IRIS Special

Regulating Access to Digital Television

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Digital Television Glossary

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Digital Television Glossary
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There can be no doubt that understanding the functioning of digital television and related services presents a big challenge for many of us? At the same time, understanding this technology is the essential prerequisite for comprehending related policy issues and legal problems. These issues range from consumer rights and business decisions to media concentration, with many more questions in-between.

In September 2003, the European Audiovisual Observatory and the Institute for Information Law (IViR) jointly organised a workshop that shed light on *Vertical Limits – New Challenges for Media Regulation* raised by digital television – challenges related, in particular, to technical bottlenecks or vertically integrated services. The key question was how, if at all, positions of power that allow access control over digital television are or could be addressed by regulation.

The results of the workshop are published in the main part of this *IRIS Special* on *Regulation Access to Digital Television*. It consists of the workshop report, 13 contributions by the participants, and this *Digital Television Glossary*.

The latter was commissioned by the Observatory from the Institute of European Media Law (EMR) with a view to creating this *IRIS Special* and in preparation of the workshop. Concretely, we asked for a description of the functioning of digital television and – in parallel to this – a highlighting of those structures and mechanisms that carry the potential for creating bottlenecks and allowing control over who accesses that particular market. You will find these gateways to digital television marked in italics.

We are grateful to Alexander Scheuer and Michael Knopp from the EMR for having taken on that very difficult task. We purposely asked trained lawyers and experts in media law issues to explain the intricacies of digital television assuming that their language will best meet the needs of most of our readers.

Although we consider the *Digital Television Glossary* to be an integral part of this *IRIS Special*, we gave it a physical life of its own in order to facilitate its use as a dictionary. Long may it live in this rapidly changing world of technology!

Strasbourg, December 2003

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Digital Television Glossary

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I. Introduction

Digital television has made the technical background to television rather more complex than in the analogue age. It begins with the transformation of pictures into digital data streams. Because of their enormous size, these data streams must be compressed before they are broadcast. This compression, together with the splitting up of picture and sound data into separate packages, makes it possible to form so-called multiplexes, made up of several programmes and services. A multiplex can then be broadcast via a channel. This means that, on a channel that would have carried only one programme using analogue technology, it is now possible to broadcast 6 to 8 programmes. To this can be added services plus a multitude of extra programme information that was completely alien to analogue television. Furthermore, digitisation brings television technically closer to the Internet. At the receiving end, the old analogue television can stay put, but it has to be accompanied by a set-top box, which decodes the digital data, converts the multiplex back into separate programmes and contains the technology for future innovations. Examples worth mentioning are the electronic programme guide (EPG) as well as many more or less interactive services, such as telebanking, teleshopping, video-on-demand, etc. Interactivity also means that it must be possible to communicate with each programme and service provider over a return channel. Each of these areas also requires forms of standardisation, which are so numerous that they make the technological background seem even more complex.

II. Digital television

Misunderstandings, which may be accounted for in part by the broad range of terms used in connection with digital television, begin with the term "digital television" itself. Until now, both the recording and the reproduction of pictures have, as a general rule, taken place in a traditional analogue manner. Even though nowadays much of the production of programmes is already carried out digitally, for the time being cameras are still analogue devices. The pictures recorded by them must first be digitised, although this already happens inside the camera. A comparable situation applies to television sets, which still work on the principle of the display on lines of an analogue and hence a wave-based broadcasting signal. "Digital television" is mainly a question of the digital transmission of television and the ensuing increase in television's technical possibilities.

The word "digital" is derived from the Latin word "*digitus*", meaning "finger" or "digit", which later came to mean a single number. What is meant is the representation of signals by figures, which are generally binary and hence made up of a series of zeros and ones.

Broadcasting in this form only became possible when refined compression techniques and uniform standards were introduced. Introducing standards means coming to agreements or making commitments as to what the specification of new technology might be. Knowledge of this makes investments more secure and production figures higher. In Europe most of these standards have been devised and established by the DVB (Digital Video Broadcasting)

Group.[1] These standards include, above all, the data-compressing standard, DVB-MPEG 2, and the transmission standards, DVB-T,[2] DVB-S,[3] and DVB-C.[4] It should also be mentioned that the digitisation of broadcasting techniques is not just limited to television but also applies to radio broadcasting, which is governed by the DAB[5] (Digital Audio Broadcasting) Standard.

There is a close link between digital television and the realm of interactivity. The technical potential to create interactivity exists but it is not easy to determine at exactly what point applications can be said to be interactive. There is no clear definition. Interactivity may, however, be described as follows: the user and the provider each influence one another while they act and react to one another. What is unclear is what degree of intensity this mutual exchange has to reach for it to be described as interactivity. The main question is whether there has to be a reaction on the part of the service provider or the programme maker – for example, in such a way that changes to the broadcasting signal occur as a result of the return message. After all, a slight interaction even occurs with conventional teletext, as the viewer chooses which page he wants to be shown. On the other hand, it has to be said that the broadcasting signal contains all of the teletext pages permanently. This means that this is not a reaction which influences the broadcasting process in the manner described above, as the interaction is limited to the television screen. Nevertheless, even at this basic level, we can still talk of interactivity (so-called local interactivity). The customary term for this is "enhanced TV". On the other hand, it is hardly conceivable either that the viewer will exert any full or individual influence on the programme being broadcast outside a firmly established mould.[6]

"True" interactivity presupposes that an individual message is sent via a return channel, to which the service provider reacts by transmitting the data and services requested by the individual alongside the main television programme. Switching between true and local interactivity – and thus, in some ways, simulated interactivity – is, however, increasingly easy from a technical viewpoint, meaning that the distinction will become more and more difficult for users to perceive.[7]

A clearer understanding of the term interactivity and a delimitation of non-interactive choices by viewers will probably depend on future technical development.

III. General terms

Irrespective of concepts that are directly linked to the technical processes of digital television, our first task is to provide an explanation for some frequently encountered general terms.

1. Interoperability

A term that comes up again and again, particularly in lists of objectives and in guidelines, is interoperability. [Operability is the attribute of something that is made so that it can be worked with]. Interoperability means the ability of devices or machines to work together with one another and to communicate in one language. Accordingly, the ETSI (European Telecommunications Standards Institute) defines interoperability as "the capability to provide successful communication between end-users across a mixed environment of different domains,

1) The Digital Video Broadcasting Group is an industry-led consortium of over 300 broadcasters, manufacturers, network operators, software developers, regulatory bodies and others in over 35 countries, committed to designing global standards for the global delivery of digital television and data services.
2) ETSI Ref EN 300 744; http://www.dvb.org/index.php?id=59&sid=32
3) ETSI Ref EN 300 421; http://www.dvb.org/index.php?id=59&sid=25
4) ETSI Ref. EN 300 429; http://www.dvb.org/index.php?id=59&sid=1
5) http://www.worlddab.org
6) *Deutsche TV-Plattform e.V.* (ed.), „Fernsehen heute und morgen" ("Television today and tomorrow"), chapter 6.2.2.
7) Communication from the Commission on barriers to widespread access to new services and applications of the information society through open platforms in digital television and third generation mobile communications, COM (2003) 410 final, 9 July 2003, p. 9.

networks, facilities, equipment, etc. from different manufacturers and (or) providers. In this context the communication is meant between end-users or between an end-user and a service provider."[8] (STF228) The term end-user is defined by the relevant European Directive[9] as a user not providing public communications networks or publicly available electronic communications services.

In the area of digital television this means, for example, that interactive content can be transferred between separate sets, thereby taking advantage of the full functionality of this content on enhanced digital television equipment.[10] This requires suitable interfaces and the common interpretation of signals. Where digital television is concerned, the availability of interoperability plays a major role in the development of horizontal markets, in which software, middleware and hardware produced by various manufacturers have to work together.

2. Compatibility

A word which is related to and hard to distinguish from interoperability is the term "compatibility" [congruency, interchangeability, coherence]. The term relates to the correspondence of a piece of hardware or software to a specific existing model system or standard. This provides a guarantee that even when made by different manufacturers, various components which are supposed to function as a coherent whole, are able to operate together harmoniously without the need for further applications such as adapters.[11] This compatibility between components or different products is knowingly brought about and, from certain economic viewpoints, it may contribute to a situation wherer the need for a second compatible product is created only by an existing one – such as the need for compatible storage devices created by a new recording apparatus.

The difference between interoperability and compatibility can be perceived in the fact that interoperability is used to describe the actual working of components in combination or their ability to communicate with one another, whereas compatibility describes conformity with common technical specifications.

3. Horizontal and vertical competition

In many European countries, the digital television market is characterised by the fact that its foundations were laid by a pay-TV service.[12] Because appropriate providers had to begin by creating the necessary technical conditions for digital television, more often than not most of the steps in a whole series of processes lie in the hands of a closely-knit coterie. In the absence of open standards[13], subsequent competitors were forced to offer services covering the whole chain if they did not want to place themselves in a dependent relationship. In the end this has led to several providers, but they each provide equipment and services for the whole chain of processes, from the production of digital programmes to the making of receiving equipment. As a result the individual components in each product range are or were incompatible with those of other providers.

8) Communication from the Commission on barriers to widespread access to new services and applications of the information society through open platforms in digital television and third generation mobile communications, COM (2003) 410 final, 9 July 2003, p. 9; ETSI User Group "STF228 Progress Report", available on http://docbox.etsi.org/UserGroup/Open/50-20030214-Offenbach/TD15%20STF228%20Progress%20Report.doc

9) Directive 2002/21/EC on a common regulatory framework for electronic communications networks and services (Framework Directive), Article 2, para. (n).

