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Digitalna videoradiodifuzija (DVB) – Povratni kanal za kabelske TV (CaTV) distribucijske sisteme

Digital Video Broadcasting (DVB); Interaction channel for Cable TV distribution systems (CATV)

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European Broadcasting Union EBU UER Union Européenne de Radio-Télévision

DVB Digital Video Broadcasting

Digital Video Broadcasting (DVB); Interaction channel for Cable TV distribution systems (CATV)

ETSI

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Foreword

This European Telecommunication Standard (ETS) has been produced by the Joint Technical Committee (JTC) Broadcast of the European Broadcasting Union (EBU), Comité Européen de Normalisation ELECtrotechnique (CENELEC) and the European Telecommunications Standards Institute (ETSI).

NOTE: The EBU/ETSI JTC Broadcast was established in 1990 to co-ordinate the drafting of ETSs in the specific field of broadcasting and related fields. Since 1995 the JTC Broadcast became a tripartite body by including in the Memorandum of Understanding also CENELEC, which is responsible for the standardization of radio and television receivers. The EBU is a professional association of broadcasting organizations whose work includes the co-ordination of its members' activities in the technical, legal, programme-making and programme-exchange domains. The EBU has active members in about 60 countries in the European broadcasting area; its headquarters is in Geneva.

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Digital Video Broadcasting (DVB) Project

Founded in September 1993, the DVB Project is a market-led consortium of public and private sector organizations in the television industry. Its aim is to establish the framework for the introduction of MPEG-2 based digital television services. Now comprising over 200 organizations from more than 25 countries around the world, DVB fosters market-led systems, which meet the real needs, and economic circumstances, of the consumer electronics and the broadcast industry.

Transposition dates	
Date of adoption of this ETS:	20 March 1998
Date of latest announcement of this ETS (doa):	31 October 1998
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Date of withdrawal of any conflicting National Standard (dow):	30 April 1999

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1 Scope

This ETS is the baseline specification for the provision of interaction channel for Cable TV (CATV) networks.

It is not intended to specify a return channel solution associated to each broadcast system because the inter-operability of different delivery media to transport the return channel is desirable.

The solutions provided in this ETS for interaction channel for CATV networks are a part of a wider set of alternatives to implement interactive services for DVB systems.

2 Normative references

This ETS incorporates by dated and undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this ETS only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

[1] EN 50083-2: "Cabled Distribution Systems for television and sound signals".

[2] EN 300 429: "Digital Video Broadcasting (DVB); Framing structure, channel coding and modulation for cable systems".

[3] EN 300 421: "Digital Video Broadcasting (DVB); Framing structure, channel coding and modulation for 11/12 GHz satellite services".

[4] ITU Recommendation I.361 (11/95): "B-ISDN ATM layer specification".

[5] ITU-T Recommendation I.363: "B-ISDN ATM Adaptation Layer specification".

[6] EN 300 468: "Digital Video Broadcasting (DVB); Specification for Service Information (SI) in DVB systems".

3 Abbreviations

For the purposes of this ETS, the following abbreviations apply:

ATM	Asynchronous Transfer Mode
BC	Broadcast Channel
BRA	Basic Rate Access
CATV	Community Antenna TeleVision / Cable TV
CRC	Cyclic Redundancy Check
DAVIC	Digital AudioVIsual Council
DVB	Digital Video Broadcasting
EMC	ElectroMagnetic Compatibility
ESF	Extended SuperFrame
FAS	Frame Alignment Signal
FDM	Frequency Division Multiplex
FEC	Forward Error Correction
IB	In-Band
IC	Interaction Channel
INA	Interactive Network Adapter
IQ	In-phase and Quadrature components
IRD	Integrated Receiver Decoder
ISDN	Integrated Services Digital Network
LFSR	Linear Feedback Shift Register
LSB	Least Significant Bit
MAC	Media Access Control
MMDS	Multi-channel Multi-point Distribution System
MPEG	Motion Picture Expert Group
MSB	Most Significant Bit

NIU	Network Interface Unit
NSAP	Network Service Access Point
OOB	Out Of Band
OSI	Open Systems Interconnection
PM	Pulse Modulation
PSK	Phase Shift Keying
PSTN	Public Switched Telephone Network
QAM	Quadrature Amplitude Modulation
QoS	Quality of Service
QPSK	Quaternary PSK
RMS	Root Mean Square
SL-ESF	Signalling Link Extended Superframe
SMATV	Satellite Master Antenna Tele-Vision
SNR	Signal to Noise power Ratio
STB	Set Top Box
STU	Set Top Unit
TDMA	Time Division Multiple Access
TS	Transport Stream
VCI	Virtual Channel Identifier
VPI	Virtual Path Identifier

4 Reference model

This clause presents the reference model for system architecture of narrowband interaction channels in a broadcasting scenario (asymmetric interactive services).

