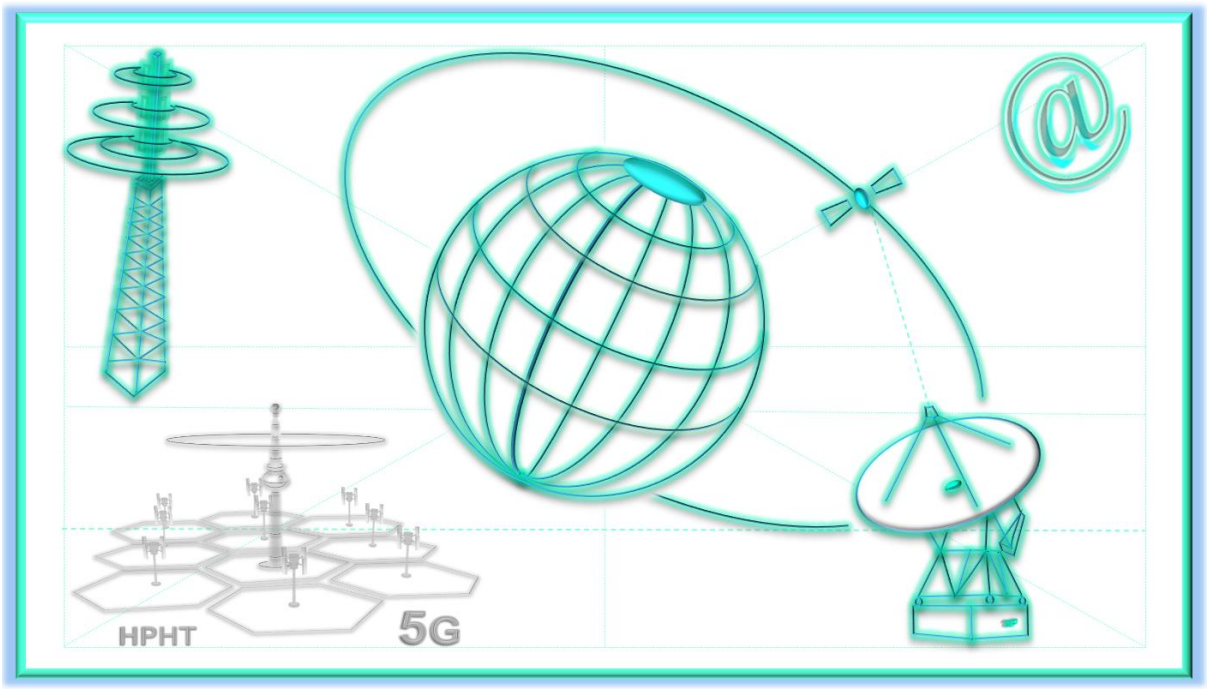
UHD Book

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



Final 2.0

ULTRAHD FORUM ITALIA
Beyond Definition

CONFINDUSTRIA RADIO TELEVISIONI

UHD Book Collection

Table of Contents

Tables

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Foreword (DVB-I related)

Among the main highlights of this new volume, we introduce **MANDATORY** support of the new DVB-I standard, which is a candidate to play an important role in linear TV distribution over IP.

This is a potential step of significant innovation for the European and Italian television scenario, while being aware that its implementation on receivers is not necessarily on the current agenda of the entire supply chain, at least until the Italian ecosystem gives signs of commitment to introduce at some point in time the services that this standard will make possible.

Therefore, there is a need to have the widest possible involvement of the value chain, with a process of planning and coordination between radio and television operators, transmission networks, manufacturers of receivers, regulatory authorities as well as certification bodies, in order to develop the most stable conditions to launch a consumer service capable of determining a consolidated and competitive experience of fruition.

The MANDATORY status of DVB-I referred to in Section 7.3 is dependent upon completion of all the following conditions:

1. the DVB-I specification has been ratified by ETSI as International Standard.
2. There have been DVB-I PoC/trials completed by major Italian Broadcasters, showing the real interoperability of an end-to-end system between TV services, network services and receivers.
3. On completion of successful trials as per 2. above, the results of the trials have been used to develop the conditions for a new reference Italian “bollino” for the certification of receivers compliant to the requirements included in the current UHD Book 2.0 volume.
4. The conditions for a new "bollino" requiring DVB-I have been published with 18 months advance notice ("sunrise" period) of launch of the new "bollino".

The MANDATORY "status" for DVB-I included in the body of the volume does apply indeed to the technological requirement; the implementation "conditions", to which the status is subject calls for the implementation of the above-mentioned conditions, so that operators in the supply chain can correctly identify them with respect to realistic market conditions and the commitment of the parties involved.

We hope that this approach will give more confidence to the operators of the supply chain and at the same time spread awareness about the involvement and commitment to be given to allow the introduction of DVB-I technology in the best conditions of use for its success.

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1. Introduction

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.

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, since 2005 DIGITALEUROPE, the major category association in Europe, had licensed a number of logos relating to HD and UHD but in April 2018 DIGITAL EUROPE decided to discontinue ALL of its logo programs.

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

- Color Depth: 10 bits as 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).

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 run 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

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.

The UHD Book Collection achieves this by mandating support for AC-4. While it already provides recommendations for basic NGA use cases, 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 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 volume 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 [5] 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 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 in 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 [5] 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 [14], 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 [9]. 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.

1.2.3. Content protection solutions

1.2.3.1. Embedded CAS *(*Conditional Access System)

Embedded CA technologies are new, emerging solutions aimed at embedding conditional access firmware within the receivers, both TV and STB, allowing the broadcasters to adopt so called "cardless/CAMless/light CA" business models. Embedded CA solutions might be an interesting marketing and technical tool that could be used to help the operators promote FTA and pay-TV services, both on SAT and DTT.

Recent marketing studies indicate that consumers are increasingly choosing OTT based subscription video services over traditional broadcast Pay TV services. However, broadcast Pay TV continues to be a force in the market for the foreseeable future as do hybrid broadcast/broadband solutions. Consequently, there is still a need for traditional conditional access systems (CAS) to protect content and content distribution services. However, content protection technologies aren’t standing still. Hollywood studios have determined that the security of modern DRM systems is now on par with traditional CAS and have shown this by entrusting DRM systems to protect their most valuable products such as UHD, 4K or early release window content. Thanks to the evolution of the content protection solutions, new possibilities are offered to Operators to provide such a service being cost effective even targeting a large audience. In the latest months several vendors have been developing this type of Content Protection products, and some of them are already implemented in commercial receivers.

If on one side the increased availability of broadband connection allows Operators to leverage the benefits of connected devices, on the other side it will be a key factor the support of unconnected devices as well to ensure the largest households footprint. Using traditional broadcast mechanisms to serve receivers which are not connected to a two-way network is still very important in order to ensure the best quality of service, the best user experience and the most efficient usage of transmission bandwidth which is often a scarce resource.

In the near future it will be of paramount importance providing such functionality to both connected and unconnected receivers through a unique hybrid content protection platform, to allow Broadcasters to streamline their operations and reduce the total cost of ownership.
With no appreciable difference in security between CAS and DRM and the popularity of hybrid OTT and broadcast services, it is only natural that operators will seek operational efficiencies by converging the two technologies. Traditional CAS requires the installation of a separate hardware-based CA module (CAM) on the TV device. Embedded CAS (or hybrid DRM/CAS) provides a better user experience by removing the need for smart-cards or other hardware modules, taking advantage of DRM solutions embedded in the client and integrated in the service back-end. As there is no need to purchase smart cards, the hybrid approach to content protection also significantly reduces users' out of pocket expenses.

An existing DRM system that is already integrated with a hardware based Trusted Execution Environment (TEE) can be extended to provide CAS functionalities and provides the same level of security that has been used for distributing UHD content on internet. The savings resulting from not having to support a hardware-based CAM also allows operators to be more aggressive and creative with pricing and program offerings.

The embedded CAS approach allows for the same client hardware and software stacks to support seamlessly secure playback of protected content delivered via unidirectional broadcast as well as broadband or a mixture of both. This feature will dramatically enhance the ability of operators to reach users on various devices.

Modern DRM systems meet the security requirements set by MovieLabs for UHD, 4K, and early release window content and also support the self-certification by device manufacturers integrating the DRM systems of their compliance with the MovieLabs requirements. Accordingly, it is expected that self-certification along with operator-based certification will be sufficient for embedded CAS as well.

