EUNIS 2016: Camera-ready template for Full Papers

1st Gregory D. Palmer[1]
[1]University of Pennsylvania, 3401 Walnut Street Suite 221-A, Philadelphia, PA 19104-6228, gpalmer@isc.upenn.edu

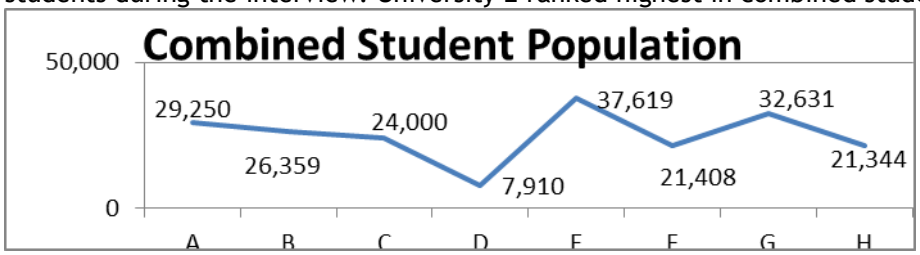
Keywords
IT, Research, Support, Services, Computing, Data Center

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

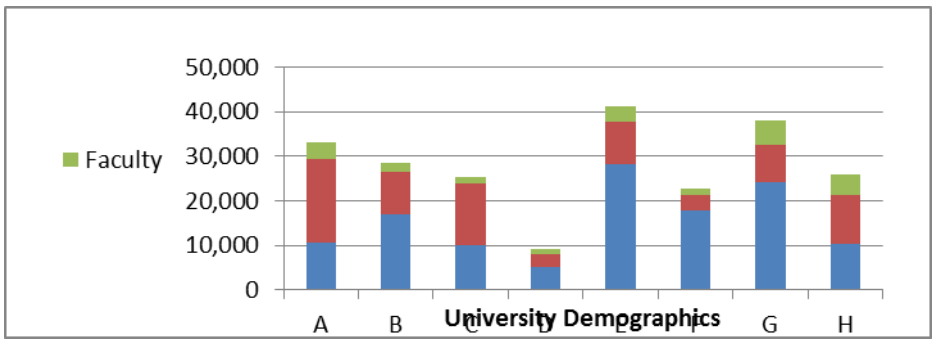
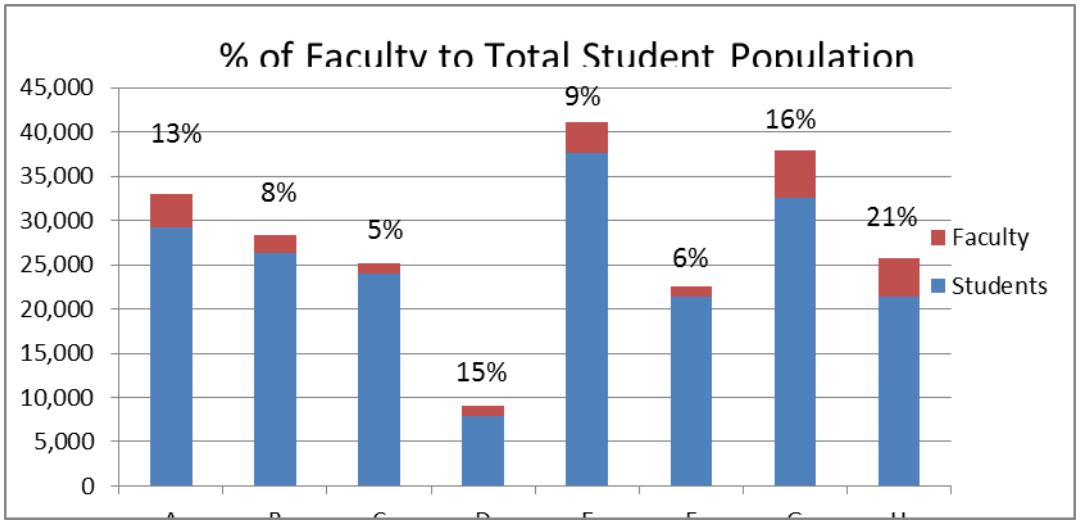


Figure 3 – Percentage of Faculty to Total Student Population



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

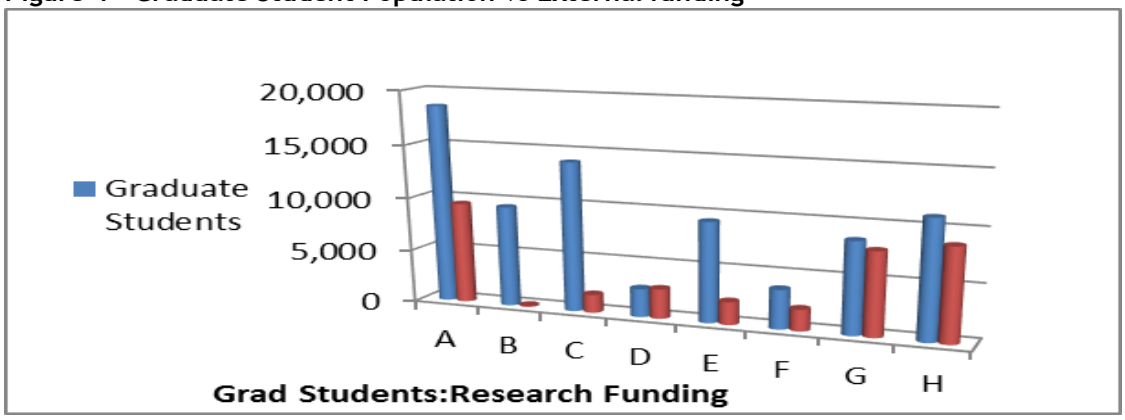
2.0 Overview of Central IT Organizations

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	UniversityF	$ 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.

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

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	

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-Reach-for/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 10-point 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

Awards

- Invited Speaker, Wharton School of Business, University of Pennsylvania – Executive Masters in Technology Management Speaker Series - 2003
- Invited Speaker, University of Texas/Dallas – 2002
- 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

Experience

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