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DEPLOYMENT OF INTERNET PROTOCOL TELEVISION (IPTV): HOW READY IS NIGERIA?

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ABSTRACT

Over the last decade, the growth of satellite service, the rise of digital cable, and the birth of High Definition Television (HDTV) have all left their mark on the television landscape. Technology advancements in TV services have brought about some exciting developments in form of Internet Protocol (IP) Technology and broadband, which have created an emerging market called Internet Protocol Television (IPTV). Internet Protocol Television is a system where a digital television service is delivered using Internet Protocol over a network infrastructure, which may include delivery by a broadband connection. It is a television content that, instead of being delivered through traditional broadcast and cable formats, is received by the viewer through the technologies used for computer networks. IPTV covers both line TV (multicasting) as well as stored video (Video on Demand VOD). The playback of IPTV requires either a personal computer or a set-top box connected to a TV. Internet protocol television IPTV has arrived, and backed by the deep pockets of the telecommunications industry, it is poised to offer more interactivity and bring serious competition to the business of selling TV. How prepared is Nigeria for deployment of Internet Protocol Television IPTV? This paper discusses the architectural characteristics of IPTV, requirements for effective deployment of IPTV network and how Nigeria will cope with the inevitable transition from Satellite dish and cable technology to Internet Protocol Television Technology. The authors are of the view that early transition preparations are inevitable to avoid future failures.

Keywords: Broadband; Digital cable; HDTV; IPTV; satellite service; VOD

INTRODUCTION

IPTV as an operator service over broadband network has been available for some time. Until recently, however, it has mainly been offered in small networks or in parts of networks (Kim *et al.,* 2005; Cagenius *et al.,* 2006). There has been an anticipated increase in traffic over broadband access networks. This increase will largely be driven by IPTV service. Even though today's networks have been built to support triple-play service, upgrading them to support mass deployment of IPTV service will be a major challenge. This is because the new media experience this service provides is not restricted to passively viewing broadcasted content but rather presents end users with interactive and personalized media, including on-demand content and combinational communication services.

To meet these challenges, operators are investing in deep-fiber access and upgrading their IP edge capabilities (Baker *et al.,* 2007). Ultimately, the network must support an increasing portion of unicast traffic (that is, dedicated media streams to individual users). Notwithstanding, multicast traffic will continue to be an important feature for efficiently distributing content to many users. Another challenging issue relates to the efficient distribution of content while guaranteeing the quality of the IPTV media experience.

In summary, to successfully deliver this service, the network must scale well and be flexible in order to account for user uptake and future services. This paper describes the IPTV network infrastructure as could be deployed in Nigeria, its challenges and probable mitigation and how it can evolve into the full service broadband architecture, thereby supporting the new media experience of IPTV.

REVIEW

IPTV was conceived in the mid- 1990s by Gerry Pond, then CEO of NB Tel (Kim *et al.,* 2005), as a platform that would enable the company and its industry peers to penetrate the entertainment services business and leapfrog the existing services delivered via satellite, coaxial cable and terrestrial broadcast.

In the mid-1900s, Real player the first audio and video browser plug-in was released into the market by Real works web browser which had formerly been constrained to displaying HTML and still images (Gilon, 2005), now have the capability to display audio and video. Before long other multimedia players joined Real player in the multimedia plug-in market; the likes of Apple (Quick time) and Microsoft (windows media player).

During these early years, rudimentary compression technologies and limited bandwidth resulted in stuttered media display with poor visual and auditory quality. These technical limitations hampered on the widespread diffusion of web enabled stream on media. The development of Internet Protocol Television (IPTV) services is quickly becoming a central strategy for major telecom operators, with Asia and Europe leading the industry in terms of network deployments and customer adoption (http://www.bundesnetzagentur.de, DVB Internet Protocol).

Unlike ordinary Internet video services that stream or download highly compressed video to a PC screen, IPTV systems deliver high quality standard-definition and tent in real-time to more demanding displays, such as large-screen TVs. This requires a stable and reliable high-bandwidth network infrastructure. IPTV system deployments usually drive major upgrades to the network infrastructure to meet these requirements.

