A GUIDELINE FOR THE USE OF DVB SPECIFICATIONS AND STANDARDS

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1. Introduction

In the course of recent years the DVB Project has very successfully developed a considerable list of specifications for Digital Video Broadcasting. As a matter of fact, the term "Digital Video Broadcasting" has even become too restricted, since DVB specifications can be used for broadcasting all kinds of data as well as of sound, accompanied by all kinds of auxiliary information. Some of the specifications aim at the installation of bi-directional communication channels, for example, using cable installations.

Due to the considerable complexity of the DVB environment many different documents have to be taken into consideration when planning services or equipment. For those who have been deeply involved in the development of the DVB solutions the list of documents may be comprehensible, but at least for newcomers it would be quite natural to overlook some of the existing specifications, guidelines, standards etc.

It is the purpose of this paper to present an overview of the existing DVB documents. This overview should be regarded as a "cookbook", listing all the ingredients for a DVB meal. It does not serve the purpose of giving a detailed description of the contents of the documents described below.

For those readers interested in some introductory literature that describes the DVB environment globally and/or in detail, the following reading is recommended [Reimers], [Wood].

2. Baseband Processing

One of the fundamental decisions which were taken during the early days of DVB was the selection of MPEG-2 for the source coding of audio and video and for the creation of programme elementary streams, transport streams etc. - the so-called systems level. The three documents [ISO 13818 - 1] , [ISO 13818 -2] and [ISO 13818 -3] are international standards which describe MPEG-2 systems, video and audio. All three are truly generic and can be considered too wide in scope for them to be applied to DVB directly.

Therefore [ETR 154] was created by the DVB project. This "guidelines document" includes restrictions to the syntax and parameter values described by MPEG-2 as well as recommendations for preferred values for the use in DVB applications.

In analogue TV services Teletext has been used for many years. Millions of TV receivers out in the field provide Teletext decoding. Viewers are used to the convenience of obtaining information from Teletext pages. Since for many years to come the existing TV receiver concepts will be used to display DVB services which have been received and decoded by a "black box" connecting the satellite LNB, the cable outlet or the rooftop aerial to the existing receiver (the so-called Integrated Receiver Decoder - IRD), a mechanism needs to be provided which enables the delivery of "analogue" Teletext to the receiver via DVB. This mechanism is described in [ETS 300 472] and is known as DVB-TXT.

In many countries it is customary to broadcast TV programmes with the original soundtrack and to provide a translation into the local language in the form of subtitles. Another practice is to add graphic elements to the transmitted images like, for example, station logos etc. In [ETS

300 743] a potent mechanism is described which allows the transmission of all kinds of subtitles and graphic elements as part of the DVB signals.

Future DVB services will consist of a wide variety of programmes carried via a large number of transmission channels. In order for the IRD to be able to tune to such channels and in order for the DVB customer to be able to navigate the profusion of programmes, powerful navigational aids need to be provided as part of the DVB streams. The "Service Information - SI" described in [ETS 300 468] constitutes this set of aids, entitled DVB-SI. [ETR 211] includes a set of guidelines describing how the SI should or could be used. In [ETR 162] SI codes are being listed which indicate services by different broadcasters.

3. Transmission

Technical specifications for the transmission of the baseband signals (as described in paragraph 2) via all sorts of broadcast delivery channels have been among the principal deliverables of the DVB Project.

The first specification which it was possible to finalise was that for the satellite delivery of DVB signals [ETS 300 421] entitled DVB-S. In this document different tools for channel coding were described for the first time, which later on became important for all other delivery media as well.

[ETS 300 429] describes channel coding and modulation for DVB signal delivery on cable [CATV] systems (DVB-C). This document forms the basis of [ETS 300 473], in which the use of (Satellite) Master Antenna TV ([S]MATV) installations for DVB is described (DVB-CS).

