EBU Tech 3307

Service Requirements for Free-to-Air High Definition Television Receivers

Project Group B/TQE
(Television Quality Evolution)

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This document outlines the general requirements, as perceived by EBU members, of free-to-air broadcasters for the reception of HDTV services, whether by DVB-T, DVB-S or S2, or by other means. It is intended as a discussion document for manufacturers, broadcasters, operators, and national HDTV platforms.

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1. Video and Audio

1.1. Video Compression and Standards

Any HDTV services launched later than the middle of 2005 will use one of the 'advanced coding' schemes (MPEG-4-AVC/H.264 or possibly VC1) now becoming available. MPEG-2 Transport Stream packetisation will be used, as described in ETSI TS 101 154 [1].

In order that channel changes may take place rapidly, the use of a maximum of a half-second[1] GOP (Group of Pictures) structure is near universal and HDTV services are likely to follow suit. Some more advanced coders already have the ability to vary the GOP length, for example to start a new GOP at a scene change, or at points specified by the broadcaster.

The HDTV receiver shall also support the decoding of MPEG-2 Main Profile@High Level (MP@HL) bitstreams, and any bit stream that a standard definition TV (SDTV) receiver is required to decode (so providing backwards compatibility).

In addition, the EBU Technical Committee has recommended that EMISSION standards for HDTV should be based on progressive scanning in EBU document R112-2004 [2].

1.2. Audio Compression and Standards

HDTV Audio should meet similar quality expectations to those of HDTV Video. Generally, HDTV Audio quality should be superior to the quality provided by standard definition television.

In order to meet these expectations, the following requirements shall be met:

- HDTV audio should be at minimum a 5.1 multichannel configuration, according to Rec. ITU BS.775 [3].
- At least one of the audio coding schemes, described in ETSI TS 101 154[1] shall be used.
- The HDTV receiver shall offer the encoded audio bitstream on its digital outputs, as well as decode internally the 5.1 audio signal, and support 2.0 downmix (at minimum).
- HDTV Audio should be scaleable, both in terms of channel bit rates and channel configurations. Bitrate scalability implies that several bitrates, ranging from very high to relatively low, could be used, depending on the quality level requirements, bandwidth availability and receiver capability. Configuration scalability implies simply that the channel configurations may vary from 5.1 down to 2.0.
- Audio-only multi-channel services shall be supported.
- Downward compatibility to existing SDTV-services is required, i.e. MPEG-1 Layer II baseline decoder is required.
- It should be possible to provide additional audio services for the visually or hearing impaired or alternative languages or commentaries at an efficient bitrate and within current broadcast

[1] 12-frames in a 25 Hz interlaced environment

infrastructure. The ability to mix these additional services within the receiver would be beneficial.

- The receiver should support broadcaster's originated Metadata carried as a part of the compressed audio stream.
- Consumer side dynamic range processing should be implemented. This should utilise broadcasters generated Metadata, if available.

1.3. Switching between Video Standards

EBU Technical Recommendation R112 – 2004 [2] states:

> "As consumer electronics equipment (e.g. set-top boxes and displays) will accept both 720p and 1080i formats, broadcasters will be able to select either of these formats – even on a programme-by-programme basis."

The change must occur with the minimum of disruption so far as the viewer is concerned. This implies that receivers must be capable of switching between formats within about one second (or comparable to the time taken for a channel change), whilst the broadcast video signal is faded to black. It would be preferable if receivers could switch faster, possibly instantaneously.

1.4. Signalling from the Broadcaster

The transmission will convey information concerning the resolution (e.g. Standard Definition interlace, 1280x720 progressive, 1920x1080 interlace) and the frame rate.

The broadcaster should not need to signal the absence of copy protection requirements (see below) – this is an area that is likely to be specified by DVB.

If the broadcaster is transmitting film mode (1080psF25[2] within a 1080i25 structure), this should be flagged. This is a new requirement, and might be achieved though the definition of a new item of user data – this is an appropriate area for discussion in DVB. The switch should be frame accurate, and probably occur at the start of a GOP. In the case of a variable-GOP capable encoder, the broadcaster might force this start of GOP. A mechanism should be provided for this information to be flagged across the interface between receiver and display. This will enable the receiver or display to correctly decode the material as progressive. It is imperative that the correct field sequence is maintained, both by the broadcaster and within the receiver.