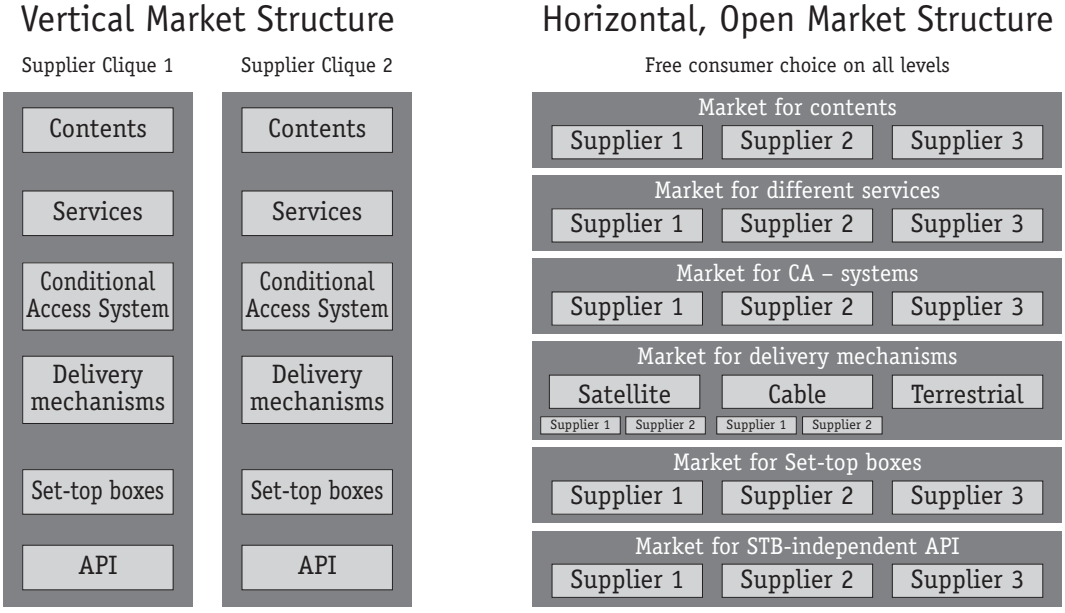
10) Directive 2002/21/EC on a common regulatory framework for electronic communications networks and services (Framework Directive), Considerations (31).

11) Kleinaltenkamp, "Die Bedeutung von Produktstandards für eine dynamische Ausrichtung strategischer Planungskonzepte" ("The significance of product standards for a dynamic organisation of strategic planning concepts"), in *Strategische Planung*, 1987, p. 8 *et seq*.

12) Communication from the Commission on barriers to widespread access to new services and applications of the information society through open platforms in digital television and third generation mobile communications, COM (2003) 410 final, 9 July 2003, p. 15.

13) Openness means that the standard is available to every interested party, regardless of the means of distribution.

This market structure is the sign of a vertically integrated market. Such a market structure is disadvantageous for the manufacturer or supplier of mere individual contents or components of a set-top box, an encryption system, a single application system or a service. A market player trying to operate outside a vertical clique of this kind has practically no chance of finding a market, because none of his supplies can replace the individual links in the chain; or alternatively because the end-users, who already receive everything from one source, are not interested in what he can offer. A vertical market structure also, however, limits the users' options in this respect when it comes to the individual assemblage of separate components. This problem can only be resolved once an open, horizontal market has been established. Such a market exists when general standards and interoperability of technical components allow competition to develop between various suppliers at the respective levels of the "value chain".



4. Platform

The term platform can be used in several connections. In the present context it is used to describe the technical basis for one or more pieces of equipment, to which further applications or extensions are added. The term can, however, be applied to software as long as it provides the basis for additional applications. Taken in its broader meaning, the term can even extend beyond technical requirements. As regards digital television, the functions of a platform can be regarded as all the components that are necessary to bring programmes from the producer to the customer, such as multiplexing, delivery mechanisms, conditional access systems, marketing, customer services, etc.[14] Alongside the primarily technical use of the word there is also an aspect of the term "platform" that relates to content. When people talk of a programme and service platform what they mean is the standardised basis for a marketing and sales structure in which an operator's own programmes and those of others can be passed on to customers via a single service[15].

14) Sosalla, "Anforderungen an die zugangsoffene Plattform" ("Demands on the open-access platform", in Institute of European Media Law (EMR) (ed.), „Digitale Breitbanddienste in Europa" ("Digital broadband services in Europe"), EMR publications, Volume 27, p. 131 *et seq*.

15) Case no. IV/M. 993 – Bertelsmann/Kirch/Premiere, 27 May 1998, Official Journal of 27 February 1999, No. L 53, p. 1 (paragraph 26).

5. Network levels

In Germany, for instance, cable broadcasting can be divided into four network levels. The first is the means by which signals are sent from the content producer, for example a television studio, to broadband-communication distribution-points. The second level consists of the means of transmitting signals to generic repeater stations via radio transmitters, satellite and directional radio. Network-level three includes the local distribution networks, consisting, for example, of broadband cables, and ends with the so-called building entrance facilities. This is where network-level four begins with the private home distribution equipment, which connects the building entrance facilities with the aerial socket in the customer's home[16]. Network level four also incorporates smaller local networks called "city-carriers".

IV. Digitisation

The digitisation of analogue signals is the first step in the process of digital television broadcasting. Digitisation is carried out by an analogue-to-digital converter (ADC), which encodes the original analogue signal.

1. Pulse code modulation (PCM)

The process used to encode analogue signals is called pulse code modulation (PCM) and is based on the sampling of the source signal over fixed time intervals (temporally discrete sampling). The sample values are allotted binary code words, each of which corresponds to a specific value. By a code word we mean a series of bits, that is a series consisting of zeros and ones. 8 bits equal a byte, but longer code words are possible (comprising 10, 12 or even 24 bits). The allocation of binary codes to a value of the analogue signal is called quantisation. As it is only possible to encode a median value over the sampling interval, sampling frequency, that is to say the subdivision of a time segment of the signal into separate sampling intervals, must be so high that the resulting distortion of quantisation is invisible to the human eye. The chronological sequence of quantised signal values is then converted into a succession of binary numbers, or, in other words, encoded.[17] For video signals inside studios, 10-bit encoding is what is generally used for this, while for sound signals, even 16-bit encoding is common because of sound's greater dynamic range.[18] 10-bit encoding means that 2^{10} or 1024 different values can be constituted per sampling interval.

Video analogue-to-digital converters still also operate according to the parallel conversion process, which makes for a very short conversion time (flash conversion). The binary code signal is then obtained using a parallel-to-serial converter. These and other processes are standardised by the International Telecommunications Union (ITU).[19]

2. Studio multiplex

An analogue signal is made up of a number of components, which individually indicate brightness (luminosity or light density) (Y) and colour (chrominance) (C_B / C_R – chrominance consists of two signals for blue and red), meaning that several components are produced at encoding. These must now be processed into a uniform serial signal, that is to say that it must be possible for the individual code words for the sample values of each component signal to be transmitted one after another. For this purpose a piece of digital information relating to timing is added to the data packages formed by the code words, thus giving rise to a digital time division multiplex. Therefore, when we talk of a multiplex, what we mean is the merger of several data streams to form one unified data stream, which can be separated again later. Up until now, however, the signal has been missing its four audio channels, in other words its sound

16) Ziemer, "Digitales Fernsehen" ("Digital television"), 3rd edition. 2003, p. 112 *et seq.*
17) Ziemer, "Digitales Fernsehen" ("Digital television"); p. 26 *et seq.*
18) Mäusl, "Digitales Fernsehen" ("Digital television"), p. 28 *et seq.*
19) Kalhöfer, "Fernsehen: Die Produktion" ("Television: production"), in *Deutsche TV-Plattform e.V.* (ed.), "Fernsehen heute und morgen" ("Television today and tomorrow"), chapter 4.1; http://www.itu.org

data. These are also added to the unified data stream, and together this makes up the studio multiplex. With the studio multiplex we have our first simple multiplex.

3. Compression

On its own, the process of converting analogue video and sound signals in a studio context does not make digital television possible. The resulting amounts of data would be far too large for this. For them to be distributed to television viewers, they must first be compressed, which requires a considerable reduction in the data. The demands and processing of audio and video signals differ and so they are compressed separately.

a) MPEG

The Europe-wide standard for compression in the digital television field is DVB-MPEG 2,[20] – MPEG stands for "Motion Picture Expert Group". This standard, which was introduced in 1994, makes for a reduction in data-rates from over 200 Mbit/s to 2–15 Mbit/s[21] and is especially suited to the compression of video signals in today's usual resolutions. The standard contains recommendations for the reduction of both picture and sound data (source coding) and for the assemblage of picture, sound and additional data into a unified data stream (multiplexing). Since early 1999, MPEG 2's successor, MPEG 4, has also been ready to be introduced as an international standard, to which complementary standards are already being added. MPEG 4 extends the area of application of MPEG 2, which applies to the reproduction of audio-visual content by means of digital storage media (DVD) or digital broadcasting (DVB), to the whole multimedia spectrum, including, in particular, the Internet. The main focus of further development was improved compression performance, the establishment of interoperability and the incorporation of Digital Rights Management (DRM) techniques.[22]

b) Redundancy reduction

Underlying the MPEG process are various methods of data compression. In the process of redundancy reduction, information that is superfluous because it is already known is omitted. This is achieved using the differential pulse code modulation (DPCM). In contrast to normal pulse code modulation, this process no longer entails encoding a value for each sampling interval but starting from one value and encoding only the difference between it and the following data, meaning that the statistically most frequent value is "0" – i.e. no difference. Because large difference values are statistically rarer, only a part of the quantisation area is encoded, and a shorter code, using only four bits instead of eight, is possible. This leads to a substantial reduction in data. Seen in terms of the whole picture, what this means is that the existing situation is no longer totally recorded but, with ever-repeated reference to one picture, only the existing changes or movements are recorded. For a film this means that the compression and encoding of a background that remains the same in places can be largely dispensed with when broadcasting. Accordingly, this means that redundancy reduction results in a substantially greater reduction for a news programme, in which there is little movement in the background, than is the case for a sports event or an action film, in which there is a lot of movement both in the foreground and in the background.

c) Irrelevancy reduction

The process of irrelevancy reduction is based on the removal, prior to transmission, of information that lies totally beyond the viewer's or listener's perception. Because it means that the original picture cannot be fully reproduced, this process entails a loss of data. In the area of video signals a suitable means of reducing irrelevancy has proved to be the Discrete Cosine Transform (DCT). This is based on dividing the content of the picture into blocks. In view of certain deficiencies in human vision, parts of these blocks can be encoded less accurately.

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20) ETSI TR (Technical Report) 101 154 V 1.4.1, Implementation Guidelines for the use of MPEG 2 system, video and audio in Contribution Applications.

