated formulae may be a lengthy process. This depends heavily on the form and quality of the documents delivered by the teachers. The working time needs to be evaluated on a case-by-case basis, and experience shows us that it is extremely variable: the preparation of documents of the same length may require less than a day of work in some cases, or up to a month in others. However, the expertise of the graphic designer is always crucial.

Implementing the documents in the MOOC platform is often the responsibility of the instructional designer with the help of a web designer. Possibly he/she may have to rework existing documents and the workload may vary.

So, altogether, building a MOOC may require the collaboration of 5 to 10 people. The workload varies according to the field of study and the skills needed to build documents of high quality. This is quite new to most teachers and many may fill uncomfortable, having the filling to loose their freedom and their ideas.

3. BUDGET FOR A 6 WEEKS MOOC

This section is a summary of a study presented in Pomerol, Epelboin & Thoury (2014), chapter 2.

We have first considered a Science course, 8 weeks long, equivalent to one hour in front of the teacher and one hour of applied lecture and the official work time for the teachers as recognized by the university for online distance teaching. Then, in a second time, these estimations have been discussed in a seminar with a number of people who had been responsible for the first 10 MOOCs of the French MOOC platform FUN (2013). All participants agreed that the time had been underestimated and, in agreement with their experience, the results have been corrected and correspond now to a 6-week course. Later we have confronted our results with American colleagues, who have confirmed our estimations.

For this study we consider that the course is being used 3 times with 20% of modification before each rerun.

UPMC is a Research university and we were in charge of supporting e-education in all fields of Science. Thus we have chosen a Science MOOC from our 15 years of practice of distance learning at UPMC-Sorbonne universities and our experience in building websites and recording videos of courses. According to the subject and discipline it must be remembered that, in practice, the estimations may vary from 50% up to 150% of the presented data.

3.1. Staff resources

The workload may be divided in three parts: teachers (table 1), pedagogical support (table 2) and support staff (table 3).

Table 1 is the only part, which cannot be partially or completely outsourced. Data show that it is much higher than for a conventional course. The institution must be able to mobilize the requested resources. This is not only a question of financial budget but mainly depends on the availability of professors in the discipline. Before entering the adventure of the MOOCs an institution must precisely examine the available manpower. Many projects fail before the end due to an overestimation of available free time by the teachers. This is especially important the first year, when building the MOOC. For the subsequent years, the necessary updates represent about 1/3 of the initial time – i.e. 20 hours for the documents, and much less for the preparation of the oral content. Thus it could be wise to plan three years in advance to assemble an adequate team.

Table 1: Teachers working load

Task	Hours			Total	Comments
	Course 1	Course 2	Course 3		
Oral preparation	40	8	8		
Documents writing	90	20	20		
Writing of exercises	40	10	10		Varies with discipline
Recording of video	32	8	8		
Preparation of quizzes and homework	32	6	6		
Preparation of the project	30	5	5		
Total	264	57	57		
Total time				**378**	Preparation of the MOOC
Animation MOOC	48	48	48		When open
Total MOOC	312	105	105	**520**	

The pedagogical support is presented in table 2.

Table 2: Workload for the pedagogical support

Task	Hours			Total
	Course 1	Course 2	Course 3	
Instructional designer	40	8	8	
Project manager	60	12	12	
Testers	60	12	12	
Total	160	32	32	
Total for the MOOC				**225**

Most of the required resources can be outsourced but it must be taken into consideration in the budget (table 4).

Table 3 presents the workload for the support staff. It is of the same importance than for the teachers. These figures may vary considerably according to the discipline: a medicine course with many figures and graphics means much more work for the support staff, as well as for the teachers, to design these illustrations than a law course, which is mainly textual. Moreover, according to the local copyright laws, many figures, which could be projected in an amphitheater, must be completely redesigned for their use on the Web.

The complexity of the videos is also an important factor. For courses where the video is mainly the support of an oral discourse in-camera editing may considerably shorten the editing time. On the other hand when animations are required or when experiments are recorded data are underestimated.

Table 3: workload for the technical support

Task	Hours			Comments
	Course 1	Course 2	Course 3	
Video recording	32	6	6	
Video editing	240	50	50	Can be reduced to the expense of quality
Formatting of texts	10	2	2	Variable according to the initial documents production
Illustrations	35	7	7	Variable depending on the number and complexity of the documents
Integration	15	3	3	
Participation in meetings	10	2	2	
Total	342	70	70	
Total for the MOOC				480

Building a MOOC is much more demanding than preparing a conventional course and require skills, which not always exist in the universities. Subcontracting the work can be costly, thus, before engaging enthusiastically in the MOOC's adventure, institutions must evaluate the resources to be involved and their own capacities. It is a strategic decision, which must involve the highest levels of the university, i.e. the Presidency.

Table 4 presents the financial cost for the salaries, on the basis of 5000 €/month for the teachers, 4000 € for the support staff. At the time of the writing the euro and the dollar have about the same value.

Table 4: Estimated budget for human resources

	Year 1	Year 2	Year 3	**Total €**
Teachers	15,000	5,200	5,200	
Teaching support staff	6,000	1,200	1,200	
Technical support	10,000	2,000	2,000	
Total	31,000	8,400	8,400	
Total cost (approximate)				**48000**

This budget corresponds to the salaries but does not take into account the environment needed for the work: housing, training… and ordinary equipment such as personal computers. The practice (Kurt Salmon private conversation) is to multiply this estimation by a factor 1.8 up to 2 depending on the location of the university.

3.2. Logistics for a MOOC

Except for the video, the equipment is quite reasonable: computers and their software, from word and HTML editors up to Adobe Photoshop and Illustrator or equivalent. When animations are required it is more complicated and can be justified, in-house, when used elsewhere in the institution.

The environment for recording the videos may vary considerably, according to the desired quality and sophistication of the videos. The first factor to be taken into consideration is the available skills.

It would be useless to build an expensive studio for video beginners. It rises from a few thousands euros to record an oral speech up to €30,000-50,000 to be able to change the background, to be able to record a writing hand and to multiply the points of view. EPFL (2012), in Lausanne, has written a short memo to guide the newcomers.

The environment needed to distribute the course and make it available to the students will be discussed later together with the business models for the MOOCs providers because we believe that it would be unwise for a single university to be its own provider: running an Information Systems environment 24/7, accessible for tens of thousands users or more without disturbance is not within the reach of most universities.

4. COST EFFICIENCY OF DIFFERENT METHODS OF TEACHING

In the beginning of MOOCs much has been said about the end of the universities since MOOCs would permit a mass education for a much cheaper price. See for instance Frey (2013) or The Economist (2014) but looking at the previous figures one can imagine that the reality is not so simple.

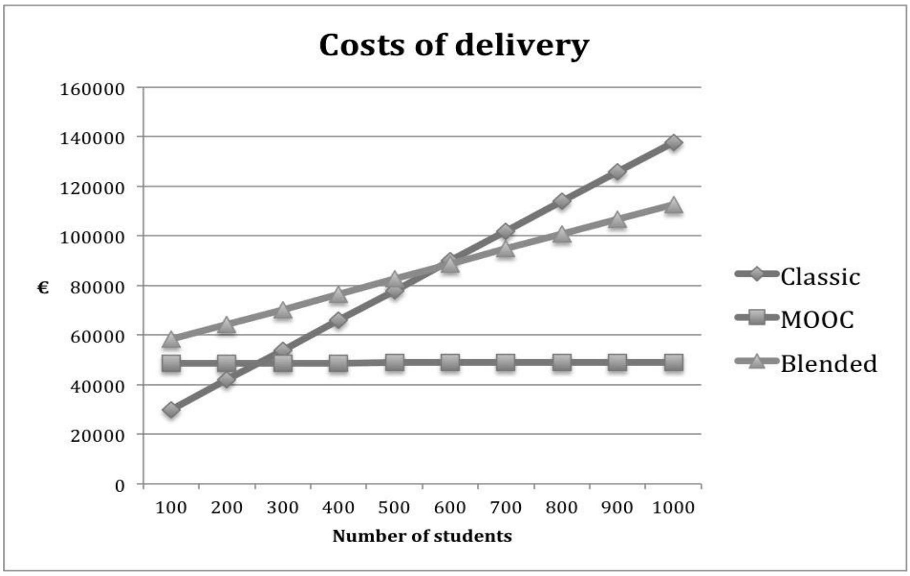
Let us now compare the costs when delivering the same course in a hybrid mode, i.e. a SPOC (Small Private Online Course) with small groups of students in face-to-face classes like it is used at EPFL or in the classical approach, i.e. in a lecture hall. The SPOC needs fewer teachers because plenary lectures in the amphitheater are suppressed and the number of application lectures in small groups is reduced. When delivering the course as a MOOC, community managers only are needed in front of the students. This cost is drowned in the total cost to build the MOOC, especially considering the variability of our estimation between 30 000 € and 100 000 €!

In our calculation, we consider one teacher for 50 students and a meeting every two weeks for the hybrid mode (SPOC). For the classical delivery one hour in the theater per week and one meeting every week in small groups (50 students). Since we did not have a precise estimation for the cost of the buildings, our estimation is based on the lower bound of rental prices. This therefore includes the depreciation of the assets. Thus this curve is not correct when taking into account the huge investment of building new premises. When this investment is not available, such as in many African and Asian countries, SPOCs and MOOCs become the only solution. This will have to be remembered when presenting some business models later.

Results are shown in figure 1.

The cost increases rapidly with the number of students because the salaries of the teachers represent an important part of the expenses.

Distance education and SPOCs are about the same and are represented on the same curve. Distance education requires personal exchanges between the teachers and the students and the workload is



about the same. The only difference is the cost of the buildings.

Figure 1: comparison of the cost of delivery of a conventional course, a SPOC and a MOOC

For the classical delivery, our estimates are based on the official working time of Higher Education teachers in France: 6 hours of work for one hour in front of the students in the lecture hall, 4 hours of work for one hour of applications lecture with small groups of students. Playing with all these variables and different estimations for the cost of the MOOC, gives always curves shown in figure 1.

Below 200 up to 300 students the cheapest means to deliver a course is the classical approach. Blended learning (SPOC) becomes cheaper only for large classes above 500 students. A conventional MOOC, i.e. delivering a course without face-to-face interaction and no personal interaction is never of interest below 300 students. These values vary with the real cost of the MOOC and other variables such as salaries, buildings… which may change from one university to another, but the message is very clear: savings can be made, using MOOCs or SPOCs, only for very large groups of students. For a single university it may only work for the freshmen years.

This leads to two conclusions: increasing the number of students or grouping universities, to share the costs, are the only solutions to save money. These are just the solutions, emerging in some US universities.

5. BUSINESS MODELS: WHY TO INVEST IN A MOOC?

MOOCs can be used in various contexts: initial or life long education or simply for personal development. The list of possible motivations is infinite.

In the classical framework of universities, MOOCs permit to innovate by offering alternative methods of teaching and learning, complementary or substitute of the traditional methods. The MOOC approach is not really new since traditional Learning Management Systems (LMS) already permit this approach. But it has been seldom used. MOOCs add the new Web 2.0 popular social aspects, and are a unique opportunity to generalize initiatives, which, in the past, have had difficulties to go beyond the prototype stage and were kept in a niche. In a globalized world, where it would be necessary to open a university every day to educate the young generation, MOOC are the only realistic substitute to educate large masses of students. This is true in Africa and Asia, but also in a number of other countries.

Before proposing a strategy and its business model, it is necessary to clearly define the goals, prioritize them and estimate the budget required. The following list summarizes possible orientations. The order of presentation has no meaning.

1. *As a support for an educational transformation*
   SPOCs might be an important constituent of a change in education, including the first year in university. This is one of the major objectives of the EPFL in Lausanne. Flipped pedagogy

through MOOCs aims to make the students involved in their training. This approach is being thought mainly for newcomers, in the first year of bachelor. One of the concerns is to train the students to be autonomous. This approach has some limitation since the campus social life, at least in Western societies, is an important aspect of the culture for young people and it is necessary to offer spaces where they may work together, watch courses videos together and, more generally, mix. In other words it is necessary to create learning spaces and learning centers.

2. *For students who missed an examination*
   When a student does not succeed in a module for the first semester, at least in France, he/she has to wait until June to pass again the examination. In the mean time he/she no longer addresses the matter. This is also relevant for students who have been allowed to go into the next year without completely acquiring the previous year.
3. *At the entrance of the University*
   Many students engage in Higher Education without having the level and/or without really knowing the discipline they have chosen. Specialized short MOOCs could help them to realize the direction in which they undertake studies, what does it means and also and to assess themselves their skills in order to avoid disappointment.
4. *For life long learning, specialization, improvement of professional skills.*
   When addressing people already engaged in their professional life, face-to-face exchange may not be necessary and may be replaced by any exchange tool, from videoconference (Skype for instance) to simple chat. However, each student must be able to interact with a teacher and establish a personal relationship. This is the only difference with a MOOC, where students remain quite anonymous and requires a different approach called SPOC (Small Private Online Course).
5. *For all international students who cannot access higher education.*
   Universities from less developed countries, Africa and Asia first, would appreciate a help from more developed countries. Not all countries speak English and there is a place for other languages. Moreover, the approach to teaching and learning is strongly related to the national culture and a number of countries might be interested in a different approach from the dominant US one. The best approach would certainly be to help these countries to develop their own MOOCs, taking into account their own culture.

   Culture dissemination being one of the HE mission, such MOOCs are a good means to fill it.
6. *To share an expertise or learning on any topic with anyone.*
   The scientific reputation of excellence of a university must be based on two legs: research and teaching. It is one of the missions of the universities. Moreover, it is a good means to establish and maintain the reputation of the institution.
7. *To attract good students from all around the world at bachelor or master level.*
   Students from abroad as well as students who have been following other curriculums would be better prepared to attend a curriculum, especially at higher level, when using MOOCs before arriving.