While the number of environments in which devices have no network connectivity is forecast to decline over time as a result of improved viewer choice via broadband services as well as the desire for the increased potential revenue from targeted ads and additional network-based products, embedded CAS systems are designed to support all playback environments with or without a network connection.

Traditional video service operators are used to working with standards-based technologies. Even with the introduction of OTT services by video service operators, it is expected that standards will continue to play a significant role in the future. This will also be true for embedded CAS. These systems need to support standards-based frameworks such as HbbTV and rely on standard cryptographic algorithms (e.g., MPEG Common Encryption) and to be able to operate along with legacy CAS via DVB Simulcrypt. As video service operators evaluate embedded CAS vendors, they should pay attention to the extent to which the vendors support such industry standards.

Consequently, HDFI will be committed to follow the technical evolution of embedded CA systems and, considering the reliability of the proposed technologies and the interest coming

both from the broadcasters and from the manufacturers, to possibly include a dedicated section regarding the embedded CA solutions in future releases of the UHD Book.

1.2.4. Catching-up with HbbTV

1.2.4.1. Targeted Advertisement

Addressable TV advertising, based on HbbTV technology, is a relatively new feature at which commercial broadcasters are aiming to differentiate and innovate in the advertising market; enhanced adverts, L-shaped banners overlaid using HbbTV are already a commercial reality in Germany and Italy. But the real market challenge is ad substitution (aka “Targeted Advertising” or TA), where a broadcast linear channel ad spot can be substituted with a personalized one, supplied via broadband from an ad server, even leveraging programmatic technology, to target clusters of specific interest viewers; in TA jargon this is called Dynamic Advert Substitution (DAS), which normally happens client side (CSAS).

Compliant implementations of HbbTV-TA will be able to perform dynamic substitution of broadcast adverts more reliably, more cleanly and in more circumstances than would be possible on a HbbTV 2.0 implementation not supporting HbbTV-TA.

The whole set of specification are provided by [107][108][109][110][111].

This is different from scenario related to broadband VOD or IP delivered linear channels where both Dynamic Advert Insertion (DAI) and Dynamic Advert Substitution (DAS) are already a reality and they is already supported by the HbbTV technology in today’s receivers, through both server and client-side technologies”

1.2.5. New HbbTV work items

1.2.5.1. Usage of HbbTV in a DVB-I context

DVB is going to complete its important work item defining technical specification to allow terminals compliant to such a specification to natively manage the full coexistence of DVB-S/C/T and I services, offering a similar user experience to DVB terrestrial, cable, satellite and IPTV systems in terms of service information, parental control, subtitles, etc.

Within this enlarged system the HbbTV ecosystem will be maintained, i.e. all existing HbbTV use cases on traditional broadcast networks are covered and benefit, allowing users to get the full HbbTV service offering along with services delivered via IP. Moreover:

- Service providers can increase the market reach of their HbbTV offerings and avoids fragmentation of their overall offerings due to deviating capabilities of network/platform types
- Terminal Manufacturers can offer devices which provide the full feature set to customers regardless of which input mode is used

Broadcaster/Operator can offer services which convey the full HbbTV application range.

1.2.6. Improvements in Video Coding Technologies

The set of video coding technologies currently specified in the UHD Book includes MPEG-2 Video/H.262, AVC/H.264, and HEVC/H.265, as defined by the DVB toolbox in ETSI TS 101 154. This set ensures support for a broad range of TV services such as SD, HD, and UHD-1 delivery with wide colour range, high dynamic range and increased bit depth.

While there is a constant demand in the market for technologies providing superior video quality, there is also a request for improved coding efficiency to cope with the ongoing

process of spectrum reduction for the digital terrestrial TV medium in favour of telecommunication mobile services.

Recently, several video codecs have emerged claiming the next level of compression beyond HEVC/H.265. At the time of writing, DVB is at a very early stage of looking at a number of new codecs for potential inclusion in a future version of TS 101 154, among which are VVC/H.266 “Versatile Video Coding” (VVC), jointly developed by ITU-T and MPEG; MPEG-5 Part 1 “Essential Video Coding” (EVC), developed by MPEG; AV1 developed by the Alliance for Open Media and AVSx developed by the Audio and Video Coding Standard Workgroup of China. Also, under consideration is MPEG-5 Part 2 “Low Complexity Enhancement Video Coding“ (LCEVC) developed by MPEG as an enhancement layer for codecs (not a codec itself). As part of its process, DVB is also considering other codecs and technology options.

All codecs aim to improve on previous generations: in compression, in handling various environments (broadcast, IP, …), in speed, in power consumption. The proponents are in addition trying to prevent the re-occurrence of one of the main issues encountered with HEVC: since its introduction in the market, HEVC has been affected by an unclear situation in terms of licensing costs and composition, with three patent pools with different licensing policies and several other Companies owning other potential essential Intellectual Property Rights (IPR) for this technology.

The Joint Video Experts Group, a joint group of ITU-T SG16 VCEG and ISO/IEC JTC1 SC29 MPEG, has recently finalized the first version of a new video codec: MPEG-I Part 3 or ISO/IEC 23090-3 or Versatile Video Coding (VVC), also available as ITU-T Recommendation H.266. VVC/H.266 is the successor to HEVC/H.265 and provides a bit rate reduction of about 50% for the same subjective video quality compared to HEVC with a reasonable increase in terms of complexity. VVC is largely based on technologies developed for HEVC, therefore it is possible that some of the IPR issues faced with the adoption of HEVC will also affect VVC. The Media Coding Industry Forum (MC-IF) was purposely created to avoid that by fostering the formation of a single, voluntary pool covering VVC essential patents. The standard was approved in June 2020 and it is expected to be published in October 2020.

Developed by MPEG under the name MPEG-5 Part 1, or ISO 23094-1 or Essential Video Coding (EVC), EVC defines a royalty free profile (Baseline profile) and a higher performance profile (Main profile) with more advanced compression tools to provide significant bit-rate savings of about 40% compared to HEVC. Its license terms for the Main profile are aimed to be published no later than the first half of 2022. The standard was approved in June 2020 and it is expected to be published in October 2020.

In 2018, the Alliance for Open Media (AOM) published the first version of the video codec AV1. It is primarily promoted as royalty free solution for the internet, aiming at achieving 30% of bitrate reduction over VP9. AV1 has already been deployed in a number of production TV devices in 2020.

The Audio and Video Coding Standard Workgroup of China has developed several generations of AVS and is developing a new version which aims to provide up to 40% improvement over HEVC. Patent pool for this latest version was kicked off in August 2020 and the terms are not yet published.

LCEVC, not a codec itself, is based on enhancement layers applied to bitstreams generated by other codecs (including the ones mentioned above) to reduce bandwidth and decoding complexity. Its licensing terms are not disclosed yet but the essential IPR are owned by a single company.

Next versions of the UHD Book may include one or more of the video compression technologies described above, possibly with different combinations defined for either broadcast or internet delivery.

1.2.7. Ongoing DVB activities

1.2.7.1. Native-IP for next generation broadcast

Until today, the broadcast and streaming ecosystems for video distribution have evolved largely in their own silos, while the deployment of Smart TV sets in consumer homes was rapidly increasing. Consequently, most media content providers have typically several distribution platforms: legacy DVB broadcast head-ends (for example for DTT and DTH services), using MPEG-TS, serving integrated digital TVs (IDTVs) or custom-made set-top boxes connected to consumer's main room TV screen, and in addition an OTT streaming platform supporting live and on-demand content distribution, using unicast ABR streaming to serve the personal electronic devices, but also delivering on-demand services such as catch-up, start-over, personal recording, etc., to set-top boxes and Smart TVs.

Operating multiple different video distribution platforms has significant implications for content providers. The "Native-IP" work in DVB aims at developing a media distribution format applying end-to-end IP technology for a converged next generation broadcast solution offering the well-established strengths of DVB broadcast, i.e. low latency, high quality of service, scalability and bandwidth resource optimization, and the benefits of OTT, i.e. the ability to target a multiplicity of end-user devices and easy personalization.

