

# Deliver knowledge in a Digital World: Successfully Livestream In-Person, Virtual or Hybrid large-scale educational events - Challenges and best practices

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## Abstract

The rapid transformations that the Covid-19 pandemic brought to educational institutions worldwide have already shaped the next steps of academic reality. Institutions have experienced unprecedented changes in learning practices and relations, bringing an interconnection of a multidisciplinary community to focus. As the academic activities are slowly reconstructing from a strictly online approach to a more hybrid one, solutions are forming in order to provide the best model for the new requirements. Therefore, universities are at the forefront of this transformation by being the main stakeholders influencing the advancements in hybrid educational activities and the first consumers of new technological solutions. Live stream hybrid events are the latest trend. The paper tackles the case of Aristotle University of Thessaloniki (AUTH) on how the university delivers live stream large-scale educational events for in-person, online/virtual, and hybrid mode. Moreover, the paper sheds light on the challenges brought forth, the solutions implemented, and what proposals are designed to improve the services offered.

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# 1 Introduction

In recent years there has been a particular need for web and digital services, mainly due to unexpected and unprecedented circumstances caused by the Covid-19 pandemic. Without any doubt, the pandemic significantly altered student education. In addition, new methods of more effective teaching in research and learning programs of the new technologies are organized in all levels of education worldwide (Agorogianni et al., 2011).

Universities around the world have experienced rapid changes influenced by all of the above as well as technological advancements and social trends. Moreover, universities were faced with the challenge of dealing with a large multidisciplinary community interacting at an online level, raising the issue of resources, tools, and support (Kalfa et al., 2021). Many digital tools have seen an explosive usage increment in the education industry, especially those tools related to video conferencing and live streaming services.

Live streaming has increasingly become a way to share and obtain technical knowledge since it allows streamers to broadcast their work to live viewers worldwide. (Chen et al., 2020). Live streaming hybrid events, or events that combine both in-person and virtual experiences, are essential to the new normal. Professors and other academic staff can reach an audience never before possible using Audio Visual (AV) technology, primarily through live streaming. While video conferences are great for small classes, live streaming for education-focused events offers the chance for the academic staff to encounter thousands of students.

This paper presents what the IT Center of Aristotle University of Thessaloniki (AUTH) implemented to successfully support and deliver live streaming services for in-person, virtual, and hybrid large-scale educational events. The paper also sheds light on a) recognizing the challenges and difficulties, b) the good practices and solutions implemented c) proposals for improving digital infrastructure and services to support any type of educational event.

## 2 Challenges and issues

The rapid digitalization of education due to lockdowns affected the whole educational ecosystem of AUTH. With restrictions on indoor capacities due to COVID-19 health and safety protocols in classrooms, meeting rooms, event rooms, etc., and a population less willing to be in the physical presence of others, event organizers except for in-person and virtual events, also adopted new forms of event delivery such as hybrid events (Hashim et al., 2021).

AUTH is the largest University in Greece, and with larger online audiences than ever before, the live streaming landscape is fraught with many challenges.

### 2.1 An extremely high demand of live streaming requests for large-scale events

Referring only to large-scale events<sup>‡</sup>, during the last year, the IT Center of AUTH received over 380+ requests<sup>§</sup> for live streaming services of different types of events (in-person, virtual, and hybrid) in various locations inside the campus. In other words, the ratio was approximately one large-scale event per day.

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<sup>‡</sup> with over 300 people invited

<sup>§</sup> Requests for live streaming through personal meetings and other low-scale events are not included.

## 2.2 Different types of events

Some of the main critical key factors that specify the type of event are: a) the location, b) the accessibility, c) interaction with the public.

In a comprehensive University offering a broad choice of large-scale events by 11 faculties and 41 Schools, each event type, which requires live streaming, has its requirements, specific features, and challenges. More specifically, the IT Center of Aristotle University of Thessaloniki is supporting Live streaming services for three types of events according to presence - attendance: a) in-person events require all the attendees to be present in a physical location at the time of the event b) virtual events are those in which everyone attends online and c) hybrid events are a mix between a virtual event and an in-person event where some people attend online and others attend in-person.