Comparing IPTV with Internet Video

1. Internet Video involves wide range of sources, compression techniques (viewed on personal computers or network devices, it also operates over unreliable networks and dedicated stream to each viewer, meaning it does not support multicast.
2. IPTV has the advantage over internet video in that it provides continuous broadcast of video channels (similar to broadcast, CATV (cable television) or Satellite) viewed on television via STB [8]. All channels are compressed at the same time and it is typically implemented on private networks supporting multicasting and rate control of non-video data.

DESIGN ARCHITECTURE

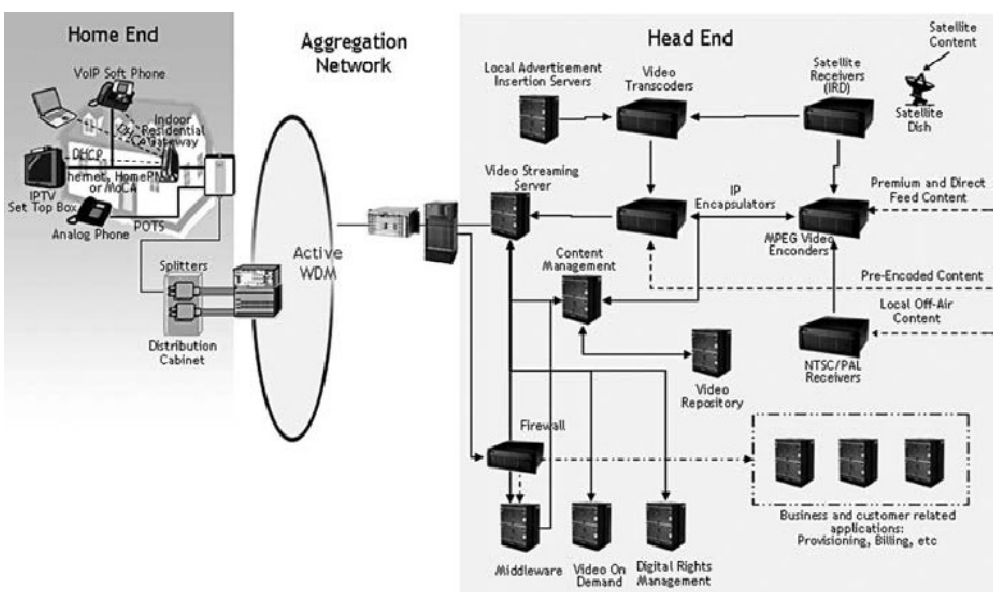

Figure 1. Showing IPTV architecture [16]

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The IPTV Head-End

The IPTV head-end is where content (such as television channels or Video on Demand movies) is received and prepared for transmission across the operator's private IP network (DVB Internet Protocol IP). Perhaps the most complex piece is simply "capturing" the content. It comes from analog satellites, digital satellites and antennas; the content may be standard definition, high definition, or music; the format can be DVB (digital video broadcasting) or earlier proprietary implementations. A typical head-end will require six or more different types of systems, and multiples of each is required.

Once the signal is "down-linked" or "down-converted", it often needs to be altered to fit the operator's network. If an analog signal is received, an encoder is required to digitize, compress and packetize the signal. If the signal is received in digital format, it may still need to be converted into the format used by the operator. After that, the operator typically will add local commercials.

The Conditional Access (CA) system then encrypts the signal to prevent service theft or unauthorized copying. Finally, the desired signal is placed onto the network for delivery to the subscriber. Video on Demand (VoD) traffic goes through a similar process, except that the final version is placed onto a server until someone requests to view the content (Casner and Deering, 1992).

Network Backbone

The network backbone is an often overlooked piece of enabling IPTV services. The backbone must be addressed by service providers, however, as many of today's provider backbones will likely not be able to handle the bandwidth required to offer even basic IPTV services (Cisco).

IP Based Network Designs

We started by considering a network provider carrying IPTV traffic over an IP infrastructure. At one extreme, we consider a dedicated IP network constructed purely to carry IPTV traffic. This has the advantage in that the design can be customized to support IPTV services (DVB Internet Protocol), and that IPTV traffic is not mixed with traditional Internet traffic, thereby isolating this sensitive traffic from the perils of the public Internet. The other extreme is to use a single common network to carry all traffic including Internet, VPN, and IPTV services.