The first commercial use cases will be in the B2B segment: for example, mobile ecosystems fed with Native IP broadcast content – especially live – originating from an OTT headend, eventually even feeding 5G towers directly; delivery of video content to public Wi-Fi hotspots, whether complementing terrestrial broadband connectivity or as the sole distribution channel. The B2C use cases are expected later, with a Native IP specification powering next generation DTH services, with or without return path connectivity. Most of the commercial requirements identified by DVB would also be applicable to a terrestrial Native-IP delivery system, but at present it is unclear whether there would be a commercial demand for such a specification.

1.2.8. 5G for media content distribution to mobile devices

The development and deployment of 5G technology is one of the key topics around the globe today. While previous mobile technologies established a closed communication universe, 5G introduces a paradigm shift with respect to industry engagement, new services and business opportunities in many market sectors, including the media industry, where huge benefits are expected along the entire value chain. 3GPP has introduced in the 5G standard the support for multicast and broadcast modes starting from release 14, and then release 16, in compliance with the broadcaster requirements for media distribution to mobiles.

1.2.8.1. 5G Media Action Group

In 2019, the 5G Media Action Group (5G-MAG) – a cross-industry organization gathering stakeholders across the media sector, including content and service providers, network operators, technology solution suppliers, equipment – was created, to provide a collaboration framework for a market-driven implementation of 5G solutions capable of meeting the requirements for the production and distribution of audiovisual media content and services.

Building on the 3GPP standards family, 5G-MAG is working at the identification of relevant use cases in the global media industry where 5G may be beneficial. Particularly, 5G-Broadcast is considered to extend the linear TV service offer to mobile devices. Work is concentrated at stimulating and supporting the actual deployment of networks and services,

both at the technical and commercial level: the technical functionalities of the equipment required to enable this use case, including chipsets and user devices, are defined and the commercial perspectives identified, through the estimation of the volumes of user devices, chipsets and related required equipment by the global market together with a timeframe for their availability and deployment.

1.2.8.2. DVB

In 2020, after a Study Mission conducted in 2019, DVB started working on the way to provide DVB-I services by means of 5G network. A dedicated Commercial Module Task Force has been established in order to gather relevant use cases and commercial scenarios for usage of DVB-I as a service layer on top of 5G Rel-16 technologies and identifying coverage of existing DVB specifications for the use cases and identify gaps that may have to be addressed in technical work.

Being fully aware of activities running within other organization, DVB will monitor the relevant work in both in 3GPP and 5G-MAG, collaborating with them as necessary.

1.3. DTT migration in Italy

1.3.1. Introduction

If on one side the technological innovation pushes towards a significant increase in quality, resolution and definition of images and sounds, on the other side broadcasters in Europe will face a drastic 30% reduction of the UHF frequency spectrum available for digital terrestrial transmission in the coming years due to the refarming of the 700 MHz Band in favour of 5th generation mobile services.

In Italy, to cope with such spectrum reduction for TV broadcasting, the transition to DVB-T2 has been planned by the Government starting from July 1st 2022, when the 700MHz Band is going to be finally released.

The high-impact event, 10 years after the previous switchover ended in 2012, induces operators to re-evaluate their broadcasting strategy to face the dual need to maintain the current number of channels/services offered, while increasing quality with much less transmission resources.

In the following, 2 particular aspects related to this transition are discussed:

- Management of LCN conflicts for simulcasted services
- Possible variations of format for the same service

1.3.2. LCN or HD_Simulcast_LCN conflicts in the transition period

SD/HD simulcasting solutions still used today, with codecs now technologically obsolete such as MPEG-2, can no longer be considered as plausible solutions.

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, thanks also to a law mandating the presence of DVB-T2 and HEVC in all the receivers sold as of January 1st, 2017.

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.

As a consequence of the planned 700 MHz Band 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.

1.3.2.5. 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 may be included into future version of this specification.

In order to reduce the unnecessary options to the user, a further automatic selection of services or service variants is proposed as an interim solution to resolve LCN/HD_simulcast_LCN conflicts (see §7.2.2.5.3), 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.

1.3.3. Dynamic Format Switching

Having to face the limitations caused by the 700MHz Band release, broadcasters will have to adopt transmission countermeasures both in the qualification and definition of their channels and in the preparation of schedules to optimize their programming by making a measured use of the multiplex bandwidth, in order to avoid any waste of resources such as for example: discontinue SD/HD simulcast of services; resort to the use of current or new generation codecs such as HEVC, to reduce bandwidth consumption to maintain the current technical quality rather than to improve the quality and definition of programs, avoiding upscaling of content when native source is at lower resolution

The transmission use cases which will possibly be adopted by broadcasters in the near future with the aim of remedying the aforementioned limitations are represented in Annex L. It provides the basis for the definition of operational guidelines that will allow for a dynamic programming of UHD contents, encoded with variable parameters such as: format, picture resolution, framerate, EOTF (Electro-Optical Transfer Function), colour gamut and others, dynamically configured on a content by content basis. However, it is anticipated that a thorough analysis will have to be performed on the service and multiplex setup in order to

introduce these features without disrupting the normal operation of the existing commercial receivers.

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:

- MUST: This word, or the terms "REQUIRED" or "SHALL", means that the definition is an absolute requirement of the specification.
- MUST NOT: This phrase, or the phrase "SHALL NOT", mean that the definition is an absolute prohibition of the specification.
- 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.
- 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.
- 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 UHD Books 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.

October 2020

2. Document History

Document	Revision	Changes	Date
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 §0 and 7.2.2.5.3, 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 - 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	
	1	- Section 8.2 revised and extended - New section 9.3.4 on certified terminal identification - Informative Annexes G, H, I and J added, respectively for Marlin, Nagra, PlayReady and Widevine CENC-compatible DRMs - HbbTV highlights moved to Annex K with new sections on Cookies/WebStorage API, DASH in-band signalling and <video> element - Section 6.4 and 6.5 on remote control dropped - Technology outlook section updated	
UHD Book 2.0	0	- Parameters for tivùsat Backup Home Channel added in Annex E - OPTIONAL support for CI Plus 2.0 added - CI Plus references revised - Sections 8.1.2.1, 8.1.2.2, 8.1.2.3, 8.3 and 9.3.1.2.1, dealing with CICAM Player Mode support, deprecated - Launching a CS application from an HbbTV application no more a requirement - Annex K revised with new clauses	

Document	Revision	Changes	Date
		- Introduced OPTIONAL support for LL-DASH - Specification for Linear IP Services aligned to DVB-I - DVB-I related Foreword added with previous Foreword renamed as Introduction - Technology Outlook updated	

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This volume is dedicated to the loving memory of Giannicola Resta.

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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.

Low Latency DASH (LL-DASH): extension of the former DVB-DASH profile, addressing a reduction of the end-to-end latency, in order to make it comparable to traditional broadcast delivery. It relies on MPEG CMAF (Common Media Adaptation Format) chunks and the possibility to start requesting and playing a portion of a segment before it is fully completed and made available by the packager.

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	Common Interface Conditional Access Module
CoD	Content on Demand
COFDM	Coded Orthogonal Frequency Division Multiplexing
CRL	Certificate Revocation List
CRTV	Confindustria Radio TV
CS	Companion Screen
CSA	Common Scrambling Algorithm
CVBS	Component Video Baseband Signal
DAB	Digital Audio Broadcasting
DAE	Declarative Application Environment
DAI	Dynamic Advert Insertion
DAS	Dynamic Advert Substitution
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-I	DVB Internet
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
LL-DASH	Low Latency DASH
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
TA	Targeted Advertisement
TEE	Trusted Execution Environment
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 Books

5.1. Introduction

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: Dolby, EI Towers, Eurofins, Eutelsat, Fastweb, Fincons Group, Fondazione Ugo Bordoni, Fraunhofer IIS, Gruppo Industriale Vesit, Kineton, LG Electronics, Lutech, MainStreaming, Mediaset, Nagra, Panasonic, RAI, Samsung, Sisvel Technology, Sky, Sony Europe, 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).

5.2. From D-Book to UHD Book: the Collection

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 considered 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 considered. 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).

“UHD Book 1.0” for the first time has provided specifications for interoperable DTT and SAT UHDTV receivers in a single volume. That marked a fundamental milestone in HDFI’s history! Key new features of UHD Book 1.0 were:

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

A few months after UHD Book 1.0 was published, it was felt valuable and necessary to cover also, in a neutral manner, the protection of contents delivered via broadband. That has led to the UHD Book 1.0.1 document where a few Informative Annexes have been added, each one devoted to a CENC-compliant DRM system which manufacturers may choose to support (at least one).