Accordingly, the same is true in the case of in-person learning, virtual learning, and hybrid learning in education. Having different types of events and supporting the needs of a multidisciplinary community means that one-size-fits-all does not exist when hosting educational events. That is why there are different solutions for different educational events. Consequently, last-minute changes on event type (e.g., from in-person to hybrid or sometimes to entirely virtual) due to emergency protection measures of the Covid-19 pandemic are usually on the top of the challenges that IT Center is dealing with.

## 2.3 There are too many requests for hybrid events than available equipped building infrastructure.

The IT Center of AUTH now administrates centrally more than sixty (60) IP cameras for live streaming purposes, installed in rooms inside and outside the main campus.

The difference between the high demand for Live Streaming services and the small number of conference rooms available shows a considerable need for more rooms equipped with the latest technology to support large-scale educational events of any form.

## 2.4 Lack of know-how of the people directly involved.

The Covid-19 has brought the world to a situation where those who are not having the appropriate digital skills face the imbalance of digital exclusion. Fortunately, as previously mentioned, education in a digital world never stops. Live streaming as a web service is a valuable tool that can be combined with any form or type of event with the appropriate user support and learning mechanism

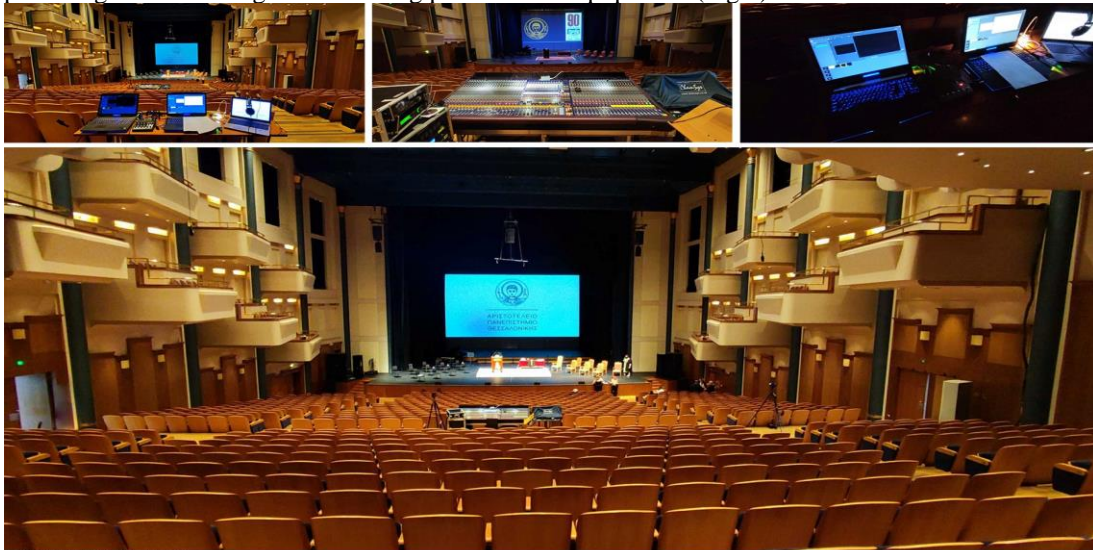
As previously mentioned, AUTH is a multidisciplinary university, and as it is well known, as regards the academic staff, not everyone comes from the IT field. Therefore, there were cases where people of the academic staff wanted to support virtual or hybrid events with Live streaming services on their own (e.g., custom live streaming through Zoom).

Although most academic staff sooner or later learned how to use teleconferencing systems and applications like "Zoom for Meeting, Zoom for Webinars, and Zoom Events" to meet their needs, there were many cases in which extra training was required. Similarly, when planning large-scale events (especially hybrid ones), the organizers, the speakers, and participants needed training on operating such an event or how to behave based on the available equipment in meeting rooms, conference rooms, or event halls at Aristotle University.

## 2.5 The need for live streaming services in any location.

The live-streaming landscape is fraught with known and sometimes unknown challenges. The ultimate AUTH's IT Center goal is always to provide the best viewer experience to our physical or remote attendees. In practice, this means low latency, minimum compression, consequently better video

quality, and last but not least continuous availability of web services. However, things are not always as straightforward as they might seem. In some cases, the IT Center is often called upon to cover events of any form from many different locations where the AUTH may not have permanently installed equipment, i.e., IP cameras, microphone and sound system, etc. Therefore, there is a need to use portable equipment (kit) that includes a complex AV infrastructure. One such case as a typical example concerns the coverage of a significant large-scale hybrid educational event at Thessaloniki's Concert Hall (TCH), providing live streaming services using portable AV equipment. (Fig.1)



**Figure 1** – Livestream Hybrid large-scale educational event at Thessaloniki's Concert Hall (TCH)

Another typical example is the case of covering events in preserved and valuable historical sites, such as the old ceremony hall in the old building of the School of Philosophy of AUTH\*\* (Fig.2). In places like this, there are difficulties in installing permanent equipment while existing restrictions regarding the remodeling of the hall.



