Uni TV
Trialling IPTV for Education
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Executive Summary

This white paper examines the outcomes of a trial of Internet Protocol Television (IPTV), which was tested as an educational platform by the Melbourne Dental School at the University of Melbourne.

It is often very difficult for students and those wishing to engage in continuing professional development to attend classes and tutorials on a university campus, particularly when they live and work in outer-metro, regional and rural communities. Lecturers and tutors may also spend a lot of time travelling between widely separated campuses. Thus so called time- and place-shifting in learning is growing.

IPTV is capable of delivering very high quality video content via a managed data service. This is in contrast with the relatively poor quality and user-experience of best-effort applications such as YouTube. A set top box is used to decode the incoming broadband data and display it on a high definition TV. IPTV has traditionally been an entertainment platform delivering movies on demand for example. The innovation of this study is the examination of IPTV for educational content and services.

This white paper finds that IPTV is an excellent method of delivering high quality educational video material to a range of end users at various locations over a broadband network. High-definition (HD) video material can be broadcast live in a TV channel and also as video-on-demand (VoD). The latter allows the viewer full control of the material so it can be paused, fast forwarded and so on. Such flexibility of access is of interest in an educational setting, allowing repeated review prior to examinations, or to concentrate on particular techniques being demonstrated, for example. IPTV can also deliver 3D video which adds value to the educational experience: the viewer receives extra depth-of-field clues as to, for example, the proper angle and depth of drilling in dental procedures.

This white paper also identifies several barriers to the use and acceptance of IPTV in an academic setting: the most important relates to the difficulties in translating a service originally designed for mass entertainment into one for relatively limited numbers of users often in niche education markets.

This white paper recommends that:

• Educational institutions utilise IPTV to help them reach out to end-users who are demanding more time and place-shifted educational services.
• The standard IPTV operating system is redesigned to meet the specific requirements of academic end-users to give more flexibility in recording options, particularly to capture key moments, spontaneous demos and reorganised classes. For example, a simple ‘record now’ button on a user interface with an option to add basic metadata on the same screen would be ideal.
• Fully managed IPTV is implemented only where highest video quality and service is needed.
• Multiple channel providers and large numbers of end-users must be found to provide the economies of scale to provide a sustainable business whenever the licence-fee-per-user model of the entertainment industry has to be implemented.
• Lower cost alternatives such as over-the-top (OTT) IPTV can be more easily and cheaply implemented to support educational services, even if at the expense of ultimate levels of quality and reliability.
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1 IPTV explained

1.1 Introduction

Internet Protocol Television (IPTV) utilises broadband data networks to deliver live and pre-recorded channels as well as video-on-demand (VoD), to consumers. Although the term IPTV is often used to describe unmanaged ‘over-the-top’, or OTT, Internet video services, its ultimate form means a fully managed broadcast quality data service that offers high definition (HD), as well as the ability to deliver 3D, excellent quality of experience (QoE), and the highest levels of reliability (Arberg et al. 2007). In short, the service is fully managed from video source to set-top box by the IPTV service provider. The IP protocol is used to convey the audio and video streams as well as the necessary management and control overheads. To achieve all of this, consumers must be subscribers to the service which also requires them to log-in and authenticate in some manner. This also provides secure payment mechanisms for those situations requiring it. IPTV has traditionally been used successfully in the entertainment sphere to deliver sports, movies, drama and a host of other consumer channels to hundreds of thousands of customers in many instances across the globe in the USA, Europe and Asia (Zhu et al. 2009).

More recently IPTV’s potential in education is starting to be explored (Pohradsky et al. 2010) with particular interest in China (Zhu et al. 2008). Students of all ages and types increasingly expect to have access to more flexible alternatives to campus-centric models of learning in so-called time- and place-shifted models. Often they want to fit their learning around other commitments, such as jobs and family, and to access educational services in multiple ways. This is one of the major drivers for the current interest in using IPTV to provide the necessary 24/7 access via multiple screened devices such as tablets and smart-phones as well as domestic TVs. The result is so-called blended learning: a model where students receive their education in a mix of face-to-face and online, or eLearning, experiences.

Figure 1: IPTV is a commercial reality today, available across multiple devices (source: Ericsson)

IPTV is capable of providing services in a variety of situations across the educational spectrum, from school age children, through higher education to continuing professional development (CPD), as well as for the general population.

