# DVB: From Broadcasting to IP Delivery

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## ABSTRACT
This paper gives a brief overview of the Digital Video Broadcasting (DVB) project. Starting in 1993, this project produced standards for digital broadcasting in all media (satellite, cable, terrestrial) using return channels of various kinds. In the current phase, DVB has also embraced Internet Protocol (IP) based delivery on telco and cable.

## Categories and Subject Descriptors
A.1 INTRODUCTORY AND SURVEY
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C.2.2 Network Protocols
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## 1. INTRODUCTION
The DVB project is famous for its activities relating to the broadcast of digital television services to consumer electronics devices such as TV sets and set-top boxes (STB). Traditionally most TV broadcasting was (and still is) based on the MPEG2 transport stream, but increasingly IP has influence in this domain. After a short overview of the structure and working methods of the DVB project, we will review the main DVB activities related to television transmission using IP. A more complete overview of the entire spectrum of the DVB technology can be found in referenced publications [1] and [2].

## 2. DVB HISTORY AND WORKING STRUCTURE
DVB was created in 1993 as a joint effort to create standards for the distribution of digital television via satellite, cable, or direct terrestrial transmission. DVB is a project and not a standardisation development organisation, but the DVB specifications are forwarded for standardisation to ETSI or CENELEC respectively. DVB today has more than 260 participating organisations from all constituencies involved in digital television: broadcasters, manufacturers, network operators, and regulators.

The activities quickly proved to be very successful: the first DVB specification was officially standardised in 1994. Since then, video broadcast over satellite (DVB-S) based systems have been rolled out on all continents and DVB-S holds the lead in satellite transmission worldwide.

One of the foundations of DVB's success is its strict market orientation. The stability of the standards owes much to the key rule, unchanged since the very beginning, that all decisions must be unanimous– a difficult rule that requires members to be ready to find compromises acceptable to everyone. Two modules form the core of the project: the Commercial (CM) and the Technical Module (TM). Based on the request of at least five companies from two or more constituencies, the CM sets up an ad hoc group to draft commercial requirements for the system requested. Only after these requirements have been completed and are formally approved by the Steering Board, will the TM start the design of the technical specification to meet these requirements. The technical and editorial work is done in ad hoc groups of the TM, grouping the experts of a given field.

Initially the project targeted the broadcast of digital television. DVB developed design standards for this kind of transmission, taking the transport stream concept of the Moving Pictures Experts Group (MPEG) as the delivery mechanism. For the MPEG2 standard, DVB issued guideline documents detailing the choice of parameters to achieve interoperability and to allow production of television equipment at an economical scale. In the late 1990s, DVB issued standard proposals for satellite (DVB-S), cable (DVB-C), and terrestrial (DVB-T) channels. It also issued a complete range of standards for implementing a return channel from the plain old telephone network via GSM channels to the cable channel.

Looking at today's set of DVB standards one finds everything needed for broadcast transmission. In fact, DVB standards are deployed in many countries, not only in Europe. One good example is the DVB-T specification, now selected by more than 100 countries worldwide and deployed in more than thirty. Further information of DVB-T deployments is available from www.dvb-org.

In addition to the standards enabling digital broadcasting, DVB also developed middleware for interactive TV. This system, called Multimedia Home Platform (MHP), is used in large portions in the US cable industry's Open Cable Application Platform (OCAP) and has also found its way into the interactive system used on Blu-ray discs.

The world of broadcast television saw the enormous success of the Internet and its protocol suite on the world of consumer devices so it adapted, by first carrying general data over TV channels, and later by taking more and more of the IP architecture into account for the transmission of audiovisual content. The first specification on data broadcasting was published in 1997 [10], and since DVB entered its second phase DVB 2.0 in 2002, this work has continuously been intensified.

## 3. DATA BROADCASTING AND IP DELIVERY

Each transport stream (TS) multiplex used in broadcast applications already contains program specific information (PSI) and service information (SI) data for housekeeping purposes (e.g. tables to identify the different streams that make up the multiplex, or data that allows the user to identify DVB services, possibly carried in a different multiplex) [12]). Not only can classical radio and TV services be transported, but also private data. This mechanism can be used for transmitting internet data over the satellite downstream (IP tunnelling) (uplink done with PSTN), or to download software updates to STB.