The HDTV receiver provides SDTV and HDTV display formats depending on the original broadcast format. However, the receiver of a HDTV bit stream shall down-convert the decoded picture to an SDTV resolution display format for output to the SCART [4] connector.

The HDTV receiver may up-convert SDTV pictures for display at HDTV definition. The up-converted SDTV signal should be routed to the HD interfaces.

The HDTV receiver shall have the possibility of manually setting the output format of both the Analogue Component Interface and the Digital Interface to 576i (480i60), 576p (480p60), 720p or 1080i/p. The option should be implemented in such a way that it can be switched, e.g. on the remote control or back panel, without the need for displaying the control function on the television screen. If a display is provided on a receiver front-panel, this display shall give an indication as to which mode is active.

If the HDTV receiver makes use of the Extended Display Identification Data (EDID) information provided by the display to determine the receiver output format automatically, the receiver should provide the preferred raster announced by the display even if that raster is not a standard television format (e.g. WXGA).

In addition to the default behaviour of the receiver to provide a single output format irrespective of the format being received, the receiver should provide an 'original format' option. When enabled this option allows the receiver to provide (after adding the graphics layers) the format that it receives. For example, a received and decoded 720p50 signal will appear as 720p50 on the HD interface while a received and decoded 1080i/25 signal received will appear as 1080i25 at the output.

1.4.1 Support for PVRs

As a general principle, HDTV PVRs (Personal Video Recorders) should record HDTV signals and play back not only video and audio streams, but other data streams that were an integral part of the original programme,

[2] 1080 lines progressive, segmented frame, 25 frames per second. The system makes use of a segmented-frame (25sF) interface to allow progressive signals to pass through an interlace infrastructure.

such as DVB subtitles, alternative audio tracks, audio descriptions, and signing for the deaf. It is not foreseen, however, that multiple video streams for the same programme could be handled in the first generation of free-to-air HDTV PVRs.

The PVR should at a minimum expect to have DVB-SI, including EIT tables, available. If TV-Anytime data is available, this may also be supported by the PVR. In all cases, the user interface should be simple and intuitive.

The PVR may choose to record all the streams associated with one service, or specific service components only.

PVRs should cope with the situation where the number of service components, or the content of service components, changes between the time when the PVR is set up for recording by the user and the time when the recording actually starts (or even while the recording is in progress). The PVR should apply strategies to ensure that all components relevant for the user will be recorded.

Further considerations are included in **Appendix 1**.

1.5. Audio Video Timing

The transmitted signal is assumed to have audio and video that are co-timed. The time stamp mechanism within the MPEG system is capable of maintaining timing between the coder and the decoder to better than 1ms.

Audio shall be synchronous with video (for the same television programme) at all control junctions of the transmission chain; audio/video synchronisation in the set-top box (STB) must be within a tolerance of -5ms (audio early) to +15ms (audio late) between decoded video and decoded audio outputs. Where audio leaves the STB in an encoded form (such as in IEC61937 [5] outputs), the STB should compensate for the decoding latency of a reference decoder, such that the output of a reference decoder would be -5ms to +15ms with respect to the decoded video.

2. Interface between Receiver and Display

Any receiver should be capable of interfacing with displays meeting the EICTA HD-Ready requirement [6], that is a display where:

- The display device accepts HD input via Analogue YPbPr [7], and DVI [8] or HDMI [9]
- HD capable inputs accept the following HD video formats:

  1280x720 @ 50 and 60 Hz frame rate, progressive (“720p”), and

  1920x1080 @ 25 and 30 Hz frame rate, interlaced (“1080i”)
- The DVI or HDMI input supports content protection (HDCP) [10].

A standard definition output should be available on a SCART connector.

A bitstream connection over IEEE 1394 [11] might be required to link to an external PVR.

2.1. Content and Link Protection

Most free-to-air broadcasters will choose not to use conditional access. Under these circumstances content protection on the link (for example, HDCP) should be switched off. The default condition for the HDCP scrambling should be ‘off’.