4.1 Protocol stack model

For asymmetric interactive services supporting broadcast to the home with narrowband return channel, a simple communications model consists of the following layers:

Physical layer: Where all the physical (electrical) transmission parameters are defined.

Transport layer: Defines all the relevant data structures and communication protocols like data containers, etc.

Application layer: Is the interactive application software and runtime environments (e.g. home shopping application, script interpreter, etc.).

This ETS addresses the lower two layers (the physical and transport) leaving the application layer open to competitive market forces.

A simplified model of the OSI layers was adopted to facilitate the production of specifications for these nodes. Figure 1 points out the lower layers of the simplified model and identifies some of the key parameters for the lower two layers. Following the user requirements for interactive services, no attempt will be made to consider higher layers in this ETS.

Layer Structure for Generic System Reference Model

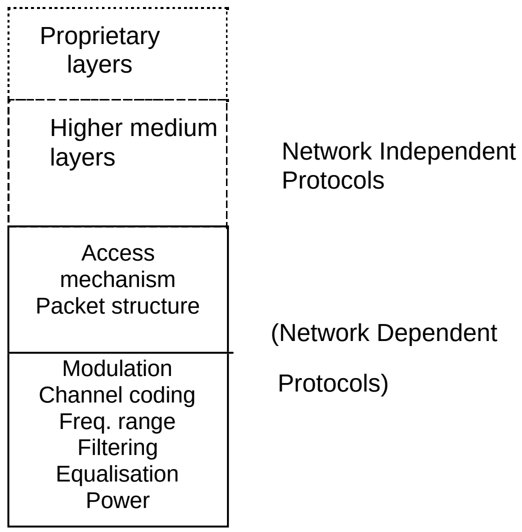

Figure 1: Layer structure for generic system reference model

This ETS addresses the CATV network specific aspects only. The network independent protocols are specified separately (ITU-T Recommendation I.361 [4]).

4.2 System model

Figure 2 shows the system model which is to be used within DVB for interactive services.

In the system model, two channels are established between the service provider and the user:

- **Broadcast Channel (BC)**: A uni-directional broadband BC including video, audio and data. The BC is established from the service provider to the users. It may include the Forward Interaction path.

- **Interaction Channel (IC)**: A bi-directional IC is established between the service provider and the user for interaction purposes. It is formed by:

  - **Return Interaction path**: From the user to the service provider. It is used to make requests to the service provider or to answer questions. It is a narrowband channel. Also commonly known as return channel.

  - **Forward Interaction path**: From the service provider to the user. It is used to provide some sort of information by the service provider to the user and any other required communication for the interactive service provision. It may be embedded into the broadcast channel. It is possible that this channel is not required in some simple implementations which make use of the BC for the carriage of data to the user.

The user terminal is formed by the Network Interface Unit (NIU) and the Set Top Unit (STU). The NIU consists of the Broadcast Interface Module (BIM) and the Interactive Interface Module (IIM). The user terminal provides interface for both broadcast and interaction channels. The interface between the user terminal and the interaction network is via the IIM.

