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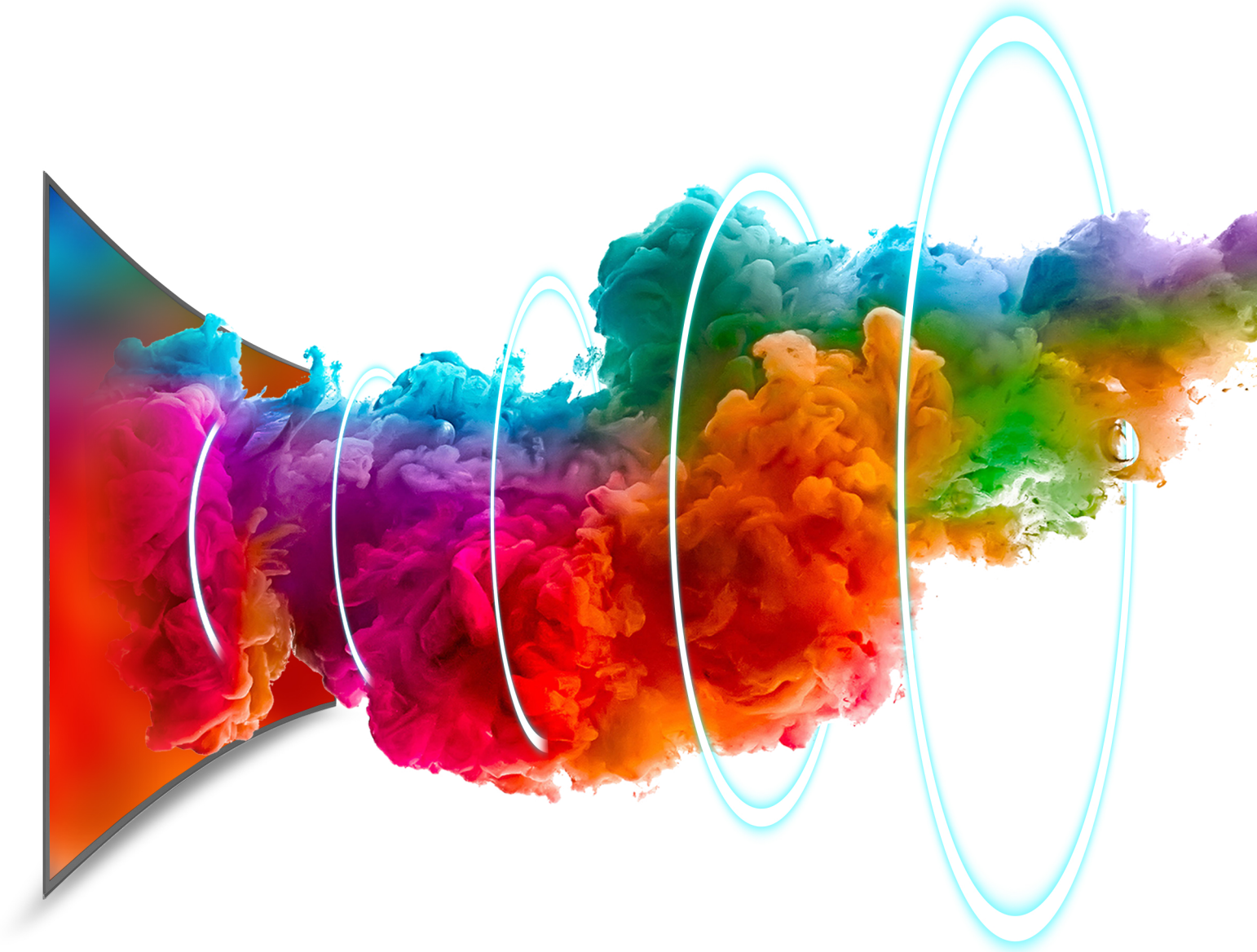

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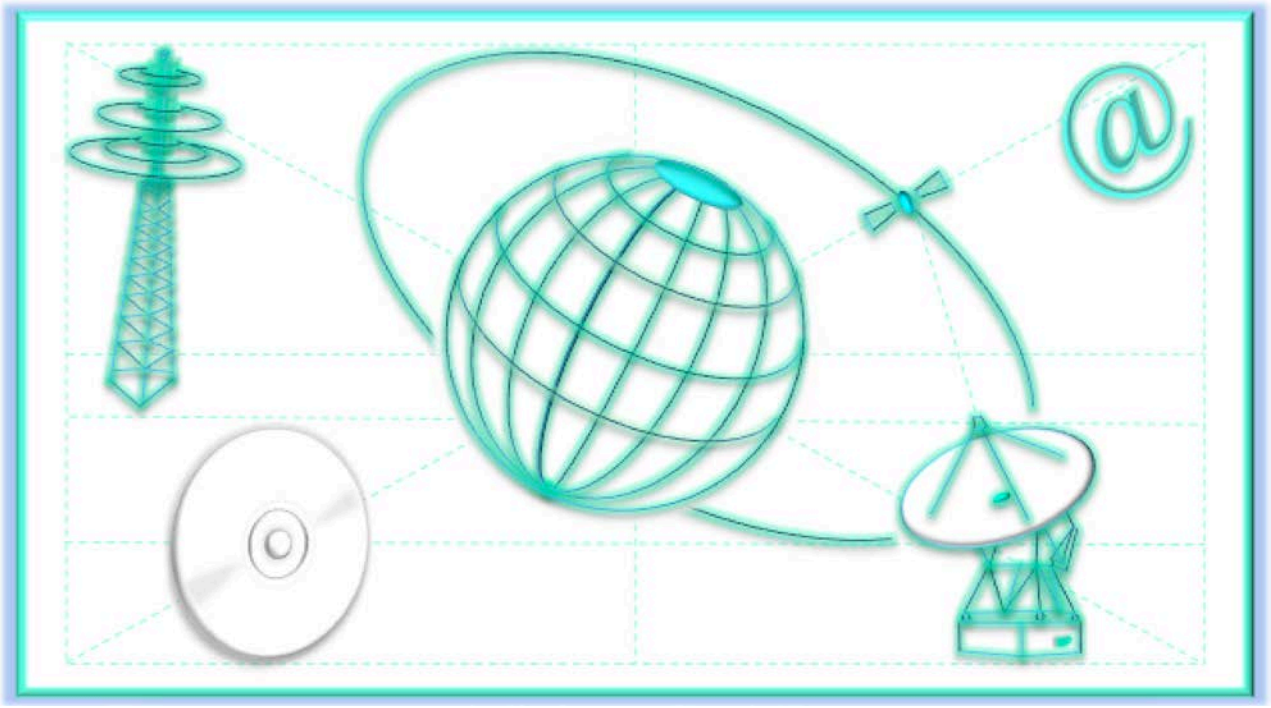
Beyond Definition

UHD Book

Compatible High Definition and Ultra High Definition receivers for the Italian market: baseline requirements



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ULTRAHD FORUM ITALIA
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CONFINDUSTRIA RADIO TELEVISIONI

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1. Foreword

Since 2005, the High Definition Television formats, 720p and (mostly) 1080i, have entered the European satellite TV broadcasting market, with a wide offering of tens of HDTV channels provided by different Pay TV aggregators, such as Sky Italy with an offering of HDTV sport channels. Today also the DTT platform offers a significant number of HD channels, compatibly with the capacity limitations imposed by the available spectrum and the need of MPEG-2/SD simulcasting for legacy receivers.

Nowadays the majority of TV sets off-the-shelf feature displays with progressive scan and panoramic view that are compatible with UltraHD. These screens are capable of providing better chromatic details, luminance and contrast that make a completely new user experience possible.

New Ultra-high-definition audio-visual sources such as media players for home video, Ultra HD Blu-ray disc players, UHDTV cameras, 4K video game consoles, as well as ultra high-definition television programmes, are designed to accurately reproduce very high-quality contents, when viewed on a UHDTV display.

In perspective, “today HDTV is moving forward to Ultra HDTV" with sharper and more brilliant images for an astonishing user experience also thanks to a new generation of audio technologies with a powerful 3D sound. Based on this premises, it is really important to continue the migration route from today HD into UHD to match the increased quality of large screen displays and TV sets as well as the increasing demand from users.

Production and transmission of HD and UHD contents with HDR (High Dynamic Range) and WCG (Wide Colour Gamut) has become a need for a successful competitive positioning of Italy in the worldwide advanced digital television market. In a global industrial context where large European and extra-European entities are rapidly progressing there is a serious risk of losing relevant market quotes of the Italian content industry, with detrimental effects on the promotion of the Italian culture.

Appealing ultra high-quality content productions require huge investments. Furthermore, broadcasters in Europe will face a drastic 30% reduction of the UHF frequency spectrum available for digital terrestrial transmission in the coming years. SD / HD simulcasting solutions still used today, with codecs now technologically obsolete such as MPEG-2, can no longer be considered plausible solutions. In Italy, a law mandates the presence of DVB-T2 and HEVC in all the receivers sold as of January 1st, 2017.

1.1. Market outlook

CE industry is particularly committed to boost sales of increasingly larger screen displays in order to maintain a steady cash flow thanks to a constant and rapid renewal cycle of TVs’ installed base. For this purpose they undertook, through their major category association in Europe, (DIGITALEUROPE), the initiative of creating some licensed labels, corresponding to a precise set of technical requirements.

First labels of this kind were launched back in 2005: HD Ready (for TVs) and HDTV (for TVs and STBs) and their counterparts in 1080p format.

Displays** or **Video Projectors

Receivers

More recently, in 2014, to inform consumers that the display device they are considering to buy is compatible with all major sources of Ultra HD content and that it will be able to display this content in Ultra HD format, DIGITAL EUROPE has introduced a new label devoted to Ultra High Definition (3840x2160 pixels) display devices.

The new label timely targeted the first generation of UHD displays available in retail shops since 2015. In fact, despite the current very limited availability of UHD contents and services, in the last couple of year UHD displays have literally boomed, moving from niche to mass market products, with prices as low as €500.

Even if the above UltraHD logo has been widely recognized in the consumer electronics market, the technical requirements of first generation UHD displays have been largely overcome by new advanced standards and guidelines.

UHD Alliance, the consortium created to promote products and contents at Ultra HD resolution, has communicated the necessary specifications to receive the Ultra HD Premium certification. The certifications will cover three areas: the receivers (essentially TV sets), the content distribution and the realization of the masters.

The new logo intends to promote further technologies of today's UltraHD screens and TV sets, such as:

- Color Depth: 10 bit aa a minimum,
- Wide Color Gamut (WCG): support of BT.2020 colorimetry,
- High Dynamic Range (HDR): support for the EOTF SMPTE ST2084 standard,
- Brightness peak of 1.000 cd/m^2 and black level of 0.05 cd/m^2 or 540 cd/m^2 and black level of 0.0005 cd/m^2

This UHD Alliance logo, while going in the right direction, is not covering all the requirements addressed by the most recent DVB specifications (e.g. HLG), therefore DIGITALEUROPE is working at the definition of an updated logo.

1.2. Technology outlook

In the following a few other emerging technologies and standards are introduced that may become part of the UHD-Book toolbox in future releases.

1.2.1. HFR (High Frame Rate)

HDTV and first generation UHD formats runs at up to 50/60 fps which are not sufficient to guarantee a fully satisfactory motion portrayal for fast moving pictures (i.e. Sports). UHDTV resolution is 4 times larger than HDTV and consequently the definition of fast moving pictures becomes further penalized.

HFR technology allows frame rates up to 100/120fps, so increasing picture sharpness and stability. HFR has been fully specified by DVB in the latest revisions of ETSI TS 101 154 [9] but its implementation is so demanding in terms of computational resources that it will still take a couple of years to make it happen in mass market UHDTV products.

The use of HFR, together with the adoption of HDR and extended colour gamut (BT.2020 colorimetry), will enhance the TV viewing far beyond the current user experience.

This will require a number of changes to occur, involving not only manufacturers but also broadcasters and content providers, who will have to enhance accordingly their own production and delivery chains. Italian broadcasters and content providers are taking steps in this direction.

1.2.2. Improvements in Audio Technologies

For UHD-Book 1.0, the introduction of Next Generation Audio (NGA) codec capabilities is a very important new feature which allows the audio experience and efficiency to match the improvements included in video. This book achieves this by mandating support for AC 4 [85], including its NGA codec capabilities as specified by the DVB in ETSI TS 101 154 v2.3.1 [9]. This allows audio coding and feature improvement comparable to the video enhancements offered by HEVC, enabling the cost-effective and efficient roll out of enhanced and futureproof audio experiences and services.

In previous HD-Books 3.0 and 4.0 a selection of audio codec usage recommendations were included, in particular providing guidance for DVB-T2 services when deployed alongside advanced video codecs like H.264/AVC and HEVC. The current document adds AC-4 to these recommendations.

The inclusion of NGA solves the issue that traditional audio codecs specified in previous Books were at least ten years old. NGA brings in audio features like much improved compression efficiency, better accessibility, dialogue enhancement, intelligent loudness management and new experiences provided by object-based audio to complete the experience for UHD-capable TVs in particular.

HD-Book DTT 4.0 primarily addressed Full-HD use cases whereas UHD-Book 1.0 addresses UHD-capable TVs to be introduced in the Italian market, with partial or full support for certain so-called “UHD-1 Phase 2” features like HDR and NGA.

UHD-Book 1.0 now sees mandatory support on UHD receivers for AC-4 in broadcast and broadband. With increased penetration of UHD-capable TVs, it provides the opportunity to minimize legacy scenarios and simplify the roll-out of NGA services by the Italian broadcasters.

While this book already provides recommendations for basic NGA use cases using AC 4, it is also possible to envisage that more advanced NGA use cases could be included in future specifications – further use cases are expected when these NGA improvements are added to the DVB DASH specification and to HbbTV. This will ultimately result in greater differentiation opportunities for the operators and manufacturers alike, and in richer interfaces and experiences for the audiences.

1.2.2.1. Object-based audio

"Objects" in object-based audio could be compared with the individual elements in a conventional mix. On the other hand, the codecs offered for object-based audio include the ability, on the broadcaster's or the viewer's part, to put individual audio objects or elements, into specific locations in the sound field, to turn individual audio components on and off, to change their v
olume levels relative to the other audio components, and, in some cases, to choose between alternate components, such as multiple announcer streams.

If object-based audio would catch on, it could change the technical topography of the living room in much the same way that 5.1 surround did a decade ago. It's important to distinguish between dynamic object-based audio, where components are constantly moving around, and static object-based audio, where individual objects are in a specific place but can be turned on or off or have their volume or location varied by the viewer.

Object-based audio side products are dialogue enhancement and better delivery efficiency through seamless switching of bitrates for different objects and single transmission with adaptation to the renderer, including evolved loudness and dynamic range management.

1.2.2.2. Audio Codec ETSI TS 103 190: AC-4

After the widespread deployment of AC-3 services and receivers and of its successor, E-AC-3, the AC-4 audio codec [85] has been designed to go beyond providing simple compression efficiency. The widespread availability of AC-4 decoding for broadcast and OTT in consumer receivers in Europe, together with extended and ongoing on-air trials of the codec across DVB geographies since 2015 made AC-4 the strong choice for services addressing UHD-Book 1.0 compliant receivers.

AC-4 enables new, more immersive and personalized consumer audio experiences, such as Dolby Atmos. Users are able to hear the football match as if sitting the stands or standing on the field. Consumers will experience the kind of sound that transports them right to the centre of the action, whether they are enjoying sports watching a movie, or enjoying their favourite drama or entertainment show.

Solving several key issues currently facing the industry, the main benefits of AC-4 include:

- Intelligent Loudness: fully automated loudness management means more precise control and eliminates problems with cascaded processing. It acts across a wide range of devices and applications (home theatre to mobile) and can be configured to align with numerous worldwide standards and/or recommendations.
- Advanced Dialogue Enhancement: end-users can have control of the dialogue level in relation to other sounds in the programme - suiting individual hearing needs and preferences.
- Advanced Accessibility: service providers can easily and efficiently deliver secondary audio in 5.1 surround sound for the visually impaired without doubling the file size or bitrate.
- A/V Frame Alignment: AC-4 is the first emission audio format in the Italian specifications that allows the audio frame sizes to precisely match the video frame size. This allows the AC-4 data stream to be edited/spliced at video frame boundaries to maintain synchronization without the need to decode and re-encode the audio.
- Bandwidth Efficiency: AC-4 utilizes state-of-the-art compression techniques that provide significant bandwidth savings or higher levels of functionality for any audio service including stereo and 5.1

AC-4 [85] is standardized in ETSI and included in the DVB reference specification for audio and video codecs (ETSI TS 101 154 v2.3.1 [9]).

1.2.2.3. Audio Codec ISO/IEC 23008-3: MPEG-H 3D Audio

The MPEG-H 3D Audio International Standard is standardized in ISO/IEC 23008-3 [86], and the MPEG-H 3D Audio Low Complexity (LC) Profile, Level 3, is included in the DVB reference specification for audio and video codecs, ETSI TS 101 154. Offering true immersive sound and advanced interaction and personalization features, the MPEG-H 3D Audio Low Complexity (LC) Profile Level 3 best complements the improved user experience offered by UHD video services. The main benefits of MPEG-H Audio include:

- Advanced Loudness Compensation and Dynamic Range Control: The MPEG-H system provides instantaneous and automated loudness normalization, offering consistent loudness of the reproduced audio content at the decoder. This is accomplished in two steps:
  - Loudness Normalization aligns the loudness between program items under different playback conditions, and
  - Loudness Compensation additionally compensates for loudness changes due to user interaction.
- Advanced Accessibility and Multi-language Services: MPEG-H Audio enables efficient delivery of programs containing multiple languages and Audio Description elements in several languages in a single audio elementary stream. MPEG-H Audio includes the Dialogue Enhancement feature for automatic device selection (prioritization) as well as for user manipulation or personalization in the user interface providing the direct adjustment of the enhancement level. Additionally, MPEG-H Audio also allows the user to spatially move the Audio Description to a user selected position (e.g., to the left or right), enabling a spatial separation of main dialogue and audio description. This results in a better intelligibility of the main dialogue as well as the Audio Description.
- Immersive Sound and Personalization: MPEG-H Audio enables delivery of immersive sound from the receiving device (e.g. TV, STB) to the playback device (e.g., AVR, Soundbar) while at the same time enabling the User Interactivity in the receiving device (e.g., on the TV). For this purpose, MPEG-H Audio provides a unique solution to separate the user interactivity processing from the decoding step.
- True Random Access Points: MPEG-H Audio allows for seamless switching and sample accurate configuration changes and stream splicing. This enables alignment of the audio stream to the video Frame boundaries with no bitrate overhead.
- High Coding Efficiency: MPEG-H Audio provides excellent broadcast audio quality at very low bitrates, as proved by the MPEG Verification Tests.

1.3. DTT migration in Italy

1.3.1. Introduction

In Italy, services on DTT currently operate with DVB-T/MPEG2 (SD), DVB-T/AVC (SD and HD) and DVB-T2/AVC (SD and HD), plus some premium events occasionally transmitted in UHD with DVB-T/HEVC. In the next few years (2020-2022) it is expected a growing penetration of DVB-T2/HEVC/UHD-HDR services, with resolutions ranging from 1080p up to 2160p, in view of the 700 MHz band refarming.

Service lists are managed by LCN and HD_simulcast_LCNs. At a receiving point, there may be several services signalled with the same LCN or HD_simulcast_LCN. In this case, as specified in the present document and previous versions of the HD Book, the user is given the choice to select the service which will be placed according to its LCN or HD_simulcast_LCNs. The other services conflicting for the same LCN or HD_simulcast_LCN will be placed in the Main Overflow range (850+).

Several instances of the same service may be received at one location. In this case, the receiver only places the best received service in the service list.

1.3.2. LCN or HD_Simulcast_LCN conflicts in the transition period

As a consequence of the planned 700 MHz bandwidth release, the Italian Digital Terrestrial platform is going to migrate from a mixed DVB-T/T2 MPEG-2/AVC service offer to a DVB-T/T2 AVC/HEVC service offer. This migration may be progressive, i.e. region by region, potentially transmitter per transmitter.

Given the very limited spectrum available and in order to maintain coverage quality and service continuity to the maximum possible extent, various partial migration scenarios (e.g. service per service) may be envisaged. The following examples may illustrate some partial approaches of these migrations with their possible intermediate steps:

- DVB-T/ MPEG 2/SD -> T or T2/AVC/SD -> T2/HEVC/SD -> T2/HEVC/HD
- DVB-T/AVC/HD-> T2/AVC/HD -> T2/HEVC/HD
- DVB-T/AVC/HD -> T2/HEVC/UHD

Such partial migration could take place per individual service or per complete multiplex with or without some simulcast (1 day up to 1 year). Also temporary transmitter sites with different coverage may be operated for the migration.

During DTT migration, as described above, at a given location and at a given time, for the same LCN or HD_Simulcast LCN, a receiver may receive:

- several variants of the same service,
- several instances of a same service
- several regional variants of a service
- several regional services
- a combination of all or part of the above

1.3.2.1. Service Variants

A selection of the following parameter combinations[1] could form the set of service variants conflicting for the same LCN or HD_Simulcast_LCN which may be present at the same time at one place, potentially with different reception quality[2]:

- DVB-T MPEG2 SD 720x576i50
- DVB-T AVC SD 720x576i50
- DVB-T AVC HD 1920x1080i50
- DVB-T2 AVC SD 720x576i50
- DVB T2 AVC HD 1920x1080i50
- DVB-T2 HEVC SD 960x540p50
- DVB T2 HEVC HD 1920x1080p50
- DVB T2 HEVC HD 1920x1080p50 HDR
- DVB T2 HEVC UHD 3840x2160p50
- DVB T2 HEVC UHD 3840x2160p50 HDR

[1] The full set of video conformance points is specified in Table 4

[2] Though possibly on-air during the transition, as reported above, DVB-T HEVC services are not considered in the following as they will be of transient nature (e.g. UHD early trials and/or HD HEVC test signals) . As such, operators will be very cautious in avoiding LCN conflicts with this kind of services

1.3.2.2. Several Instances of a Service

Several instances of a service (i.e. instances of a service with exactly the same content and video format using the same DVB triplet ONID, TSID, SID) may be received at one place due to overlap of transmitters or common use of transmitter sites..

1.3.2.3. Regional variants of a service

Several instances of a regionalized service, i.e. regional variants of a same service carrying most of the time the same content but varying partly or completely during the day, conflicting for the same LCN or HD_Simulcast_LCN may be received at one place due to overlap of transmitters or common use of transmitter site.

1.3.2.4. Regional Services

Several fully regionalized services, i.e. services available only in some part of Italy, conflicting for the same LCN or HD_Simulcast_LCN may be received at one place due to overlap of transmitters or common use of transmitter sites.

1.3.3. HDFI's approach

HDFI's overall objective is to limit the number of unnecessary LCN/HD_simulcast_LCN conflicts presented to the user during the transition phase whilst delivering the best quality experience and driving consumers away from legacy services to their most up-to-date variants.

More concretely, in case of LCN/HD_simulcast_LCN conflicts for the same position preference should be automatically given to the best receivable service variant, i.e. the one offering the best image quality and/or the most up-to-date coding or transmission technology.

In addition, users should only be offered the choice amongst receivable regional services and regional service variants of a service.

HDFI is currently studying a comprehensive technical solution to allow a user friendly automatic resolution of LCN/HD_simulcast_LCN conflicts which will be included into future version of this specification.

In order to reduce the unnecessary options to the user, the UHD Book 1.0 proposes as an interim solution a further automatic selection of services or service variants to resolve LCN/HD_simulcast_LCN conflicts (see §7.4) based on SDT's service_type, stream_content and component_type. In any case, the services variants or services not automatically selected will still be available to the viewer in the Main Overflow range.

1.4. Compliance notation

A word on the vocabulary: the use of shall, must, should, may is often baffling for non native English speakers. We have chosen to follow the IETF (Internet Engineering Task Force) which in its RFC 2119 states:

1. MUST: This word, or the terms "REQUIRED" or "SHALL", means that the definition is an absolute requirement of the specification.
2. MUST NOT: This phrase, or the phrase "SHALL NOT", mean that the definition is an absolute prohibition of the specification.
3. SHOULD: This word, or the adjective "RECOMMENDED", means that there may exist valid reasons in particular circumstances to ignore a particular item, but the full implications must be understood and carefully weighed before choosing a different course.
4. SHOULD NOT: This phrase, or the phrase "NOT RECOMMENDED" mean that there may exist valid reasons in particular circumstances when the particular behaviour is acceptable or

even useful, but the full implications should be understood and the case carefully weighed before implementing any behaviour described with this label.
5. MAY: This word, or the adjective "OPTIONAL", means that an item is truly optional. One vendor may choose to include the item because a particular marketplace requires it or because the vendor feels that it enhances the product while another vendor may omit the same item. “

N.B. Throughout this document “MANDATORY” is also often used as a “REQUIRED” synonym.

1.5. Acknowledgments

The persons that have contributed to the D-Book first, to the HD-Books and finally to this UHD-Book are so numerous we would shortly run out of space if we tried to thank them individually. The HDFI / CRTV Joint Technical Group can only extend its gratitude to all of them and repeat that without them, this work could not have been completed. Of course, all errors and omissions are the sole responsibility of the editors and of the HD Forum Italia.

Manufacturers, through their constructive remarks and questions have played a major role in helping us to clarify and improve many points of the specification. Let them be thanked here.

November 2017

2. Document History

Document	Revision	Changes	Date
HD-Book DTT 1.0	0	Final issue ready for Publishing	28/10/2008
HD-Book DTT 2.0	0	- EIT schedule requirements cleared up and aligned in Tables 26 and 27 - country_availability_descriptor no more required - added note on service_type=0x0 - LCN visibility_flag support made mandatory - New requirement on CAM powering off when in stand-by - following AGCOM Deliberation 155/09/CONS, 7MHz Italian channel raster in VHF Band III is no more required - Broadband Interaction channel mandatory also for iDTVs - DGTVi Broadband Addendum merged within sections 6.1.2 and 8.4 - New requirement related to application autostart - MMI-MHP interaction scenarios specified - Download CoD OPTIONAL -> RECOMMENDED - EIT schedule compression specified - Download CoD API clarified - Memory requirements in Table 8 clarified - HTTP proxy option added - Removed Resident Broadcaster Defined Applications section - LCN management reviewed (Preference Overflow and Successor Service concepts deleted) - PAE's Pause/Resume controls fixed - Section 5.2 (Broadband Features) imported from HD-Book SAT - New property system.hw.macaddress - error message for broadband apps - corrections and more details to Streamed CoD APIs - custom player creation made RECOMMENDED in 8.4.1.1 - SCART in connector for iDTVs made mandatory (as per EC Directive and CCE) - recommended procedures for CI Plus CAM behaviour during first installation and reset - .mov extension equated to .mp4 - rules for multiple audios over broadband - only 1 HD graphic plane required again - 1080p50 support removed, 1080p25 added - updated references to OIPF R2 - OIPF HAS mandatory support added - OIPF generic DRM API support required - Monitoring&Reporting API (Annex K) - explicit support for HTTP REDIRECT added - guidelines for AIT URL (§8.3.6) - correct sequence of embedded and MMI Parental Control messages specified - support for "Frame-Compatible" 3D TV added at decoder, HDMI and signaling level - added OpenGL API requirement - DVB-T2 specified (Sections 6 and 7) - Annex A redefined for DVB-T2 tables - Clarified that AAC-LC is required - MIME-Type for HAS detailed - only MediaLocator can be passed to JMF player - STB -> receiver in §7.5.2 - MENU key behaviour further specified in §6.4 - Prioritization of EIT Schedules (Normal/Compressed) and MHP	10/01/2011

Document	Revision	Changes	Date
		view specified - HD graphics requirements clarified (new text and figure) - Updated Streaming monitoring API - Removed MHP as IP media format - Frame-Compatible 3DTV text aligned to DVB - OTT Locator introduced - notes on JMF time, ? in URL and content length added in 8.4.1.1 - new org.dvb.user.GeneralPreference “Last Locator” required - §8.6.1 text improved - PP8 applicable only in Single PLP mode - note on service_type=0x00 removed (LCN visibility flag to be used for that purpose) - no root certificates OTA - T2 Noise Figure set to 6dB as per Nordig (former NF Table in Annex A dropped) - New tables in Annex A for C/N Performance, FEF and AUX testing - Warning recommended if service auto update is disabled by user - Reminder section on IXC added - New reqs linked to low-power standby mode - new org.dvb.user.GeneralPreference “IXC” mandated - step-by-step JMF Player start procedure enforced in §8.4.1.1.1 - introductory section on 3DTV added (§5.3) pointing to new Annex M for 2D Service Compatible scenarios - minimum input level specified for DVB-T and T2 - new introductory section on DRM added (§5.2.3) - §8.4.2 title changed and text reworded - 720p50 Side-by-Side 3DTV format added (broadcast and broadband) - 3D Display STB menu setting added	
HD-Book DTT 2.1	0	- Easy-net section removed - Manual setting procedure of IP address fully specified - Recommended IPv6 support - HTTPS streaming specified - MPEG DASH supersedes OIPF HAS for Adaptive Streaming - Reference [54] updated and text aligned accordingly (SEI Information box -> Stereo Video box) - Clarified that DVB Subtitles support is not mandated in case of SbS and T&B TS - Added ADTS support when “self-contained” (raw) audio files are introduced and audio/aac MIME Type to last row in Table 6. - .mov extension support removed - SHALL -> SHOULD for warning message in §6.4 option 2 - Historical requirement on APP key added to §6.4 - Requirement in §7.5.2 modified to cater for MHP-only services - Parental Control requirements aligned to new AGCOM 220/11/CSP - 960x540 HD Graphics made optional (again) - BAS replaces MHP Security	19/12/2011

Document	Revision	Changes	Date
HD-Book DTT 2.1	1	- Clarified that LastLocator must refer only to conventional DVB services (no HTTPLocator or AIT file) - Clarified that HTTPLocator doesn't apply to AIT file - Removed requirement on CI Plus Browser contrasting with CIplus C&RR - Optical connector made mandatory for SPDIF - Introduced optional HDMI ARC support - CI Plus reference updated to 1.3 - Clarifications and constraints on BAS certificate store added in §9.3.4.2 and §9.4.2 - Behaviour in case of multiple <AdaptationSet> elements better specified - Reference to OIPF/DTG list of root certificates added in Table 3 - Annexes K and L now only reference GEM 1.3 (with clarification on MPEG-7 classification schemes) - Removed any reference to analogue tuner (optional by law since 1/1/2013) and channels - Enforcement for supporting at least 2 service contexts simultaneously active - Exposure of BAS white list requested (§9.4.4 and Annex P) - Linkage between RCMM and BAS white list made explicit - Clarifications on DASH live scenario (Dynamic MPD) added in Annex Q - Decoded PCM multichannel audio added to HDMI audio outputs with related system menu	30/09/2012
HD-Book DTT 3.0	0	- Provisions hard or impossible to be met removed in §7.3.4.5.3 (Service removal) - Automatic channel update (§7.6.5), previously only recommended, set as mandatory. Removed constraint "the receiver shall start the scanning procedure 1 hour after being put in standby mode". Added clarifications on conflicts handling (pop-up timeout, stand-by case) - Table 34 added to clarify Application manager expected behaviour - In case of multiple network interfaces (e.g. Ethernet and WiFi), system.hw.macaddress property shall expose the currently active one. - Clarified that In case of DASH contents, languages defined at MPD level must be taken into account for controls provided by org.davic.media.LanguageControl only if language information is missing at container level. - New section 9.3.5 dealing with impact of BAS on broadcast applications - Clarified in §9.3.4 that any GEM resource which is neither basic, nor system, nor private, shall be accessible by any BAS-compliant or non BAS-compliant application without the need of any PRF or certificate. - Option of certificates bound to one or more particular application introduced in §9.3.4 but left platform-dependent. - Sections A.2.1 and A.2.2 renamed - Ordering of representations returned by VideoStreamQualityInfo specified in Annex K - New sections 6.2.9 and 6.3.5, dealing with Player Pad added - Table 14 revised to include clarifications/requirements on certain keys' behaviour during playback of broadband contents - Support for MPEG DASH MPEG2-TS Simple Profile removed. - Support for DVB-DASH Profile added. As a consequence previous profiling reqs in §6.1.2.1 have been marked as RECOMMENDED. - Support for EBU-TT-D Subtitles added in Table 4, §6.1.2.1 and §8.4.1.1.5 - iDTV SCART input and STB Output RF connectors downgraded to OPTIONAL - T2 reference updated to version 1.4.1 and reference to	

