Project in Sistemas de Telecommunicações

VIDEO ON DEMAND

Web resource:

http://www.stud.ntnu.no/~runarjoh/st/

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1. Introduction

After television was introduced for the mass market in 1937, it offered programmes from a number of available channels and was very simple to use. The Cable TV made it possible to choose programmes from large number of channels. Then came video rental service in combination with the video recorder, which provided customers to select movies of the shelf. This service could be called *video on demand* (VOD).

Nowadays VOD includes much wider services and opportunities. Today's technology allows telecommunication network operators to offer services such as home shopping, games, and movies on demand. These services should have a competitive price comparing to the video rental, and even better; customers do not need to travel for the services. These possibilities have been reached by the development of the telecommunication and electronic industry. The capacity of a hard disk has doubled almost every year at near-constant cost. The useful compression ratio for video has been increased considerably; MPEG-formatted video can be transported at a bit rate of few Mbit/s. The digital signal processing techniques permit the transport of multimedia content over existing copper wires for a distance of a few kilometres. Finally, *Asynchronous Transfer Mode* (ATM) systems allow the switching of any reasonable bit rate to a single or multiple customers among a large number of connected customers.

As more and more people are online, and bandwidth is increasing, VOD is getting more and more popular, and by many foreseen as the "killer application" for interactive television. This report presents a step-by-step introduction to the different parts of a typical VOD system.

1.2 Definition

The report is based on the following definition of Video on Demand:

"A service which provide the consumer with the interactive multimedia content video of his/her choice when and where he/her pleases over a digital communication channel."

In accordance to this definition, the report gives and introduction to:

- The typical VOD system
- The product
- The servers
- The network
- The consumer and the clients

Finally it gives a discussion about the status of today's service and future perspective of VOD.

1.3 The typical VOD system

The typical VOD system consists of 3 mayor parties. As figure 1 shows, at one end we have the *product* that is controlled by the content providers and aggregators. They decide what content is delivered, the type of delivery, to which communities it is delivered, and when it is delivered.

Network operators provide the product a mean of transportation for the service or product. They can benefit from increased and more efficient bandwidth usage, and the ability to offer and bill for exciting new services over new and existing network infrastructures.

Consumer and users benefit from a new, attractive form of interactive entertainment or information tailored to their individual tastes or requirements. VOD multimedia can provide the best of television with the best of the Internet, broadcast to a wide range of fixed and mobile *clients*.

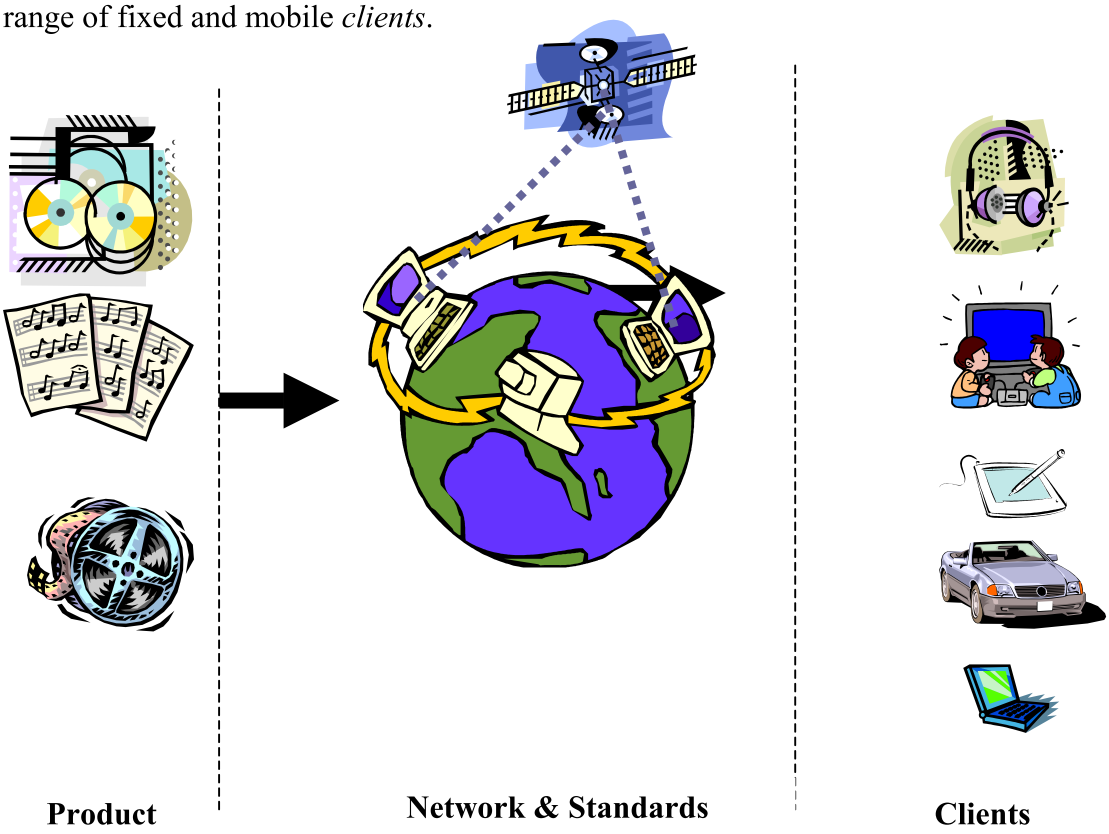

Figure 1.1, Parties of VOD system

The structure of this report is based on this description of a VOD system, and in the next chapters we will describe the different parties in more detail.

2 PRODUCTS

It seems that VOD products are under development, but some devices and software are available already today. Due to many trials and continuing standardisation, there are many kinds of products from different companies. For example, the video server market has become quite a mass of confusion. Servers generally can be used to store all kinds of data, audio, text, moving video, and stills. Most can do variable compression or no compression at all. They can differ with respect to the amount of data space, the overall bit rate of data that can leave or enter the server and the number of channels of data that can flow out or in at a particular time. Also some companies have developed their own video servers.

2. 1 Interactive services

The current TV broadcasting will meet a fundamental change by interactive video delivery services. Many TV stations broadcast their programmes simultaneously to users, who select one channel of the available channels to view at a particular time. In contrast, by an interactive system much wider selection of programmes becomes available at any time.

