IPTV and Internet Television

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Abstract

Since it has been invented in the early 1930s, television has become todays most important medium. Several different broadcasting methods have been developed, including satellite and cable television. By sending television services over the internet, broadcasting has reached a new dimension. The internet makes it possible to introduce interesting new features for more interactive services and high definition television on the one hand and cheap and easy broadcasting on the other hand. Two main terms have evolved when talking about internet television services: IPTV and Internet Television. This report will give an overview of the technologies used behind these terms and the differences between them.

Contents

Chapter 1

Introduction

After being commercially available in the late 1930s, TV became the most common broadcasting service in the world. Today a world without TV cannot be imagined. Television is used to entertain and to inform people everywhere and is integrated as an inherent part in many peoples daily routine. While in the beginning TV was only broadcasted using terrestrical technologies there are many different possibilities to broadcast television today. People might access programming by using cable, satellite or the internet today. Digital broadcasting replaces analog broadcasting and brings its own standards for every access media, e.g. DVB-C, DVB-S, DVB-T. In addition to that consumers requirements for mobile television and new interactive services lead to new technolgies that make television more entertaining and receivable everywhere. Increasing numbers in statistics of internet consumption confirm this trend.

Although television needs to be available in many different locations and on different devices it would be much easier if all devices would use the same transport medium for television data. Since the 4G generation of mobiles is designed to be IP-capable devices the internet can be this new medium. Increasing bandwidth and broadband connections offer new possibilities of transfering huge amounts of data. By using this resources providers can broadcast television over the internet and since there are many IP-capable devices reach many costumers. These providers are usually the huge telecom companies that own the networks. In Germany these are primary Deutsche Telekom, Arcor and Alice/Hansenet. A provider that offers Internet access, IP-telephony and TV services over a single connection is called TriplePlay-provider.

When talking about internet television services one will stumble over two terms: IPTV and Internet Television. While both are technologies used for television broadcasting there are significant differences between them in broadcasting technology and in the content that is available.

Chapter 2

IPTV

2.1 Introduction

IPTV is the term for the commercial television broadcasting services offered by telecom companies. It is based on the fundamental internet protocols including IP, TCP/UDP and RTP/RTCP and always broadcasted over a network that is totally controlled by the service provider (usually the network owner). IPTV requires huge bandwidth and therefore is only available in areas with VDSL connections supporting up to 25 mbit/s at the moment. Often IPTV providers offer Internet access, IP-telephony and TV services over a single connection which is called TripplePlay.

2.2 Technical details

The video signal has to be encoded using an algorithm with small lossrate. Otherwise high definition programming couldn't be transmitted without quality deficit. Hence for HD programming MPEG-4 (H.264) is used and MPEG-2 (H.262) for ordinary programming. After encoding the video signal the produced slices are encapsulated into RTP packets. The whole protocol stack is shown in figure 2.2.

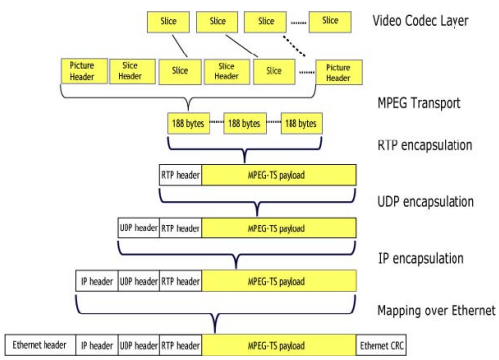


Figure 2.1: Header Encapsulation in IPTV

The main difference between ordinary broadcasting and IPTV is that just one channel (the one one wants to receive) is transmitted to the customer. This is possible because IPTV has a twoway communication design which means that receivers can contact the transmitter to issue commands, e.g. for selecting the television channel. Still transmitting the video

signal to every particular receiver would be impossible because of insufficient backbone bandwitdth in the providers network. Therefore all receivers watching the same channel at one time join a multicast group. The video signal is then transmitted via IP multicast to the customers. Only for Video-on-Demand IP unicast is used. VoD describes a feature of selecting video content from a providers library and the airing date and time. The IPTV network architecture is very similar to the ordinary internet access architecture: It consists of network core routers and access nodes to which the receivers are connected. The television signal is received by the providers using any technology. This can be terrestrical, satellite or ip access. After the television signal is feeded into the providers network it has to be reencoded by special (re-)encoding systems. Other servers hold the video content for VoD features and also contribute video data. Special aggregation servers combine different signal sources and forward them to the core network. The whole IPTV infrastructure is shown in figure 2.2.