Universities are constrained by their financial and staff resources. The high expenditure can be recover only for large numbers of students such as newcomers in universities or through an active policy for distance education. In other parts of the world, mainly Africa and Asia, where it should be necessary to build one university everyday, using MOOCs may drastically decrease the capital investment in buildings and teacher training. However, it is not so easy to maintain a link between students and teachers, as the experience of the virtual university in Senegal seems to show it (Caramel 2015). In all other cases building MOOCs is a political decision for which a precise business model must be established. The adequate human and financial resources must accompany it.

6. BUSINESS MODELS FOR MOOCS PROVIDERS

There are two kinds of providers. The most well known, Coursera and EdX (see figure 2), distribute MOOCs build by associates. They act as the editors of a collection of books and partner with universities.

Others, such as Udacity, MiriadaX in Spain not only distribute contents but also build their own MOOCs. Business models, for the first category, are based on the distribution of contents. For the second category, the content is also a value. Udacity started in the first category, then its founder, S. Thrun, declared that "there was no money to make with universities" and switched to continuous education, where he sells his services to companies as well as to individuals.

6.1. Coursera

Coursera is the leading MOOC provider. It is an enterprise venture, which has raised its capital from various venture-capital structures involved in innovative areas (Wikipedia 2015) and partners with selected universities that deliver their courses for free. Depending on the contract, Coursera may take a certain percentage of the revenue generated by the re-use of the MOOC by other universities or interested bodies.

Coursera generates revenues through the delivery of different levels of certifications. The basic was just an attestation of success at the end of the course. It was delivered for free but seems to have disappeared since May 2015. Free access, for a number of MOOCs, is now limited to the documents themselves. Answers to quizzes and pair-to-pair control are no more available. The verified track certificate is delivered with a signature track, which allows verifying the identity of the student. It price varies from a few tens dollars up to one hundred about. Coursera is making more than $1 Million per month in revenue from verified certificates (Shah 2015). The upper level is specialization. Specializations are made from bouquets of coherent MOOCs and the added cost ranges between $250 and $500. In some ways it is blurring the distinction between university grades and free MOOC consumption. In an interview at the Wharton school Koller (2012), one of the two Coursera founders, claimed, "*In five years we will be able to offer most curricula in most disciplines*". In a new interview (Koller 2015) she recognizes that "*MOOCs will not put universities out of business*" and acknowledged that Coursera is turning more to young adults who want to improve their education.

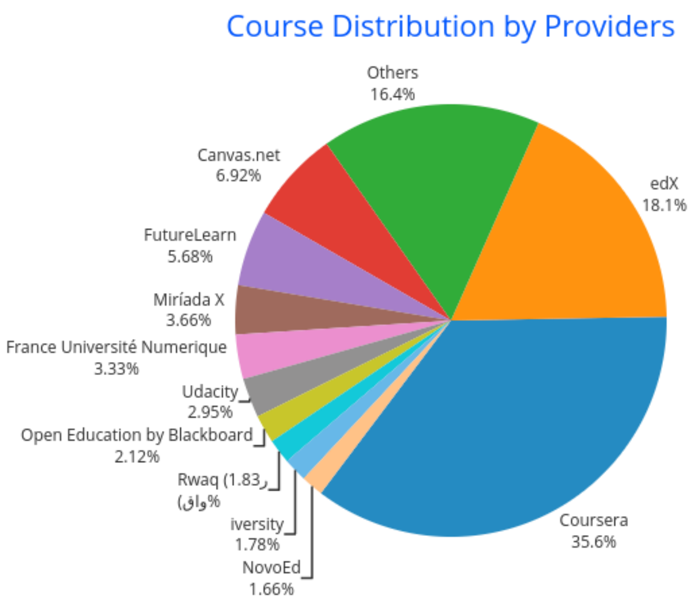


Figure 2: Providers distribution in 2015 (Shah 2016)

Some people doubt that Coursera will be able to make money from certificates only and wonder if it may not turn into an online university later. For the moment D. Koller claims that "*the pressure* [is] *to bring in revenue because we want to bring revenue back to our university partners so that they can sustain their course development*".

Coursera business model, based on delivering certificates, is constraint by avoiding competition with its partner universities. Since Coursera is selecting its partners it may restrict itself into competing with the most modest colleges only, offering “the best courses for a modest fee”. Not everybody is convinced that Coursera will be able to generate enough revenue through the delivery of certificates.

6.2. EdX

EdX has a complete different business model. It is a not-for-profit company, a foundation with primary funding from MIT, Harvard and the Bill and Melinda Gates Foundation. More than 50 institutions have joined them. Partners may choose between two models. In the first one, EdX retains most of the revenue made from the course. In the second one it may provide assistance to its partners and act as consultant (Kolowich 2013, Ross 2014).

Access to the EdX platform may be free for universities but EdX retains most of the possible revenue. Partners universities can become members of the foundation and must pay a high fee. EdX encourages another form of partnership through the development of Open EdX, which has been adopted by many consortiums and private companies such as FUN in France, XuetangX in China, Edraak in Jordania… More than 120 installations exist now around the world.

Students may obtain for free an Honor code certificate, simple attestation of participation. They may also obtain verified certificates similar to the Coursera ones for a fee between a few $tens and $100. Xseries certificates are equivalent to the Coursera specializations.

A main difference between both business models is that EdX must just sustain itself and does not need any other return to its initial investors. EdX President Arnt Agarwal declares that EdX wants only to be self-sustained. EdX counts on its partners’ consortiums, which are running Open Edx. EdX sustainability is linked to the good will of its partners. How long will they be able to provide funds?

6.3. Other US providers

Coursera and EdX are working mainly with universities. Among the other providers it is worth mentioning Udacity and Udemy, which have a very different business model

Udacity started, like Coursera, as a private company and with the same objectives: to complement or to be a substitute to the classical Higher Education approach. Its funder, S. Tron went to the point to work with San Jose University but this initiative was a failure, very few students passing the final grade with success. He concluded that massive open online courses do not work for Higher Education (Waters 2014) and turned quickly towards professional development (Chafkin 2013). Udacity offers its own courses to the public for a small amount of money (some are free) and also develop courses at the demand for companies. It works together with names such as Google, Facebook, and ATT… For $200 per month students may follow selected bouquets of courses developed with the industry (similar to Coursera specializations) and obtain nanodegrees. It includes a personal coaching and pretends to become an alternative to university grades for people already engaged in their professional life.

Udacity pretends to build its business model by working with the industry to offer intensive courses oriented towards high skill jobs. The company said it officially reached profitability in July 2015 (Mathewson 2015).

Udemy (Udemy 2013) follows a different business model. It acts as an online marketplace where independent instructors can build and sell courses. Udemy is taking a share of the money that students pay to follow the courses. This share depends on who is recruiting the students, the teacher or Udemy. Other vendors use the same business model and the competition may become tough to retain the best teachers (McGuire 2014).

Looking at EdX business model on one hand and Coursera and Udacity on the other one, it seems that Coursera is more and more following Udacity business model finding more potential from partnership with the industry.

Maintaining a list of all startups in the MOOC business is quite a challenge. See for instance Class Central (2015) although it is mainly oriented towards the US market.

6.4. European Providers

Nobody in Europe can claim to be the European provider. A few countries have established national providers, most of the others rely on local or private initiatives of limited extends.

Futurelearn (2013), in UK, is a charity from the Open University; Futurelearn wants to bring the best of UK universities worldwide. More recently it has invited foreign universities to join but publishes courses in English only. Futurelearn develops its own software with a different insight towards the pedagogy, encouraging interactions among the students. Access is free but a statement of participation (a simple unverified certificate) costs 29£. A statement of Attainment (verified certification) costs 119£. Futurelearn does not look for other resources. Its total dependency from The Open University is its weakness: the charity recently announced that it was in deficit of £ 17M, due to the declining number of students registering for its distance learning.

France Université Numérique (FUN 2013) is a national initiative launched by the Ministry of Higher Education in France in June 2013, it made the choice of Open EdX as soon as available. It is now a consortium of most French universities. FUN delivers unverified certificates. Very soon its members will offer ECTS (European Credit Transfer System) through classic examinations or distance control like EdX and Coursera. Members of the consortium pay a fee from €5,000 for two MOOCs per year up to €20,000 per year for an unlimited number of MOOCs, 5 SPOCs per year and the possibility to use the platform to deliver their courses their courses for online continuous education. A recent report (France Stratégie 2016) mentions that it must find additional resources through various means, selling courses for continuous education to the industry or to other universities.

Iversity (2015) in Germany, plays a double role as a classical MOOC provider in Germany and, at the same time, develops its own line of courses. Iversity's business model is also to act as a broker of ECTS for European students. Although European universities have standardized their curricula, it is not easy today for an European student to include external ECTS in the curriculum of the university where he/she is registered. Iversity believes it can act as an intermediary.

MiriadaX, in Spain, is less known. However, according to figure 2, it is the second provider in Europe. It is a Spanish-speaking platform with contributors from 45 universities from Spain and South America with support from Telefonica, Banco Santander. Very few is known about its business model. It seems to be oriented mainly toward education in South America.

These are the most well known European providers working with universities. Each of them is mainly working in its own country, although they are willing to expand their influence.

EADTU (European Association of Distance Education) is trying to assemble information about existing MOOCs and to act as a hub through a European initiative OpenupEd (OpenupEd 2013). It is only a relay of information.

A number of private start-ups are going into the business of MOOCs. Their business model is mainly oriented towards continuous education and with some sectors of the Higher Education able to provide a technical education of direct interest for the companies. They sell their courses to individual and to the industry. Openclassrooms, in France, is a good example: for 20€/month any individual may have access to their documents, for 90$ people may follow a given course and for the duration of the course have a weekly distance class exchange with a tutor. For 300€ it becomes a personal tutoring.

A number of providers build their business models around freemium: free or cheap access to basic documents and different levels of fees according to personal or group training.

7. Business models for universities

Various conferences in Europe show that the interest for MOOCs in Europe does not yet reach the peak of the hype curve, showing a large difference of the strategy between the European HE institutions and the US ones. This is clearly explained in the Porto (2014) declaration in favor of open and online education. But, to our knowledge, very few business models seem to appear in Europe when the path is already paved in the US. In other parts of the world (Middle East and Asia) the situation is unclear.

7.1. Business models for US education

The fees, in the US institutions, have reached an unacceptable level and the result is that the total student debt is greater than the housing one, of the of the order of $1200 Billions! Between 2002 and 2012 the mean debt per student has doubled (Wikipedia 2016), so that more and more young people are asking themselves about the value of HE study above the Bachelor level. At the same time there is a demand for more colleges seats at a reasonable price. To decrease the cost of education by the means of MOOCs it is necessary to assemble large cohorts of students, as seen in figure 1. Coursera and EdX are playing this role.

Arizona State University, one of the largest US Universities, has established, in partnership with EdX, the Global Freshman Academy (Hill 2015), an online program to offer to freshmen the first year of university, for a lower price. Students must acquire 8 credits among 12 courses, each for $200, but they will pay only in case of success. The only non-reimbursable fee is for the verified certificates, which will cost $45. This means that a year of study will cost less than $6000 and that most of the money *will be paid in case of success only*. The number of students is unlimited. ASU is paying for the courses development and EdX for the platform. Knowing the number of students, who leave the university without anything, the smart idea with this project is to pay in case of success only. ASU and EdX believe they will attract enough students to recover the investment.

Another example (Straumsheim 2015) is the online MBA program from Urbana Champaign University; it is built in partnership with Coursera. This eMBA will be made of specializations. The contents, made of 18 courses, will be available for free as MOOCs. Students, who pursue the eMBA, will follow the same courses with the addition of all the university facilities and mentoring from a distance for $1000 each. They must also pay $79 for each verified certificate. The total cost of the degree will be about $20000. A great idea is that they can take (and pay) the courses individually and postpone their decision until the end, thus paying by fractions, if they go to the end of the program. Once again, this model allows students not to pay before knowing their chances of success. Coursera recovers some funds through the verified certificates; the University expects to bring enough students in its existing MBA to cover its expense.

MIT has a different approach, considering using the same courses internally as SPOCs and a selection of them externally as MOOCs. The smart idea is that the additional expense is very limited when using internal resources outside. Since Open EdX is their LMS, the additional cost to transform an internal course into a MOOC is just exporting the course to EdX and paying for the animation of the course. They also plan to use MOOCs as an admission test. Newer is a pilot program for a micromaster degree, which can be obtained online through selected MOOCs and verified certificates. Successful students may then apply for a second semester on campus to complete their degree.

These examples show an ongoing direction, in the US, to mix online and on campus courses, to decrease the fees addressing the courses to a larger number of students. At the same time, in a world where universities are competing to recruit the best students, MOOCs are a good means to attract and test good students. Some universities, for instance, offer grants to the students, who succeed in their own MOOCs.

More generally, in the US, MOOCs are now merging in the online offer. Some may be opened to the general public and, at the same time, being used internally with a full mentoring.

7.2. Business models for European universities

A very important difference, between Europe and the US, is that (with the exception of UK except Scotland), most universities are under State regulations and that the level of fees is rather limited. Thus the interest in MOOCs is seldom to decrease the cost of the fees. Reasons to build a MOOC are more relevant to the categories presented in section 5. No one university believes it may recover the expense needed to develop MOOCs except for the few, which may be sold for continuous education. This is why business models are mostly based on the possibility of obtaining grants from national and European agencies.

EPFL in Lausanne (Switzerland) is one a few HE institutions with a clear business model. Pioneer for the MOOCs in Europe, working with Coursera and EdX, EPFL has first offered MOOCs as an efficient communication medium and has been very successful in this. It now offers full curricula, delivering

ECTS for €30, a full cursus being made of 8 to 12 ECTS. Examinations are of the classic form in partners' centers (EPFL 2014). This hybrid education is oriented mostly towards French speaking Africa, where EPFL expects to find a relay of development.