The key novelty introduced in this UHD Book 2.0 is that the prototypal Linear IP Service specification present since HD-Book 3.0 has been replaced by the new DVB-I standard.

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.

5.3. 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)

The following other visual notations are used throughout the document:

Refers to an UHD-specific feature (italic)

~~Refers to a deprecated feature~~ (strikethrough text)

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

5.4. 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).

5.5. 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.

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 [21] 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] [21] 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][16] [58] 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 5MBaud 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 consider 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
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)

[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 (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.*
Audio Multi-Language	*Language shall be selectable.*	*Behaviour as specified in §7.5.2*

[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
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:* *○ Video formats: 3840x2160,3200x1800, 2560x1440* *○ Frame rate: 25 and 50 Hz progressive scan* *2. "HEVC HDR UHDTV IRDs using HLG10" with the following parameter limitations:* *○ 3840x2160,3200x1800, 2560x1440, 1920x1080,1600x900, 1280x720, 960x540* *○ Frame rate: 25 and 50 Hz progressive scan* *3. "HEVC HDR UHDTV IRDs using PQ10" with the following parameter limitations:* *○ 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 [3] 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 numeric keys or P+/P- button) or from an EPG; always through the remote user can get

[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

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:

- Streaming 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 Streaming 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 as defined by [64], 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 Streaming 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. Support of LL-DASH streams [64] is OPTIONAL until it will be suitably validated through specific tests and field trials.In particular, as a minimum, receivers SHALL be able to successfully play a LL-DASH Adaptation Set (with no improved performance with respect to non LL-DASH streams); optionally, receivers SHOULD support low latency presentation of LL-DASH streams (according to Section 10.20 in [64]). *Furthermore, UHD receivers SHALL support HDR extensions introduced in [64], which is aligned to [9].*
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).

Feature	Specification	Comment
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].
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 Streaming 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).

[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.

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.

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 an 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 in case of non LL-DASH Adaptation Sets, or 960ms in case of LL-DASH Adaptation Sets, 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 [26] for DTT, [30] 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 [65] and HDCP version 2.2 Copy Protection [69] 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 [3]*

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 [65] and HDCP version 2.2 Copy Protection [69].* *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 [3]*
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 1.4)	PC Card (aka PCMCIA) Connector as specified in [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 [26]	"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 [30]	"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 1.4)	PC Card (aka PCMCIA) Connector as specified in [37]	As an alternative to embedded CA
Common Interface (CI Plus 2.0)	USB 2.0 Standard-A plug as specified in [75]	OPTIONAL, in addition to the PC Card CI Plus 1.4 connector.

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
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 Infoframe bits 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)

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) made available via the default DVB-I service list for the Italian market.

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 in [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 10: 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 11: 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[14] 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

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

Component	Descriptor	Tag	Status
Teletext	Teletext descriptor	0x56	C m
SSU stream	Databroadcast_id descriptor	0x66	O m

Table 12: 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	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 13: 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 14: 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 consider 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 15: 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

E 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 consider 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 16: 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 17: 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_LCN 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 18: 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.

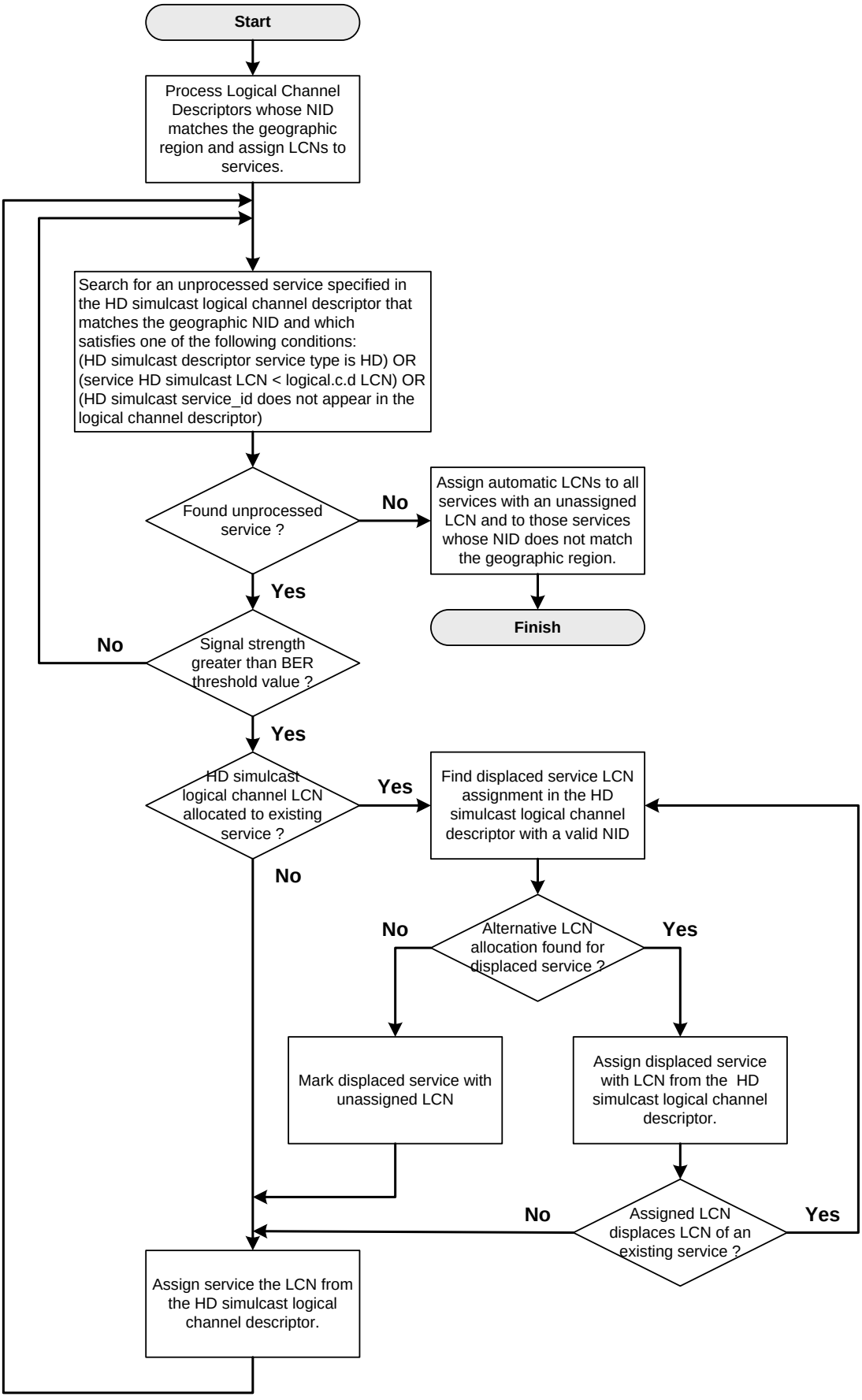

Figure 1: HD_simulcast_LCN operation

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 consider the service type, i.e. all service types share the same number space.

The logical channel number does not consider 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 19: Network descriptors (BAT first loop)

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

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

Table 20: 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*[15] *0x08*	*O*	*O*

Table 21: 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

[15] 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 and sub-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 and sub-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 and sub-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 (9 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*
9	*0x20*	*0x09*	*0x00*	*0x05*	*HEVC UHD PQ10*	*DVB-T2*	*2 & 3& 4*

Table 22: 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 23: 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 24: 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 25: Private SI recognised in the E-Book

7.3. Linear IP services

Linear IP service support, as specified in the following, is MANDATORY (see the Foreword). Discovery of linear IP services SHALL follow the DVB-I specification [15].

The aim of the DVB-I specification is to support the discovery of TV services and their associated service and programme metadata via the Internet. These TV services can then be listed, received and displayed by connected receivers (e.g.: TV, STB, PC, tablets, smartphones) with the same ease of use as RF-based broadcast linear TV services.

The combination of the DVB-I service discovery mechanism with DVB DASH delivery (and optionally DVB LL-DASH) allows receivers to incorporate linear IP services into a comprehensive hybrid service list, including broadcast (DVB-S/T) services, ordered according to a common LCN scheme, and with the associated service guide.