21) Ziemer, "Digitales Fernsehen" ("Digital television"), p. 248. *Deutsche TV-Plattform e.V.* (ed.) "Fernsehen Heute und Morgen" ("Television today and tomorrow"), chapter 2.

22) Koenen, "From MPEG-1 to MPEG-21: Creating an Interoperable Multimedia Infrastructure", available on: http://www.chiariglione.org/mpeg/from_mpeg-1_to_mpeg-21.htm

4. Programme stream (PS) multiplex (Mux)

The programme stream is generated during programme production and is stored on magnetic tapes or disks. It forms the basic framework into which the individual programmes can be slotted and is made up of video, audio, and additional information, along with control data. The payload data, i.e. the coded video and audio signals, make up the packeted elementary stream (PES). Added to these are the control data, which are recorded in the six-byte long packet header. The header contains data on packet length and identification. Because programme streams contain relatively long packets of 65,535 bytes, they are very prone to interference and so they are kept within the service provider's in-house environment.[23]

V. Distribution

When they are distributed, signals leave the provider's in-house environment. This requires them to be adapted to the transport mechanisms and where necessary, at this stage to be protected already from unauthorised interference. An initial decision regarding the combination of content needs to be taken because one of the major advantages of digital television is its ability to use already existing, unchanged broadcasting channels or frequency ranges not just for a single channel anymore but, depending on capacity and programme content, for six to eight channels as well as extra services.

1. Playout centre (POC)

The place where programme streams and the additional data for distribution to the transport service (and ultimately the viewer) are prepared is called the playout centre. These centres house the equipment required for encoding, multiplexing for transport data streams, modulation of data streams into the various broadcasting channels and transmission via these channels, all of which require appropriate signal adaptation.

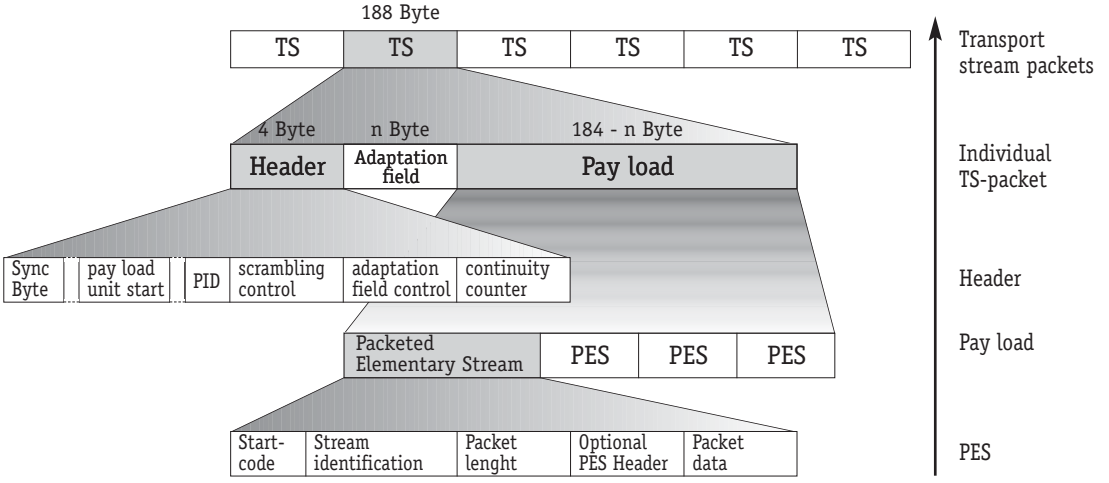
Initial access problems can arise for television companies even at this stage, if they do not have their own playout centre or, where for certain delivery mechanisms, they are obliged to use a playout centre run by a third party.

2. Transport data stream

The transport data stream is defined by the MPEG 2-standard and comprises a succession of 188-byte-long packets. Each of these contains the individual packaged elementary stream-packets of several programmes as a payload, and the accompanying control data in a four-byte long header. The first byte of the header is a sync byte for frame synchronisation, by means of which the start of each new packet can be identified. Other important components are the packet identifier (PID), which identifies the data according to channel, whether it is a video or audio signal, etc., and the adaptation field control, which refers to an adaptation field following the header with further information concerning the PES-packets. The latter includes the programme clock reference, a time stamp used to synchronise one of the programmes being transported along with it. The transport data stream is, therefore, a multiplex made up of several programmes, other services broadcast at the same time and accompanying information.

23) Mäusl, "Fernsehtechnik" ("Television technology"), 3rd edition, 2003, p. 87 *et seq*.

Structure of the Transport Stream



3. Service Information (SI)

Information about individual programmes is added to transport streams, so that programmes can be identified and located by receiving equipment. When, for instance, the transmission site of a channel is changed there is no need for the decoder to perform an automatic search through all the channels it receives. Thanks to the service information it is possible to introduce the new settings automatically. SI also makes it possible to search for channels in categories and sort them accordingly.

With digital television a much larger number of channels can be received than previously was possible with analogue television. This makes finding a channel without the relevant service information incomparably harder. Broadcasters are reliant therefore on their channels being included in service information, and on the capacity of all end-user equipment to receive such data.

4. Bit-rate management

Another of the tools that can be used in the context of the broadcasting and formation of transport-stream multiplexes is bit-rate management. Channels require different broadcasting capacities according to picture quality and the intensity of movement of content, so that, for instance, a pure news channel needs less capacity than a sports channel.

Several channels can be bundled into a single transmission channel, and within this there can be a further division of bit-rates. This makes it possible to discriminate against specific channels by refusing to allocate them a sufficient bit-rate.[24]

5. Energy dispersal

Within a data stream there can be long segments containing only zeros or ones. These regularities hamper decoding and make the data stream more prone to interference, so an attempt is made to avoid such energy peaks. The method used to do this is energy dispersal by means of scrambling and inversion. This makes the transmission process more secure.

24) Institute of European Media Law (EMR) (ed.), "Vielfalt im digitalen Rundfunk", ("Diversity in digital broadcasting") law reports, EMR publications, Vol. 20, p. 43 *et seq.*; Dörr "Der Zugang zum digitalen Kabel" ("Access to digital cable"), law reports, publications of the regional media institutes, Vol. 22, 2002, p. 90 *et seq.*

6. Encryption

Encryption forms the basis for many conditional-access services (e.g. pay-TV) and means that the data to be transmitted are changed so much by means of a cryptographic key that they are useless to anyone who does not have the key. A further area of use for encryption can be the restriction of broadcasting areas.[25]

There are different methods of encryption, meaning that this can also be an obstacle to free market access, because a piece of receiving equipment sold independently from the dominant company or platform operator is severely limited in its technical capacities (and therefore in its marketability) if it does not make it possible to receive differently encrypted programming. Proprietary systems can inhibit a horizontal market for end-user equipment. Similarly, vertically integrated market structures can make it difficult for competitors to enter the market in other parts of the production chain if access depends on an encryption system. However, the main reason why the establishment of a conditional access system is particularly conducive to a vertical market is that encryption makes it possible to tie viewers down to a particular type of set-top box. In turn, this can be a means of impeding competitors owing to a lack of interoperabiltiy.

a) Scrambling

Scrambling means that the sequence of the data stream for a programme or a service is changed in accordance with a mathematical rule. A Europe-wide standard for scrambling is applied by the DVB Common Scrambling Algorithm (CSA)[26]. Scrambling is the basis for encryption in the true sense of the word, and this is why it is mostly applied in conjunction with encryption.[27]

b) Conditional access (CA)

Conditional access means any technical measure and/or arrangement whereby access to the protected service in an intelligible form is made conditional upon prior individual authorisation.[28] This is achieved by the broadcaster encrypting the data stream, and this can happen at various levels. One possibility is for the whole transport data stream to be encrypted (and scrambled), but, alternatively, encryption can be performed on the packaged elementary stream. Decoders must contain special control data for decryption. The term CA system encompasses not just the technical process of encryption as such but also the administrative services connected with conditional access, such as the acceptance of subscribers' requests, subscription management and authorisation procedures.

aa. Entitlement control messages (ECM)

ECMs contain the keys for the decryption of data streams and are broadcast along with the transport stream. Encrypted ECMs must be continually broadcast with data streams, because the key is regularly changed at short intervals to ensure that the code remains secure.[29]

bb. Entitlement management messages (EMM)

EMMs are the means by which access rights are allocated to viewers. EMMs contain data about subscribers and their entitlement status. ECMs can be decrypted by means of control words transmitted by EMMs. EMMs also form part of transport data streams but they are not broadcast continuously[30].

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25) Report from the Commission to the Council, the European Parliament and the European Economic and Social Committee on the implementation of Directive 98/84/EC of the European Parliament and of the Council of 20 November 1998 on the legal protection of services based on, and consisting of, conditional access, COM (2003) 198 final, p. 5 *et seq.*

26) http://www.dvb.org/index.php?id=50&sid=4 ; ETSI Ref ETR 289.