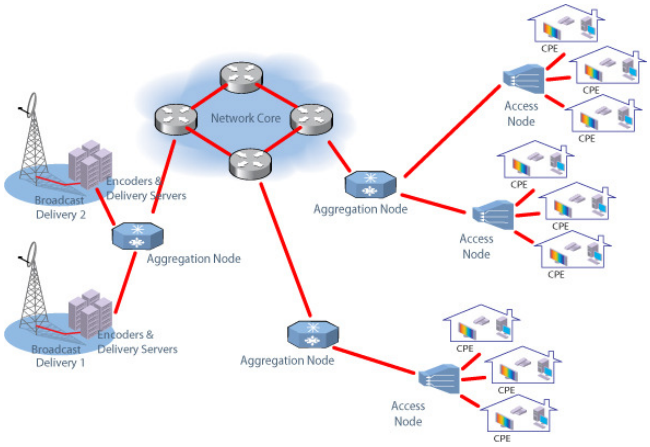


Figure 2.2: IPTV network architecture

One of the biggest advantages of IPTV is that nearly every IP capable device can act as a receiver. For homeusers this might be the PC with some software running to administrate TV channels and decode the video signal. The familiar TV feeling can be implemented by using a Set-Top-Box that acts like a cable or satellite receiver except that it's connected to the telephone cable. For mobile users IPTV can be received with mobiles of the 4G generation. Although mobile IP networks are still not very widespreaded yet, this possibility will probably be more and more attractive in the near future. Competing technologies like DVB-T mobile receivers suffer from the same problems but have other disadvantages (e.g. IP can be used for other services, DVB-T is just another TV broadcasting standard).

2.3 Features

As mentioned before the biggest difference compared to ordinary TV broadcasting is its twoway-communication design. The possibility for users to issue commands may lead to interactive television features. In addition to that twoway communication can introduce new security mechanisms for providers to prevent users from watching without paying. This includes user authentication and per-user encrypted video streams. For example the access nodes could also act as encryption entities that encrypt the signal for every user with a secret key that is located on a smartcard at clientside to decrypt the signal.

Compared to ordinary television IPTV providers did not introduce any other important features, yet. More precise providers are not sure about the customer needs regarding IPTV. Therefore many of them are currently searching for ideas to make IPTV more attractive for customers. For example Deutsche Telekom stated the "Interactive TV Award" to collect proposals for future IPTV features. One of these proposals is to create a "family IPTV channel" with selfmade content that can be uploaded at the providers website and shared with family members and friends. The channel is secured using a key that is only shared by family members. Similar features can be expected in the near future since IPTV has to compete against ordinary broadcasting.

2.4 Issues

One of the biggest problems of IPTV is its distribution. To date IPTV is only available in some cities where VDSL links already exist. Users in rural areas will suffer again from insufficient bandwidth like in the past with ADSL links. In addition to that IPTV is not cheap. Users with satellite access might ask why they should pay for watching TV. Compared to cable access IPTV is not cheap since one has to sign for a VDSL link too. The customer attitude might change as soon as new features are introduced for IPTV. But as long as providers are not sure what customers want and what customers need, introducing new features is risky and could lead to misinvestments.

In addition to that connecting different IPTV networks is difficult. A provider can only ensure the quality of the video signal in its own network. Who is responsible for QoS if higher network instances are needed to connect different IPTV networks? How can accounting be managed for users all over the world? Future developments will show if IPTV is capable to completly replace ordinary TV broadcasting in locations with VDSL.

Chapter 3

Internet Television

3.1 Introduction

Internet Television is another name for broadcasting video data over the internet but is totally different from IPTV. Instead of using a dedicated network like in IPTV Internet Television uses the whole given infrastructure/the whole internet as a transport medium. Therefore there cannot be a guaranteed quality of service in Internet Television. To efficiently make use of a worldwide transport medium Internet Television uses other techniques than IPTV to spread the signal. These can be divided into two main groups of streaming and p2ptv techniques and will be described later.