This approach allows broadcasters, including new entrants not providing their services over broadcast networks yet, to expand their offering with additional TV services delivered only over the Internet, and allows receiver manufacturers to provide a standard way of offering a linear TV experience that includes services received over broadcast and/or broadband.

7.3.1. Format

Receivers SHALL support the “IP1 hybrid receiver” linear IP service delivery profile as defined in Clause 8.4.2 of [15].

7.3.2. Signalling

Receivers supporting DVB-I services SHALL support the Interoperability Point IP1 for hybrid receivers as defined in [15].

For instance, when parsing a DVB-I service list retrieved during the installation procedure (see also clause 7.3.3) according to the DVB-I service discovery specification [15], receivers can associate with each DVB-I service:

- A unique identifier (for further cross-referencing, e.g., to the content guide);
- The service name and logo (for display in the UI);
- One or more countries and/or regions where the service is applicable;
- A channel number, equivalent to a broadcast LCN (possibly regionalised and/or in association with a Subscription Package).
- For linear IP services, the URL where the DASH manifest can be found, or alternatively, a linked application AIT URL for linear IP services that manage media playback using an HbbTV application;

- Multiple service instances corresponding to the same editorial content (e.g., a broadcast service in simulcast), with a priority attribute suggesting to the receiver which service instance should be preferred;
- PSI/SI-equivalent information associated with the service, e.g., service type, content protection, etc. For linear IP services, additional information can also be found in the DASH MPD;
- The associated content guide (now/next);
- etc.

7.3.3. Discovery of the DVB-I service list: default installation procedure

On installation, the default DVB-I service list for the Italian market SHALL be retrieved according to the procedure described in this clause. The DVB-I specification enables such a service list to be maintained by a national authority (or by an entity on behalf of it) according to the rules, specified by the same entity, under which a service can be considered trusted.

When it is first initialised or reinitialised (e.g., because the user applied for a factory reset), by default a receiver supporting linear IP services SHALL perform the following steps during installation:

1) The receiver does a frequency scan for broadcast services.

2) The receiver retrieves the URL of the default DVB-I service list for the Italian market according to the following options, in order of priority:
   a. Using a pre-provisioned URL:
      - of the official Italian DVB-I service list,
      - and/or of a Service List Registry hosting the official Italian DVB-I service list, obtained using the following query that returns a single Service List Offering: https://<CSR_URL>?TargetCountry=ITA&regulatorListFlag=true
   b. Using broadcast signalling, by detecting the presence of a uri_linkage_descriptor [10] with linkage_type=0x03 [15] in on air NITs of broadcast services:
      - For terrestrial broadcast, in the NIT of one or more DTT multiplexes;
      - For satellite broadcast, in the Home Channel(s)'s NITother (see Annex E for tivùsat case).

3) The receiver downloads the DVB-I service list from the retrieved URL.

4) The receiver SHALL build a hybrid service list as defined by the downloaded DVB-I service list XML, matching services signalled in the DVB-I service list with broadcast services found during the frequency scan (see also clause 7.4.2.6 for LCN-related aspects), and prioritizing the different service instances if more than 1 is defined for each service (i.e. DASH and broadcast).

The above steps do not prevent additional DVB-I service lists from being installed.

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. DVB-I service discovery

DVB-I service lists define the service numbering for receivers to apply to the services that content providers have chosen to include in the service list.
The DVB-I service list provider will have assigned logical channel numbers to each of the services in the DVB-I service list based on their agreements with each of the content providers. LCN assignment in the DVB-I service list may vary region by region.

Receivers may handle LCN conflicts within a DVB-I service list at their discretion, as DVB-I service lists should not contain any LCN conflicts.

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 §0).

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.
When installing a DVB-I service list, the receiver shall follow the installation procedure described in clause 7.4.2.6.1. Terrestrial services not mapped to a DVB-I service instance SHALL be placed in the “Main Overflow”; broadcast LCNs and associated conflict management rules are not used.
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, 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”[16].
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 22). 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.[17]
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) 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, it will automatically get the requested position
    - if more services have their NIDs within the range 0x3001 - 0x3100, the conflict resolution amongst such services is left up to the customer. Possible competing services whose NIDs is outside the range 0x3001 - 0x3100 will be automatically moved to Main Overflow range (850-999)
    - if all competing services have their NIDs outside the range 0x3001 - 0x3100 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)

[16] 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)

[17] 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)

7.4.2.4.2 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 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.

7.4.2.6. IP delivery

7.4.2.6.1 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 use the following procedure:

a) It SHALL enable the user to select the country and, if defined in the service list, a region or a specific postcode.

b) It SHALL enable the user to optionally select a subscription package, from the subscription packages defined in the service list for the selected region (i.e. subscription packages signaled in at least one 'LCNTable.SubscriptionPackage' element where an 'LCNTable.TargetRegion' element matching the selected region is also present). The receiver SHALL enable the user to continue installation without selecting a subscription package if there is an LCNTable without an 'LCNTable.SubscriptionPackage' element where an 'LCNTable.TargetRegion' element matching the selected region is also present.

c) It SHALL select an LCN Table matching the region and subscription package chosen by the user, if any. The receiver SHALL allocate a channel number equal to the LCN specified for each service in the LCN Table. DVB-I services not included in the selected LCN Table SHALL be installed in the "Main Overflow", except for the following services that SHALL NOT be installed:

- services only targeted at a region different to the region chosen by the user.
- services that only have service instances targeted at a subscription package not selected by the user.

7.4.2.6.2 Service List update

When the receiver, as a result of an update check (whether manual or automatically, in standby or in active state), recognises that there has been a change in the DVB-I service list (services added, removed or reordered), it SHALL add, remove, and reorder the services as indicated by the LCN elements within the applicable LCNTable element.

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 [5] 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 [5] 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 [5]

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 12) 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 elements 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 a 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[18] 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 DVB-I service list(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) and if a DVB-I service list is installed, check if the new service(s) correspond(s) to (a) service instance(s) described in the DVB-I service list;
- **automatic full scan**: the procedure is initiated automatically by the receiver; it performs a full (automatic) scan of the spectrum and processes DVB-I service list(s) (if any); its only purpose is to update the service list(s);

DVB-T2 receivers SHALL provide a single list containing both DVB-T and DVB-T2 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).

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

7.6.1.1. First Installation Procedure

- At first installation the receiver SHALL perform an automatic scan over the entire spectrum bands and process DVB-I service list (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 or discard 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" in SDT, "ServiceName" in DVB-I service list) change of a given service and update it unless it was manually edited by the end user;
    - for non-DVB-I installations, 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 position:
    - if a DVB-I service list is installed and a new terrestrial service matches with a service instance described in the DVB-I service list, then the new terrestrial service is associated with that service instance and its parent DVB-I service;
    - for non-DVB-I installations, 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, if automatic ordering is not active or if the service does not match with any DVB-I service instances, 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 (for DVB-I services, the UniqueIdentifier associated with that service shall be identified). The comparison SHALL consider 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;
    - for non-DVB-I installations, 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 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 a DVB-I service list is installed and a new terrestrial service matches with a service instance described in the DVB-I service list, then the new terrestrial service is associated with that service instance and its parent DVB-I service;
    - for non-DVB-I installations, 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 a new service doesn’t carry any LCN, if automatic ordering is not active or if the service does not match with any DVB-I service instances, 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”, 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).

7.6.1.5. 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 DVB-I service list(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) and if a DVB-I service list is installed, check if the new service(s) correspond(s) to service instance(s) described in the DVB-I service list;
- automatic full scan: the procedure is initiated automatically by the receiver; it performs a full (automatic) scan of the spectrum and processes again DVB-I service list(s) (if any); its only purpose is 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 by it. The platform's service list can alternatively be built based upon Home Channel(s)'s NIT/BAT/SDT tables alone (Fast Scan).
- Process DVB-I service list(s) (if any).
- 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 or discard 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 DVB-I service list) change of a given service and update it unless it was manually edited by the end user;
  - for non DVB-I installations, 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:
  - if a DVB-I service list is installed and a new satellite service matches with a service instance described in the DVB-I service list, then the new satellite service is associated with that service instance and its parent DVB-I service;
  - for non-DVB-I installations, if they carry an LCN and automatic ordering is active, the rules given in §7.4.2.5 for allocation and conflict resolution apply;
  - if they don't carry any LCN, if automatic ordering is not active or if the service does not match with any DVB-I service instances, they will be appended at the end of the list in the 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) 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 (for DVB-I services, the UniqueIdentifier associated to that service shall be identified).