**Figure 2** - The ceremony hall in the old building of the school of Philosophy

## 2.6 Data availability issues.

In the Aristotle University of Thessaloniki, almost 90% of the events, especially the large-scale ones, are recorded for educational and archive purposes and Video on Demand (VoD).<sup>††</sup>

<sup>\*\*</sup> The old building of the school of Philosophy was built in 1888.

<sup>††</sup> VoD is a free-for-all available service provided by AUTH's main website (<https://www.auth.gr/>).

Therefore, live streaming services and video recording have a high importance level, and indeed, all the above demand more storage space and network bandwidth.

## 2.7 Data Security issues.

Another challenge is related to the issues of data security. The protection of the recorded video material and Live Streaming connections are essential issues that AUTH's IT Center pays much attention to. In practice, this means that there is always a need for improvements at all levels concerning data security.

Regarding the VoD and the live streaming service, it is a university's policy to avoid using famous social media services like Facebook or Youtube<sup>‡‡</sup> since they indefinitely keep the right to store and own valuable academic data on their data centers worldwide.

All of the AV equipment that is installed in many different locations throughout the campus is connected to a secured network. Video capturing and then the inbound streaming data are encrypted using specific streaming protocols i.e., HLS, RTMP, and RTSP.

In AUTH, IT Center acts under specific policies and standards according to General Data Protection Regulation (GDPR) law regarding data privacy and security. Particularly, most of our data is kept in our privately owned data centers and served through our on premises servers. Instead of that, since AUTH has fully complied with GDPR as a European country, the IT Center of AUTH uses its university internal systems and services. Any data format is stored in IT Center's data centers which means more security. Even when transferring some particular data to other European data centers, a high level of encryption is applied.

## 3 Best Practices – Suggested Solutions

This section will present some of the key best practices - solutions followed by the IT Center to successfully meet the growing needs and challenges highlighted above concerning Live streaming services

### 3.1 Manuals and Training Programs

At AUTH, live streaming applies for any event form if the organization committee decides to use that service. With this in mind, there are several times that there is a particular need for training of people who want to organize an event (virtual, or hybrid) who are obviously not so familiar with the necessary equipment as well as the services involved. In this scenario, the tactic pursued by the IT Center of AUTH as a learning model to prepare others is providing them all the necessary training material following the old saying approach of "Teaching Them How to Fish."<sup>§§</sup>

More specifically, the IT Center has developed text manuals and instructional videos on the use of services that combine Teleconferencing, Live Streaming, and other related operations and services. Last year, over 120+ people of the academic staff successfully trained through face-to-face or virtual training programs due to the plethora of hybrid events.

Regarding the scenario of the In-Person events, procedures are fully automated and centrally controlled by the IT Center, so in that scenario, there is no need for training or preparing people involved in an event. Remote IP Cameras are centrally controlled, providing live streaming and recording services.

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<sup>‡‡</sup> In that statement, AUTH's Official pages in social networks are not included.

<sup>§§</sup> Famous old saying about the value of education: "Give a man a fish, and you feed him for a day. Teach a man to fish, and you feed him for a lifetime."

Of course, large institutional level educational events are supported and covered by experienced technical staff; however, whether small departmental level events are held, it is beneficial for all to obtain digital skills and knowledge. In other words, the know-how should be spread and remain to others as a legacy in a point of view. This is a big step in contributing to the technical development of the University members and strengthening its extroversion.

### 3.2 Room Categorization (In-Person, Virtual, Hybrid)

The IT Center has categorized the rooms available for Live Streaming, according to the type of the event it could be supported. Consequently, members of AUTH are able to know which room is suitable for the format of the event they want to use. The categorization applies as follows:

- In-person Rooms (The equipment of the hall is used for Live Streaming events with physical presence only.)
- Virtual Rooms (The room equipment is used for teleconferencing and Live Streaming through of it, with the speaker (the small group of speakers) being the only physical presence.)
- Hybrid Rooms (The room equipment is used for Live Streaming and Teleconferencing events having a partial physical and partial virtual presence.)