2.2. Video Format Alignment Procedure between Receiver and Display

In the case of a separate receiver and display, the quality of the displayed picture can be critically dependent on the decisions taken as to the video standard employed on the link. Care should be taken in both the receiver and display design to ensure that this negotiation is handled so as to give the best possible picture quality. Progressive signals should be maintained as such wherever possible, and the number of scaling operations kept to a minimum. De-interlacing, where necessary, might best be undertaken in the receiver, where information from the decoder can assist in making the best decisions.

2.3. Interfaces for Audio

Home networking is becoming of high interest in the digital A/V domain. It should be considered that future

receivers will comply with, for example, the DLNA [12] design guidelines for home networking.

The following audio interfaces between receiver and home audio equipment shall be provided:

- Stereo audio shall be available on a pair of analogue stereo outputs.
- Suitable digital output for bitstream out shall be available on IEC 61937 and/or HDMI and/or IEEE 1394 (known variously as FireWire, iLink etc.).

  NOTE: Where compatibility with legacy receivers is a commercial requirement, IEC 61937 shall be mandatory.
- Optionally, the STB should be able to provide an uncompressed PCM signal on its digital output instead of the bitstream.

3. Overscan and Safe Areas

Scaling for overscan is traditionally the domain of the display, rather than the STB.

In a modern HDTV system there is no obvious requirement for a large amount of overscan. The main requirement is to mask the edge effects of scaling and filtering operations, as well as timing errors in production equipment, (which are now much less than was formerly the case).

Bearing in mind that:

- Very few display manufacturers will market CRT-based HD displays in Europe, and
- Coding large areas of picture that are not going to be seen by the viewer is very wasteful of resource.

It appears that the 5% overscan conventionally applied in CRT displays is too much. Further study will be required to establish an appropriate amount of overscan for a modern HDTV system. Communication between the STB and the display should however enable the re-scaling to be done optimally for the individual display.

Existing safe areas will need to be maintained by broadcasters for an interim period for material which might be produced in HD and down-converted for SD transmission.

4. Middleware

Middleware delivers the user interface, service enhancements, interactivity, and multimedia elements. It is not the purpose of this document to specify the middleware to be used in every case, but the capabilities required of it can be considered.

It is recognised that for a variety of strategic, technical, infrastructure, capacity and cost reasons, broadcasters in Europe will use a variety of middleware solutions. The preference of public-service broadcasters is for an open standard, or if this is not possible, a system for which the specification is published and which is free to use.

EBU Technical Recommendation R106-2001 [13] recommends that broadcasters should use DVB-MHP on new digital TV platforms, and that broadcasters using other APIs on existing digital TV platforms should give serious consideration to migrating to DVB -MHP.

4.1. Subtitles

If subtitles are selected, the receiver is required to deliver the correct material, legibly, in the place on the screen and in a colour defined by the broadcaster. Its presentation should be timed to an accuracy of better than about 100ms. The presentation of subtitles should be consistent across different implementations.

EBU Recommendation R110-2004 [14] recommends that new digital television subtitle services operated by EBU members and by other broadcasters, should use the DVB Subtitling system (EN 300 743 [15]). It goes on to request that consumer electronics manufacturers should ensure the compliance of DVB set-top boxes and IRDs with the DVB Subtitling system.

4.2. Signing and other access services

The system should be able to deliver the level of interactivity required for the addition of a signing service for hearing impaired people.

The receiver should be able to select between a number of audio components, including in particular, audio description, clean dialogue and multi-lingual channels. It may also be desirable for audio description to be selected separately to outputs, independent of the main audio.

EBU Technical Information I44-2004 [16] includes a long list of recommendations, most of which are as relevant to HDTV as to other forms of digital television.

4.3. Software Downloads

The receiver should be capable of receiving software downloads.

4.4. Return Channel

Appropriate DVB systems should be used if a return channel is required.