Document	Revision	Changes	Date
		DIGITALEUROPE T2 white paper added - Updated rederence [8] to IEC 62216 - CAD support added (§6.1.2.1, §8.4.1.1, §8.4.1.1.5 and §8.4.1.2) for broadband parental control and playlists - T2 profile revised (PP8 support dropped, resistance to interference row added, NF revised and extended to multi tuner case, new C/N Performance table - Reference to CIPlus updated to version 1.3.1 - CICAM section (§9.1.3) extensively reviewed. - Historical Annex G dropped with still valid points moved to §9.1.3 - Historical Annexes C and D removed - Requirements for H.264/AVC broadcast and broadband profiles rewritten in terms of conformance points - HEVC support introduced: - References [8][9] and [10] updated and [74] added - HEVC Main 10 Profile @ up to Level 4.1 support mandated for broadcast and broadband profiles - HEVC Main 10 Profile @ up to Level 5.1 support recommended for broadband profile on UHD receivers, with specific maximum bit rate values - PSI and SI text added for HEVC in §7.2.2.2 and §7.2.5.1 - HEVC compatibility points added to Table 37 (CENC)- HEVC signalling in §7.2.5.1 aligned to final DVB version, specifying that service_type 0x01 is not allowed for HEVC services - Removed any reference to maximum bit rate for UHD contents streamed over HTTPS. - Added “UHD Receiver” definition in §4 - Same text as for SD -> HD graphics scaling added for SD/HD -> UHD graphics scaling in §8.3.5 - In order to maintain historical embedding of D-Book (SD) specs within HD-Book, MHP 1.0.3 and 1.1.3 are both mentioned and referenced - UHDTV DVB naming adopted instead of “UHD-1 Phase 1” - Delivery of EBU-TT-D subtitles as a separate document in a single file is not supported at this stage. - DIGITAL EUROPE HDMI/HDCP requirements for UHD receivers endorsed - Added notes in Table 1 on obsolesce of MPEG-1 L2 Audio and on EAC-3 embedding AC-3 - AC-3 removed from Table 5 and 37 - Added note in Table 5 on obsolesce of MPEG-1 L2 Audio - New references to Nordig, EBU and DIGITAL EUROPE documents on DVB-T/T2 front-end - DVB-T NF changed to 7dB (8dB for multiple tuners) - Minimum DVB-T input level updated with Annex C reused for new data - Table 1 rows on interference refined and extended to LTE case for both DVB-T and DVB-T2 - New note on FEF and Auxiliary Streams - Handling of T2-Lite signal specified - Sections A.2 extensively revised with new tables on T2 C/N performance - Update of service name and LCN during automatic scan added in section 7.6.5 - Chapters 1 and 5 revised altogether - Forgotten “UHD-1 Phase 1” changed to “UHDTV” - References to HDMI 2.0 and HDCP 2.2 added for UHD receivers - SCART connector made OPTIONAL for UHD STB receivers - Clarifications on HDMI/HDCP output for UHD STBs added - Improved definition of “UHD Receiver” - Updated IEC references for RF connectors	

Document	Revision	Changes	Date
		- 1080p50 set as new default HDMI output format for STBs - Section 1.1 revised and smoothed by HDFI Board - Added icons in Table 15 - New HEVC system property introduced in §8.3.4 - HDFI logo updated	
HD-Book DTT 4.0	0	- Reference to Delibera 216/00/CONS updated to 685/15/CONS and extended to relevant T2 parameters - S/PDIF downgraded to OPTIONAL - HDMI ARC made MANDATORY unless S/PDIF is present - DASH support aligned to DVB-DASH and HbbTV 2.0.1 profiles - SSU section rewritten with OTN update added - New text in Chapter 1 for HFR and HDR - 1080p25 AVC encoded and 2 UHD sub-resolutions added for OTT - EITschedule compression removed from Chapter 7 and Annex J - Chapter 8 and 9 swapped and extensively revised (MHP removal and HbbTV introduction, CIPlus 1.4.1 support) - Annex B dropped - AFD section moved to Chapter 6 - Linear IP services introduced. Chapter 7 extensively revised accordingly - Removed any reference to EACEM_stream_identifier_descriptor - CICAM applicability extended to STBs as an alternate option to embedded CA - Function of BACK and EXIT keys revised in Table 8 - 3D support extended to HEVC - Standard DVB service replacement feature added/enforced - Annexes reordered after removal of several Voids - Reference to SI split in two (last published version of ETSI EN 300 468 and BlueBook with next one) - Duplicated section on “Service variation options” removed - 3DTV disclaimer added in Chapter 5 after 7/4 HDFI Steering Board	
UHD-Book 1.0	0	- HD-Book 4.0 DTT and SAT merged - Autostart setting removed from Table 40 as not applicable to HbbTV - component_type signalling added for UHD - new editorial convention adopted (italics for feature applicable only to UHD receivers) - S2 Implementation Margin restored to 1dB with S2 Es/No values updated accordingly and fixed - Table 3 restructured in terms of HD and UHD receivers - Provisions for LCN (implicit) prioritization added (new sections §1.3 and §7.2.2.5.4, modified section §7.4) - AC-4 support introduced (RECOMMENDED/MANDATORY for HD/UHD receivers) - OPTIONAL support for S2X introduced - support added on UHD receivers for HDR and further video formats - DVB T2 HEVC UHD 3840x2160p50 added in §1.3.2.1 - Corrected references in §7.2.2.2.3.2 and §7.2.2.2.3.3 - Fixed 3 wrong (since HD-Book DTT 3.0!) table references in A.2.3 - DVB-SSU OTN downgraded to OPTIONAL in 9.4.2 - Removed any technical reference to 3D (it remains just in history) - Clarified OPTIONAL nature of Linear IP services spec - Support for HDR, as defined in DVB-DASH v2, made MANDATORY for UHD receivers - Support for ECP made MANDATORY for UHD receivers - New section on HbbTV highlights for Italy added - Optional HDMI output for TVs removed - Maximum S2X symbol rate set to 45Mbaud - dCSS support mandated for SAT front-end	

Document	Revision	Changes	Date
		- text and references on ECP support fixed - AC-4 text revised with simple NGA use cases added - references cleaned up - distinct references for DVB-DASH v1 (base reference for all formats, including AC-4 channel based coding) and v2 (HDR extensions only) - DVB-S2 LNB section equated to DVB-S one - Implicit HDMI-CEC support made explicit - Foreword revisited	

Credits:

D-Book:

Coordinator: *M.Pellegrinato*

Editors: *S.Vitale, E.Lambert, G.Venuti*

Contributors: *G.Alberico, A.Bruno, G.Burzi, G.Gentile, E.Lambert, F.Lucidi, E.O'Neill, C.Rosa, M.Visintin, D.Turi, R.Borroni, T.Tessarolo*

Translation: *E.O'Neill*

HD-Book and UHD-Book:

Prj. Coordinator: *M.Pellegrinato*

WorkGroup manager: *G.Alberico (formerly G.Ridolfi)*

Editor: *G.Venuti*

Joint HDFI/DGTVi/CRTV Experts Group: *D.Airola Gnota, V.Arrigoni, R.Armussi, G.Asti, G.Ballocca, M.Bertolotti, M.Bito, A.Borgato, A.Bertella, M.Bito, R.Borroni, S.Bossi, S.Braghieri, G.Burzi, B.Buscema, B.Campbell, O.Déprez, P.Di Giacomo, G.Dimino, D.Doldi, V.Drugeon, N.Frame, M.Frattolin, M.Fumagalli, M.Futagami, C.Gaglione, M.Garganico, G.Gentile, D.Gibellino, A.Gioia, O.M.Grasso, F.Grilli, D.Hill-Jowett, I.Kain, M.Katri, V.Kostov, R.Iacoviello, A.Mapelli, V.Mignone, A.Morello, A.Murtaza, L.Noblet, M.Oriana, J.Outters, R.Paludo, B.Papini, N. Pawlowski, A.Pegoraro, P.Peraboni, A.Pettazzi, L.Piccarreta, J.Piesing, F.Piolini, D.A.Rascio, J.Rosenboom, S.Quesito, F.Rebucci, G.N.Resta, L.Rocchi, A.Roman, B.Sacco, G.Sammartano, S.Savage, L.Seccia, P.Sunna, M.Tabone, S.Trigila, P.Valiente Echezarreta, M.Visintin, S.Waller, J.Wilson*

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4. Definitions and abbreviations

4.1. Definitions

Adaptive Streaming: a technique, used in the context of OTTV to cope with Open Internet varying throughput conditions, where more files corresponding to encodings at different bit rates of the same content which the receiver can seamlessly switch to are made available by the Service Provider.

Application Service Provider: an entity that manages and distributes applications and services for interactive television to customers (i.e. broadcasters and consumers) from a central data center. This entity may also provide interaction channel processing services.

Cross carriage: Carrying the data (typically EIT data) pertaining to one multiplex on a different multiplex. Cross carriage agreements usually imply reciprocity.

HD Receiver: either a TV set with HD resolution capable of decoding HD signals specified in this document and used as receiver or a STB capable of decoding HD signals specified in this document and of driving a display with HD resolution.

Interaction Channel: a bi-directional link connecting the Receiver to a Server for providing extra functionality, such as personalized data, billing, e-commerce, etc. Often called return channel.

License: An object that governs the use of Content and specifies the conditions for allowing access to the Content Key used to encrypt the Content.

Locator: The unique identifier of a DVB service/event.

Out of Box Experience: the first contact of the user with the product, as experienced when taking it out of the packaging box and plugging it into the wall socket and antenna cable (without having to read tons of manuals…).

Over-The-Top Services: A general term for video services delivered over the Open Internet. It's referred to as "over-the-top" because these services ride on top of plain Internet access service and don't require any business or technology affiliations with the network operator.

Receiver: a piece of equipment designed to receive (and decode) DTTV signal. It can be provided as a separate box – in this case it is often called Set Top Box (STB), and sometimes Integrated Receiver Decoder (IRD) – or can be incorporated into a TV set, which is then called an Integrated Digital TV set (iDTV).

Service: For TV and Radio, a sequence of programmes under the control of a broadcaster which can be broadcast as part of a schedule [10]. For Applications and Data, refers to a data stream that can be used directly or be presented to an output interface, without having to tune into a TV or Radio service.

Service List: List of all autonomously accessible services (television, radio, application, and data) identified through a service number

TV Viewing Mode or Viewing Mode: normal TV viewing condition, when less than 5% of the screen area is covered by any HbbTV, or receiver proprietary, GUI.

UHD Receiver*: either a TV set with UHD resolution capable of decoding UHD signals specified in this document and used as receiver or a STB capable of decoding UHD signals specified in this document and of driving a display with UHD resolution.*

4.2. Abbreviations

3DTV	Plano-stereoscopic 3D TV
AAC	Advanced Audio Coding
AAC-LC	AAC Low Complexity
AC-3	Audio Coding 3
AC-4	Audio Coding 4
ACE	Active Constellation Extension
ADSL	Asymmetric Digital Subscriber Line

ADTS	Audio Data Transport Stream
AES	Advanced Encryption Standard
AFD	Active Format Descriptor
AGCOM	Autorità per le Garanzie nelle Comunicazioni
AIT	Application Information Table
API	Application Programming Interface
AVC	Advanced Video Coding
BAT	Bouquet Association Table
BER	Bit Error Rate
BW	Band Width
CA	Certification Authority
CA	Conditional Access
CAD	Content Access Descriptor
CAM	Conditional Access Module
CEC	Consumer Electronics Control
CENC	Common Encryption
CHAP	Challenge Handshake Authentication Protocol
CI	DVB Common Interface
CICAM	CI CAM
CoD	Content on Demand
COFDM	Coded Orthogonal Frequency Division Multiplexing
CRL	Certificate Revocation List
CRTV	Confindustria Radio TV
CVBS	Component Video Baseband Signal
DAB	Digital Audio Broadcasting
DAE	Declarative Application Environment
DASH	Dynamic Adaptive Streaming over HTTP
dCSS	digital Channel Stacking Switch
DHCP	Dynamic Host Configuration Protocol
DiSEqC	Digital Satellite Equipment Control
DRM	Digital Rights Management
DTS	Digital Theater Systems
DTT(V)	Digital Terrestrial Television
DTV	Digital Television
DVB	Digital Video Broadcasting
DVB-H	DVB Handheld
DVB-T	DVB Terrestrial
EACEM	European Association of Consumer Electronics Manufacturer
ECP	Enhanced Content Protection
EDID	Extended Display Identification Data
EHDF	European HD Forum
EICTA	European Information and Communication Technology Association
EIT	Event Information Table
EPG	Electronic Program Guide
ETSI	European Telecommunications Standards Institute
EU	European Union
FEF	Future Extension Frame
FIFO	First In First Out
FFT	Fast Fourier Transform
FTTH	Fiber To The Home
GPRS	General Packet Radio System
GS	Generic Stream
GUI	Graphic User Interface
HbbTV	Hybrid broadcast broadband TV
HD	High Definition

HDCP	High bandwidth Digital Copy Protection
HDFI	HD Forum Italia
HDMI	High Definition Multimedia Interface
HDR	High Dynamic Range
HDSPA	High-Speed Downlink Packet Access
HDTV	High Definition TV
HE-AAC	High Efficiency AAC
HEVC	High Efficiency Video Coding
HFR	High Frame Rate
HTTP	Hyper-Text Transfer Protocol
HTTPS	Hyper-Text Transfer Protocol Secure
iDTV	Integrated Digital TV Set
IP	Internet Protocol
IPTV	IP Television
IRD	Integrated Receiver Decoder
ISO	International Organization for Standardization
ISOBMFF	ISO Base Media File Format
ISP	Internet Service Provider
i-TV	Interactive Television
LAN	Local Access Network
LTE	Long Term Evolution
MFN	Multi Frequency Network
MHP	Multimedia Home Platform
MIME	Multipurpose Internet Mail Extensions
MPD	Media Presentation Description
MPEG	Moving Picture Experts Group
NGA	Next Generation Audio
NID	Network ID
NIT	Network Information Table
NTS	Network Time-Shift
OFDM	Orthogonal Frequency Division Multiplexing
OIPF	Open IPTV Forum
OMA	Open Mobile Alliance
ONID	Original Network ID
OSD	On-Screen Display
OSDT	Online SDT
OTA	Over The Air
OTT-TV	Over The Top TV
PAE	Procedural Application Environment
PAL	Phase Alternate Lock
PAP	PPP Authentication Protocol
PAPR	Peak-to-Average Power Ratio
PAT	Program Association Table
PCMCIA	Personal Computer Memory Card International Association
PDC	Program Delivery Control
PID	Packet IDentifier
PKI	Public Key Infrastructure
PLP	Physical Layer Pipe
PMT	Program Map Table
POP	Point Of Presence
PPP	Point-to-Point Protocol
PPPoE	PPP over Ethernet
PSI	Program Specific Information
PSTN	Public Switched Telephone Network
QAM	Quadrature Amplitude Modulation

QEF	Quasi Error-Free
QPSK	Quadrature Phase Shift Keying
RRC	Regional Radio Conference
RSA	Rivest, Shamir, Adleman
SCART	Syndicat des Constructeurs d'Appareils Radiorécepteurs et Téléviseurs
SCR	Satellite Channel Router
SD	Standard Definition
SDR	Standard Dynamic Range
SDT	Service Description Table
SEI	Supplemental Enhancement Information
SFN	Single Frequency Network
SI	Service Information
SID	Service ID
SIM	Security Identity Module
SSU	System Software Update
STB	Set Top Box
T-DMB	Terrestrial Digital Media Broadcasting
T2-IRD	DVB-T2 Integrated Receiver Decoder
TLS	Transport Layer Security
TM	DVB Technical Module
TFS	Time Frequency Slicing
TR	Tone Reservation
TS	Transport Stream
TSID	Transport Stream ID
UHD(TV)	Ultra High Definition (TV)
UHF	Ultra High Frequency
UI	User Interface
UNT	Update Notification Table
URL	Uniform Resource Locator
USB	Universal Serial Bus
VHF	Very High Frequency
WAN	Wide-area Access Network
WLAN	Wireless LAN
WCG	Wide Colour Gamut
WSS	Wide-Screen Signalling

5. The HD-Books and the UHD-Book

HD-Books are a collection of technical specifications aimed to manufacturers of television receivers (STB and TV). It sets out the baseline requirements for the Italian digital television platform: open, horizontal, interoperable, hybrid. The HD-Book Collection, born in 2008, consists of specific HD-Book volumes, dedicated to the different distribution platforms: DTT (Digital Terrestrial Television), SAT (Open Satellite) and OTT (Over the Top). The HD-Book Collection is published by HD Forum Italia, in collaboration with the other stakeholders of the Italian digital television platform: CRTV (Confindustria Radio Televisioni) and Tivùsat.

HD Forum Italia (HDFI) is an association constituted on September 19th. 2006, to represent the general interests of the industry and consumers towards high definition. HDFI is aimed to promote, support, illustrate and disseminate the utilization of multimedia contents and audiovisual programmes, productions and technology in high definition format (HD) and beyond (3DTV, UHDTV).

The HDFI association members represent the major institution & companies in the audiovisual & telecommunication Industry in Italy. They cover most segments of the entire production chain, from content creation to end users: Azienda Autonoma di Stato per i Servizi Pubblici (Republic of San Marino), Archimedia, Dolby, Eurofins, Eutelsat, Fastweb, Fincons Group, Fondazione Ugo Bordoni, Gruppo Industriale Vesit, LG, Lutech, Mediaset, Nagra, Panasonic, Piksel, RAI, Samsung, Sisvel Technology, Sky Italia, Sony, TIM, Tivù and TP Vision.

HDFI adheres, as Italian member organization, to FAME (Forum on Advanced Media in Europe, formerly known as EHDF, European HD Forum), promoted and jointly chaired by the international organizations EBU (European Broadcasting Union) and DIF (Digital Interoperability Forum.

DGTVi has been the association which has represented the general interests of the Italian DTT industry until ASO completion on June 2012. Since June 2013 DGTVi role has been taken over and widened in scope by Confindustria Radio Televisioni (CRTV) which now represents the general interests of the whole Italian broadcasting industry (TV, Radio, DTT, SAT).

This document describes the **baseline requirements** that are needed for a HDTV or UHDTV DTT and/or SAT receiver with broadband connectivity to claim compatibility with joint HDFI/CRTV specifications.

The first baseline specification was finalized by DGTVi in September 2004 under the name of “D-Book, Compatible DTTV receivers for the Italian market” (v1.0). This specification was later updated with different stand-alone addenda. The “D-Book 1.2” merged all these addenda in a single clean document which took into account the comments received by the industry.

The D-Book 1.2 has been the basis on which HD-Book DTT 1.0 was jointly developed in 2008 by HDFI and CRTV, by introducing all HD-specific features (formats, codecs, connectors, signalling, simulcasting). At the same time, latest developments in the areas of supplementary audio and of automatic channel ordering (LCN) to cope with cross-border conflicts were taken into account. Such developments were then incorporated in D-Book 1.3.

Besides applying all the necessary corrigenda to HD-Book DTT 1.0, its 2.0 successor merged the so-called “Broadband Addendum” [51] which had been developed by DGTVi in

the second half of 2009, after HD-Book DTT 1.0 was published, to complement it in the area of media delivery over broadband (IP) lines.

The 2.x versions of HD-Book DTT brought new advanced features to the Italian DTT platform, like DVB-T2, first generation (Frame Compatible) 3DTV and broadband enhancements (e.g. Adaptive Streaming, Broadband Applications Security and generic DRM support).

The HD-Book DTT 3.0 baseline requirements fostered the introduction of top quality services (Full HD 1080p50 and UHD 2160p50) based on most advanced video compression standards (HEVC), in order to achieve maximum efficiency in spectrum utilization

In particular, as everybody agrees that the driving force for first generation UHDTV will be OTT while it might take much more time for seeing it on DTT (especially in Italy), within HD-Book DTT 3.0 UHDTV support was specified only on the broadband side.

This cautious approach was confirmed in the HD-Book DTT 4.0, where HbbTV 2.0.1 middleware replaced MHP, CIPlus version 1.4.1 was adopted and linear IP services were introduced.

All major HD-Book DTT releases mentioned above have had a SAT counterpart, usually published a few months later in partnership with Tivùsat, differing only for the front-end and few other aspects (e.g. LCN signalling and handling policy).

The present document is simply named “UHD-Book” because for the first time it provides specifications for interoperable DTT and SAT UHDTV receivers in a single volume. That marks a fundamental milestone in HDFI’s history! Key new features of this UHD-Book 1.0 are:

- *HDR support*
- *AC-4 support*
- LCN prioritization (DTT only)
- *Enhanced Content Protection (ECP)*
- dCSS (SAT only)

Special attention has always been paid to the needs of impaired people through some ancillary requirements specifically devoted to them. The following symbols are used by European broadcasters to mark transmissions offering audio description or video subtitling services.

Some optional features are also described that allow compatibility with the innovative services being introduced on the digital TV networks.

5.1. Terminology and notation

The features are divided into two main categories: “mandatory” and “optional”.

When a feature is “mandatory”, its inclusion is mandatory and it must conform to the defined specification.

When a feature is “optional”, its inclusion is left at the choice of the manufacturer, but whenever implemented, it shall be implemented in conformance with the specification.
Within the optional category, the document presents some features, which would be of a great advantage to the user, as “recommended”.

Features or requirements which apply only to either STBs or iDTVs are clearly highlighted both in the text and in visual form, namely:

Refers to a feature or a section applicable only to iDTVs (yellow marker)

Refers to a feature or a section applicable only to STBs (light blue marker)

Refers to an UHD-specific feature (italic)

The different TV formats are represented in the document according to the following notation [41]:

<active lines> <scanning> <frames/s>

For instance:
576i25 (aka 576@50i) represents the 720x576 interlaced format in 50Hz systems
720p50 (aka 720@50p) represents the 1280x720 progressive format in 50Hz systems
1080i25 (aka 1080@50i) represents the 1920x1080 interlaced format in 50Hz systems

5.2. Linkage with other organizations

Where available and compatible with the Italian situation, the specification contained in this document refers to standards developed by standards setting organisations (DVB, ETSI, DIGITALEUROPE, NorDig, MPEG, OIPF, ISO, CEI, CEN). Furthermore, it follows the Italian legislation in force concerning DTT and reception equipment for Digital Terrestrial Television [2].

For the aspects of the receiver where nothing is indicated, the expectation is that manufacturers will follow the EICTA E-book. The version 2.0 is taken as a reference (with the exception of obvious editorial errors).

However, the HD-Book DTT does not endorse the E-Book specifications concerning the transmitted signal (which principally concerns networks operators and not receiver manufacturers) and expects that receivers shall be compatible with all DVB legal configurations and signalling. This is to great extent due to the fact that the E-Book is not adapted to the specific structure of digital terrestrial broadcasting in Italy.

5.3. Graceful Degradation

A receiver compliant with this specification shall implement a “graceful degradation” mechanism for specific unsupported (optional) features and shall behave as follows:

- the receiver shall not unexpectedly terminate the current runtime application
- the receiver shall not hang up
- the user shall be unaware of any exception thrown by the middleware (for applications conforming to the HbbTV specification), but shall be informed of the unavailability of the requested service or functionality on the receiver.

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6. Basic requirements

6.1. Front End & Signal Decoding

6.1.1. Terrestrial Front End

The Italian DTT network is still evolving. Receivers must support a range of transmission parameters and modes to allow for changes in the use of the allocated spectrum.

Receivers MUST meet minimum performance criteria to maximise both network coverage and the reliability of receivers acquired by consumers in the retail market.

The receiver SHALL support the signal characteristics specified in the following.

A receiver capable of receiving DVB-T2 broadcasts [47] SHALL also be capable of receiving DVB-T broadcasts [13]. Such a receiver is in the following referred to as “T2-IRD”, when there is a need to differentiate such a receiver from a receiver supporting DVB-T only. The T2-IRD shall automatically detect whether DVB-T or DVB-T2 signal is being used in the specific channel.

Feature	Specification	Comment
DVB-T		
Channel Bandwidth	- 7 MHz in Band III (European VHF channel allocation) - 8 MHz in Band IV-V (UHF)	Ref. : [2] Since July 2009, according to resolutions taken at Regional Radio Conference GE06, Italy has adopted 7MHz bandwidth in Band III with European channel allocation [32]
Digital demodulation	COFDM DVB-T (EN 300 744)	Ref. : [2]
Transmission mode	2k and 8k	Ref.: [2]
Constellation Combinations	QPSK, 16-QAM, 64-QAM, hierarchical 16-QAM, hierarchical 64-QAM)	Ref.: [2]
Code rates	1/2, 2/3,3/4, 5/6 or 7/8	Ref.: [2]
Guard Interval	1/4, 1/8, 1/16 or 1/32	Ref.: [2]
Hierarchical Modulation	Alpha=1, 2 or 4 (where applicable)	Ref.: [13] The receiver is required to demodulate and present all and only the services that it is able to handle among those possibly available in both high (HP) and low priority (LP) streams.
Noise Figure (NF)	Better than 7 dB Note: for dual or multiple internal tuners a NF better than 8 dB is highly recommended for implementation.	Ref.: [56] [28] Same as §12.7.3 in E-Book [8]. 1 dB better than in [2].
Implementation Margin	Better than 3 dB.	Ref.: [2]

Feature	Specification	Comment
Minimum signal level	The demodulator operates on Gaussian channel at QEF performance (i.e. BER less than $2x10^{-4}$ after convolutional decoding and before Reed-Solomon decoding) with a minimum input signal of -78.2dBm across the whole UHF range (8k, 64 QAM mode, 2/3 code rate, Tg/Tu ¼, 8dB NF and 7.61MHz bandwidth).	Ref.: [2], [77], [78]. See Annex B. The value -78.2 dBm is the value mandated in [2], under the main hypothesis of NF=8 dB.
Maximum Signal Level	Greater than -28 dBm (80 dBµV on 75 Ohm) without degrading the signal (Implementation Margin).	Ref.: [2] Even with a strong reduction in the power transmitted, in the hypothesis of an antenna gain of 12 dB and a cable loss of 4 dB there could be levels reaching the receiver of -35dBm (73 dBµV on 75 ohm) and of the order of -25, -30 dBm. The deliberation of AGCOM reports: "The front end must operate with an over-specified Implementation Margin [note of the editor: equivalent to 3dB] with maximum signal of -35dBm."
Resistance to interference (analogue and digital) co-channel, on adjacent channel and from LTE signals in 800 MHz Band.	Reference values on resistance to interference (analogue and digital) from other channels are contained in [2]. Reference on resistance to interference from LTE signals in 800 MHz Band is the NorDig Unified ver. 2.5.1, chapter 3.4.10.6.2 "Immunity to 800 MHz LTE signals in other channels" [78].	It's expected that the DVB-T receiver permits an interfering DVB-T/T2 signal with (minimum) interference to signal level ratio (I/C) of 38 dB when the interference is on +/-2 channels (Band IV and V UHF, 8MHz BW), while maintaining QEF reception for DVB-T modes 64QAM, GI 1/4, code 2/3 and 3/4. See also [78], paragraph 3.4.10.6.1 and Table 3.16.
Behaviour in the presence of two static (distant) echoes	The receiver correctly operates in the presence of two static echoes (i.e. 2 paths) with a relative delay in a range of 0,2 µs. and 0,9 times the duration of the guard interval, independently of the value of the amplitude and of the relative phases. This requirement applies to all possible modes.	This is the minimum requirement if one wants the receiver to also operate in a Single Frequency Network as well. The minimum performance and test profile are those presented in E-Book [8], §12.7.8.1
Behaviour in the presence of short echoes	In the presence of echoes of matching levels, the demodulator operates with an implementation margin of 3.5 dB when the channel profile corresponds to that reported in EN 300 744 [13] (Rice and Rayleigh profiles using the six strongest rays). In the presence of an echo at 0 dB, in the absence of noise, to the limit of the guard interval, and for any guard interval, the demodulator operates with QEF performance in the 64 QAM mode and with 2/3 code rate.	Ref: [13] [2] The minimum performance and test profile are those presented in E-Book [8], §12.7.8.2
Change of modulation parameters	At least code rate, time guard and constellation changes shall be automatically detected	Network(s) evolution shouldn't impact existing services

Feature	Specification	Comment
Demultiplexing	MPEG-2 System Transport Stream	Ref.: [9]
DVB-T2		
Channel Bandwidth	- 1.7 MHz (OPTIONAL) - 7 MHz (European VHF channel allocation) in Band III - 8 MHz in Band IV-V (UHF)	Since July 2009, according to resolutions taken at Regional Radio Conference GE06, Italy has adopted 7MHz bandwidth in Band III with European cannel allocation [32] [2]
Digital demodulation	COFDM DVB-T2	Ref. : [47] [2]
Transmission mode	1K, 2K, 4K, 8K normal and extended, 16K normal and extended, 32K normal and extended	Ref.: [47] [2] - For 8 MHz DVB-T2 signal, a normal carrier mode corresponds to a signal bandwidth of 7.61 MHz and an extended carrier mode corresponds to a signal bandwidth of 7.71 MHz for FFT size of 8K and 7.77 MHz for FFT size of 16K and 32K. - For 7MHz DVB-T2 signal, a normal carrier mode corresponds to a signal bandwidth of 6.66 MHz and an extended carrier mode corresponds to a signal bandwidth of 6.80 MHz. - For 1.7 MHz DVB-T2 signal, a normal carrier mode corresponds to a signal bandwidth 1.54 MHz and an extended carrier mode corresponds to a signal bandwidth of 1.57 MHz
Constellation Combinations	QPSK, 16-QAM, 64-QAM, 256-QAM, both rotated and non-rotated	Ref.: [47] [2]
FEC Frame length	64800, 16200	Ref.: [47] [2]
Code rates	1/2, 3/5, 2/3, 3/4, 4/5, 5/6	Ref.: [47] [2]
Pilot pattern	PP1, PP2, PP3, PP4, PP5, PP6, PP7	Ref.: [47] [2]
Guard Interval	1/128, 1/32, 1/16, 19/256, 1/8, 19/128, 1/4	Ref.: [47] [2]
Single/Multiple PLP	Both	Ref.: [47] [2] The receiver is required to demodulate and present all and only the services that it is able to handle among those possibly available. Input Mode A (single PLP) or Input Mode B (Multiple PLPs – Common PLP, Type 1 and 2 up to the maximum allowed figure 255)
Time interleaving	$2^{19}+2^{15}$ OFDM cells for a data PLP and its common PLP together	Ref.: [47] [2]

Feature	Specification	Comment
PAPR	All possible configurations: - No PAPR - ACE-PAPR only - TR-PAPR only - both ACE and TR	Ref.: [47] [2]
SISO/MISO	Both	Ref.: [47] [2]
Time Frequency Slicing (TFS)	Not required	Ref.: [47] [2]
FEF parts and Auxiliary streams	The receivers are not required to demodulate or decode the content of FEF parts and auxiliary streams, but the existence of FEFs and/or auxiliary streams shall not cause receiver to malfunction. Receivers are required to ignore the possible presence of a T2-TX-SIG signal.	Ref.: [47] [2] See Annex A. Note: The 'auxiliary-stream" and the 'FEF' methods described in [75] are complementary and may, if desired, be used in combination.
T2-Lite	The receivers are not required to demodulate or decode the content of T2-Lite signals, but the existence of T2-Lite signals shall not cause the receiver to malfunction. Receivers are required to ignore the possible contemporary presence of a T2-Lite and a T2-TX-SIG signal. Optionally, the receiver can also demodulate and present the list of available T2-Lite services. For this feature: • The characteristic of the T2-Lite signals shall comply with [47] and [48], including all the limitations in terms of Modulation, Mode, PLP data rate and T2-Lite receiver buffer model. • Only the T2-Lite signals that use one of the T2-Base code-rates (1/2, 3/5, 2/3, 3/4, 4/5, 5/6) are considered. The case of T2-Lite signals that use the T2-Lite additional code-rate "1/3" or "2/5" is out of scope.	Ref.: [47][48][75] See Annex A Note: • T2-Lite signals can be transmitted as "stand alone" signals i.e. in a multiplex dedicated to T2-Lite. • For the combination of T2-Lite and T2-Base in the same multiplex, T2-Lite is transmitted in the FEF of T2-Base and vice versa. • Alternatively the content of the above "T2-Lite services" can be transmitted in a separate PLP to the above "T2-Base services" but this PLP is subject to the range and limitations of the range of modcod parameters available to the T2-base transmission. The same FFT size and guard interval must be used for both PLPs and the "1/3" and "2/5" T2-lite code rates cannot be used. In this case no FEF mechanism is required.
Resistance to interference (analogue and digital) co-channel,on adjacent channel and from LTE signals in 800 MHz Band.	See Annex A	Ref.: [56][78]
Noise Figure (NF)	Better than 6dB Note: for dual or multiple internal tuners a NF better than 7 dB is highly recommended for implementation	Ref.: [28] [78]
C/N Performance	See Annex A	

Feature	Specification	Comment
Minimum signal level	The receiver SHALL provide QEF reception for the following minimum signal levels (P_{min}): For 7MHz Normal/Extended Bandwidth: P_{min} = -105.7dBm + NF [dB] + C/N [dB] For 8MHz Normal Bandwidth: P_{min} = -105.2dBm + NF [dB] + C/N [dB] For 8MHz Extended Bandwidth: P_{min} = -105.1dBm + NF [dB] + C/N [dB]	[78] with C/N values given in Annex A
Demultiplexing	MPEG-2 System Transport Stream	Ref.: [9]

Table 1: Terrestrial front end features table

6.1.2. Satellite Front End

Receivers SHALL meet minimum performance criteria to maximise both network coverage and the reliability of receivers acquired by consumers in the retail market.