From the beginning, the Generic Data Broadcasting & Service Information Protocols (GBS) group dealt with data included in the TS multiplex (e.g. tables identifying the different programmes). It soon extended its activity to defining how content other than audiovisual could be transported, such as downloading software updates into end devices. To serve the needs of all imaginable applications, GBS defined four different ways to carry general IP data over DVB links.

Using DVB's broadcast channels to bring IP data to the consumer is only a marginal activity of DVB, however. More important is the extension of the DVB broadcast specification framework to allow DVB services to be carried over IP based networks. Different developments target the use of the IP network to carry DVB services.

The IPI (IP Infrastructure) group defined a first version of the DVB-IP standard [5] describing how to carry MPEG2-TS based DVB services over bi-directional IP networks (e.g. xDSL) for live media broadcast and content on demand. The merit of this specification is to get a first level of interoperability for emerging IPTV services.

| |
|---|
| MPEG2 or advanced codecs (H.264,…) |
| MPEG2- transport stream |
| RTP/UDP |
| Internet Protocol |
| Physical/Link layers |

**Figure 1 – DVB-IP protocol layers (simplified)**

At the beginning of this year, DVB approved extensions to the existing DVB-IP specification including the support of advanced A/V coding (see Figure 1) and a TV-Anytime based Broadband Content Guide.

Currently the IPI group is mainly working on application level forward error correction (FEC), a solution for remote management and in-home networking, based on the specification of the Digital Living Network Alliance (DLNA), www.dlna.org, but taking into account the special needs of DVB services brought in to the home by broadcast or other means. A more detailed overview on this work can be found in [3]-[6].

In the beginning of DVB the most advanced compression format usable in consumer devices was the MPEG2 family, and this format is not quite ready to disappear from the scene. But with higher processing power and progress in compression other formats have grown in importance, especially for the new services: HDTV and transmission to handheld terminals with lower screen size and resolution. The Audio Visual Coding Formats (AVC) group also deals with these other, "after MPEG-2 content", formats and standardises parameters for interoperable DVB services. Concentrating on H.264 (MPEG4-10), these formats were immediately specified for transport over both TS and direct IP (also including the VC-1 format), with special emphasis on the synchronisation aspects crucial for the audio-visual world.

The DVB-T standard has become successful for broadcasting of television services to terrestrial devices. Its flexible parameters allow optimal reception for fixed or mobile devices. It carries MPEG2 or MPEG4 coded video inside MPEG2 transport stream packets.

To minimise power consumption for small handheld devices with limited battery capacity such as PDAs and mobile phones, the DVB-H group added provisions for grouping packets of the same service together into short time-slices (Figure 2), which allows these devices to power off receiving equipment for extended periods of time (up to 90%)[7]. The backwards compatibility of this specification allows programmes for the DVB-T and DVB-H receivers to be carried in the same channel. The group also adopted a generic way to carry the IP protocol over the transport stream for an entirely IP based content distribution system, the MultiProtocol Encapsulation (MPE) defined by GBS. This scheme also allows adding forward error correction to each time slice in order to improve reliability of the transmission in the mobile environment.

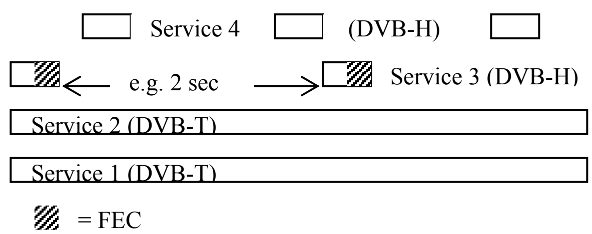


**Figure 2- DVB-H time slicing**

Note here a common misunderstanding: while the current versions of the DVB-IP and DVB-H standards both use the MPEG2 transport stream, it is part of the video layer and carried above the IP in DVB-IP (Figure 1), but it is a layer 2 protocol in DVB-H (Figure 3), the video content being carried directly over the real time protocol (RTP) according to RFC 3984 [13].