Such an approach simplifies network management, in terms of having only a single network to design and operate, but requires careful performance management to ensure that the IPTV traffic receives high priority forwarding and is isolated from the vagaries of the Internet. Intermediate solutions also exist, for example, overlaying a dedicated topology on top of an existing infrastructure. This can be achieved by using the common backbone routers, but with separate links to carry IPTV traffic, providing a level of isolation for the highly sensitive IPTV traffic.

Integration with an Existing IP Backbone

We assume a scenario in which a network provider already has an existing IP network over which they will incorporate the new IPTV demands. As mentioned before, only the backbone links are shared and access links are dedicated for IPTV traffic. Utilizing an existing infrastructure enables rapid deployment of the new services (Choy, 2001), with minimal overhead and efficient utilization of the network resources.

Access Network

The general guideline for offering IPTV service is that the network must support at least 20 Mbps for long-term viability of a service offering that includes HDTV service. Today, many early adopter implementations will go as low as 10 Mbps total bandwidth to the home. This only supports 2 SDTV channels, 2 Mbps of Internet access, plus support for voice traffic (Cisco). A 20 Mbps pipe to the home would enable 3 or 4 HDTV channels, with enough bandwidth left over for 4 to 8 Mbps of Internet access and support for voice traffic. For new construction or overbuilding, fiber is often deployed right to the subscriber premises since laying fiber costs about the same as running copper. Passive Optical Networks (PON) is most commonly used (Goralski, 1997). PON shares the bandwidth between 32 or more users. In denser areas requiring higher bandwidth, Ethernet may be a better solution.

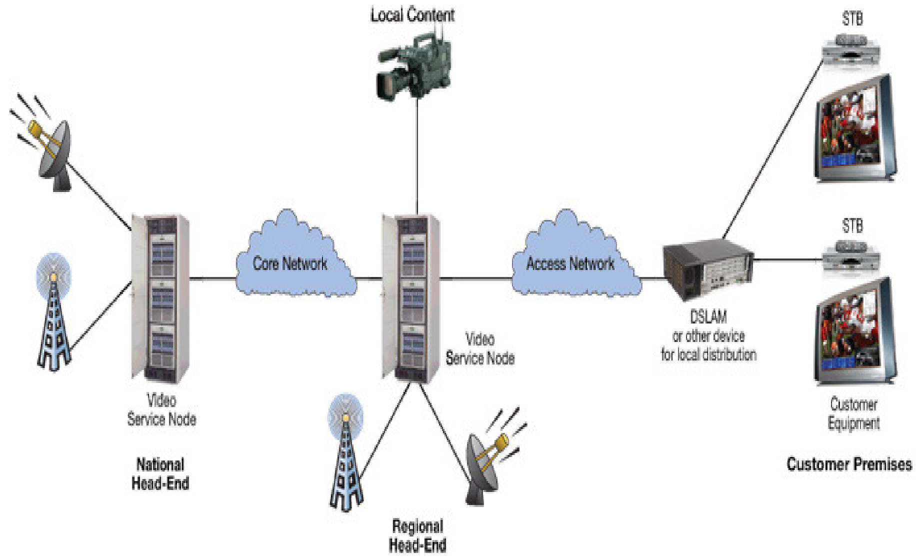

Figure 2. Showing IPTV network

The Subscriber Site

The subscriber's premise is often the most costly portion of the overall solution. Each site requires a demarcation device such as a DSL modem. The PON equivalent is called an Optical Network Unit (ONU). Although powered, these typically include bypass circuitry so that the phone works even during a power failure. Both types provide connections for the subscriber to connect the end-user equipment (Goralski, 1997). Connections may include telephone jacks, Ethernet, coaxial cable for television, or even T1 lines (operating at 1.544Mbps).

There are many ways to connect this demarcation device to the set-top box. Ethernet enabled wiring is the most common method. Unfortunately, Ethernet cannot run on most in-home telephone wiring, so the telecom company must run new wire that typically absorbs this cost. Third-party devices allow Ethernet to run on existing coax cable, allowing re-use of existing television wiring. This function is now getting integrated into DSL modems and set-top boxes. Broadband Power Line (BPL) (Cisco) sends the signals across the existing in-home power wiring, eliminating the need for separate "packet" connectors.