The receiver SHALL support the following signal characteristics on the satellite side:

Feature	Specification	Comment
DVB-S		
Digital demodulation	QPSK	[1]
LNB	Power: Vertical: +13V, Horizontal: +18V 22Khz Tone DiSEqC: Version 1.2 is mandatory Unicable v1 (SCR) and v2 (dCSS) SHALL be supported	[54][57][62][72][83] DiSEqC Version 1.2 is required for controlling motorized antennas; SCR and dCSS for distributing satellite signal to multiple (respectively up to 8 and 32) receivers using a single coaxial cable (dCSS is backward compatible with SCR).
Symbol Rate	7.5 to 45 MSymbols/s	[78]
FEC mode	1/2, 2/3, 3/4, 5/6, 7/8	[1]
Signal Level	-25 dBm to -65 dBm	[78]
Frequency Range	10.7 to 12.75 GHz	[78]
Change of code rate	Code rate changes SHALL be automatically detected	Network(s) evolution shouldn't impact existing services
RF Performance	Es/No to be 3.8/5.6/6.7/7.7/8.4 dB respectively for CR 1/2, 2/3, 3/4, 5/6, 7/8	[78]
Demultiplexing	MPEG-2 System Transport Stream	[9]
DVB-S2		
Digital demodulation	QPSK, 8PSK	[55]
LNB	Same as DVB-S	
Symbol rate	7.5 to 45 Msymb/s (QPSK) 5 to 30 Msymb/s (8PSK)	[78]
FEC mode	½ (only for QPSK), 3/5 (only for QPSK and 8PSK), 2/3 (only for QPSK, 8PSK), 3/4, 4/5, 5/6, 8/9, 9/10	[55]
Signal Level	-25 dBm to -65 dBm	[78]
Frequency Range	10.7 to 12.75 GHz	[78]
Roll off	0.20, 0.25, 0.35	[55]

Feature	Specification	Comment
Pilot aided demodulation	Yes	[55]
RF Performance	Es/No to be 2.0, 3.2, 4.1, 5.0, 5.7, 6.2, 7.2, 7.4 dB respectively for CR 1/2, 3/5, 2/3, 3/4, 4/5, 5/6, 8/9, 9/10 (QPSK) Es/No to be 6.5, 7.6, 8.9, 10.4, 11.7, 12.0 dB respectively for CR 3/5, 2/3, 3/4, 5/6, 8/9, 9/10 (8PSK)	The figures include an implementation margin of 1dB specified by Nordig [78]
Demultiplexing	MPEG-2 System Transport Stream	Support of multiple TS [55] is RECOMMENDED.

Table 2: Satellite front end mandatory features table

UHD receivers MAY support the following signal characteristics on the satellite side:

Feature	Specification	Comment
DVB-S2X		
Digital demodulation	*QPSK, 8PSK, 8APSK-L, 16APSK, 16APSK-L, 32APSK, 32APSK-L*	*[17]*
LNB	*Same as DVB-S*	
Symbol rate	*From 5 MBaud to 45Mbaud*	
FEC mode	*QPSK: 1/4,1/3, 2/5, 1/2, 3/5, 2/3, 3/4, 4/5, 5/6, 8/9, 9/10 (S2-MODCODs); 13/45; 9/20; 11/20* *8PSK: 3/5, 2/3, 3/4, 5/6, 8/9, 9/10 (S2-MODCODs); 23/36; 25/36; 13/18* *8APSK-L: 5/9;26/45* *16APSK: 2/3, 3/4, 4/5, 5/6, 8/9, 9/10 (S2-MODCODs); 26/45; 3/5; 28/45; 23/36; 25/36; 13/18; 7/9; 77/90* *16APSK-L: 5/9; 8/15; 1/2; 3/5; 2/3* *32APSK: 3/4, 4/5, 5/6, 8/9, 9/10(S2-MODCODs); 32/45; 11/15; 7/9* *32APSK-L: 2/3*	*[17] FEC FRAME is limited to 64,800 bits.*
Signal Level	*Same as DVB-S2*	
Frequency Range	*Same as DVB-S2*	
Roll off	*0.05, 0.10, 0.15, 0.20, 0.25, 0.35*	*[17]*
Pilot aided demodulation	*Yes*	*[17]*
RF Performance	*Es/No performance for a single carrier shall comply with the requirements given in [17] plus an implementation margin, less than 1 dB*	*[17]*
CCM/VCM	*Support of Variable Coding and Modulation in addition to Constant Coding and Modulation*	*[17] Any DVB-S2X receiver shall be able to recognize the whole set of MODCODS within the PLHeader and skip the XFECFrame if the MODCOD is not supported."*
Channel Bonding	*In the case of optional multiple tuner receivers, up to 3 bonded transponders*	*[17]*
Demultiplexing	*Support of multiple Transport Streams*	*[17]*

Table 3: Satellite front end optional features table

NOTE: DVB S2X transmissions are not anticipated in Italy before 2020. At the time of editing this specification, there are no S2X capable receivers available in the market. This trend is anticipated to stay unchanged in the medium term. Broadcasters intending to use DVB S2X for transmissions need to take into account that their services will not be received by the large majority of installed devices.

6.1.3. Signal Decoding

Feature	Specification	Comment
HD receivers		
Audio Decoder	The following standards SHALL be supported: - MPEG-1 Audio Layer I & II [5] - HE-AACv1 up to level 2 for stereo and level 4 for multichannel (5.1) - AC-3 (aka Dolby Digital) - Enhanced AC-3 (aka Dolby Digital Plus) up to 5.1 channels [6] The following standards SHOULD be supported: - AC-4 up to Level 3 ([9] – clause 6.7.2) Receivers SHALL support audio description in the following formats as per [10]: - MPEG-1 L2 broadcaster mix - MPEG-1 L2 receiver mix - HE-AACv1 and Enhanced AC3 receiver mix Receivers SHOULD support audio description in the following format as per [10]: - AC-4 receiver mix Receivers MAY support other modes of audio description. Receiver MAY support "clean-audio" in broadcaster-mix format.	Ref.: [9] Full decoding of stereo transmissions is *MANDATORY* for any of the standards listed aside. PCM Stereo downmix of 5.1HE-AACv1, AC-3 or Enhanced AC-3 transmissions is *MANDATORY*. Presentation of the downmixed analog signal on SCART and RCA outputs (if present) is *MANDATORY*. Transcoding of 5:1 HE-AACv1 transmissions to AC-3 or DTS and of Enhanced AC-3 transmissions to 5:1 AC-3 signal is MANDATORY unless the receiver provides a minimum 5 channel audio reproduction system capable of driving at least 5 speakers. If the receiver is capable of decoding AC-4 transmissions it SHALL also be capable of transcoding those streams to 5.1 Enhanced AC-3 or 5.1 AC-3, unless the receiver provides a minimum 5 channel audio reproduction system capable of driving at least 5 speakers. Presentation of the transcoded or native AC-3 signal on SPDIF output (if present) is MANDATORY.
Audio Multi-Language	Language shall be selectable.	Behaviour as specified in §7.5.2

[5] It is expected that this old and inefficient audio codec will remain confined to legacy SD services on DVB-T and it will not be used on DVB-T2 alongside advanced video codecs like H.264/AVC and HEVC.
[6] It is expected that the Enhanced AC-3 codec should be used for DVB-T2 services, alongside advanced video codecs like H.264/AVC and HEVC. Older and less efficient codecs such as AC-3 are not recommended for DVB-T2 services. It must be noted that any Enhanced AC-3 receiver is also, by design, an AC-3 receiver

Feature	Specification	Comment
Video Decoder (SD mode)	MPEG-2 Video Main Profile @ Main Level and H.264/AVC High Profile @ Level 3 (576i25) SHALL be supported. Colour space: according to BT.601 Video Format: 720x576i25 Chroma subsampling: 4:2:0 Video Aspect Ratio: 4:3; 16:9.	Ref. : [9], [2] The support of a picture aspect-ratio conversion function to transform programmes broadcast in the format 16:9 to 4:3 (and vice-versa) is mandatory. The receiver shall follow indications given by the Active Format Descriptor, if present (see §6.3.4)
Video Decoder (HD mode)	H.264/AVC High Profile @ up to Level 4 support is MANDATORY for the following conformance points: - 1080i25 - 1080p25 [7] - 720p50 - 720p25 - 576p50 [8] HEVC Main 10 Profile @ up to Level 4.1 support is MANDATORY [9] for the following conformance points (16:9 aspect ratio): - 1080p50 - 720p50 - 540p50 [10]. Colour space: according to BT.709 Chroma subsampling: 4:2:0 Video aspect ratio: 16/9	Ref.: [8], [9]
UHD receivers		
Audio decoder	*Further to the audio formats specified above for HD receivers, UHD receivers SHALL also support the following standard:* - *AC-4 up to Level 3 ([9] – clause 6.7.2)* *Receivers SHALL support audio description in the following format as per [10]:* - *AC-4 receiver mix*	*Ref.: [9]* *Full decoding of stereo transmissions is MANDATORY for any of the standards listed aside.* *PCM Stereo downmix of AC-4 transmissions is mandatory. Presentation of the downmixed analog signal on SCART and RCA outputs (if present) is MANDATORY.* *Transcoding of AC-4 to 5.1 Enhanced AC-3 or 5.1 AC-3 is MANDATORY unless the receiver provides a minimum 5 channel audio reproduction system capable of driving at least 5 speakers.* *Presentation of the transcoded or native AC-3 signal on SPDIF output (if present) is MANDATORY.*

[7] Broadcasters might be interested into this format for certain applications
[8] Broadcasters might consider this format (Enhanced Definition TV) for new H.264/AVC SD services.
[9] Support for HEVC Tiles and WPP (Wavefront Parallel Processing) is OPTIONAL
[10] 720p50 and 540p50 (16:9 aspect ratio) are two formats which broadcasters might consider for new HEVC near-SD services.

Feature	Specification	Comment
Audio Multi-Language	*Language shall be selectable.*	*Behaviour as specified in §7.5.2*
Video Decoder	*Further to the video formats specified above for HD receivers, UHD receivers SHALL also support DVB's UHDTV contents, which call for HEVC Main 10 Profile @ Level 5.1 video decoding capabilities, according to the following conformance points defined in [9]:* *1. "HEVC UHDTV IRDs" with the following parameter limitations:* *o Video formats: 3840x2160,3200x1800, 2560x1440* *o Frame rate: 25 and 50 Hz progressive scan* *2. "HEVC HDR UHDTV IRDs using HLG10" with the following parameter limitations:* *o 3840x2160,3200x1800, 2560x1440, 1920x1080,1600x900, 1280x720, 960x540* *o Frame rate: 25 and 50 Hz progressive scan* *3. "HEVC HDR UHDTV IRDs using PQ10" with the following parameter limitations:* *o Frame rate: 25 and 50 Hz progressive scan*	*Ref.: [9]* *It must be noted that conformance point 1) allows for both BT.2020 [74]and BT.709 [81] colour spaces while conformance points 2) and 3) require BT.2020 colour space.* *Conformance point 2) provides backwards compatibility with receivers that can receive signals compliant to conformance point 1).* *Note that signals at HD resolution formatted according to conformance point 2) are not backwards compatible with HD receivers only supporting BT.709 colour space, due to the colour space mismatch.*

Table 4: Signal decoding features table

6.2. Interaction Channel

Support to interactive TV, with specific reference to true interactive services, including media delivery over broadband (IP) connections, is deemed of paramount importance for HD receivers. Therefore

- Both STB and iDTV receivers SHALL have at least one wireline interaction channel

Two families of interaction channel implementations are in fact considered[11]:

- wireline interaction channel
- mobile interaction channel.

It is up to the manufacturer to implement, as an option, a mobile interaction channel in addition to the wireline default one.

In the scope of this document "broadband (IP) connections" are best-effort Internet connections offered by ISPs. In other words, the services enabled by this addendum don't strictly require a connection to the (managed) network of an IPTV Service Provider.

Media contents can be delivered over broadband (IP) lines either as linear services or as Content on Demand (CoD) type of services.

A linear IP service simply reproduces on a broadband connected receiver the same user experience of a conventional DVB service: it can be selected directly through the remote (via

[11] this classification refers to the technology used to access the public network: so for instance a receiver connected via a Wireless LAN to an ADSL modem/router fits into the wireline interaction channel family

numeric keys or Ch+/Ch- button) or from an EPG; always through the remote user can get information about current and next events, select among different audio languages, turn subtitles on/off, etc.. Consumption of the content is started from the point where user “tuned” into.

Content on Demand (CoD) service is a service where a user can select the individual content items they want to watch from a list of available contents. Consumption of the content is started upon user request.

2 types of CoD services are addressed in the following:

- Streamed CoD services, where content is consumed while the content itself is being delivered (real-time streaming)
- Download CoD services, where the whole content has to be downloaded first to the local storage in the receiver before consuming it. Consumption is then independent of the delivery.

Support of Streamed CoD services is MANDATORY.

Support of Download CoD services is RECOMMENDED in receivers with internal or external storage capabilities.

6.2.1. Wireline interaction channel

A wired or wireless (IEEE 802.11 b/g/n) Ethernet port for connecting to broadband access services (e.g. ADSL, FTTH) through a residential gateway (e.g. ADSL modem, ADSL modem/router, FTTH termination) would offer the user the full potential of interactivity, through always-on and broadband capabilities.

From the application viewpoint, Ethernet connections can be seen either as LAN (connectionless) or virtual dial-up connections. The former is mandatory, whereas the latter, which requires support for PPPoE by the receiver, is optional.

Feature	Specification	Comment
Ethernet	IEEE 802.3 10/100 Mbit/s autosense	
IP address	IPv4 (MANDATORY) or IPv6 (RECOMMENDED) address obtained either: • via DHCP or • manually	DCHP shall be the factory default. For manual configuration it shall be possible to insert from the resident menu: ▪ static IP address ▪ Subnet Mask value ▪ Default Gateway’s IP address ▪ Primary and Secondary DNS Server’s IP address
Optional Supplementary Protocol	PPPoE [29]	For virtual dial up. The resident menu shall allow to introduce username and password
Basic communication protocol	HTTP 1.1 [44] SHALL be supported. HTTP REDIRECT SHALL be supported.	
Secure communication protocol	HTTPS [63] SHALL be supported.	Embedding of TLS root certificates listed in [68] is RECOMMENDED
HTTP Proxy	A resident menu for defining an HTTP proxy server is RECOMMENDED.	

Feature	Specification	Comment
Protocols for streaming	Unicast streaming using HTTP 1.1 [44] SHALL be supported as defined in clause 5.3.2.2 of the OIPF Protocols specification [45]. In order to reduce unnecessary network usage, by allowing partial retrieval for use in cases such as trick play or seek operations, the Range HTTP header in a GET request form SHALL be supported. Unicast streaming using HTTPS [63] SHALL be supported as well. HTTP REDIRECT SHALL be supported. Dynamic Adaptive Streaming over HTTP (DASH) solution specified by MPEG [60] SHALL be supported, both for free and DRM protected contents.	To optimize the streaming user experience over best-effort broadband lines when DASH is not used, the receiver SHALL implement proper buffering and playback strategies to cope with varying network conditions. The details of such strategies are implementation dependant. Maximum bit rate of video delivered over broadband (IP) lines that the receiver SHALL be able to correctly decode and present for Streamed CoD services is 8 Mbit/s (HTTP) and 5 Mbit/s (HTTPS). Receivers SHALL support the ISOBMFF Live and On Demand Profiles defined in MPEG-DASH, as further profiled by DVB as DVB-DASH [64] and by HbbTV in HbbTV 2.0.1 [6]. In particular, linear IP services are implemented using DVB-DASH Live Profile. *Furthermore, UHD receivers SHALL support HDR extensions introduced in [65], which is aligned to [3].*
Protocols for download	If content download is supported, HTTP SHALL be supported as defined in clause 5.2.3 of the OIPF Protocols specification [45].	
Media formats	See Table 6	Further to the constraints specified in [9], those specified for Video and Audio formats in clauses 5 and 8 of OIPF Media Formats specification [43] apply. Some restrictions on the media types allowed within some specific container may apply (see below).
Media container	For delivery of media contents over broadband (IP) lines the following standard container formats SHALL be supported: - MPEG-2 Transport Stream (TS) - MPEG-4 File Format (MP4) [42]	Further to the constraints specified in [9], those specified for “TS system layer format” in clause 4.1 of OIPF Media Formats specification [43] apply. In particular, only a single program SHALL be contained in the Transport Stream container. The TS SHALL contain only one Program Map Table (PMT).
Subtitles	For media contents delivered in TS container the DVB Subtitles format SHALL be supported. For media contents delivered in a MPEG-4 File Format (MP4) container the following subtitle format SHALL be supported: - EBU-TT-D [70]	Subtitles delivered via HTTP Progressive Download or via DASH SHALL be encapsulated in ISOBMFF container [61] in accordance to EBU Carriage of EBU-TT-D in ISOBMFF [71]. Delivery of EBU-TT-D subtitles as a separate document in a single file is supported in the context of HbbTV 2.0.1 [6].

Feature	Specification	Comment
Content Access	The Content Access Streaming Descriptor structure with the syntax and MIME type defined in Annex E.2 of the OIPF DAE specification [73] SHALL be supported to describe content available for streaming.	"The content access descriptor has an optional <ParentalRating> element which can be used to carry parental rating information associated with the content that it references." (see §8.2.2)

Table 5: Wireline interaction channel features

The media formats to be supported within each container type are the following ones:

		Container	
Media Format		TS	MP4/DASH
Video	MPEG-2 Video Main Profile @ Main Level	X	
	All formats specified in Table 4 for HD receivers plus H.264/AVC Baseline Profile @ Level 2 minus MPEG-2 Video Main Profile @ Main Level		X
	All formats specified in Table 4 for UHD receivers		*X*
Audio	MPEG-1 Audio Layer I & II[12]	X	
	All formats specified in Table 4 for HD receivers but MPEG-1 Audio Layer I & II	X	X
	All formats specified in Table 4 for UHD receivers but MPEG-1 Audio Layer I & II	*X*	*X*
Teletext	EBU Teletext carried in DVB streams	X	
Subtitles	DVB Subtitles	X	
	EBU-TT-D Subtitles		X

Table 6: Container/media compatibility matrix

Regarding DASH, it must be noted that all video formats listed above are supported by HbbTV 2.0.1 [6] but 576p25, which is required for backward compatibility with previous versions of this document [25] and with legacy contents.

UHD receivers SHALL also support UHDTV contents, as defined in and Table 4, delivered via IP (TS and MP4 container, including the DASH case),

Maximum bit rate of UHDTV video delivered over broadband (IP) lines that UHD receivers SHALL be able to correctly decode and present for Streamed CoD services is 25 Mbit/s (HTTP).

In order to make video encoded with H.264/AVC Baseline Profile decodable also by a Main/High Profile decoder, support of AVC error resilience tools included in Baseline Profile is OPTIONAL (i.e. `constraint_set1_flag` is equal to "1" in case of Baseline Profile).

Particular cases of "self-contained" contents which can be delivered over broadband (IP) lines are audio-only streams. The following formats SHALL be supported for such streams:

- MPEG-1 Audio Layer III
- HE-AACv1
- AAC-LC

Audio-only streams based on the latter two formats can be carried either using Audio Data Transport Stream (ADTS) [67] or within the MPEG-2 TS and MP4 containers.

[12] It is expected that this old and inefficient audio codec will not be used alongside advanced video codecs like H.264/AVC and HEVC.

Usage of MPEG-1 Audio Layer III is restricted to audio-only streams, i.e. it will not be used for audiovisual streams, either broadband or broadcast.

For the sake of backward compatibility with DASH profile defined in previous HD-Book versions, implementations SHOULD comply with the following additional constraints:

- In case of ISOBMFF container each 'moof' box SHALL contain only one track fragment box 'traf' and associated media data box 'mdat' SHALL contain only the media samples referenced from that track fragment box
- The Movie Fragment, which consists of a 'moof' box and a 'mdat' box, SHALL correspond to a Segment element in a DASH MPD.
- Representations described in a MPD MAY be organized in up to 16 different <AdaptationSet> elements for each Period
- In each <AdaptationSet> element is possible to describe no more than 16 different representations for video/audio tracks
- In case of multiple <AdaptationSet> elements containing different video representations the receiver can select the first one it is able to present
- In case of multiple <AdaptationSet> elements for the same media component (e.g.: video) the receiver SHALL select by default the one with a Role element with a value of "main" according to urn:mpeg:dash:role:2011 scheme. If such a Role element is not defined the receiver can select the first <AdaptationSet> element it is able to present
- Representations included in an <AdaptationSet> element MAY vary in terms of codec Profile@Level, Resolution, and Bitrate
- Media Segments SHALL have a minimum duration of 2s, except for the last media segment which MAY be shorter.

6.2.2. Mobile interaction channel

Any advanced packet-switched mobile connection (e.g. GPRS over EDGE, HSDPA, LTE, …) can be used as mobile interaction channel.

6.3. I/O Connectors

6.3.1. Mandatory Connectors

The following connectors shall be present in any applicable receiver (see comments).

Connector	Specification	Comment
Input RF connector.	Input: Female, 75 Ohm [82] for DTT, [84] for SAT	Tuner input.

Connector	Specification	Comment
SCART Connector (Primary)	Peritelevision standard [4] • RGB • CVBS: PAL Out • Audio Output A/V Control Pin 8	For connection to old TV sets. Only applicable to STBs. As an option, the user menu may offer the possibility to output a Y/C signal instead of the RGB signal. In case of HD or UHD signal, the downsampled SD version has to be presented on this output, both in composite and component mode, with the same user settings defined in the menu page for connection to 4:3 or 16:9 TV sets. Teletext reinsertion on VBI is required (see §8.1.2). The stereo output pins will carry one of the following: • a mono or stereo signal, in the case of the received audio component being mono or stereo; • a two channel downmixed signal, in the case of the received audio component being multi-channel. *SCART Connector is OPTIONAL on UHD STBs.*

Connector	Specification	Comment
Output HDMI Connector with HDCP content protection	Type A (Female) [38] Automatic audio/video sync is required. Support of HDMI-CEC is MANDATORY. HDCP [39] must be ON by default. 1080p50 is the recommended default output format. *HDMI output(s) on UHD STBs SHALL support HDMI version 2.0b [79] and HDCP version 2.2 Copy Protection [80] when they output with a resolution higher than 1920X1080 a UHD signal as specified in §6.1.2.1.* NOTE: When HDCP2.2. is supported by the HDMI sink , it is highly recommended to keep HDCP 2.2 protection constant for all the services to avoid delays when switching channel.	For digital connection of STBs to HD Ready or HD Ready 1080p or UHD displays. According to DIGITALEUROPE HD TV and HD TV 1080p logos' requirements, a "dynamic" output (unscaled) mode shall be available where the HD output format (720p50 or 1080i25) will match the HD transmission format (720p50 or 1080i25 respectively) based on EDID. By avoiding possible (even multiple) format conversions, such mode would in theory provide the best video quality. But due to limitations in early HDMI/HDCP implementations it would likely cause some substantial extra delay, with respect to a fixed 720p50 or 1080i25 output setting, when moving between services or events with different HD or SD transmission formats. For these reasons, the dynamic output mode SHALL be available in user menus but not necessarily as the default value. In order to possibly minimize the number of cascaded conversions, when dynamic output mode is selected SD output towards HD Ready or HD Ready 1080p displays SHALL be set to 576p50. *To allow connection of UHD STBs to legacy HD displays it SHALL be possible setting output resolution via system menus to UHD (default) or HD (1920x1080).* *UHD capable STBs outputs UHD video signals, when set to do so:* *- with a resolution of 3840x2160 pixels* *- at frame rates 25p and 50p* *- with a minimum supported bit depth of 8 bits* *- at a chroma sub-sampling rate of 4:2:0 for 50p and 4:2:2 for 25p* *- with minimum supported colorimetry according to BT.709 [81]*

Connector	Specification	Comment
Input HDMI Connector with HDCP content protection	Type A (Female) [38] E-EDID support, including HDMI VSDB (Vendor-Specific Data Block) Lipsync-related fields, is required. Support of HDMI-CEC is MANDATORY. HDCP [39] must be ON by default.	For digital connection of STBs to TV sets. Support of HDMI ARC (Audio Return Channel) specified in [38] is MANDATORY at least on one input unless Output SPDIF Connector, per §6.4.2, is present. *HDMI input(s) on UHD TV sets SHALL support HDMI version 2.0b [79] and HDCP version 2.2 Copy Protection [80].* *UHD capable inputs accept UHD video signals:* *- with a resolution of 3840x2160 pixels* *- at frame rates 25p and 50p* *- with a minimum supported bit depth of 8 bits* *- at a chroma sub-sampling rate of 4:2:0 for 50p and 4:2:2 for 25p* *- with minimum supported colorimetry according to BT.709 [81]*
Ethernet Port	RJ 45 Connector	Mandatory for receivers with wireline interaction channel also in case they provide (in-house) wireless access [13].
Smart card slot	ISO 7816 1,2,3 with T=0 and T=1	For CA and non-CA applications. Mandatory unless a CIplus slot is available.
Common Interface (CI Plus)	EN 50 221, as explained in Chapter 8, with CI Plus extensions [37]	Applicable and mandatory only for iDTVs with screen diagonal over 30cm (13”).
USB Port (Host)	USB Type A Connector	Compliant with USB 2.0 or later specification [52]. For user-managed software upgrade and/or for attaching external storage media

Table 7: Mandatory connectors table

6.3.2. Optional Connectors

The following table includes a non-exhaustive list of connectors which might be present in some receivers. When present the specifications given therein do apply.

[13] An USB port could actually turn into an Ethernet (wired or wireless) or advanced mobile (GPRS, EDGE, UMTS, HDSPA) port through a suitable adapter but the sole presence of such a port doesn’t fulfil the requirement. A receiver with USB port will be considered compliant with this requirement only if the aforementioned adapter would come bundled with the receiver itself.

Connector	Specification	Comment
Output RF connector (DTT pass-through)	Male, 75 Ohm [82]	"Loop through" facility. Only applicable to STBs. Necessary to transmit the signal from the receiving antenna to a VCR, and/or to a TV set.
Output RF connector (SAT pass-through)	Female, 75 Ohm [84]	"Loop through" facility.
SCART In Connector (1)	Peritelevision standard [4] • RGB In • CVBS: PAL In • Audio In • A/V Control Pin 8	Applicable only to iDTVs, for connecting legacy SD devices.
SCART Connector (Secondary)	• CVBS: PAL Out • Audio: Output • Y-C (super VHS)	Useful to record Digital Channels on a VCR. Such output must not to be affected by OSD (On Screen Display) graphics. Applicable only to STBs. In case of HD signal, the downsampled SD version has to be presented on this output, either/both in composite or/and component mode (if present), with the same user settings defined in the menu page for connection to 4:3 or 16:9 TV sets. Teletext reinsertion on VBI is recommended (see §8.1.2). The stereo output pins will carry one of the following: • a mono or stereo signal, in the case of the received audio component being mono or stereo; • a two channel downmixed signal, in the case of the received audio component being multi-channel.
SCART Connector (Primary)	Peritelevision standard [4] • RGB • CVBS: PAL Out • Audio Output A/V Control Pin 8	For connection to external legacy SD equipment. As an option, the user menu may offer the possibility to output a Y/C signal instead of the RGB signal. In case of HD signal, the downsampled SD version has to be presented on this output, both in composite and component mode, with the same user settings defined in the menu page for connection to 4:3 or 16:9 TV sets. Teletext reinsertion on VBI is required (see §8.1.2). The stereo output pins will carry one of the following: • a mono or stereo signal, in the case of the received audio component being mono or stereo; • a two channel downmixed signal, in the case of the received audio component being multi-channel.

Connector	Specification	Comment
RCA Connectors (Composite)	• 1 Video • 2 Audio (left/ right)	In case of HD signal, the composite downsampled SD version has to be presented on the video output, with the same user settings defined in the SCART menu page for connection to 4:3 or 16:9 sets. Teletext reinsertion on VBI is required. The stereo output connector will carry one of the following: • a mono or stereo signal, in the case of the received audio component being mono or stereo; • a two channel downmixed signal, in the case of the received audio component being multi-channel.
RCA Connectors (Component)	• 3 Video (YPbPr) as per CEA 770.3 • 2 Audio (left/ right)	In case of HD signal, the composite downsampled SD version has to be presented on the video output, with the same user settings defined in the SCART menu page for connection to 4:3 or 16:9 sets. The stereo output connector will carry one of the following: • a mono or stereo signal, in the case of the received audio component being mono or stereo; • a two channel downmixed signal, in the case of the received audio component being multi-channel.
Serial data port (RS-232) 9-pin	D-sub connector Female	
SIM slot	Receptacle for standard SIM. Access to the SIM slot shall not need opening the case of the receiver.	For receivers with mobile interaction channel. The slot may be either inside the receiver box itself or in an external device.
Mobile high gain antenna connector	One of three possible standards • RP TNC female • RP MC Card female • RP SMA female	For receivers with mobile interaction channel.
Output SPDIF Connector	As per [27] with Optical connector.	A second SPDIF output with Electrical (RCA) connector is OPTIONAL. This output may be omitted when the receiver provides a minimum 5 channel audio reproduction system capable of driving at least 5 speakers with a digital bitstream.
Common Interface (CI Plus)	EN 50 221, as explained in Chapter 8, with CI Plus extensions [37]	As an alternative to embedded CA

Table 8: Optional connectors table

6.3.3. Audio outputs matrix

The following matrix specifies which audio shall be presented on which output (if present) of a compliant receiver, based on the received signal, both for broadcast and broadband:

	HDMI (including ARC)	SCART	RCA	SPDIF
Mono/stereo audio (any codec)	Decoded PCM mono/stereo audio	Decoded analog mono/stereo audio	Decoded analog mono/stereo audio	Decoded PCM mono/stereo audio

	HDMI (including ARC)	SCART	RCA	SPDIF
AC-3 5.1 audio	AC-3 5.1 audio or decoded PCM multichannel audio or stereo downmix of multichannel audio, in the given preference order, based on sink's capabilities (as per EDID)	Analog stereo downmix of multichannel audio	Analog stereo downmix of multichannel audio	AC-3 stream
Enhanced AC-3 5.1 audio	Enhanced AC-3 5.1 audio or AC-3 5.1 transcoded stream or decoded PCM multichannel audio or stereo downmix of multichannel audio, in the given preference order, based on sink's capabilities (as per EDID)	Analog stereo downmix of multichannel audio	Analog stereo downmix of multichannel audio	AC-3 5.1 transcoded stream
HE-AAC v1 5.1 audio	AC-3 or DTS 5.1 transcoded stream or decoded PCM multichannel audio or stereo downmix of multichannel audio, in the given preference order, based on sink's capabilities (as per EDID)	Analog stereo downmix of multichannel audio	Analog stereo downmix of multichannel audio	AC-3 or DTS 5.1 transcoded stream
AC-4 audio	*AC-4 or Enhanced AC-3 5.1 audio or* *AC-3 5.1 transcoded stream or* *decoded PCM multichannel audio or* *stereo downmix of multichannel audio, in the given preference order, based on sink's capabilities (as per EDID)*	*Analog stereo downmix of multichannel audio*	*Analog stereo downmix of multichannel audio*	*AC-3 5.1 transcoded stream*

Table 9: Audio channel mapping

It SHALL be possible to change via system menus the default output on HDMI, amongst those notified by the sink via EDID.

6.3.4. Active Format Descriptor

Transmission of this description by the broadcaster is OPTIONAL, but, when present, use of this description by the receiver is MANDATORY.

As explained in Annex B of ETSI TS 101 154 [9] "The Active Format Description (AFD) describes the portion of the coded video frame that is "of interest". It is intended for use in networks that deliver mixed formats to a heterogeneous receiver population. The format descriptions are informative in nature and are provided to assist receiver systems to optimize their presentation of video.

"[…] The AFD is intended for use where there are compatibility problems between the source format of a programme, the format used for the transmission of that programme, and the format of the target receiver population. For example, a wide-screen production may be transmitted as a 14:9 letter-box within a 4:3 coded frame, thus optimized for the viewer of a 4:3 TV, but causing problems to the viewer of a wide screen TV.
The appropriate AFD may be transmitted with the video to indicate to the receiver the "area of interest" of the image, thereby enabling a receiver to present the image in an optimum fashion (which will depend on the format and functionality of the receiving equipment combined with the viewer's preferences).
The AFD itself does not describe the aspect ratio of the coded frame (as this is described elsewhere in the MPEG-2 video syntax)."

The use, by the broadcaster, of this description allows it to optimize the presentation of its program for both 4:3 and 16:9 displays. Therefore, by default, the receiver shall make use of this descriptor. However, the manufacturer may implement a manual override and/or a manual disable.

6.3.4.1. Syntax and Semantics

For standard definition programs, the receiver SHALL recognize AFD transmitted according to [9] Annex B.2.2.

In case of HDTV compatible receiver, the receiver SHALL recognize AFD transmitted according to [9] Annex B.3.2.

6.3.4.2. Valid Values for Descriptor

All values referenced in [9] Annex B "table B.2 active_format" are valid in the broadcast signal.