Firstly, some details about generic IPTV services and technology will be provided below.
1.2 Basic IPTV features

Users require a set top box (STB), which is connected to the Internet via a broadband connection. This provides the link to the IPTV service provider. The STB is also connected to their domestic TV and decrypts the incoming data to provide the TV with a recognisable video and audio signal. The STB can be seen as the middleman in IPTV transactions: it takes the user commands and interacts with the IPTV management and control layer to provide the requested channel and any associated user functions (Chae 2007). Access to IPTV channels and services normally involves some form of login and authentication. This can mean simply entering a four digit pin number via the STB’s remote control, or selecting a user from a list and then entering a password via a remote control which can have a mini-keyboard built in. In any open setting such as domestic lounge or hotel room, authentication allows for some form of secure pay-per-view mechanism if required: the IPTV management system knows who is logged in, and this person can authorise payment for particular movies, via their personal account.

A typical IPTV platform provides two standard services. One is so-called linear TV which is rather like traditional broadcast TV: by using the STB remote, users can select from a number of channels that are delivered according to a published schedule. These can be live events such as sports as well as pre-recorded material. The second service, video-on-demand (VoD), presents the user with category lists with user-friendly thumbnail images of videos that can be selected and viewed at any time, as shown in figure 2. The user then has full control of trick-features such as pause, channel record, fast forward, rewind etc, from their STB remote control. In function it is rather like having a DVD player or personal video recorder attached to the TV. This is where the critical issue of latency, or system delay, has most impact: if the user feels that the IPTV system is slow to respond to their commands then this quickly degrades the quality of experience.

STB functionality can be built into the TV set and have its function mimicked by a Smart TV (basically a TV with built in personal computer). Other screened devices such as PC’s, smart-phones, and tablets can be used instead of a TV that use software to replace the STB function entirely.

Figure 2: Educational VoD on IPTV
1.3 IPTV hardware

A high quality IPTV service requires some key elements in terms of hardware;

1. A server architecture that takes the locations and spread of its users into account so that it can efficiently host and deliver a wide range of video content with low latency and low cost.

2. Encoding platforms that take various video and audio feeds from a range of sources, live or recorded, and compress them into MPEG2 or MPEG4 data streams. These data formats are then ingested by the video server and allow the delivery of much smaller amounts of data compared with the originals, but still maintain the high quality necessary for an HD picture.

3. A high-speed, reliable broadband network that offers quality of service (QoS), data differentiation so that the IP (TV) packets can be delivered to end users with priority over Internet best-effort traffic (Arberg et al. 2007).

4. Uni-cast and multi-cast capability must also be supported by the network. For example, when a user makes a request for a particular VoD item the video server will return it in a uni-cast stream. This means the data stream is directed on a one-to-one basis from the server to each STB. Alternatively, live channels can be ‘broadcast’ to multiple simultaneous viewers analogously to terrestrial broadcast TV. This involves the use of multi-cast data which is an efficient way of distributing video through a network: additional data streams are only created where required, rather than sending multiple copies entirely from end to end (NBN Co 2012). However, multicast is usually difficult to implement across multiple network providers so over-the-top, or OTT, IPTV is often used. For example, HTTP live streaming and unicast is used by some service providers (Akamai 2013). OTT provides the necessary flexibility for content owners, who usually do not own their own networks, and is the most common form of IPTV.
14 IPTV middleware

IP Multimedia Subsystem (IMS) is a standardised architecture for providing IP-enabled services, and is designed to have the flexibility to deliver new types of combined telecommunications and Internet services into the future (Mas 2008). It allows users to access all of their multimedia and voice services from any platform, fixed or wireless. It is used by large telecommunications entities.

IPTV middleware refers to the software that provides communication and delivery of data, and connects the separate parts of the IPTV ecosystem. It can be integrated with IMS to enable the service provider to give their IPTV customers an interactive, customised, or even mobile experience (Nguyen 2010). For example, IPTV can be delivered to multiple screens, not just large TVs, so that users can watch and have control over video streams on mobile devices such as tablets and smart-phones. Messaging, social media and other telecommunications services can also be integrated with the IPTV service to add to the user experience (Beck 2007). Middleware enables ease of integration with the video server and STB to ensure channel handling from different sources, optimised graphics for the end-user interface and content protection capabilities.