**Figure 3 - Conference Halls for In-Person, Virtual, and Hybrid Events - AURDC, KEDEA**



**Figure 4 - Conference Hall for In-Person, Virtual, and Hybrid Events – AUTH's Library**

Undoubtedly due to the Covid-19 pandemic, most of the events are hybrid (Fig.3, Fig.4). In addition, many claims that this whole hybrid model (Hybrid working, hybrid learning, hybrid events, etc.) both during and after the pandemic is here to stay. (BBC, 2021) In practice, this means that the need for rooms that meet the hybrid event form will constantly increase.

### 3.3 Procedure for handling requests for live streaming events

The IT Center of AUTH, having been certified both under a quality assurance perspective (according to ISO 9001:2015<sup>\*\*\*</sup>) and an information security management perspective (according to ISO/IEC

<sup>\*\*\*</sup> ISO 9001:2015 specifies requirements for a quality management system when an organization: a) needs to demonstrate its ability to consistently provide products and services that meet customer and applicable statutory and regulatory



27001:2013<sup>†††</sup>), handles all the live streaming requests with standardized procedures ensuring, among other things, the compliance of the Organizers with GDPR, Intellectual Property rights (IPR), etc.

The live streaming requests handling is supported by an in-house developed ticketing system that allows organizing and categorizing the requests by event type.

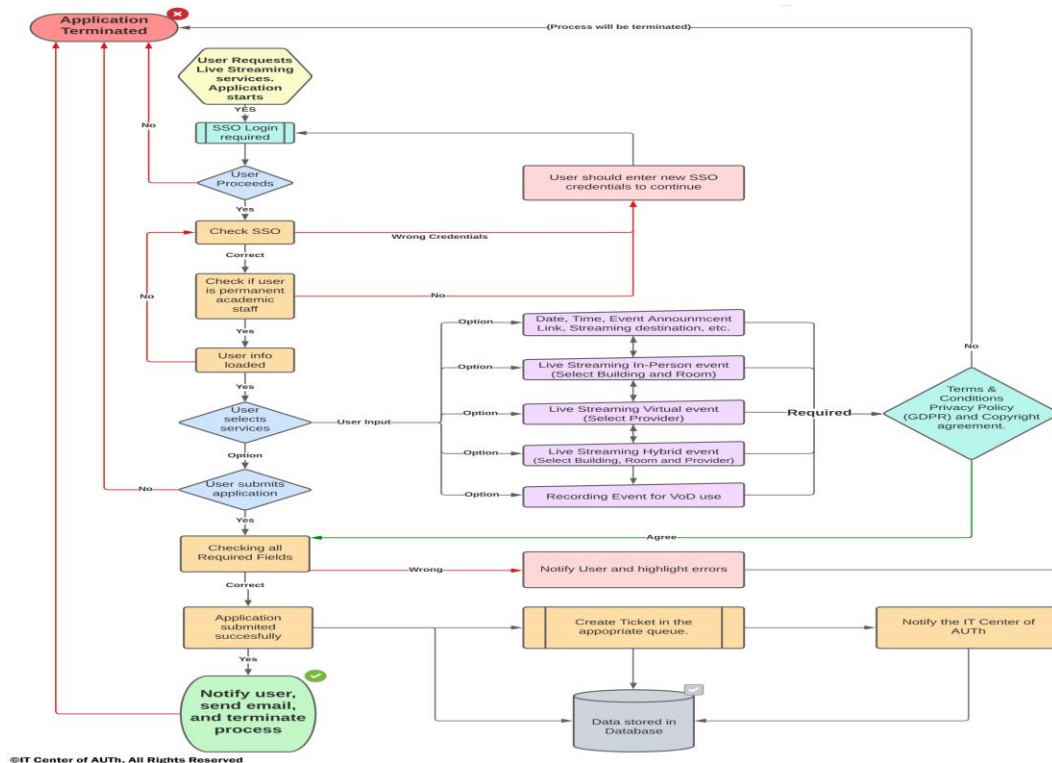


Figure 5 - IT Center's flowchart of procedures to apply for live streaming services.