2.2 Types of interactive services

Based on the level of interactivity, interactive services can be classified into several categories. The following categories are collected from an article written by Thomas D.C. Little and Dinesh Venkatesh from Boston University [1].

- *Broadcast* (No-VOD) services similar to broadcast TV, in which the user is a passive participant and has no control over the session.
- *Pay-per-view* (PPV) services in which the user signs up and pays for specific programming, similar to existing Cable TV(CAT TV) PPV services.
- *Quasi Video-on-Demand* (Q-VOD) services, in which users are grouped based on a threshold of interest. Users can perform at the simplest level temporal control activities by switching to a different group.
- *Near video-on-demand* (N-VOD) services in which functions like forward and reverse are simulated by transitions in discrete time intervals (on the order of 5 minutes). This capability can be provided by multiple channels with the same programming skewed in time.
- *True Video-on-Demand* (T-VOD) services, in which the user has complete control over the session presentation. The user has full-function *Video Cassette Recorder(VCR)* (virtual VCR) capabilities, including forward and reverse play, freeze, and random positioning. T-VOD needs only a single channel per customer; multiple channels become redundant.

PPV services are the easiest to implement, and T-VOD systems are the most difficult to implement. PPV and Q-VOD are services like watching movies. In these cases, a local controller, setup-box, can filter multiple channels to achieve the service. T-VOD requires a bi-directional signal from the user to a centralised controller.

Interactive services cover a wide range of services from movies-on-demand to distance learning. Some of the basic interactive multimedia services are listed below in Table 1.1

Application	**Description**
Movies-on-Demand	Customers can select and play movies with full VCR capabilities
Interactive video games	Customer can play downloadable computer games without having to buy a physical copy of the game.
Catalogue browsing	Customer examines and purchase commercial products.
Distance learning	Customers subscribe to courses being taught at remote sites. Students tailor courses to individual preferences and time constraints.
Interactive advertising	Customers respond to advertiser surveys and are rewarded with free services and samples.
Video conferencing	Customers can negotiate with each other. This service can integrate audio, video, text and graphics.
Interactive news television	Newscasts tailored to custome tastes with the ability to see more detail on selected stories. Interactive selection and retrieval.

Table 1.1. Interactive multimedia services.

2.3 The industry

This new technology is being developed all the time, because Video-on-Demand has so many different applications to offer to the customers and economical possibilities have been seen. Many companies, organisations and universities are developing products and standards. Both CAT TV and telephone operators invest to their networks and have some trials in Video-on-Demand. To finance the required investments, higher consumer volumes must be reached from residential side instead of business side that is running ahead in the development of technology. The battle is hard, and it is getting harder all the time. So some companies have established business relationships to get their knowledge and resources together. In addition, they may avoid some regulation restrictions before telecommunication markets are opened to everyone. Considering the US market as the most developed and having difficulties of obtaining data from Europe, we present facts from this market.

Video on Demand has long been seen as the "killer application" for interactive TV, but expensive setup box requirements and stratospheric costs per stream have delayed its long-awaited rollout. After years of unfulfilled promises, the age of content on demand is finally approaching. At 2001, equipment costs, plant upgrades, and digital setup box penetration have begun to achieve the critical mass required for commercial deployment [2]. New research from Strategy Analytics predicts half of US homes will be regular VOD users by 2008, spending $26 billion on VOD services over the next seven years.
The study defines three stages in cable VOD rollout: availability, activation and usage. Estimating that more than 8 million US homes are currently passed by VOD-capable cable networks, this number will rise to nearly 50 million by the end of 2003. Activated VOD homes (those with setup boxes loaded with VOD software) currently number around two million, and this will rise to 7.6 million by end 2002.
But the VOD revenue flow will begin only slowly, because services will be in their infancy, and consumers will need to be educated on service availability. Strategy Analytics estimates that only 2.4m homes will actively use VOD this year, or fewer than 10% of those passed.
VOD revenues are forecast to reach $287 million for 2002, but will then rise rapidly to reach $3.5 billion by 2005, and $8.2 billion by 2008. Subscriptions will be the leading VOD business model, accounting for nearly two thirds of revenues. By 2008, VOD will be taking revenues from existing video rental as well as premium pay TV channel markets.
The report predicts that middlemen such as Entertainer will play an important role in the near term, but that media and communications majors such as AOL Time Warner will eventually dominate the market [3].