6.3.4.3. Behaviour of receiver in the presence of AFD

The receiver SHALL behave in accordance with "The DTG Receiver Implementation Guidelines" [35].

NB: AFDs supplement and qualify - but do not replace - the aspect ratio flag carried in the MPEG sequence header of digital broadcasts. Receivers must interpret both the aspect ratio flag and the AFD in order to present the image in the correct manner.

6.3.4.4. Analogue output of the receiver

The receiver should reinsert WSS data in analogue standard definition outputs according to what is specified in [35].

6.3.4.5. AFD and HDMI

Receivers with HDMI output are recommended to provide at least one of the following methods to process aspect ratio and AFD information for video output on HDMI:

- Provide a reformatting function for the video to match the aspect ratio of the display based on AFD, aspect ratio and user preference as per section 6.4.3.5 in [35] (for 16:9 displays). Support for scaling to 4:3 aspect ratio for HDMI is optional (since consumer HD displays are 16:9). Aspect ratio signaling in the HDMI AVI Infoframebits R0..R3, M0, M1 (see CEA-861) shall be set in accordance with the properties of the video on the output.
- Pass the video to the HDMI output unprocessed with respect to AFD and aspect ratio scaling, and pass AFD and aspect-ratio signaling in the video to the HDMI output as part of the AVI Infoframe bits R0..R3, M0, M1 (see CEA-861)

6.4. Remote Control

6.4.1. Introduction

To ensure a common and stable reference for application developers and consumers, it is necessary to specify a certain number of points concerning the remote control. This necessity has been identified and confirmed by different groups (e.g. ETSI STF228 on ”User interoperability criteria”, see [21]).

The points taken into consideration cover aspects of:

- physical layout of the remote
- labelling of the keys
- behaviour on “undo” commands
- interaction of output from the remote with the OSD
- interaction with applications for alpha-numeric input

In all cases where possible, the requirements are based on specifications produced by other bodies. Lastly this chapter contains some advice on good remote control design, taken from extensive research conducted elsewhere. It is highly recommended manufacturers follow this advice – for the benefit of the consumer.

Unlike vertically integrated digital platforms it is not possible to mandate a single remote control design. However, it is essential to have a common minimum of remote-control functionality to ensure that all broadcast services – and in particular interactive applications - are available to the viewer as intended by the broadcaster. In addition, any labelling used needs to be consistent, both to allow the inclusion of on-screen instructions in broadcast services and to enable an easy dialogue with any support staff, e.g. call-centres.

6.4.2. Overview

The mandatory keys and key events available to the application are very limited, and thus keys and key event may vary from manufacturer to manufacturer. Even if all necessary (for the consumer and the applications) keys are present on the remote, there is no obligation to make the events available to the application.

6.4.3. Generic functional description of the remote control

The remote control is used for different purposes:

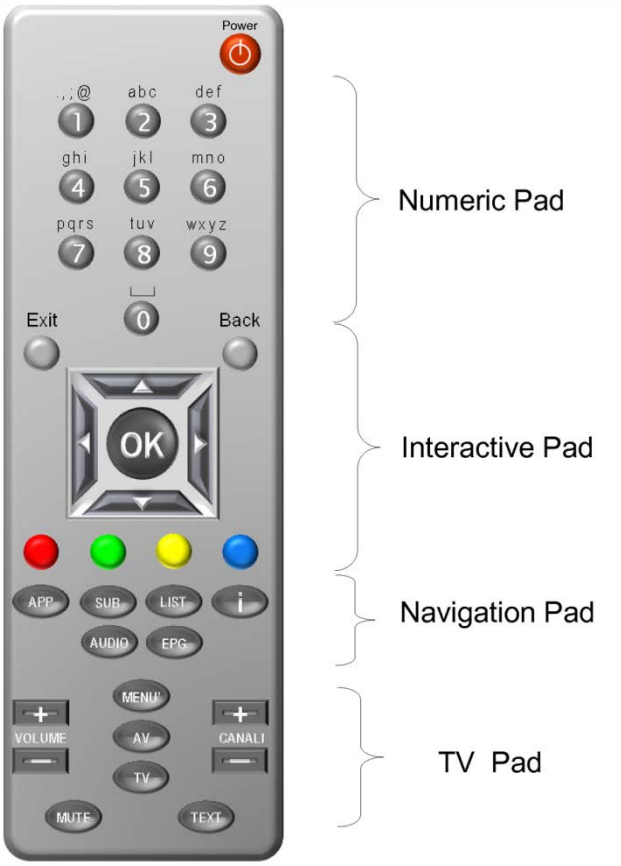

Figure 1: Typical Remote Control

- TV/receiver control
- channel selection
- accessing information about programs and services
- interactivity

It is strongly recommended that the keys be grouped together by function, and the groupings should be clearly separated.

6.4.4. General Recommendations

The following recommendations are based on international studies and on evidence coming out of qualitative research based on MHP services already deployed in the last 10 years in Italy.

6.4.4.1. The Main Remote

Receiver remotes need to make possible controlling all the main functions of the TV Set. It has to replace the analogue remote by keeping the same simplicity and user friendliness (few & large keys are needed).

6.4.4.2. Single hand friendly

- The remote control needs to stay comfortably in one hand and be balanced in weight. A rubber band can be useful if placed around the border of the remote.
- The remote will stay in one hand and the keys will be pressed with the thumb. All the keys need to stay in “thumb range”.

6.4.4.3. Clear structure

Keys for normal TV viewing and keys for interactivity and navigation need to be grouped in clearly separated sections of the remote

6.4.4.4. Channel selection

- Speed: channel selection (video-video switch) should take less than 0,8 seconds both for an inband or an outband switch. For a channel switch implying a change of hierarchical mode, a maximum of 1 second is tolerable for switching. The switching time shall be calculated using the channel up/down button and will not consider the time for validating the channel number to switch to when using the numeric pad for channel selection..
- AV source dedicated key for VCR or DVD (or other receiver)
- Led on the receiver to indicate the reception of signal coming from the remote.

6.4.4.5. TV controls

STBs whose remote gives the opportunity of directly controlling volume on the TV set were ranked at the top both in Easy TV and Italian Broadcasters' research.

6.4.4.6. Now and Next

Need for a dedicated key for Now-and-Next information and for accessing on screen help for navigating channels and services.

6.4.4.7. Navigation keys

- Navigation keys need to be near and consistently placed.
- Colour keys need to be placed following on screen layout.
- There has to be one only red key on the remote
- Symbols: use well known metaphors.

6.4.5. The Numeric Pad

6.4.5.1. Overall Function Description

The Numeric Pad is used:

- For channel selection
- In HbbTV, for application specific purposes.
- For various (manufacturer proprietary) purposes within the receiver's menus

6.4.5.2. Requirements for the Numeric Pad

6.4.5.2.1 Time-out for channel selection

It is recommended that the time-out for channel selection/switching through numeric pad should be less or equal to 1 second *for SD video and 2 seconds for HD video*[14]. Longer time out length is perceived as misfunctional or annoying by users

6.4.5.2.2 Labelling of Numeric Pad keys

The labelling of the numeric pad keys shall be as shown in Figure 1. This labelling is fully compliant with ETSI ES 202 130 [16]. Letter labels can be also printed on the numeric keys, if they are clearly visible.

[14] It is acknowledged that meeting such targets will depend also on broadcasted signal (e.g. MPEG GOP size) and HDMI/HDCP switching time (if dynamic output mode has been selected)

6.4.6. Interactive Pad

6.4.6.1. Overall Function Description

The Interactive Pad is used:

- For navigating within any receiver proprietary GUI
- For navigating within any HbbTV application

6.4.6.2. Requirements for Interactive Pad

No receiver proprietary function shall be assigned to the interactive pad when outside of a proprietary STB menu or sub-menu and, in general, when in TV viewing mode condition (see definition in § 4.1). As a consequence, the arrows should not be used neither for channel switching (Ch+ / Ch – should be used instead) nor for volume adjustments. These functions have to be performed by specific dedicated keys.

No key that can bring to a sudden and unexpected killing of an HbbTV application should be placed near to the interactive pad keys.

Figure 2: The Interactive Pad

The order of the colour keys shall be strictly followed (Red, Green, Yellow, and Blue).

6.4.7. The Navigation Pad

6.4.7.1. Overall Function Description

The Navigation Pad is used:

- For accessing SI tables data (e.g.: EIT present/following, AIT)
- For accessing the overall channel list
- For selecting the alternative audio track (if any)
- For accessing the EPG application (resident or on-air)
- For accessing Subtitles (DVB or Teletext)

Not all the keys shown in the Navigation PAD are mandatory and have to be included on the remote control.

Refer to following section in the Remote Control chapter for more detailed specifications.

6.4.7.2. Suggestions for Navigation Pad

All the keys in this particular group are receiver proprietary and labels shown in the picture are to be taken as suggestions, but are completely up to the manufacturer for definition.
Shape, disposition and order of such keys are up to the manufacturer. It is warmly suggested using keys with a clearly distinct shape for identifying these keys and distinguishing them from Interactive Pad keys.

Figure 3: The Navigation Pad

It is strongly suggested keeping these keys grouped together in order for the user to access them easily.

Availability on remote controls, or at least on custom models, of a dedicated “hot” key for people who are blind and visually impaired to easily access Audio Description possibly associated to certain programs is RECOMMENDED.

6.4.8. The TV Pad

6.4.8.1. Overall Function Description

The TV Pad is used:

- For accessing to receiver proprietary settings.
- For controlling volume and for channel hopping.
- For selecting alternative video sources (DVD, VHS, Gaming Consoles…).
- To return to TV mode.

Not all the keys shown in the TV Pad are mandatory and have to be included on the remote control.

Refer to following section in the Remote Control chapter for more detailed specifications.

All the keys in this particular group are receiver proprietary and labels shown in the picture are to be taken as suggestions, but are completely up to the manufacturer for definition.
Keys for volume adjustments and for channel up/down scrolling should be easy to identify and clearly separated from the Interactive Pad.

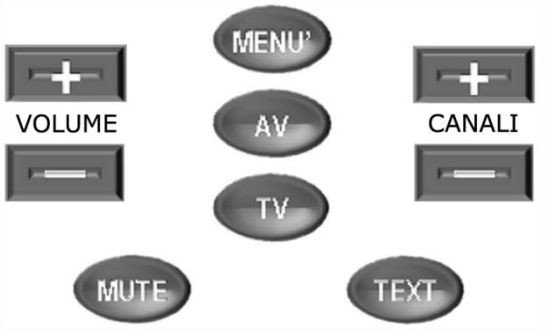

Figure 4: The TV Pad

6.4.9. The Player Pad

6.4.9.1. Overall Function Description

The Player Pad, if present, is used to give interactive applications the possibility to control in an intuitive manner playback of contents received via broadband network, that is:

- to start/pause/resume/stop playback

- to skip forward/backward within the content being played back.

6.5. Remote control keys detailed specifications

6.5.1. The Numeric Pad

item	Keys	Status	Function	Additional specs
1	⓪ .. ⑨	Mandatory	HbbTV standard	The letter text labelling has to be followed

Table 10: The Numeric Pad

6.5.2. The Interactive Pad

item	Keys	Status	Function	Additional specs
2	Back	Mandatory	HbbTV standard	
3	Exit	Mandatory	HbbTV standard	HbbTV spec states that the EXIT key is handled by the terminal and is not passed to the application.
4	▼▲	Mandatory	HbbTV standard – Arrow Up / Down	
5	◄ ►	Mandatory	HbbTV standard – Arrow Left / Right	
6	Ok	Mandatory	HbbTV standard	
7		Mandatory	HbbTV standard – Red Key	
8		Mandatory	HbbTV standard – Green Key	
9		Mandatory	HbbTV standard – Yellow Key	
10		Mandatory	HbbTV standard – Blue Key	

Table 11: The Interactive Pad

6.5.3. The Navigation Pad

item	Keys	Status	Function	Additional specs
11	Info	Mandatory	This key gives access to information associated to the current channel.	If such key is pressed while IP A/V content is playing and no broadcast A/V content is playing, it SHALL NOT display information related to the event on the broadcast channel. It SHALL either be made available to interactive applications with the code VK_INFO or it SHALL be inhibited.
12	EPG	Mandatory	This key gives access to the Electronic Program Guide.	The labelling has to be decided by the manufacturer.
13	List	Optional	This key gives access to the receiver's service list	Audio/video, audio only and stand alone interactive services (see § 7.2.5.1).

item	Keys	Status	Function	Additional specs
14	Audio	Optional	This key allows the viewer to choose among different audio tracks/languages.	If such physical key is not present, the same function SHALL be implemented through some other proprietary keys or menus. If such key is present and it is pressed while IP A/V content is playing and no broadcast A/V content is playing, it SHALL NOT display information related to the event on the broadcast channel. It SHALL either be made available to interactive applications with the code VK_AUDIO or it SHALL be inhibited.
15	Sub	Optional	This key allows the viewer to activate/deactivate presentation of subtitles and to select among different languages, when available.	See Subtitling specs in §8.1.3 If such physical key is not present, the same function SHALL be implemented through some other proprietary keys or menus. If such key is such key is present and it is pressed while IP A/V content is playing and no broadcast A/V content is playing, it SHALL NOT display information related to the event on the broadcast channel. It SHALL either be made available to interactive applications with the code VK_SUB or it SHALL be inhibited.

Table 12: The Navigation Pad

6.5.4. The TV Pad

Item	Keys	Status	Function	Additional specs
16	Menu	Mandatory	Access to receiver's proprietary menu. Labelling is up to the manufacturer.	
17	Vol+	Mandatory	Increase volume	
18	Vol-	Mandatory	Decrease volume	
19	CH +	Mandatory	Switch channel up of one position according to the channel list	
20	CH -	Mandatory	Switch channel down of one position according to the channel list	
21	AV	Optional	Selection of external video sources such as DVD, Gaming Consoles, …	
22	TV	Optional	This key allows the user to restore TV viewing (e.g. out from Teletext)	

Table 13: The TV Pad

6.5.5. The Player Pad

item	Keys	Status	Function	Additional specs
23		Optional	Stop playback	Associated to VK_STOP virtual key event
24		Optional	Start playback	Associated to VK_PLAY virtual key event
25		Optional	Pause playback	Associated to VK_PAUSE virtual key event
26		Optional	Start/pause toggle	Associated to VK_PLAY_PAUSE virtual key event
27		Optional	Skip forward	Associated to VK_FAST_FWD virtual key event
28		Optional	Skip backward	Associated to VK_REWIND virtual key event

Table 14: The Player Pad

Support of Player Pad keys, if present, in the context of linear IP services is RECOMMENDED with the behaviour specified in Annex C.

6.5.6. Other Keys

item	Keys	Status	Function	Additional specs
29		Mandatory	Switch on/off the receiver	This key SHOULD NOT be red.
30		Mandatory	Teletext (see also §9.1.1. HbbTV standard otherwise.	The labelling “Text” is recommended.
31		Optional	Muting the volume	Pressing this key once will mute the volume. By pressing the same key again the volume level will be restored at the previous level

Table 15: Other keys

6.6. Text entry

For entering text into an application HbbTV requires either multi-tap or an equivalent method (e.g. software keyboard), where characters are input character by character in the text field.

6.6.1. Multi-tap key assignment

In assigning specific alphanumeric characters to single numeric pad keys, the manufacturers shall take ETSI ES 202 130 [16], page 103 table 48 "Keypad assignment for Italian“, as a guideline.

A subset of the mandatory characters is recommended to be implemented within the overall ETSI character list.

6.6.1.1. Standard Characters Subset

Key	Requirement	Subset Character Sequence
	Mandatory	a b c 2 à A B C

Key	Requirement	Subset Character Sequence
def 3	Mandatory	d e f 3 è D E F
ghi 4	Mandatory	g h i 4 ì G H I
jkl 5	Mandatory	j k l 5 J K L
mno 6	Mandatory	m n o 6 ò M N O
pqrs 7	Mandatory	p q r s 7 P Q R S
tuv 8	Mandatory	t u v 8 ù T U V
wxyz 9	Mandatory	w x y z 9 W X Y Z
— 0	Mandatory	0 “space” “new line”

Table 16 : Standard Character subset

6.6.1.2. Special Characters Subset

As per ETSI ES 202 130 v. 1.1.1 (2003-10), (page 103 table 48 "Keypad assignment for Italian“) all special characters have to be assigned to numeric key “1”.

Key	Requirement	Subset Character Sequence
.,:;@ 1	Mandatory	. , ; @ 1 ? ! : “ % ( ) + - / * = < > € #

Table 17: Special Character Subset

The subset of special characters listed in the previous table has to be considered as the minimum mandatory requirement for manufacturers.

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7. Service Information & Channel Selection

7.1. Introduction

On installation, receivers must offer the viewer all services that may be received at the current location, both via broadcast (DTT and/or SAT) and via broadband (linear IP services).

The services being received at a given location will change over time. To ensure that the viewer is always able to access every service currently active, the receiver must detect and reflect to the viewer any such changes with minimal viewer involvement.

Services may have an associated Logical Channel Number (LCN). Broadcasters may use this as a marketing tool for service promotion to the viewer. Consequently, when possible, receivers SHOULD present the channels so that a numeric entry will always select the service with the corresponding Channel Number. However, viewers SHALL also be free to re-order and/or filter the channel list as they require.

Access to, and use of, accurate service information is essential if the viewer is to enjoy all of the content being delivered. Receivers must offer a complete list of available services and information, if available, about the current and following programmes.

7.1.1. Terrestrial delivery

Due to the distributed nature of DTT transmissions, a receiver may be able to receive more than one instance of a particular service, which may include regional variants of a service, and must handle such an occurrence sensibly from a viewer perspective.

7.2. Broadcast services

7.2.1. DVB Locator

The DVB locator is the unique identifier of a DVB service. It is composed of three elements:

- Original_Network_ID
- Transport_Stream_ID
- Service_ID

Its format is dvb://<onID>.<tsID>.<sID>[.<ctag>[&<ctag>]][;<evID>][<path>]. (The optional parameter [;<evID>] allows to identify a single event within a service.)

To ensure a harmonious use of the relevant codes, a coordinated allocation of codes and code ranges is recommended for the Italian Digital Terrestrial Television environment. The details of the scheme adopted by Italian DTT broadcasters is given in Annex D.

7.2.2. SI and PSI Information

A receiver specification should not put any constraints on the broadcast signal as the receiver must be robust against erroneous or incomplete signalling and present all services whenever they are present. Of course, receiver behaviour, in many cases will be dependent on the presence, in the signal, of supplementary signalling.

7.2.2.1. Notation

The same symbols as in the E-book (# 9.1.4 [8]) are adopted for specifying the expected implementation for Broadcast or Receiver.

Meaning	Specification applies to:	
	Broadcast	Receiver
Mandatory to broadcast – this shall be present in all broadcasts	M	
Mandatory to understand – receivers are required to understand and act on this item		m
Conditional to broadcast – this shall be present if certain criteria are met (for example, certain signalling is required for CA controlled services)	C	
Recommended to broadcast – inclusion of this item improves the usefulness of broadcasts to receivers and allows them to provide better facilities to users. It is preferable for broadcasts to include this. However receivers shall be able to work correctly without this information	R	
Optional to broadcast – this item is allowed in broadcasts and has a defined meaning. However, receivers shall be able to work correctly without it	O	
Undefined to broadcast – this item is allowed in broadcasts but has no defined use within this specification. Receivers should ignore this information unless they are designed with information from other specifications that define its use	U	
Forbidden to broadcast – this item is not allowed in broadcasts as it may cause confusion to receivers that conform to this specification	F	

Table 18: Symbols notation as per E-Book

7.2.2.2. Program Map Table (PMT)

The descriptors possibly carried by this table at Program level are the following:

Descriptor	Tag	Status
Conditional access descriptor	0x09	C
Private data specifier descriptor	0x5F	C

Table 19: Program descriptors (PMT)

The descriptors possibly carried by this table at Elementary Stream level are listed hereafter.

Component	Descriptor	Tag	Status
Any	Stream identifier descriptor	0x52	C m
	Conditional access descriptor	0x09	C
	Private data specifier descriptor	0x5F	O
Audio	ISO 639 language descriptor	0x0A	C m
	Audio preselection descriptor	*0x7F*[15] *0x19*	*O*
Private data (AC-3)	AC-3 descriptor	0x6A	C m
Private data (EAC-3)	Enhanced AC-3 descriptor	0x7A	C m
Private data (AC-4)	*AC-4 descriptor*	*0x7F*[14] *0x15*	*C m*
Private data (AAC)	AAC descriptor	0x7C	C m
DVB Subtitles	Subtitling descriptor	0x59	C m
Teletext	Teletext descriptor	0x56	C m

[15] Indicating use of the extension descriptor in conjunction with the relevant descriptor_tag_extension [46]

Component	Descriptor	Tag	Status
SSU stream	Databroadcast_id descriptor	0x66	O m

Table 20: Elementary stream descriptors (PMT)

7.2.2.2.1 Multiple components of the same type

The PMT may contain multiple instances of components with identical signalling. For example, multiple audio components with the same stream type, language and audio_type, or multiple video components in services providing multi-angle viewing (and single audio).

In this case the receiver SHALL select as default component the one with the lowest PID among those of the same type.

However, all the components shall be presented for manual selection when requested by the user. As another example, multiple interactive services listed inside an AIT table shall be presented in ascending order from the lowest application_ID, and if multiple AIT are referenced in one PMT, their order shall also be preserved.

7.2.2.2.2 (U)HD-specific elementary stream types

Further to the stream types

- 0x02 for MPEG-2 or MPEG-1 constrained parameter video streams
- 0x03 for MPEG-1 audio streams
- 0x05 for MPEG-2 TS private_sections
- 0x06 for PES packets containing private data
- 0x0B for MPEG-2 DSM-CC type B streams

whose support was already required for SD receivers by DGTVI's D-Book [36], the following stream_type values SHALL also be supported in the scope of this document:

- 0x11 for MPEG-4 AAC and MPEG-4 HE AAC packetized elementary streams
- 0x1B for H.264/AVC video streams
- 0x24 for HEVC video streams

The value of stream_type for an Enhanced AC-3 *or AC-4* elementary stream will be 0x06 (indicating PES packets containing private data), same as for AC-3.

7.2.2.2.3 Supplementary Audio

For TV-broadcasting applications, noticeably public service broadcasting, there is often a requirement for commentary or narration audio services to provide for different languages or Visually Impaired or Hearing Impaired audiences.

7.2.2.2.3.1 DVB solution

DVB solution encompasses both receiver-mixed and broadcast-mixed Supplementary Audio. Relevant signalling specifications are contained in new Annex to latest [9] revisions.

7.2.2.2.3.2 Enhanced AC-3 solution

Compliance with the behaviour specified in [9] §6.2.1.2 and §6.2.2.2 is required.

7.2.2.2.3.3 AC-4 solution

Compliance with the behaviour specified in [9] §6.7.4.1 is required.

7.2.2.3. Network Information Table (NIT)

The descriptors possibly carried by this table in first loop are the following:

Descriptor	Tag	Status	
		Actual	Other
Network_name_descriptor	0x40	M m	O m
Multilingual_network_name_descriptor	0x5B	O m	O m
Linkage_descriptor	0x4A	C	C
Private_data_specifier_descriptor	0x5F	C	C
URI_linkage descriptor	ext(0x13)	O m	O

Table 21: Network descriptors (NIT first loop)

If a change occurs in the “network_id” in the NIT, during transmission, the receiver SHALL ignore it and continue to present the services already in the list and not delete them.

If a change occurs in the “network_name_descriptor” the receiver SHALL ignore it and continue to present the services already in the list and not delete them.

7.2.2.3.1 URI linkage descriptor

This descriptor MAY be used for discovering a list of linear IP services (see below §7.3).

The URI_linkage_descriptor includes a parameter, the min_polling_interval, that represents the minimum time, in intervals of two seconds, the receiver should poll this URI for possible updates.

7.2.2.3.2 Terrestrial delivery

The descriptors possibly carried by this table in second loop are the following (DTT case):

Descriptor	Tag	Status	
		Actual	Other
Terrestrial_delivery_system_descriptor	0x5A	M m*	O
Frequency_list descriptor	0x62	R	R
Service_list_descriptor	0x41	R	R
Private_data_specifier_descriptor	0x5F	C	C
Logical_channel_descriptor	0x83	O m	O
HD simulcast descriptor	0x88	O m	O m
T2_delivery_system_descriptor	ext(0x04)	M m	O

Table 22: Transport stream descriptors (NIT second loop for DTT)

7.2.2.3.2.1 Terrestrial delivery system descriptor

Receivers may use the modulation parameters in the terrestrial_delivery_system_descriptor as a recommendation when trying to tune to a multiplex but the receiver shall always be able to detect the modulation from the transmission itself (e.g. assisted by TPS bits).

MFN network may include repeaters (or channel translations can be performed in MATV systems): the receiver shall ignore the “centre_frequency” specified in the terrestrial delivery system descriptor. In other words the receiver shall select the service in a DVB-T channel according to the frequency used during the tuning procedure, ignoring the value contained in the NIT.
The receiver SHOULD take into account the
- other_frequency_flag (inside the terrestrial_delivery_system_descriptor)

Receiver SHALL ignore the “bandwidth”, “priority”, “constellation”, “hierarchy_information”, “code_rate”, “guard_interval” and “transmission_mode” values in the terrestrial_delivery_system_descriptor of the NIT.

7.2.2.3.2.2 T2 Delivery System descriptor

T2_delivery_system_descriptor is signalled in the extension_descriptor (Tag extension value 0x04).

The T2-IRD SHALL uses the system parameters in the T2_delivery_system_descriptor to determine the mapping between original_network_id/network_id/transport_stream_id and T2_system_id/plp_id.

The T2-IRD SHOULD uses the other system parameters in the T2_delivery_system_descriptor as a recommendation when trying to tune to a multiplex. The T2-IRD SHOULD, however, always be able to detect these system parameters from the transmission itself (i.e. assisted by L1 signalling).

Operators can broadcast the same transport stream in the same network using different system parameter settings, reflected in a different T2_system_id. This allows for optimization of the network coverage in frequency planning involving SFN and MFN combination networks.

7.2.2.3.2.3 Other_frequency_flag

The terrestrial_delivery_system_descriptor may signal the use of possible alternative frequencies through the other_frequency_flag. This flag may be used (inter alia) to advise the receiver that an identical multiplex may be receivable on other centre frequencies. The receiver must always be able to receive all the available services in the RF channels.

If the same service is available on two different RF channels, both were tuned (with the automatic or manual scan procedure), and both are available to the user.

Support by receivers of this flag is OPTIONAL. It is expected that broadcasters in Italy will not use this flag.

7.2.2.3.3 Satellite delivery

The descriptors possibly carried by this table in second loop are the following (SAT case):

Descriptor	Tag	Status	
		Actual	Other
Satellite_delivery_system_descriptor	0x43	M m*	O
Frequency_list descriptor	0x62	R	R
Service_list_descriptor	0x41	R	R
Private_data_specifier_descriptor	0x5F	C	C
Logical_channel_descriptor	0x83	O m	O
HD simulcast descriptor	0x88	O m	O m

Table 23: Transport stream descriptors (NIT second loop for SAT)

7.2.2.3.3.1 Satellite delivery system descriptor

Receivers can rely upon the modulation parameters in the satellite_delivery_system_descriptors carried by the platform’s Home Channel(s) (see Annex

F for tivùsat case) to build the platform's service list, as an alternate to raw frequency scanning.

The receiver SHALL always be able to detect the modulation from the transmission itself.

7.2.2.3.4 Logical Channel Descriptor

The logical channel descriptor provides a default channel number label for services. This information is quasi-static. The logical channel descriptor may be inserted once in the second descriptor loop of the NIT (actual or other) or of the BAT.

The logical channel number does not take into account the service type, i.e. all service types share the same number space.

Syntax	No. of bits	Type
`logical_channel_descriptor{`		
`descriptor_tag`	8	uimsbf
`descriptor_length`	8	uimsbf
`for (i=0; i<N; i++){`		
`service_id`	16	uimsbf
`visible_service_flag`	1	bslbf
`reserved`	5	bslbf
`logical_channel_number`	10	uimsbf
`}`		
`}`		

Table 24: Syntax of the logical channel descriptor

Descriptor_tag: This shall be assigned to be 0x83.

Service_id: This is a 16 -bit field which serves as a label to identify this service from any other service within the network. The service_id is the same as the program_number in the corresponding program_map_section. Services shall be included irrespective of their running status.

Visible_service_flag: When set to '1', this 1-bit field indicates that the service is normally visible and selectable (subject to the service type being suitable, etc.) via the receiver service list. When set to '0' this indicates that the receiver is not expected to offer the service to the user in normal navigation modes. However, the receiver should provide a mechanism to access these services (for example, by direct entry of the logical channel number).

See also Receiver rules. Support by receivers of the visible_service_flag is MANDATORY.

Reserved: All "reserved" bits shall be set to '1'.

Logical_channel_number: This is a 10 -bit field which indicates the broadcaster preference for ordering services. Its use is defined in the following table:

logical_channel_number	Description
0	Service not suitable for selection by the user a)

logical_channel_number	Description
1 - 999	logical_channel_number
1000 - 1023	rfu – not usable
a) For example, the value zero may be used for data services only intended for selection from interactive applications or for firmware download services, etc.	

Table 25: Logical channel number

Any service with LCN=0 shall be ignored.

See also Receiver rules.

7.2.2.3.5 HD Simulcast Logical Channel Descriptor

The HD Simulcast Logical Channel Descriptor provides a means to override the default channel number label of services for an HD receiver. This information is quasi-static.
The HD simulcast logical channel descriptor may be inserted in the second descriptor loop of the NIT. The descriptor may appear more than once in this location.

The constraints on uniqueness are the same as those for the logical channel descriptor.

Syntax	No. of bits	Type
HD_simulcast_descriptor{		
descriptor_tag	*8*	*uimsbf*
descriptor_length	*8*	*uimsbf*
for (i=0; i<N; i++){		
service_id	*16*	*uimsbf*
visible_service_flag	*1*	*bslbf*
reserved	*5*	*bslbf*
logical_channel_number	*10*	*uimsbf*
}		
}		

Table 26: Syntax of the HD simulcast logical channel descriptor

Descriptor_tag: This shall be assigned to be 0x88.

Service_id: This is a 16 -bit field which serves as a label to identify this service from any other service within the network. The service_id is the same as the program_number in the corresponding program_map_section. Services shall be included irrespective of their running status.

Visible_service_flag: When set to ‘1’, this 1-bit field indicates that the service is normally visible and selectable (subject to the service type being suitable, etc.) via the receiver service list. When set to ‘0’ this indicates that the receiver is not expected to offer the service to the user in normal navigation modes. However, the receiver should provide a mechanism to access these services (for example, by direct entry of the logical channel number).

See also Receiver rules. Support by receivers of the visible_service_flag is mandatory.

Reserved: All “reserved” bits shall be set to ‘1’.

Logical_channel_number: This is a 10-bit field which indicates the broadcaster preference for the ordering of services. This descriptor shall only be interpreted by receivers that are

able to decode an advanced codec HD digital television service. The channel number label assignment defined by this descriptor overrides the channel number label assignment defined by the Logical Channel Descriptor that is located in the same network_id. The rules for the set of channel number labels used by this descriptor is the same as the rules for the set of channel number labels
used by the Logical Channel Descriptor.
In the case where this descriptor assigns to a service (service A) a channel number label which is already assigned to another service (service B) (perhaps by the Logical Channel Descriptor), the receiver shall treat the original service (service B) as having no assigned channel number label and assign one automatically in the normal manner.
This descriptor is intended to be used for HD services broadcast in simulcast with the same service in SD so that the HD service appears at the primary channel number label on HD capable receivers while the SD service appears at that label for SD-only capable receivers.

Expected receiver behaviour in the presence of HD_simulcast_LCN_descriptor is outlined in the following flow chart.

