Internet Protocol Television (IPTV)

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Abstract- IPTV is one of the mostly used technology of Internet and IP application. IPTV is a service for the delivery of
broadcast TV, movies on demand and other interactive multimedia services over a secure, end-to-end operator managed
broadband IP data network with desired QoS to the public with a broadband Internet connection. IPTV system may also include
Internet services such as Web access and VoIP where it may be called Triple Play and is typically supplied by a broadband
operator using the same infrastructure. IPTV is not the Internet Video that simply allows users to watch videos, like movie
previews and web-cams, over the Internet in a best effort fashion. IPTV technology offers revenue-generating opportunities for
the telecom and cable service providers. For traditional telephone service providers, Triple Play is delivered using a combination
of optical fiber and Digital Subscriber Line (DSL) technologies to its residential base.

IPTV is a system where a digital television service is delivered by using Internet Protocol over a network infrastructure, which
may include delivery by a broadband connection. A general definition of IPTV is 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.

In this paper I am trying to discuss this topic as my knowledge, including what is IPTV, how it works, its advantages and its
applications.

1. Introduction

What is an IPTV?
IPTV, essentially, has two components:

Part 1: Internet Protocol (IP): specifies the format of packets and the addressing scheme for a network. Most networks combine
IP with a higher level protocol. Depending on the vendor solution, user datagram protocol (UDP) is the most typical higher-level
protocol. The protocol establishes a virtual connection between a destination and a source. IP allows you to address a package of
information and drop it in the system, but there’s no direct link between you and the recipient.

Part 2: Television (TV): specifies the medium of communication that operates through the transmission of pictures and sounds.
We all know TV, but here we are referring to the services that are offered for the TV, like linear and on-demand programming.

IPTV is hence a system used to deliver digital television services to the consumers who are registered subscribers for this system.
This delivery of digital television is made possible by using Internet Protocol over a broadband connection, usually in a managed
network rather than the public Internet to preserve quality of service guarantees. Often, this service is provided together with
Video facility on demand. In addition to this, there is provision to include Internet services such as web access and Voice over
Internet Protocol (VoIP). In cases when internet service is also provided, it may be called Triple Play.

2. How does IPTV Work?

Before we get into the internal details of the way the IPTV network is configured to provide transmission of television signals,
we see what are the various steps followed to convert the audio and video feed signals into a suitable form to be transmitted in the
form of IP (Internet Protocol) packets, which forms the basis of the whole concept of IPTV and how they are received on the
other side as television signals.

2.1 Digitization - Converting Video Signals and Audio Signals to Digital Signals
A key first step in providing Internet Protocol Television service is converting the analog audio voice signals into a digital form
(digitization) and then compressing the digitized information into a more efficient form.
Digitization is the conversion of analog signals (continuously varying signals) into digital form (signals that have only two levels). Analog signals are converted into digital signals because they are more resistant to noise (distortion) and they are easier to manipulate than analog signals. For the older analog systems (continuously varying signals), it is not easy (and sometimes not possible) to separate the noise from the analog signals. Because digital signals can only have two levels, the signal can be regenerated and during this regeneration process, the noise is removed.

Television signal digitization involves digitization of both the audio and video signals.

2.2 Sending Packets

Sending packets through the Internet involves routing them through the network and managing the loss of packets when they can't reach their destination. Packet routing involves the transmission of packets through intelligent switches (called routers) that analyze the destination address of the packet and determine a path that will help the packet travel toward its destination.

2.3 Gateways Connect the Internet to Standard Televisions
A television gateway is a communications device or assembly that transforms audio and video that is received from a television media server (IP television signal source) into a format that can be used by a viewer or different network. A television gateway usually has more intelligence (processing function) than a data network bridge as it can select the video and voice compression coders and adjust the protocols and timing between two dissimilar computer systems or IP Television networks.

**IP Television Gateways**

This diagram shows that the gateway must convert audio, video and control signals into a format that can be sent through the Internet. The gateway first converts video and audio signals into digital form. These digital signals are then analyzed and compressed by a coding processor. Because end users may have viewers that have different types of coders (such as MPEG and AAC), the media gateway usually has available several different types of coding devices. The gateway may have a database (or access to a database) that helps it determine authorized users and the addresses to send IP television signals.