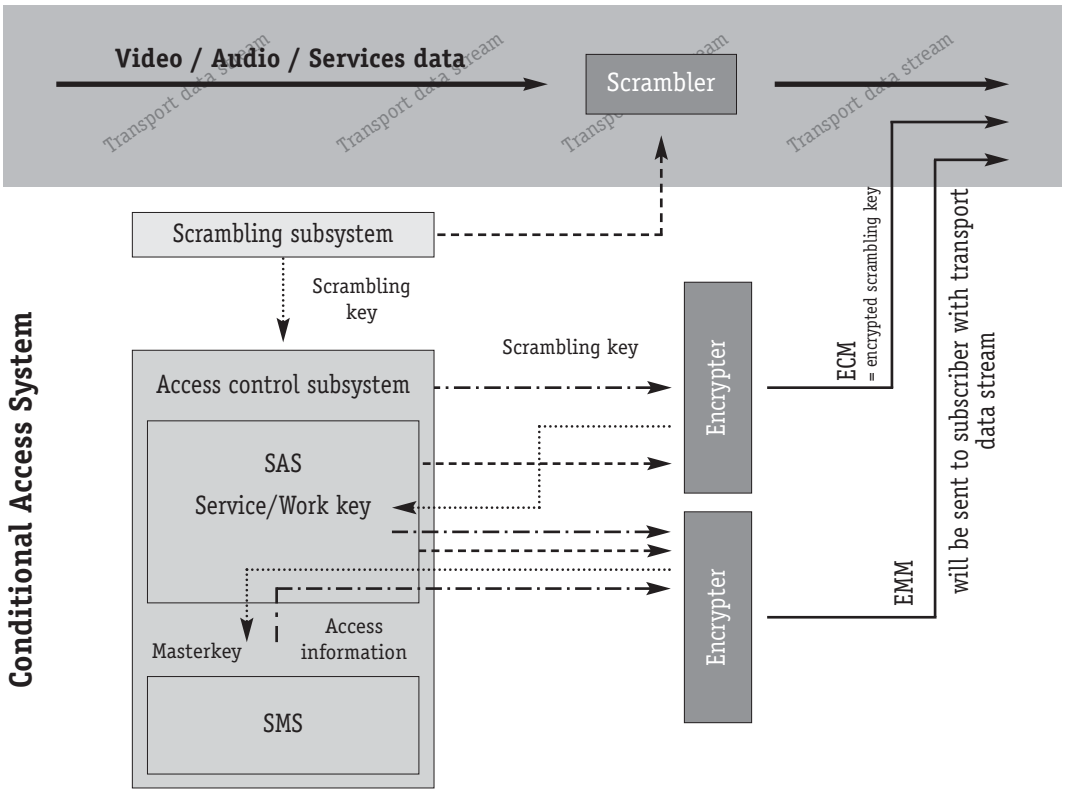
27) Pfitzmann, "Anforderungen an die gesetzliche Regulierung zum Schutz digitaler Inhalte unter Berücksichtigung der Effektivität von technischen Schutzmechanismen" ("Demands on the statutory regulation for the protection of digital content in view of the effectiveness of technical protection mechanisms"), report commissioned by the German Multimedia Association (*DMMV*), p. 23 *et seq.*

28) Directive 98/84/EC on the legal protection of services based on, or consisting of, conditional access, Article 2(b).

29) Namba, "Technologies and Services on Digital Broadcasting (6) – Scrambling (Conditional Access System)", available on http://www.nhk.or.jp/strl/publica/bt/en/le0012.pdf

30) http://www.tele.ucl.ac.be/CAS/systems/cryptoworks.html

Encryption

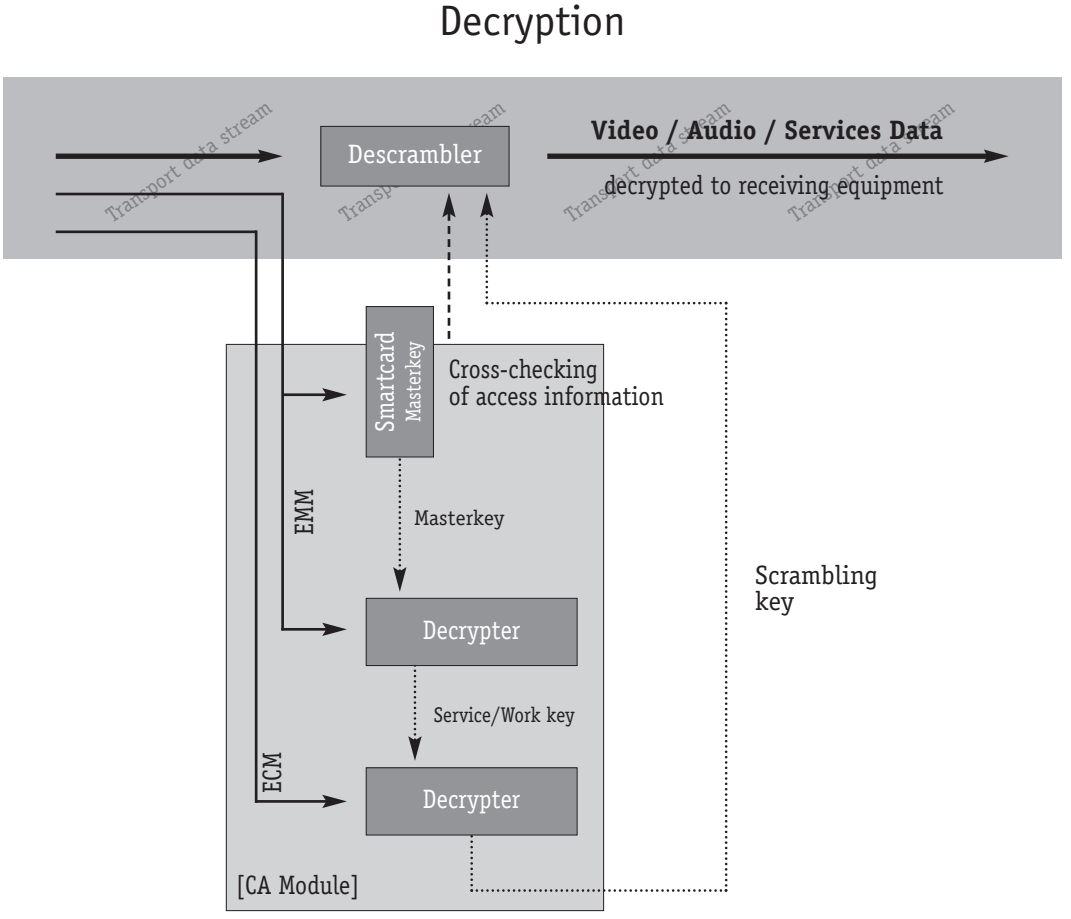


cc. Subscriber Management System (SMS)

The subscriber management system is a part of the conditional-access system; it manages viewer data and calls up entitlement management messages (EMMs) from the subscriber authorisation system. If, for instance, no payments are received from a particular subscriber, then his entitlement to decrypt programmes by means of the EMM can be withdrawn.

dd. Subscriber authorisation system (SAS)

The subscriber authorisation system establishes the EMM at the request of the subscriber management system. It ensures, in addition to this, that subscribers obtain the authorisations they require to view programmes. It is also a part of the conditional access system.



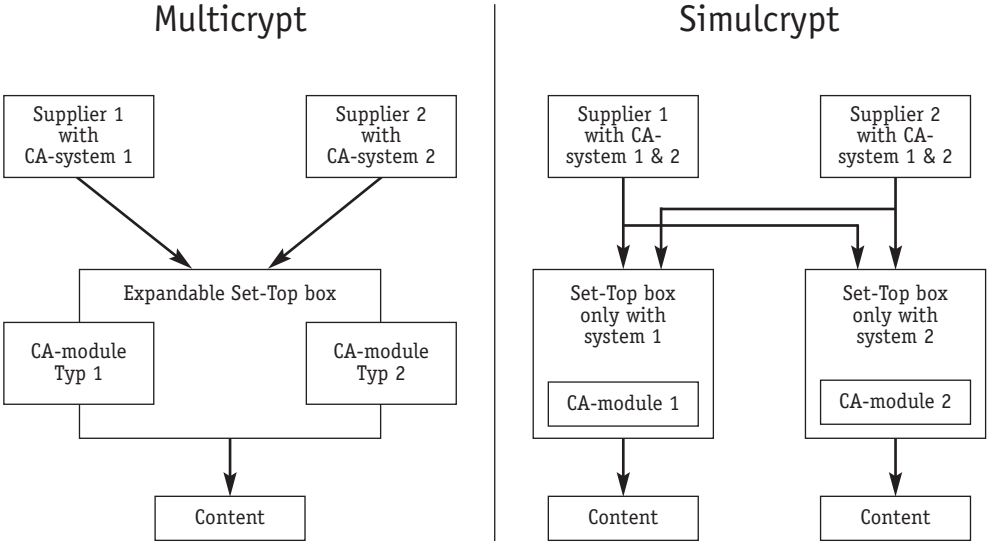
c) Simulcrypt and multicrypt

To make decoders more universally usable, two processes were established under the DVB standardisation system, simulcrypt and multicrypt.[31] Simulcrypt means that several encryption variants or the CA passwords for several CA systems are broadcast simultaneously, so that if the viewer has only one of the encryption systems used, he can still decrypt the signal without having to buy a second decoder. The advantage of this method is that it involves very little expense for the viewer; on the other hand, however, it does mean more expense for the broadcaster. As regards security, simulcrypt has the drawback that it is sufficient to crack the most vulnerable encryption system and so the degree of security is determined by the weakest link in the chain.

With the multicrypt system, on the other hand, the ability to take advantage of various, differently-encrypted services is built into the set-top box itself. Channels are transmitted using only one individual encryption system at a time. To be able to watch a channel, the viewer needs the decryption system pertaining to that particular channel. If the set-top box contains only one fixed decryption module, then the viewer will have to buy a new set-top box for each further channel that uses an encryption system different to that of the channel he has received thus far. The idea behind the multicrypt process is to make the CA-module in the set-top box interchangeable or make it possible to use several CA-modules in the set-top box, so that set-top boxes need only be expanded or only a single part has to be changed. Implementing a Common Interface (CI) presupposes, however, that set-top boxes have the necessary room for expansion – and this has not generally been the case up until now — otherwise customers will indeed be forced to acquire another set-top box.

31) See also http://www.dvb.org/index.php?id=50

There have been attempts to make multicrypt a legally binding standard. In mid-2001, Austria had been considering applying relevant restrictive regulations to set-top box interfaces, but the idea was dropped as a consequence of the agreement concluded between the ORF and the Kirch Group over the use of the d-box.[32] In Spain, Law 17/1997 provided that all decoders must be open[33]. Article 2 of Decree 136/1997 made it compulsory for operators to register conditional access services.[34] Registration could be refused if the equipment being sold, which also had to be specified in the application, did not comply with certain technical specifications. However, in a preliminary ruling, the Court of Justice of the European Communities found this prior authorisation scheme to be unjustified[35].



d) Transcontrol

The term transcontrol describes a series of technical processes by means of which the administration of a CA system can be passed on from one operator to another.[36] Since most CA systems operate using the DVB common scrambling algorithm, it is usually enough to exchange the ECM and the EMM. There is no need to change the encryption of MPEG data. However, in order to make these changes, it is necessary to have one's own subscriber management system (SMS) and subscriber authorisation system (SAS). It is also possible, without changing the encryption, to monitor the group of people entitled to receive programmes by entering the EMM. In this case the CA system remains the same. The CA system must make transcontrol possible, allowing the possibility for full control by network operators at local or regional level of the services using such conditional access systems.[37] Transcontrol processes can no longer be used, however, once unbundling or repackaging takes place. At this point the transport stream is broken up and reconstituted. This causes a change in the scrambling process, so that it is no longer possible to pass on the encryption system.