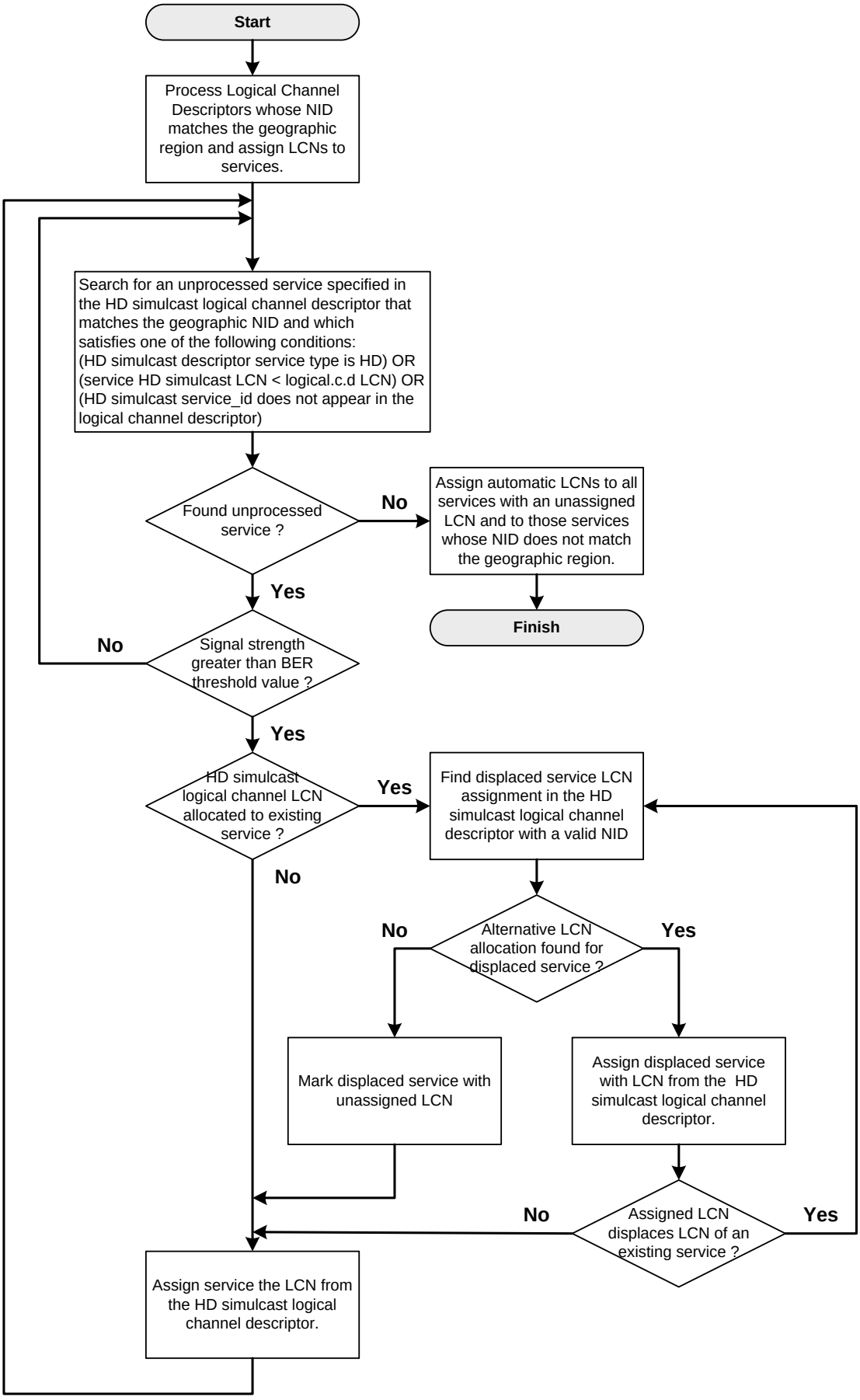

Figure 5: HD_simulcast_LCN operation

7.2.2.3.6 Terrestrial LCNs

In DTT context the logical channel number is not necessarily unique within the same original_network_id (except when its value is zero) but may be re-used for regional variants of a service or for local services with strictly not overlapping coverage. Hence the number is not unique within the original network.

The logical channel number does not take into account the service type, i.e. all service types share the same number space.

The logical channel number does not take into account the transmission standard, i.e. services transmitted on DVB-T and DVB-T2 share the same numbering space.

7.2.2.3.7 Satellite LCNs

An open satellite platform will define its own channel list, which will be broadcasted through logical channel descriptors inserted into Home Channel(s)'s NIT(s) (actual and/or others) or BAT.

All receivers compliant with this specification SHALL recognize this information and enlist services accordingly. All other channels that are received by the receiver, but are not included in the platform's channel list, must NOT be discarded, but given a position in the 1000+ range.

By periodically checking (at least once a day and anyway each time the receiver is put into standby mode) the Home Channel, the receiver SHALL recognize possible additions/deletions/changes into broadcasted platform's channel list and update its own accordingly.

An example of LCN implementation on tivùsat satellite platform and the structure for logical channel descriptor are given in Annex E. Expected behaviour for DTT/SAT "combo" receivers under LCN handling respect is given in Annex F.

7.2.2.4. Bouquet Association Table (BAT)

In some platforms BAT may be used for conveying Logical Channel Numbers. Receivers addressing such platforms SHALL support BAT.

The descriptors possibly carried by this table are listed hereafter.

Descriptor	Tag	Status
		Actual
Bouquet_name_descriptor	0x47	C m
Multilingual_bouquet_name_descriptor	0x5C	O m
Linkage_descriptor	0x4A	C
Private_data_specifier_descriptor	0x5F	C
Eacem_stream_identifier_descriptor	0x86	O

Table 27: Network descriptors (BAT first loop)

Descriptor	Tag	Status
		Actual
Service_list_descriptor	0x41	R
Private_data_specifier_descriptor	0x5F	C

Descriptor	Tag	Status
Logical_channel_descriptor	0x83	O m
HD simulcast descriptor	0x88	O m

Table 28: Transport stream descriptors (BAT second loop)

7.2.2.5. Service Description Table (SDT)

The descriptors possibly carried by this table are the following:

Descriptor	Tag	Status	
		Actual	Other
Service_descriptor	0x48	M m	O m
Component_descriptor	0x50	C m	C m
CA_identifier_descriptor	0x53	C m	C m
Private_data_specifier_descriptor	0x5F	C	C
Preferred_name_list_descriptor	0x84	O	O
Linkage_descriptor	0x4A	O m	O m
Message_descriptor	*0x7F[16] 0x08*	*O*	*O*

Table 29: Service descriptors

In the presence of a CA_Identifier_Descriptor, the receiver shall always try to present the service to the end user. In case the service is effectively scrambled, and the relevant CA system is not present, the receiver shall present an error message (see 7.5.1.2).

The preferred_name_list_descriptor, as defined in [8], provides a list of alternative names, and name identifiers, for the service. This information is quasi-static.

7.2.2.5.1 Service descriptor

When tuning a service receivers SHOULD detect a “service_name” change since the last (re)install or manual/automatic service list update and update it unless it was manually edited by the end user.

Receivers SHALL only list a service in their service selection interfaces where the service is of a type, as declared in the “service_type” value, which the receiver is able to present to the user or to a receiver interface.

NB: Users may be confused or frustrated if the receiver presents for selection services that are not decodable by the receiver (such HD services on an SD receiver) or are not intended for user selection (such as receiver firmware update broadcasts).

Receivers are required to support at least the following service types:

service_type = 0x01, digital television service
service_type = 0x02, digital radio sound service (MPEG-1 Layer 1 or 2 audio)
service_type = 0x0A, advanced codec digital radio sound service
service_type = 0x16, advanced codec SD digital television service
service_type = 0x19, advanced codec HD digital television service
service_type = 0x1C, advanced codec frame-compatible plano-stereoscopic HD digital television service

[16] Indicating use of the extension descriptor in conjunction with the relevant descriptor_tag_extension [46]

The following signalling SHALL be present for HEVC HD or sub-HD services in accordance with [10]:

service_type = 0x1F
stream_content = 0x9
stream_content_ext = 0x0
component_type = 0x00 (HEVC Main Profile HD, 50 Hz) or
0x01 (HEVC Main 10 Profile HD, 50 Hz)

The following signalling SHALL be present for HEVC UHD services with SDR in accordance with [10]:

service_type = 0x1F
stream_content = 0x9
stream_content_ext = 0x0
component_type = 0x04 (HEVC Ultra High Definition Video)

in accordance with [10], HEVC UHD services with HLG10 HDR SHALL be signaled as:

service_type = 0x1F
stream_content = 0x9
stream_content_ext = 0x0
component_type = 0x04 (HEVC Ultra High Definition Video)

plus, OPTIONALLY, a component descriptor for the HLG10 component with

stream_content = 0xB
stream_content_ext = 0xF
component_type = 0x04 (HEVC Ultra High Definition Video with HLG10 HDR)

The following signalling SHALL be present for HEVC UHD services with PQ10 HDR in accordance with [10]:

service_type = 0x20
stream_content = 0x9
stream_content_ext = 0x0
component_type = 0x05 (HEVC Ultra High Definition Video with PQ10 HDR)

Receivers supporting HEVC SHALL interpret and correctly react to the above signalling (service_type, stream_content, stream_content_ext, component_type).

> NOTE: In the future, the same service_type may be used for formats which may not be supported by the HEVC receiver described in this version of specification. For this reason, it is essential that receivers interpret the four fields described above.

According to DVB SI [10], service_type=0x01 should be used for MPEG-2 SD digital television service. However, it may also be used for services using other encodings, including encodings that have a specific entry, e.g. advanced codec HD digital television service. That doesn't apply to services using HEVC video coding which SHALL be explicitly and unambiguously signalled as stated above.

A service, as identified by its DVB triplet, will exclusively be either SD or HD.

Support for other service types (for example service_type = 0x06, mosaic service) is optional.

7.2.2.5.2 Running status

Receivers are required to support at least the following values and behaviours for the running_status in SDT:

running_status = 4, running -> normal behaviour
running_status = 1, not running -> display banner with the following exception

If a linkage descriptor with linkage type 0x05 (service replacement service) is present in SDT for a given service, the receiver SHALL automatically select the replacement service, if selectable, instead. The receiver SHALL listen to updates of the running_status value (from running to not running or from not running to running) of the given service in SDT, automatically selecting the replacement service or the service itself, if selectable.

7.2.2.5.3 Priorities amongst services and service variants

For the purpose depicted in the following section §7.4, DTT receivers SHALL apply the following priorities to service variants and services:

Priority (8 is highest)	service_ type	stream_ content	stream_ content_ext	component_ type	Service	Delivery System	See notes
1	0x01	any	any	any	MPEG-2 SD	DVB-T	1 & 3
2	0x16	any	any	any	AVC SD	DVB-T	1 & 3
3	0x16	any	any	any	AVC SD	DVB-T2	1 & 3
4	0x19	any	any	any	AVC HD	DVB-T	1 & 3
5	0x19	any	any	any	AVC HD	DVB-T2	1 & 3
6	0x1F	0x09	0x00	0x00	HEVC Main HD	DVB-T2	3 &4
7	0x1F	0x09	0x00	0x01	HEVC Main10 HD	DVB-T2	3& 4
8	*0x1F*	*0x09*	*0x00*	*0x04*	*HEVC UHD*	*DVB-T2*	*2 &3& 4*
8	*0x20*	*0x09*	*0x00*	*0x05*	*HEVC UHD PQ10*	*DVB-T2*	*2 & 3& 4*

Table 30: Service priorities

NOTES:

1 Service_type 0x01 could be (and actually is) legitimately used to signal AVC HD and AVC SD services. Broadcasters should be aware of that in case of self-caused LCN conflicts.

2 Services with HLG have no obligation to add a component descriptor for the HLG component. Therefore, a PQ10 service is given the same priority as UHD (SDR/HLG) service

3 As HEVC services with HD resolution and lower have to use the same DVB SI signalling, HEVC services with 960x540p50 resolution will have higher priority than AVC HD (1920*1080i) services.

*4 Services with a resolution of 1920*1080 or less with BT.2020 and HLG or PQ10 will be signalled as UHD services according to EN 300 468 [10]*

7.2.2.6. Event Information Table (EIT)

7.2.2.6.1 Event Information Descriptors

The EIT can carry the following descriptors to meet the requirements of EN 300 468 [10] and TR 101 211 [19]:

Descriptor	Tag	Status			
		Present/Following		Schedule	
		Actual	Other	Actual	Other
Linkage descriptor	0x4A	O m	O m	C	C
Short event descriptor	0x4D	M m	M m	O m*	O m*

Descriptor	Tag	Status			
		Present/Following		Schedule	
		Actual	Other	Actual	Other
Extended event descriptor	0x4E	C m	C m	O	O
Component descriptor	0x50	M	M	O	O
CA identifier descriptor	0x53	C	C	C	C
Content descriptor	0x54	R	R	R	R
Multi lingual component descriptor	0x5E	O	O	O	O
Parental rating descriptor	0x55	O m	O	O	O
Time shifted event descriptor	0x4F	F	F	F	F
Private data specifier descriptor	0x5F	C	C	C	C
PDC descriptor	0x69	C	C	C	C
Preferred name identifier descriptor	0x85	O	O	O	O
* Mandatory only if no other EPG than the one based on SI data is available on the receiver					

Table 31: Event Information Descriptors

The preferred_name_identifier_descriptor, as defined in [8], may be used in the EIT to identify the preferred service name at the time of an event and so allows a schedule of service names.

7.2.2.7. Summary of mandatory tables

Table	Actual	Other
Program association table	M m	N/A
Program map table	M m	N/A
Conditional access table	C	N/A
Network information table	M m	O m
Bouquet association table	U	N/A
Service description table	M m	M m
Event information table present/following	M m	M m
Event information table schedule	O m*	O m*
Time and date table	M m	N/A
Time offset table	R m	N/A
Running status table	U	N/A
* Mandatory only if no other EPG than the one based on SI data is available on the receiver		

Table 32: List of mandatory tables

7.2.2.8. Private Data

When private descriptors are present in a broadcast, a private data specifier descriptor SHOULD be used (cf. EN 300 468) to identify the definer of the private descriptor.

For the Logical Channel Descriptor, the private data specifier value used in the E-Book, as registered in ETSI TR 101 162, shall be used; it is the one registered for EACEM (then EICTA, DIGITALEUROPE today).

The following table lists this value and the other private SI items that are defined within its scope.

Organisation/ specification	PDSD	Private SI information	Value	Type
EACEM	0x00000028	Eacem stream identifier descriptor	0x86	Descriptor tag
EACEM	0x00000028	Logical channel descriptor	0x83	Descriptor tag
EACEM	0x00000028	Preferred name list descriptor	0x84	Descriptor tag
EACEM	0x00000028	Preferred name identifier descriptor	0x85	Descriptor tag
EACEM	0x00000028	HD simulcast descriptor	0x88	Descriptor tag

Table 33: Private SI recognised in the E-Book

7.3. Linear IP services

In the following a comprehensive specification of linear IP services is provided. Its implementation must be considered OPTIONAL until it will be suitably validated through specific tests and field trials.

7.3.1. Format

As already introduced in Chapter 6, linear IP services compliant with the present specification SHALL comply with DASH Live Profile, as further profiled in [64] and [6].

Generally speaking, a linear IP service could convey whatever a DASH manifest could actually do (free contents, protected contents, subtitles, multiple audio languages, …).

7.3.2. Signalling

For the purpose of notifying compliant receivers about linear IP services made available within the current (broadcast) platform, the Online SDT (OSDT) is adopted, as defined in the context of CIPlus 1.4 [37].

In particular, through OSDT receivers can associate to each linear IP service

- A service name and a domain name
- The URL where their DASH manifest can be found
- One or more countries where the service is applicable
- A number equivalent to broadcast LCNs

For other PSI/SI-equivalent information associated to linear IP services, like service components (e.g. multiple audio/subtitle languages), their encryption status and event metadata (e.g. name of the event, start time, duration, parental rating) receivers will instead rely on DASH MPD information elements.

7.3.2.1. OSDT profile

For application to linear IP services compliant with this specification, the following profiles of the OSDT schema defined in [37] apply[17]:

Element/attribute	Description	Status
SubRegionType	A type used to provide the name of the sub-region.	O m
Region	The name of the sub-region. Multiple elements of this type may be	O m

[17] For the “Status” column the same notation introduced in §7.1.2.1 for broadcast is used

Element/attribute	Description	Status
	provided as long as they have different languages	
RegionListType	A type used to define the region and provide the region name.	M m
PrimaryRegion	The details of the region, defined in a hierarchical manner starting from the primary region.	M m
CountryCodes	The list of countries that make up the region which is further defined by the PrimaryRegion element.	M m
TargetRegionType	A type used to provide the country and region within the country where the service is intended to be received. Where this is intended to be equivalent to the target region descriptor, the use of sub-regions shall be limited to two levels (i.e. primary regions containing sub-regions which contain sub-regions).	M m
RegionList	The list of regions within the countries.	M m
AccessibleOutOfRegion	A flag indicating whether the service should be accessed when the Host is not in one of the listed regions.	O

Table 34: Profile for OSDT's SubRegionType

Element/attibute	Description	Status
ServiceLocationType	A type used to provide the location information for the service along with DRM information and audio/video information.	M m
DRMControlInformation	Used to provide DRM information, including the DRM system ID and other metadata, for this version of the service. At most one element may be present.	C m
ContentAttributes	The attributes of the audio, video, captioning and signing of this version of the service.	O
IPMulticastAddress	Signals the use of IGMP to access the service and provides the transport address and other parameters at which the service may be accessed.	U
RTSPURL	Signals the use of RTSP to access the service and provides the URL at which the service description may be accessed.	U
UriBasedLocation	Provides the URI where the service is located, where the target of the URI has the MIME type as provided in the contentType attribute.	M m
priority	The priority of this ServiceLocationType element relative to other ServiceLocationType elements for the service.	O m
ExtendedURIType	A type used to provide a URI with additional information.	M m
contentType	The MIME type of the object identified by the URI. Receivers shall support "application/dash+xml". ExtendedURIType elements with different values may be ignored.	M m
URI	The URI providing the location of the service	M m
ContentAttributesType	A type used to provide the audio, video and other attributes of the service.	O
AudioAttributes	The audio attributes of the service.	O
VideoAttributes	The video attributes of the service.	O
CaptionLanguage	The language of the captions on the service.	O
SignLanguage	The language of the signing with the service..	O
LCNType	A type used to provide the logical channel number for the service.	O m

Element/attibute	Description	Status
LCN	The logical channel number. The semantics for this attribute are the same as for the logical_channel_number field in §7.1.2.3.5	O m
subscribed	A flag indicating whether the user has subscribed to this service or not. When false, the device can assume that it will not be able to present this service. If this attribute is not provided, the subscription status is not known.	U
selectable	A flag indicating whether the device should allow the service to be selected via direct numerical entry of the logical channel number. This flag is only interpreted when the visible flag is set to false. When set to true, the flag indicates that the hidden service is selectable by direct entry of the logical channel number; when set to false, then the hidden service is not directly selectable by the user (but may be selectable by LCN from an application environment).	U
visible	A flag indicating whether the device should include this service in any service list or EPG presented to the viewer. When set to true, this flag indicates that the service is normally visible via the Host service or channel list and EPG etc. When set to false, this indicates that the receiver is not expected to offer the service to the user in normal navigation modes but the receiver shall provide a mechanism to access these services by direct entry of the logical channel number, depending on the setting of the selectable flag.	O m
IPServiceType	A type used to provide the details of the service.	M m
UniqueIdentifier	The unique ID of the service. This ID should never be changed for a service, even if all other parameters of the service are changed. The child attribute DomainName, if omitted, shall take the value of the domain from where this file was located.	M m
DVBTriplet	The DVB triplet that can be used to refer to this service, even if the service is not delivered in a TS. Note: If this triplet matches the triplet of another service, it can be assumed that the services editorially carry the same content.	M m
ServiceLocation	The location(s) where the A/V content for the service may be found. If multiple elements of this type are present, the one with the highest value of the priority attribute has the highest priority	M m
LCN	The logical channel number of the service.	O m
TargetRegions	The target regions for the service where the service is intended to be received.	M m
ServiceName	The name of the service. Multiple elements of this type may be provided as long as they all have different lang attributes.	M m
ApplicationLocation	The location of the XML AIT file where the application associated with the service may be found, as defined in TS 102 809 [34].	O m
ServiceGenre	The genre of the service.	O
ServiceType	The service type, as defined in EN 300 468 [10].	O
ContentAttributes	The attributes of the content for the service	O
BCG	The details of a broadband content guide carrying metadata for this service.	O
IPServiceListType	A type to list all the available services and the BCG covering these services.	M m
IPService	The details of the services.	M m
BCG	The details of a broadband content guide carrying metadata for this service	O

Element/attibute	Description	Status
Version	The version number of this parent element.	M m

Table 35: Profile for OSDT's ServiceLocationType

7.3.2.2. Programme metadata

Content programme metadata for linear IP services are delivered in the MPD by using both "native" DASH elements, like @presentationTime and @duration respectively for event start time and duration [60], and EventStreams as specified in section 9.1.2 of DVB-DASH [64].

The TV-Anytime BroadcastEvent/InstanceDescriptionType used therein for this purpose is profiled as follows [49]:

Element/attribute	Description	Status
InstanceDescriptionType	Complex type used to describe programme instances	M m
Title	A title of the programme.	M m
Synopsis	A textual description of this instance.	M m
Genre	A genre for the programme.	O
PurchaseList	A list of purchase items.	U
CaptionLanguage	Describes one language of the caption information included with the programme. The type of the caption information associated with the programme is denoted by the closed attribute. Closed captions can be turned on or off by the user, while open captions (or subtitles) are part of the picture itself and remain visible.	U
SignLanguage	Specifies the sign language provided for the multimedia content and, optionally, qualifies the use of signing as a primary language and/or as a translation of the spoken dialogue.	U
ParentalGuidance	A parental rating code for this instance. Defined as an TV-Anytime extension to the MPEG-7 datatype, ParentalGuidanceType (see clause 9.2.3 of ISO/IEC 15938-5 [50] for a detailed specification). For parental rating the "urn:dvb:iptv:rating:2014" scheme is used, where the "id" is a decimal number representing the minimum recommended age encoded as per ETSI EN 300 468 (e.g. age 5 is encoded with an "id" of "2") [10]	C m
AVAttributes	Technical (audio-visual) attributes about this particular instance.	U
MemberOf	A list of groups of which the programme is a member.	U
OtherIdentifier	An additional optional identifier to identify the instance.	U
RelatedMaterial	A relation attribute to signal a variety of relationships between content publications.	U

Table 36: Profile for TV-Anytime BroadcastEvent/InstanceDeclarationType

The following table summarizes the essential elements a receiver will use to populate info and channel banners for linear IP services, comparing them with the corresponding elements used on broadcast ones (in parenthesis where they are located):

Information	*Broadcast*	*IP*
Service name	service_name (SDT)	ServiceName (OSDT)
Event name	event_name (EIT)	Title (MPD)
Event start time	start_time (EIT)	@presentationTime (MPD)

Information	Broadcast	IP
Event duration	duration (EIT)	@duration (MPD)
Event parental rating	rating (EIT)	ParentalRating (MPD)
Event description	Item_description (EIT)	Synopsis (MPD)

Table 37: Basic elements used to populate info and channel banners

7.3.3. Discovery

Receivers SHALL discover the URL of one or more OSDT files (if any) by looking at on air NITs for uri_linkage_descriptor with linkage_type=0x00 [10].

Based on private agreements between manufacturers and platform/service providers, outside the scope of this document, one or more “well-known URLs” MAY also be used to download OSDT(s).

Other possible OSDT(s) discovery mechanisms (e.g. based on DNS like RadioDNS Hybrid Radio) are left for further study.

7.3.3.1. Terrestrial delivery

Based on the OSDT discovery mechanisms introduced above, several use cases can be envisaged on DTT:

- A single platform-wide OSDT is maintained by an independent entity at a given URI. Such URI could be either embedded in receivers or broadcasted in the NIT of one or more multiplexes, to maximize its reception probability
- Same as above for national linear IP services, plus one or more OSDTs for local ones
- Same as above plus one or more OSDTs defined by Pay TV Operators with a CIplus 1.4 CICAM [37]
- Different (partial) OSDT’s URIs are signalled by the various terrestrial operators in their NITs, much like they do for broadcast channels

Even though the present specification is expected to support any of above uses cases and more, for the first experimental phase of linear IP services receivers may assume that a single OSDT will be signalled via the URI_linkage_descriptor, possibly repeated on more muxes/NITs.

7.3.3.2. Satellite delivery

For open satellite platforms compliant with this specification, a single platform-wide OSDT is maintained by the platform operator at a given URI. Such URI could be either embedded in receivers or broadcasted in Home Channel(s)’s NIT_{actual}. See Annex E for tivùsat case.

7.4. LCN operation

The role of the LCN is to enable user presentation of service numbers in a convenient and familiar form.

Logical channel numbers allocated should be usable directly as service numbers in a receiver.

7.4.1. Network operator rules

7.4.1.1. Terrestrial delivery

To avoid conflicting allocation of LCNs:

- The logical_channel_number should be unique across all the networks that cover the same geographical region.
- The same logical channel number should be reused only in non-adjacent regions,
- Regional variants of a service may nevertheless use the same logical channel number.

Receivers need to have a mechanism for handling conflicting LCN allocations either within the same country or on the borders of confining countries (see below).

This specification defines the logical channel number concept for conveying such service numbering information to receivers. Network operators should obey the following specification rules in order for receivers to be able to properly operate.

Services with the same triplet (original_network_id/transport_stream_id/service_id) shall have the same logical_channel_number. Within the scope of one network (as defined by the network_id), logical channel numbers shall be allocated uniquely.

When defining regional variants of a service, the same logical_channel_number may be used (for example in neighbouring networks). This facilitates defining a consistent and compact national/regional/local channel numbering scheme, as well as indicating to the receiver that services with the same logical_channel_number are similar (regional variants).

Proper usage for their networks by Italian and confining broadcasters of NIT network_id values in the ranges officially assigned by DVB to the respective DTT networks (see Annex D) allows receivers to understand which LCNs belong to which country and then to give priority in case of conflicts to those from the country selected at first installation time.

7.4.1.2. Satellite delivery

Network operators and content providers operating within an open satellite platform have supposedly elected to choose a service numbering scheme between them.

This specification defines the logical channel number concept for conveying such service numbering information to receivers. Network operators should obey the following specification rules in order for receivers to be able to properly operate.

Platform's LCNs may be carried in NIT_{actual} and/or in any NIT_{other} or in BAT possibly present on the Home Channel(s). Redundancy rules for Home Channel set out in Annex E apply.

The centralized mechanism for LCN broadcast defined by this specification will avoid, under normal operating conditions, any conflicting allocation of LCN on the given platform.

7.4.1.3. Multiples LCNs for a single service

Network operators and/or service providers MAY allocate up to four LCNs to a single service. This allows the service to be identified and associated with other services according to different criteria, such as local service, with pay elements, belonging to a specific bouquet and being of specific thematic content.

7.4.1.4. Invisible services

It is recommended to allocate high service numbers to services marked as invisible to avoid accidental collision of service numbers with those of visible services when they are being automatically or manually reallocated.

7.4.2. Receiver rules

Receivers SHALL provide an automatic service numbering facility on the basis of logical channel numbers with the rules set out below.

It SHOULD be possible for the user to select, in the set up menu, the possibility to switch off and on this automatic ordering possibility. Default setting SHALL be ON.

7.4.2.1. General rules

The receiver SHALL be able to associate with one service (i.e. with a unique triplet) at least the first logical channel number set by the broadcaster in the LC descriptor associated with that service. Support of other possible LCNs (up to 4) associated to the same service is OPTIONAL.

When a viewer uses the channel up-down arrows, the receiver SHALL skip all service numbers which are not allocated or are allocated to “invisible” services.

7.4.2.2. Logical channel number zero

Services associated to logical channel number “0” should be disregarded as part of the process below (irrespective of the value of the visible_service_flag). These services are not intended to be presented as part of the viewer’s service list. These services are not intended to be selectable by viewers.

7.4.2.3. Invisible services

Receivers complying with this specification:

- SHALL support a “default” mode in which they will not show services marked “invisible” in their user service list or selectable in normal P+/P - browsing.
- SHALL ignore the presence of “invisible” services when (re-) allocating services to service numbers requested by “invisible” services.
- SHOULD support a mode (for example as a service mode or as an installation option) in which it will allow direct selection of all services (irrespective of being marked invisible) by the user.

7.4.2.4. Terrestrial delivery

As a consequence of the decided 700MHz bandwidth release by year 2022, DTT in Italy is preparing its migration to T2/ HEVC. This may lead during the transition period to the reception of many service variants with the same LCN or HD_simulcast_LCN (see §1.3).

7.4.2.4.1 First initialisation

When a receiver is first initialised or reinitialised (e.g. because the user applied for a factory reset), it is expected that user will be present in front of the receiver.

The receiver SHALL perform in accordance with the following rules:

a) It should give the user the possibility to choose between automatic (LCN-driven) and manual (based on discovery) service numbering (see above).

b) If automatic service numbering has been selected the receiver shall attempt to allocate in the Service List each service with associated LCN(s) to the service number(s) equal to the LCN(s) requested for that service. This rule implies that if there is only one service with a particular logical_channel_number request, it shall be allocated to that service number.

c) In the case of the presence of the same service (identical DVB triplet - ON_id, TS_id & S_id) on two different frequencies, the conflict shall be resolved as described in §7.6.1.5.

d) In the presence of a conflict between different services that request the same logical channel number the receiver shall first check if the conflict would arise

between a service from a network from the country selected at first installation time, i.e. from a network whose network_id comes from the range assigned to that country by DVB or for one of the countries associated in the OSDT to that service, and a service from another country. In that case the requested service number will be allocated to the former and the latter will be moved in the so called "Main Overflow"[18].
Secondly, if an LCN conflict still exists, the receiver SHALL categorize the services, regional variants of a service or service variants according to their priority (see Table 30). The conflicting LCN SHALL be allocated to the service with the highest priority whilst services, regional variants of a service or service variants with lower priority SHALL be placed in the "Main Overflow".
In case of multiple services, regional variants of a service or service variants with the same highest priority the receiver SHALL:
- present the viewer with a menu allowing to select which service to maintain at the requested position; automatic resolution of the conflict, either based on signal power or first/last found during scan, will be performed after expiration of a suitably long timeout
- allocate the other service(s) to the next unallocated number(s) in the Main Overflow.[19]

e) If a service does not have an associated logical_channel_number, it SHALL be allocated an available number in the Main Overflow.

The detailed expected behaviour for cross-border LCN conflicts resolution is the following:

- if a particular LCN position is claimed by only 1 service, it will be granted that position regardless of its network_id (NID) or OSDT's CountryCodes and of the position claimed (i.e. including LCNs in Main Overflow range)
- if more services are competing for the same LCN position
    - if only 1 service has its NID within the range 0x3001 - 0x3100 or CountryCodes="ITA" in OSDT (if Italy has been selected as Country at installation time,) it will automatically get the requested position
    - if more services have their NIDs within the range 0x3001 - 0x3100 or CountryCodes="ITA" in OSDT, the conflict resolution amongst such services is left up to the customer. Possible competing services whose NIDs is outside the range 0x3001 - 0x3100 or having CountryCodes≠"ITA" in OSDT will be automatically moved to Main Overflow range (850-999)
    - if all competing services have their NIDs outside the range 0x3001 - 0x3100 or having CountryCodes≠"ITA" in OSDT, the conflict resolution is left up to the customer
    - whatever the above case, all the other services which haven't got the requested position will be moved to Main Overflow range (850-999)

7.4.2.4.4.2 Adding new services

When adding services to the Service List as a result of an update scan (whether manual or automatically, in stand-by or in operate mode), the receiver shall first try to allocate each new service to the number(s) indicated in the LC descriptor, if any. That applies also to each service which is already in the Service List but at a position different than the LCN itself. Should such position be actually free, the receiver will move the subject service there in the

[18] The Main Overflow occupies service numbers 850 to 999. In case Main Overflow space would get filled up, free positions from 849 backwards SHALL be used)

[19] When an existing service is moved to another multiplex, e.g. because of a network operator reorganizing the services carried across more multiplexes, in order to ease customers' migration both previous and new service variants may be simulcast for a period of time, which can trigger an LCN conflict. In such a case, if the requested LCN is allocated to the previous service variant, when that service is finally removed, the receiver SHALL re-allocate the new service variant to that LCN, even if the new service variant is placed in the Main Overflow or at a different LCN (see §7.6.1.4 and §7.4.2.4.3)

Service List, to cope with services which didn't have an LCN at the time when they were first tuned.

In case of conflict (i.e. the number is already occupied by a "non-invisible" service or is requested by several services), the receiver shall proceed with the same rules given above for first initialisation (§7.4.2.4.1).

In particular, after signalling to the user that new services are available (as in the procedure described in §7.6.1), the receiver SHALL display a pop-up menu for each case of conflict, to allow the viewer to select which service to allocate to the requested service number. If there is already a service at the requested number, that service SHALL be the first in the list and the one selected by default (e.g. in case of timeout). If the update scan is performed while in stand-by, pop-up menus for conflict resolution SHALL be displayed as soon TV viewing is started after leaving stand-by mode.

7.4.2.4.3 Removing a service

If, during an automatic or a manual update scan, the receiver decides that a service can be removed from the Service List, it will exclude the service and its service number from the Service List and the Master User List.

A service will be considered as removed in case it's no longer present in the NIT actual and the SDT actual or in OSDT.

After the removal of a service, if its LCN is still requested by another service, the receiver SHALL allocate it to that service. If the LCN is still requested by multiple other services, regional variants of a service or service variants, the receiver SHALL allocate the LCN as described in §7.4.2.4.1 step d).

7.4.2.5. Satellite delivery

7.4.2.5.1 First initialisation

When a receiver is first initialised or reinitialised (e.g. because the user applied for a factory reset), it is expected that user will be present in front of the receiver.

The receiver shall perform in accordance with the following rules:

a) It should give the user the possibility to choose between automatic (LCN-driven) and manual (based on discovery) service numbering (see above).

b) If automatic service numbering has been selected the receiver SHALL allocate in the Service List each service with associated LCN(s) to the service number(s) equal to the LCN(s) requested for that service.

c) If a service does not have an associated logical_channel_number, it SHALL be allocated an available number in the 1000+ range.