### 2.4 Transmission

IP Television channel transmission is the process of transferring the television media from a media server or television gateway to an end customer. IP television channel transmission may be exclusively sent directly to specific viewer (unicast) or it may be copied and sent to multiple viewers at the same time (multicast).

#### 2.4.1 Unicast

Unicast transmission is the delivery of data to only one client within a network. Unicast transmission is typically used to describe a streaming connection from a server to a single client.

Unicast service is relatively simple to implement. Each user is given the same address to connect to when they desire to access that media (such as an IP television channel). The use of unicast transmission is not efficient when many users are receiving the same information at the same time because a separate connection for each user must be maintained. If the same media source is accessed by hundreds or thousands of users, the bandwidth to that media server will need to be hundreds or thousands of times larger than the bandwidth required for each user.
Multicast transmission is a one-to-many media delivery process that sends a single message or information transmission that contains an address (code) that is designated to allow multiple distribution nodes in a network (e.g., routers) to receive and retransmit the same signal to multiple receivers. As a multicast signal travels through a communication network, it is copied at nodes within the network for distribution to other nodes within the network. Multicast systems form distribution trees of information. Nodes (e.g., routers) that copy the information form the branches of the tree.

IP multicast has several perceived advantages because it enables the service provider to propagate one IP stream per broadcast channel from the video head end to the service provider access network. This is beneficial when multiple users want to tune in to the same broadcast channel at the same time (e.g., thousands of viewers tuning in to a sporting event).
2.5 The IPTV Network Elements

An IPTV system is made up of four major elements; all are generic and are common to any vendor’s (or combination of vendors”) infrastructure. This is a high-level overview and, in reality, many IPTV subsystems and networking solutions are required to make each incarnation of IPTV unique and of varying complexity.

Figure above also illustrates the two-way nature of an IPTV network, which contributes to many of the advantages IPTV has over traditional television service delivery models.
2.6 IPTV System Architecture:

Figure below illustrates a generic IPTV system architecture to support applications such as digital (broadcast) television and Video on Demand (VoD). The generic IPTV architecture is utilized here as a baseline reference to discuss IPTV distribution in-home networks.

![Generic IPTV System Architecture](image_url)

**Generic IPTV System Architecture**

IPTV operators receive digital satellite channels by satellite antenna and digital terrestrial Services by UHF antenna. The channels are routed to the transmission center’s signal Converter equipment, which converts the television content to an IP network-compatible Format and transmits it into homes via operators’ broadband backbone and access Networks. In homes, IPTV services are received by an IP STB whose software and Updates are managed by a configuration server located in the transmission centre.

2.7 IPTV Components

1. **Video Head End**

   An IPTV service requires a video head end, this is the point in the network at which linear (e.g., broadcast TV) and on-demand (e.g., movies) content is captured and formatted for distribution over the IP network. A head end takes each individual channel and encodes it into a digital video format, like MPEG-2, which remains the most prevalent encoding standard for digital video on a worldwide basis. After encoding, each channel is encapsulated into IP and sent out over the network.

2. **Video Server**

   Video servers are computer-based devices connected to large storage systems. Video content, previously encoded, is stored either on disk or in large banks of RAM. Video servers stream video and audio content via unicast or multicast to STBs. Typical storage systems range from 5 terabit (Tb) to 20 Tb. Video servers are mostly used for VoD.

3. **The Service Provider Core/Edge Network**

   The grouping of encoded video streams, representing the channel lineup, is transported over the service provider’s IP network. Each of these networks is unique to the service provider and usually includes equipment from multiple vendors. These networks can be a mix of well-engineered existing IP networks and purpose-built IP networks for video transport. At the network edge, the IP network connects to the access network.

4. **The Access Network**

   The access network is the link from the service provider to the individual household. Sometimes referred to as the “last mile,” the broadband connection between the service provider and the household can be accomplished using a variety of technologies. Telecom service providers are using DSL (digital subscriber line) technology to serve individual households.
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5. The Home Network

The home network distributes the IPTV service throughout the home. There are many different types of home networks, but IPTV requires a very robust high bandwidth home network that can only be accomplished today using wireline technology.