The use of terrestrial transmission for DVB (DVB-T) is currently being prepared (winter 1996) in several European countries. The specification relevant to this application is [ETS 300 744]. If a single-frequency network approach is taken for the transmission of DVB-T signals, the synchronisation of all the transmitters that contribute to the network is of the utmost importance. [TM 1743] contains the Specification of a Mega-frame for SFN Synchronisation.

If Microwaves are used for the delivery of DVB signals, two specifications can be chosen for the Multichannel Microwave Distribution System (MMDS), depending on the frequency range applied. [ETS 300 748] describes MMDS for use at 10 GHz and above (DVB-MS). This transmission system is based on the use of the DVB-S technology. [ETS 300 749] is applicable to MMDS transmission at frequencies below 10 GHz. This standard is based on DVB-C technology and has therefore been called DVB-MC.

4. Conditional Access

In many cases DVB-based services will either be of the „pay“ type or will at least include some elements which are not supposed to be freely available to the public at large. The term „Conditional Access“ is frequently used to describe systems that enable the control over the access to programmes, services etc. Conditional Access (CA) systems consist of several blocks; among others, the mechanism to scramble the programme or service, the „Subscriber Management System (SMS)“, in which all customer data are stored and the „Subscriber

Authorisation System (SAS)“, that encrypts and delivers those code words which enable the descrambler to make the programme legible.

It was one of the strategic decisions taken by the DVB Project that neither SMS nor SAS should be standardised. The only part of a CA system which was developed jointly by members of DVB is the „Common Scrambling Algorithm“ [ETR 289], a powerful tool to make secure scrambling of Transport Streams or Programme Elementary Streams possible. Owing to the peculiar nature of this system it is not disclosed to the public in detail. The specification can be obtained from a „custodian“ by way of a process described in [A 011].

All other parts of CA systems for DVB are offered in the form of several competitive, commercial products which are marketed by DVB members.

To enable an Integrated Receiver Decoder to descramble programmes which have been broadcast in parallel, using different CA systems, a „Common Interface for Conditional Access and other Digital Video Broadcasting Decoder Applications“ [EN 50 221] can be incorporated into the IRD. By way of inserting a PCM/CIA module into the common interface, different CA systems can be addressed sequentially by that IRD. The term „MultiCrypt“ is used to describe the simultaneous operation of several CA systems.

Another way of providing the viewer with access to programmes which have been processed by different CA systems is called „SimulCrypt“. In this case commercial negotiations between different programme providers have led to a contract which enables the viewer to use the one specific CA system built into his IRD to watch all the programmes, irrespective of the fact that these programmes were scrambled under the control of one of several CA systems. A basic contract to enable SimulCrypt is described by a „Code of Conduct“ [DVB GA 2 (94) 9, rev. 1].

It is one of the goals of the DVB Project to help create European „Anti-Piracy Legislation“, which should allow strict penalising of so-called "pirates" for the breach of CA systems. A proposal for such legislation is included in [A 006].

If scrambled programmes received via satellite and terrestrial transmission are to be fed into cable networks it may in certain cases be advisable for the operator of that cable to change the CA system so that all the programmes in his network are under the control of only one CA system. The process of changing the CA system at a cable head end is called „Transcontrol“ and is supported by the DVB Project.

5. Interactive Services

Many of the service offers possible in the DVB world will require some form of interaction between, for example, the user and either the programme provider or the network operator. This interaction may consist of the transmission of just a few commands but may be extensive and may thus resemble communication via the Internet.

In DVB the tools for enabling interaction have generally been split into two sets. One is network-independent and can be regarded as a protocol stack which extends approximately via ISO/OSI layers two to three [ETS 300 802]. An important part of this stack was derived from the Digital Storage Media Command Control (DSM-CC) protocols created by MPEG [ISO

13818 - 6]. Document [TM 1631] was created as a "guideline" in order for users to be able to understand and use this somewhat complicated stack.