7.4.2.5.2 Service List update

When the receiver, as a result of an update check (whether manual or automatically, in stand-by or in operate mode) on the Home Channel(s), recognizes that there has been a change in the platform's Service List (service added, removed or reordered), it SHALL add, remove, and reorder the services as indicated by the LC descriptors.

If no LC descriptor is specified for a service (this means that the service is not part of platform's offer) then it SHOULD be listed in the 1000+ range at the last position occupied by services not belonging to the platform.

7.4.3. Service variation options

7.4.3.1. Network re-configuration

For major network reconfigurations, it is recommended that the user proceed with a re-installation, even at the risk of losing his/her custom numbering, if any.

When the receiver detects a service offer change, which includes the addition and deletion of multiple services and/or networks it shall first remove all services which it can determine positively (see Removing a service) to be removed permanently from the service list, and then add the new services.

7.4.3.2. Change of LCN numbering scheme

Any re-arrangement by the broadcasters of LCN numbering of services will be treated as above under network re-configuration. This implies that user changes and non-default allocation of services to service numbers by the receiver should be preserved as much as possible unless a re-installation is done.

7.5. Receiver functions

7.5.1. Service Change

When changing service, parameters need to be set to deal with video formats, languages and unexpected failures in service selection. The minimum requirements for receiver behaviour during service change are outlined in the following paragraphs.

7.5.2. Audio language

It is assumed that the user has entered one or more language preferences during the receiver installation process. If the selected service has audio tracks in more than one language, the language is selected according to the user preferences.

For services including AC-4 audio:

- If an audio_preselection_descriptor is included in the ES_info descriptor loop associated to the AC-4 audio, then receivers SHOULD prioritise preselections matching preferred language(s)
- If no audio_preselection_descriptor is so included, then the receiver SHALL prioritise preselections whose language_tag_bytes contained within content_type [85] indicate preferred language(s)
- If no unique preselection is selected from the above logic, then the receiver SHALL select the presentation with the lowest presentation_group_index [85] from those that are preferred
- If no preselection is selected from the above logic, then the receiver SHALL select the presentation with the lowest presentation_group_index [85]

For other services:

- If preferred languages do not match any of the available languages, then the receiver SHALL automatically select the “undefined” (“und” code of the ISO_639_Language_descriptor) audio stream.
- If “undefined” stream is absent, the stream with the lowest PID (lowest numerical value - unsigned integer) in the specified program SHALL be selected.
- In case no language descriptor is specified the audio stream with the lowest PID SHALL be selected.

NOTE:
Since it is optional for receivers to parse the audio preselection descriptor (see Table 20) a receiver can always rely on the information contained within the AC-4 elementary stream to prioritise on a single preselection. It is however recommended for receivers to use the audio preselection descriptor given the fact that it may enable future functionality beyond alternative languages (accessibility services, alternative commentaries, etc.)

In addition to this automatic soundtrack selection, it shall always possible for the user to manually select any of the available languages.

7.5.3. NGA Audio Use Cases

In addition to delivering complete stereo or 5.1 channel-based mixes, NGA capabilities allow broadcasters to deliver, in a single bitstream, discrete audio elements that are grouped into one or more presentations, each of which represents a complete audio mix and a different user experience.

Each presentation defines a way of mixing a set of audio sub-streams to create a unique rendering of the program. Instructions for which sub-streams to use and how to combine them for each presentation are contained in the in the AC-4 elementary stream.

Presentations enable multiple versions of the audio experience, such as different languages or commentary, to be delivered in a single bitstream in a convenient, bandwidth-efficient manner.

The following audio use cases SHALL be supported by all receivers which support the AC-4 audio codec:

a) Use Case 1 - Movies, Documentaries, Entertainment shows, etc.:

Transmission: A service contains the following audio elements and the presentation information for the combinations of elements defined as valid by the broadcaster. These are sent as a single elementary stream.

- Music and Effects (up to 5.1 channels)
- Dialogue A + B + C (i.e. up to three dialogue languages as three separate elements)
- Audio Description

Receiver: The receiver SHALL enable the selection and mixing of the Music and Effects element together with at least 1 of the Dialogue elements and the Audio Description element (if Audio Description is required by the user) according to a valid presentation sent in the stream. The receiver SHOULD optionally enable independent level adjustment for the Dialogue and Audio Description elements)

b) Use Case 2 - Sports or international events (e.g. Eurovision Song contest, football etc.):

Transmission: A service contains the following audio elements and the presentation information for the combinations of elements defined as valid by the broadcaster. These are sent as a single elementary stream.

- Music and Effects (up to 5.1 channels)
- Dialogue A + B + C + … N (i.e. N dialogue tracks as separate elements)
- Audio Description

Receiver: The receiver SHALL enable the selection and mixing of the Music and Effects element together with at least 2 of the Dialogue elements according to a valid presentation sent in the stream. The receiver SHOULD optionally enable independent level adjustment for the dialogue elements

In all cases, if an user has not yet made an input or selection (including any global selections made via the IRDs static settings, e.g. preferred language), the default presentation as indicated by the broadcaster SHALL be selected.

7.5.4. CA controlled services

Where a component cannot be presented due to the presence of scrambling, an error message shall be displayed. Otherwise the receiver shall present the component, even in the presence of a CA descriptor.

7.5.5. Service Not Available

If the video component within a video service, the audio component in a radio service or the data component in a data service cannot be presented because it is no longer accessible on the registered parameters (PID, etc.), an error message is shown to the user indicating that the service cannot currently be accessed. In case secondary components are missing, the receiver shall present the main component of the service: e.g. a video service with no audio component shall be presented anyway with no error message.

"Service not available" error message SHALL NOT be shown if an HbbTV auto-start application is associated to the service.

The receiver SHALL present all the components of a service it can present.

7.6. Service List initialization and maintenance

A general principle is that any scanning [20] procedure shall make accessible to the user all the services available at a given location.

As new multiplexes or new services inside already existing multiplexes or new linear IP services will be started over the time, it is important to make it very easy for the user to enjoy all the new services as soon as they are active, without any need for a manual rescan. Receivers should then be able to automatically and regularly update the service list without the need of direct intervention by the viewer.

Obviously, the viewer has to be able to perform a complete scan at any moment, either manually or automatically. Furthermore, the viewer SHOULD have the possibility to disable the automatic service list update procedure.

7.6.1. Terrestrial delivery

In order to make receivers capable of managing the situations previously described, the following functions SHALL be implemented:

- **manual full scan**: the procedure, initiated by the user, performs a full (automatic) scan of the spectrum and processes OSDT(s) (if any); it can be used to **update** the channel and service lists or to **re-install** everything from scratch;
- **manual scan (single channel)**: a manual tuning procedure allowing the user to manually select and tune a single VHF/UHF channel (giving for example the channel number) or the OSDT(s) (if any)

[20] Here and in the following the term "scan", strictly applicable to broadcast, is used also for linear IP services

- **automatic full scan**: the procedure is initiated automatically by the receiver; it performs a full (automatic) scan of the spectrum and processes again OSDT(s) (if any) with the only purpose being to update the lists;

DVB-T2 receivers SHALL provide a single list containing both DVB-T and DVT-2 services, plus linear IP services (if any).

For the terrestrial part of all the described tuning procedures, receivers SHALL scan the following spectrum bands [2]:

- III-VHF (BW=7MHz with European channel raster),
- IV-UHF and V-UHF (BW=8 MHz).

7.6.1.1. First Installation Procedure

- At first installation the receiver SHALL perform an automatic scan over the entire spectrum bands and process OSDT(s) (if any), searching for all the digital services available.
- At the end of the scan, all the services found (audio/video/data) are stored in the service list
- If automatic ordering of services mechanism is active (based on a logical channel numbering scheme) the resulting lists will be organised according to the criteria described in §7.4.2.4. Otherwise the list will be organised according to frequency scan order.
- The receiver SHALL provide an interface allowing the user to access the list and move, rename, discard or restore services from the list.

7.6.1.2. Manual Full Scan Procedure

7.6.1.2.1 Update

The receiver SHALL:

- update (where necessary) in the list those services which were already existing; for example:
  - the receiver shall detect a service name ("service_name" is SDT, "ServiceName" in OSDT) change of a given service and update it unless it was manually edited by the end user;
  - if automatic ordering is active, the receiver shall move, if possible based on the rules given in §7.4.2.4 for allocation and conflict resolution, an existing service to the new position indicated by the LCN;
- insert newly available channels or services (audio/video/data) in the relevant list:
  - if they carry an LCN and automatic ordering is active, the rules given in §7.4.2.4 for allocation and conflict resolution apply;
  - if they don't carry any LCN or if automatic ordering is not active, they will be appended at the end of the list.

7.6.1.2.2 Re-install

Same as §7.6.1.1.

7.6.1.3. Manual Scan Procedure (Single Channel)

Same as §7.6.1.2.1 on single channel.

7.6.1.4. Automatic full scan (Automatic service list update)

To maintain an up to date service list, the receivers SHALL implement an automatic service list update procedure, in accordance with the following requirements:

- The receiver SHALL perform an automatic scan at regular intervals (at a specified hour and with a specified frequency) to search for new services.
- The automatic scan can be performed both in standby mode (recommended) and in operate mode (optional). Refer to the following table for automatic channel scan default settings.
- The automatic scan in either mode can be disabled – separately - by the user, but, as a default setting, it should be active only in stand-by mode. In case user would decide to disable automatic search for new channels in standby mode he/she should be warned that this way the capability of automatically tracking evolution of networks and services will be hindered. For this purpose a message like "Warning! After disabling this feature the receiver won't be any more able to keep your channel list automatically updated with respect to services on-air" (Italian translation: "Attenzione! Disabilitando questa funzione il ricevitore non sarà più in grado di aggiornare automaticamente la lista canali in base a quelli effettivamente trasmessi") should be presented.
- When the receiver performs the scan, looking for new channels, it compares any single service found with the list of services already registered. This comparison will be based on frequency, Ts_id, On_id and Service_id of the broadcast services and on OSDT's DVBTriplet of linear IP services. The comparison SHALL take into account all services including those that were discarded by the user from the channel/service list and are listed in the "discarded channel list".
- For those services already registered in the service list, the receiver SHALL:
    - detect a "service_name" change and update it unless it was manually edited by the end user;
    - if automatic ordering is active, move an existing service, if possible based on the rules given in §7.4.2.4 for LCN allocation and conflict resolution, to the new position indicated by the LCN;
- If any service is found with frequency, Ts_id, On_id or Service_id or with OSDT's DVBTriplet different from those of the channels already registered, it will be added to the channel list (in its own category group) according to the following rules:
    - if new service carries an LCN and automatic ordering is active, the rules given in §7.4.2.4 for allocation and conflict resolution apply
    - if new service doesn't carry any LCN or if automatic ordering is not active, it will be appended at the end of the list.
- If any new service is found a message will be shown on screen when the receiver is switched on (if it was in standby mode) and will be left on screen until the user presses the OK key. The message will be something like: "New channels were found and added to the channel list" (Italian Translation: "Sono stati trovati nuovi canali in onda. I nuovi canali sono stati aggiunti alla lista canali").
- In case both the "search for new channels in standby mode" and the "search for new channels in operate mode" options are set on "YES", than the receiver must start the automatic scan at the time indicated for performing the channel search in operate mode.
- In case the "search for new channels in operate mode" is available and set on "YES", at the time specified for starting the procedure, a 30 seconds countdown will appear on screen with a message like the following: "The receiver will start looking for new channels in … seconds". Italian translation: "Il Box Interattivo comincerà la ricerca di nuovi canali entro … secondi" (mutatis mutandis for IDTV sets). The user will be able to press "OK" for letting the procedure start immediately or "exit" for aborting the procedure. In case the user will choose "exit", the procedure will be aborted and will not be performed again until the next scheduled time.
- In case the "search for new channels in standby mode" option is set on "YES", but the "search for new channels in operate mode" option is available and set on "NO" (or was aborted – refer to previous point), the receiver shall start the scanning procedure

some time, implementation dependent, after being put in standby mode (in case the receiver is put in standby mode more than once a day, this procedure has to be performed only once daily).

7.6.1.5. Handling of duplicate services

In the presence of the same service available on different frequencies/Transport Streams, the Receiver shall behave as follows.

When identical services (i.e. with the same original_network_id, transport_stream_id and service_id triplet) are received on different frequencies (obtained from different transmitters or generated by the MATV system), the receiver SHOULD present to the user all of the instances of the service (i.e. including duplicates). In the channel list, the position associated with the lowest ordinal number should be given to the service with the best QoS. Extra instances of services should be regrouped at the end of the list.

The minimum requirement is that only the instance with best C/N out of the services with the same DVB triplet found during scan shall be kept, provided that the situation is revisited at each automatic or manual rescan.

In the context of interactive applications (e.g. an EPG) the (unique) DVB Locator of duplicate services shall refer to the one with the best QoS. (In case of equivalent QoS, it shall refer to the service first discovered).

7.6.2. Satellite delivery

In order to make receivers capable of managing the situations previously described, the following functions SHALL be implemented:

- manual full scan: the procedure, initiated by the user, performs a full (automatic) scan of the spectrum and processes OSDT(s) (if any); it can be used to update the service list or to re-install everything from scratch;
- manual scan (single channel): a manual tuning procedure allowing the user to manually select and tune a single transponder (giving for example the transponder number) or the OSDT(s) (if any)
- automatic full scan: the procedure is initiated automatically by the receiver; it performs a full (automatic) scan of the spectrum and processes again OSDT(s) (if any) with the only purpose being to update the service list;

The receiver SHALL be able to register at least 2000 services. Receivers SHOULD be able to register at least 4000 services.

7.6.2.1. First Installation Procedure

- At first installation the receiver SHALL perform an automatic scan over all the Ku Band, searching for all the digital services that can be received through the home satellite receiving system, and process OSDT(s) (if any). The platform's service list can alternatively be built based upon Home Channel(s)'s NIT/BAT/SDT tables alone (Fast Scan).
- At the end of the scan, all the services found (audio/video/data) are stored in the service list.
- If automatic ordering of services mechanism is active (based on a logical channel numbering scheme) the resulting list will be organised according to the criteria described above.
- The receiver SHALL provide an interface allowing the user to access the list and move, rename, discard or restore services from the list.

7.6.2.2. Manual Full Scan Procedure

7.6.2.2.1 Update

The receiver SHALL:

- update (where necessary) in the list those services which were already existing; for example:
  - the receiver shall detect a service name ("service_name" in SDT, "ServiceName" in OSDT) change of a given service and update it unless it was manually edited by the end user;
  - if automatic ordering is active, the receiver shall move an existing service to the new position indicated by the LCN;
- insert newly available services (audio/video/data) in the service list at the proper position (platform's LCN or 1000+ range).

7.6.2.2.2 Re-install

Same as §7.6.2.1.

7.6.2.3. Manual Scan Procedure (Single Channel)

Same as §7.6.2.2.1 on single channel.

7.6.2.4. Automatic full scan (Automatic service list update)

To maintain an up to date service list, the receivers SHALL implement an automatic service list update procedure, in accordance with the following requirements (specific implementation is left up to manufacturers):

- The receiver SHALL perform an automatic check of the information carried in the platform's Home Channel(s) at regular intervals (e.g. at a specified hour and with a specified frequency) or whenever possible
- The automatic scan can be performed both in standby mode (recommended) and in operate mode (optional). In case of receivers with constraints on power consumption in stand-by mode, the automatic check will be performed before either entering or leaving stand-by mode. Refer to the following table for automatic channel scan default settings.
- The automatic scan in either mode can be disabled – separately - by the user, but, as a default setting, it should be active only in stand-by mode. In case user would decide to disable automatic search for new channels in standby mode he/she should be warned that this way the capability of automatically tracking evolution of networks and services will be hindered. For this purpose a message like "Warning! After disabling this feature the receiver won't be any more able to keep your channel list automatically updated with respect to services on-air" (Italian translation: "Attenzione! Disabilitando questa funzione il ricevitore non sarà più in grado di aggiornare automaticamente la lista canali in base a quelli effettivamente trasmessi") should be presented.
- When the receiver performs the check it compares any single service found in NIT_{actual} and/or in any NIT_{other} or BAT possibly present on the Home Channel(s) and/or in OSDT with the list of services already registered for the platform. This comparison will be based on frequency, Ts_id, On_id and Service_id of the broadcast services and on OSDT's DVBTriplet of linear IP services..
- For those services already registered in the service list, the receiver SHALL:
  - detect a "service_name" change and update it unless it was manually edited by the end user;
  - if automatic ordering is active, move an existing service to the new position indicated by the LCN;

- If any service is found with frequency, Ts_id, On_id or Service_id or with OSDT's DVBTriplet different from those of the channels already registered, it will be added in the relevant list(s) at the proper position (platform's LCN or 1000+ range).
- If any new service is found a message will be shown on screen when the receiver is switched on (if it was in standby mode) and will be left on screen until the user presses the OK key. The message will be something like: "New channels were found and added to the channel list" (Italian Translation: "Sono stati trovati nuovi canali in onda. I nuovi canali sono stati aggiunti alla lista canali").
- At the end of the update procedure any service with an LCN whose TS_id, On_id or Service_id are different from those of any service currently advertised on the Home Channel(s) will be removed from the service list.
- In case both the "search for new channels in standby mode" and the "search for new channels in operate mode" options are set on "YES", then the receiver must start the automatic scan at the time indicated for performing the channel search in operate mode.
- In case the "search for new channels in operate mode" is available and set on "YES", at the time specified for starting the procedure, a 30 seconds countdown will appear on screen with a message like the following: "The receiver will start looking for new channels in … seconds". Italian translation: "Il Box Interattivo comincerà la ricerca di nuovi canali entro … secondi" (mutatis mutandis for IDTV sets). The user will be able to press "OK" for letting the procedure start immediately or "exit" for aborting the procedure. In case the user will choose "exit", the procedure will be aborted and will not be performed again until the next scheduled time.
- In case the "search for new channels in standby mode" option is set on "YES", but the "search for new channels in operate mode" option is available and set on "NO" (or was aborted – refer to previous point), the receiver shall start the scanning procedure some time, implementation dependent, after being put in standby mode (in case the receiver is put in standby mode more than once a day, this procedure has to be performed only once daily).

7.6.3. Default settings for automatic scan

N.	Settings / Italian Translation	Default settings
1	"Automatic search for new channels in standby mode" / "Ricerca automatica di nuovi canali in standby"	YES / SI' (MANDATORY)
2	"Automatic search for new channels in operate mode" / "Ricerca automatica di nuovi canali a decoder acceso"	NO / NO (if available)
3	"Time" / "Ora"	04:30 AM
4	"Repetition" / "Frequenza"	"Daily" / "Quotidiana" = default ("Weekly" / "Settimanale" – other options possible)

Table 38: Default settings for automatic scan

7.6.4. Automatic Ordering of Channels and Services in the absence of LC descriptor acquisition

If the off-the-air LC descriptor acquisition mechanism is not activated in the receiver, the services shall appear in the order they have been detected (taking into account the procedure described in §7.6.2) and grouped into three categories in the following order:

- TV channels
- Radio channels

Interactive services linked to TV or Radio services shall not be shown.

7.6.5. Network evolution

As specified in Table 38 on default settings for automatic scan, the receiver SHALL implement, by default, an automatic scanning procedure, to adapt the receiver to the evolution of the network.

As specified in §6.1.1.1, changes in modulation parameters of existing services SHALL be automatically detected.

7.6.6. Default channel numbering of services

No default service numbering shall be implemented by manufacturers.

7.7. User interface to SI carried data

This clause describes the minimum set of views of the SI information that receivers SHALL (M), SHOULD (R) or MAY (O) be able to present to the user.

The minimum lengths for text fields (if present) that shall be displayed by receivers are defined in the following table. Note that the figures given are for the number of displayable characters (including spaces) required to represent the text field. The number of bytes required will depend on the use of control codes and whether one or two byte character representation is used.

Field name	Field length in displayable characters	M/R/O	Comments and examples
Network Name	247	O	“Operator X”
Service Provider Name	20	O	“Media Company Y”
Service Name or Preferred Name	32	M	“Italia International” Full name for display on set-up menus
Short Name of Service	8	O	“It.Int” A short version for display on browse and listing display. Possibly shortened by broadcasters from full name by use of escape characters as defined in TR 101 211. Otherwise the full length Service Name should be displayed.
Event Name	40	M	“La Grande Zia” Individual broadcasters are free to add an episode title to the title within the space, for example “Lo Zio: la Storia Segreta”
Short Event description	200	M	“Un giorno, Zio esce per cercare sigarette. Torna venti anni dopo.” Broadcasters must ensure that the text does not overflow the maximum descriptor size.
Extended Event Text	3984	O	The extended event text complements the short event description.
Component description	32	O	“In alta definizione”

Table 39: Text Field Lengths

7.7.1. Timer

Must be locked to the Time & Date Table (TDT) and adjusted by the Time Offset Table (TOT), if broadcast.

7.7.2. Access to the Service List

Access to the Service List SHALL be provided through a dedicated key (recommended) or by a resident menu. This list SHALL present TV Channels, Radio Channels, and Independent Interactive services (i.e. when they are not bound to a TV or a Radio service, or another Interactive Service) following the indication of the associated LC descriptor.

If the LCN acquisition mechanism is not active, the Service List SHALL be grouped by:

- TV services,
- Radio services

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8. Content protection

8.1. Smart Card based systems

Pay TV services or other services with controlled/conditional access are an integral part of the Italian Digital TV platform.

Based on both CA providers and manufacturers willingness, the CA system(s) adopted by standalone or platform operator(s) for restricting access, completely or partially, to their contents could be either embedded in the receiver or implemented in a Conditional Access Module (CAM) plugged in a Common Interface (CI) slot.

In this latter case, if a CICAM is provided with the digital receiver (e.g. in case of iDTV), the CICAM provider and the digital receiver provider guarantee the coexistence of more CA systems in the same manner as embedded CA system(s). The CICAM provider and the iDTV vendor guarantee the same security level as for CAS embedded.

8.1.1. Embedded CA(s)

Devices providing smart card interface for embedded conditional access purpose shall be conforming to the ISO 7816 standard, levels 1 to 3 (with T=0 and T=1).

Embedded CAS integration is based on proprietary implementations which require agreement between Device Manufacturer and Embedded-CAS provider. It is then out of the scope of this document.

8.1.2. CICAM

CICAM-equipped HD receivers complying with this document SHALL be consistent with the CI Plus Limited Liability Partnership (LLP) specification [37].

CICAM-equipped HD Receivers complying with this document MAY comply with the CI Plus Limited Liability Partnership (LLP) Enhanced Content Protection (ECP) specification [53].

CICAM-equipped UHD Receivers complying with this document SHALL comply with the CI Plus Limited Liability Partnership (LLP) Enhanced Content Protection (ECP) specification [53].

8.1.2.1. CICAM Player mode

Terminal SHALL support Host initiated play of content using CICAM Player Mode, both for VOD and Live contents, as well as for IP linear services, as specified in CI Plus LLP Specification [37]. Support for CICAM initiated playback is OPTIONAL.

8.1.2.2. CICAM with IP connection

Terminal SHALL support CICAM Player Mode where the CICAM performs direct IP data retrieval without the use of the LSC resource. The Terminal SHALL determine that the CICAM performs direct IP data retrieval when the CICAM starts the ‘CICAM player session’ with input_max_bitrate set to zero.

8.1.2.3. CICAM using Host connectivity

Terminal shall support CICAM Player Mode where the CICAM performs IP data retrieval by requiring the setup of a Hybrid LSC connection.

8.1.2.4. Virtual Channel and Auxiliary File System

Terminal SHALL provide a mechanism which allows the user to launch an interactive application provided by the CICAM, whenever he/she selects a channel which is also provided by the CICAM. Such a channel SHALL be listed in the channel list provided by the terminal.

The mechanism is based upon features provided by CI Plus LLP Specification [37], i.e.:

- Virtual Channel
- Auxiliary File System
- Application MMI

The mechanism to coordinate virtual channel access with CICAM interactive application launch is fully provided by CI Plus LLP Specification [37] clause 5.4.

8.1.2.5. Low Speed Communication resource V4

In order to allow a CICAM to perform a speed test of the terminal's broadband connection, the terminal SHALL implement LSC version 4 as described in CI Plus Specification [37], including the Hybrid LSC Connection.

8.1.2.6. Physical engagement

The Common Interface Connector and the Module SHOULD be implemented in such a way that the smart card shall be inserted with the contact area facing upwards when horizontal.

8.1.2.7. Backward compatibility

Host SHALL provide full backward compatibility to previous version of CIPlus (earlier than [37]) and to DVB-CI [15].

In particular, a Host SHALL operate according to the version agreed between CICAM and Host.

8.1.2.8. Implementation guidelines

In order to enforce the above requirement on backward compatibility, some recommendations regarding particular scenarios where issues were found are given in the following. Refer to [40] Annex E too, for clarifications about CICAM use cases.

8.1.2.8.1 General

1. Should the CA(s) associated to the tuned service be supported both at Host (embedded) and Module level, the former SHALL have the priority as active (descrambling) device.
2. By default, during the channel scanning procedure all the channels found SHALL be stored by the device independently from the channel scrambling status.
3. The Host SHALL maintain the last tuned frequency when entering the main menu;
4. To cope with possible Module malfunctioning without requiring extreme measures by customers, like Module extraction/insertion and/or Host power unplug/plug cycles, the Module SHALL be restarted as soon as Host comes out of stand-by (Module power-cycle or Module reset). The exception to this is if the Module is performing some task that requires it to remain operational (e.g. Host is recording and requires the CICAM to continue to descramble).
5. Host first installation while Module is inserted, could lead to two different failure scenarios:
   a. Module authentication failure during channel scan, in relation to:

i. Lack of signal
ii. Muxes carrying bad data in DVB-SI table used to get time-date (TDT and TOT)

In order to avoid these scenarios, Host SHALL send to the Module a RESET command as soon as the first installation is terminated.

b. Host first installation failure. In order to avoid this scenario, Host SHALL ignore any MMI message coming from the Module during first installation process.

6. Host SHALL ignore any Module request, through the Host Control resource, of tuning to a service with dvb://0.x.y locator;
7. Whenever communication between the Host and the Module has been lost, i.e. polling function time out expires (see [15] A.4.1.12), Host SHALL reset the Module, in order to properly restart it

8.1.2.8.2 High Level MMI

1. Host SHALL support the High Level MMI Interface as specified in [37]
2. Host SHALL include in the main menu a CAM defined Menu tree.
3. Host SHALL support MMI Pop-ups.
4. Host SHALL comply with the following requirements applied to MMI pop-ups and CAM menus:
   - at least 5 lines SHALL be displayed simultaneously
   - in case of pop-ups/menus composed by more than 5 lines the display SHALL support scrolling.
   - at least 50 characters SHALL be displayed for each line
5. Host SHALL allow MMI pop-ups to have control of the Remote Control keys until the user exits the MMI itself. MMI messages shall not be automatically closed.
6. Host SHALL allow MMI to support the following RC keys:
   - Numeric keys
   - UP, DOWN, LEFT, RIGHT arrow keys
   - OK key
   - Back/Exit key(s)
7. In case a System RC Key (P+, P-, Menu, List, …) is selected by the customer while a pop-up message is displayed, Host SHALL close the popup and perform the related system action.
8. Host SHALL allow MMI pop-ups to have higher video priority over downloaded HbbTV applications.

8.2. Embedded DRM based systems

8.2.1. Introduction

As for embedded CAS, adoption of one or more DRM systems is outside of the scope of this document and it is left up to interested Operators and device Manufacturers instead.

8.2.2. Common Encryption (CENC)

In addition to the media formats defined in Table 3, the Common Encryption for ISO Base Media File Format (CENC) [59] SHALL be supported by DRM-enabled receivers. CENC is used to protect contents packaged in MP4 container and delivered either with HTTP Streaming or HTTP Adaptive Streaming.

The CENC protection scheme enables DRM interoperability at the content level for IP delivery much like Simulcrypt does for CA systems in the broadcast environment.

Common Encryption for MPEG-2 TS protected contents is left for further study.

8.3. Protection of IP linear services

When an IP linear service is selected, the terminal shall use the corresponding ServiceLocation available from the OSDT in order to determine whether the CICAM Player shall be used for the service decryption.

When DRMControlInformation element is absent from at least one of the ServiceLocation of the IP linear service, then the terminal shall consider the IP linear service as non-encrypted and shall proceed on its own for service presentation, without requiring usage of the CICAM Player.

When DRMControlInformation element is present in all the ServiceLocation of the IP linear service, then the terminal shall consider the IP linear service as encrypted, and shall evaluate each ServiceLocation in turn, in descending priority order, until the terminal determines that a ServiceLocation is supported by an embedded DRM or by the CICAM Player of one of the present CICAM(s).

During evaluation of a ServiceLocation, the terminal shall first verify whether it is supported by an embedded DRM. When a ServiceLocation is not supported by an embedded DRM, then the terminal shall secondly verify whether it is supported by one of the present CICAM implementing the CICAM Player mode.

When the terminal determines that a ServiceLocation is supported either by an embedded DRM or by a CICAM, then the terminal does not evaluate the other ServiceLocation with lower priorities, if any, and shall select the matching configuration, either embedded DRM or CICAM Player, to decrypt the IP linear service.

Ifthe IP linear service is effectively encrypted and the terminal has no possibility to decrypt the service neither by use of an embedded DRM, nor by use of a CICAM, nor by use of any other unspecified mean, then the terminal shall present an error message.

The above behaviour is represented in the following informative flow chart:

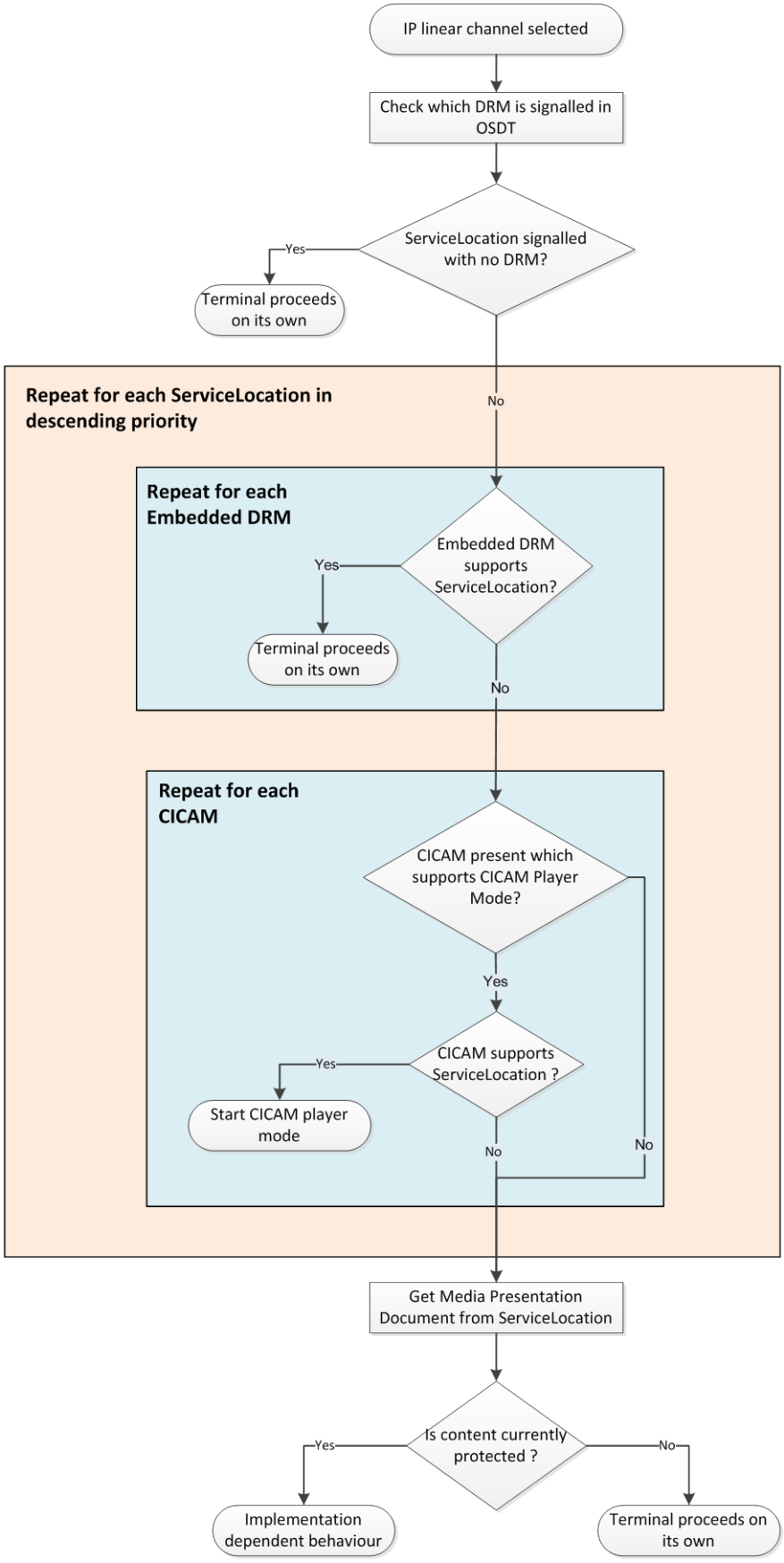

Figure 6: Linear IP channel DRM selection

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9. Resident Software and API

Enhanced and interactive television services are an essential part of the Digital TV proposition. Receivers must fully support all specified functionality.