Other initiatives, where institutions deliver ECTS, slowly emerge all around Europe, but, as already mentioned, these ECTS are not, for the moment, transferable between institutions and thus cannot be part of a diploma and are of very limited value. This may change when MOOCs will be used intensively in the universities as part of their distance learning activity but nothing, comparable to the US, is yet visible. EPFL is an exception.

So, to conclude, no clear business model is yet emerging in European universities.

7.3. Business models in Asia and Africa

Education is certainly one of the main objectives, in any country, for a better future. This requires huge capital investments; it is not only a question of finances. Most countries in Africa and Asia do not possess the number of required teachers and their training will take years. They do not have the capacity, in capital investment and in human resources, to build classical universities. A special form of MOOCs, if adapted to the local environment and local culture, is the only solution. Teaching through MOOCs will lower the number of required teachers and the capital investments to teach a huge number of students. For the moment most of the initiatives are coming from the Northern countries and the main providers. Most do not yet have any business model and are supported by the enthusiasm of local universities, who do a fantastic job with very modest means. Edraak (2013) is a political one for Arabic speaking countries. Oyo and Kalema (2014) have explained the state of online courses in Africa and why this continent is far from thinking about business models. See also eLearning Africa news 2015.

In Asia, MOOCs have mainly be the playground of the main US providers except for the Chinese state agency XuetangX already mentioned. Singapore, Hong Kong universities obviously have the capacity to build and distribute their own MOOCs but it is too early to speak of business models.

8. CONCLUSION: WHERE DO WE STAND?

MOOCs business models are not yet established. The future may be quite different in US and in Europe. In US, where the fees are sky-rocketing some Higher Education institutions, at the college level, might be in danger and be challenged by distance education through MOOCs. However, the universities, offering master and doctorate levels, seem confident about their future. MOOCs have been a push to develop online courses both for distance and for on-campus studies. MOOCs are a byproduct of this movement and will continue to grow. In Europe the changes are slower and a number of universities still believe in the interest of "open" MOOCs. However, this generous idea is challenged by the limitation of resources. MOOCs are moving traditional teaching out of a false equilibrium and we may expect that online education will be fully recognized in traditional education. Nevertheless funding will be a limitation in most institutions. In Asia and Africa the movement is only starting. India is becoming an active player after China. MOOCs are the only solution to respond to the education challenge when one should build one university every day. But it is still to come.

Continuous education will be revolutionized. Successful companies appear already both in US and Europe. It is the area where the business models are clearer and all companies and institutions, involved today in this area, will be challenged soon.

9. REFERENCES

Barshay J. (2013). *My first MOOC: Online class about how to create online classes failed miserabily*. The Hechinger Report. Retrieved from http://digital.hechingerreport.org/content/my-first-mooccrashed_371/

Butecher N., & Wilson-Strydom M. (2012). *A guide to quality in online learning. Academics Partnership*. Retrieved from http://teachonline.ca/sites/default/files/tipstools/A%20Guide%20to%20Quality%20in%20Online%20Learning.pdf

Caramel L. (2015). *Le calvaire des étudiants de l'Université Virtuelle du Sénégal*. Le Monde, 23/07/2015. Retrieved from http://www.lemonde.fr/afrique/article/2015/07/23/le-calvaire-bienreel-des-etudiants-de-l-universite-virtuelle-du-senegal_4695253_3212.html

Chafkin M. (2013). *Udacity's Sebastian Thrun, Godfather of free online education changes course*. Fastcompany, 14 November. Retrieved from http://www.fastcompany.com/3021473/udacitysebastian-thrun-uphill-climb

Class Central (2015). *List of MOOCs providers.* Retrieved from https://www.classcentral.com/providers

Edraak (2013) Arabic MOOC Platform. Retrieved from https://www.edraak.org/ eLearning

Africa News (2015). Retrieved from http://ela-newsportal.com/tag/mooc/

EPFL (2012). *MOOC Studio Recording*. Center for Digital Education. Retrieved from https://documents.epfl.ch/groups/m/mo/moocs/www/MOOC-Full-Studio.pdf

EPFL (2014) *Formations hybrides EPFL*. Retrieved from http://moocs.epfl.ch/page-118161-fr.html

Frey T. (2013). *By 2030 over 50% of colleges will collapse*. Retrieved from http://www.futuristspeaker.com/2013/07/by-2030-over-50-of-colleges-will-collapse/

France Stratégie (2016) *MOOC français : l'heure des choix* (in French), February 4th. Retrieved from http://www.strategie.gouv.fr/presse/communiques-de-presse/mooc-francais-lheure-choix

FUN (2013). France Université Numérique. http://www.france-universite-numerique.fr/moocs.html

Futurelearn (2013) UK MOOC Platform. Retrieved from http://www.futurelearn.com

Guo P. (2013). Retrievd from http://blog.edx.org/optimal-video-length-student-engagement/ Hill P.

(2015). *ASU, edX and The Black Knight: MOOCs are not dead yet*. E-Literate, April 22.

Retrieved from http://mfeldstein.com/asu-edx-and-the-black-knight-moocs-are-not-dead-yet/

Iversity (2015). Retrieved from https://iversity.org/en/pages/financing-round-in-the-millions

Koller D. (2012). *Interview at Wharton School*. Retrieved from http://knowledge.wharton.upenn.edu/article/moocs-on-the-move-how-coursera-is-disrupting-thetraditional-classroom/

Koller D. (2015). *Interview at Wharton School*. Retrieved from http://knowledge.wharton.upenn.edu/article/moocs-making-progress-hype-died/

Kolowich S. (2013). *How EdX plans to earn and share revenues from ist free online course*. The Chronicle of Higher Education. 21 februa ry. Retrieved from http://chronicle.com/article/How-EdX-Plans-to-Earn-and/137433/

Mathewson T.G. (2015). *Udacity's new business model markets nanodegrees for high-demand skills*. Education Dive 17 september. Retrieved from http://www.educationdive.com/news/udacitys-newbusiness-model-markets-nanodegrees-for-in-demand-skills/405832/

McGuire R. (2014) *Is the Udemy Marketplace model still valuable to instructors?*. Skilldup. 5December. Retrieved from http://www.skilledup.com/insights/is-the-udemy-marketplace-modelstill-valuable-to-instructors

Openclassrooms (2013). OPenclassrooms. Retrieved from http://www.openclassrooms.com

OpenupEd (2013) Retrieved from http://www.openuped.eu/

Oyo B. & Kalema B.M. (2014) *Massive Open Online Courses for Africa by Africa*. IRRODL, december. Retrieved from http://www.irrodl.org/index.php/irrodl/article/view/1889/3127

Parr C. (2014). *Reputation at risk as platform fail to screen MOOCs*, Time Higher Education. Retrieved from https://www.timeshighereducation.com/news/reputations-at-risk-as-platforms-failto-screen-moocs/2014381.article

Pomerol J-C., Epelboin Y. & Thoury C. (2014) *MOOCs, Design, Use and Business Models*. Wiley Eds.

Porto Declaration (2014) *Porto Declaration on European MOOCs*. Porto 27 november. Retrieved from http://www.eadtu.eu/images/News/Porto_Declaration_on_European_MOOCs_Final.pdf?utm_medium=email&utm_campaign=EADTU+Newsletter+November+2015&utm_content=EADTU+Newsletter+November+2015+CID_12422e5728562d0324c93d7c15c01389&utm_source=Analytics&utm_term=Porto%20 Declaration

Roos D. (2014). *How edX Works*. 17 October. HowStuffWorks.com. Retrieved from http://people.howstuffworks.com/edx.htm

Shah D. (2015) *How does Coursera make Money?*. Edsurge October 15. Retrieved from https://www.edsurge.com/news/2014-10-15-how-does-coursera-make-money

Shah D. (2016) *By the Numbers: MOOCs in 2015*. Class Central January 2016. Retrieved from https://www.class-central.com/report/moocs-2015-stats/

Straumsheim C. (2015). All-MOOC M.B.A. Inside HigherEd, 5 May. Retrieved from https://www.insidehighered.com/news/2015/05/05/u-illinois-urbana-champaign-offer-online-mbathrough-coursera

The Economist (2014). *The future of universities. The Digital Degree*. June 28th 2014 Ed. Retrieved from http://www.economist.com/news/briefing/21605899-staid-higher-education-business-aboutexperience-welcome-earthquake-digital

Udemy (2013) Udemy. Retrieved from htt^://www.udemy.com

Waters J.K. (2014) *Breaking the MOOC Model*. January 2014. Campus Technology. Retrieved from http://online.qmags.com/CPT0114?sessionID=56D4E974BEF0C8ABAFEEFA5FA&cid=2732174&eid=18574#pg18&mode1

Wikipedia (2015). *Coursera*. Retrieved from https://en.wikipedia.org/wiki/Coursera

Wikipedia (2016). *Student debt*. Retrieved from https://en.wikipedia.org/wiki/Student_debt

XuetangX (2013). *Chine MOOC Platform*. Retrieved from https://www.xuetangx.com/

10. AUTHORS' BIOGRAPHIES

Yves Epelboin is Emeritus Professor at UPMC since September 2014, special advisor to the President for MOOC strategy from 2012 to 2014 and past CIO for teaching and learning since 2007. Before inn 2002 he founded the multimedia center at UPMC. He obtained his Doctorate of Sciences in 1974 at UPMC in the field of Materials Sciences. He has been working 2 ½ in the US at IBM Research in Yorktown Heights and six months at Bristol University.

He is a member and advisor of the French National MOOC initiative, expert for the French Ministry of Higher Education and a founder and past President of EUNIS. He held different responsibilities at French and European levels and continues to work at these levels.

http://www.linkedin.com/in/yepelboin

The Greek Universities Open Courses Program

Pantelis Balaouras[1], Konstantinos Tsimpanis[2], Lazaros Merakos[3]

[1,2,3] National & Kapodistrian University of Athens (UoA), Greek Academic Network (GUnet), Panepistimiopolis, 15784 Athens, Greece, [1]p.balaouras@noc.uoa.gr, [2]costas@noc.uoa.gr, [3] merakos@di.uoa.gr

Keywords
Open Courses, MOOCs, OER

Summary

Since 2012, twenty five Greek Higher Education Institutes (HEI) have participated in a coordinated nationwide effort for developing open courses, available to the general public, from their undergraduate and graduate programs. After three years of development, more than 3.500 high quality open courses with common specifications are available through a national open courses portal. We present the contributions of a horizontal project, designed to coordinate and support the projects of the participating HEI, regarding to course specifications, design guidelines, training, technical approach (architecture & hosting), and the developed software platforms and products.

Extended abstract

Offering open educational material of high-quality for free over the Internet has started the revolution of "opening up higher education" [1-3]. At the same time, the emergence of MOOCs (Massive Open Online Courses) [4-6] has created new potential and has raised intense debate about their future role in higher education. In this context, the majority of the Greek Higher Education Institutes (HEI) – Universities and Technological Education Institutes – have launched projects for developing open courses, available to the general public.

In addition to the HEI's Open Courses projects, the horizontal project "Central Repository of Greek Open Courses" [7] has been launched at national level in order to coordinate and support the aforementioned HEI projects in developing and providing the open courses. It was carried out by the Greek Academic Network (GUnet) [8] – a non-profit organization formed by the Greek HEI. This group of projects forms the Greek Open Academic Courses Program, which has been funded by the Greek Ministry of Education in the context of the Operational Program "Life Long Learning" [9], cofinanced by Greece and the European Union.

The main objective of the projects is the creation and provision of open academic courses, i.e. courses taught at Greek HEIs that have been adapted to the digital environment, and they are freely available over the Internet to everyone. The open courses do not form any kind of distance learning program. The term MOOCs is not used for the developed courses because a) the content is always available, not only during a specific time period as in MOOCs, b) presently, no support nor certifications are provided. Anyone may access the open courses without registration: the target groups are students and graduates, researchers, professionals, lifelong learners and whoever wishes to extend or renew their knowledge. Open courses provide a free learning environment for the general public, consistent with the mission of the public HEIs. The participants gain new knowledge, training and learning opportunities.

After three years of development, more than 3.500 high quality open courses with common specifications from 25 HEIs are available at the national portal developed for the open courses. Presently, the open courses account for more than the 7% of all the courses taught at Greek HEI, covering a wide range of topics. The most covered subjects are Natural Sciences (25,99%), Humanities and Arts (14,88%), Engineering and Technology (14,67%), Social Sciences (13,97%), Medicine and Health Professions (6,16%), Agricultural Sciences (1,52%).

Based on their educational content, the open courses are classified in three different categories:

- **A- courses**: provide the learner with course description and goals, keywords and glossary terms, educational material organized in course units, notes or/ and presentation slides, bibliography,
- **A courses**: in addition to A- provide podcasts synchronized to presentation slides,
- **A+ courses**: in addition to A- provide exercises and quizzes, digital resources and multimedia educational material. Please note that only A+ courses include videolectures as part of the educational material.

More than 500 technical staff have collaborated with more than 3.000 faculty members (about 15% of all faculty members) in order to develop the courses. These numbers show that one of the most important goals - the creation of more awareness regarding open courses, open educational resources and open education in the faculty members - has been achieved.

Apart from raising awareness, the other main objectives of the horizontal project were

- the design, development and operation of the i) **National Open Courses Search Gateway** (NOCSG) [10],ii) the **Open Delos** platform [11], a rich media and lecture platform for education, iii) the upgrading of the **Open eClass** platform [12] in terms of architecture, user interface and functionality to support open courses
- the drafting of common specifications for the open courses structure and the required equipment for the development phase
- the provision of guidelines, training and consulting services, related to the development of open courses, to the HEI staff
- the central hosting of open courses to achieve economies of scale
- the awarding of the best open courses and the promotion and dissemination of the results

This paper discusses the aforementioned objectives and the support provided by the horizontal project to the institutional projects.

In conclusion, the open courses program has had a strong impact on the Greek academic community and has raised awareness on open education and OER: it has created more than 3.500 open courses and involved more than 3.000 faculty members. This program may serve as a good practice example for other countries and academic communities.