Figure 3: The IMS for IPTV (source: Ericsson)
1.5 3D technology

The cost of 3D technology, such as domestic TV screens and high-definition cameras, has fallen dramatically in the past two years thanks to its wide uptake and ongoing development by the entertainment industry (Deal News 2011). This means that 3D can now be used for practical, cost-effective educational purposes in many scenarios, and IPTV can extend 3D’s reach out of the laboratory, clinic, and classroom and into the homes of users via broadband data networks. For a considerable period of time, the usage of 3D has been recommended to facilitate learning in situations that would be impractical in the real world, to transfer knowledge through the contextualisation of learning, to enhance intrinsic motivation and to create spatial representations of complex concepts (Chitaro 2007). IPTV’s ability to store, to provide easy repeated access, and to display 3D HD reliably at broadcast quality makes it an excellent choice for these situations.

Figure 4: 3D chemistry lecture via IPTV on domestic TV with active shutter glasses
2 The Uni TV service

The service challenge was to create or capture content and deliver it in a way that was both appealing and effective for the ‘audience’ in a pedagogically sound manner. The main benefits initially envisaged of a successful implementation of Uni TV were better trained dental students and professionals who could then deliver improved health outcomes for their patients in both metro and regional areas. In addition, the fact that regional dentists could carry out more advanced procedures thanks to additional training received via IPTV locally would mean that their patients would no longer need to travel to metro areas to get certain specialist treatments. This would save them time, as well as travel and accommodation costs.

The ultimate aim would be to see IPTV delivering multiple education channels in many subject areas across the state and country, bringing quality education to users at all levels of society.

2.1 Participants

The Melbourne Dental School (MDS) was the trial user of the Uni TV IPTV service. MDS is adjacent to the University of Melbourne’s Parkville campus. In 2012-2013 it built a nearby clinical teaching facility named MOHTEC on Swanston Street. This new facility was originally designed with in-house AV and separate videoconferencing system to provide multiple camera feeds from a wide range of scenarios; seminar room events; view from above the dentist chair; podium cameras that capture demonstrations of procedures.

Figure 5: Uni TV in MOHTEC’s seminar room (note STB above screen).
Students in second and third year, and staff in the above locations could access the service, including those based in Shepparton in north east regional Victoria. The trial also extended to a professional dentist based at home in Brunswick, Victoria, as well as to users with a general interest at the Institute for a Broadband-Enabled Society based on the Parkville campus. The system could also be used to deliver continuing professional development (CPD) to professional dentists who have to undertake regular mandatory training to maintain their qualifications as well as learn the latest dental techniques.

2.2 Service locations

The following table lists the details of locations with multiple users receiving the Uni TV service.

<table>
<thead>
<tr>
<th>Institution</th>
<th>Installations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Melbourne Dental School</td>
<td>4 screens in second level seminar room</td>
</tr>
<tr>
<td>Carlton</td>
<td></td>
</tr>
<tr>
<td>Rural Health Academic Centre</td>
<td>2 screens in seminar room</td>
</tr>
<tr>
<td>Shepparton</td>
<td></td>
</tr>
<tr>
<td>Institute for a Broadband-Enabled Society</td>
<td>1 screen in broadband laboratory</td>
</tr>
<tr>
<td>Parkville</td>
<td></td>
</tr>
<tr>
<td>Professional dentist home user</td>
<td>1 screen in Brunswick NBN build area</td>
</tr>
<tr>
<td>Brunswick</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Details of the IPTV nodes

Figure 6: 3D Stereo-microscope pre-clinical demonstration broadcast live via IPTV
2.3 Features

Uni TV leveraged off of the previously described AV system at MOHTEC to provide new and improved video services; HD rather than just SD feeds; remote locations as well as in-building ones; compelling 3D HD vision from a clinical stereo-microscope specially fitted with twin cameras and encoding hardware for the project.

The system consists of Sun, HP, and Edgware servers based in MOHTEC, which ingests live video and holds the recorded content, and also manages the user experience. The IPTV gear provided 3 linear channels: channel 1 was made up of general University of Melbourne content from various faculties and university events; channel 2 was live programming from the 2D cameras attached to the AV system; channel 3 was live programming of 3D video direct from the clinical stereo-microscope.