32) Roßnagel/Sosalla/Kleist, "Der Zugang zur Digitalen Satellitenverbreitung" ("Access to digital satellite distribution"), EMR report commissioned by the Joint Office for Digital Access (*GSDZ*), sub-paragraph *3.4.1.2.1.2,* p. 133, http://www.emr-sb.de

33) IRIS 1997–9: 9 [ES–] The Spanish Government modifies the Digital TV Law.

34) Roßnagel/Sosalla/Kleist, "Der Zugang zur Digitalen Satellitenverbreitung" ("Access to digital satellite distribution"), EMR report commissioned by the *GSDZ*, sub-paragraph *3.4.1.4.1.2, p. 139 et seq.*

35) ECJ, C-390/99, Judgment of 22 January 2002, Canal Satélite Digital SL/Administracíon General del Estado.

36) Communication from the European Commission "The Development of the Market for Digital Television in the European Union" COM (1999) 540 final, p. 24. Available on http://europa.eu.int/comm/information_society/policy/telecom/digtv/pdf/dtv_en.pdf

37) Directive 2002/19/EC of the European Parliament and Council of 7 March 2002 on access to, and interconnection of, electronic communications networks and associated facilities (Access Directive), Annex I, Part I (a).

VI. Means of conveyance

Means of conveyance are one of the most important points to look at when considering the technical make-up of digital television.

Even though there are many methods available, it goes without saying that means of conveyance are a key means of access to the market. And the cause of this is not least that for technical reasons (development and exploitation) and legal reasons (rules pertaining to housing rental), the various means of distribution are not available everywhere or to the same extent.

1. Network structures

Within means of conveyance the structure of each network can vary. Below we will deal only with the different structures of networks imaginable (in particular cable networks), which can take the form of a tree, a web or a circle. More significance should be attached to the layout of a network, which determines whether point-to-point and/or point-to-multipoint connections are supported. Point-to-multipoint connections mean that all the points to which a single point is connected via branches can be reached simultaneously. This structure is suitable for the distribution of content destined for the general public. Point-to-point connections on the other hand make it possible to distribute content to individual viewers. Thus content can be sent to a single point or person.

2. Cable

The term cable (television) networks describes the means used to distribute TV and radio broadcasts by means of broadband cables (copper or fibre-optic cables) laid in the ground. This means of delivery has the advantage that neither local conditions nor the weather can affect the quality of the signal. Basically, the same frequencies are used as for terrestrial delivery except that they are occupied somewhat differently. However, the range of frequencies available is broader because, in the terrestrial sphere, certain resources are reserved for other purposes (emergency services, military uses, aircraft control, etc.). The transmission standard for digital cable television is determined by the DVB-C standard laid down by the DVB[38].

One of the particular features of cable networks is the fact that the operators of each local network (at network levels 3 and 4) can assemble individual channels to which they have access into new packages at their cable head ends. They can also add their own services at this point. Cable head ends are the repeater stations where operators feed programmes and services into the cable network.

The capacity of a cable network depends on its state of development. A fully developed cable network has more than 800 MHz of bandwidth at its disposal, which, with an 8 MHz channel raster gives us around 100 channels. Data rates depend on the way in which the digital signals are modulated. A 64-QAM modulation results in a data rate for payload data of around 38 Mbit/s per channel. The theoretical capacity of a cable system can now be calculated if we apply a rate of 4 Mbit/s for the video and audio data stream of an average programme. 100 channels times 38 Mbit/s per channel, divided by 4 Mbit/s per programme results in about 1000 programmes.[39] This gives us an idea of the heights to which technical possibilities and numbers of programmes could climb once a complete changeover to digital technology has been effected. Cable networks have enormous development potential, particularly as they also allow two-way communication.

In the debate over access problems, the first significant point is that in the final analysis, network level 3 cable operators (and network level 4 operators who still remain separate, as in Germany) always seem to end-users to have a monopoly, because end-users generally have no choice of supplier unless they switch to one of the other means of delivery. Secondly, specific

38) ETSI EN 300 429.
39) Ziemer, "Digitales Fernsehen" ("Digital television"), p. 113.

problems may arise depending on the payment arrangements for cable use. For analogue television in Germany, for instance, the arrangement still follows the transport model, i.e. network operators collect connection fees and transmission costs for the use of their channels.[40]It is to be expected though that with individual marketing strategies, models such as revenue-sharing or reselling will be adopted. Under the revenue-sharing system, network operators put their services at the broadcasters' disposal and take a share in the ultimate profits. Under the reselling system, cable network operators purchase channels, make up their own packages and market them independently. This gives them far-reaching organisational possibilities, which are not without some influence on the market access of the various other market players.[41]

3. Satellite

The greatest advances in the development of digital television so far have occurred in satellite television[42]. The features of satellites such as orbital positions and broadcasting frequencies, transmitting power, supply areas, etc. are governed at international level by the World Radio Conference. In Europe, the broadcasting standard for digital satellite television is DVB-S.[43] From a technical viewpoint, satellites function in principle like a combination of a mirror and a booster, sending what they receive (the uplink) back down to earth (the downlink). In this process, signals are distributed to individual transponders, with a bandwidth ranging from 26-72 MHz, although most have 36 MHz. Since the bandwidth of a digital programme varies according to quality and scope between 4 and 6 MHz, about five or six digital programmes can be broadcast on each transponder. Since the satellite cannot broadcast a signal back on the same frequency that it received it on, it performs another modulation into a different frequency range. Satellite transmission is prone to more interference than cable transmission and so larger channel bandwidths are used. Depending on the number of transponders they contain, satellites can also achieve a high broadcasting capacity. Using DVB-RCS, both SES Astra and Eutelsat offer the technical potential for a return channel, which can be developed further.

One of the drawbacks of satellite is that the viewer's satellite dish has to be directed very accurately and so, as a rule, each dish can receive signals from only one or two satellites at a time. This means that the customer is either bound to one satellite and the channels broadcast by it or he has to go to the disproportionate expense of arranging to switch between satellites. This also hampers competition between different satellite platforms. Because satellites function as the feeds for cable head ends, the arrangement of the economic and legal situation of satellite broadcasting also affects access to cable transmission.

4. Terrestrial broadcasting

Terrestrial broadcasting (*terrestris* (Lat.) = pertaining to the earth) is based on the distribution of broadcast signals via earth-bound transmitters, which are located in suitable places such as mountain-tops or telecommunications towers. In Europe, digital terrestrial television is governed by the DVB-T standard.[44] Problems in establishing digital terrestrial services are caused by the shortage of frequencies available. This makes it difficult to arrange a simulcasting stage, that is to say a period of simultaneous analogue and digital transmission. To avoid a total and abrupt switch-off of analogue television, the changeover in Germany, for example, is to be carried out progressively in separate geographical areas (referred to as "islands"). However, a blanket changeover would have the advantage that it would be possible to increase frequency-use considerably by introducing a single frequency network (SFN). With analogue broadcasting techniques one programme requires several delivery channels because of the overlapping of transmitter stations, but with this system only one channel will be needed.

40) Hein/Schmidt "Entgelte für die Übertragung von Rundfunksignalen über das Breitbandkabel" ("Payment for the delivery of radio and TV signals via broadband cables"), in *K&R* 2002, p. 409 et seq.
41) Dörr, "Der Zugang zum digitalen Kabel" ("Access to digital cable"), p. 74 et seq.
42) Ziemer, "Digitales Fernsehen" ("Digital television"), p. 114 et seq.; Reimers, in *Deutsche TV Plattform* (ed.), „Digitales Fernsehen heute und morgen" ("Digital television today and tomorrow"); chapter 5.1.
43) ETS 300 421.
44) ETSI EN 300 744.

DVB-T also improves reception quality through its in-built error-correction processes. Reception remains consistently good right up to the edge of the reception area. One of the drawbacks of terrestrial broadcasting is that it is impossible to organise a return channel via the same means. Therefore there would always be the need for a hybrid system using the telephone network for example. Another disadvantage of terrestrial broadcasting is that even after the changeover, frequencies will be in short supply, because terrestrial services offer fewer transmission channels than cable and satellite. Moreover, only four television programmes can be broadcast over a terrestrial transmission channel. In Germany for instance, there will probably only be room for 30 programmes in the final development stage.[45]

In the meantime the situation has arisen that all the delivery mechanisms are frequently in direct competition with one another. It has to be said though that terrestrial broadcasting is practically the only means that permits mobile use and this ensures that there will be a certain niche in the market for it. Other technically feasible delivery mechanisms such as power line, Wireless Local Loop (WLL) or UMTS, possibly in conjunction with WLAN, that is to say using radio-based data transmission, have not (yet) been successfully placed on the market. Other existing processes generally cover too limited a range.

5. Internet

A means of transmitting digital television that is rarely used at the moment but has great potential is the Internet. Transmission capacity is still too small to give blanket coverage, as many end-users use telephone modems or *ISDN* access. However there is a recognisable trend towards broadband access, which will bring the necessary boost in capacity. At a transmission rate of 1 Mbit/s, video data can already be delivered in VHS-quality under the MPEG IV standard, so the road from "postage-stamp" television to genuine television viewing over the Internet does not seem quite so long any more. Via satellite, Eutelsat and SES Astra already offer IP connections that would have sufficient capacity, mostly for company networks.