References

[1] MIT OpenCourseWare. http://ocw.mit.edu

[2] Open Education Consortium. http://openedconsortium.org

[3] Pan-European initiative OpenupEd around so-called MOOCs. http://openuped.eu

[4] Coursera online courses. http://coursera.org

[5] Edx online courses. http://edx.org

[6] Udacity online courses. https://www.udacity.com

[7] Project "Central Repository of Greek Open Courses", http://project.opencourses.gr

[8] Greek Academic Network (GUnet), http://www.gunet.gr

[9] Operational Program "Life Long Learning", http://www/edulll.gr

[10] The Greek Open Courses Search Gateway, http://opencourses.gr

[11] The Open Delos platform, http://www.opendelos.org

[12] The Open eClass platform, http://www.openeclass.org

Author biographies

Dr. Pantelis Balaouras holds a PhD degree in Informatics and Telecommunications and a Diploma in Computer Engineering. He is in charge of the multimedia-based e-learning and communication services at the Network Operations Center of the National & Kapodistrian University of Athens. He also serves as the technical director of GUnet's Center for e-learning and media production (mc.gunet.gr), and he is responsible for the development of the Open Delos platform (opendelos.org). He is the technical and project manager of the horizontal project “Central Repository of Greek Open Courses”.

Costas Tsibanis holds an M.Sc in Informatics, an M.Sc in Management and Economics of Telecommunication Networks, and a B.Sc. in Mathematics. At the Network Operations Center of the National & Kapodistrian University of Athens, he is leading the group responsible for designing and deploying web-based Internet and e-learning services. Since 2003, he has been the lead architect of the Open eClass platform (openeclass.org) and the Open Courses Search Gateway (opencourses.gr).

Lazaros Merakos is a Professor in the Department of Informatics and Telecommunications at the National & Kapodistrian University of Athens, and Director of the Communication Networks Laboratory and the Networks Operations and Management Center. His research interests are in the design and performance analysis of communication networks. He has authored more than 250 papers in the above areas. He is chairman of the board of the Greek Academic Network (GUnet), vice-president of the board of the Greek Research Network (GRnet), and member of the board of the Computer Technology Institute and Press "Diophantus". He is the scientific person in charge for the horizontal project “Central Repository of Greek Open Courses”.

Computer science higher education in Poland. Quality & quantity analysis.

Andrzej Żyławski

Warsaw School of Computer Science/Warszawska Wyższa Szkoła Informatyki, Poland, 00-169 Warszawa, ul. Lewartowskiego 17, e-mail: azylawski@wwsi.edu.pl **Keywords**

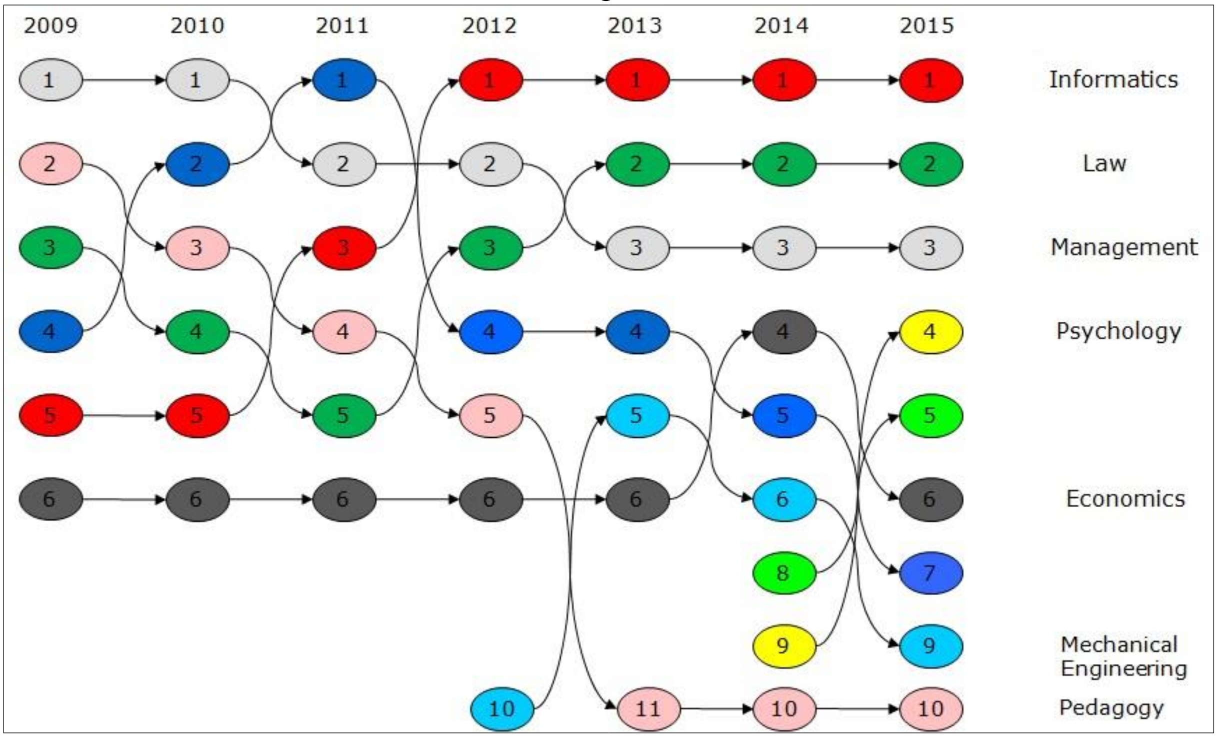
computer science, higher education in Poland, assessment of quality, PAC's assessment

ABSTRACT

The ubiquitous digitization creates demand for IT specialists not only in IT industry but also in other areas of national economy. Digital competences have become major advantage in obtaining an interesting and well-paid job. Employability of computer science graduates reaching 100 % is one of the highest among university leavers. So both interests in ICT technologies and pragmatic approach to future job perspective is the reason that for the last several years we have seen in Poland growing interest of candidates choosing informatics as a field of studies. Computer science from 2012 holds firmly the undisputed leader position among high school graduates who plan further education on university level [see: figure 1].

Figure 1

The most popular fields of university studies in Poland 2009-2015 among secondary school graduates



Comparing the computer science studies enrolment statistics in Europe with Polish ones we can see stabilized trend in most of the European countries and dynamic growth in Poland of 46% in the years 2009-2015. We can expect the same trend to be observed in computer science graduates figures in the next years. This makes the Polish situation very untypical in comparison to other European countries. Poland may become the main European exporter of IT workforce.

Computer science studies are run in over 100 Polish public and non public universities. Geographical and ownership distribution of computer science studies delivery in Poland over the last years is the next interesting issue to be discussed. Political and system changes after 1989 brought a new category of non public schools which especially in the last few years tried to enter computer science higher education market. Nowadays it seems that academic computer science courses stay firmly at big public universities which are more conservative in curricula and less responsive to labor market needs.

For all Polish universities the basis for creation computer science curricula are the instructions that are included in the national educational standards for informatics, national qualification framework for higher education, accreditation standards of Polish Accreditation Committee and the model learning outcomes defined by the Minister of Science and Higher Education. Educational programs cover the following areas of interest of computer science: algorithms and data structures, programming languages, architecture, computers and computer networks, numerical and symbolic, operating systems, software engineering, database and information retrieval systems, artificial intelligence, human - computer communication, computer graphics. Curricula projects represent all of the above areas of computing interest. The specific objectives, content, learning outcomes and ways of verifying the learning outcomes at the level of subjects are presented in study programs (syllabuses) and graduates professional profiles.

Finally the Polish Accreditation Committee (PAC) is an institution that since 2003, assesses the fields of studies conducted by individual universities / faculties in Poland. One of them is computer science. PAC's assessment is the fullest and most reliable source of quality evaluation of individual universities / departments conducting studies in computer science in Poland. According PAC's information, computer science as the field of study and research has been assessed by the Committee a total of 289 times (17 times PAC abandoned the assessment and in one case, the evaluation rating has not been issued). The number of total issued final grades are as follows: outstanding - 9 positive - 199, conditional - 42, negative - 21. Since 2009, PAC next to the final rating also introduced partial ratings for evaluation purposes. Since 2011, according to the statute of PAC final rating includes 8 sub-criteria: (1) assessment of the field of study development concept, (2) assessment of the educational aims and learning outcomes and a system of their verification, (3) assessment of the curriculum, (4) assessment of quality of academic staff (5) assessment of educational facilities, (6) assessment of the quality of research, (7) assessment of the students support system in learning process , and (8) assessment of internal quality assurance system.

Table 1

PAC computer science faculties assessment results for chosen universities

	University/ Department Name	Faculty development concept	Educational Aims and results and system of verification	Curriculum	Quality of Academic Staff	Teaching/ learning facilities	Quality of scientific research	Student's support In the learning process	Internal quality assurance system	Final rating	Date of final rating
1	University of Information Technology and Management In Rzeszow, Faculty of Applied Informatics	fully	fully	fully	fully	outstanding	fully	fully	fully	Positive	2015-05-21
2	Warsaw University of Technology, Faculty of Electronics and	outstanding	fully	fully	outstanding	outstanding	outstanding	fully	fully	Positive	2015-03-12

	Information Technology										
3	Warsaw School of Computer Science	fully	fully	fully	outstanding	fully	outstanding	fully	fully	Positive	2013-10-17
4	Warsaw School of Information Technology under the auspieces of the Polish Academy of Sciences, Faculty of Computer Science	fully	fully	fully	fully	signific	fully	fully	fully	Positive	2015-06-25

PAC's assessments criteria and results don't involve any elements of e-learning tools and new teaching methods used in computer science delivery. Although some universities use new educational technologies intensively there are no traces of this in PAC's reports.

Computer science studies is the most popular field of higher education for Polish secondary school graduates. The new socio-economic situation in Poland, also in higher education after over 25 past years made no visible changes on computers science higher educational map, although some private universities forced public universities to some extant to be more active in introducing new teaching/learning methods and adapting curricula to labor market needs. These changes are very merely reflected in PAC's assessment criteria. Its the labor market and the students themselves who finally will modernize the system to be more effective, innovative and flexible one.

REFERENCES

Polish Accreditation Committee reports, http://www.pka.edu.pl/portfolio-item/baza-ocen/.

Polish Ministry of Science and Higher Education statistics , http://www.nauka.gov.pl/.

e-Skills in Europe. Trends and Forecasts for the European ICT Professional and Digital Leadership Labour Markets (2015-2020).

Empirica Working Paper, November 2015, http://eskills-lead.eu/fileadmin/lead/working_paper__supply_demand_forecast_2015_a.pdf.

AUTHOR'S BIOGRAPHIE

Andrzej Żyławski most of his professional life has been managing educational institutions preparing computer science specialists. 1991-2000 director of Mila College, 2000-2012 rector of Warsaw School of Computer Science. Presently president of Warsaw School of Computer Science. From 2007 chairman of the audit committee of Polish Scientific Association of Internet Education. In 2009 received a New@Poland award for Polish Open Internet Informatics Academia Project from Polish Association of Private ICT Employers. In 2013 received award from Informatics Europe for Best Education Practices in recognition of the outstanding educational initiatives. Research areas involve IT usage in pre and university education, education management and university – business relationships.

Warsaw School of Computer Science/Warszawska Wyższa Szkoła Informatyki, Poland, 00-169
Warszawa, ul. Lewartowskiego 17, e-mail: azylawski@wwsi.edu.pl
Linked in profile: https://www.linkedin.com/profile/preview?vpa=pub&locale=

An Integral Approach to Support Research Data Management at the Humboldt-Universität zu Berlin

Malte Dreyer[1], Andreas Vollmer[1]

[1]Computer and Media Service, Humboldt-Universität zu Berlin, Unter den Linden 6, 10099 Berlin, Germany, malte.dreyer@cms.hu-berlin.de, andreas.vollmer@cms.hu-berlin.de

1. Abstract

To address the increasing requirements on research data management, the Humboldt-Universität zu Berlin (HU) developed and established an integrated approach to provide research data support and services to scholars, students and administrative staff. This paper will discuss the type of requirements from external stakeholders, as well as the needs expressed and identified from within the HU. The derived concept will be explained in detail and examples for specific activities will be given.

2. Introduction

Results or products of research are not just solely publications (Piwowar, 2013), but also raw data, data aggregations, visualizations, software or even complex infrastructures. Compared to traditional research products like papers and books, digital artifacts change and eventually vanish much faster when not taken care for in a proper way (Vines et al., 2014). Many common publication formats have developed throughout the last centuries of traditional publishing and still influence how publications look like today (Gross, Harmon, & Reidy, 2002). Common standards for handling and enriching digital research data are not yet widely established. Data formats are far more heterogeneous (Arms & Fleischhauer, 2005), there are just few stable formats which last more than a decade, processing data is mostly individual (Hey, Tansley, Tolle, & others, 2009). Even long term storage and preservation, besides being costly, is not a commodity yet, like it is for storing books or journals (Palaiologk, Economides, Tjalsma, & Sesink, 2012). Data is being produced in vast amounts and unlike for traditional publications, individual data are often not enriched by metadata, categorized or described by abstracts by the libraries (Wessels et al., 2014). Hence, proper data management and data literacy is an increasing requirement on research processes. In the context of research transparency, fidelity and veracity as well as good scientific practice, more and more research funders mandate certain methods of research data management or at least require a documented reflection on the intended data handling processes (Keralis, Stark, Halbert, & Moen, 2013). Data literacy or “research data literacy” (Schneider, 2013) however can't just be seen as a requirement from funders about research transparency. Proper data handling, well reflected views on data quality and fidelity and related software also enables for extended capabilities to re-use data and to develop more sustainable software systems.

Among other aspects, this results in research data being a far more ephemeral and fragile format than their paper pendants (Warner & Buschman, 2005). What is more, addressing the open science paradigm of sharing research data even extends the scope of complexity to specific scholarly cultures (Borgman, 2012).