There are also many features available for set top boxes. The lowest cost equipment supports standard definition television service. Higher-end units support high-definition television, integrated hard disks for recording programs, digital audio outputs for connecting to the home audio system, web browsers, USB ports, and many other options. Offering one set top box is not sufficient for all subscribers, yet offering too many alternatives drives up testing and support costs.

Table 1.Capabilities of terminals used for IPTV service (MDA is multimedia delivery architecture) (Mikoczy, 2007)

	Desktop TV	MDA
Processor power	2.2GHz core duo	400MHz
RAM	2Gb	128Mb
Screen resolution	1920*1280	320*176
Bit rate	Video:8Mbps Audio:192Kbps	Video:256Kbps Audio:12Kbps
Access network	Ethernet, 100Mbps	Wireless LAN, 54Mbps

The Broadband Access Network

The broadband access network must support quality of service (QoS), multicast, the separation of end-user traffic, and differentiate between services (Baker *et al.,* 2007); it must be secure and robust (with high in-service performance); and it must have a telecommunications management solution that supports network operation and maintenance (O&M). Many of these features have been standardized in DSL Forum specification, which calls for an Ethernet based aggregation network.

Key Design Issues

There are several technical challenges to offering IPTV service in addition to bandwidth issues described previously. Broadcast television requires extensive use of IP multicast, and most network equipment cannot support the 100 multicast streams required to offer an IPTV service. It may be desirable to deploy emerging techniques such as MPEG4 Advanced Video Compression (AVC), which cuts the amount of bandwidth required roughly in half (MPEG-4 Advanced Video Coding). VoD servers must concurrently support thousands of subscribers, each seeking to view, rewind, pause and fast forward their picture. Placement of VoD caching to minimize network usage is critical to keeping the overall cost down. Distributed head-ends may be needed to capture local channels and add that into the video stream. NCC requirements also mandate that an antenna be placed typically within 55 miles of each subscriber. Ensuring that thousands of users can order a pay per view movie minutes before it starts is another possible bottleneck.

All of these reflect that IPTV is a nascent technology. Riding the silicon technology curve will allow service providers to overcome most of these obstacles, with bandwidth and lack of standards remaining the biggest challenges. Most telecoms company no longer question whether they will deploy IPTV; rather the question is when they will deploy it.

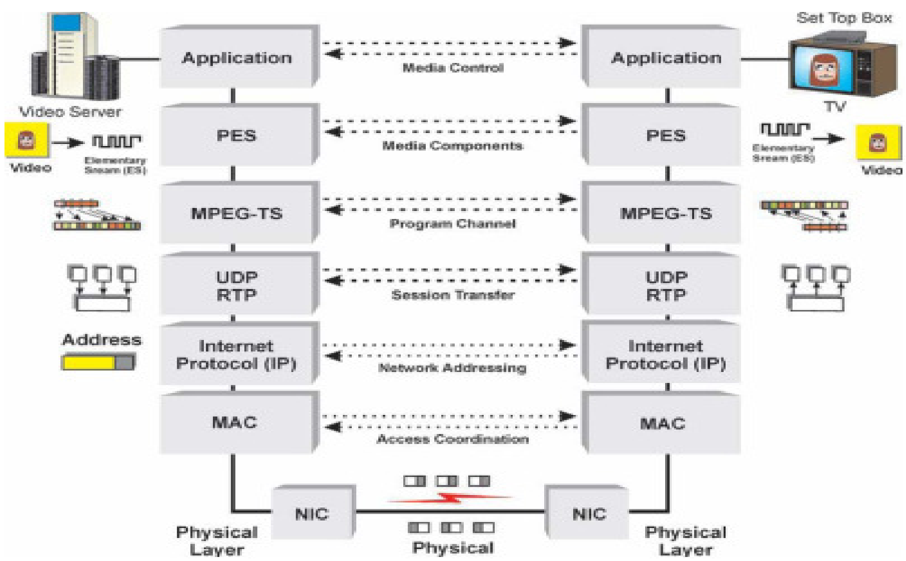

Figure 3. Showing IPTV protocol model (Rajiv Chaudhuri, 2008)

Describing the IPTV Protocol Model

Physical layer: converts the bits of information into data packets that are transferred to the network.