In addition to technical differences there are also differences in broadcasted content. Since Internet Television is designed to be an open plattform for broadcasting multimedia content, everyone can act as a broadcaster and contribute video data. There is no need for commercial providers and Internet Television is usually free to watch except some special additional services.

TV stations use Internet Television to offer parts of their regular programming after it has been aired on ordinary TV or to archive programming. Viewers are browsing the libraries online and content is distributed via Streaming (e.g. ARD Tagesschau). Beside the big TV stations that must focus on programming for the masses there are the niche content providers. These usually focus on topics that will only adress small amounts of viewers. This can be done since broadcasting is cheap because of the already existing infrastructure. This is the very same development like with internet radio stations and podcasts. A good example is demoscene.tv a small Internet Television station that focuses on digital computer art including 3D graphics, music and 2d images. Demoscene.tv reports from demoscene meetings (like "Breakpoint" in Cologne, biggest demoscene party in the world) and shows demoscene content 24/7. According to their website, their daily viewer rate is about 10.500 on average per day.

3.2 Technical details

As mentioned before two main groups of techniques are used: The classic client/server approach called Streaming and the peer-to-peer approach called P2PTV. Both have advantages and disadvantages and are used in different scenarios.

3.2.1 Streaming

The definition of streaming is the process of playing a file while it is still downloading. For this purpose the continuous mediastream must be sent in discrete parts. The order of the arriving parts at the receiver must be kept in sequence but not all sent packets neccessarily will take the same way. In addition to that the network conditions can influence the quality of the stream. Although it would be nice if there won't be no packet loss at all, a streaming application will not use the reliable transport mechanism provided by TCP since resending lost packets would create huge delays and timing conditions could not be fulfilled. Instead UDP is used in cooperation with several other protocols which provide more features to control, give feedback about and transport streams. Basically three protocols form todays streaming standard:

- RTSP - RealTime Streaming Protocol[1]
- RTP - Realtime Transport Protocol[2]
- RTCP - Realtime Transport Control Protocol[2]

3.2.2 RTSP - RealTime Streaming Protocol

[3]

The RTSP is an application layer protocol on top of TCP or UDP and used to control the session between client and server. For example this includes commands to pause and play the stream. It acts like the remote device and is only used to issue commands, the stream data itself is at no time transported via RTSP. To create an independant streaming framework, RTSP was designed to be working with any transport protocol and is therefore not tied to any special transport protocol.

3.2.3 RTP - Realtime Transport Protocol

[3]

RTP is not only a transport protocol for streaming data, it's a whole protocol framework and has to be instantiated for a specific application. Basically RTP just

provides a container for multimedia data but brings special features and intermediate systems to implement complex streaming scenarios. RTP is an application layer protocol, tasks like segmentation and adressing are provided by lower level protocols (e.g. UDP and IP).

Figure 3.1: RTP Header

The most important RTP header fields are the payload type to define the type of multimedia data that is transported by this RTP packet and the sequence number. Since RTP and RTCP closly work together, RTCP can use the sequence number of RTP packets to determine the packet loss rate and other statistics to report feedback to the streaming server.

Mixers and Translators are special RTP intermediate systems with special functionality. A RTP Mixer can be used to combine several different streams into one single new stream. Therefore all ingoing streams are reencoded. For example this can be used to lower the quality for users behind the mixer entity with small bandwidth. A RTP translator can be used to connect different transport-level networks to exchange streaming data between different networks.

3.2.4 RTCP - Realtime Transport Control Protocol

[3]

The main task of RTCP is to provide feedback on the quality of stream data distribution. This feedback can be used by the sender, to adapt to different network conditions. Therefore clients periodically send Receiver Reports including details on lost packets, interarrival jitter, etc. The maximum consumption of bandwidth for RTCP messages is calculated to be 5% to prevent bandwidth wastement by flooding with RRs.

An complete example session including all three protocols is illustrated in figure 3.2.4. First a session description is retrieved via HTTP, that is what happens when the user is clicking on a link to a stream. After that the stream is started by sending RTSP commands. Streaming data is exchanged via RTP and periodically the client sends Receiver Reports via RTCP back to the streaming source.