The second group of DVB specifications relates to the lower layers (approximately one to two) of the ISO/OSI model and therefore specifies the network-dependent tools for interactivity. So far (winter 1996) two specifications have been created. The first describes ways to use Public Switched Telephone Networks (PSTN) and Integrated Services Digital Networks (ISDN) as physical networks for interaction [ETS 300 801]. The second deals with a comprehensive solution for the use of CATV networks for the same purpose [ETS 300 800]. In the near future specifications will be designed which connect (S)MATV systems to the outside world of interactivity via Very Small Aperture Satellite Transmission (VSAT) and which can be used for the interaction channels accompanying terrestrial DVB.

6. Miscellaneous

One of the strengths of DVB technology lies in the fact that it enables the point-to-multipoint transmission of very large amounts of data at high data rates while very securely protecting them against all kinds of transmission errors. These data my be audio and video but in many applications the data will be files or other forms of generic information. In order to enable the transmission of such kind of data, including the possibility of repeat transmissions of the same data at regular or irregular time intervals, a specification for data broadcasting has just been finalised [TM 1827, rev. 1]. The document describes four application areas, namely „data piping“, „data streaming“, „multiprotocol encapsulation“, and „data carousel“. This specification is the implementation of such a data broadcasting scheme recommended by DVB. Other (proprietary) implementations may coexist.

At the request of some broadcasters the DVB Project is currently considering the possible future designing of a set of specifications for Digital Satellite News Gathering (D-SNG). This set will most probably consist of some of the documents mentioned above plus some new tools; for instance, for enabling bi-directional communication between the personnel operating the D-SNG uplink and the downlink, respectively.

Telecommunications networks will play an important role in connecting, for example, the playout centre of a broadcaster and the satellite uplink station in another city. Different types of networks will be used (PDH, SDH, ATM etc.) for this purpose. The DVB Project has designed an interface which will be used for connecting the world of DVB signals to PDH networks [ETS 300 813]. A comparable interface to SDH networks is described in [300 814].

DVB systems are new technology for equipment manufacturers, broadcasters and network providers. The testing and evaluation of such systems therefore require some form of guidelines. These guidelines [ETR 290] will help to distinguish meaningful from useless measurements and help to understand how the measuring should be carried out.

Instead of specifying the architecture of the hardware needed in professional DVB installations and in the Integrated Receiver Decoders (IRD) or specifying some form of operational software - for instance, the Application Programming Interface (API) of such units - the DVB Project, after lengthy discussions, decided, at the request of the manufacturers, that it would restrict its activities to specifying external interfaces only. In [EN 50 201] interfaces for the

IRD are specified. [EN 50 083 - 9] describes interfaces for the use in cable head ends, satellite uplink stations and similar professional installations.

In order for the IRD to be able to interoperate with future types of storage media (DVD, DVC, D-VHS etc.) certain conditions must be met by the DVB data streams. These conditions relate, for example, to the maximum bit rate that may be used for the transmission of programmes, which in its turn is defined by the recording capabilities of the respective storage medium. These conditions were included in [ETR 154] and [ETS 300 468].

7. Conclusion

The work of the DVB Project has resulted in a comprehensive list of technical and non-technical documents describing solutions required by the market players in order for them to be able to make the best use of the new technology of broadcasting digital signals. These documents are the result of the united efforts of many individuals who spent thousands of hours designing new solutions to new problems.

Many organisations have provided important contributions to the work of the project in that they have either made available some results of their work to DVB (MPEG, DAVIC) or through actively co-operating with DVB in transforming specifications into standards and norms (ETSI, CENELEC).

Both the extremely valuable contributions by the many individuals and the co-operation of the organisations involved are highly appreciated.

The work of the DVB Project has reached a high level of maturity, but it has not ended yet. Numerous design activities are still ongoing. Among these activities is the compilation of a document which describes ways to broadcast High Definition TeleVision (HDTV) using the DVB solutions. Thus DVB is preparing the medium-term to long-term future of television just as it has, over the last few years, provided solutions for the immediate future of our business.

8. References

Because of the rapid development of specifications and standards it is recommended to verify in each case whether the following documents have been replaced by more recent versions. The following list was compiled in February 1996.