9.1. Services

9.1.1. Teletext

Teletext [12] is an important medium in Italy. Not all analogue Teletext services will immediately be converted to interactive applications. Thus there is a need to maintain compatibility with DVB Teletext [11].

The DVB Teletext signal shall be decoded and presented within the receiver and displayed using graphical functions (so-called Teletext Mode 2). That's particularly true for STBs as (analogue) VBI Teletext signal cannot be carried across (digital) HDMI interface. At least level 1.5 Teletext, as defined in ETS 300 706 [12], shall be supported.

One single remote control is then sufficient to view audiovisual services and Teletext using the "Text" key.

In order to preserve customers' investments in TV sets with advanced Teletext features, Teletext signal shall be anyway reinserted on the TV SCART and RCA (if present) VBI lines. Insertion shall conform to ITU-R BT.653-2 [31]. Teletext data will be inserted from lines 6 to 22 and 320 to 335.

It is recommended that VBI data, including Teletext, be reinserted on the VCR SCART (including the Y/C signals) when present (see 6.1.4.2), even if many VCRs will not be able to replay this data. Insertion shall conform to ITU-R BT.653-2 [31]. Teletext data will be inserted from lines 6 to 22 and 320 to 335.

9.1.2. Subtitling

Concerning subtitling it is expected that broadcasters will follow the EBU recommendation on subtitling in digital services [7]. However, compatibility must also be maintained with subtitling through Teletext.

As a consequence, the receiver SHALL implement DVB Subtitling and Teletext subtitling.

9.1.2.1. DVB Subtitling

DVB Subtitling shall be implemented in conformance with [18].

HD Subtitling shall be implemented according to [28].

A Display Definition Segment shall only be included in the subtitle stream when the video is HD. The maximum display_width shall be 1919 and the maximum display_height shall be 1079. It is recommended that receivers support Display Definition Segments.

9.1.2.2. Teletext Subtitling

Teletext subtitling is part of both Teletext modes described above. Information about the presence of Teletext subtitles shall be obtained from the teletext descriptor and this information shall be made available to the user, at his request (e.g. when pressing the "Sub" key, or through a banner).

It is acceptable to make the user select the relevant teletext page for viewing subtitles, as long as a clear message on the availability and modality of access to the subtitles is presented to the user (e.g. a channel banner).

Where possible, receivers should be able to display both subtitles and interactive graphics simultaneously. However, not all receivers may be able to do this: in that case, when an application is activated, it shall be able to suspend the rendering of Teletext.

9.2. Resident Software

9.2.1. Resident Manufacturer Specific Applications

9.2.1.1. Navigator

It shall be present. It is defined by the manufacturer (see [1]).

9.2.1.1.1 Handling of input events by the Navigator

When the receiver is in TV Viewing Mode (see definition §4.1), it is expected that any running application shall release input keys VK_0 to VK_9. The Navigator shall always be able to handle those input events.

The Navigator must also handle all the other keys used for TV viewing (e.g. channel list, volume, and channel up/down). Those keys are different from the keys of the “Interactive Pad” (see §6.2 on the Remote Control, in the D Book [36]).

9.2.2. Parental Control

The receiver shall provide a PIN-controlled Parental Control menu to perform the following functions:

1) setting age thresholds (at least for 14 and 18 years) for viewing single events
2) changing the PIN value
3) activating/deactivating PIN checking on 1), 2), 3) above and on the menu itself

The PIN value SHALL be explicitly set by the user during installation procedure. In conformance with National Authority AGCOM Directive 220/11/CSP [66], manufacturers SHALL NOT provide a default value for such a PIN. Reset of the PIN, e.g. in case it was forgotten, can only be achieved through an overall receiver reset to the out-of-the-box status. User SHOULD be duly warned about this drawback during installation procedure.

From the receiver Parental Control menu it shall be possible setting an age threshold to be matched against the value set by broadcasters, on a per event/content basis, in:

- the Parental_rating_descriptor of the EIT (conventional DVB services)
- the ParentalRating of a DVB-DASH MPD, as specified in §7.2.2.2 (linear IP services or CoD contents)
- the <ParentalRating> element of a CAD (CoD contents)

If this value is equal or greater than the age threshold set, the current event can be viewed only entering a PIN. Such PIN is the same as the receiver’s Parental Control PIN (if any). The PIN protection can be enabled/disabled by means of an appropriate receiver menu. At least the 14 and 18 years thresholds must be present.

The parental rating is associated to one or more countries through

- the country_code in EIT’s Parental_rating_descriptor

- the CountryCodes in OSDT's TargetRegions
- the Region attribute in CAD's ParentalRating element.

That could either be a code assigned to a single country (e.g. "ITA" for Italy) or to an ETSI defined group of countries (e.g. "902" for all countries, "905" for Europe). A given parental rating will be applicable if the associated country code would match or include the country set in the receiver at installation time.

By default the receiver shall be set to block all events and/or channels flagged with an 18 years threshold.

Locking/unlocking single services could be also optionally offered by manufacturers. In this case from the Parental Control menu it will be possible to lock one or more specific services so that they can be viewed only entering a PIN. Such PIN is the same as the receiver's Parental Control PIN (if any). The PIN protection can be enabled/disabled by means of an appropriate receiver menu.

9.3. Hybrid broadcast broadband TV (HbbTV®)

The receiver SHALL access all Italian broadcast digital terrestrial television, radio and interactive services, based on HbbTV standard [6]. Receivers SHALL implement all errata published against this specification, to take advantage of bug corrections.

9.3.1. Content protection aspects

9.3.1.1. Embedded DRM

If a terminal provides one or more DRMs for use by an HbbTV application, it SHALL support the DRM feature and expose those DRMs as defined by HbbTV specification [6].

9.3.1.2. CICAM

9.3.1.2.1 Broadband contents managed by the CICAM

Terminals compliant with section 8.1.2 SHALL support CICAM player mode including trick mode operations (mapping between HTML5 video element and CICAM player mode), as defined in section 11.4.5 and Annex K of HbbTV specification [6].

9.3.1.2.2 CICAM - Virtual Channel and Auxiliary File System

Terminals compliant with section 8.1.2 SHALL support virtual channel mechanism in order to start an HbbTV application provided by the CICAM Auxiliary File System, as defined in section 11.4.4 of HbbTV specification [6].

9.3.2. Service requirements

In relation to [22] and [25], the following features SHALL be provided.

9.3.2.1. Launching a CS application from an HbbTV® application

It is required that "terminal manufacturer (or one of their agents) provides a Companion Screen application that can link to, and control the terminal from the Companion Screen application", as defined in HbbTV specification [6], in relation to "Launcher application".

9.3.2.2. Interaction between Resident and Downloaded Application

When a resident application is called by the user or automatically, it should not kill the running HbbTV application.

In case the application is being loaded when the resident application is called, the application should continue being loaded in the background.

9.3.3. Coexistence with legacy MHP applications and receivers

Terminals compliant with this specification SHALL ignore, as expected, the reserved_future_use bit preceding the application_type field in the application_signalling_descriptor. According to TS 102 809 [34] all reserved_future_use bits in interactive application signalling should be set to "1" but lab tests with signals reproducing the future simulcasting of MHP and HbbTV applications on the same service have shown that most legacy MHP receivers wouldn't work properly in such scenario if that particular bit was set to "1" in the application_signalling_descriptor of HbbTV application. As a consequence this reserved_future_use bit within the PMT will be set to "0" by operators simulcasting MHP and HbbTV applications on the same service.

9.3.4. Highlights for HbbTV receivers in Italy

Based on early HbbTV 2.0.1 field trials run in Italy, some requirements already mandated in [6] are felt worth of being highlighted in the following.

9.3.4.1. Stream Event management

Terminals compliant with this specification have to correctly manage stream-events carried by a broadcast DSMCC carousel, as described in [34] and [6].

Registration to broadcast stream-events have to be supported both by DSMCC and XML file.

9.3.4.2. Http User Agent

Terminals compliant with this specification have to provide all data marked as mandatory within Http-User-Agent, as described in HbbTV specification ([6] clause 7.3.2.4), i.e.:

```
HbbTV/1.4.1 (<capabilities>; <vendorName>; <modelName>;
            <softwareVersion>; ; <familyName>; <reserved>)
```

9.3.4.3. AIT version fields

As described in HbbTV specification ([6] clause 7.2.3.1) and in the official HbbTV test suite, terminals don't have to launch autostart applications where the `minor` version of the application is greater than the `minor` version of the specification version supported by the terminal.

Autostart HbbTV applications for the Italian market will initially be signaled as:

```
version.major = 1
version.minor = 4
version.micro = 1
```

9.3.4.4. Application Priority through AIT

Terminals compliant with this specification have to be able to correctly manage application priority as described in [6] clause 6.2.2.5.1. Here below an example:

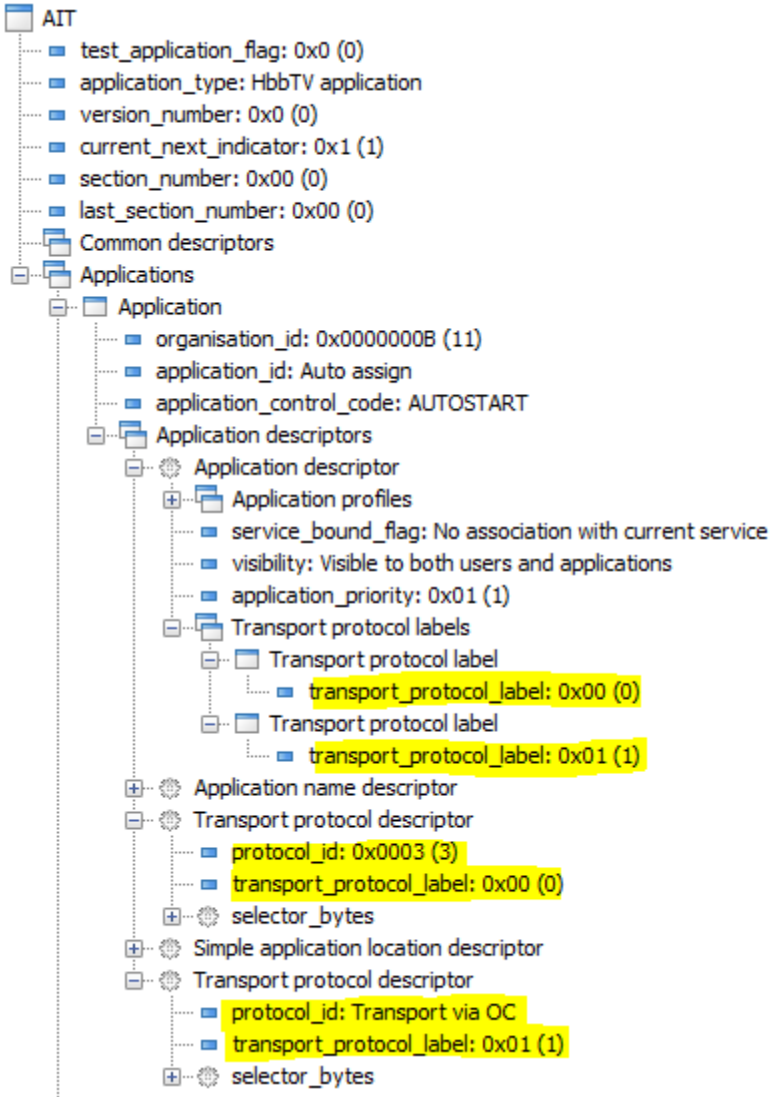

Figure 7: Sample usage of AIT application_priority

9.4. Maintenance and Upgrade

It is very important for the receiver to automatically and regularly look for available software upgrades and to automatically load and install such new software.

The procedure must be designed to guarantee both the manufacturers and the broadcasters that over-the-air software upgrades are received and automatically installed on the receiver in the households. This will also make the viewers sure that their receivers are always updated and fully compliant with the services on air.

The process of upgrading shall cause minimal disruption to the viewer. However, to minimise the diversity of deployed software builds and to most efficiently use the available broadcast capacity, the receiver must detect and act upon the broadcast of the relevant software download. After a System Software Update has been performed, user settings like services listings (preferred, etc,) shall be preserved, whenever feasible.

Obviously, the viewer has also to be able to perform a manual search for software upgrades in any moment. Further, the viewer has to be allowed to disable the automatic software upgrade procedure.

9.4.1. Automatic software upgrade procedure

To allow for a simple user interaction, the receiver SHALL behave in the following manner:

1. The receiver has to automatically look for available software upgrades over the air.
2. The automatic software upgrade procedure can be disabled by the user.
3. When the receiver looks for available software upgrades, it has to scan all the multiplexes.
4. The software upgrades put over the air need to be model specific so that there is no chance that a software intended for a particular receiver model can be downloaded and installed on a receiver with a model different from that to which the software upgrade was intended, as specified in DVB TS 102 006 [23].
5. If any new software version is found, it will be automatically downloaded, but should only be installed after explicit confirmation by the user (manufacturer option).
6. The automatic software upgrade can be performed both in standby mode (mandatory) and optionally in operate mode (at a specified hour and with a specified frequency). Receivers are not required to perform automatic software upgrade while in low power mode. Refer to the following table for automatic channel scan default settings.
   a) If the "automatic software update in standby mode" option is set to "YES"
      - in supposedly stable standby conditions (e.g. 30 minutes after standby mode has been entered) and anyway before entering low power mode (if available), the receiver has to search for new software;
      - if receiver is switched on while new software search has already started the update procedure will be aborted
      - if receiver is switched on after new software has been found and download or upgrade is ongoing, the update procedure will be duly completed (loader progress messages should help user understanding what's going on)
   b) If the "automatic software update in operate mode" option is available and set to "YES", then:
      - at the specified time and with the specified frequency, if the receiver is on it has to search for new software;
      - at the time the procedure is started, a 30 seconds countdown will appear on screen with the following message: "The receiver will start looking for new software in … seconds". Italian translation: "Il Box Interattivo comincerà la ricerca d'aggiornamenti software entro … secondi".
      - The user will be able to press "OK" for letting the procedure start immediately or "exit" for aborting the procedure. In case the user will choose "exit", the procedure will be aborted and will not be performed again until the next scheduled time.
7. When new software has been installed, then (after the receiver has been automatically rebooted, if necessary, and switched on if it was in standby) a message like the following shall appear on screen: "Your receiver was successfully upgraded. New features are now available." (Italian Translation: "Il Box interattivo è stato aggiornato. Nuove funzionalità sono state aggiunte"). A further message could be displayed briefly describing what functionalities were added to the receiver. This message is up to the manufacturer and is intended for informing the user on what features were added on the receiver. This additional message is not mandatory, but it is strongly recommended. This message will even contain the manufacturer's call centre telephone number (if any) or, at least, a web site where finding the description of such new functionalities.

8. If new software is found and installed the message described above should be displayed and the automatic channel list updating procedure should be skipped. It is absolutely mandatory that the message described above is seen by the viewer.
9. The message will stay on the screen until the viewer presses the OK key.
10. It is strongly recommended that, within the receiver menu, a section is provided for describing the new features of the last downloaded software.

N.	Settings / Italian Translation	Mandatory default settings
1	"Automatic software upgrade in stand by" / "Aggiornamento automatico del software con Televisore in standby".	YES / SI
2	"Automatic software upgrade in operate mode" / "Aggiornamento automatico del software con Televisore acceso".	YES / SI (if available)
3	"Time" / "Ora"	**04:00** AM
4	"Frequency" / "Frequenza"	"Daily" / "Quotidiana" = default ("Weekly" / "Settimanale" – other option possible)

Table 40: Default settings for auto software upgrade

9.4.2. System Software Update

Taking into account on one hand the increasing scarcity and expensiveness of broadcast capacity and on the other hand the huge size of modern receivers' software images (1GB+ on some TV sets), Over The Air (OTA) System Software Update (SSU) of installed receivers is not always viable: in fact, a 100MB image would take more than 2 hours to download using 100kbit/s bandwidth, the maximum value that broadcasters can reasonably afford. For this reason:

- receivers with software images up to 100MB SHALL support the DVB System Software Update (DVB-SSU) specification as defined in [24], using the Simple Profile of DVB Data Downloading as defined in [23].
- receivers with software images larger than 100MB MAY support DVB-SSU notifications of updates made available for download over the Internet, as specified in latest DVB-SSU versions [24]. Thanks to DVB SSU Notifications receivers not connected to the internet could be informed that an update is available and then prompt the user to connect it, if possible, so that it can retrieve and download the update.
- receivers with software images larger than 100MB MAY support DVB-SSU using the Simple Profile of DVB Data Downloading as defined in [23].

Manufacturers SHALL provide appropriate recovery measures to cope with possible receiver failure or hang-up during the System Software Update.

9.4.2.1. Terrestrial delivery

Receivers SHALL be able to find out their own DVB-SSU files without relying on the relevant linkage_descriptor in NIT or BAT.

9.4.2.2. Satellite delivery

Receivers SHALL look for the relevant linkage_descriptor (linkage_type=0x09) in Home Channel(s)'s NIT_{actual}. See Annex E for tivùsat case.

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10. Accessories and Setup

Receivers must be both easy to install and use. An existing viewer of analogue services needs to be able to complete a basic digital installation, i.e. just for viewing, using only what has been supplied with the receiver. In addition, on-screen information must be provided in a clear and consistent manner both to aid installation and (if required) to enable an easy dialogue with any support staff, e.g. call-centre

10.1. Receiver Accessories

The manual should contain at least the following information:

- Advice on the verification and eventual adaptation of reception equipment
- The modes of connection of other peripheral appliances (TV, VCR, DVD, other STB)
- Mode of connection to the broadband network
- Set up and tuning of the receiver
- Description of the functions of the remote control keys
- Options and accessories (e.g. Infra-red Keyboard, etc…)
- Troubleshooting
- Information on a call centre number to resolve connection problems.

Accessory	Presence
1 Power Cable	Mandatory
Handbook in Italian language	Mandatory

Table 41: Accessories

10.2. Power Supply / Voltage

220V AC + 15%; 50 + 2 Hz (Low Voltage recommendation 73/23/CEE e 93/68/CEE. Law n° 971/1977).

10.3. Low-power mode

In order for receivers supporting a low-power standby feature, based on mandatory or voluntary EU ecodesign requirements, to meet operators' needs (e.g. rights refresh for Pay TV services, spot software upgrade campaigns), the following recommendations/constraints apply:

1. It SHOULD be possible disabling/enabling low-power standby mode through a dedicated menu option
2. before entering low-power standby mode receivers SHALL perform, if currently enabled, automatic channel list update and software upgrade
3. transition from normal to low-power stand-by mode SHOULD take at least 1 hour
4. low-power standby mode SHOULD NOT last longer than 23 consecutive hours before normal stand-by is entered; after house keeping (point 2) is performed and proper transition time waited (point 3), low-power standby mode will be entered again.

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11. Default settings

The following is a list of the overall default settings of the receiver. These requirements are intended to provide to all receivers on the market a very similar behaviour when they are installed or restored to factory defaults.

Those strictly related to broadcasters' services and applications (Parental Control, Automatic OTA Update, Automatic Channel Update, LCN) SHALL be compliant with the table below. The rest should be considered by manufacturers just as a suggestion.

Feature	Specification	Status	Note
Present and Next banner			
• Duration	Less or equal to 4 sec.	Mandatory	
• Current Time	Active	Optional	
• Channel number	Active	Mandatory	
• Service name	Active	Mandatory	Long "channel name" label
• Volume indicator	Active	Optional	If the receiver allows to locally control volume, the volume bar SHALL be present
Country	As per after the first installation	Mandatory	After first installation the default country SHALL be Italy
Language options			
• Language	As per after the first installation	Mandatory	After first installation the default language SHALL be Italian
• Primary Audio	As per after the first installation	Mandatory	
• Subtitles	Not Active	Mandatory	
• Primary Subtitles language	As per after the first installation	Mandatory	
Automatic Channel Numbering	Active	Mandatory	This is a toggle active/inactive
TV settings			
• Screen Format	16:9	Mandatory	
• HDMI output format	As per after the first installation	Mandatory	
• TV SCART output	RGB	Mandatory	
• VCR SCART output	CVBS	Mandatory	when available
Parental Control settings			

Feature	Specification	Status	Note
PIN protected events	PIN SHALL be asked for any event with rating value equal or greater than 18 years	Mandatory	
Automatic software upgrade			
In Stand by mode	Active*	Mandatory	
In Operate mode	Active*	Optional	
Time	4:00 am	Mandatory	
Repetition	Daily	Mandatory	
Automatic channel list update			
..in Stand by mode	Active	Mandatory	
..in Operate mode	Not Active	Optional	
Time	4:30 am	Mandatory	
Repetition	Daily	Mandatory	

Table 42: Default settings summary table

* The automatic software upgrade SHALL be ON to avoid users missing the necessary upgrades. However, if an automatic upgrade feature is present, this must be clearly indicated to the user so that, at set up, he/she may choose to deactivate it. In that case, the information on availability of new software for the receiver SHALL be presented to the user.

Annexes

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A DVB-T2 Performance Tables[21]

A.1 FEF and Auxiliary streams

To test that FEFs do not cause malfunctions the following T2+FEF test signal shall be generated and input to the receiver, with FEF power same as T2 signal and no added noise. The receiver should be able to receive this signal with no errors in the displayed video for PLP#0.

Property	*Value*
Overall	
FFTSIZE	32k
GI	1/16
Lf	62
SISO/MISO	SISO
PAPR	TR-PAPR
Frames per superframe (N_{T2})	6
Bandwidth	8MHz
Extended Bandwidth Mode	Yes
Pilot Pattern	PP4
L1 Modulation	64QAM
FEF Type	0
FEF Length (samples)	588000
FEF Interval	6
FEF P1: S1 Value	2
FEF P1: S2 Value	1
L1 Repetition	0
PLP #0	
Type	1
Modulation	256QAM
Rate	3/5
FEC Type	64800
Rotated QAM	Yes
FEC blocks per interleaving frame	200
TI blocks per frame (N_TI)	3
T2 frames per Interleaving Frame (P_I)	1
Frame Interval (I_JUMP)	1
Type of time-interleaving	0
Time Interleaving length	3

Table 43: FEF test signal

To test that the presence of Auxiliary streams does not cause malfunctions the following test signal shall be generated and input to the receiver, with no added noise. The receiver, with Auxiliary streams enabled, should be able to receive this signal with no errors in the displayed video for PLP#0.

[21] All data specified in this Annex are preliminary because DVB-T2 experience in real operations is very limited, especially in case of SFN

Property	Value
Overall	
FFTSIZE	32k
GI	1/16
Lf	62
SISO/MISO	SISO
PAPR	TR-PAPR
Frames per superframe (N_{T2})	6
Bandwidth	8MHz
Extended Bandwidth Mode	Yes
Pilot Pattern	PP4
L1 Modulation	64QAM
FEFs	Not used
L1 Repetition	0
PLP #0	
Type	1
Modulation	256QAM
Rate	3/5
FEC Type	64800
Rotated QAM	Yes
FEC blocks per interleaving frame	200
TI blocks per frame (N_TI)	3
T2 frames per Interleaving Frame (P_I)	1
Frame Interval (I_JUMP)	1
Type of time-interleaving	0
Time Interleaving length	3

Table 44: Auxiliary streams test signal

A.2 C/N Performance

Examples of C/N values and sensitivity are given in the following tables.

AWGN and “0dB echo” C/N calculations are based on NorDig [78] and EBU [76] assumptions for implementation losses.

Ricean and Rayleigh C/N calculations are based on EBU assumptions [76].

Modulation	Code rate	C/N performance (dB)							
		32KE PP2 C/N (dB)				32KE PP2 Sensitivity 8MHz, NF=6, 290K (dBm), Px=-33dBc			
		Profile1 Gaussian (AWGN)	Profile2 (Ricean) F1	Profile3 (Rayleigh) P1	Profile4 (0dB echo)	Profile1 Gaussian (AWGN)	Profile2 (Ricean) F1	Profile3 (Rayleigh) P1	Profile4 (0dB echo)
QPSK	1/2	3.5	3.7	4.5	5.2	-95.6	-95.4	-94.6	-93.9
QPSK	3/5	4.7	4.9	6.0	6.8	-94.4	-94.2	-93.1	-92.3
QPSK	2/3	5.6	5.9	7.4	8.4	-93.5	-93.2	-91.7	-90.7
QPSK	3/4	6.6	6.9	8.7	9.8	-92.5	-92.2	-90.4	-89.3
QPSK	4/5	7.2	7.6	9.6	10.9	-91.9	-91.5	-89.5	-88.2
QPSK	5/6	7.7	8.1	10.4	12.0	-91.4	-91.0	-88.7	-87.1
16 QAM	1/2	8.7	8.9	10.2	10.9	-90.4	-90.2	-88.9	-88.2
16 QAM	3/5	10.1	10.3	11.8	12.7	-89.0	-88.8	-87.3	-86.4
16 QAM	2/3	11.4	11.6	13.3	14.3	-87.7	-87.5	-85.8	-84.7
16 QAM	3/4	12.5	12.9	14.9	16.3	-86.6	-86.2	-84.1	-82.8

Modulation	Code rate	C/N performance (dB)							
		32KE PP2 C/N (dB)				32KE PP2 Sensitivity 8MHz, NF=6, 290K (dBm), Px=-33dBc			
		Profile1 Gaussian (AWGN)	Profile2 (Ricean) F1	Profile3 (Rayleigh) P1	Profile4 (0dB echo)	Profile1 Gaussian (AWGN)	Profile2 (Ricean) F1	Profile3 (Rayleigh) P1	Profile4 (0dB echo)
16 QAM	4/5	13.3	13.7	16.2	17.8	-85.8	-85.4	-82.9	-81.3
16 QAM	5/6	13.8	14.2	17.0	18.9	-85.3	-84.8	-82.1	-80.1
64QAM	1/2	13.0	13.3	15.0	16.0	-86.1	-85.8	-84.0	-83.1
64QAM	3/5	14.8	15.1	16.9	18.0	-84.2	-83.9	-82.2	-81.1
64QAM	2/3	16.2	16.5	18.3	19.7	-82.9	-82.6	-80.8	-79.4
64QAM	3/4	17.7	18.0	20.4	22.0	-81.4	-81.1	-78.7	-77.1
64QAM	4/5	18.7	19.2	22.0	24.0	-80.3	-79.8	-77.1	-75.1
64QAM	5/6	19.4	19.8	23.0	25.5	-79.7	-79.3	-76.1	-73.6
256 QAM	1/2	17.0	17.4	19.5	20.6	-82.1	-81.7	-79.6	-78.5
256 QAM	3/5	19.4	19.6	21.7	23.1	-79.7	-79.5	-77.4	-76.0
256 QAM	2/3	20.8	21.1	23.3	25.1	-78.2	-77.9	-75.8	-73.9
256 QAM	3/4	22.9	23.2	25.8	28.0	-76.2	-75.9	-73.2	-71.1
256 QAM	4/5	24.3	24.8	28.0	30.8	-74.8	-74.3	-71.1	-68.2
256 QAM	5/6	25.1	25.6	29.5	33.6	-73.9	-73.5	-69.6	-65.5

Table 45: Example of maximum required C/N and sensitivity for QEF reception at TS output (PP2 and FFT size 32KE)

Modulation	Code rate	C/N performance (dB)							
		32KE PP4 C/N (dB)				32KE PP4 Sensitivity 8MHz, NF=6, 290K (dBm), Px=-33dBc			
		Profile1 Gaussian (AWGN)	Profile2 (Ricean) F1	Profile3 (Rayleigh) P1	Profile4 (0dB echo)	Profile1 Gaussian (AWGN)	Profile2 (Ricean) F1	Profile3 (Rayeigh) P1	Profile4 (0dB echo)
QPSK	1/2	3.1	3.3	4.1	4.8	-96.0	-95.8	-95.0	-94.3
QPSK	3/5	4.3	4.5	5.6	6.4	-94.8	-94.6	-93.5	-92.7
QPSK	2/3	5.2	5.5	7.0	8.0	-93.9	-93.6	-92.1	-91.1
QPSK	3/4	6.2	6.5	8.3	9.4	-92.9	-92.6	-90.8	-89.7
QPSK	4/5	6.8	7.2	9.2	10.5	-92.3	-91.9	-89.9	-88.6
QPSK	5/6	7.3	7.7	10.0	11.6	-91.8	-91.4	-89.1	-87.5
16 QAM	1/2	8.3	8.5	9.8	10.5	-90.8	-90.6	-89.3	-88.6
16 QAM	3/5	9.7	9.9	11.4	12.3	-89.4	-89.2	-87.7	-86.8
16 QAM	2/3	11.0	11.2	12.9	13.9	-88.1	-87.9	-86.2	-85.2
16 QAM	3/4	12.1	12.5	14.5	15.8	-87.0	-86.6	-84.6	-83.2
16 QAM	4/5	12.9	13.3	15.7	17.4	-86.2	-85.8	-83.3	-81.7
16 QAM	5/6	13.4	13.8	16.5	18.5	-85.7	-85.3	-82.5	-80.6
64QAM	1/2	12.6	12.9	14.6	15.5	-86.5	-86.2	-84.5	-83.5
64QAM	3/5	14.4	14.7	16.4	17.6	-84.7	-84.4	-82.6	-81.5
64QAM	2/3	15.7	16.0	17.9	19.2	-83.3	-83.0	-81.2	-79.8
64QAM	3/4	17.3	17.6	20.0	21.6	-81.8	-81.5	-79.1	-77.5
64QAM	4/5	18.3	18.8	21.6	23.5	-80.8	-80.3	-77.5	-75.6
64QAM	5/6	18.9	19.3	22.5	25.0	-80.2	-79.7	-76.6	-74.1
256 QAM	1/2	16.5	17.0	19.0	20.2	-82.5	-82.1	-80.1	-78.9
256 QAM	3/5	18.9	19.1	21.2	22.6	-80.2	-79.9	-77.8	-76.4
256 QAM	2/3	20.4	20.7	22.9	24.6	-78.7	-78.4	-76.2	-74.4
256 QAM	3/4	22.4	22.7	25.3	27.4	-76.7	-76.3	-73.7	-71.7
256 QAM	4/5	23.8	24.3	27.4	30.2	-75.2	-74.8	-71.7	-68.9
256 QAM	5/6	24.6	25.1	28.9	32.7	-74.4	-74.0	-70.2	-66.3

Table 46: Example of maximum required C/N and sensitivity for QEF reception at TS output (PP4 and FFT size 32KE)

Modulation	Code rate	C/N performance (dB)							
		32KE PP4 C/N (dB)				32KE PP4 Sensitivity 8MHz, NF=6, 290K (dBm), Px=-33dBc			
		Profile1 Gaussian (AWGN)	Profile2 (Ricean) F1	Profile3 (Rayleigh) P1	Profile4 (0dB echo)	Profile1 Gaussian (AWGN)	Profile2 (Ricean) F1	Profile3 (Rayeigh) P1	Profile4 (0dB echo)
QPSK	1/2	2.4	2.6	3.4	4.1	-96.6	-96.4	-95.6	-94.9
QPSK	3/5	3.6	3.8	4.9	5.7	-95.4	-95.2	-94.1	-93.3

Modulation	Code rate	C/N performance (dB)							
		32KE PP4 C/N (dB)				32KE PP4 Sensitivity 8MHz, NF=6, 290K (dBm), Px=-33dBc			
		Profile1 Gaussian (AWGN)	Profile2 (Ricean) F1	Profile3 (Rayleigh) P1	Profile4 (0dB echo)	Profile1 Gaussian (AWGN)	Profile2 (Ricean) F1	Profile3 (Rayeigh) P1	Profile4 (0dB echo)
QPSK	2/3	4.5	4.8	6.3	7.3	-94.5	-94.2	-92.7	-91.7
QPSK	3/4	5.5	5.8	7.6	8.7	-93.5	-93.2	-91.4	-90.3
QPSK	4/5	6.1	6.5	8.5	9.9	-92.9	-92.5	-90.5	-89.2
QPSK	5/6	6.6	7.0	9.3	11.0	-92.4	-92.0	-89.7	-88.1
16 QAM	1/2	7.6	7.8	9.1	9.9	-91.4	-91.2	-89.9	-89.2
16 QAM	3/5	9.0	9.2	10.8	11.7	-90.0	-89.8	-88.3	-87.4
16 QAM	2/3	10.4	10.6	12.3	13.3	-88.7	-88.5	-86.8	-85.8
16 QAM	3/4	11.5	11.9	13.9	15.2	-87.6	-87.2	-85.2	-83.9
16 QAM	4/5	12.3	12.7	15.1	16.7	-86.8	-86.4	-84.0	-82.3
16 QAM	5/6	12.8	13.2	15.9	17.9	-86.3	-85.9	-83.2	-81.2
64QAM	1/2	12.0	12.3	14.0	14.9	-87.1	-86.8	-85.1	-84.2
64QAM	3/5	13.8	14.1	15.8	16.9	-85.3	-85.0	-83.3	-82.1
64QAM	2/3	15.1	15.4	17.2	18.6	-84.0	-83.7	-81.8	-80.5
64QAM	3/4	16.6	16.9	19.3	20.9	-82.4	-82.1	-79.8	-78.2
64QAM	4/5	17.7	18.2	20.9	22.8	-81.4	-80.9	-78.2	-76.2
64QAM	5/6	18.3	18.7	21.9	24.3	-80.8	-80.4	-77.2	-74.8
256 QAM	1/2	15.9	16.3	18.4	19.5	-83.2	-82.8	-80.7	-79.6
256 QAM	3/5	18.3	18.5	20.6	22.0	-80.8	-80.6	-78.5	-77.1
256 QAM	2/3	19.7	20.0	22.2	23.9	-79.3	-79.0	-76.9	-75.1
256 QAM	3/4	21.7	22.1	24.6	26.6	-77.3	-77.0	-74.5	-72.4
256 QAM	4/5	23.2	23.6	26.6	29.3	-75.9	-75.5	-72.4	-69.8
256 QAM	5/6	23.9	24.4	28.0	31.6	-75.1	-74.7	-71.0	-67.5

Table 47: Example of maximum required C/N and sensitivity for QEF reception at TS output (PP7 and FFT size 32KE)

Note 1: Values do not include any possible additional Implementation Loss for Ricean (e.g. 0.5dB) and Rayleigh (e.g. 0.75dB) that can be adopted as “safety margin” for receiver conformance purposes only. It’s expected that this possible additional margin shall be included into the typical (e.g. 1 dB) “measurement error margin” that is always admitted for receiver conformance purposes.