As scientific disciplines or domains differ considerably in requirements, technological preferences, standards and collaboration schemes, global activities like the Research Data Alliance (RDA) are a crucial community activity to work on the plethora of issues involved and explore specific problem domains, provide guidelines or document existing diversity (Berman, Wilkinson, & Wood, 2014). Exploiting these recommendations and results enables to adjust objectives and focus on more stable task domains.

It still remains a complex task to foster and establish research data management and research data literacy within a bigger higher education institution like HU.

3. Identifying requirements

The Computer and Media Service (CMS) as the data center of the HU is active in this field for many years. By establishing a position for research data management coordination, the HU was able to invest capacity into improving the mutual communication on diverse scientific processes and central infrastructure.

To evaluate the current status, best practices, requirements and gaps concerning research data and related methods at HU, the data center conducted a survey in January 2013. With around 500 responses the results helped to shape a research data strategy (Schirmbacher, Kindling, & Simukovic, 2014). Main requirements from scholars as well as service gaps could be identified. The following illustration depicts the strongest demands expressed by the scholars:

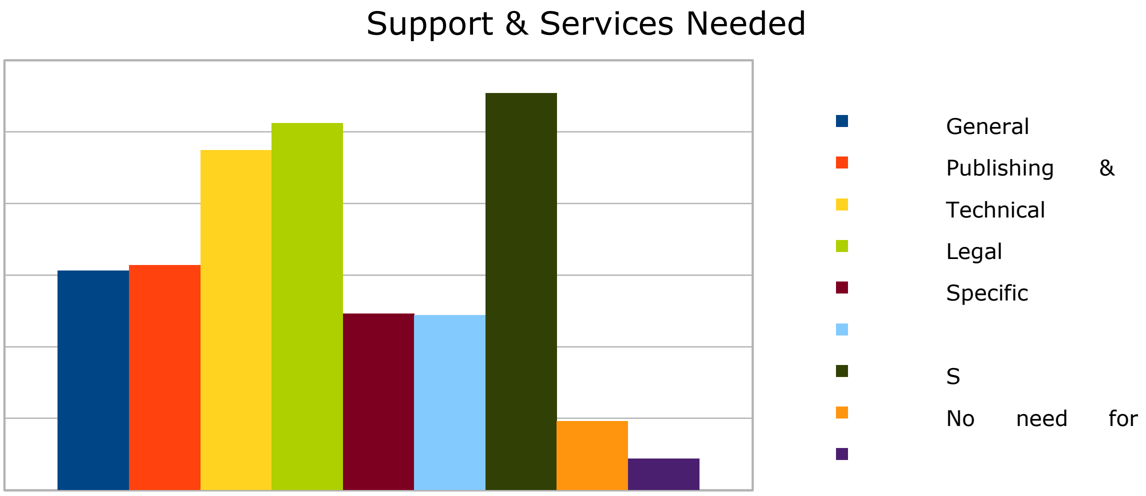


Figure 1: Expressed needs for support (Schirmbacher, Kindling, & Simukovic, 2013)

As a result of this survey, the strongest requirement is in the area of storage, followed by legal and technical issues. These issues were addressed first. Storage surprisingly got the highest number of responses, although the data center offers a broad set of storage services for many purposes, still it appears to be insufficient. This contradiction finally resulted in a new storage service implemented.

As a next step after the survey, a research data policy was designed and discussed with all stakeholders involved. It was adopted by the senate of Humboldt University July 8th 2014.

The policy defines basic principles in the context of safeguarding good scientific practices like documenting the data lifecycle or proper preparation for long-term archiving ("Humboldt-Universität zu Berlin Research Data Management Policy," 2014).

4. Building blocks

Based on these preparations, in 2015 a new concept was designed as an integrated approach to foster, facilitate and support research data management at HU. The main components are:

- **Community Building** to identify most active stakeholders and establish working groups.
- **Building tools and services** to address needs that have been expressed frequently, like easy to use storage services, DOI assignment to data sets, or cloud infrastructure to provide virtual server rooms (Dreyer, Döbler, & Rohde, 2015).

- **Repository services**, recommending external appropriate best practice discipline repositories or building own repository farms with specific focus to support high volume data formats found across many institutes at HU. It is essential to support interoperability with other infrastructure and the natural workflows of scientists. One example is the development of a *media repository farm* covering all kind of media, like audio, video, graphics, texts which have to be grouped, enriched by metadata, integrated into the Moodle system for teaching or being cited in publications. Within the *Laudatio project* another flexible repository for historical linguistic corpora was developed and now is being used by more and more disciplines for corpora and annotation management (Krause et al., 2014). A *repository for tabular data* is currently in design and community building phase to support the management, visualization and alignment of tabular data.
- **Presentations and Workshops** for specific disciplines or stakeholder groups in the institutes designed for broad dissemination of the HU research data management activities. Workshops could be stakeholder focused, like for the Humboldt Graduate School doctoral students or more generic and introductory.
- A **Contact point** (person and web portal) has been established to aggregate all activities, information, tools and news ("DataMan - research data management portal at HumboldtUniversität zu Berlin," 2016).
- **Online tutorials** for data management will be created in 2016, like introductory movies, small modules to support the creation of research data management plans or metadata definition.
- **Developing strategic projects** to exploit further potential and applying for external funding in common projects between the infrastructural organizations of the HU and the institutes, like the DFG funded *eDiss+ project* to support doctoral students managing and publishing research data related to their thesis or the *re3data project* to list discipline specific repositories and their features worldwide.

The following figure provides a comprehensive overview about the components of the research data management concept:

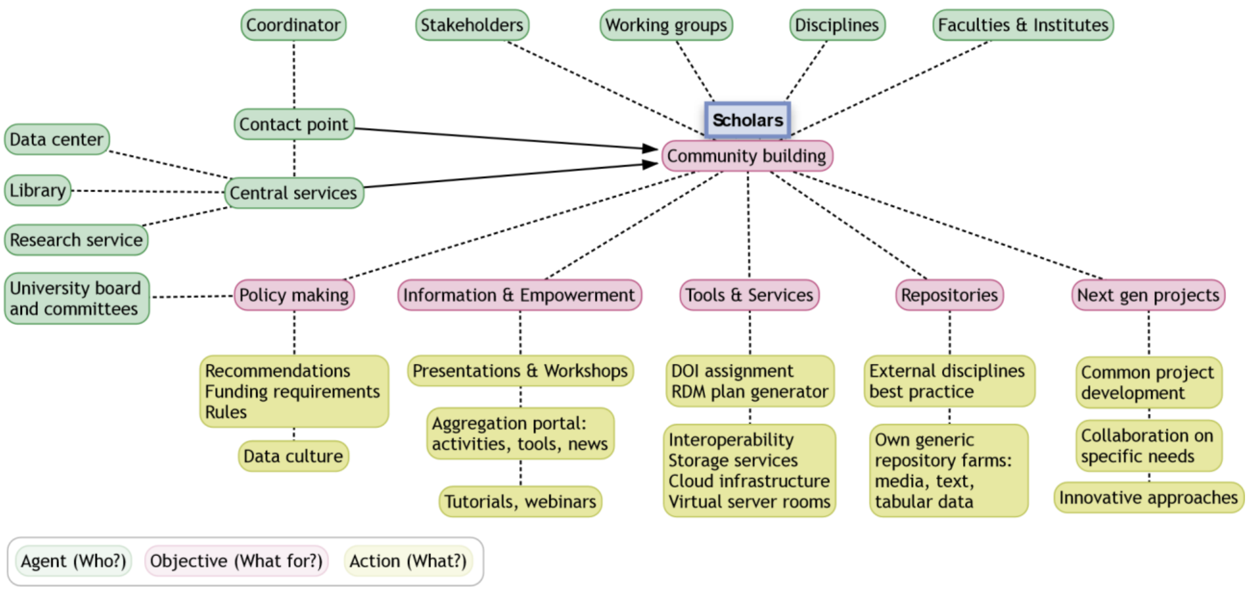


Figure 2: Agents, Objectives, and Actions

The position of the research data coordination and point of contact is situated within the data center's innovation group. Additional services are provided in the appropriate departments of the data center. The library advises on metadata enrichment and electronic publication aspects. The HU research service center is providing legal advice about research data handling, e.g. about usage rights or intellectual property rights involved.

5. Community Building and Communication

As each scientific discipline has very unique communication, collaboration and publication cultures, the research data activities aim for a better understanding of their specific needs by stipulating discussions with the institutes and scholars most active in this area.

It is worth mentioning that each stakeholder group, professors, research fellows, project staff, or administration have a very distinct view on requirements and ways to address them. This makes multifold solutions to the very same problem necessary and raises the institutional awareness for research data, especially in the field of arts and humanities. To address these problems, discussions about specific faculty or institute positions for the local support of data management started. Currently, related support activities are very time consuming, like the development of small services, the cleaning of data, writing scripts to transform data or metadata structures. When it comes to shared staff for these tasks, the competitive requirements have to be managed in a very structured way to provide benefits for as many different people as possible and to keep the newly created position for research data coordination from congestion and finally dissatisfaction. Given the very specific issues within an institute's domain and therefore the long learning period involved, this new kind of position should provide an appropriate long-term perspective.

Additional communication activities include e.g. PhD seminars like "Introduction to research data management" or "How to develop a data management plan" as well as supporting scholars to find the suitable external research data repository.

We expect to fully establish this integrative approach by the end of 2017. New discussions about small supporting services and tools are currently started to include as much new insight from scholars as possible. As the cooperation with institutes intensifies and the community grows, the view on service gaps and further organizational instruments improves steadily. It is expected, that the current paradigm and trend about digitalization will amplify the needs for supporting services within the next 5 years. As research is ever changing and especially top research is changing focus every some years, it will be a big challenge to create instruments that are flexible enough and prepared for change as well as to stay close to state of the art.

6. Two examples for tools and services

To accomplish the formally adopted research data management policy and get its intentions into realworld action, it has to be accompanied by helpful services to enable for reliable, user-friendly management and ongoing curation of data. The university data center and the university library both continue to establish related services. The university library e.g. established services like the persistent identifier Datacite (Brase, 2009) service, inclusion into the library catalog or citation formatting as well as support and advice on metadata, digitization and additional identifiers. The data center currently focusses on repositories and storage technology. Both align and adjust their strategy in a common jour-fixe.

6.1. HU Box

One service created in the course of these activities is the "HU Box" service, which provides an online/offline sync and share scenario to HU users. At HU there are two main usage scenarios for such a service:

- a data exchange platform for network based sharing of files and collaboration of groups using various devices

- personal and synchronized data storage (file synchronization) with on-premise storage

Several free and commercial software products were evaluated by HU, JGU Mainz, and TU Kaiserslautern. The evaluation of the following software products was cancelled at HU due to missing functions: aeroFS, Ajaxplorer, Druva inSync, Teamdrive and Tonido. Final candidates for closer examination were “Seafile”, “ownCloud” and “Powerfolder". Seafile turned out to be the most suitable solution for the requirements listed.

Besides the main scenarios for file exchange and sharing, additional more specifically research data oriented scenarios have been identified. These are e.g. in the fields of additional identifiers to be assigned as well as interfaces to existing systems, data privacy levels or collaborative editing features as well as write-once storage concepts to enable for stable data citation. They will be explored individually in separate projects.

6.2. Media Repository Farm

As another example service, the media repository farm will be explained in more detail. The media repository farm at the HU aims at providing a flexible, yet long-term supported media management platform for research and teaching. For this purpose, the open source software “ResourceSpace” was extended by modules enabling scholarly usage as well as teaching scenarios. A wide range of audio, video, textual or presentation formats is supported. The concept of “projects” is used in this farm for highly individual, self-administrable workspaces for HU users. The CMS of the HU provides a guarantee for at least 15 years of data and metadata longevity. The longevity of the underlying software platform “ResourceSpace” and related software development is dependent to many external factors. This is why a platform with a well-established and broad user base was selected instead of other very specialized software systems. The usage scenarios start from integrating contents in web content management systems or disseminating specific contents into the Moodle LMS as well as capturing photos while on the go with mobile devices and up to automatized imports of mass data with semiautomatic or even automatic extraction and enrichment of metadata. Currently e.g. an automated optical character recognition (OCR) is integrated in the media repository farm to better support the management of digitized media. As a well-established, still rapidly growing service, training for the media repository farm is included into the further education program of the HU on a regular base.

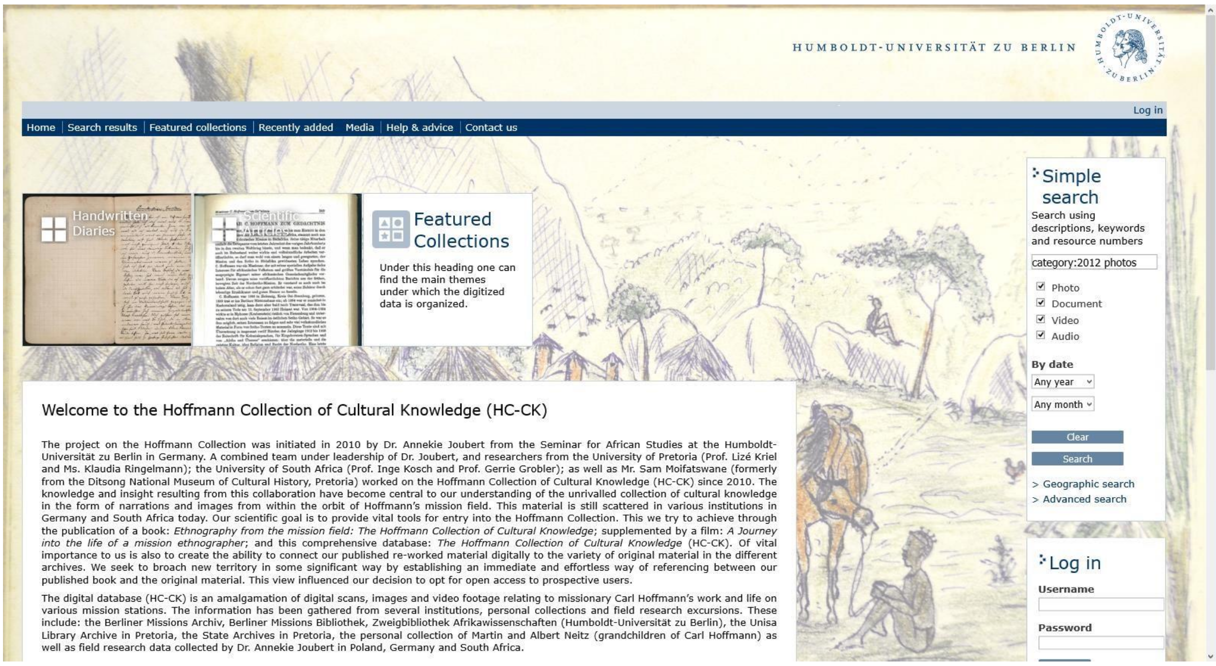


Figure 3: Media Repository Farm Example (Hoffmann Collection, http://dx.doi.org/10.17172/MR/22)

7. Conclusion

While research data management at the HU is still an evolving topic, a well-defined set of services to support scholars at the HU could be developed and put into operation. Having an established concept for further improvements and developments for both, community building and services, helps to review the progress achieved so far. As there is no quick and comprehensive technological solution to research data management, communication and community work is still a key to increase the awareness and enhance related capabilities within the university. Especially for young researchers, the continuous workshop and training program is very well received.