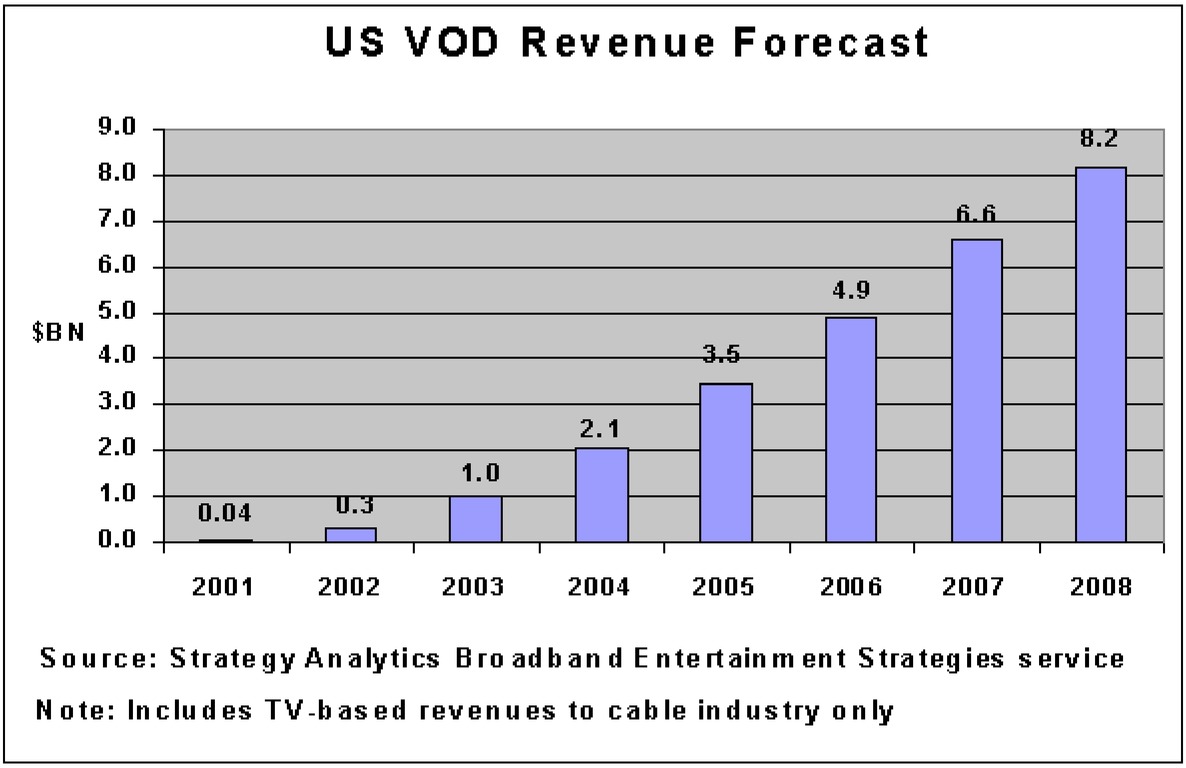

Figure 2.1, US VOD revenue forecast

2.4 Copyright

In a way it's easy: you look for a film, you pay and see it – almost like at cinema or videotheque. Like at the videotheque the film is available during 24 hours. It does not matter how often you see the movie.

Windows media format
the Microsoft Format is the only-one which offers good licence management[4].

The mayor part offering licence managed VOD content use the "Windows Media Video" -Format from Microsoft, because most people have it and because of the integrated Digital Rights Management. So the Industry (requires) supposes that Windows Media Players Version 7.1 is installed. Nowadays, the Industry put more and more on "Windows Media 9"-Format, which has a better management and image quality then the previous.

The film is fundamentally transmitted codified. So after paying, in addition you receive a licence-key, which expires after 24 hours. If you want to see the movie after those 24 hours you need another licence-key – but the Movie still is on the hard disk.

In the key there are some notes of the licence dates. At each playing of the film, Windows Media Player check if there is a licence for this film and if there is one he looks if the licence is valid. Changing the clock of the system doesn't help for watching the movie further.

DivX Networks and Fraunhofer Center for Research (the developers of the audio format MP-3) in Computer graphics want to develop Digital Right Management for DivX.

That called Digital Rights Management is considered as “The medicine” against the illegal distribution of digital contents like video, music or text. To see if it wills decrease the pirate activity, is yet to see.

3 The Network & Standards

A VOD service requires real-time display of the video purchased by the client. A typical video stream consists of frames of pictures, sounds corresponding to those frames, and captioned text. The large quantity of information needed to be transmitted to the client continuously with minimal delay poses high performance requirements on the network. A VOD network should be a high speed network with reasonable error rate as retransmission is unacceptable. Since video information is delay sensitive, the delay variation (jitter) should be kept to a minimum.

Unlike traditional computer communications that are bursty and short-lived, the deliveries of videos involve sending enormous amount of data to customer homes continuously for a long-period of time (the length of the movie presentation). Videos are usually encoded using MPEG-1 or MPEG-2 standards. Since MPEG encoding standards exploit the intra-dependency between frames, the resulting encoded video streams are usually of variable bit rates. These characteristics of videos lead to new criteria and challenges on the network.

3.1 Network Requirements of VOD Systems

High Speed Network. High speed networks are definitely needed for VOD systems. For example, videos compressed using MPEG standards require a bandwidth between 1.5 and 6 Mbit/s. A system supporting 100 users requires a bandwidth close to 600 Mbit/s. Ordinary 10 Mbit/s Ethernet or 28.8 kpbs telephone lines cannot support such video transfers.

Connection-Oriented Transfer. VOD services are real-time multimedia application services. In other words, the time at which packets arrive at the destination is strictly bounded. Any packets arrived later than their expected time is useless and discarded. Moreover, retransmissions are not possible. Consequently, connection-oriented services, which reduce the rate of dropped and late packets, are desired.

Latency and Jitter. The delay between a video stream being sent from the server and it being received by the client needs to be minimized. Variations in delay (jitter) must be kept within rigorous bounds to preserve the quality of the presentation [5].
In order to provide VOD services, the network needs to deliver guaranteed services to delay-sensitive variable-bit-rate video traffic [6]. The delay sensitive characteristic of video services requires the network to support some resource reservation schemes for each video stream.

3.2 Existing Network Technologies

As mentioned above, a typical video stream requires an average bandwidth of 1.5Mbit/s.

A typical VOD network can be divided into two levels: backbone and local distribution networks. The backbone connects servers and routers/access nodes together, while the local distribution network links a client site to its nearby router/access node. Each local distribution network link needs a bandwidth of at least 1.5 Mbit/s - the bandwidth of a single VOD video stream. The bandwidth of the backbone is usually on the order of hundreds megabits per second, depending on the number of simultaneous connections the VOD network has to support.

3.2.1 Backbone Network

VOD services require high-speed and low-jitter networks to support hundreds or even thousands of simultaneous connections. The required bandwidth of the backbone is on the order of hundreds megabits per seconds. Two attractive solutions are SONET and ATM.

SONET. SONET is a synchronous fiber optic network. The entire bandwidth of a fiber optic link is devoted to a single channel. Nodes connecting the channel transmit data at different time slots. A basic SONET channel (STS-1) has a bandwidth of 51.84 Mbit/s. SONET can also multiplex multiple digital channels together [7] to support more viewers. For example, three STS-1 channels are multiplexed to form a STS-3 channel with 155.52 Mbit/s bandwidth. SONET is suitable for delivering VOD streams because bandwidth is guaranteed and jitter is zero.

ATM. ATM is the acronym for Asynchronous Transfer Mode. It is asynchronous because it allows data arriving at irregular intervals [7]. ATM is suitable for transferring VOD data because it is a connection-oriented packet switching network. ATM transmits data at a rate from 1.544 Mbit/s to 622 Mbit/s, over copper and fiber media.

Note that a backbone with ATM running over SONET can also be adopted.