A fundamental problem with the capacity of the Internet is caused by its point-to-point structure, in which data packets are sent to their individual recipients via various routers.[46] A router is a network component that uses the addresses of data packets to determine their subsequent path through the net. It is used to link up several sub-nets. Large data savings would result from the spread of multicast-capable routers, which would make it possible simply to pass on the data called up to the last router, which would then distribute it to the end-users. With unicast, the data would have to be sent out every time they were called up, placing a considerable extra burden on delivery mechanisms. The transmission of the various communication forms and techniques such as digital television (DVB), DAB and 3G mobile services over a multi-platform datacasting environment by the use of the Internet Protocol is called IP-datacasting.[47]

6. Various levels of picture and sound quality / High definition (HD)

For all the DVB standards for each means of transmission, it can be said in summary that they can support the various types of picture and sound quality. This relates in particular to limited definition (LD), standard definition (SD), enhanced definition (ED) and the long- and much-discussed high definition (HD). As regards sound quality, there are the options of mono, stereo, surround and multichannel sound. While LD achieves about the reproduction quality of a video

45) Digital Fernsehen "DVB-T – Digital Fernsehen über Antenne" ("DVB-T – Digitial television via an aerial"), available on http://www.digitalfernsehen.de/Home/14000

46) The data rate for a film delivered in VHS quality – after MPEG 4-compression – comes to about 150 kilobytes per second. A precise, universally applicable figure for data volume cannot actually be determined though, because the quality of the films to be transmitted varies and VHS is a comparatively low standard. Even if we assume that for an hour's-worth of film, an average figure of somewhere between 0.5 to 2 gigabytes will be required, it becomes quite clear how high the accumulated data volume is.

47) Communication from the Commission on barriers to widespread access to new services and applications of the information society through open platforms in digital television and third generation mobile communications, COM (2003) 410 final, p. 14.

recorder, HD produces real high-resolution pictures. When referring to television pictures, we talk of HDTV when there is a resolution of over 700 lines vertically by over 1000 pixels horizontally. The picture comes in the 16:9 format.[48] In Europe, there has been hardly any progress towards HDTV because the existing television system was considered satisfactory. However, it may be beneficial to introduce HDTV resolution for accompanying text-based services, because it would improve technical possibilities in this area.[49]

VII. Packaging

TV channels are compiled into packages depending on navigation methods, access categories and broadcasting areas. This may take place in a playout centre or as part of a so-called repackaging process at a cable head end before their entry into a cable network. Packages are marketed by the broadcasters or the network operators accordingly. Packages of programmes and services that are distributed under one programme operator are sometimes described as bouquets. These packages are not necessarily identical with the technical multiplex. Packages can be spread over several channels and multiplexes, and are determined not by technical links but by the content of programmes and services.

Being allocated to an unattractive package can therefore have a really discriminatory effect on an individual service provider, just as the withdrawal of an attractive individual channel can considerably diminish the worth of a package. On the other hand, major programme makers, who may market their package together with their own proprietary technology, have no interest in adopting competing channels from outside, covering only specialist subject areas. Other obstacles arise where a service provider only offers his specialist packages (sports or film channels) together with a basic package. A person who is interested in one of these specialist packages can no longer be reached by further providers of basic packages. Furthermore, because additional packages can be offered at cheaper rates owing to the income from the basic package, providers of lone specialist channels or packages have a particularly hard time. . Much more interest is shown in taking on competing channels with an already -established audience base, adding to the attractiveness of a package.

At this point we can also see the drawback for the consumer, who is constantly obliged, through the practice of "bundling", to receive whole "bundles", instead of choosing a channel that interests him and receiving it individually. Bundling also means that a service or product, in this case a television channel, is compulsorily combined with the purchase of other services or products. Individual purchases are impossible.[50]

VIII. Signal processing

Conventional televisions require analogue signals to produce pictures and since they cannot restore transport data streams, a decoding device called a digital-analogue converter is required.

1. Set-Top-Box

The device required for the reception of digital television is the set-top box. Outwardly this appears to be a device like the already well-known satellite receiver, which is connected to the television at the same point in the chain. The set-top box got its name from its customary position on top of the TV set – it is also referred to as the integrated receiver decoder (IRD). Its main task is to decompress and decode the data stream so that a normal AV signal can be sent

48) Ziemer, "Digitales Fernsehen" ("Digital television"), p. 296.
49) OXERA, "Study on Interoperability, Service Diversity and Business Models in Digital Broadcasting Markets – Executive Summary", p. 7.
50) Publication by OFTEL, "Bundling in the pay television market", available on http://www.oftel.gov.uk/publications/1995_98/broadcasting/itc1297.htm

to the television. However, all the hardware for all the other possible functions of digital television is also located in the set-top box. It should also be mentioned that the functions of the set-top box can be integrated into a television. In this case the television is called an integrated (digital) television set (i(D)TV). To produce an AV signal (analogue audio/visual signal) that the television set understands, the whole process of digitisation, compression and encryption must be performed in reverse order. This begins with the demodulation of high frequency signals into a digital stream. Subsequently, the transport stream multiplex has to be broken down into its constituent parts by the demultiplexer. The instructions required to classify the individual data packets are provided by the packet header, which is generally uncoded. The MPEG 2 decoder then decompresses the requisite audio and video signals or makes the additional services available. Depending on whether access to the content is conditional or not, the data stream might then need to be decrypted. For this purpose a set-top box that is capable of this process contains a permanently embedded or exchangeable CA module. To reverse the scrambling process, the box contains a descrambler. Applications are controlled by the Application Programming Interface (API), which serves as middleware between the hard- and software. This is also the source of interactive applications, which are also controlled by the set-top box.

Because digital television was mostly developed by pay-TV operators who immediately offered customers a suitable set-top box, the set-top boxes developed initially were not compatible with one another. Because of efforts to create an open market, there have been increasing calls in more recent times for set-top boxes to be rendered interoperable.

The use of non-interoperable set-top boxes makes it possible, in practice at least, for a company to keep programme and service providers working outside its vertically integrated sales structure away from its own customer-base. If the proprietary set-top box has already secured a large market share, this can even completely block access to the market or force other operators to place themselves in a technically-dependent relationship. Further suppliers of set-top boxes are also dependent where it comes to the licensing of their set-top boxes – a situation which can also be compared to a market-access restriction. The key elements in such a procedure are the API and the conditional access system used and, in addition to this, the arrangement of the hardware in the set-top box, which can be laid out in such a manner that it cannot deal with other systems. Growth in the market share of conditional access services can be reined in provided that there has been a broad-ranging distribution of so-called free-to-air boxes. This is not the result of the use of proprietary standards or anything of that nature; it is based on the fact that these free-to-air boxes do not have any decryption equipment. If, as in Germany, there is a very large supply of free-to-air programmes and services, then there will be no incentive to acquire new and expensive machines, even if they are capable of decryption. This leaves the aforementioned conditional access services with a large untapped source of customers – a situation that can make them almost non-viable.

Different types of set-top boxes

A basic distinction has to be made between the various types of set-top boxes. Firstly, up until now, each different delivery mechanism (terrestrial, satellite, cable) has required its own set-top box according to the transmission standard (DVB-T, DVB-S and DVB-C) and the way in which this standard is modulated. A second distinction can be made in terms of the technical equipment built into the box, particularly in relation to CA systems, because this determines what it can and cannot receive.

a) Free-to-air box

Free-to-air boxes are the simplest model, because they have no means of deciphering encrypted programmes that are not generally available. They can only receive free-to-air channels and the accompanying services.

b) Boxes with embedded CA

Embedded CA means that the equipment for the decryption of channels that are not generally accessible is already permanently built into the set-top box. This means that this type of set-top box is limited to a particular type of encryption technology and cannot be used for channels that are encrypted in a different way. However, all that is required in order to change between

operators using the same encryption technology is a new smart card. Nevertheless, an embedded CAM does not rule out the installation of a common interface (CI), meaning that mixed models are also possible.[51]

c) Boxes with CI (common interfaces)

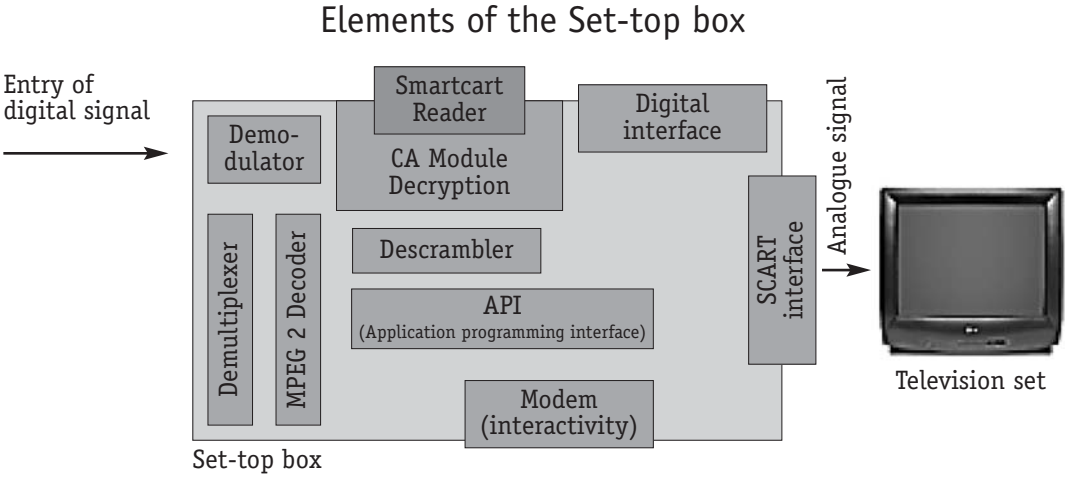
Boxes with a common interface, a standardised slot, have the greatest potential because the CI makes it possible to connect various decryption modules to the machine. One or more CIs can also be installed alongside an embedded module. This means that separate modules have to be acquired for different encryption technologies but it is no longer necessary to buy a new set-top box.

d) Integration into a television set

It is still rare but entirely possible to build the functions of a set-top box directly into a television set.

e) Integration into a PC

The functions of a set-top box can also be performed easily by a conventional PC fitted with a digital TV card. PCs already contain most of the necessary components and because they are designed to process digital media formats, they are the perfect starting point. The TV card merely has to contain a tuner and a demultiplexer for the appropriate transmission format. By combining a modem for the return channel and a DVB card, it is also possible to establish a high-quality Internet connection. Depending on whether the decoding of the MPEG data stream is performed by the hardware (i.e. the card) or the software (using the PC and its software), older PCs with a 200 MHz or 600 MHz processor are sufficient. In view of the growing orientation of PCs towards multimedia applications and the spread of increasingly large screens, the conversion of PCs into media-boxes represents a genuine alternative.[52] The only major difference is the differing use patterns and the different locations of PCs and television sets in the house.