Even with the mentioned set of community work, services and tools, the basic infrastructure to deal with research data in a transparent way, is far from being complete. Transparency in this context can be extended from pure data documentation to extended context descriptions and up to dynamic aspects of the creation, the software involved, activity protocols, related procurements and procedures. As these aspects will get workable, the requirements on research data services will constantly grow and will constantly demand more expertise from data centers to address them. It is expected that many, but not all related services will be provided by centralized, discipline specific service providers. Where not standardized (yet), local data centers will still be in charge.

For the HU data center CMS, the research data management activities have a strong impact on the service management procedures as the communication processes are closer to the scholars and often highly individual. So far, these changed communication styles had very beneficial side-effects by strengthening collaboration between the data center's service managers, administrators and the scholars. Within the coming years, support for research data management and closer involvement into the research data related processes also will have a strong influence on the service profile and innovation focus of the data center.

8. References

Arms, C., & Fleischhauer, C. (2005). Digital formats: Factors for sustainability, functionality, and quality. In *Archiving Conference* (Vol. 2005, pp. 222–227). Society for Imaging Science and Technology.

Berman, F., Wilkinson, R., & Wood, J. (2014). Building Global Infrastructure for Data Sharing and Exchange Through the Research Data Alliance. *D-Lib Magazine*, *20*(1/2). http://doi.org/10.1045/january2014-berman

Borgman, C. L. (2012). The conundrum of sharing research data. *Journal of the American Society for Information Science and Technology*, *63*(6), 1059–1078.

Brase, J. (2009). Datacite-a global registration agency for research data. In *Cooperation and Promotion of Information Resources in Science and Technology, 2009. COINFO'09. Fourth International Conference on* (pp. 257–261). IEEE.

DataMan – research data management portal at Humboldt-Universität zu Berlin. (2016). Retrieved February 29, 2016, from https://www.cms.hu-berlin.de/en/ueberblick-en/projekte-en/datamanen/welcome?set_language=en

Dreyer, M., Döbler, J., & Rohde, D. (2015). Building Service Platforms using OpenStack and CEPH: A University Cloud at Humboldt University. *Eunis 2015*, *11*, 63–68.

Gross, A. G., Harmon, J. E., & Reidy, M. S. (2002). *Communicating Science: The Scientific Article from the 17th Century to the Present*. Oxford University Press. Retrieved February 29, 2016, from https://books.google.de/books?id=ctrhBwAAQBAJ

Hey, A. J., Tansley, S., Tolle, K. M., & others. (2009). *The fourth paradigm: data-intensive scientific discovery* (Vol. 1). Microsoft research Redmond, WA.

Humboldt-Universität zu Berlin Research Data Management Policy. (2014, August 7). Retrieved February 29, 2016, from https://www.cms.hu-berlin.de/en/ueberblick-en/projekte-en/datamanen/info/policy

Keralis, S. D., Stark, S., Halbert, M., & Moen, W. E. (2013). Research Data Management in Policy and Practice: The DataRes Project.

Krause, T., Lüdeling, A., Odebrecht, C., Romary, L., Schirmbacher, P., & Zielke, D. (2014). LAUDATIORepository: Accessing a heterogeneous field of linguistic corpora with the help of an open access repository. Digital Humanities 2014 Conference. Poster Session.

Palaiologk, A. S., Economides, A. A., Tjalsma, H. D., & Sesink, L. B. (2012). An activity-based costing model for long-term preservation and dissemination of digital research data: the case of DANS. *International Journal on Digital Libraries*, *12*(4), 195-214.

Piwowar, H. (2013). Altmetrics: Value all research products. *Nature*, *493*(7431), 159–159. Retrieved February 29, 2016, from http://doi.org/10.1038/493159a

Schirmbacher, P., Kindling, M., & Simukovic, E. (2013). *Humboldt-Universität zu Berlin Research Data Management Survey Results*. ZENODO. Retrieved February 29, 2016, from http://dx.doi.org/10.5281/zenodo.7448

Schirmbacher, P., Kindling, M., & Simukovic, E. (2014). Unveiling research data stocks: A case of Humboldt-Universitaet zu Berlin. *iConference 2014 Proceedings*.

Schneider, R. (2013). Research Data Literacy. In S. Kurbanoğlu, E. Grassian, D. Mizrachi, R. Catts, & S. Špiranec (Eds.), *Worldwide Commonalities and Challenges in Information Literacy Research and Practice: European Conference on Information Literacy, ECIL 2013 Istanbul, Turkey, October 22-25, 2013 Revised Selected Papers* (pp. 134–140). Cham: Springer International Publishing. Retrieved February 29, 2016, from http://dx.doi.org/10.1007/978-3-319-03919-0_16

Vines, T. H., Albert, A. Y. K., Andrew, R. L., Débarre, F., Bock, D. G., Franklin, M. T., … Rennison, D. J. (2014). The Availability of Research Data Declines Rapidly with Article Age. *Current Biology*, *24*(1), 94–97. Retrieved February 29, 2016, from http://doi.org/10.1016/j.cub.2013.11.014

Warner, D., & Buschman, J. (2005). Studying the reader/researcher without the artifact: digital problems in the future history of books.

Wessels, B., Finn, R. L., Linde, P., Mazzetti, P., Nativi, S., Riley, S., and others. (2014). Issues in the development of open access to research data. *Prometheus*, *32*(1), 49-66.

9. Authors´ biography

Malte Dreyer is the technical director of the Computer and Media Service of Humboldt-Universität zu Berlin, Germany. Before, he was director for the department of research and development at Max Planck Society, Max Planck Digital Library.

He designed and developed research and publication data infrastructure for the Max Planck Society's institutes, as well as many research tools. Within several major German, European and international projects he is active in the areas of digital research infrastructure, repositories, virtual research environments and software architecture across many scientific disciplines.

Providing advice on software and information architecture, he is a member of several technical boards. He was a member of the German national alliance initiative working groups for research data and virtual research environments as well as a member of commission "Zukunft der Informationsinfrastruktur in Deutschland" and DINI member of the board.

Malte Dreyer's interests now are in the field of scalable information management architectures and infrastructures in the intersection of organizational perspectives on ICT from data centers and information management organizations. Current projects are in the fields of research data management and repositories, linguistics, as well as cloud architectures and integrated cloud services.

Andreas Vollmer has been teaching for a decade in the Humanities at HumboldtUniversität zu Berlin till he joined Computer and Media Service in 2002 when a new unit for the promotion of digital media in teaching and learning was formed. He coordinated this group and a number of projects focused on the development of services and infrastructural aspects.

He is interested in academic workflows and smooth interaction between its processes. Research data management has been assigned to his group to foster an integral implementation in existing infrastructure and new projects.

Project THOR: Persistent Identifiers in the service of open, interoperable research

Tom Demeranville ORCID EU/THOR, Josh Brown ORCID EU/THOR

Keywords Persistent Identifiers, Interoperability

Summary

Project THOR works with persistent identifiers across discipline and infrastructure boundaries to increase interoperability and promote open science. THOR aims to improve links between article, data, funder, institution and researcher metadata throughout the research lifecycle.

This session will demonstrate the value of persistent identifiers, describe work done so far to increase their utility and outline future plans. It will also explain how to get involved and realise the benefits of persistent identifier use within your own organisation.

The THOR consortium includes ORCID, DataCite, EMBL/EBI, The British Library, CERN, PANGAEA, DRYAD, Elsevier Labs and PLOS. It is a 30 month project funded by the European Commission under the Horizon 2020 programme.

Extended Abstract

The THOR project (http://project-thor.eu) is a 30 month project funded by the European Commission under the Horizon 2020 programme. THOR aims to extend the integration of persistent identifiers (PIDs) into platforms, services and workflows. This will place PIDs at the fingertips of researchers and institutions, building them into the services that they already use, across disciplines, regions and systems. The aim is not to build new, standalone services, but to work with existing systems and the community to increase interoperability, the use of PIDs and to solve shared problems. By creating new, and improved, integrations of PIDs in the services that researchers and institutions actually use, we aim to ensure that PIDs are embedded in research outputs and activities from the very beginning, with no additional effort for researchers.

Persistent Identifiers (PIDs) uniquely identify entities within the research ecosystem and help define relations between contributors, research artefacts, and organizations. They can be used to link across disciplines and infrastructures to build clearer pictures of how research is generated. They not only provide connections between authors and articles, but also between datasets, funders and institutions, enabling better attribution and information on where research originated. PIDs are a vital part of e-infrastructure that enable open and reproducible science and enhance the exchange of research information through interoperable systems.

Information about researchers' activities is gathered in multiple systems outside researchers' home institutions. Manuscript submissions systems, grant funding applications, datacentres, citation indices, other institutional or disciplinary repositories and personal webpages are all vital sources of information. PIDs enable the discovery and collection of this information, and ensure that data can be compared, matched and combined with greater efficiency and accuracy. This is vital now, as institutions work to understand their entire research portfolio. PIDs can help make research reporting more efficient (borne out by the growing number of funders mandating ORCID iDs, for example) and can help to demonstrate compliance with policies for research data management and open access.

This importance is only likely to grow as PIDs become embedded in even more systems, and linked to new kinds of information (about software, data analysis or peer review for example) meaning that institutional systems that do not make full use of these tools as they emerge risk under-serving the institution and its researchers. THOR partners are not just working to increase the availability of PIDs to researchers and the systems that support them, they are building tool kits, resources and training programs to ensure that information and technology professionals across the sector are ready to make the best use of PIDs every day.

The THOR consortium includes ORCID, DataCite, EMBL/EBI, The British Library, CERN, PANGAEA, DRYAD, Elsevier Labs and PLOS. Alongside publishers, datacentres, research organisations and national libraries, there are two major PID infrastructure providers; ORCID and DataCite.

ORCID provides identifiers for people involved in generating research. These identifiers are persistent, actionable and provide links to research activities such as publications, datasets and funding via other identifier systems such as Digital Object Identifiers (DOIs) and Fundref. ORCID records are maintained by their owners who curate input from other systems such as publisher, datacentres and institutional systems. ORCID iDs also help to improve the accuracy of information held in, and shared between, systems. As of February 2016, almost 2 million ORCID identifiers have been claimed.

DataCite is a DOI registration agency that provides identifiers for a wide range of academic outputs with a particular focus on data. Datacite works with data centres to assign persistent identifiers to research objects and develop infrastructure that supports simple and effective methods of data citation, discovery, and access. As of February 2016, DataCite have minted over 7 million identifiers.

Authors' Biographies

Tom Demeranville, Senior Technical Officer, THOR Project, ORCID EU.

Tom investigates and develops links with other identifier systems as part of the EC-funded THOR project. Tom has a long history of working with software in the academic sector. Before joining ORCID he was employed by the British Library as a Technical Lead on the ODIN project and prior to that he was a Senior Software Engineer working on federated identity at Eduserv. Tom has a first class honours degree in Software Engineering from the Open University. Contact: t.demeranville@orcid-eu.org

Josh Brown, Regional Director, Europe, ORCID EU.

Josh directs the operations of ORCID EU. He works with stakeholders across Europe to support understanding and engagement, and promote adoption of ORCID. Before ORCID, Josh was consortium and operations manager for SCOAP3, programme manager for digital infrastructure at Jisc, project officer for SHERPA-LEAP at University College London, and held positions in the library at the University of Brighton and the University of Sussex. He earned an MA in Information Management from the University of Brighton and a BA in Philosophy and English from the University of Sussex.

How Do Researchers Manage their Data? An Empirical Comparison between Policies and Practice

Anne Thoring[1], Dominik Rudolph[1], Raimund Vogl[1]

[1]Westfälische Wilhelms-Universität Münster, ZIV, Röntgenstraße 7-13, 48149 Münster/Germany, {a.thoring|d.rudolph|rvogl}@uni-muenster.de

Keywords
Research data management, open science, e-science, research infrastructure

1. ABSTRACT

Several academic organizations like the German Research Foundation (DFG) increasingly emphasize the importance of a professional research data management for the scientific community. Regulations for secure storage and making data available in terms of open science need to be established, to fully harness the immense value of research data as a proof of accuracy and as a basis for future studies. With 667 completed questionnaires by researchers at Münster University (WWU), this survey aims to provide insights on the implementation of research data management in research practice generally and in different academic disciplines in particular.