3.2.2 Signaling Schemes

A local distribution link requires a bandwidth of 1.5 Mbit/s. Many signalling schemes can deliver video data at such a data rate over existing communication links [1]. Two such schemes are described below.

Asymmetrical Digital Subscriber Loop (ADSL). ADSL is a signalling scheme used on copper-wire networks (e.g. telephone networks). It can deliver data at high speed with few signal distortions over existing copper wires. ADSL consists of a pair of ADSL units. One is installed in the client site; the other is attached at the central phone office. ADSL uses advanced integrated circuit designs, complex digital signal processing techniques, and software-based algorithms to compensate distortions in copper wires [8]. ADSL can provide a subscriber with a down-link of 1.536 Mbit/s wide-band signal, an up-link of 16 Kbit/s, and a basic-rate ISDN channel/the analogue 4 kHz telephone channel on existing twisted copper wire [1]. These characteristics satisfy the bi-directional communication and bandwidth requirements posted by VOD services. If the client site is within 5.5 km of the access node, no additional equipments are necessary to ensure strength of the received signal. ADSL is achievable because it divides the signal on a range of carrier frequencies, dynamically adjusting to achieve the most efficient channel allocation [9]. Extensions of ADSL include HDSL, SDSL, S-HDSL, and VDSL. HDSL has a data rate of 6 Mbit/s, and it can support MPEG-2 video streams up to about 2 km [8]. An ADSL local distribution network is shown in figure 3.1.

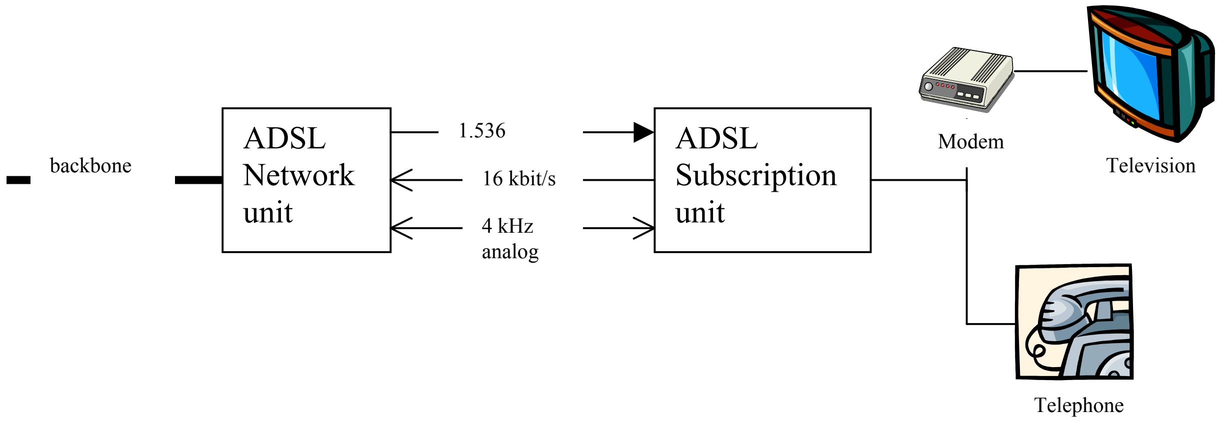

Figure 3.1. An ADSL Local Distribution Network [7]

Hybrid Fiber Coax (HFC). HFC is currently being installed by cable TV and telecommunication companies. Variations on HFC exist and have been implemented. They include:

- fiber-to-feeder
- fiber-to-the-hub
- fiber-to-the-zone
- fiber-to-the-curband
- fiber-to-the-tap

Fiber-to-the-feeder and fiber-to-the-hub are networks with fiber trunks, coaxial distribution links and subscriber drops. The others are networks consist of fiber trunks and distribution links, but coaxial subscriber drops [10]. The migration to HFC involves a replacement of the current 300-450 MHz coaxial cables by new 750 MHz coax cables [7]. Each channel is subdivided in 125 6-MHz sub channels. Bi-directional communications are implemented using split band systems. In North America, the frequency band between 5-54 MHz is used as up-link. The remaining bandwidth is guard band and down-link. Since clients share the same physical medium, collisions occur when they try to access the medium at the same time. The problem of sharing the transmission medium limits the number of clients attached to a coax tree structure [10]. The network architecture of HFC is depicted in Figure 3.2.