As Figure 5 shows, the ticketing system recognizes the applicant's role as a member of Aristotle University and guides him to choose the appropriate Live Streaming service depending on the type of event. In addition, after mandatory acceptance of the relevant regulations on GDPR, the applicant can select the video recording option or not. The following flowchart analytically shows the procedures followed by IT Center of AUTH using a fully standardized ticketing system for the live streaming requests.

### 3.4 Automated processes and central administration.

The IT Center controls and administrates all the wired IP cameras installed in the entire campus centrally and remotely.

PTZ and remote cameras are the perfect partners for live streams. With various connections ranging from USB to SDI, NDI, and IP, PTZ cameras have never been more valuable and relevant, especially

requirements, and b) aims to enhance customer satisfaction through the effective application of the system, including processes for improvement of the system and the assurance of conformity to customer and applicable statutory and regulatory requirements.

<sup>†††</sup> ISO/IEC 27001:2013 specifies the requirements for establishing, implementing, maintaining and continually improving an information security management system within the context of the organization. It also includes requirements for the assessment and treatment of information security risks tailored to the needs of the organization.

for live production. We have multiple benefits through centralized control of the AUTH's IP cameras. Some of the main benefits are: 1) remote software updates, 2) fast recognition and error debugging, 3) instant remote controlling, 4) instant storing of raw data, 5) automated live streaming and recording scheduling tasks, 6) fast and multiple-serving of requests for audiovisual services, 7) remote configuration and setup without physical presence.

### 3.5 On-Premise Infrastructure

At Aristotle University, a software and hardware infrastructural setup that is deployed and running from within the confines of our organization is a must. In other words, using on-premise infrastructure, we own complete control over the entire infrastructural setup. On the other hand, all the valuable personal and academic data stay safe since they are encrypted in our private network, and nobody other than our team has access to the information.

For the live streaming processes, the IT Center uses the Wowza streaming engine, a customizable, flexible, and stable software that runs on-premises on multiple Linux servers at the university's physical location. The main benefit of the Wowza streaming engine is the ability to ingest any live stream and deliver it to any device. Moreover, some other additional benefits led IT Center to choose Wowza as a streaming engine like a) ingesting streams from any encoder, b) creating live, linear, or on-demand streaming applications, c) streaming live events, video conferencing, and audio streaming without time limits d) delivering video and audio streams to any player or device (Wowza, 2022)

In Figure 6, we see AUTH's typical workflow for live transcoding consisting of three phases: 1) input, 2) transcoding, 3) Output / Playback

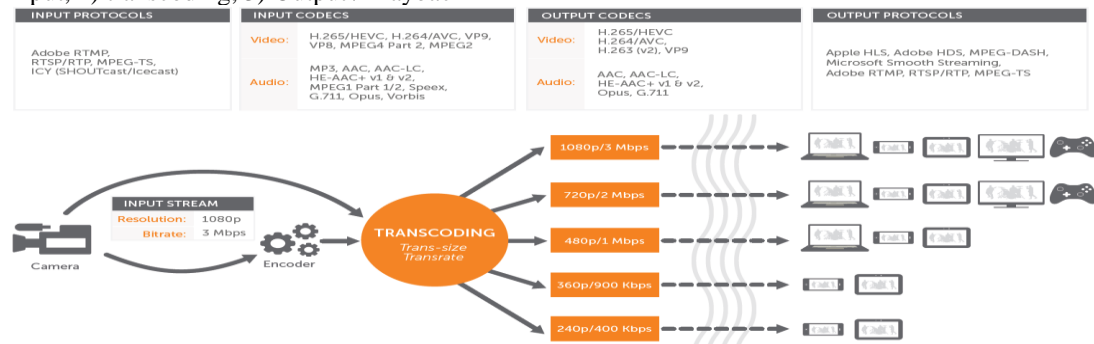
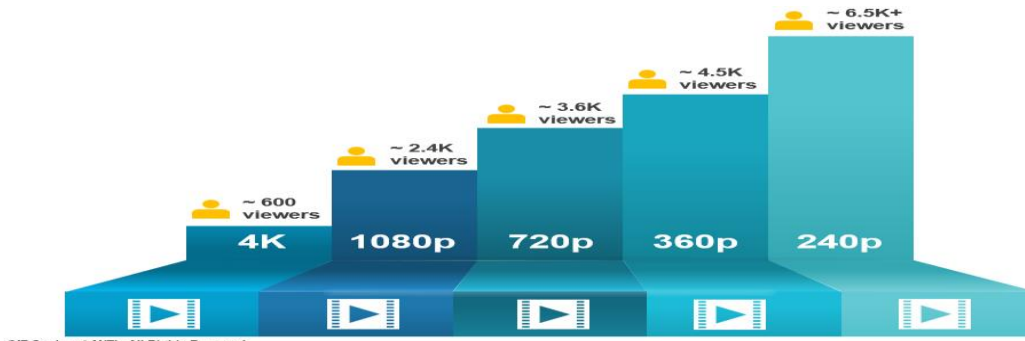