The VoD was split into various categories to make content handling and navigation with the STB remote easier. Tabs at the top of the VoD screen were segregated by course-name and year. Users could highlight a tab and then enter to find video relevant to their course. Some previously recorded video material was also made available from the MDS archive to broaden the range and appeal of content.
2.4 Operation

Recording of video needed adequate preparation as the electronic programming guide, or EPG, needed to be created one or two weeks in advance, ideally, so users would be able to scroll through the program listings to see items of interest. A spread-sheet was set up to record basic info such as recording name, presenter name, date and time, as well as a paragraph or two describing the content, otherwise known as the metadata. The IPTV support engineers from Ericsson would then take the academics’ spreadsheet and populate the corresponding details via the IPTV management software.

At the time of a live event (demo, lecture, etc.) the academic would use the AV system (figure 8) to select the appropriate camera feed via a graphical user interface, or GUI, on a Mac computer. Whichever camera was selected on the AV would automatically be fed via a switch to create channel 2 of the Uni TV system. If the academic required the 3D stereo-microscope then it had its own separate hardware and feed to an MPEG encoder sitting at the input of the IPTV system. This two channel encoder was used to create the mpeg2-ts format video files in near real-time (involving a 6-8 second buffering and processing delay). The 3D feed formed channel 3 on the Uni TV service. The only remaining task was to ensure a microphone was also set up via the AV system to record simultaneous audio if required. This would also be picked up by the IPTV system.

Figure 8: GUI-controlled AV system from which Uni TV captures 2D camera feeds.
Figure 9: A podium camera used to capture clinical demonstrations.
3 Outcomes

3.1 User feedback

The quality of the video provided by Uni TV, in particular the 3D video, and the ease of accessing these videos was “outstanding” and received constant positive feedback from all categories of end-users. As a source of video on demand the system was rated by end-users generally as “very effective”.

Clinical educators noted the possibilities of undertaking good quality education with a mixture of live presentation via video conferencing, while playing pre-recorded video on demand material (in 2D and 3D), in an interactive way for distance education between Shepparton and Melbourne for example. The video of this interactive educational session itself could then be available for ongoing review via Uni TV by students and professionals.

However, it should be noted that IPTV is not the same as a videoconferencing system as it does not strictly work in real-time as far as ‘live’ broadcasts are concerned: as described previously there is a 6-8 second delay as the system ingests, buffers, and processes the camera feeds. This is expected behaviour and similar to delays pay TV consumers might note between ‘live’ sporting events shown on TV compared with radio commentary of the same event. (Note that video-on-demand material does not have this delay). Educators who nevertheless trialled UniTV as a method for real-time interactive teaching via simultaneous use of a video-conferencing system, found the delay factor between the two systems to be “considerable,” and made this particular teaching mode “almost impossible”. It should also be stressed at this point that when there is no simultaneous videoconferencing or phone call in progress viewers are unaware that Uni TV is not truly ‘live’ so experience no difficulties.

Observations of, and discussions with viewers found that the STB remote controls were “easy” to use within a few minutes of first time use, and the UniTV on-screen menus and options equally “easy” to navigate. The latter was helped by the decision to hold video-on-demand in categories named after particular courses offered by MDS. The so-called ‘trick play’ features such as fast-forward, pause, and rewind of video-on-demand were felt to be “very responsive” to the users’ commands.

Some educators pointed to the difficulty of subsequent packaging of already recorded material to provide succinct and relevant VoD for example: “A lot of demonstrations occur at different and somewhat random times during a 3 hour teaching session”. In effect this means subsequent viewers would have to fast-forward through a lot of irrelevant material unless the recording was edited before appearing in the VoD categories. This process would involve a lot of additional effort on behalf of staff. Interviews with various users produced ideas for a redesigned front-end that would meet the specific requirements of educators to give more flexibility in recording options, particularly to capture key moments, spontaneous demos and reorganised classes. For example, a simple ‘record now’ button on the AV interface with option to add basic metadata on the same screen would be ideal. In addition to this, some form of app to allow easy creation and editing of EPG data would be highly desirable.
3.2 Barriers to adoption

Although there was considerable effort put into the development of the electronic programming guide for live TV channels as well as recordings, a large number of pre-clinical demonstrations taking place during the trial period failed to take advantage of this. One of the major problems was the unfortunate failure of some staff to fully engage with the project despite showing previous willingness to participate. The result of this impacted on viewers who then lacked access to new material as well as existing archives of video material that should have been loaded onto the IPTV server for class use, and they failed to find accurate information on the EPG about upcoming classes and demonstrations, etc. The major stumbling block for these staff members seemed to be heavy teaching workloads, leaving little to no time to attend to tasks not seen to be of critical importance. Also the previously mentioned lack of a simple ‘record now’ option on the system prevented many events being captured by them.