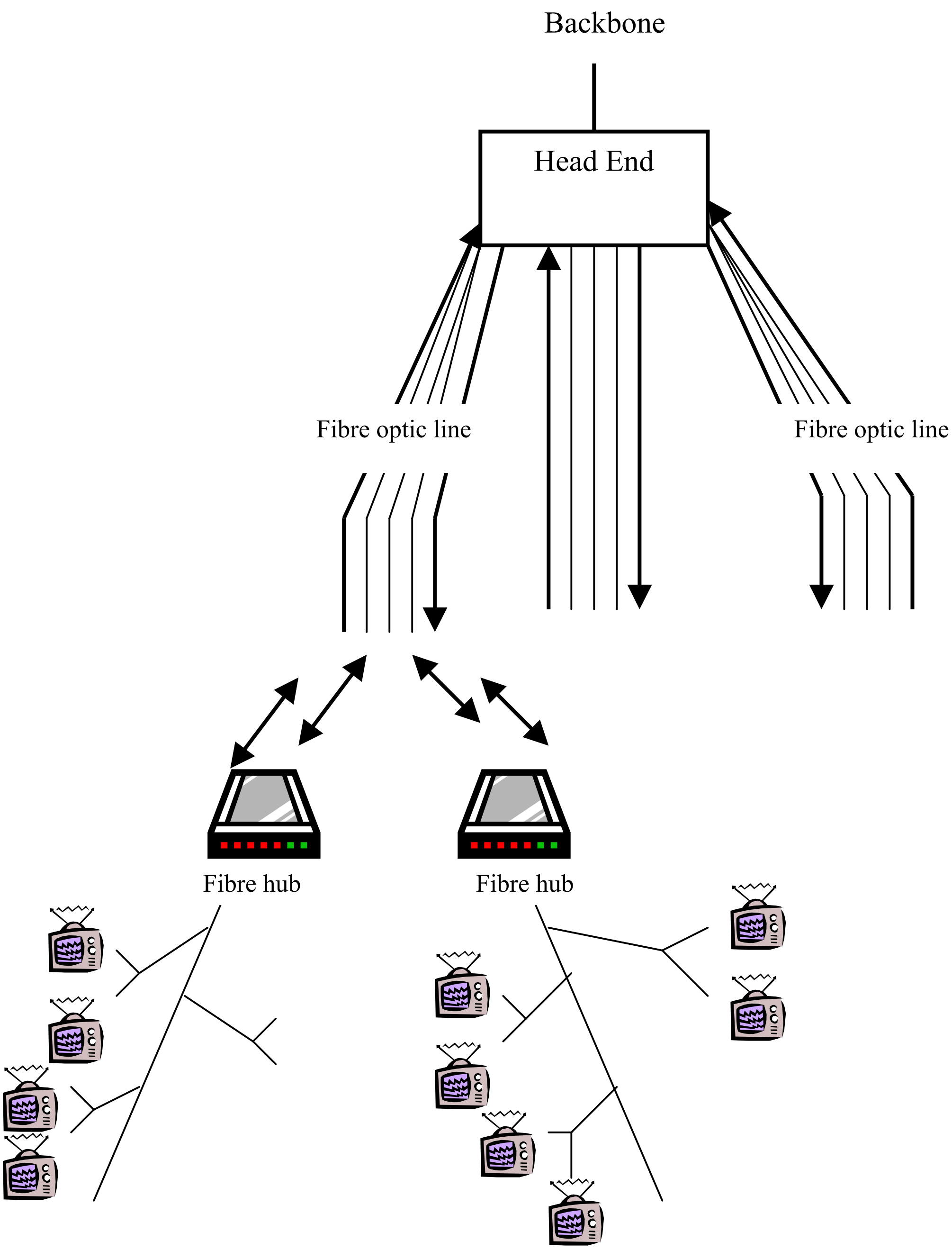

Figure 3.2. A hybrid Fiber Coax Local Distribution Network [8]

VOD services are feasible on HFC because the frequency band of the coaxial cables is splitted so that an up-link is available for sending clients' requests to servers.

Wireless

Hybrid fiber and wireless distribution network could be used within the neighbourhood for reducing the installation and maintenance costs, not so much for mobility. Such a system could be useful in the area where the copper wires are in a bad condition or physical connection between a local distribution point and the customer residents is limited or costs too much, for example when the service provider owns a fiber infrastructure but not the copper plants to the homes. WLAN-solutions provided by companies such as Cisco is gain territory, supporting up to 10 Mbit/sec. per base station. Dealing with wireless VOD, three issues require extra attention:

- Compression efficiency - Performance exceeding industry image compression standards.
- Error resiliency - Consistent image quality maintained under noisy channel conditions.
- Low power consumption - Real-time decoding power at less than 10 *mW*.

Portable, personal communication involves mobile transmitters and receivers. Multipath interference introduces fading. Unknown environmental factors introduce noise, such as weather conditions etc. giving a more unpredictable system; noise can change at any time!

3.3 Standards

As mentioned earlier in chapter 2.3, for VOD to be a profitable business, a large market has to be reached. To avoid a chaotic distribution environment with many different formats, standardization plays a crucial role in achieving the goal of mass distribution.

Table 3.1 shows some technical parameters of the standards.

Standard	Year	Service/applications	Bitrate	Codification technique
ITU-R 601	1982	Television in studio	216 Mbit/s	PCM
ITU-T H.120	1984	Video conference	2 Mbit/s	DPCM Entropy coding
ITU-T H.261	1990	Video telephoning and Videoconference	P x 64 kbit/s	DPCM DCT transformation Movement compensation Entropy coding
ISO/JPEG	1990	Photography	-	DCT transformation Entropy coding
ISO/MPEG 1	1991	Video on CD-ROM	1.5 Mbit/s	DPCM DCT trans. Movement compensation Entropy coding
ISO/MPEG 2 ITU-T H.262	1993	HDTV	> 2 Mbit/s	DPCM DCT trans. Movement compensation Entropy coding
ITU-T H.263	1995	Video telephone in analogue networks	< 64 kbit/s	DPCM DCT trans. Movement compensation Entropy coding

Table 3.1, Principal caracteristics of the international standards for image and video [14]

Details about every standard are beyond the scope of this report. Nevertheless we have chosen to write in more detail about the MPEG-4 standard. MPEG-4 represents a breakthrough in the way the user can interact with the different multimedia content. As a VOD-product normally contains more than just video, but also sound, text etc., giving the consumer the possibility to select and manipulate the different content opens for a new array of interactive entertainment. Therefore we have chosen to write a bit about this standard, highlighting its benefits.

3.4 MPEG-4, perhaps the future standard for VoD

The ISO/IEC standard MPEG-4 is perhaps the future standard for VOD demand. MPEG-1 and MPEG-2 have been successful standards that have given rise to widely adopted commercial products, such as CD-interactive, digital audio broadcasting, and digital television. However these standards are deeply limited in terms of the functionalities provided by the data representation models used.

The recent MPEG-4 standard opens new frontiers in the way users will play with, create, re-use, access and consume audiovisual content. The MPEG-4 object-based representation approach where a scene is modelled as a composition of objects, both natural and synthetic, with which the user may interact, is at the heart of the MPEG-4 technology.

MPEG-4 provides a set of technology to satisfy authors, service providers and the end users alike. The standard also brings multimedia-content to new networks, also those with a low bit rate.