- 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;
  - for non DVB-I installations, 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 different from those of the channels already registered
  - if a DVB-I service list is installed and a new satellite service matches with a service instance described in the DVB-I service list, then the new satellite service is associated with that service instance and its parent DVB-I service;
  - for non-DVB-I installations, if they carry an LCN and automatic ordering is active, the rules given in §7.4.2.5 for allocation and conflict resolution apply;
  - if they don’t carry any LCN, if automatic ordering is not active or if the service does not match with any DVB-I service instances, they will be appended at the end of the list in the 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

N.	Settings / Italian Translation	Default settings
4	“Repetition” / “Frequenza”	“Daily” / “Quotidiana” = default (“Weekly” / “Settimanale” – other options possible)

Table 26: 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 (considering 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 26 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.

Field name	Field length in displayable characters	M/R/O	Comments and examples
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 27: 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 through a Common Interface Conditional Access Module (CICAM).

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

Receivers complying with this document that integrate a CI Plus 1.4 (PC Card) interface SHALL be consistent with the CI Plus Specification [37].

Receivers complying with this document that integrate an optional CI Plus 2.0 (USB) interface SHALL be consistent with the CI Plus Specification [75].

Non-UHD receivers complying with this document that integrate a CI Plus interface MAY comply with the CI Plus ECP Specification [53].

UHD Receivers complying with this document that integrate a CI Plus interface *SHALL comply with the CI Plus 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 PC Card Connector and the corresponding Modules 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 CI Plus (earlier than [37]) in accordance with the CI Plus Specification [37].

Specifically, Host and CICAM 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. Additional clarifications about CICAM use cases are provided by CI Plus LLP in CI Plus Specification 1.3.2 [40] Annex E and in CI Plus Implementation Guidelines 1.0.6 [72].

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, 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] and [75].
2. Host SHALL include in the main menu an entry for the CICAM Menu.
3. Host SHALL support MMI Pop-ups.
4. Host SHALL comply with the following requirements applied to MMI pop-ups and 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 key
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 systems

8.2.1. Common Encryption (CENC)

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

Nevertheless, having CENC-compliant [59] DRMs embedded in receivers would enable a single encrypted content, delivered either with HTTP Streaming or HTTP Adaptive Streaming, to be consumed on receivers with different DRMs. With this goal in mind,

receivers compliant with this specification SHALL embed at least one CENC-compatible ISOBMFF-compliant UHD-grade DRM. Informative Annexes G, H, I and J present suitable profiles for implementing some of them.

In particular:

1. protection scheme type:
    a. 'cenc' encryption scheme SHALL be supported.
    b. Support of other schemes is OPTIONAL
2. implementations SHALL support at least 8byte Initialization Vector (IV) values.

In case of mismatch between DRM metadata provided in the MPD and DRM metadata embedded in the content, as specified in clause B.5.2.3 of [6], the former should take precedence over any metadata in the initialisation segment in the content, but a subsequent media segment could contain new metadata which would effectively replace what was originally provided in the MPD.

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

8.2.2. Device Profiles

There are 2 receiver profiles as clients for protected CoD services:

- **Streaming Device** that is not equipped with storage for content files. So, content (progressive) download is requested per each playback of the content and will not remain in the device after the playback. Streaming Devices SHALL support Streaming CoD services.
  A Streaming Device SHALL allow persistent internal storage of at least 1500 kB for licences.
  A Streaming Device accessing content located in external storage MAY actually behave as a Download Device if such behaviour is supported by device manufacturer (this includes the availability of the related APIs for Download CoD).

- **Download Device** that is equipped with storage, available at HbbTV application level, for content and license files. It SHALL behave as Streaming Device and furthermore it SHALL be able to store the content and/or license for future playback or further use cases such as local content sharing. In other words, Download Devices SHALL support Streaming CoD services and it SHALL support Download CoD services.

~~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.~~

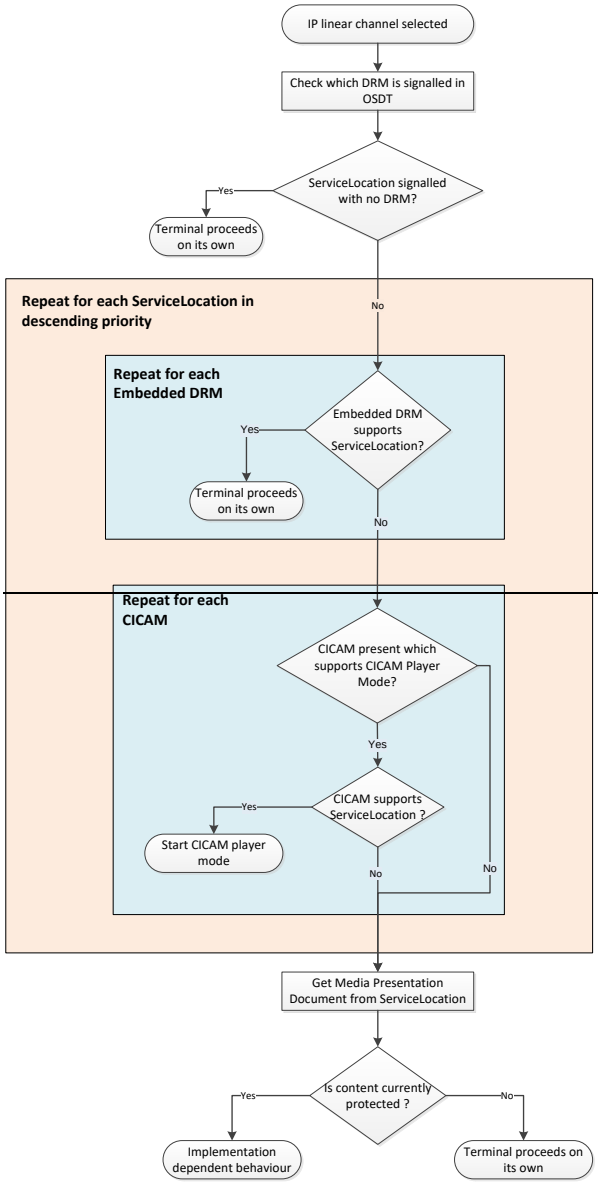
~~When DRMControlInformation element is present in all the ServiceLocation of the IP linear service, then the terminal shall consider the IP linear service as encrypted, and shall evaluate each ServiceLocation in turn, in descending priority order, until the terminal determines that a ServiceLocation 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.~~

~~If the 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 2: 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.

9.2.1.1.1 Handling of input events by the Navigator

When the receiver is in TV Viewing Mode (see definition in §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 program up/down).

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 ParentalGuidance element in the DVB-I content guide metadata (see clause 6.10.14 of [15]) or in a DVB-DASH MPD (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 attribute associated with the selected region in the RegionList elements of the DVB-I service list
- 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 and/or satellite television, radio and interactive services, based on HbbTV standard [6]. A number of key HbbTV features for Italian broadcasters are highlighted in Annex K. 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], the following features SHALL be provided.

9.3.2.1. 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. Certified terminal identification

Terminals formally certified to be compliant with this specification SHALL provide Operators' back-end services the way to identify them.

For this purpose, the HTTP `User-Agent` header SHALL also include the string specified here below:

`"LaTivu_<version-M>.<version-m>.<version-u>_<yyyy>"`

Where

- "`version-M`" represent the "major version" "`version-m`" the "minor version" and "`version-u`" the "micro version" of the reference specification (i.e. UHD Book M.m.u).
- `"yyyy"` represents the year in which the terminal has been certified

The string introduced above SHALL not influence in any way the Terminal behavior, it is used on Operator back-end side only.

For example, for terminals compliant to this document and certified in 2019, the string SHALL be:

"LaTivu_1.0.1_2019"

A valid example of the `User-Agent` for the ACME terminal Pippo belonging to Pluto family with software version 1.0 certified in 2019 is:

```
User-Agent: HbbTV/1.5.1 (+DRM;ACME;Pippo;1.0;;Pluto;) LaTivu_1.0.1_2019
```

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 28: 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.