Figure 6 - A typical workflow for Live Transcoding

In AV and streaming systems, "transcoding" is a technical term that covers a number of digital media tasks and functionalities. Transcoding is taking already compressed (or encoded) content, decompressing (decoding) it, and then altering and recompressing it. Transcoding is critical in today's live streaming workflow because it enables administrators to change the video and/or audio format (codec) from one to another. For example, converting from an H.264 video and AAC audio source to H.265 video (Wowza, 2022).

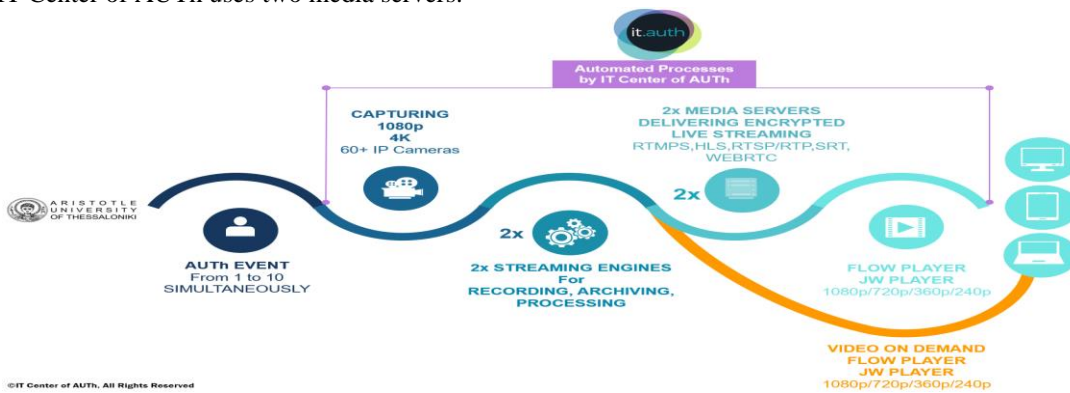
On the other hand, transrating refers specifically to changing the bitrate of the video or audio source, such as taking an HD video input stream at 5 Mbps and converting it into one or more lower-bitrate streams (such as 3 Mbps, 1.5 Mbps, 1 Mbps, 600 kbps, etc.) to enable adaptive bitrate (ABR) streaming (Wowza, 2022). The ABR in the transrating process is an essential feature that IT Center uses widely. For instance, there are many cases of large-scale educational events with a large audience of live streaming viewers who demand to see the video of the live event. By converting the bitrate streams, consequently, the quality of the served video by device type and by the ratio of the number of live viewers, IT Center achieves to provide the live streaming service to more active live viewers, from approx. 600 viewers in 4K quality to approx. 6.5K viewers in 240p quality (Fig. 7).





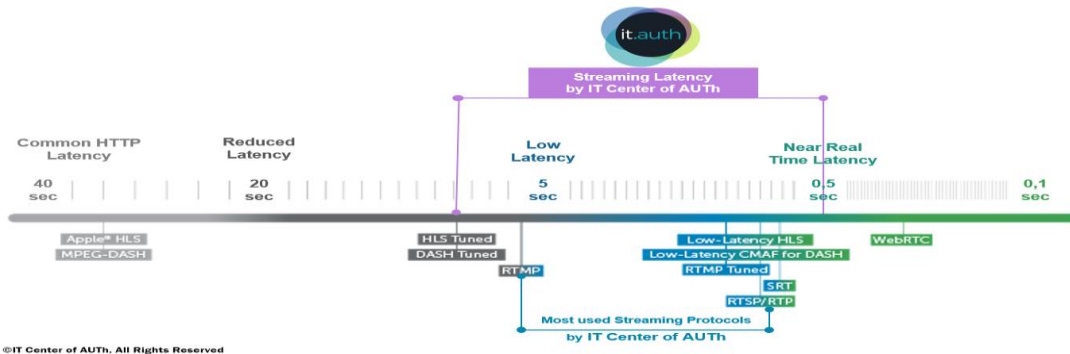
**Figure 7** - The ratio of the number of live users towards live streaming video quality