The representation of *media objects* is a important new feature, Splitting the multimedia-content, into objects of still image, video, audio, text, graphics, and synthetic sound. The standard provides a solid and flexible platform for different needs to avoid a multitude of different non-interworking formats and players. In its coding form each media object can be separated, allowing the objects to be handled in a 2-D or 3-D audiovisual scene. Media objects enable a range of functionalities such as having a object available in a scaleable form, simple extracting and editing of a object, and good error robustness. The standard has especially proven success in[15]:

- Interactive graphics application
- Interactive multimedia (www, distribution of and access to content)
- Digital television

The interactivity with the media objects provides good opportunities for interactive Video on demand. Operations a user may be allowed to perform include:

- Change the viewing/listening point of the scene, e.g. by navigation through a scene;
- Drag objects in the scene to a different position;
- Trigger a cascade of events by clicking on a specific object, e.g. starting or stopping a video stream;
- Select the desired language when multiple language tracks are available;

Management and identification of intellectual property, and copyright issues plays a central role in VOD, and it is important to have the possibility to identify intellectual property in MPEG-4 media objects. MPEG-4 incorporates identification the intellectual property by storing unique identifiers, which are issued by international numbering systems (e.g. ISAN, ISRC, etc.). These numbers can be applied to identify a current rights holder of a media object. Since not all content is identified by such a number, MPEG-4 Version 1 offers the possibility to identify intellectual property by a key-value pair (e.g.:»composer«/»Pedro Lopez«). Also, MPEG-4 offers a standardized interface that is integrated tightly into the Systems layer to people who want to use systems that control access to intellectual property. With this interface, proprietary control systems can be easily amalgamated with the standardized part of the decoder.

3.4.1 Streaming data delivery

To handle the delivery of streaming data over different networks, MPEG-4 has a synchronisation layer and a delivery layer. This layer has the possibility to exploit the *Quality of Service (*QoS) available from the network. MPEG-4 defines a toolbox of advanced compression algorithms for audio and visual information. The data streams (Elementary Streams, ES) that result from the coding process can be transmitted or stored separately, and need to be composed so as to create the actual multimedia presentation at the receiver side.

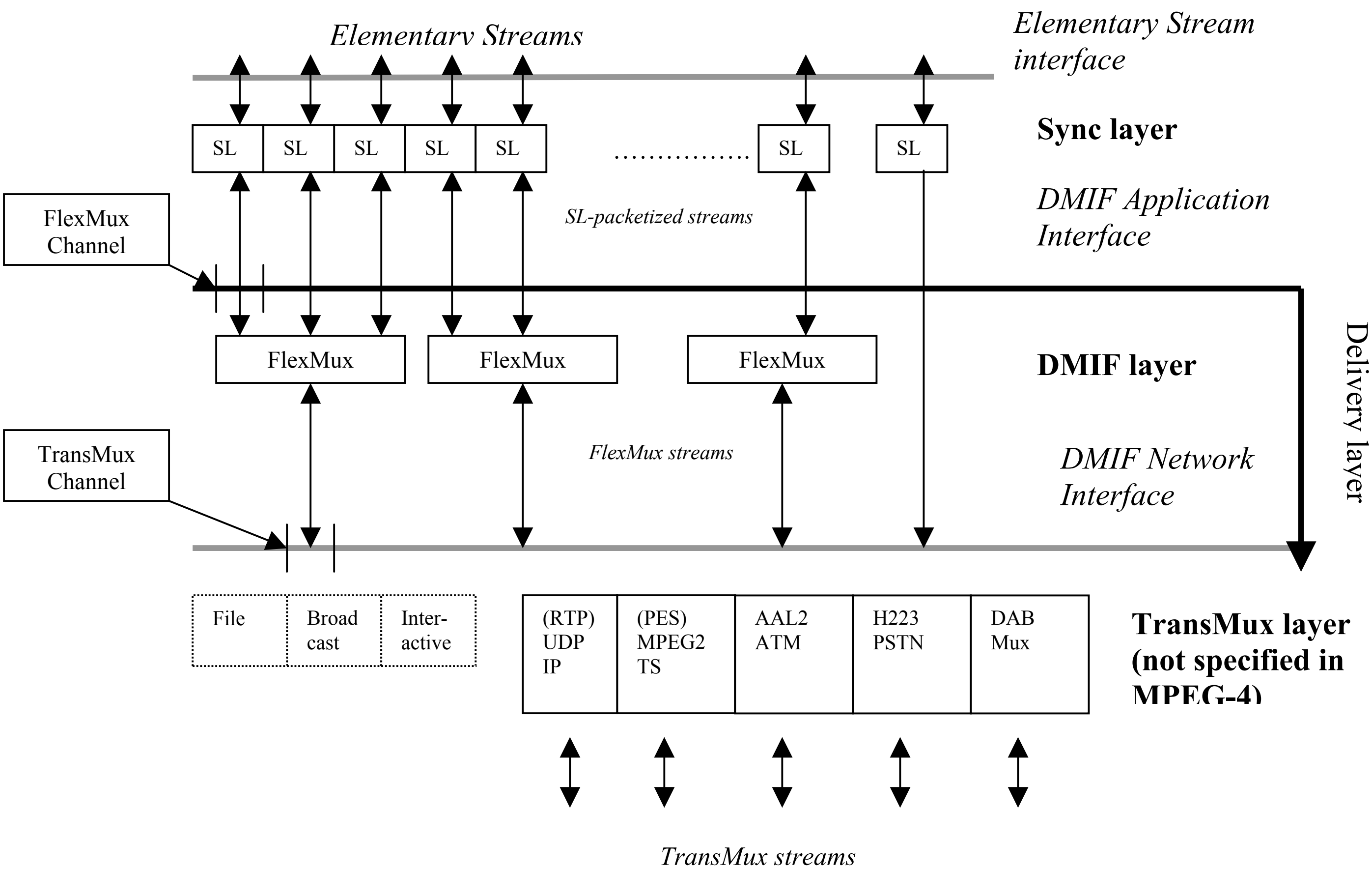

Figure 3.3 , The MPEG-4 System layer model[15]

The first multiplexing is managed by the *Delivery Multimedia Integration Network* (DMIN). This multiplex may be embodied by the MPEG-defined FlexMux tool, which allows grouping of Elementary Streams (ESs) with a low multiplexing overhead. Multiplexing at this layer may be used, for example, to group ES with similar QoS requirements, reduce the number of network connections or the end to end delay. The “TransMux” (Transport Multiplexing) layer in figure 3.3 models the layer that offers transport services matching the requested QoS. Only the interface to this layer is specified by MPEG-4 while the concrete mapping of the data packets and control signaling must be done in collaboration with the bodies that have jurisdiction over the respective transport protocol. Any suitable existing transport protocol stack such as (RTP)/UDP/IP, (AAL5)/ATM, or MPEG-2’s Transport Stream over a suitable link layer may become a specific TransMux instance. The choice is left to the end user/service provider, and allows MPEG-4 to be used in a wide variety of operation environments. Use of the FlexMux multiplexing tool is optional and, as shown in Figure 3.3, this layer may be empty if the underlying TransMux instance provides all the required functionality. The synchronization layer, however, is always present.