The physical placement of the TV screens was also flagged to be of critical importance to the use of the service. Students in the ground-floor pre-clinical area, where most of the teaching and demos are undertaken, would have preferred the Uni TV service to also be available in that area rather than in a separate seminar room. This would allow on-the-spot review of previous material during sessions and would have seen greater usage of the service.

Any commercial-grade managed IPTV platform is a complex system requiring highly skilled teams to operate and manage it. This makes it a relatively expensive undertaking that requires thought as to a sustainable business model. Alternatives such as OTT IPTV variants could be considered for lower cost operations where the increased likelihood of reduced video quality and unreliability is also accepted as an inevitable part of the package. This is the subject of Section 4.
3.3 **Ongoing work**

The project group formed to carry out the Uni TV trial continues to seek out opportunities for IPTV in educational settings. In September 2013 a consortium of collaborators received funding for a project named *Wadeye IPTV: delivering significant and at risk audio-visual archives to remote Aboriginal communities via IPTV*. The collaborators are:

- Kanamkek-Yile Ngala Museum, Wadeye, Northern Territory
- Thamarrurr Development Corporation, Wadeye, Northern Territory
- School of Languages and Linguistics, the University of Melbourne
- Centre for Health and Society, Melbourne School of Population and Global Health
- Centre for Cultural Materials Conservation, the University of Melbourne
- Institute for a Broadband-Enabled Society

The project will trial how culturally significant and endangered audio-visual archival material might be most effectively and appropriately preserved and made accessible for future generations. The Wadeye museum currently holds significant collections of audio-visual recordings of ceremonies, songs and dances, languages and local ecological knowledge covering at least six different language/tribal groups. The platform will stream content to a smart-phone/PC/TV, and will also demonstrate automated replication and updating of remote video servers at Wadeye from centralised, secure archive servers. The project will trial the use of OTT IPTV at Wadeye and will stream video locally via WiFi. IPTV is seen as an excellent technology fit as it can provide very granular, controlled access to content by separate cultural groups, and provides metadata to allow easy searching of the video archive by users, which also makes it a valuable resource for specialists such as linguists. If successful, the model will be applicable to many communities.

As well as supporting Wadeye TV and Uni TV, additional IPTV channel partners are always being sought to enhance the future sustainability for all users.
4 IPTV business models

When it comes to providing a sustainable educational IPTV service there are two major aspects that are inevitably intertwined. These are the choice of technology that will do the content delivery, and the method of funding provision of the service.

4.1 Technology Choice

The first issue, as mentioned previously, is that IPTV can mean different things to different people. YouTube, for example, could legitimately be described as an educational IPTV service as it uses broadband networks to deliver a wide range of VoD material to users at home, office or even on the move. The types of services to be delivered will normally determine the choice of technology: YouTube may be acceptable in many instances but it will not broadcast 2D or 3D HD live TV channels simultaneously to multiple locations. Equally it does not offer 24/7 technical support or customer-assistance hot-lines that premium IPTV services must offer as part of their business.

As well as the range of service features on offer, a key difference in the various flavours of IPTV on offer in the market is the quality of service provided. This can range from no-guarantees-whatsoever in the case of YouTube up to the type of user experience provided to paying subscribers in examples such as Foxtel in the Australian entertainment context.