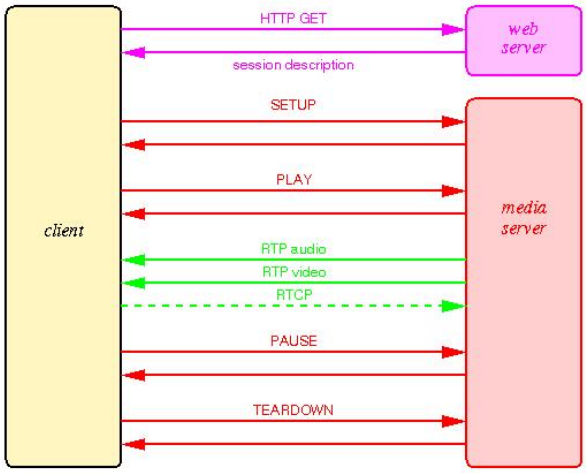


Figure 3.2: Streaming example session

3.3 P2PTV

The P2PTV approach is the more "public spirited" way of content delivery. Instead of consuming stream data from a central server, every client redistributes the video stream (or at least parts of it) by uploading it to others. In an ideal P2P architecture there are no central servers, nevertheless there is none that can live without them. They still undertake the task of administrating the clients or feeding in the video streams.

The main goals of a P2PTV architecture are:

- Minimization of the overall network load by building an efficient overlay network
- Maximization of the usage of every clients upload bandwidth
- Maximization of video quality for every client

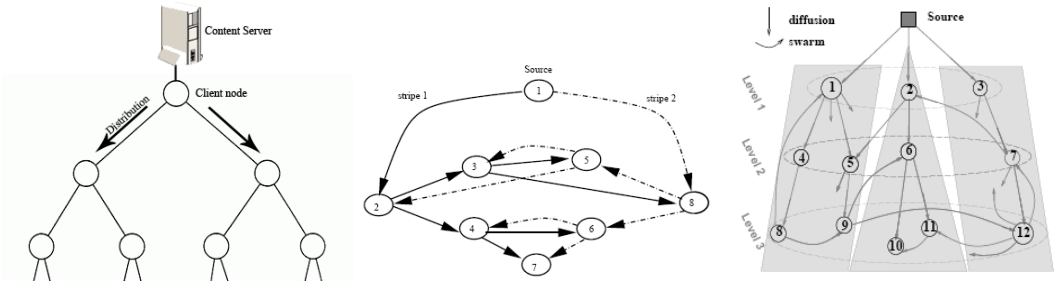
3.3.1 Overlay networks and P2P network topologies

To create a P2P network one has to build a new logic network topology based on the underlaying network (the internet). Recent P2PTV proposals can be distinguished into two main categories: Treebased (with a special case called forestbased) and meshbased topologies.

In a treebased topology the content is pushed from the root of the tree towards all peers[4]. Every inner node of the tree replicates the video data it receives and sends it to its children. In a binary tree, this means every inner node has one input

flow and two output data flows at maximum. The main problem is that leaf nodes do not contribute to the P2P network and are just consuming. In a binary tree, leaf nodes form one half of all peers of the network at maximum. To solve this problem one can create many different trees where every client is at least a parent node in one of the trees. This is the forest based topology. Another problem of treebased topologies is that broken connections between peers can lead to failures of huge parts of the tree. For example if one of the first two children in a binary tree loses the connection to its children the whole branch will be dead. Therefore the tree has to be repaired and updated if peers fail or new peers arrive.

In a meshbased topology[5] a node can have multiple parents and multiple children. There are easy algorithms to form a mesh, the easiest is to select random connections between children. The repair costs in a meshbased topology are very low, basically just the invalid connections to the disconnected peer have to be deleted.



(a) treebased (b) forestbased (c) meshbased

Figure 3.3: P2P overlay network topologies

3.4 Conclusion and Outlook

This report tried to give an overview about todays television broadcasting techniques using the internet. Two main technologies with different designs, advantages and limitations have been discussed to impart basic knowledge of Internet Television broadcasting services. While the commercial IPTV aproach will have to compete against ordinary television broadcasting, InternetTelevision in terms of streaming and P2PTV will never be able to replace dedicated broadcasting because of bandwidth limitations and the absence of a QoS instance. Nevertheless InternetTelevision is relevant to todays multimedia entertainment. The main question in future developments of TV broadcasting is if IPTV providers are capable of introducing new interactive TV features to compete against other broadcasting technologies.

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