| |
|---|
| H.264 content |
| RTP/UDP |
| Internet Protocol |
| Multi-protocol Encapsulation (MPE) |
| MPEG2- transport stream |
| Radio layers |

**Figure 3- DVB-H/IPDC protocol layers (simplified)**

The Convergence of Broadcast and Mobile Services (CBMS) group finally is defining the IP Datacast over DVB-H (IPDC) system. This combines very efficient unidirectional DVB-H broadcast transmission of general content with bi-directional transmission over the mobile/cellular network for interactivity, dedicated content, or file repair. Figure 4 shows the main reference points taken into account.

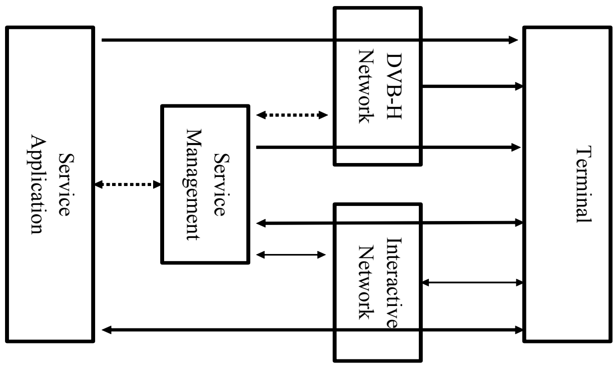


**Figure 4 - CBMS architecture**

The broadcast network is used for streaming video services of general interest to a large number of subscribers, leveraging the efficiency of H.264 directly transmitted over RTP. The scalability of this approach not only allows whoever is on the upper end of the pipe to stream video services to a large number of subscribers; but also downloading of general data as terminal software updates, as well as video services pushed into the terminal at the time of low network usage, ready to be consumed on demand at a later stage is done over this network using the FLUTE [14] protocol. The Electronic Service Guide (ESG), a large dynamic database transmitted in form of XML fragments allowing user and terminals to stay informed about all services delivered, be it streaming or push Video on Demand (VoD), is also continuously transmitted in this manner.

The bi-directional channel can be used for the same type of services when only a small number of users need to be served, allowing providers to significantly increase the services offered. By combining broadcasting and the bi-directional channel a provider can offer the large volume audience channels broadcast, and the low audience channels on the bi-directional channel. Further uses of this channel are specified, such as taking advantage of this secure channel using acknowledged protocols for repairing files that were incompletely received over the broadcast channel, (e.g. when driving through a tunnel). Also, error statistics may be sent back from the terminal to the head-end, giving the operator the information needed to optimise network usage.

The first version of these specifications [11] was recently issued and has already become the basis of the first commercial DVB-H services launched this year by 3 Italy (more than 100k subscribers after 6 weeks) and by Telecom Italia Mobile.

Work is ongoing specifying further services: interactive, enhanced roaming support, the ability to notify terminals and users of special events (from emergency to advertising) and much more.

## 4. OTHER CURRENT ACTIVITIES IN DVB

This short overview focused on the work DVB has done and continues to do in direct relation to the Internet Protocol.

There are other activities progressing in parallel. Besides the IPTV and CBMS activities, there is a very active debate around security. The discussions include Content Protection and Copy Management (CPCM); a general security framework including the next version of the Common Interface (CI) for Conditional Access (CA).

The Audio Video Content format group (AVC) is looking into various new developments for compression mechanisms that need to be included to make the suite of DVB standards as powerful as possible. The ongoing debate about the roll-out of HDTV services in Europe was also briefly looked at. In fact, all necessary standards are in place, the last effort was a slight enhancement for the DVB subtitling standard that needed to take the larger image sizes into account.

Comprehensive information about all DVB groups working on related and/or other domains can be found at http://www.dvb.org.

## 5. ACKNOWLEDGMENTS


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