YouTube is also an example of a cloud delivery model where the content producer has no infrastructure themselves but relies on YouTube to host, manage, and deliver content for them. At the other end of the spectrum there is the model as described in this whitepaper where the content producer also owns, operates and maintains the necessary infrastructure to deliver multiple types of high quality IPTV services to the consumer. In between these two extremes are all sorts of middle ground OTT IPTV systems: cloud delivery models that require payment to a third party to encode and deliver video material hosted on multiple independent servers across the world, and relatively simple IPTV systems that serve a limited number of customers with video content and terrestrial TV channels, which could be installed on an oil-rig, in a retirement village, or on a student campus for example.
4.2 Funding Models

Given the range of IPTV technology options outlined above it is obvious that the operational expenditure and capital expenditure situation can vary dramatically from practically zero to many hundreds of thousands of dollars for the fully managed, multi-service, multi-channel IPTV approach. When large expenditures need to be funded and, perhaps, profits generated there are three main types of funding model that can provide the necessary revenue streams. These can potentially be used in combination depending upon the situation.

4.2.1 Pay TV

This is the typical method for financing the operation of a commercial-grade multi-channel IPTV platform in the entertainment sphere where tens of thousands of users are supported. A range of monthly subscriber fees are charged for particular bundles of channels and/or may involve additional pay-per-view charges for VoD content such as movies or special sporting events.

In the education domain charges could be levied as part of course fees for access to particular channels or VoD, and this is also of relevance for CPD as many professions and trades require maintenance of skills through regular courses taken annually; for example dentists, accountants, and paramedics. Many organisations could take advantage of a multi-channel IPTV system to offer more convenient out of hours training to their members while attracting revenue via the in-built payment mechanisms of IPTV.

4.2.2 Cross-subsidisation

It is possible that an IPTV service could be supplied effectively free to educational end-users as a business differentiator which would help attract more of the best students to a particular institution. This could be funded out of business areas such as marketing as the intention is to see an eventual net financial gain from the extra students that would be enrolled.

There could also be a range of pay and free services on an IPTV platform with premium educational content for particular courses attracting a charge. The revenue generated by the latter could then subsidise the provision of the former.

4.2.3 Advertising & sponsorship

As per the traditional TV model, IPTV is also capable of supporting the time-honoured traditions of adverts slotted into programming and VoD. It is also possible to re-skin the look of the IPTV EPG and login screens to contain branding for marketing purposes. Without doubt, a wide range of commercial entities would be interested in reaching an educated, tech savvy youth market, as well as professionals undertaking CPD.
5 Discussion and recommendations

There are many IPTV variants in the market and new ones are constantly being created. Many of them could support innovative education service delivery by taking advantage of the time- and place-shifting that such technology allows. This white paper has described a trial that used a commercial grade, multi-cast enabled IPTV platform to deliver both 2D and 3D HD TV and video for dental education purposes. Such platforms are normally used by multiple channel providers with thousands of end-users to give the appropriate economies of scale and revenue streams to make them sustainable. Other lower cost approaches to IPTV have been described, such as over-the-top, or cloud delivery models. These can suit the needs of small or not-for-profit operators very well, such as those in the education domain which is the target of this white paper.

This report also found that the interface and management design of available IPTV systems, usually targeted at the entertainment market, would need to be redesigned to suit the particular requirements of educators. This would allow them to easily capture the key moments of demos, tutorials and lectures, which can often be of a spontaneous, rather than scripted nature. The system should also allow them to easily input the necessary metadata. This adds great value for all subsequent users searching and navigating content on the system.

When choosing the appropriate technology and business model it must start with some simple questions:

1. Number and type of IPTV services to be offered?
2. Number and location of end-users?
3. Type of screened devices to be used (TV, PC, smart-phone, etc.)?
4. Quality of experience users will require?
5. Funding required to provide the above?

This white paper recommends that:

- Educational institutions utilise IPTV to help them reach out to end-users who are demanding more time- and place-shifted educational services.
- The standard IPTV operating system is redesigned to meet the specific requirements of academic end-users to give more flexibility in recording options, particularly to capture key moments, spontaneous demos and reorganised classes. For example, a simple ‘record now’ button on a user interface with an option to add basic metadata on the same screen would be ideal.
- Fully managed IPTV is implemented only where highest video quality and QoS is needed.
- Multiple channel providers and large numbers of end-users must be found to provide the economies of scale to provide a sustainable business whenever the licence-fee-per-user model of the entertainment industry has to be implemented.
- Lower cost alternatives such as OTT IPTV can be more easily and cheaply implemented to support educational services, even if at the expense of ultimate levels of quality and reliability.
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