[A 006]	Antipiracy Legislation for Digital Video Broadcasting. DVB Blue Book A 006, October 1995.
[A 011]	DVB Common Scrambling Algorithm. DVB Blue Book A 011, September 1996.
[DVB GA 2 (94) 9, rev. 1]	Code of Conduct - Access to Digital Decoders. Appendix 1 to DVB GA 2 (94) 9, rev. 1.
[EN 50 083-9]	Cabled Distribution Systems for Television, Sound and Interactive Multimedia Signals; Part 9: Interfaces for CATV/SMATV Headends and similar Professional Equipment. Draft European Norm prEN 50 083-9, Comité Européen de Normalisation Electrotechnique CENELEC, March 1996.
[EN 50 201]	Interfaces for DVB-IRDs. Draft European Norm prEN 50 201, Comité Européen de Normalisation Electrotechnique CENELEC, June 1996.
[EN 50 221]	Common Interface Specification for Conditional Access and other Digital Video Broadcasting Decoder Applications. Final Draft European Norm prEN 50 221, Comité Européen de Normalisation Electrotechnique CENELEC, June 1996.
[ETR 154]	Digital Video Broadcasting (DVB); Implementation Guidelines for the Use of MPEG-2 Systems, Video and Audio in Satellite and Cable Broadcasting Applications. ETSI Technical Report ETR 154, European Telecommunications Standards Institute ETSI, September 1996.
[ETR 162]	Digital Broadcasting Systems for Television, Sound and Data Services; Allocation of Service Information (SI) Codes for Digital Video Broadcasting (DVB) Systems. ETSI Technical Report ETR 162, European Telecommunications Standards Institute ETSI, October 1995.
[ETR 211]	Digital Video Broadcasting (DVB); Guidelines on implementation and usage of service information. ETSI Technical Report ETR 211, European Telecommunications Standards Institute ETSI, January 1997.
[ETR 289]	Digital Video Broadcasting (DVB); Common Scrambling (CS) System Description. Draft ETSI Technical Report ETR 289, European Telecommunications Standards Institute ETSI, Working Draft, 8 August 1996.
[ETR 290]	Measurement guidelines for DVB systems. Draft ETSI Technical Report ETR 290, European Telecommunications Standards Institute ETSI, August 1996.
[ETS 300 421]	Digital broadcasting systems for television, sound and data services; Framing structure, channel coding and modulation for 11/12 GHz satellite services. European Telecommunication Standard ETS 300 421, European Telecommunications Standards Institute ETSI, December 1994.
[ETS 300 429]	Digital broadcasting systems for television, sound and data services; Framing structure, channel coding and modulation for cable systems. European Telecommunication Standard ETS 300 429, European Telecommunications Standards Institute ETSI, December 1994.

[ETS 300 468] Digital broadcasting systems for television, sound and data services; Specification for Service Information (SI) in Digital Video Broadcasting (DVB) Systems. European Telecommunication Standard ETS 300 468, European Telecommunications Standards Institute ETSI, May 1996. Edition 2

[ETS 300 472] Digital broadcasting systems for television, sound and data services; Specification for conveying ITU-R System B Teletext in Digital Video Broadcasting (DVB) bitstreams. European Telecommunication Standard ETS 300 472, European Telecommunications Standards Institute ETSI, October 1996.

[ETS 300 473] Digital broadcasting systems for television, sound and data services; Satellite Master Antenna Television (SMATV) distribution systems. European Telecommunication Standard ETS 300 473, European Telecommunications Standards Institute ETSI, November 1996.

[ETS 300 743] Digital broadcasting systems for television, sound and data services; Subtitling systems. Draft European Telecommunication Standard prETS 300 743, European Telecommunications Standards Institute ETSI, May 1996.

[ETS 300 744] Digital broadcasting systems for television, sound and data services; Framing structure, channel coding and modulation for digital terrestrial television. Draft European Telecommunication Standard prETS 300 744, European Telecommunications Standards Institute ETSI, May 1996.