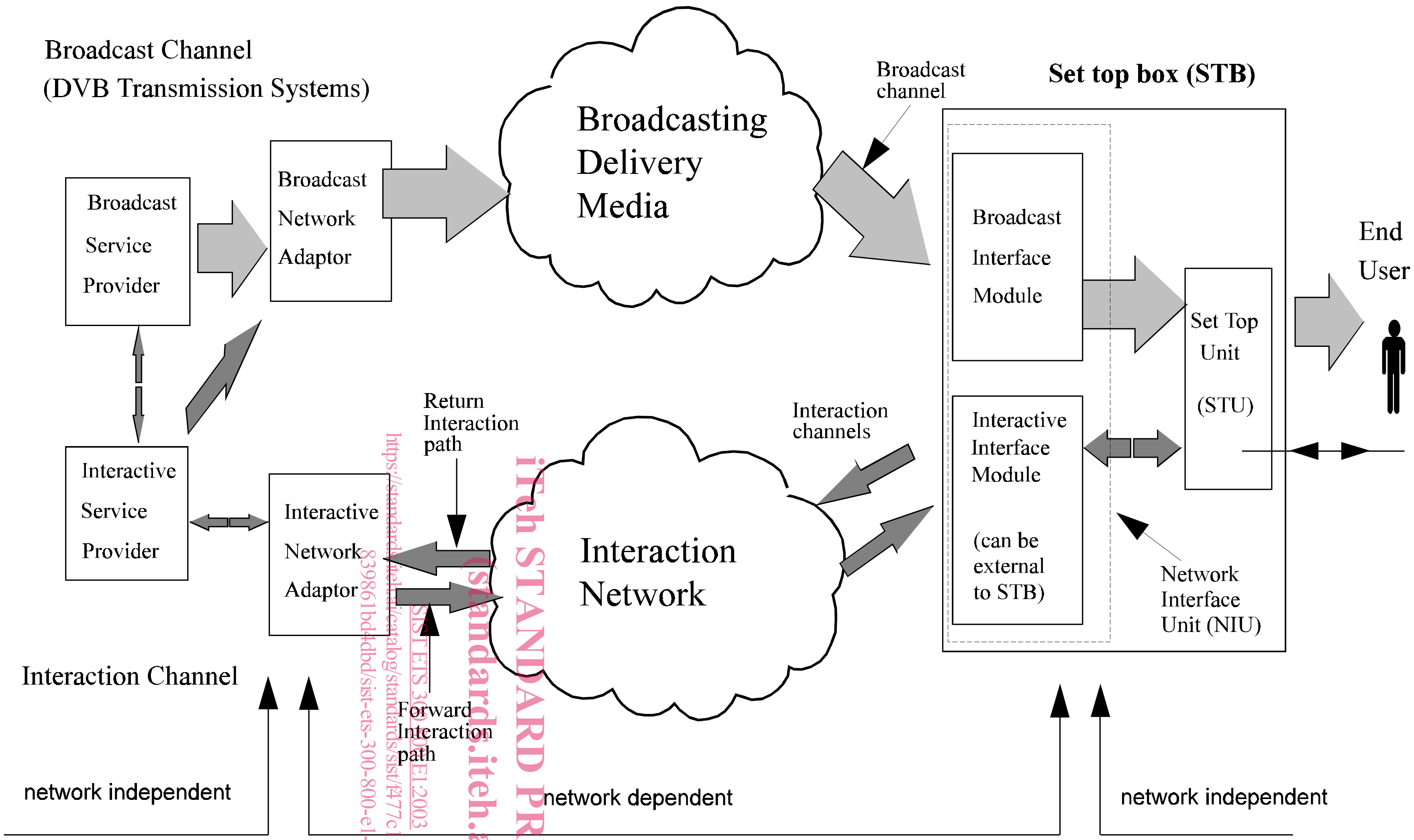

Figure 2: A generic system reference model for interactive systems

5 DVB interaction channel specification for CATV networks

The CATV infrastructures can support the implementation of the return channel for interactive services suitable for DVB broadcasting systems.

CATV can be used to implement interactive services in the DVB environment, providing a bi-directional communication path between the user terminal and the service provider.

5.1 System concept

The interactive system is composed of Forward Interaction path (downstream) and Return Interaction path (upstream). The general concept is to use downstream transmission from the INA to the NIUs to provide synchronization and information to all NIUs. This allows the NIUs to adapt to the network and send synchronized information upstream.

Upstream transmission is divided into time slots which can be used by different users, using the technique of Time Division Multiple Access (TDMA). One downstream channel is used to synchronize up to 8 upstream channels, which are all divided into time slots. A counter at the INA is sent periodically to the NIUs, so that all NIUs work with the same clock. This gives the opportunity to the INA to assign time slots to different users.

Three major access modes are provided with this system. The first one is based on contention access, which lets users send information at any time with the risk to have a collision with other users' transmissions. The second and third modes are contention-less based, where the INA either provides a finite amount of slots to a specific NIU, or a given bit rate requested by a NIU until the INA stops the connection on NIU's demand. These access modes are dynamically shared among time slots, which allows NIUs to know when contention based transmission is or is not allowed. This is to avoid a collision for the two contention-less based access modes.