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With regard to Figure 3.3, it is possible to:

- Identify access units, transport timestamps and clock reference information and identify data loss.
- Optionally interleave data from different elementary streams into FlexMux streams
- Convey control information to:
    - Indicate the required QoS for each elementary stream and FlexMux stream;
    - Translate such QoS requirements into actual network resources;
    - Associate elementary streams to media objects
    - Convey the mapping of elementary streams to FlexMux and TransMux channels

It is important to note that the work and integration of MPEG-4 is not finished. Never the less the standard represent a new way of handling multimedia content, and could have great impact on changing our habits on using interactive multimedia content.

4 Clients

A client subscribing to an Interactive VOD service has a display device (usually TV) and some audio devices (e.g. speakers) to present the movie requested. He/She interacts with the system via an input device such as a remote control, a mouse, or a keyboard. To support interactive services, considerable functionalities must be built into the setup box. Four important components for setup box are Network Interface, Buffer, Decoder and Synchronization Hardware. Figure 4.1 depicts the components at the client site.

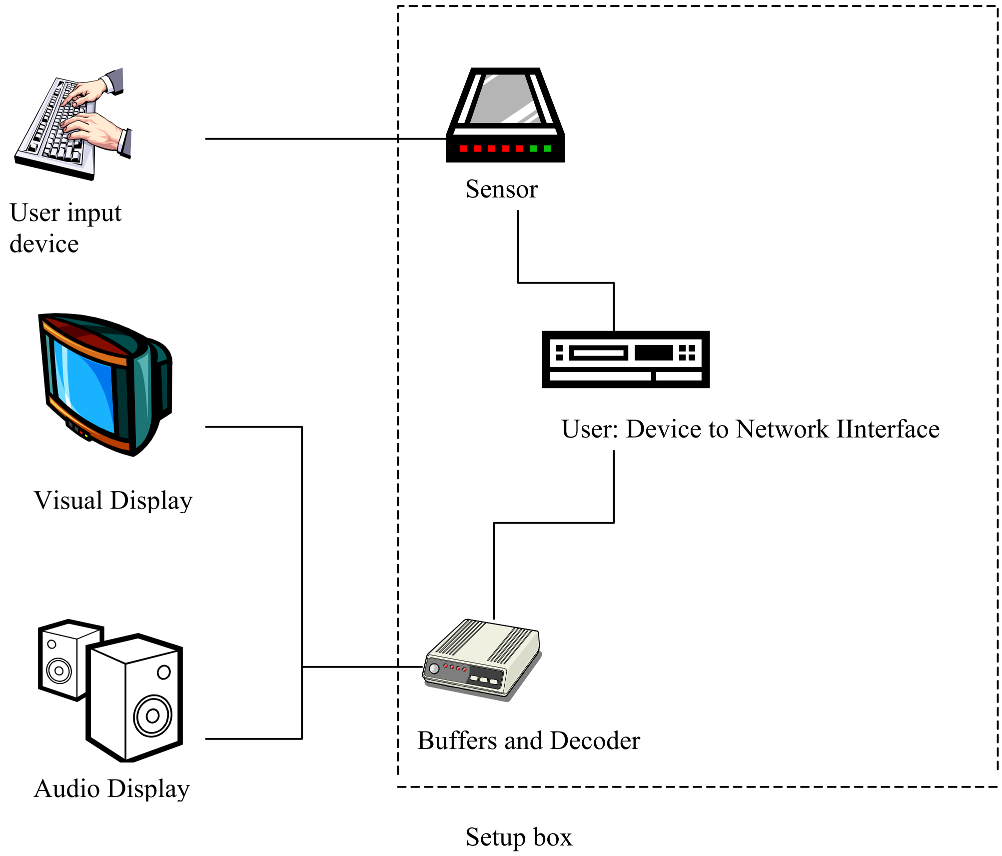

Figure 4.1. A User's Setup Box

4.1 Network Interface

The network interface allows the client to receive data from server. Moreover, it provides a mechanism to translate user commands received by the sensor to appropriate signals for transmissions on network.

4.2 Decoder

In order to save storage space, disk bandwidth, and network bandwidth, movies are usually encoded before they are stored. Thus, a decoder at the client's site is needed to decode the arrived media streams before presenting them to the viewer.

4.3 Buffer

Due to delay jitters in the network, the arrival time of a video stream cannot be determined exactly. In order to guarantee starvation-free (continuous) playback, the

server must ensure a media unit is available at the client prior to its earliest predicted playback time. By taking into account the maximum network delay (d_{max}), the server can transmit a media unit at least d_{max} prior to the unit's earliest predicted playback time. However, if the actual network delay experienced by the media unit is less than d_{max}, the media unit will arrive at the client earlier than its scheduled playback time, and will have to be buffered [11].
If the buffer size is large enough and the Jump size is relatively small, Jump Forward or Jump Backward may not require data delivery from the server. In other words, the data required are already in the client's buffer. The response to the jumps will be faster as compared to those requiring data from the server. Buffering also makes the response to Fast Forward and Fast Rewind faster if the initial data required is in the buffer.
As mentioned above, decoding is required at the client's site. Buffering of data that may be required for future display allows data to be decoded while the current data is being displayed. Less powerful decoding hardware or decoding algorithm can be used since real-time decoding is avoided.

4.4 Synchronization Hardware

A movie consists of both video and audio streams. They must be synchronized before being presented. Synchronization is required at the client site to support scalable video [12]. In scalable video, a video stream is decomposed to a base stream and one or more additional streams. The additional streams are to be combined with the base stream to produce higher quality video. Each of those streams is stored as individual media files on the server. Depending on the quality demanded and the bandwidth available to the client, the presentation may require zero or more of the additional streams [12]. Therefore, different media streams must be synchronized before presenting to the customers.
Lastly, the user interface should be simple and easy to use. Preferably, the same remote control can be used for both the IVOD system and the video cassette recorder. In addition, the cost of setup box must fall within reasonable limits (under a few hundred euros) for the technology to succeed. Open and interoperable systems that let users subscribe to several different services are preferred [1].