Mac layer: is responsible for requesting and coordinating access to the physical layer.

IP layer: is responsible for adding the network address to packet so they can travel through the network to reach their destination.

Transport layer (UDP/RTP): responsible for transporting packets between the sender and receiver.

Session layer (MPEG-TS): coordinates and oversees the transfer of media components for the program channel (such as MPEG).

PES (packet elementary stream) layer: maps and coordinates the media components to the transport streams.

Application layer: coordinates the information interface between the communication device and the end user or program they are using.

Supporting Features

The IPTV service puts unique demands on every node in the broadband network. For instance, to deliver unicast and multicast video services, the network must provide continuous bandwidth, IP control features, and scalability. In addition, it must provide the same level of flexibility and reliability as are associated with telecom carriers' services

Why IPTV?

Support for Interactive Service

The two-way capabilities of an IPTV system allow service providers to deliver a whole raft of interactive TV applications. The type of service delivered via an IPTV service can include standard live TV, high definition TV (HDTV), interactive games, and high speed Internet browsing.

Interactive broadcasting contents are provided to a media operation management system by a contents provider. Thus;

i. The attributes of contents are considered to provide the service.
ii. The contents are reworked for showing on interactive IPTV and they are sent to a network provider.
iii. STB (Set-Top-Box) is connected via multicast broadcasting and then STP shows the broadcasting contents.
iv. The IPTV user has communication with service provider. And the user requests the service information from a service provider.
v. The attributes of contents are considered to provide the service.
vi. vi. STB (Set Top Box) provides interactive service to customer via mobile terminal and computer.

Time shifting: IPTV in combination with a digital video recorder permits time shifting of programming content.

Personalization: An end-to-end IPTV system supports bidirectional communications and allows the end user to personalize their TV viewing habits by deciding what they want to watch and when.

Low Bandwidth Requirement: Instead of delivering every channel requirements to every end user, IPTV technologies allow service providers to only stream the channel that the end user has requested. This attractive feature allows network operators to conserve bandwidth on their networks.

Accessible on Multiple Devices: Viewing of IPTV content is not limited to multiple devices televisions. Consumers often use their PCs and mobile devices to access IPs.

As stipulated in the outlines above, certain measures must be put in place by government in order facilitate the effective deployment of the IPTV system via; Standardization of the interface and protocols will be necessary for promoting competition, consumer's affordability and convenience. The pricing, quality of service and tariff issues needs to be handled separately under the respective licensing regimes/bodies. This clarification will be important to clear the doubts regarding the implementation of IPTV services by different stakeholders. This will facilitate provision of IPTV services and encourage competition, which will ultimately benefit the customers.

Functions of STB

The following features are often also provided in STBs

i. Network interface, to receive the IPTV signals and transmit user commands
ii. Video and audio outputs, which is connected to the viewer's video display and speaker system.
iii. User interface, both on the front panel STB and by way of an on-screen display and remote control.
iv. Conditional access hardware/software, to support secure viewing of valuable content

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v. Hard disk drive, for recording video programs.

IPTV Business Growth

According to Multimedia Research Group (MRG), in 2008 the actual IPTV subscribers ended up at about 1 million over its last forecast in late 2008 of 21.3 million, resulting in projected subscriber growth of 26.9 million in 2009 to over 81 million in 2013. Combined CapEx (capital exchange) revenue plus service revenue will grow from US$9.7 billion in 2009 to US$25.6 billion in 2013.

IPTV Business Challenges

Business model

a. The new service and the absence of business experiences at scale and the important size of the required investments (e.g. Content and technology)
b. The important trade-off between service and content offerings
c. The Cost of content and Service.

Content and media management

a. Setting up a dedicated team for content selection and program schedule management
b. Developing expertise in content negotiation, cross-selling, promotional offer management and defining the content refreshment policies
c. Quality assurance and compliance.