Periodically, the INA will indicate to new users that they have the possibility to go through sign-on procedure, in order to give them the opportunity to synchronize their clock to the network clock, without risking collisions with already active users. This is done by leaving a larger time interval for new users to send their information, taking into account the propagation time required from the INA to the NIUs and back.

5.1.1 Out-Of-Band (OOB) / In-Band (IB) principle

This interactive system is based either on OOB or IB downstream signalling. However, Set Top Boxes (STB) do not need to support both systems.

In the case of OOB signalling, a Forward Interaction path is added. This path is reserved for interactivity data and control information only. The presence of this added Forward Information path is in that case mandatory. However, it is also possible to send higher bit rate downstream information through a DVB cable channel whose frequency is indicated in the forward information path.

In the case of IB signalling, the Forward Information path is embedded into the MPEG-2 TS of a DVB cable channel. It is not mandatory to include the Forward Information path in all DVB cable channels.

Both systems can provide the same quality of service. However, the overall system architecture will differ between networks using IB and OOB STBs. Both types of systems may exist on the same networks under the condition that different frequencies are used for each system.

5.1.2 Spectrum allocation

Figure 3 indicates a possible spectrum allocation. Although not mandatory, a guideline is provided to use the following preferred frequency ranges, 70 MHz to 130 MHz and/or 300 MHz to 862 MHz for the Forward Interaction path (downstream OOB) and 5 MHz to 65 MHz for the Return Interaction path (upstream), or parts thereof. To avoid filtering problems in the bi-directional RF amplifiers and in the STBs, the upper limit 65 MHz for the upstream flow shall not be used together with the lower limit 70 MHz for the downstream flow in the same system. For passive networks, the frequency range 5 MHz to 65 MHz could be used bi-directionally. Furthermore, to avoid intermediate frequency impairments of STBs as well as analogue receivers in the same network, it could be necessary to leave out some parts of the range 5 MHz to 65 MHz which includes the intermediate frequency ranges of these appliances.

NOTE: To fix detailed limits for the usable frequency range(s), future investigations concerning the intermediate frequency immunity of receivers shall be carried through.

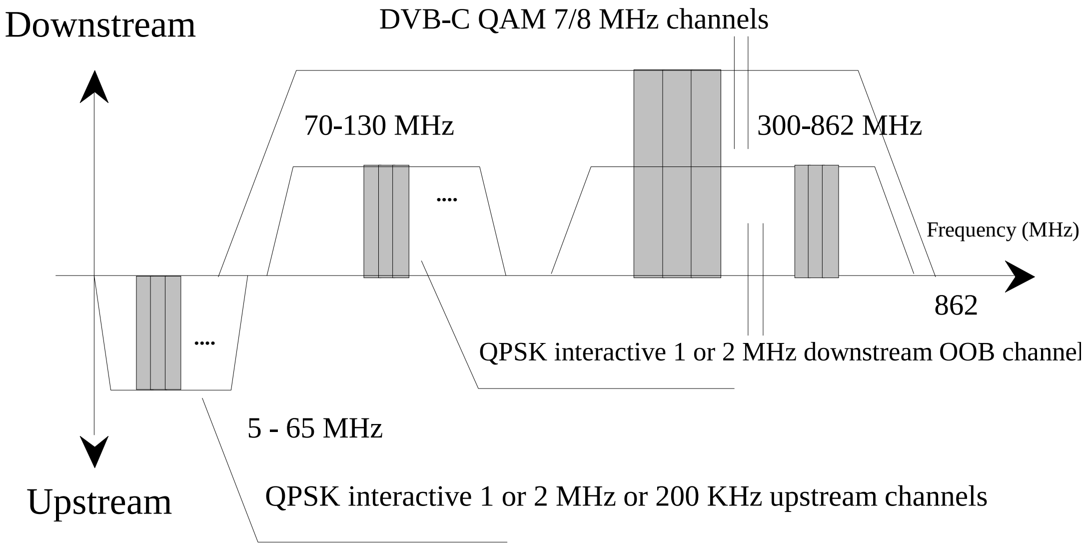

Figure 3: DVB preferred frequency ranges for CATV interactive systems

5.1.3 FDM/TDMA multiple access

A multiple access scheme is defined in order to have different users share the same transmission media. Downstream information is sent broadcast to all users of the networks. Thus, an address assignment exists for each user which allows the INA to send information singlecast to one particular user. Two addresses are stored in STBs in order to identify users on the network:

MAC address: It is a 48-bit value representing the unique MAC address of the NIU. This MAC address may be hard coded in the NIU or be provided by external source.