Note 2: Values of Sensitivity are calculated under the assumption NF= 6dB

Note 3: Values of sensitivity for 32KN (8MHz BW) can be obtained taking into account the difference of the signal BW between the two cases (7.77 MHz vs. 7.61 MHz), giving for 32KN a reduction of approximately 0.1 dB with respect to the case of 32KE. Values of sensitivity in case of 7MHz BW can be obtained accordingly to the previous rule (6.80 MHz for 32KE and 6.66 MHz for 32KN) giving a value of approx. 0.6 dB less than the case of 8MHz BW.

Note 4: Receivers shall be capable of QEF reception for all the DVB-T2 possible modes (as from the list of “Mandatory requirement”) listed in this version of HD-Book. Additional values for the C/N Performance (e.g. valid for PP1) can be obtained using similar assumptions to those in [76] and [78].

Note 5: C/N values in the Tables can be used for 32KN FFT size and also for other FFT sizes e.g. 16K. Guard Interval does not influence C/N and, therefore, sensitivity.

Profile 1: Gaussian noise (N) is applied together with the wanted carrier (C) in a signal bandwidth of a DVB-T2 signal. No echo is applied.

Profile 2: The Ricean channel is defined according to the following table (derived from Table B.1 of [13]). Path #14 is omitted.

Profile 3: The Rayleigh channel definition is derived from the following table as well by removing path #0 and re-normalising amplitude values.

#	normalised ρi [dB]	τi(μs)	θi(deg)
0	-0.4	0.000	0
1	-24.0	0.074	122
2	-27.5	0.144	226
3	-36.8	0.154	63
4	-27.5	0.194	198
5	-26.4	0.204	63
6	-21.6	0.430	340
7	-18.8	0.519	336
8	-22.8	0.603	215
9	-24.1	0.641	191
10	-22.6	0.849	36
11	-23.4	0.924	210
12	-35.8	1.003	278
13	-35.2	1.017	311
14	-22.7	1.369	23
15	-29.7	1.381	162
16	-19.0	1.936	9
17	-21.4	2.752	127
18	-20.1	3.229	175
19	-25.7	3.325	331
20	-26.1	5.422	196

Table 48: Ricean channel definition

Profile 4: The “0 dB echo” is the combination of two paths at the same level. The 0 degree channel center shall be used in fading simulator and attenuation 0dB for the second path with delay 1.95μs. In this context it means that the carriers from the direct and echo signal are cumulative and the output power of the simulator is the power sum of the two paths.

A.2.1 Behaviour in the presence of echoes inside the guard interval

The receiver SHALL provide the reference BER (QEF) when the DVB-T2 channel contains two (or more) static paths with relative delay from 1 μs up to 95% of the guard interval length, independently of the relative amplitude and phases of the paths. No noise is added.

A.2.2 Behaviour in the presence of echoes outside the guard interval

QEF reception SHALL be possible for 32k FFT modes with echo levels up to the values defined in the following tables (Echo attenuation in dB relative reference).

Delay -/+ μs (8MHz channels)	120	150	200	230	260
Delay -/+ μs (7MHz channels)	135	165	215	266	298
256QAM, PP4, GI 1/16, code 3/5	-	-	-	2.0	4.0
256QAM, PP4, GI 1/16, code 2/3	-	-	-	3.0	6.0
256QAM, PP4, GI 1/16, code 3/4	-	-	-	4.0	8.0
256QAM, PP4, GI 1/32, code 3/5	2.0	4.0	7.0	9.0	10.0
256QAM, PP4, GI 1/32, code 2/3	3.0	6.0	10.0	11.0	12.0
256QAM, PP4, GI 1/32, code 3/4	4.0	8.0	12.0	13.0	14.0

Table 49: QEF reception for echoes outside the guard interval for PP4

Delay -/+ µs (7MHz channels)	266	298	400	512	608
256QAM, PP2, GI 1/16, code 3/5	2.0	4.0	9.0	11.0	12.0
256QAM, PP2, GI 1/16, code 2/3	3.0	6.0	11.0	14.0	15.0
256QAM, PP2, GI 1/16, code 3/4	4.0	8.0	14.0	16.0	18.0

Table 50: QEF reception for echoes outside the guard interval for PP2, GI 1/16, 7MHz

Delay -/+ µs (8MHz channels)	120	150	200	230	260
Delay -/+ µs (7MHz channels)	135	165	215	266	298
256QAM, PP2, GI 1/8, code 3/5	3.5	5.5	7.0	8.0	8.5
256QAM, PP2, GI 1/8, code 2/3	5.0	7.0	8.5	9.5	10.0
256QAM, PP2, GI 1/8, code 3/4	7.0	9.0	10.5	11.5	12.0

Table 51: QEF reception for echoes outside the guard interval for PP2, GI 1/8

As a non-mandatory indication of typical receiver performance, QEF reception in case of three SFN static paths inside the guard interval and one SFN static path outside the guard interval should be possible for the T2 modes and echo profiles below:

- 8MHz, FFT 32K, 256QAM, CR 2/3, PP4, GI 1/16

Path (tap)	Delay (µs)	Relative attenuation (dB)
1 (useful)	0	6
2 (useful)	50	0 (reference -60 dBm)
3 (useful)	180	10
4 (interference)	270	20.7

Table 52: Test set-up (PP4) for pre-echoes and echoes outside the guard interval (informative)

- 8MHz, FFT 32K, 256QAM, CR 2/3, PP2, GI 1/8

Path (tap)	Delay (µs)	Relative attenuation (dB)
1 (useful)	0	6
2 (useful)	50	0 (reference -60 dBm)
3 (useful)	180	10
4 (interference)	550	21.1

Table 53: Test set-up (PP2) for pre-echoes and echoes outside the guard interval (informative)

A.2.3 Behaviour in the presence of co-channel interference

QEF reception shall be possible in the presence of a DVB-T/T2 co-channel interferer with a C/I level according to column “C/N Ricean” (profile 2) in Table 45, Table 46 and Table 47 when the interference is uncorrelated with the wanted signal.

As a non-mandatory indication of typical receiver performance, in the case of a co-channel interference where the interferer may be correlated with the wanted DVB-T2 signal symbol timing and pilot pattern (e.g. inside an SFN), an additional margin of 1dB should be added.

A.2.4 Behaviour in the presence of digital signal in other channels

Reference is the NorDig Unified specification ver. 2.5.1 [78], chapter 3.4.10.6.1 “Immunity to DVB-T/T2 signals in other channels”.

A.2.5 Behaviour in the presence of co-channel analogue signals

Reference is the NorDig Unified ver. 2.4 [56], chapter 3.4.10.8 “Immunity to Co-Channel Interference from Analogue TV signals”.

The receiver shall perform better than specified in Table 53 when a 8MHz DVB-T2 signal is exposed to interference from a co-channel G/PAL signal including video with teletext, an FM sound and a NICAM sub carrier. The level of the FM sound relative to the vision carrier is -13 dB. The level of the NICAM signal relative to the vision carrier is -20 dB.

Constellation	***256 QAM***		
Code rate	3/5	2/3	3/4
C/I	3 dB	5 dB	7 dB

Table 54: Carrier to Interference, C/I (dB) for QEF reception, when DVB-T2 signal is interfered with by an analogue TV carrier.

A.3 List of some DVB-T2 modes for different types of networks and receiving conditions

Table 54 shows a list of suitable T2 modes for a number of different network configurations and receiving conditions. It represents only a small sample of all the T2 modes that are possible. The intent is to give some examples, without limiting the possibility to adopt different T2 modes.

Being the exact Bit-Rate of these modes subject to the choice of other parameters like, e.g., Lf and L1mod (and the combination of the PLPs in case of multiple PLP), all the values in the table are rounded and given only as an indicative value.

Type	***Very Large SFN***	***Very Large SFN***	***Large SFN-MISO***	***Large SFN***	***Local SFN***	***MFN***	***Portable***	***Mobile***	***Fixed/ Portable***	***Fixed/Mobile***	
	Single PLP								**Multiple PLP**	**T2 Base/Lite**	
Examples	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***	
FFT	32K	32K	32K	32K	32K	32K	16k	16k	32K	32K	8K
BW Extension (E/N)	E	N	E	E	E	N	E	E	E	E	N
GI	1/8	1/8	19/256	1/16	1/32	1/128	1/4	1/4	1/8	1/16	1/4
GI duration (µs)	448	448	266	224	112	28	448	448	448	224	224
PP	PP2	PP2	PP2	PP4	PP4	PP7	PP1	PP1	PP2	PP4	PP1
PLP1 Modulation	256QAM	256QAM	256QAM	256QAM	256QAM	256QAM	64QAM	16QAM	256QAM	256QAM	QPSK
Rotation (R/NR)	R	NR	R	R	R	R	NR	R	R	R	R
PLP1 Code rate	2/3	¾	2/3	2/3	2/3	3/5	3/4	1/2	3/4	3/4	2/3
PLP2 Modulation	-	-	-	-	-	-	-	-	16QAM	-	-
Rotation (R/NR)	-	-	-	-	-	-	-	-	R		
PLP2 Code rate	-	-	-	-	-	-	-	-	3/4	-	-
SISO/MISO	SISO	SISO	MISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO
T2-Base/Lite	T2-Base	T2-Base	T2-Base	T2-Base	T2-Base	T2-Base	T2-Base	T2-Base	T2-Base	T2-Base	T2-Lite
Bit-Rate (Mbit/s)	33	36	34	36	38	35	25	11	33	28	1,9

Table 55: List of some DVB-T2 Modes

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B DVB-T Minimum input level

QEF reception (BER 2E-4 after Viterbi) shall be possible with the minimum input levels in the table below for UHF Channels (8MHz BW), FFT 8k and GI 1/4.

Below table is based on the values in [78] (Table 3.14) and in [77] (Table 2.2). Values for “60s Error free video” are given as a suitable reference for measurement purposes. The description of the “60s Error free video” method is included in [77] at paragraph 2.3.2 (QEF Quality Measurement Methods).

The value for 64QAM 5/6 and the profile 4 (0 dB echo) for “60s Error free video”, is indicative only. It is an expected value for a typical DVB-T receiver.

Reference values for VHF channels (7 MHz BW) are those in [78] (Table 3.14) and [77] (Table 2.2).

		Minimum input level (dBm)			
		Profile 1 Gaussian		Profile 4 0 dB echo	
		UHF Band IV & V 8 MHz signal		UHF Band IV & V 8 MHz signal	
Modulation	Code rate	"60 s Error free video"	BER 2E-4 after Viterbi	"60 s Error Free video"	BER 2E-4 after Viterbi
QPSK	1/2	-94.4	-93.1	-90.6	-89.4
QPSK	2/3	-92.6	-91.3	-86.3	-84.5
QPSK	3/4	-91.6	-90.3	-84.1	-80.8
QPSK	5/6	-90.6	-89.3	-	-
QPSK	7/8	-89.8	-88.5	-	-
16 QAM	1/2	-88.7	-87.4	-86.1	-84.9
16 QAM	2/3	-86.4	-85.1	-81.9	-80.3
16 QAM	3/4	-84.9	-83.6	-79.2	-76.1
16 QAM	5/6	-83.9	-82.6	-	-
16 QAM	7/8	-83.5	-82.2	-	-
64 QAM	1/2	-83.0	-81.7	-80.4	-79.2
64 QAM	2/3	-80.8	-79.5	-76.4	-75.0
64 QAM	3/4	-79.3	-78.0	-73.4	-70.6
64 QAM	5/6	-77.9	-76.6	-69.0	-
64 QAM	7/8	-77.0	-75.7	-	-

Table 56: DVB-T minimum input levels (dBm)

Note: Values in above table are calculated under the assumption NF= 7dB.

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C Behaviour of Player Pad keys for linear IP services

C.1 Definitions

In the case of linear IP services (DASH live streaming using dynamic MPD [60]), the following definitions apply:

- T_0: Presentation time of the first segment made available on the server for this live content
- T_n: Presentation time of the segment associated with the client wall-clock time NOW
- T_x: Presentation time of the segment currently presented by the client. If no forward/backward skips were previously invoked by the user, T_x is equal to T_n
- T_{0bd}: T_n - `timeShiftBufferDepth`, i.e. presentation time of the first segment available on the server taking into account `timeShiftBufferDepth` parameter (if present in the MPD)
- T_{00}: T_0 if `timeShiftBufferDepth` is not present in the MPD or if it is present but (T_n - T_0) < `timeShiftBufferDepth`, T_{0bd} otherwise
- S: Amount of skip forward/backward time associated to a single FAST_FWD/REWIND key press. S=30s
- T_p: Presentation time of the segment being presented by the client when it executes a pause command
- T_r: Presentation time of the first segment presented by the client when it executes a resume command
- T_s: Presentation time of the first segment presented after a skip forward/backward command

As defined in DASH [60], Presentation time is the time associated to an access unit that maps it to the Media Presentation timeline.

DASH standard itself warns that a client not synchronized with a DASH server, which in turn is expected to be synchronized to UTC, may experience issues in accessing Segments as the Segment availability times provided by the server and the local time NOW may not be synchronized. Therefore, DASH clients are expected to synchronize their clocks to a globally accurate time standard.

C.2 Expected behaviour

Player Pad keys, if present, should behave as follows:

- PAUSE key will pause presentation at time T_p
- PLAY key will resume presentation at time T_r=max(T_p, T_{00})
- FAST_FWD key will move presentation to T_s=max(T_x + S, T_n)
- REWIND key will move presentation to T_s=max(T_x - S, T_{00})

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D Allocation and usage of SI codes in Italy

D.1 Allocation of SI codes

As explained the Italian DTT environment is "*multi-network*" and "*multi-operator*". According to DVB SI Specification [10] and SI Guidelines [20]:

- a **network** is a collection of MPEG-2 Transport Stream (TS) multiplexes transmitted on a single delivery system (e.g. all digital channels on a specific cable or **terrestrial** system)
- a **service** is uniquely identified by the following parameters (the DVB locator):
  - **original_network_id (ON_ID):** unique identifier of a network
  - **transport_stream_id (TS_ID):** unique identifier of a TS within an original network.
  - **service_id (S_ID):** unique identifier of a service within a TS

The network_id (N_ID) is not part of this path.

The following figure shows the service delivery model for digital broadcasting:

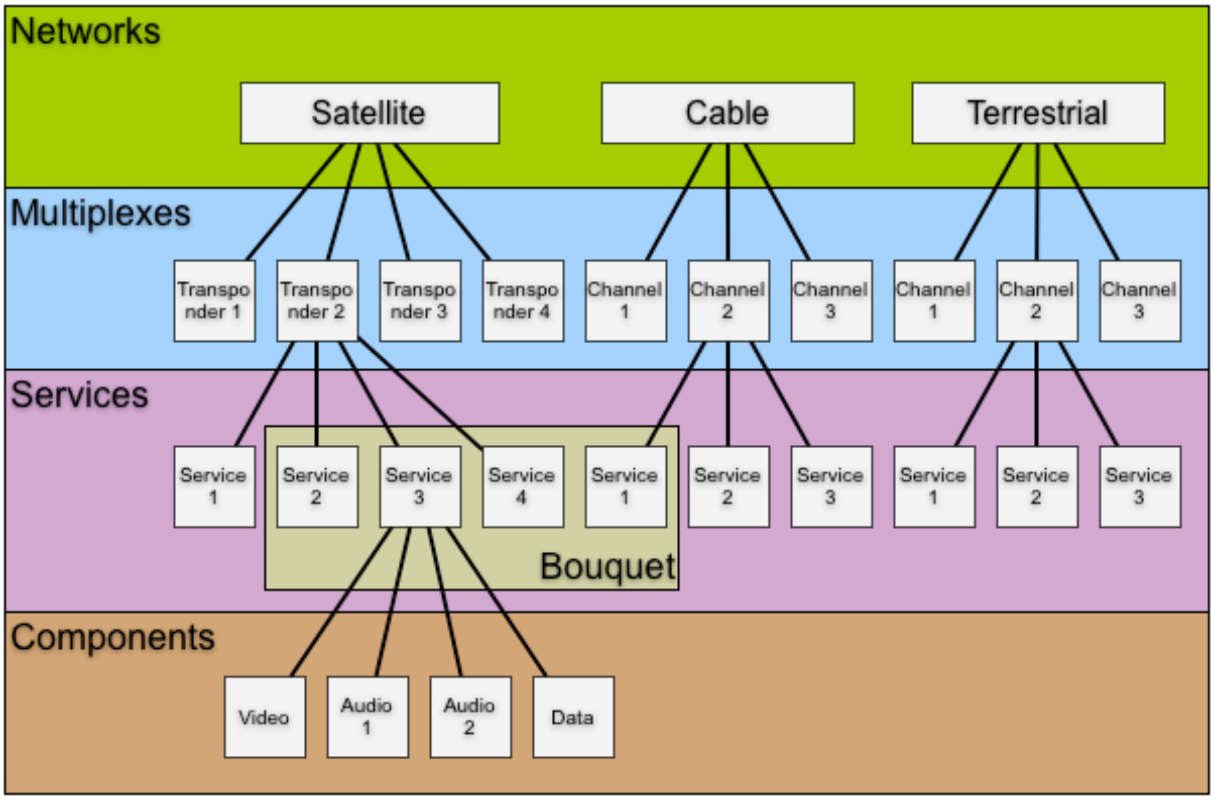

Figure 8: Service delivery model

The unique identification of a service cannot be guaranteed if each operator allocates these codes on arbitrary basis. A policy needs to be defined in order to avoid potential situations of conflict

D.2 Original_network_id

Allocation of original_network_ids is presently handled by the DVB Project Office, on behalf of the ETSI.

The value of already pre-assigned ON_ID codes for terrestrial services is 0x2000 + 3-digit country code. Then for Italy the original_network_id value that should be allocated is: 0x217C (380dec - 0x17Chex is the country code for Italy).

The registration of this value shall be formally requested, by the competent authority to the DVB Project Office, in order to obtain afterwards the formal registration by ETSI in the Register of Service Information (SI) Codes.

It is recommended that all terrestrial operators in Italy use this value for ON_ID to avoid potential conflicts with other networks in the same area or in neighbouring countries.

Operators that have been allocated, by the DVB, a value for ON_ID and operators with services that originate from a satellite network may keep their allocated ON_ID or the ON_ID used on the satellite network.

D.3 Transport_stream_id

The ON_ID value is not meant to be used to distinguish multiplexes of different operators.

Therefore, TS_ID and S_ID are the two parameters that are used to distinguish terrestrial multiplexes and services.

The Transport_Stream_ID has 65535 possible values (for each ON_ID): a unique value can be assigned to each and every national, regional or local multiplex. Every network operator shall be granted one or more values, as he requests and depending on the configuration of his network (number of transmitters).

D.3.1 Recommended allocation of codes

DGTVi recommended the following allocation of codes:

transport_stream_id	Use
0x0000	Reserved
0x0001 – 0x03FF	Range usable for national networks (1023 values)
0x0400 – 0x0FFF	Reserved for extension of national codes (3072 values)
0x1000 – 0xB7FF	Range usable for regional/local networks (43008 values)
0x1000 – 0x17FF	Region 1 (Piemonte) – 2048 values
0x1800 – 0x1FFF	Region 2 (Valle d'Aosta) – 2048 values
0x2000 – 0x27FF	Region 3 (Lombardia) – 2048 values
0x2800 – 0x2FFF	Region 4 (Trentino) – 2048 values
0x3000 – 0x37FF	Region 5 (Veneto) – 2048 values
0x3800 – 0x3FFF	Region 6 (Friuli Venezia Giulia) – 2048 values
0x4000 – 0x47FF	Region 7 (Liguria) – 2048 values
0x4800 – 0x4FFF	Region 8 (Emilia Romagna) – 2048 values
0x5000 – 0x57FF	Region 9 (Toscana) – 2048 values
0x5800 – 0x5FFF	Region 10 (Umbria) – 2048 values

transport_stream_id	Use
0x6000 – 0x67FF	Region 11 (Marche) – 2048 values
0x6800 – 0x6FFF	Region 12 (Lazio) – 2048 values
0x7000 – 0x77FF	Region 13 (Abruzzo) – 2048 values
0x7800 – 0x7FFF	Region 14 (Molise) – 2048 values
0x8000 – 0x87FF	Region 15 (Campania) – 2048 values
0x8800 – 0x8FFF	Region 16 (Puglia) – 2048 values
0x9000 – 0x97FF	Region 17 (Basilicata) – 2048 values
0x9800 – 0x9FFF	Region 18 (Calabria) – 2048 values
0xA000 – 0xA7FF	Region 19 (Sicilia) – 2048 values
0xA800 – 0xAFFF	Region 20 (Sardegna) – 2048 values
0xB000 – 0xB7FF	Reserved for future use

Table 57: Allocation of TS_IDs in Italy

D.3.2 National Codes already in use

Following codes are compatible with the recommended allocation.

transport_stream_id	Operator
0x0001	Rai
0x0002	Rai
0x0003	Rai
0x0004	Rai
0x0005	Rai
0x0006	Rai
0x0009	Rai
0x0200	Persidera
0x0201	Persidera
0x0202	Persidera
0x0204	Persidera
0x032A	H3G
0x0384	D-Free
0x0385	Mediaset
0x0389	Mediaset
0x03A2	Mediaset
0x03AC	Mediaset
0x03B6	Mediaset

Table 58: National TS_IDs in use

D.4 Service_id

Because of the uniqueness of TS_ID assigned to every multiplex, the allocation of Service_IDs (65535 possible values) can be left to each multiplex operator. Receivers shall distinguish services with the same service_id (and ON_ID) but different TS_ID.

D.5 Network_id

The DVB *network_id* is defined by ETSI TR 101 162 [19] which allocates the identifiers on a geographical basis to ensure that no conflict in adjacent network identities occurs in different geographic regions. The allocation is typically referred to as the DVB color map as shown in the following figure.

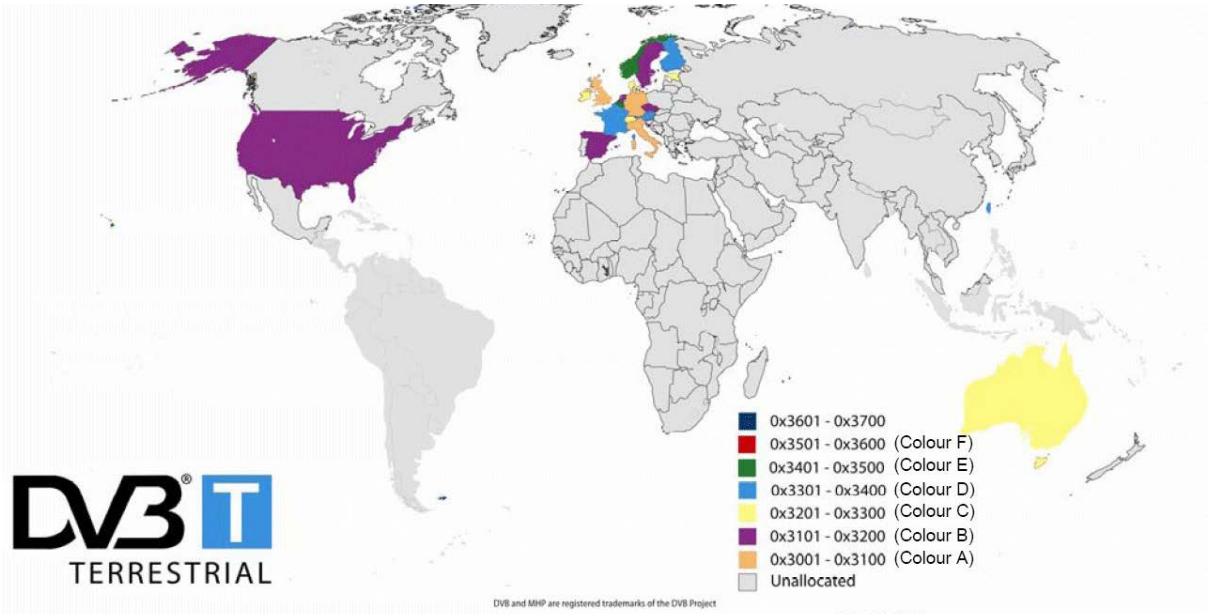

Figure 9: Colour map for allocating network_ids in terrestrial networks

The allocation of the network_id for countries in the European region comprising Italy is shown in the following table:

Country	network_id
Austrian Digital Terrestrial Television	0x3301 ÷ 0x3400
French Digital Terrestrial Television	0x3301 ÷ 0x3400 [22]
Italian Digital Terrestrial Television	0x3001 ÷ 0x3100
Slovenia Digital Terrestrial Television	0x3201 ÷ 0x3300
Spanish Digital Terrestrial Television	0x3101 ÷ 0x3200
Swiss Digital Terrestrial Television	0x3201 ÷ 0x3300

Table 59: Network_ids of interest

Network_ids shall not be used to uniquely identify a service.

Network_ids shall instead be used to identify the country which a network belongs to for the purpose of LCN conflicts (see §7.3.2.5). In particular, if Italy has been selected as “Country” at first installation time, all networks whose network_id fits in the 0x3001÷0x3100 range shall be considered as belonging to Italy.

D.6 Network Name

No assumption is or shall be made for this parameter.

[22] France will likely go on using as single network_id for the whole country the same value assigned by DVB to French DTT as original_network_id (0x20FA)

E Home Channel concept and tivùsat implementation

E.1 Introduction

For the purpose of accessing and presenting an open platform bouquet in an effective and consistent manner, the “Home Channel” concept has been introduced.

The (Master) Home Channel is a multiplex found at well-defined satellite coordinates (frequency, orbital position, …) which carries key information for tuning and ordering services hosted by the platform. Maintenance information is carried as well by the (Master) Home Channel.

For redundancy reasons, the same information will also be carried by another (Backup) Home Channel.

The receiver will first look for the Master Home Channel. If not found it will revert to the Backup Home Channel.

As a last resort, if neither the Master nor the Backup Home Channel is available, the receiver SHALL provide a means, for experienced users, to manually enter the Home Channel coordinates.

E.2 Home Channel(s) coordinates

The precise parameters needed for tuning the tivùsat Home Channel (Master or Backup) are given in the following table:

Parameter	Home Channel (Master)	Home Channel (Backup)
Frequency	10992MHz	
Orbital position	13^{o}	
West/East	East	
Polarization	Vertical	
Symbol rate	27.5Mbaud	
Inner FEC	2/3	

Table 60: Tivùsat Home Channel(s) parameters

These parameters SHALL be stored in receiver’s non-volatile memory. It SHALL be possible to change these parameters via OTA update.

E.3 Tuning info

Tivùsat relies upon NIT_{other} tables to convey tuning and channel ordering information to receivers. Thanks to the satellite_delivery_system descriptors carried in all the NIT_{other} tables, receivers will be able to tune all the multiplexes containing one or more services belonging to the tivùsat as a possible alternative to full Ku spectrum scan.

E.4 Service list

Thanks to LC descriptors carried in all the NIT_{other} tables and to the service_descriptors carried in all the SDT_{other} tables found in the Home Channel, at first installation receivers will be able to quickly build an automatically ordered tivùsat service list (Fast Scan) as a possible alternative to full Ku spectrum scan.

Any LCN possibly present in Home Channel's NIT_{actual} SHALL be ignored[23]. No BAT support is required by tivùsat.

Each tivùsat service will then be univocally identified by the following parameters:

- satellite_delivery_system descriptor of the hosting transponder
- original_network_id of the associated NIT_{other} table
- transport_stream_id of the associated NIT_{other} table
- service_id of the associated LCN

Because of the loosely centralized nature of tivùsat, there might be transient differences between platform's services signaled in NIT_{other}/SDT_{other} of Home Channel's tables and in NIT_{actual}/SDT_{actual} of hosting transponders' tables. For instance, a service still signaled in the Home Channel's NIT_{other} may have instead been removed from the NIT_{actual} of the hosting transponder or the service_name of a service in the SDT_{actual} of the hosting transponder may differ from the service_name of the same service in the Home Channel's SDT_{other}.

For this reason, to keep customers as much aligned as possible with the real situation of platform's services, during automatic service list update receivers SHALL always check them on the respective hosting transponders and make the information given therein prevail.

E.5 Maintenance

The receiver SHALL first look for its own DVB-SSU files within the Home Channel without relying on the relevant linkage_descriptor in NIT or BAT.

If no DVB-SSU file is found within the Home Channel, the receiver SHALL look for the relevant linkage_descriptor (linkage_type=0x09) in Home Channel(s)'s NIT_{actual} and follow it if present. According to DVB-SSU standard, it will drive the receiver to the service which a software update data carousel is possibly associated to.

For tivùsat only the "generic" OUI (Organizationally Unique Identifier) value reserved to DVB (0x00015A) will be used in linkage_descriptor's private data bytes, so receivers SHALL be able to recognize their own DVB-SSU files, if any, by the standard data carousel itself.

[23] LCNs possibly present in Home Channel(s)'s NIT_{actual} might in fact refer to the DTT platform (Home Channel used also to feed DTT transmitters).

F Requirements and recommendations for combo satellite/terrestrial receivers

F.1 Service lists

F.1.1 Separate service lists

The receiver is required to keep at least 2 distinct favourite lists, each one using the same 1-999 numbering range, for satellite platform's (e.g. tivùsat) bouquet and for DTT services.

Automatic ordering of services within those 2 lists is based on each respective LCN schema. For the terrestrial part all the rules and procedures specified in §7.4.2.5, in particular those dealing with conflicts, duly apply.

Switching from one list to the other should be as fast and easy as possible, ideally through a dedicated key on the remote control.

F.1.2 Seamless service lists

A "seamless service list", i.e. a single list including both satellite and terrestrial services, would be very valuable for end users, especially if services were automatically sorted out according to broadcasters' LCNs. The problem is how to handle (potentially numerous) DTT-SAT LCN conflicts. They will in fact be of 4 kinds:

(1) exactly the same service received with the same LCN both on SAT and DTT
(2) almost the same service received with the same LCN on SAT and DTT (this is the case of services which on DTT at certain hours of the day may differ at regional level)
(3) different services with the same LCN on SAT and DTT
(4) different services with the same LCN on DTT, i.e. the normal D-Book conflict case

How to deal with all these kinds of conflicts is in general left to manufacturers offering a seamless service list on their receivers. A not exhaustive list of not exclusive solutions possibly adopted by a manufacturer here follows.

1. Manual resolution

As conflicts of type (1) and (2) are even difficult to recognize at pure technical level while type (3) and (4) should be left to users' choice, the manual resolution option, although potentially cumbersome for users, should always be available.

2. Automatic resolution

Whenever a SAT-DTT LCN conflict is detected either SAT or DTT service is preferred based on a dedicated menu option. Factory default preference is left to manufacturer. User preference could be requested at (re)installation time.

3. Allotted list

Based on a dedicated menu preference, the seamless service list is allotted as follows:
- if the preference is set to SAT, satellite platform's (e.g. tivùsat) services are listed from position 1 to position 999 according to LCN values defined by this specification. DTT services are instead listed from position 1001 to position 1999 by adding a 1000 offset to their LCN value. All remaining satellite channels outside satellite platform's (e.g tivùsat) bouquet are listed from position 2001 on.
- if the preference is set to DTT, DTT services are listed from position 1 to position 999 according to their LCN values. Satellite platform's (e.g tivùsat) services are instead listed

from position 1001 to position 1999 by adding a 1000 offset to their LCN value. All remaining satellite channels outside satellite platform's (e.g tivùsat) bouquet are listed from position 2001 on.

Factory default preference is left to manufacturer. User preference could be requested at (re)installation time.

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