Service control

a. Supporting new services such as network personal video recording, PVR, VOD Distribution scheme
b. Limit access to certain services in case of network and service infrastructure overload e.g. Video servers
c. QoS Management and service control architecture to handle load peaks and service mixes

End to End service assurance

a. Strong need for real time troubleshooting
b. Monitor all the end to end architecture (TV, STB)
c. Proactive segment status analysis, automated management and recovery process if required; Identify the customers who could be affected by the service and network problem
d. Proactively managing new challenging areas such as video quality management and conditional access management

Customer care and billing

a. Integrating the IPTV billing processes with the existing billing processes
b. Design new billing processes and build interfaces with Customer self-subscription
c. Managing the peak for customer care during prime time hours
d. Building attractive commercial offer by bundling TV services with Voice and data (Casner & Deering, 1992).

SEURITY THREATS TO DEPLOYING IPTV

It is important to remember that the IPTV business model is based on the general public being able to access intellectual property owned by third parties and being distributed by service providers. Both content owners and service providers derive their revenues from the secure operation of the service. If content were disclosed in digital form and full quality, then the potential revenue would be greatly reduced. The symbiotic relationship between content owners and service providers depends on the use of technological mechanisms to reduce the risk of unauthorized release of the digital media. What are the threats, risks and vulnerabilities that the industry is trying to overcome?

There are two main areas of concern:

1. The underlying communication technology used to send the content to the subscribers. This is composed of the networking equipment and communication equipment linking the display to the source of data.
2. The second area is the IPTV-related equipment. This is a series of elements designed to operate the IPTV service and provide access and information to enable the service to operate.

Access Fraud

Access fraud is one of the oldest forms of fraud within premium/paid TV. This happens when an individual circumvents the conventional access mechanisms to gain unauthorized access to TV contents without paying a subscription or increasing the access granted.

An example of the type of threats faced by IPTV vendors comes from the satellite TV industry. For years they have been fighting access fraud. The widespread nature of fraud has caused, during recent years, some satellite TV companies to start taking legal action against defendants for unauthorized access to TV content.

Unauthorized Broadcasting

IPTV contents are distributed in digital format, simplifying the work of any individual with an interest in copying or broadcasting the contents. One of the arguments in the campaign against movie piracy is that bootleg DVDs tend to be recordings made at the cinema by people using handheld cameras. However, with digital content broadcast as part of an IPTV service there is no difference between pirate and original content.

A major impact on the satellite TV industry has been fraudsters selling modified 'all access' smart cards based on modifications to valid smart cards and receivers. If fraudsters are successful at the same type of attack within an IPTV environment, they will be able to create 'all access' IPTV set top boxes or cards. As a result, the IPTV industry faces an entirely new threat – with broadcasting stations residing on every home PC, hackers would be able to redistribute the broadcast stream to other computers all over the world.

Access Interruption

The major weaknesses within the IPTV environment, related to access interruption, are as follows:

1. Middleware servers, even if deployed in a high-availability environment, are a single point of failure. If vulnerability were exploited on the servers, then intruders could shut down the middleware servers.
2. Denial of service is also a major risk within the middleware servers. If there are no appropriate mechanisms, intruders could send a number of invalid requests to the middleware server, blocking access by valid users.
3. STBs tend to run known operating systems, and a worm exploiting vulnerability on those systems could shut down all STBs simultaneously, even disabling the STB permanently until a technician has physical access to the system.

Content Interruption

As the signal is being sent using normal IP protocols, intruders could connect via the web and manipulate the middleware or broadcast servers. It is also possible to change the data within the content repository before it has been encrypted. An intruder could manipulate a particular movie or content and cause the IPTV provider to broadcast inappropriate or unauthorized content.

COUNTERING THE THREATS

Covering all the security requirements of an IPTV environment brings a high level of complexity. Security professionals must take a risk-based approach and deploy Counter measures that would

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reduce the exposure on the most critical assets. There should be a balance between the expected costs of the counter measures and the benefit in terms of risk reduction. The counter measures in this chapter are aimed at the creation of a number of security layers that provide complementary protection. Most of these counter measures are interlinked, and, when one is breached, other counter measures will still be available to protect the IPTV environment.