51) Roßnagel/Sosalla/Kleist, "Der Zugang zur Digitalen Satellitenverbreitung" ("Access to digital satellite broadcasting"), EMR report commissioned by the *GSDZ*, sub-paragraph 2.1.4. p. 19, http://www.emr-sb.de

52) Ziemer, "Digitales Fernsehen" ("Digital television"), p. 252 *et seq*.

2. API (Application Programming Interface)

The Application Programming Interface (API) is a key component of the set-top box. It constitutes the link to the set-top box's operating software, on which the application programmes are based. The API is also used to decouple the application software from the specific features of the hardware. Because the hardware in set-top boxes may be made by many different manufacturers and because the technical implementation of a process, such as the displaying of information on a television screen, largely depends on the technical details of this hardware, a programmer working without an API would have to look thoroughly into the technical workings of the hardware and the operating software which manages the hardware resources in each set-top box. He is spared this task by the API, which contains the appropriate commands for the requisite technical procedures with which the application can work without having to concern itself with the actual carrying out of the command by the hardware subsequently. Because the API acts as an intermediate software programme providing the link between soft- and hardware, it is also referred to as middleware. An interface is basically the connection point between two different systems.[53] The API translates, as it were, the language of the application programmes into the language used by the hardware in the set-top box. Incidentally, the software that controls and manages the communication between individual hardware components is called the operating software. A legal definition of the API can be found in Article 2, para. (p) of EC Directive 2002/21/EC but this focuses only on its function as an interface between software distributed by broadcasters or service providers and the set-top box connectors.

Because the API is the software-platform for all subsequent applications, a proprietary API can be used to turn the set-top box into a means of restricting access. If the technical data for the API are kept secret, software developers will not be able to provide any suitable applications, and these will remain incompatible.

a) Developer suite

So that suitable applications can be developed for a particular API, the API manufacturer needs information to be made available about the API, such as the functions on offer, and a developer suite. The latter provides developers with the tools with which these applications can be programmed. In a way, the developer suite unveils the language for the development of the API.

The manufacturer generally demands a licence fee for access to the developer suite. The higher the licence fee and the less the manufacturer is actually prepared to provide access, the more this can prevent applications suppliers from reaching the customers who use these APIs.

b) Examples of APIs commonly used in Europe

In Europe a whole range of APIs have been developed in co-operation with service providers and network operators; they are based on differing concepts in regard to providing access to other users.

aa. OpenTV

OpenTV is a company whose majority shareholder is the Liberty Media Corporation. Its eponymous API is an entirely open platform, which has spread very widely. Users include BSkyB, TPS and Noos in France, PrimaCom in Germany and Via Digital in Spain. The OpenTV-MHP[54] package is supposed to make MHP compatible as well.[55]

bb. Mediahighway

Mediahighway is a development by Canal+ Technologies, which is also open to all applications developers. Mediahighway can also be adapted for MHP applications using a developer suite called the Mediahighway Development Kit. According to its own estimates[56], Mediahighway is

53) Brockhaus multimedia encyclopedia, 2002.
54) MHP stands for the standard "Multimedia Home Platform", see *infra* at VIII 2.c.
55) http://www.opentv.com
56) http:www.canalplus-technologies.com/de/media/v26/html/press/prel_mhcommunity.htm

used as middleware in around 14.5 million set-top boxes. Customers include Canal Satellite and more than thirty other digital platform operators and service providers. Its shareholders are Sun Microsystems, Sony, Sogecable and Thomson Multimedia, which is the majority shareholder.

cc. Betanova

Betanova is the API developed by BetaResearch for dbox (2), which is supplied by the Pay-TV operator, Premiere, in Germany and Austria. Betanova is a perfect example of a proprietary API in a vertical market structure. In Germany the dbox is still the most common type of set-top box, with 2.5 million users. Software is now ready for the migration to MHP, but it has not been brought onto the market.

c) A digression: MHP

In 1997, in order to solve the problem of the obstacles to access associated with the various non-interoperable APIs, the DVB Group began development of a single, open standard, which was adopted in July 2000 by the European Telecommunications Standards Institute, ETSI.[57] The European Commission then adopted these standards in accordance with Article 17 of Directive 2002/21/EC (Framework Directive), in the "List of standards and/or specifications for electronic communications networks, services and associated facilities and services".[58] Under Article 18 of the Framework Directive, Member States must now encourage the use of an open API by (1) all providers of digital interactive television services and (2) all providers of enhanced digital TV equipment.[59]

The result of this development work by the DVB Group was the Multimedia Home Platform, MHP. The goal of MHP is to make it possible to reconstitute every service and programme on offer using a set-top box. This is why the MHP API does not rely on any integrated hardware and has its technical roots in the Java technology developed by Sun. The MHP standard has been subdivided into three profiles, which are applied according to requirements. The simplest profile is enhanced broadcasting, which covers additional services on top of programme reception. Interactive broadcasting goes beyond this in that it makes interactive services possible through the incorporation of a return channel. This allows interactive games, telebanking, teleshopping and distance learning. The final profile includes Internet access and makes it possible to process html documents.

Migration

The APIs that are still currently available and the corresponding set-top boxes should, through the further development of their operating software and the APIs of the set-top boxes and as far as the hardware permits, be made MHP-compatible, so that older set-top boxes do not become worthless.

Through the dissemination of MHP a platform will be established on which free competition with regard to set-top boxes and all the accompanying services can be developed.

However, despite the great hopes placed in MHP, the current state of progress seems to point towards failure. Although various API manufacturers have already moved in the direction of MHP compatibility, overall willingness to invest in MHP seems to have waned.

d) Re-authoring

An alternative to migration to a uniform standard, albeit not a particularly attractive one from the service provider's viewpoint, is re-authoring. This means that the producers of services adapt their services accordingly once the API applications have been divulged. Special software exists for this, which translates the applications for the different APIs. Therefore, instead of a

57) TS 101 812; http://www.mhp.org
58) O.J. EC No. C 331 of 31 December 2002.
59) Communication from the European Commission (2003) 410 final, p. 17.

uniform standard there are still a multitude of various APIs. Every API has its own version of the application software manufactured for it. This can provide a limited form of inter-operability.[60]

The costs and expenses for service providers are quite considerable though, meaning that the process will tend to prevent them from developing new services. Not least it must be taken into account that the full functionality of all applications is maintained because only the re-authoring of those functions that exist for all API versions is possible.

3. Basic navigator

A basic application found in every set-top box and generally installed by the manufacturer is the basic navigator, which uses the service information (SI) to produce a list from which channels can be chosen. Because digital television will offer a considerably larger number of channels than analogue did, the basic navigator will be needed to find channels, as finding channels by means of programmed numbers would be too complicated.

Operators also have a number of options when it comes to the organisation of the basic navigator. Firstly, the basic navigator determines the position of a channel on the list, for example right at the end, and, secondly, where the relevant service information is not compatible, it may not list certain channels at all, thus making such channels practically impossible to find and view using the relevant set-top box, despite their technical availability.

A topical example of the potential conflict that may arise in connection with the positioning of a channel is the recently settled dispute between BSkyB and the BBC over the positioning of the BBC's channels, after the BBC had decided that it wanted to broadcast its channels in the clear in future and hence terminate its payments to BSkyB's service company for these services. The complaint filed by the BBC with the ITC makes it quite clear how much significance was attributed to the channel numbers 101 and 102 and the need to keep them.[61]

IX. Decryption

Because a not inconsiderable proportion of digital programmes – and not just pay TV – are encrypted, the capacity of the receiving equipment to decrypt these signals is an important aspect.

1. Conditional access module

The main building block for the decryption of programmes and services that form the basis for a CA system is the CA module. This can be permanently installed in the set-top box (as an embedded CA) or else be interchanged or inserted later. The CA module decrypts the entitlement control messages (ECMs) broadcast along with the programme or service using the keys communicated by the EMM; the ECMs can then be used to unscramble the data stream.

Because various providers have developed different encryption processes, the module required will be the one pertaining to the system used to encrypt the desired programme. If simulcrypt is used, the programme will be broadcast in several different encryptions and only one module will be needed. If the multicrypt process is adopted, several modules may be necessary.

If a service provider uses a proprietary CA system, then he can use an embedded CA module to exclude manufacturers who have not made the effort to get a licence to install the embedded CA in their boxes.

60) Commission staff working document available on http://europa.eu.int/information_society/topics/telecoms/regulatory/publiconsult/documents/211_29_en.pdf
61) Press release available on http://www.bbc.co.uk/pressoffice/pressreleases/stories/2003/06_june/13/dsat_statement.shtml

2. Smart card

The smart card is a small, programmable card, which carries its own integrated circuit and stores and processes information. Where there is a CA system, it is used to identify subscribers, and contains their details and access entitlements. All subscribers receive a smart card made specially for them from the other party to the contract. They then insert this card in the slot provided for it in the CA module. The EMMs are then forwarded to the smart card and compared by it. If the subscriber has an entitlement, the key sent in the ECM is passed on and the CA module can decrypt the signal. The smart card therefore acts somewhat like an activating key for the CA module.

3. Common interface (CI)

The CI is an interface for the insertion of CA modules and has been standardised by the DVB group.[62] It takes the form of a slot for a PCMCIA card like those that are used with personal computers (PCMCIA stands for Personal Computer Memory Card International Association). The PCMCIA card contains the decryption module for the respective CA system provider. Even in this form, the CA module must first be given authorisation by the service provider's smart card. For this purpose the smart card can be inserted into the PCMCIA card.

The spread of set-top boxes equipped with common interfaces tends to promote the use of the multicrypt process. The advantage of set-top boxes with one or more CIs is that they can be used for various encrypted packages that are not predetermined by the type of set-top box purchased. From a market point of view, the CI increases the interoperability of set-top boxes and opens up the market by making it unnecessary for the set-top box to be tied to a particular CA system.