6. Middleware: The IPTV enabler

Middleware is the software and hardware infrastructure that connects the components of an IPTV solution. It is a distributed operating system that runs both on servers at the Telco location and on the STBs. Among other things, it performs end-to-end configuration, provisions the video servers, links the electronic program guide (EPG) with the content, acts as a boot server for the STB and ensures that all STBs run compatible software.

7. Set Top Box (STB)/Terminal

An IP set top box is an electronic device that adapts IP television data into a format that is accessible by the end user. IP set top boxes are commonly located in a customer's home to allow the reception of IP video signals on a television or computer for live TV and VoD, the STB supports an EPG that allows the users to navigate through the programming.

8. Content Security/Conditional Access System (CSA)/Digital Rights Management (DRM)

A conditional access system (CAS) allows for the protection of content. CAS and digital rights management (DRM), which not only controls the real-time viewing, but also what happens to the content after it has been viewed once. Generically, most CAS/DRMs are a combination of scrambling and encryption.

3. IPTV Protocols

1. UDP or User Datagram Protocol

UDP is one of the core protocols of the IP protocol suite. The term „datagram“ or „packet“ is used to describe a chunk of IP data. Each IP datagram contains a specific set of fields in a specific order so that any receiver knows how to decode the data stream. Many protocols can be encapsulated within the IP datagram payload.

2. RTP or Real Time Protocol

RTP describes a packet-based format for the delivery of audio and video data. RTP actually consists of two closely linked parts:

- Real Time Protocol provides time stamping, sequence numbering, and other mechanisms to take care of timing issues. Through these mechanisms, RTP provides end-to-end transport for real-time data over a network. Use of sequence numbering also enables lost or out of order packets to be identified.
- Real Time Control Protocol is used to get end-to-end monitoring data, delivery information, and QoS.

3. RTSP or Real Time Streaming Protocol

Typically, RTSP messages are sent from client to server. In IPTV systems, RTSP is used in VoD applications for the consumer (client) to access and control content stored at the VoD servers. VoD is essentially a one-to-one communication established using unicast.

4. IGMP or Internet Group Management Protocol

IP multicasting is defined as the transmission of an IP datagram to a “host group”. This host group is a set of hosts identified by a single IP destination address. In an IPTV system, the host group would be a set of subscribers who wish to receive a particular program.

In practice, what this means is that the transmission systems using IGMP do not send all the content to all the users. Multicasting, using IGMP, allows control of which content goes to which users and therefore controls the amount of data being sent across the network at any one time. IGMP is the protocol used to handle channel changes in an IPTV system.
4. Viewing IP Television

1. Multimedia Computer

A multimedia computer is a data processing device that is capable of using and processing multiple forms of media such as audio, data and video. Because many computers are already multimedia and Internet ready, it is often possible to use a multimedia computer to watch IP television through the addition or use of media player software.

2. Analog Television Adapters (ATVA)

Analog television adapters are devices designed to convert digital broadband signals into analog television formats (e.g. NTSC or PAL). Using ATVAs, it is possible to use standard televisions for viewing television channels that are sent over data network such as the Internet. Analog television adapters are commonly called “IP Set top boxes.” An ATVA contains the necessary software and hardware to convert and control IP television signals.

3. IP Television (IPTV)

IP televisions are television display devices that are specifically designed to receive and decode television channels through the Internet without the need for adapter boxes or media gateways. IP televisions contain embedded software that allows them to initiate and receive television through the Internet using multimedia session protocols such as SIP.

4. Mobile Telephone Television

Mobile telephones with multimedia capabilities may be able to watch television channels. Mobile telephones have limited information processing power, limited displays, and may have restricted access to Internet services. Multimedia mobile telephones contain embedded software that allows them to initiate and receive multimedia communication sessions through the Internet.

6. IPTV-Applications and Services

The applications for IPTV deployment are to provide the delivery of digital broadcast television and also the selected VoD. Such application enables service providers to offer the so-called “triple play,” which is video, voice and data.