4.5 VOD over Internet

He/She can have VOD by Internet too. At homepages, offered Video’s are often downloads with restricted length/rights or Streaming Media. Here, instead of the setup box, the computer is used with an adequate Media player too make all the processes referred before. The Media players are Apples Quick Time, Real Networks Real Media and Microsoft Windows Media.

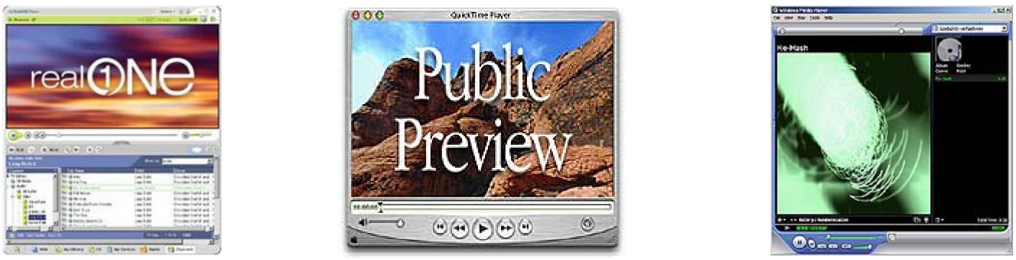

Figure 4.2, Interfaces, realplayer (left), Apple Quicktime player, and Microsoft Media Player (right)

4.6 Acceptation of the Product

In a study from Frost & Sullivan, all elements of the European VOD market are investigated, leading to a strong belief that high growth rates are imminent as it comes of age and heads towards the growth phase of the product life cycle.
Since the technology's inception, European rollout of VOD has been substantially lagging the US. At 2000, Video Networks launched VOD commercially in the UK, yet audiences remain limited. Frost & Sullivan is predicting a substantial increase in numbers of subscribers to the VOD service to 2006.

There are a number of factors driving the market towards the high levels of revenue forecast for year 2006.

- The consumer experience
- The increase in availability of bandwidth
- The increase competitive nature of the television market and amongst the service providers

However, companies planning to get involved in this market also have to take into account some important restraints.

- Unfavourable terms from content providers
- Huge amount of bandwidth required and the related slow unbundling of the local loop
- Lack of awareness of the product among the potential consumers

5 Conclusion

In this paper, we give an introduction to the overall system architecture of a VOD system.

Developing a new information delivery infrastructure requires considerable planning and effort [1]. In addition to meeting technology requirements, such as network and disk bandwidth, making VOD service a reality also involves considerations of other factors. They include the cost of building the system, international standard agreement, and service providers' security.

The economics of providing VOD service cannot be ignored. A large video server can easily cost more than a mainframe, certainly 10 million euros.
Consider a regional VOD service with 100,000 subscribers, each of which rent a 300 euro "setup box". If the networking equipments cost 10 million euros and have a 4-year depreciation period, the service has to generate 10 euros per home per month. Charging 2 euros per movie and 3 euros rental for "setup box" requires every subscriber buying 2 movies per month to break even [7]. Certainly, all the cost figures mentioned above vary with time, but it is clear that a mass market is needed for the technology to be viable [7]. For the development of a mass market, agreement on international standards must be reached. Establishing standards for a "setup box", video-file server, and standards that allow competition among service providers are important for such systems to grow. Mechanisms to protect intellectual property rights must also be established so that service providers are able to maintain control of their data and thus are able to stay in business. With new standards such as MPEG-4 combined with right-management only the future will tell if these methods are sufficient.

The technologies required to make VOD a reality already exist. Today VOD systems can be built with a reasonable cost, international standards are developed, and mechanisms for protecting the interests of service providers are established. We can easily see the appearances of large-scale VOD services in the near future.

6 References

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7 Links

www.microsoft.com	For about copyright
http://www.microsoft.com/windows/windowsmedia/default.asp	For Windows Media
www.chip.de/specials/special_index_8841446.html	For VOD
http://www.informatik.uni-mannheim.de/~whd/mvod/	For VOD
http://www.cs.tut.fi/tlt/stuff/vod/VoDOverview/vod.html#inter	For VOD
http://www.strategyanalytics.com/press/PRNG002.htm	For Industry data
http://infosoc.informatik.uni-bremen.de/internet/fgtk/OnlineInfos/Digital-Interaktiv/Digital-Interaktiv.html	For VOD
http://www.real.com	For Real Player
http://deptinfo.unice.fr/~berera/net99/ip/ip-II.htm	For Standards
http://www.itvmarketer.com/mktres/vod	For acceptation of Product data

8 Abbreviations

AAL	ATM Adaptation Layer
ADSL	Asymmetrical Digital Subscriber Line
ATM	Asynchronous Transfer Mode
CATV	Common Antenna Television, Cable TV
CD-ROM	Compact Disk-Read Only Memory
D	Dimension
d_{max}	The maximum network delay
DCT	Discrete Cosine Transform
DMIN	Delivery Multimedia Integration Network
DPCM	Discrete Pulse Code Modulation
ES	Elementary Streams
HDTV	High-definition television
HFC	Hybrid Fiber Coax
IEC	International Electrotechnical Commission
IP	Internet Protocol
ISDN	Integrated Services Digital Network
ISO	International Organization for Standardization
ITU	International Telecommunication Union
ITU-T	ITU Telecommunication Standardization Sector
Mbit/s	Megabits per second
MPEG	Moving Pictures Expert Group
No-VOD	Broadcast services
N-VOD	Near Video-on-Demand
PCM	Pulse Code Modulation
PPV	Pay-per-view
QoS	Quality of Service
Q-VOD	Quasi Video-on-Demand
RTP	Real Time Protocol
SL	Sync Layer
SONET	Synchronous fiber optic network
TV	Television
T-VOD	True Video-on-Demand
US	United States of America
UDP	User Datagram Protocol
VCR	Video Cassette Recorder
VOD	Video on demand
WLAN	Wireless Local Area Network
WWW	World Wide Web