[ETS 300 748] Digital broadcasting systems for television, sound and data services; Framing structure, channel coding and modulation for Multipoint Video Distribution Systems (MMDS) at 10 GHz and above. Draft European Telecommunication Standard prETS 300 748, European Telecommunications Standards Institute ETSI, May 1996.

[ETS 300 749] Digital broadcasting systems for television, sound and data services; Framing structure, chanel coding and modulation for Multipoint Video Distribution Systems (MMDS) below 10 GHz. Draft European Telecommunication Standard prETS 300 749, European Telecommunications Standards Institute ETSI, y 1996.

[ETS 300 800] Digital Video Broadcasting (DVB); DVB Interaction Channel for Cable TV Distribution System (CATV). Draft European Telecommunication Standard prETS 300 800, European Telecommunications Standards Institute ETSI, July 1996.

[ETS 300 801] Digital Video Broadcasting (DVB); DVB Interaction Channel through the Public Switched Telecommunications Network (PSTN) / Integrated Services Digital Network (ISDN). Draft European Telecommunication Standard prETS 300 801, European Telecommunications Standards Institute ETSI, July 1996.

[ETS 300 802] Digital Video Broadcasting (DVB); Network Independent Protocols for DVB Interactive Services. Draft European Telecommunication Standard prETS 300 802, European Telecommunications Standards Institute ETSI, November 1996.

[ETS 300 813] Digital Video Broadcasting (DVB); DVB interfaces to Plesiochronous Digital Hierarchy (PDH) networks. Draft European Telecommunication Standard prETS 300 813, European Telecommunications Standards Institute ETSI, October 1996.

[ETS 300 814] Digital Video Broadcasting (DVB); DVB interfaces to Synchronous

Digital Hierarchy (SDH) networks. Draft European Telecommunication Standard prETS 300 814, European Telecommunications Standards Institute ETSI, December 1996.

[ETS 300 815] Digital Video Broadcasting (DVB); DVB interfaces to Asynchronous Transfer Mode (ATM) networks. Draft European Telecommunication Standard prETS 300 815, European Telecommunications Standards Institute ETSI, October 1996.

[ISO 13818 - 1] Information Technology - Generic Coding of Moving Pictures and Associated Audio Information. Part 1: Systems. ISO/IEC International Standard IS 13818, November 1994.

[ISO 13818 - 2] Information Technology - Generic Coding of Moving Pictures and Associated Audio Information. Part 2: Video. ISO/IEC International Standard IS 13818, November 1994.

[ISO 13818 - 3] Information Technology - Generic Coding of Moving Pictures and Associated Audio Information. Part 3: Audio. ISO/IEC International Standard IS 13818, November 1994.

[ISO 13818 - 6] Information Technology - Generic Coding of Moving Pictures and Associated Audio Information. Part 6: Extension for Digital Storage Media Command and Control. ISO/IEC International Standard IS 13818, November 1994.

[Reimers] Ulrich Reimers (ed.): Digitale Fernsehtechnik - Datenkompression und Übertragung für DVB. Berlin; Heidelberg; New York: Springer, 1995.

[TM 1631] Guidelines for Use of DVB-SIS Specification - Network Independent Protocols for Interactive Services. Draft F. Internal Document of the Technical Module (TM) of the European DVB Project TM 1631, rev. 3, November 1996.

[TM 1743] Draft Specification of a Mega-frame for SFN Synchronisation. Internal Document of the Technical Module (TM) of the European DVB Project TM 1743, rev. 3, December 1996.

[TM 1827] Draft Specification for Data Broadcasting in Digital Video Broadcasting (DVB) Systems. Internal Document of the Technical Module (TM) of the European DVB Project TM 1827, rev. 1, February 1997.

[Wood] David Wood: Satellites, science and success - The DVB story. EBU Technical Review No. 266 - Winter 1995. Pages 4 to 11.