Digital Broadcast TV

IPTV has the full potential to offer various high-quality services and much more than what traditional broadcast, cable, and satellite TV providers have offered subscribers in the past.

The function of conventional broadcast, cable, and satellite TV is to provide all channels simultaneously (i.e., broadcast) to the subscriber home. However, IPTV is unique and different from all conventional groups. IPTV only delivers those channels which...
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are being viewed by the subscriber and has the potential to offer practically an "unlimited" number of channels. The IPTV consumers will get the freedom to control what they want to watch and also when they want to watch. This is possible because it has a combination of two-way interactive capability.

Video on Demand (VoD)
VoD is a service which provides television programs per the demands of the subscribers. The users interactively request and can receive television channels. These television services are beamed from previously stored media consisting of entertainment movies or education videos. It has a live access through live connection, such as news events in real time. The VoD application provides freedom to the individual subscribers to select a video content and view it at their convenience. There are also some additional features and services available, which are much more advanced in comparison to traditional broadcast television systems.

Anywhere Television Service
In IPTV, when an IP television viewer is connected to a data connection for the first time, it sends the request to an assignment of a temporary Internet address from the data network. After its connection to the Internet, it uses the said Internet address to get registered with the Internet Television Service Provider (ITVSP). The reason is that the ITVSP is always aware of the current Internet address, which is assigned to the IP television each time it has been connected to the Internet.

Global Television Channels
As the name indicates, global television channels are TV channels which can be viewed globally. IP television channels are beamed through the Internet and, as it offers broadband data access, it can thus be typically viewed in any part of the globe. The IP television system is capable of providing video service outside the purview of their local, often regulated, areas. This ability makes IP television a very competitive tool around the world.

Personal Media Channels (PMC)
PMC is a communication service which is user friendly to subscribers. It allows a media user, for example, to select and view media from different media sources such as video or music. Here is an example how a PMC may be used for IP television. The control and distribution of mixed media, such as digital pictures and digital videos, can be done through a personal television channel for the service of friends and family members. In this regard, an IP television customer can be assigned a personal television channel. Then, the user can upload media to their personal media channels and can thus allow friends and family to access their pictures and videos. This is done via their IP televisions.

Privacy and Security
Let us look at the important aspect of privacy and security of the subscribers. In this regard, the home network must be a closed one. Where is the user’s security in this regard? It should be a secure network where access is limited only to users and concerned devices within the home. Unauthorized users do not have the capacity to view it.

7. Advantages of IPTV

- Advanced Multimedia Program Guide
- Integrated Broadcast, VOD and DVR
- Fast scrolling & navigation
- Live picture-in-picture.
- Channel slide show
- Software-based tuning
- Advanced Video Applications with multiple PIP(Picture-In-Picture)
- Instant channel changing with richer navigation
- Quick and Responsive EPG (Electronic Program Guide) for HDTV and SDTV
- Integrate Web based services

8. Challenges for IPTV

- Assured service quality of experience.
- High network availability for always-on services.
- Single Infrastructure for multiplay and future services.
- Simplified service and network provisioning.
Scalable design for growth and change.
Security against attack.
Lowest costs – focus on the access network.
Regulatory issues.
Competition with cable operators.

9. Conclusion-A Look at the Future

IPTV is now seen by many experts as a potentially multi-billion dollar industry in the very near term. IPTV, according to industry watchers, can change the way people receive video programming and revolutionize content creation. With the expansion of broadband access and the Growth of computing and video production equipment, industry analysts believe IPTV is realizing its potential as a viable programming platform that can compete with cable, satellite and other traditional video mediums.

With on-demand IPTV services, the content comes to the consumer. Interactive applications will empower the viewer to use online video not only as an entertainment option but as a learning tool. IPTV is also seen by providers and industry watchers as a gateway for new content providers. IPTV is not simply offering traditional television programming through another device or connection. “IPTV providers are already offering content from sports leagues to home cooking shows and more. The video content is making the web experience more robust for consumers, presenting information in compelling formats that greatly interests existing and new audiences.

Reference