NSAP address: It is a 160-bit value representing a network address. This address is provided by higher layers during communication.

Upstream information may come from any user in the network and shall therefore also be differentiated at the INA using the set of addresses defined above.

Upstream and OOB downstream channels are divided into separate channels of 1 MHz or 2 MHz bandwidth for downstream and 1 MHz or 2 MHz or 200 kHz for upstream. Each downstream channel contains a synchronization frame used by up to 8 different upstream channels, whose frequencies are indicated by the Media Access Control (MAC) protocol.

Within upstream channels, users send packets with TDMA type access. This means that each channel is shared by many different users, who can either send packets with a possibility of collisions when this is allowed by the INA, or request transmission and use the packets assigned by the INA to each user specifically. Assuming each channel can therefore accommodate thousands of users at the same time, the upstream bandwidth can easily be used by all users present on the network at the same time.

The TDMA technique utilizes a slotting methodology which allows the transmit start times to be synchronized to a common clock source. Synchronizing the start times increases message throughput of this signalling channel since the message packets do not overlap during transmission. The period between sequential start times are identified as slots. Each slot is a point in time when a message packet can be transmitted over the signalling link.

The time reference for slot location is received via the downstream channels generated at the delivery system and received simultaneously by all set-top units. Note that this time reference is not sent in the same way for OOB and IB signalling. Since all NIUs reference the same time base, the slot times are aligned for all NIUs. However, since there is propagation delay in any transmission network, a time base ranging method accommodates deviation of transmission due to propagation delay.

Since the TDMA signalling link is used by NIUs that are engaged in interactive sessions, the number of available message slots on this channel is dependent on the number of simultaneous users. When messaging slots are not in use, an NIU may be assigned multiple message slots for increased messaging throughput. Additional slot assignments are provided to the NIU from the downstream signalling information flow.

There are different access modes for the upstream slots:

- reserved slots with fixed rate reservation (Fixed rate access: the user has a reservation of one or several timeslots in each frame enabling, e.g. for voice, audio);

- reserved slots with dynamic reservation (Reservation access: the user sends control information announcing his demand for transmission capacity. He gets grants for the use of slots);

- contention based slots (These slots are accessible for every user. Collision is possible and solved by a contention resolution protocol);

- ranging slots (these slots are used upstream to measure and adjust the time delay and the power).

These slots may be mixed on a single carrier to enable different services on one carrier only. If one carrier is assigned to one specific service, only those slot types will be used which are needed for this service. Therefore a terminal can be simplified to respond to only those slot types assigned to the service.

5.1.4 Bit rates and framing

For the interactive downstream OOB channel, a rate of 1,544 Mbit/s or 3,088 Mbit/s may be used. For downstream IB channels, no other constraints than those specified in the DVB cable specifications (EN 300 429 [2]) exist, but a guideline would be to use rates multiples of 8 kbit/s.

Downstream OOB channels continuously transmit a frame based on T1 type framing, in which some information is provided for synchronization of upstream slots. Downstream IB channels transmit some MPEG-2 TS packets with a specific PID for synchronization of upstream slots (at least one packet containing synchronization information shall be sent in every period of 3 ms).

For upstream transmission, the INA can indicate three types of transmission rates to users, specifically 3,088 Mbit/s, 1,544 Mbit/s or 256 kbit/s. The INA is responsible of indicating which rate may be used by NIUs. It would imply all NIUs to be able to either transmit with 256 kbit/s, 1,544 Mbit/s or 3,088 Mbit/s. Only the implementation of one of these bit rates would be mandatory.

Upstream framing consists of packets of 512 bits (256 symbols) which are sent in a bursty mode from the different users present on the network. The upstream slot rates are 6 000 upstream slots/s when the upstream data rate is 3,088 Mbit/s, 3 000 upstream slots/s when the upstream data rate is 1,544 Mbit/s and 500 upstream slots/s when the upstream data rate is 256 kbit/s.

5.2 Lower physical layer specification

In this subclause, detailed information is given on the lower physical layer specification. Figures 4 and 5 show the conceptual block diagrams for implementation of this ETS.