References

[1]	**ETSI TS 101 154**	Digital Video Broadcasting (DVB); Implementation guidelines for the use of Video and Audio Coding in Broadcasting Applications based on the MPEG-2 Transport Stream; MPEG-2 Implementation guidelines
[2]	**EBU R112 – 2004**	*EBU Statement on HDTV standards
[3]	**Rec. ITU-R BS.775-1**	Multi-channel stereophonic sound system with or without accompanying picture.
[4]	**SCART**	The SCART (Syndicat des Constructeurs d'Appareils Radiorécepteurs et Téléviseurs) 21-pin connector is used for combined analogue audio and video connections on consumer A/V devices. The connector is also known as the Peritel connector or Euroconnector. A formal description is given in CENELEC standard EN 50 049-1 and in the IEC 933-1 standard.
[5]	**IEC 61937**	Digital audio - Interface for non-linear PCM encoded audio bitstreams applying IEC 60958 (i.e. AES3 data compliance)
[6]	**EICTA**	European Information & Communications Technology Industry Association http://www.eicta.org
[7]	**YpbPr**	CEA -770.3 rev. C, November 2001, with the notice that the connectors required may be available only through an adapter.
[8]	**DVI**	DDWG, "DVI Visual Interface", rev. 1.0, April 2, 1999 as further qualified in EIA/CEA - 861 rev. B, "A DTV Profile for Uncompressed High Speed Digital Interfaces" May 2002, furthermore allowing both DVI-D and DVI-I connectors, requiring compliance to both 50 and 60 Hz profiles, and requiring support for both 720p and 1080i video formats.
[9]	**HDMI**	HDMI Licensing, LLC, "High- Definition Multimedia Interface", rev. 1.0, December 9, 2002
[10]	**HDCP**	Intel, "High-Bandwidth Digital Content Protection System", rev. 1.1, June 9, 2003 (Note: on DVI HDCP rev. 1.0 or rev. 1.1 will apply.)
[11]	**IEEE 1394**	A high speed serial bus standard that supports data transfer rates of up to 400 Mbit/s (in 1394a) and 800 Mbit/s (in 1394b). IEEE 1394 supports isochronous data, making it ideal for consumer A/V devices.
[12]	**DLNA**	Digital Living Network Alliance – http://www.dlna.org/home
[13]	**EBU R106 – 2001**	*Use of DVB-MHP
[14]	**EBU R110 – 2004**	*Subtitling for Digital Television Broadcasting - first edition
[15]	**ETSI EN 300 743**	Digital Video Broadcasting (DVB); Subtitling Systems
[16]	**I44 – 2004**	*EBU Report: Access Services

* available for free download from http://www.ebu.ch/en/technical/publications/ott/index.php

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Appendix 1: Suggested functional requirements for PVRs

Broadcasts will support strategies that might be implemented in PVRs by providing a description of the set of components that belong to an event through the following means:

- As a default, the program map table lists all components relevant for recording at the time of recording.
- The EIT (schedule as well as present/following) may contain a valid list of all components that belong to the service at the time of recording. This information will be available at the time of programming the PVR.
- Advanced description schemes such as TV-Anytime may provide additional information on service components

The PVR shall make use of information in the order as listed, if the related functionality is implemented in the specific device.

TV-Anytime supports the following functionality. Basic features that should be supported are:

- On-the-fly (i.e. 'record now') recording for time-shift viewing (private copy)
- Timed channel recording (analogue VCR-like programming)
- Ability to select the appropriate language audio, alternative audio tracks or audio description
- Ability to record essential related streams – subtitles, accessibility streams such as signing for the deaf, associated interactive applications
- Trick modes such as pause, fast-forward, etc.
- Storage and content management mechanisms
- Ability to support parental guidance systems

Furthermore, broadcasters will transmit programme schedules in the form of SI tables and/or TV-Anytime (ETSI TS 102 822 series). HDTV receiver should be compliant with the reception of signals as defined in ETSI TS 102 323 for the transport and delivery of DVB SI and TV-Anytime Phase 1 data. Work is already underway with the validation of test streams for TV-Anytime PVRs (standard definition). The extension of this work to encompass HDTV streams should occur in 2006.

In this context, the following additional features should be supported:

- EPG with current event, next event and minimum of 7 days forward-looking schedule
- EPG updating (including partial) mechanisms
- EPG-based programming and recording for time shift-viewing
- Ability to schedule recordings via trailers
- Group recording / recording of related programmes (e.g. all episodes of a series)
- Storage and content management mechanisms using in-band or off-band Metadata, including user profiles for e.g. personalised recording.

Advanced TV-Anytime features should allow in the longer term to deliver advanced services such as the delivery of content packages (Audio, video, data, applications, , web-pages, etc.), target advertising and other segment- based services. HDTV recorders should follow this evolution.