X. Services

One of the major innovations of digital television is that it has the technical capacity to provide accompanying services using conventional television transmission systems. Interactive services comprise all processes by which either the viewer calls up specific information direct from the broadcaster, influences the programme, or else, in so far as is technically feasible, exchanges information over broadcasting channels, in other words communicates his desires, decisions or commands over the return channel and takes part in events in this way.[63] Services that are based on an interactive entertainment, information or communication system, in which it is possible for the viewer to pick out one of a particular range of electronic services, are also called service-on-demand.

Accompanying services are of significance in the discussion of obstacles to access when service providers, in so far as they are not the broadcasters themselves, do not broadcast their own programmes and do not have their own access to means of delivery. Therefore they must rely on finding network operators or package providers who are willing to incorporate their service comprehensively into the relevant system or bouquet.

1. EPG

From a technical point of view, the electronic programme guide (EPG) is an application programme that is based on the API in the set-top box.[64] For the EPG to work, it has to be interoperable with the API and so it has to "speak its language".

The EPG is an especially important player on the digital television scene. It contains real-time information, which is more comprehensive than that of the basic navigator, on the current

62) EN 50201; TS 101699.
63) *Deutsche TV-Plattform e.V.* (ed.), "Fernsehen heute und morgen" ("Television today and tomorrow"), chapter 2.1.
64) "Position des VPRT zur Umsetzung des Telekom-Pakets in deutsches Recht" ("Position of the Private Sector Broadcasting and Telecommunications Association (*VPRT*) on the transposition of the "Telekom package" into German law"), p. 2; available on http://www.vprt.de/dateien/pp_telekompaket_281002.pdf

and future programmes of the broadcasters it covers. Using the EPG, viewers can request background and additional information about programmes. It may also contain video sequences and pictures. The contents conveyed by the EPG are broadcast along with the programmes. What channels it covers depends on the supplier of the EPG

The distinction between the basic navigator and the EPG is frequently overlooked. In addition, the EPG may sometimes take over the function of the basic navigator when the programmes can be controlled only by an EPG, for instance one distributed by a network operator.

EPG suppliers

An EPG supplier may also be the supplier of a particular package. Of course the supplier will give precedence to information about his own package and, then in turn, about other closely-related channels. The EPG also serves to make it clear that the individual channels in a package belong together.

However, the EPG can also be provided separately from a specific package as a digitally broadcast supplement to a printed programme guide. The EPG can then function as a user interface for the channels covered, working as a combination of a browser and a programme guide by making it possible also to search for content according to key words or categories. Depending on the configuration of the EPG, personal preferences can be stored as a user profile. Information does not have to be limited to programmes. It may also be accompanied by advertisements for services such as teleshopping and so on. As well as answering requests for information, it is this link to further-ranging services that establishes the connection between the EPG and interactive services.

It goes without saying that broadcasting goals vary according to service providers. This means that the EPG has some significance as a marketing tool. It is the ultimate forum in which providers can advertise their own programmes. However, this also means that a competitor whose package-accompanying EPGs cannot be processed owing to a lack of interoperability with the API in question, may suffer a competitive drawback. The position allocated within the EPG and the way in which the channel is portrayed may also have an adverse effect.

2. Video-on-demand

Video-on-demand means that users can order programmes or films to watch on their own television sets at any time, with the result that they can organise their own TV schedule. However, in addition to a return channel for the placing of orders, video-on-demand requires a huge capacity for point-to-point transmission. At present this capacity is not (yet) generally available in the majority of cases.

Besides this, there will also be problems with the restriction of usage as regards the broadcast contents. In principle digital content can be duplicated over and over again without any loss of quality. Operators will, however, only want to release their content for limited usage. This requires a digital rights management (DRM) system, a separate encryption procedure or a process that prevents the indiscriminate dissemination of digital content.

An example of how this kind of technology works can be observed in the Austrian interactive multimedia channel Aon.tv, which was developed as a common project with Telekom Austria throughout the European Union. A stream technology is used for content drawn from the Internet through an ASDL access. This means that, for the most part, the films or other content that are called up are played directly on a PC without any intermediate storage. A digital rights management system developed by Microsoft is applied and is made compulsory. this DRM-system is supported only by the Windows Media Player, whose use is, thus, indispensable.[65] Unauthorised duplication is prevented by the fact that content cannot be stored.

65) Press release on http://www.telekom.at/Content.Node2/de/media/standard/st_0623.php

3. Near video-on-demand

Near video-on-demand means that requested programmes are not broadcast immediately, but are broadcast by means of deferred transmission: viewers cannot watch programmes or films as soon as they are ordered but they are granted access to their choice at or about a specified time.

4. Pay-per-view

This is where the subscriber has not paid for the permanent use of the service but pays each time for the content used and has to release it for viewing before it is decrypted. He can obtain the necessary PIN by phoning or by consulting the Internet.

5. Personal video recorder / Personal digital recorder (PVR / PDR)

PVR is the abbreviation for personal video recorder. The idea behind this is to programme the video recorder or the set-top box, depending on whether a set-top box with a personal digital recorder (PDR) or a DVD recorder with a hard disk is used, in such a way that the equipment can independently record programmes of interest or the episodes of a favourite series according to a pre-set pattern, regardless of when and where they appear. The end result is a personal television schedule for the viewer, which he can watch irrespective of the time at which individual programmes were broadcast. The video recorder can be programmed either through an EPG – an approach that would correspond more to the conventional form of programming using a VPS (video programming system) than anything else – or by means of a service provided and broadcast for this specific purpose.[66] It is also possible to record a programme and begin watching it a little later while it is still recording (a process called timeshifting). This makes it possible for viewers to adapt the sequence of the programme entirely to their own needs.[67]

Among the technical possibilities offered by storage on a hard disk is that of skipping advertising breaks. This option, which has already been installed in some boxes, has already caused some considerable anxiety among US broadcasters funded by advertising revenue.[68]

6. Interactive game shows

One area in which genuine interactivity is used is television game shows, during which viewers can guess or vote along with the participants in the studio. Answers are transmitted back to the broadcaster, which may use the results in its programme or, for example, award prizes for one or more of the correct answers it receives.

7. Games

If a return channel is available and the set-top box has an appropriate extension fitted to it, it can be used as a games console. Viewers or players can play against other viewers via a network platform. However, it is also possible to offer games accompanying programmes, where, for instance, a viewer can take part in a Formula One race. It should be said though that games like this will only work if there is a return channel with sufficient capacity.

8. Multi-angle broadcasting

With multi-angle broadcasting the viewer can choose his own camera angles from several camera shots broadcast simultaneously. The main areas of use up until now for this kind of interactivity focusing on what is shown and seen have been sports events like Formula One racing.

66) http://www.golem.de/0306/26128.html
67) Ziemer "Digitales Fernsehen" ("Digital television"), 3rd edition, 2003, p. 256 *et seq.*
68) Article published in the 7 July 2003 issue of *Focus*, p. 135 "Spielfilme ohne Spots" ("Films without ad breaks").

9. Teleshopping

On teleshopping channels viewers are presented with particular products for sale. They can then order the goods they require over a return channel. A legal definition of teleshopping can be found in Article 1 (f) of EU Directive 97/36/EC.

10. Telebanking

Telebanking means carrying out banking operations by means of electronic communications facilities and communication networks. Possible uses include consulting accounts, making one-off credit transfers, setting up standing orders and dealing in shares. For telebanking to be offered as a digital television service, a protected return channel and a point-to-point network structure is required.

11. Internet via digital television

The subject of Internet via digital television covers many possibilities. The first step is to use broadband cable or satellite connections and a DVB card corresponding to the appropriate transmission standard (DVB-S/C 38 Mbit/s, DVB-T 13 Mbit/s) to download from the Internet. The link to the Internet service provider (ISP) is established over the telephone network using a modem. This enables web-surfing at broadband speeds. The technical concept represents a bridge between the worlds of the Internet protocol and the DVB. Relevant services are being developed and provided by satellite operators such as Eutelsat and SES Astra as well as cable network operators. Surfing by this method is mainly carried out using a home computer.

For company networks, there are already systems that do not rely on the hybrid solution of using the telephone network. In this case satellites are used in both directions. There is even enough transmission capacity using this system to broadcast an MPEG-4 company television channel.

Another possibility is the use of the Internet via the television set. Until now, however, there have always been difficulties in this area because of the different way in which Internet pages and television pictures are displayed. Implementing the interlaced scanning of analogue television sets in order to display Internet pages is only suitable in certain conditions.

"Walled-garden" services

The use of Internet as part of an interactive television service is often restricted to the so-called walled-garden domain. The walled garden contains a limited amount of information, e.g. from broadcasting companies relating to their programmes, from business partners in the tourism and retail-trade sectors, etc., and these are fenced off from the rest of the web environment, which cannot be reached using this service. Internet-like activities similar to those performed on a PC are made possible on the television set.[69] In a broader sense what may be meant is that access to "real" Internet sites is limited to certain areas by the operator.[70]

12. Updating STB software

Updates for many set-top boxes and their software can be communicated via broadcasting channels. Some set-top boxes even update themselves automatically, while for others, updates must be called up first. This could, for example, be a way of migrating to MHP without the need for countless new pieces of equipment.

69) http://www.4managers.de/01-Themen/..%5C10-Inhalte%5Casp%5CT-Commerce.asp?hm=1&um=T
70) http://digital.orf.at/c_daten/d_0_03.htm

XI. Return channel

To establish "true" interactivity and provide services such as video-on-demand, games, teleshopping and telebanking, along with the retrieval of learning materials, a return channel, that is to say a connection from the viewer to the service provider or programme provider, is required. For this purpose interactive set-top boxes contain a modem, which still mainly uses the telephone network at present, as this is the only system that currently offers point-to-point communication without any further cost. From a technical viewpoint it is also possible to set up a return channel via cable, satellite, mobile communications or hybrid networks. The cable network would have to be developed to provide the requisite capacity. The DVB-Return Channel Cable (DVB-RCC) standard is already available for use. There are solutions for satellites, at least in the business sector, but there are still not enough affordable solutions for the mass market. The main obstacle is the high cost of converting broadcasting equipment.[71]

71) Roßnagel/Sosalla/Kleist, "Der Zugang zur Digitalen Satellitenverbreitung" ("Access to digital satellite broadcasting"), EMR report commissioned by the *GSDZ*, sub-paragraph 4.2.2, p. 158, http://www.emr-sb.de

XII. Index