2. INTRODUCTION

During the research process, large amounts of valuable data are generated. Preserving it digitally and making it available to other scientists are the two most important challenges to tackle in order to capitalize on the advantages of e-science (Bell, 2009; Büttner, Hobohm, & Müller, 2011; Lynch, 2009). Although in this context, a professional research data management, characterized by adequate infrastructure, regulations and human resources, is indispensable (Bell, Hey, & Szalay, 2009, pp. 1297–1298), it is something of rarity in the scientific practice (Rümpel & Büttner, 2010; Strathmann, 2012; Winkler-Nees & Stefan, 2012). In research literature, an analogical lack of empirical data on the handling of research data in practice exists – forming the starting point for this survey in 2014. A quantitative approach was used to question approximately 1,000 scientists of Münster University (WWU) about the status quo of research data management, in order to form a solid basis for improvement.

When discussing the accessibility of research data, it is inevitable to come across the concept of “open science” (Fry, Schroeder, & den Besten, 2009). According to Wagner, the accessibility of primary data is nothing less than “science’s court of appeal” (Wagner, 2000, p. 47) as it allows other scientists to carry out independent re-analyses which can either verify and thereby strengthen the results, or uncover errors or even manipulations. However, accessibility per se might not be enough as Marris points out: „What do you do if you are suspicious about a paper, you ask to see the data and you get 25 cardboard boxes, 4 CDs and would have to hire a biostatistician for three months“ (Marris, 2006, pp. 520–521)?

Clearly, to be valuable to other researchers, the data needs to be preprocessed, but on the other hand, it is also necessary to consider how much additional effort is acceptable to do so. In the science system, verification processes usually take place in the context of review procedures for the publication in scientific journals (Mittler, 2007). Data accessibility is limited to those individuals involved. With a broader accessibility of research data, numerous concerns arise, e.g. when it comes to particularly sensitive patient records (Pfeiffenberger, 2007, pp. 207–210) or to the point that data without context or interpretation may be misleading or useless (Rosenblum, 2009, pp. 19–22). Furthermore, researchers raise major concerns over uncontrolled reuse and possible abuse of their data (Winkler-Nees & Stefan, 2012). The high autonomy of researchers in Germany and the associated actual or merely perceived rights of ownership over the acquired data are identified as further obstacles to a disclosure of research data (Winkler-Nees & Stefan, 2012).

Against this background, our first research question is: “What relevance does the idea of open access have for making research data available in scientific practice?” To answer this question, the following criteria (Open Science Criteria, OC) are examined:

- OC1 Making available of research data
- OC2 Regulation of disclosure by binding guidelines

Aside from access, archiving is another essential aspect of research data management. The German Research Foundation (Deutsche Forschungsgemeinschaft, DFG), for example, advises every research institution to set up clear rules not only for the accessibility of research data but also for storage (Deutsche Forschungsgemeinschaft, 2013). According to its ‘guidelines for ensuring good scientific practice’, “[p]rimary data as the basis for publications shall be kept for ten years on durable and secured storage media at the institution where they were generated” (Deutsche Forschungsgemeinschaft, 2013). Against this background and bearing in mind the general worth of data in today’s society, it is astonishing that, according to estimates, up to 90 percent of research data are irretrievably lost shortly after finishing a research project (Winkler-Nees, 2011). Then again, the reasons for such a low degree of implementation are fundamental: the trustworthiness and persistence of the storage locations, the lack of adequate licensing models to protect data proprietary rights and the lack of necessary know-how (Bertelmann & Hübner, 2007, pp. 246–250). Professional research data management requires domain-specific, methodological and technical expertise as well as knowledge of legal aspects and librarianship. Therefore, not only scientists need to be involved in such a complex task, but “[…] information and computer scientists, database and software engineers and programmers, disciplinary experts, curators and expert annotators, librarians, archivists, and others, who are crucial to the successful management of a digital data collection“ (National Science Board, 2005).

Our second research question focuses on the level of professionalism in the archiving of data: “How far have researchers progressed in terms of professional archiving?“ To answer this question the following criteria (Archiving Criteria, AC) are examined:

- AC1 Non-local storage on network drives or subject-specific repositories provided by professional IT facilities within the university
- AC2 Long-term storage on durable media for at least 10 years
- AC3 Regular backups
- AC4 Binding regulation by directives for the safe storage and systematic recording in reference databases
- AC5 Involvement of professional data specialists from the fields of IT and librarianship in the archiving process
- AC6 Targeted archiving with a clear purpose of use

Our third research question focuses on the scientists’ know-how about research data management, aiming to identify subject areas with particular need for advice: “How do researchers assess their knowledge of dealing with research data?” To answer this question, the following (Knowledge Criteria, KC) are examined:

- KC1 Knowledge of research data management
- KC2 Need for advice

To date, there are only few empirical studies on the subject of research data management in scientific practice (Campbell et al., 2002; Savage & Vickers, 2009; Simukovic, Kindling, & Schirmbacher, 2013) which are characterized by limitations (i.e. very small samples, restrictions to individual departments) and show heterogeneous results. The present study thus largely enters new territory and is designed explorative.

3. RESEARCH METHOD

The items of the online questionnaire were phrased predominantly on the basis of surveys conducted before (Quandt, 2012). Modifications were made with regard to the research questions and the specific situation of the University of Münster. The study was conducted as an online survey among the scientific staff of Münster University from July 21st to August 8th, 2014. The following analysis is based on the 667 duly completed questionnaires which remained after data cleansing. According to the current state of knowledge, this is one of the largest samples on research data management. About one-fifth of the respondents (19%) are professors, 79 percent are members of the nonprofessorial academic staff (mainly research assistants, academic counselors, PhD students). This approximately corresponds to the distribution at the University of Münster (professorships account for 23 % of the scientific staff).

4. RESULTS

4.1. Open Science

With respect to the first criterion of open science – making available (OC1) – results show only a low degree of realization in practice (Table 1). Currently, the vast majority of researchers does not grant other scientists access to research data at all or only on explicit request. Only about one quarter makes data available – usually in the context of a publication by a publishing house. Similar results were provided by a study at HU Berlin (Simukovic et al., 2013). Apparently to date, the open science idea is most present in mathematics, while it is practiced very rarely in economics and law.

Table 1: Making Research Data Available to Other Researchers (Results in percent, N=667)

	C1	**C2**	**C3**	**C4**	**C5**	**Ø**
Making data available	25.4	27.9	38.8	30.8	16.1	27.0
Thereof: via a subjectspecific repository	4.1	5.7	24.5	4.1	0.0	4.2
Thereof: in the context of a publication by a publishing house	11.4	19.7	12.2	23.1	8.1	17.4
Existence of Guidelines	16.6	33.6	20.4	26.1	12.9	21.9
Constraints						
Legal reasons	53.5	62.5	50.0	42.5	67.3	49.7
Data unsuitable	41.0	47.7	46.7	51.6	44.2	48.5
Lack of time	19.4	17.0	20.0	15.9	25.0	17.2
Lack of an appropriate platform	18.8	34.1	30.0	25.0	34.6	24.2

C1: Humanities and social sciences C2: Life sciences C3: Mathematics C4: Natural sciences C5: Economics and law.

With respect to the second criterion – existence of guidelines which regulate the disclosure (OC2) as demanded by the DFG (Deutsche Forschungsgemeinschaft, 2013) – results, likewise, show only a low degree of fulfillment. Most likely such guidelines seem to exist in the life and natural sciences, but here, as well, more than two-thirds state that they do not know any corresponding regulations.

When asked about the reasons against making research data available, respondents primarily mention legal restrictions (50%). Also, the unsuitability of data, in the sense that they are misleading or useless without context and interpretation, is a reason stated by every second interviewee. The lack of a suitable platform where data could be made available with little effort seems to be another obstacle (24%). Moreover, researchers often do not have enough time for making their research data available because of their other duties (17%). In this context, the fact that data have to be processed before disclosure is another reason. In addition, some researchers are afraid that others could publish their findings first and adorn themselves with borrowed plumes. Last, the fear of unwanted players (keyword NSA) accessing the data is relevant, too.

4.2. Archiving of Research Data

In its Guidelines for Ensuring Good Scientific Practice, the DFG prescribes storage “on durable and secured storage media at the institution where they were generated” (Deutsche Forschungsgemeinschaft, 2013, p. 21, translation by the authors). With respect to the AC1 criterion, very heterogeneous results are revealed (Table 2).

Table 2: Storage Locations (Results in percent, N=667)

	C1	C2	C3	C4	C5	Ø
Internal storage locations						
Office computer	59.6	76.2	75.5	71.2	71.0	69.9
Server of the department	32.1	61.5	57.1	56.0	40.3	48.3
Server of the computing center	36.8	36.1	42.9	34.9	30.6	34.5
External storage providers						
Subject-specific repository	7.3	13.1	18.4	7.7	8.1	7.5
External cloud provider	17.1	12.3	26.5	15.7	32.3	17.5
Other locations						
Private computer	43.0	28.7	38.8	34.6	24.2	35.7
External data storage media	61.1	72.1	46.9	67.3	41.9	62.8

C1: Humanities and social sciences C2: Life sciences C3: Mathematics C4: Natural sciences C5: Economics and law

The large number of multiple answers reflects that the data is typically stored in multiple locations – 2.8 on average. In addition to local storage on office computers (70%), where the data usually is evaluated and processed for publication too, storing data on external storage media (e.g. burned CDs / DVDs, external hard disks) is still very popular (63%). The latter, however, are very inflexible and suitable only for small data volumes, making the disclosure of data to external third parties almost impossible and entailing additional disadvantages with regard to the archiving duration. The great importance of storing data on private devices

(36%) or servers of external cloud providers (18%) – that is locations which are not part of the universities’ IT structures and have a significantly increased risk of data loss, copyright loss or even data theft – is to be treated as particularly critical. Especially external cloud storages are not a suitable location for important or even sensitive research data, because the servers of commercial providers are mostly abroad. As to the long-term perspective local storage is critical as well, because standard PCs are sorted out usually after five to seven years.

However, a large part of researchers also uses services provided by their computing center (35%) or their departments’ decentralized IT facilities (48%) for data storage. In comparison, subject-specific repositories like arxiv.org in the mathematics are surprisingly of minor relevance (8%). Again, the study identifies significant differences between the disciplines: especially in the humanities and social sciences as well as mathematics storage on private devices is common. External cloud providers, on the other hand, are used mainly in the fields of economics and law as well as mathematics.

According to the DFG Guidelines for Ensuring Good Scientific Practice (p. 21) a secure storage for at least 10 years has to be ensured (AC2). Exceptions are allowed only if the data “cannot be stored on durable and secured storage media” (p. 22, translation by the authors). Considering that the guidelines became effective in 2010, only 4 years prior to this survey, a storage duration of at least 5 years is seen as a strong indication for compliance here. On this basis the majority of researchers (53%) seems to comply with the DFG policy already, especially in the life sciences (75%) (Table 3). However, almost one-third does not know exactly how long the data of current research projects are kept, suggesting that there still is a great ignorance of the storage processes.

Table 3: Archiving Routines (Results in percent, N=667)

	C1	C2	C3	C4	C5	Ø
Storage duration: at least 5 years	47.7	75.4	38.8	54.7	40.3	52.5
Backup routine: regular, at least quarterly, backups	33.2	47.5	59.2	50.0	32.3	43.5

C1: Humanities and social sciences C2: Life sciences C3: Mathematics C4: Natural sciences C5: *Economics and law*

The secure storage stipulated in the DFG guidelines implicitly assumes regular data backups (AC3). 85 percent of the researchers stated that they generally generate backups – often not on a regular basis, though, as required for a professional research data management, but only ad hoc or at random times. No more than 44 percent of researchers produce a regular, at least quarterly, backup. As to this question too, many of the respondents are unable to make a statement. A comparison of the disciplines shows that backups are least important in the humanities and social sciences as well as in economics and law, while sensitivity for the issue of data loss is particularly high in mathematics.

Table 4: Knowledge of Guidelines for Storage and Recording (Results in percent, N=667)

	C1	C2	C3	C4	C5	Ø
University directives						
Data backup for a certain duration	8.8	37.7	20.4	26.1	3.2	19.9

Systematic recording of research data in internal reference databases	4.7	5.7	4.1	6.9	3.2	5.8
Directives of external investors	20.2	31.1	24.5	18.7	16.1	19.8

C1: Humanities and social sciences C2: Life sciences C3: Mathematics C4: Natural sciences C5: *Economics and law*

With respect to the fourth criterion of a professional long-term archiving – existence of explicit guidelines and directives for the storage and recording of data in reference databases (AC4) – results show a rather low degree of compliance. Merely one out of five researchers knows guidelines for data storage (Table 4). Mainly, they are from the fields of life and natural sciences, as in other disciplines such regulations seem to exist only sporadically. Guidelines for the verification of data, on the other hand, are available and known only to a negligible extent in all disciplines. Just as internal university directives, requirements for the handling of research data issued by external investors are not universally relevant, yet. They primarily exist in the life sciences, where about one in three researchers has had corresponding experiences.

Table 5: Persons in Charge for Data Archiving (Results in percent, N=667)

	C1	C2	C3	C4	C5	Ø
Professors	56.5	57.4	53.1	49.7	59.7	52.6
Non-professorial academic staff	86.0	95.9	91.8	94.2	85.5	91.0
Student assistants	74.6	50.8	49.0	42.3	77.4	54.1
IT staff	7.8	59.8	18.4	39.6	6.5	29.2
Library staff	4.1	0.8	2.0	0.8	3.2	1.5
External service providers	12.4	9.0	6.1	4.4	8.1	6.9

C1: Humanities and social sciences C2: Life sciences C3: Mathematics C4: Natural sciences C5: *Economics and law*

Another important aspect of a professional long-term archiving is the involvement of data specialists (AC5). According to the survey results (Table 5), the non-professorial academic staff is usually responsible for data archiving. Doctoral students who account for a large part of the academic staff and naturally work on their research projects on their own, serve as the basic explanation for this. What is surprising is the great importance of student assistants that are mentioned even more often than professors. Especially in the fields of economics and law as well as humanities and social sciences research data management is very often assigned to student assistants.