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 29: 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 housekeeping (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

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

Table 30: 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[19]

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 31: 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.

[19] 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 32: 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 33: 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 (Rayleigh) 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 34: 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 (Rayleigh) 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 (Rayleigh) 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 35: 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 considering 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 36: 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 37: 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 38: 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 39: 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 40: 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 41: 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 33, Table 34 and Table 35 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 42when an 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 42: 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 43 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 43: 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 44: 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 considering `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. Low latency presentation requires that client clock is synchronised with sub-second time accuracy.

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:

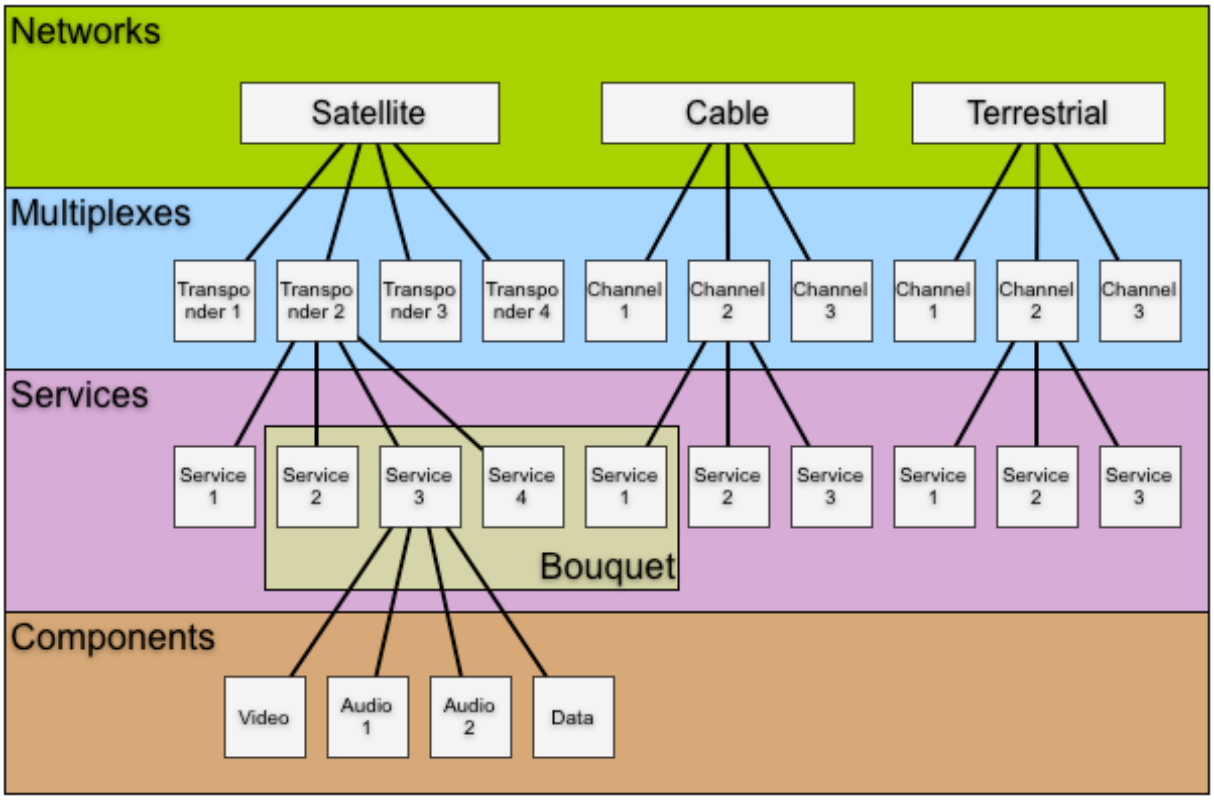

Figure 3: Service delivery model

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 45: 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
0x0107	Cairo Network
0x0200	Persidera
0x0201	Persidera
0x0202	Persidera
0x0204	Persidera
0x032A	H3G
0x0384	D-Free
0x0385	Mediaset
0x0389	Mediaset
0x03A2	Mediaset
0x03AC	Mediaset
0x03B6	Mediaset

Table 46: 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.

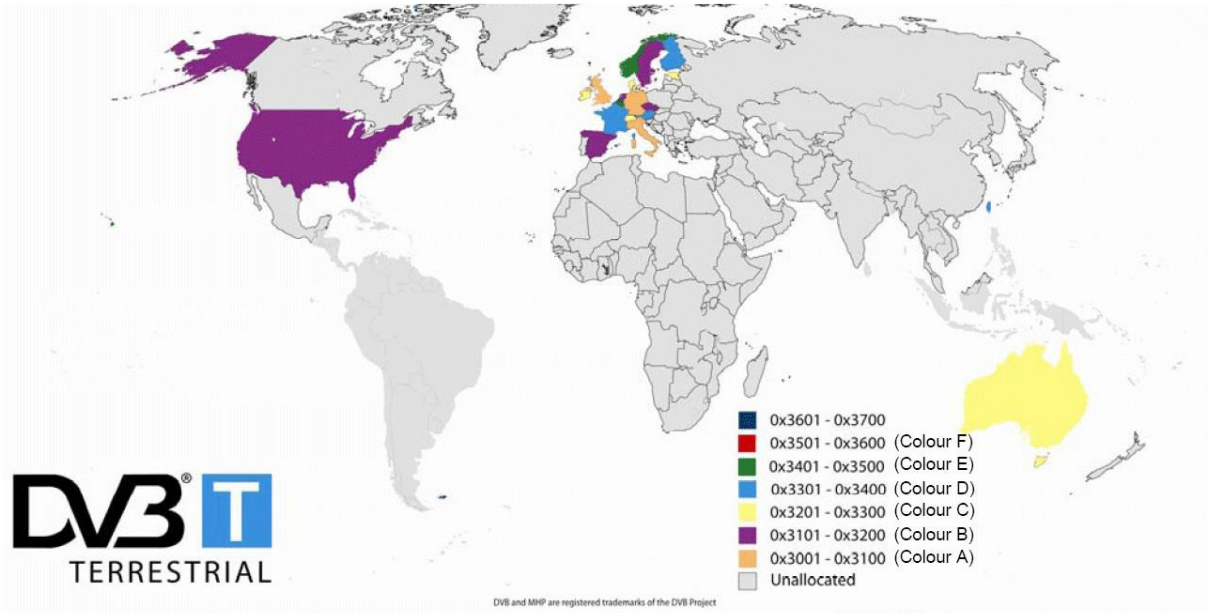

Figure 4: Colour map for allocating network_ids in terrestrial networks

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[20]
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 47: 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 §7.4.2.4). In particular, if Italy has been selected as “Country” at

[20] 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)

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.

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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	10992MHz
Orbital position	13º	13º
West/East	East	East
Polarization	Vertical	Vertical
Modulation	QPSK	8PSK
Symbol rate	27.5Mbaud	29.9Mbaud
Inner FEC	2/3	3/4

Table 48: 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[21]. 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.

[21] 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 §7.4.2.4 and §7.6.1, 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.

Such "seamless service list" can be provided as a DVB-I service list: if the receiver supports DVB-I installations that include different types of broadcast delivery, the installation procedure described in clause 7.4.2.6 applies.

Otherwise, 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.

G Marlin DRM (Informative)

G.1 Introduction

This Annex outlines Marlin DRM and its support for Streaming and Download Device profiles.

Marlin DRM is a globally deployed DRM platform, developed through an open process, for IPTV, OTT and OTA services and devices.

The Marlin Client API provides a common set of APIs and functionality across the different supported platforms allowing for example, iOS devices, Android devices, as well as STBs and Smart TVs to access the same content formats.

G.2 Marlin DRM System

Marlin can be used to protect and provide governance for broadband-delivered content that is either streamed or downloaded by implementing either of the following specifications:

- Marlin Simple Secure Streaming (MS3) [83] – streaming for simple play and forget models
- Marlin Broadband (BB) [79] – for more complex streaming use cases and download.