In Figure 8, we see the case of Aristotle University to support live-streaming its large-scale events using its on-premises infrastructure, followed by plenty of automated processes with the addition of VoD service on the same infrastructure. Undoubtedly, the tech roadmap from capturing to delivering and playing a successful stream is not always easy. Since IT Center usually covers large-scale events simultaneously, there are many cases that one single streaming engine is not enough. That is why the IT Center of AUTH uses two media servers.



**Figure 8** - AUTH's workflow for Live Streaming and Video on Demand.

On the other hand, unfortunately, there is always a slight delay when broadcasting single or multiple live streams. That is due to the steps involved in getting our ingested video out to our viewers. In other words, once our stream is received from the server assigned to process it (e.g., media server), it first needs to be transcoded from its incoming format, RTMP, to RTSP or Low Latency HLS format.



**Figure 9** - AUTH's streaming protocols and streaming latency

In most cases, while covering large-scale events, the average streaming latency is approx. 11 seconds (Fig. 9). However, in a digital world where videos are leading in multimedia use, there is a growing need for shorter latency and high video quality, giving an excellent viewing experience on any device. On the one hand, we have the evolution of wireless networks that support speeds from 1 to 20 Gbps (e.g., Optical networks, 5G wireless networks, etc.) and help on this matter. On the other hand, we have an incredibly growing demand for Internet and multimedia applications that require and consume more bandwidth (Roussos, G., 2021) (Fig. 10).



**Figure 10** – Statistics of AUTH's live streaming network throughput (one streaming engine)

What did the IT Center use to achieve better results for the academic community and everyone else? Multiple streaming engines on multiple Virtual Machines (VMs) installed on separate dedicated servers serving different video quality according to user's demand. The answer may seem short, but the entire try from the IT Center was undoubtedly huge.

Another point worth mentioning is that IT Center pays much attention to understanding video quality's impact on user engagement. Whether live streaming or VoD service, content providers must understand if and how video quality affects user engagement and how to invest their resources best to optimize video quality (Dobrian, F, et al., 2011).

As it is well-known and much-discussed worldwide, twenty years approx before, researchers mentioned that live streaming and Video-on-Demand (VoD) over the Internet is the next major step in the evolution of media content delivery. (Yu. H, et al.,2006). Nowadays, we live in a period when this phrase becomes true. A number of different protocols have been developed worldwide to facilitate real-time or near real-time streaming of multimedia content. By leveraging the increasing availability of broadband access and adapting new, improved streaming protocols (i.e. WebRTC, low-latency HLS, RTMP Tuned, SRT, and SRTP / RTP), Aristotle University offers live or video-on-demand streaming services having low latency.

Finally, by recognizing the challenges of its digital and audiovisual infrastructure and following best practices, the IT Center is more prepared to cope with any scale and any form of educational event requiring live streaming services.

## 4 Future Plans

The need to face the high demand in online and hybrid events belongs to future steps that need to be taken. Towards this direction, a new project is underway in order to upgrade with wirelessly connected state-of-the-art equipment in more than 100 rooms around campus. This project is set to be finalized by the end of 2022. The upgrade includes cameras (IP 4K cameras with face tracking), digital microphones, a centrally controlled broadcasting and recording system, remote security control with geo-location of devices via Radio Frequency Identification (RFID) technology, etc. The project also handles the transformation of a room into a green screen studio and the addition of 5 full hybrid

conference halls. As a result of the upgrade and the additional rooms, there is a high possibility of experiencing multiple server connections and thus a high server load. In addition, there is an examination in the progress of adding dedicated servers and/or cloud servers to tackle this new traffic load.

All of the above plans, including the benefits arising from there, are not intended just for the AUTH's academic community but for a multidisciplinary university; hence, this is one more big step in doing good for all in a digital world.

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