IT personnel plays an important role as well, especially when specific infrastructure is needed due to high volumes of data. This is particularly true in the life sciences and, to a lesser extent, in the natural sciences, while technical staff is almost irrelevant in the humanities and social sciences. In all disciplines the services of external providers are sought only in exceptional cases. Likewise, library staff is involved rarely in the archiving process yet.

Table 6: Storage Purposes (Results in percent, N=667)

	C1	C2	C3	C4	C5	Ø

Proof of replicability	74.6	94.3	89.8	90.1	77.4	84.9
Researchers‘ own reanalyses	81.3	88.5	95.9	87.1	77.4	84.9
Others‘ reanalyses	42.0	48.4	57.1	48.1	24.2	42.4
Scientific education	40.4	23.0	42.9	22.8	32.3	27.3
Exclusion of legal risks	39.9	59.8	26.5	42.6	27.4	42.1
Preservation as historically relevant information	31.1	9.0	14.3	8.0	11.3	14.2
Without cause	13.5	9.8	26.5	15.4	19.4	15.3

C1: Humanities and social sciences C2: Life sciences C3: Mathematics C4: Natural sciences C5: *Economics and law*

The storage of research data can serve different purposes, e.g. as a basis for further research or as proof of the correct implementation of the study (Table 6). According to the respondents, these two reasons are most, and almost equally, important. Especially in the life sciences, the elimination of legal risks (e.g. regarding data protection) plays an important role as well. The relevance of another storage purpose, the re-analysis of data by other researchers, varies greatly depending on the discipline. Whereas about 57 percent of researchers in mathematics keep this reason in mind, it is only one in four in economics and law, and one in two in the other disciplines. In the humanities and social sciences as well as mathematics, research data is often used for teaching purposes, too. Moreover, the preservation of data as an important time-specific description for future generations plays a role in the humanities. In many cases, however, researchers indicate that there is no explicit reason for storage, but obviously data are just not deleted. Here it can be assumed that, in general, data are not stored in a processed state but as-is.

Table 7: Willingness to Use University Owned Data Archives (Results in percent, N=667)

	C1	C2	C3	C4	C5	Ø
Willingness to use university owned data archives (definitely/probably)	50.8	54.1	63.3	45.1	46.8	48.1

C1: Humanities and social sciences C2: Life sciences C3: Mathematics C4: Natural sciences C5: *Economics and law*

In summary the results show that apparently there are hardly any satisfactory tools for secure archiving and easy management of research data at the moment. Therefore, researchers often choose uncomfortable or unsafe storage locations and the time for data handling is perceived as too long. One possible solution would be that the university itself provides an appropriate data archive. Of course researchers need to be highly willing to use such a platform, in order to justify its establishment. In fact, at least 48 percent of respondents would most likely use a university owned archive, another 30 percent would do so under certain conditions (Table 7).

4.3. State of knowledge

The results above show that, to some extent, there are significant differences between the theoretical ideal of a professional research data management and the actual practice, particularly in the social sciences and humanities, but also in the other disciplines. One possible cause could be a lack of knowledge (KC1). This is confirmed by the survey (Table 8).

Table 8: State of Knowledge and Need for Advice (Results in percent, N=667)

	C1	C2	C3	C4	C5	Ø
Good to very good knowledge	14.5	29.5	44.9	21.2	17.7	20.0
Need for advice	87.6	87.7	79.6	82.1	79.0	83.7
General questions	36.3	40.2	34.7	41.5	33.9	38.7
Publishing and quotation	37.3	27.0	30.6	32.7	33.9	33.1
Technical questions	50.8	59.0	40.8	46.7	32.3	48.4
Legal questions	62.2	57.4	57.1	46.4	53.2	52.9
Data management plans	28.5	36.9	26.5	27.2	21.0	28.5
Third-party funded projects	35.8	36.1	22.4	27.2	24.2	29.8

C1: Humanities and social sciences C2: Life sciences C3: Mathematics C4: Natural sciences C5: *Economics and law*

No more than 20 percent claim to have good or very good knowledge on the subject of research data, and 42 percent think their knowledge is below average. Thus, there is still a considerable need for information and advice. Interestingly, even in the life sciences only one third of researchers feels well-informed – this being the discipline with the overall highest standard when dealing with research data. Accordingly, the vast majority calls for special counseling services (KC2). Particularly technical and legal questions are of interest. The state of knowledge on the subject of research data varies between the disciplines. While especially mathematicians claim to have a rather good knowledge, researchers from the humanities and social sciences as well as economics and jurists notice a great backlog demand in their respective disciplines.

5. DISCUSSION

With regard to the research questions, the rather pessimistic impression of Rümpel and Bütter (2010) and Winkler-Nees and Stefan (2012) have to be confirmed: In terms of making research data available, in terms of long-term archiving and in terms of researchers’ knowledge, there still is a considerable need to catch up toward a professional research data management. Albeit a generally low standard, researchers in the life and natural sciences are apparently prepared best for data-centric science. Nevertheless, in all disciplines there is a lack of clear guidelines and directives, trained personnel, knowledge, and simple technical tools which make the handling of research data manageable.

Pfeiffenberger suspects “that most universities will not be able to operate a qualitatively and quantitatively appropriate “Institutional Repository” for *all* data categories of their respective disciplines” (Pfeiffenberger, 2007, p. 12), because of a lack of discipline-specifically qualified staff. Instead, he suggests that the universities’ computing centers and libraries should offer technical resources particularly for safe data storage as well as best practice handouts or training courses. This also corresponds to the results of this study where researchers communicated a great need for advisory services. According to Pfeiffenberger (2007), cooperative efforts of several institutions across university boundaries and the establishment of an appropriate technical infrastructure and corresponding expertise constitute the answer to the problem. This would argue for the use of existing storage infrastructures which are jointly operated by several universities, such as the cloud storage projects in Baden-Württemberg (Schlitter, Yasnogor, & Srajc, 2014) or North Rhine-Westphalia (Stieglitz, Meske, Vogl, Rudolph, & Öksüz, 2014). Since the conditions of the individual disciplines vary widely, subject-specific repository solutions are needed additionally (Bertelmann & Hübner, 2007). With regard to making research data available, a system that allows for flexible disclosure seems most suitable due to the existing legal restrictions and the high reluctance of researchers to fully disclose their data.

6. REFERENCES

Bell, G. (2009). Foreword. In T. Hey, S. Tansley, & K. Tolle (Eds.), *The Fourth Paradigm. DataIntensive Scientific Discovery* (pp. xi–xv). Redmont, Washington: Microsoft Research.

Bell, G., Hey, T., & Szalay, A. (2009). Beyond the data deluge. *Science*, *323*(5919), 1297–1298.

Bertelmann, R., & Hübner, A. (2007). Open access im Dienst der Wissenschaft: Umsetzung von freiem Zugang in der Helmholtz-Gemeinschaft. *Zeitschrift für Bibliothekswesen und Bibliographie*, *54*(4-5), 246–250.

Büttner, S., Hobohm, H.-C., & Müller, L. (2011). Research Data Management. In S. Büttner, H.-C. Hobohm, & L. Müller (Eds.), *Handbuch Forschungsdatenmanagement* (pp. 13-24). Bad Honnef: Bock + Herchen.

Campbell, E. G., Clarridge, B. R., Gokhale, M., Birenbaum, L., Hilgartner, S., Holtzman, N. A., & Blumenthal, D. (2002). Data withholding in academic genetics: evidence from a national survey. *Jama*, *287*(4), 473–480.

Deutsche Forschungsgemeinschaft. (2013). *Vorschläge zur Sicherung guter wissenschaftlicher Praxis: Denkschrift: Empfehlungen der Kommission "Selbstkontrolle in der Wissenschaft"*. Weinheim: Wiley VCH.

Fry, J., Schroeder, R., & den Besten, M. (2009). Open science in e-science: Contingency or policy? *Journal of Documentation*, *65*(1), 6–32. doi:10.1108/00220410910926103

Lynch, C. (2009). Jim Gray's Fourth Paradigm and the Construction of the Scientific Record. In T. Hey, S. Tansley, & K. Tolle (Eds.), *The Fourth Paradigm. Data-Intensive Scientific Discovery* (pp. 177–183). Redmont, Washington: Microsoft Research.

Marris, E. (2006). Should journals police scientific fraud? *Nature*, *439*(7076), 520–521. doi:10.1038/439520a

Mittler, E. (2007). Open Access zwischen E-Commerce und E-Science. Beobachtungen zu Entwicklung und Stand. *Zeitschrift für Bibliothekswesen und Bibliographie*, *54*(4/5), 163–169.

National Science Board. (2005). *Long-Lived Digital Data Collections: Enabling Research and Education in the 21st Century*. Arlington: National Science Foundation. Retrieved from http://www.nsf.gov/pubs/2005/nsb0540/nsb0540.pdf

Pfeiffenberger, H. (2007). Offener Zugang zu wissenschaftlichen Primärdaten. *Zeitschrift für Bibliothekswesen und Bibliographie*, *54*(4), 207–210.

Quandt, M. (2012, May). *Leibniz-Forschungsdatenumfrage 2010/2011*. Leipniz-Gesellschaft. Workshop I AK Forschungsdaten, Berlin. Retrieved from https://escience.aip.de/akforschungsdaten/wp-content/uploads/2013/07/Markus-Quandt-GESISPraesUmfrageergebnisse.pdf

Rosenblum, L. (2009). If Malinowski had been a Blogger. *LIBREAS. Library Ideas*, 19–25.

Rümpel, S., & Büttner, S. (2010). Bibliotheken und Bibliothekare im Forschungsdatenmanagement. In S. Schomburg, C. Leggewie, H. Lobin, & C. Puschmann (Eds.), *Digitale Wissenschaft: Stand und Entwicklung digital vernetzter Forschung in Deutschland. Beiträge der Tagung* (pp. 107–113).

Savage, C. J., & Vickers, A. J. (2009). Empirical study of data sharing by authors publishing in PLoS journals. *PLoS ONE*, *4*(9), e7078. doi:10.1371/journal.pone.0007078

Schlitter, N., Yasnogor, A., & Srajc, C. (2014). bwSync&Share: A cloud solution for academia in the state of Baden-Wurttemberg. In O. Kao & A. Hildmann (Eds.), *Cloudspeicher im Hochschuleinsatz. Proceedings der Tagung "Cloudspeicher im Hochschuleinsatz" am 05. und 06. Mai 2014 am ITService-Center (tubIT) der Technischen Universität Berlin* (pp. 40–46). Berlin: Technische Uni Berlin.

Simukovic, E., Kindling, M., & Schirmbacher, P. (2013). *Forschungsdaten an der HumboldtUniversität zu Berlin: Bericht über die Ergebnisse der Umfrage zum Umgang mit digitalen Forschungsdaten an der Humboldt-Universität zu Berlin*. Retrieved from http://nbnresolving.de/urn:nbn:de:kobv:11-100213001

Stieglitz, S., Meske, C., Vogl, R., Rudolph, D., & Öksüz, A. (2014). Cloud Storage Services in Higher Education – Results of a Preliminary Study in the Context of the Sync&Share-Project in Germany. In P. Zaphiris & A. Ioannou (Eds.), *Lecture Notes in Computer Science. Learning and Collaboration Technologies. Designing and Developing Novel Learning Experiences* (Vol. 8523, pp. 161– 171). Springer International Publishing. Retrieved from http://dx.doi.org/10.1007/978-3-31907482-5_16

Strathmann, S. (2012). Stand der Diskussionen und Aktivitäten: International. In H. Neuroth, S. Strathmann, A. Oßwald, R. Scheffel, J. Klump, & J. Ludwig (Eds.), *Langzeitarchivierung von Forschungsdaten. Eine Bestandsaufnahme* (pp. 41–49). Boizenburg: vwh [u.a.].

Wagner, G. G. (2000). Selbstorganisation des Wissenschaftssystems würde Datenschutz vereinfachen und Re-Analysen befördern: gesetzliches Forschungsdaten-Geheimnis könnte die Selbstorganisation unterstützen. *ZUMA Nachrichten*, *24*, 47.

Winkler-Nees. (2011). Vorwort. In S. Büttner, H.-C. Hobohm, & L. Müller (Eds.), *Handbuch Forschungsdatenmanagement* (pp. 5–6). Bad Honnef: Bock + Herchen.

Winkler-Nees, & Stefan. (2012). Stand der Diskussion und Aktivitäten: National. In H. Neuroth, S. Strathmann, A. Oßwald, R. Scheffel, J. Klump, & J. Ludwig (Eds.), *Langzeitarchivierung von Forschungsdaten. Eine Bestandsaufnahme* (pp. 23–40). Boizenburg: vwh [u.a.].

7. AUTHORS' BIOGRAPHIES

Anne Thoring is a research assistant for public relations and marketing at the Zentrum für Informationsverarbeitung (the computing center) of the University of Münster (Germany). She graduated from University College London (UK) and the University of Münster with degrees in communication sciences, publishing and strategic communication. Her research focuses on strategies and tools of corporate communications.

Dominik Rudolph is a research assistant and executive secretary of the Zentrum für Informationsverarbeitung (the computing center) of the University of Münster (Germany). He received his Ph.D. from the University of Münster, where he also studied communication sciences, economics and modern history. His graduate thesis has been awarded as one of the best dissertations in 2014 (German Thesis Award). In his research he focusses on the diffusion of media innovations from the user perspective.

Raimund Vogl holds a Ph.D. in elementary particle physics from the University of Innsbruck (Austria). After completing his Ph.D. studies in 1995, he joined Innsbruck University Hospital as IT manager for medical image data solutions and moved on to be deputy head of IT. He served as a lecturer in medical informatics at UMIT (Hall, Austria) and as managing director for a medical image data management software company (icoserve, Innsbruck) and for a center of excellence in medical informatics (HITT, Innsbruck). Since 2007 he has been director of the Zentrum für Informationsverarbeitung (the university computing center) of the University of Münster (Germany). His research interests focus on management of complex information systems and information infrastructures.

Author Index