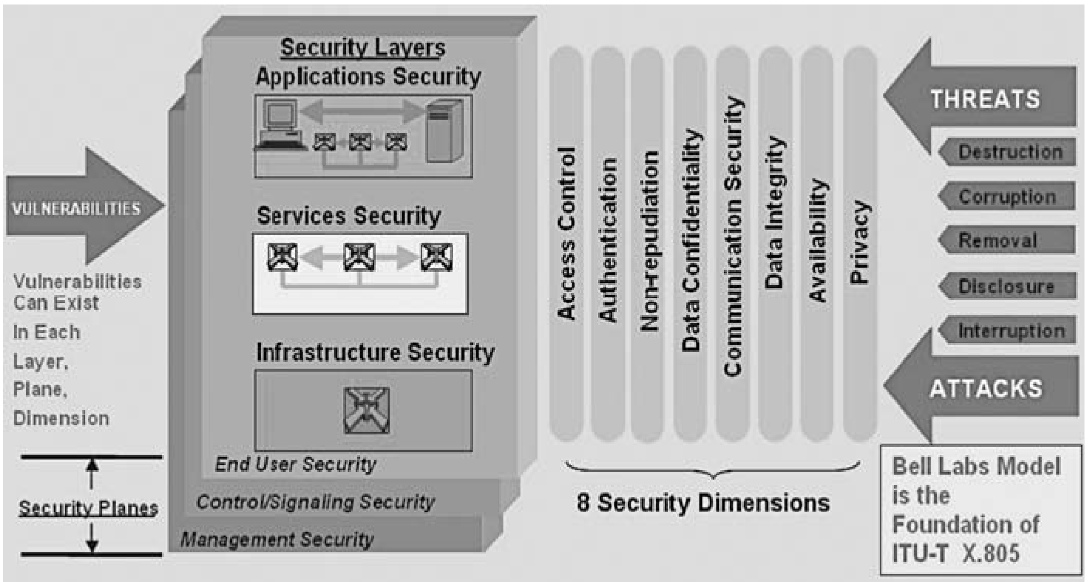

Figure 4. Showing IPTV security layer defined by the ITU-TX.805

Intrusion Detection/Intrusion Prevention

All traffic within the IPTV environment must be monitored to detect known attacks and attempted intrusions. Worms, viruses and intruders have a number of alternative ways of entry, and security professionals must deploy specific elements to detect that behavior and take timely actions. Although firewalls and access control lists (ACLs) will be deployed across the IPTV environment, reducing the type of protocols and sessions allowed, it is important to maintain rules on the IDS/IPS that will detect sessions on ports and services that have been blocked by the firewall.

Network Firewalls

Network firewalls must be used to control the traffic within the head end. The traffic flow between the servers within a VLAN is known and documented, and hence a network firewall or equivalent mechanism can be deployed to ensure that only valid requests are transmitted. These can be used for the purpose of enforcing the virtual local area network (VLANs) and also checking the traffic. If the switches are not a reliable mechanism, then dedicated equipment must be used for filtering and validating the traffic.

Hardening Operating Systems

Most elements within the IPTV environment will be supported by commercial operating systems. This will be a common situation within the head end, transport network and even within the home end.

Hardening would include activities such as (but not limited to) the following:

a. Patch implementation
b. Removal of unnecessary applications and services
c. Removal of unnecessary user accounts
d. Password restrictions
e. Log file and audit activation
f. Implementation of access controls
g. White list of authorized applications

h. Default file and folder permission

CONCLUSION AND RECOMMENDATIONS

IPTV will resolve the current negative environmental impact of satellite dishes and cable lines. Using the IPTV network, service providers can offer rich interactivity and services such as television commerce (shopping and payment of bills), Voice- Over –IP (Teleconversation), video conferencing and gaming. Also IP-based platform offers significant advantages, including the ability to integrate television with other IP-based services like high speech Internet access and VoIP. A switched IP network also allows for the delivery of significantly more content and functionality. Nigerian ISPs need to start in time to invest in IPTV infrastructure and begin gradual migration to IPTV. If this advice is heeded, it will ensure a smooth transition to IPTV technology and reaping of the abundant benefits.

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