The applicable Marlin Compliance and Robustness (C&R) rules SHALL apply to implementations of the MS3 and Marlin BB profiles. At a minimum, the C&R rules include the general C&R rules found in the Marlin Client Agreement [85]. If UHD, 4K, or Early Release Window content is being distributed, Clients must comply with the Marlin Enhanced Content Protection (ECP) Rules found in the Marlin ECP Amendment [90] to the Marlin Client Agreement [85]. The ECP C&R Rules include requirements that:

- Only HDCP v2.2 or greater is allowed for output,
- All content protection logic must be implemented in a hardware based Trusted Execution Environment (TEE), and
- Content must be processed via a secure video path rooted in the TEE.

Streaming Devices SHALL be compliant with Marlin MS3 and BB Compact Implementation as defined in [83] and [79]. Download Devices SHALL be compliant with Marlin MS3 and BB Full Implementation as defined in [83] and [79]. The following sections provide more detail.

G.2.1 MS3 specification profiling

- The device SHALL support the activation of the MS3 DRM client with the MS3 Compound URI triggering mechanism as defined in Section 3.4.2 of [83].
- Other activation mechanisms are OPTIONAL.
- The device media player SHALL recognize and parse an MS3 Compound URI according to Section 4.2 of [83].
- The device SHALL support the ms3 variable "*authenticator*" for content URI (C-URIT) obfuscation. The usage of this variable by a Service Provider is OPTIONAL.

G.2.2 BB specification profiling for Streaming Devices

- The device SHALL provide a Marlin BB *Compact Implementation Profile as* defined in [79].
- The device SHALL signal the supported Marlin BB profile and the supported topology as defined in Section 6 of [79].

G.2.3 BB specification profiling for Download Devices

- The device SHALL provide a Marlin BB *Full Implementation Profile as* defined in [79].
- The device SHALL support the BNS Extended Topologies for subscription nodes as defined in Section 5.1.2 of [79].
- The device SHALL signal the supported Marlin BB profile and the supported topology as defined in Section 6 of [79].

G.2.4 DRM System Name

DRM System Name is used to signal the type of DRM as specified in §9.3.1.1. The value of the DRM System Name for Marlin BB and MS3 SHALL be set to “urn:dvb:casystemid:19188”, the decimal number format of CA_System_ID for Marlin.

G.2.5 Operation of Marlin Technologies

This section specifies the operation of Marlin technologies to support certain type of services such as Marlin Licenses, Topologies (Nodes and Links) and Marlin protocols as well as to manage stored licenses and certificates.

G.2.5.1 *Streaming CoD services*

For Streaming CoD services, the following operations apply:

- Each Marlin Content License SHALL be bound and targeted to unique Marlin Device Personality for Marlin Broadband (download and streaming).
- Marlin Licenses MAY contain Output Control Obligations as defined in the Marlin – Output Control Specification [80].
- Marlin Licenses MAY contain temporal constraints, e.g. NotBefore/NotAfter.

G.2.5.2 *Management of stored licenses*

DRM Licenses stored in the receiver can be either related to content that is streamed to the device (not locally available) or related to content downloaded locally (in case of a receiver compliant to the Download device profile).

When a Marlin protected content is played back, receivers SHALL check for a valid license embedded in the content itself first (if the target content format supports embedded licenses), then if no valid license is found, they SHALL check for a valid license in the license storage.
If no valid license for the specific content can be found locally on the receiver, the playback will fail raising a proper exception.

MS3 does not allow for the retention of licenses and therefore an embedded license check does not apply when MS3 is used to access streaming content.

Receivers SHALL ensure a consistent management of stored licenses. A sample procedure (the logic for which is handled outside of the SDK) is described in the following:

1. Receivers check the status of the licenses stored in the license storage at least once per day (every 24 hours).
2. Licenses with an expiration-date attribute occurring in the past are removed from the license storage.
3. Licenses without an expiration date, not related to content locally stored, and acquired more than 30 days in the past are removed from the license storage. (Implementations should consider that a single license may be related to multiple pieces of content).
4. If the license storage available space is not sufficient to store a new license, that license is discarded. In this case, in order to play the associated content, a new license must be acquired.

G.3 Media formats and containers

The following protected content formats SHALL be supported and used with the following protocols:

Marlin DRM Modality	License Delivery Method	Container	Comment
Broadband Modality	▪ Marlin MS3 / MBB protocol to deliver licenses over IP (HTTP/S)	▪ DASH - CENC	The Common Encryption Format is defined in [59]. The Marlin extensions to the Common Encryption Format are defined in [89].

Table 49: Protected formats supported

Files extensions and MIME types for the various protected file formats are listed in the following table:

Format	Extension(s)	MIME type
CENC	.mp4	video/mp4
	.m4A	audio/mp4

Table 50: File extensions and MIME types for the various protected formats

G.4 Adaptive Streaming for Protected Content

This section describes usage and extensions for receivers which are compliant with Marlin BB [79] or MS3 [83] to enable HTTP Adaptive Streaming of protected content, using media formats and containers specified in the previous section.

Delivery of protected content with MPEG-DASH [60] SHALL be compliant with Marlin Adaptive Streaming Specification – Simple Profile [89] section 2.1.

G.4.1 Media Presentation Description (MPD)

If the schemeIdUri attribute of one of the <ContentProtection> elements in the MPD equals to “urn:uuid:5E629AF5-38DA-4063-8977-97FFBD9902D4”, the protected media segments are signalled as Marlin protected content, Baseline Mode [89].

G.4.2 ISOBMFF container case

For protected content, the Common Encryption for ISO Base Media file format SHALL be used as defined in [59]. The extensions to the CENC schema defined in section 2.3 of Marlin Adaptive Streaming Specification – Simple Profile SHALL be supported (with both Implicit and Explicit Content ID mapping mechanism).

G.4.3 Adaptive Streaming Operations for protected content

The following additional constraints apply for implementations operating with the HTTP based Adaptive Streaming solution defined in this specification:

- The content keys required to access the protected Media Segments in the representations available to the client in an MPD are delivered within a single Marlin license.
- A Marlin license bundle MAY include multiple Content IDs/Content Keys pairs which can be used for different Representations, AdaptationSets and Periods

G.5 Application environment

G.5.1 DRM Agent API

For the Marlin DRM agent receivers SHALL support the DRM features defined in HbbTV specification [6].

G.5.2 Triggering mechanisms

G.5.2.1 MS3

Receivers SHALL support triggering of MS3, MS3h, and MS3hs through *MS3 Compound URI* as defined in section 3.4.2 of MS3 [83]. MS3, MS3h, and MS3hs Compound URIs SHALL use the "*ms3://*" URL scheme instead of "*https://*". Receivers SHALL convert "*ms3://*" to "*https://*" when they retrieve the related S-URL.

Support for MS3, MS3h, and MS3hs Action Token (DRM API) or MS3, MS3h, and MS3hs Manifest File is OPTIONAL. If present they SHALL be compliant with sections 3.4.1 and 3.4.3 of MS3 [83].

G.5.2.2 Marlin BB

Marlin BB protocols can be initiated through the `sendDRMMessage` method, as defined in the OIPF DAE specification [73]. Implementations of this method SHALL support the Marlin bindings as described in the following Table.

Argument	Marlin bindings
msgType	*application/vnd.marlin.drm.actiontoken+xml* MIME type for Marlin Action Tokens as defined in section 5.3.4 of Marlin BB [79]
message	Marlin BB Action Token as defined in 5.3.2 of Marlin BB [79]

Table 51: Arguments of Marlin bindings for Marlin BB

When the `sendDRMMessage` is invoked by passing a Marlin Action Token as specified above the receiver shall forward the message to the DRM Client. The result of the operation triggered by the `sendDRMMessage` is then asynchronously notified through the `onDRMMessageResult` function. See HbbTV specification [6] for more details.

G.5.2.3 DRM Agent restrictions

Marlin MS3 interactions using the Compound URI triggering mechanism SHALL comply with the following requirement:

- If the license acquisition procedure cannot be completed successfully, DRM rights errors SHALL be managed by A/V Control object or HTML5 Media element as defined in HbbTV specification [6].

G.6 Device output controls

The following mandatory output connectors are defined in §6.3.1:

- HDMI Output with HDCP (for STB only)
- SPDIF Output

The following optional output connectors are also specified in §6.3.2:

- HDMI Output with HDCP (for iDTV only)
- SCART Connector
- RCA Connectors (Composite and/or Component)

The following restrictions SHALL be applied for each compliant device:

- HDCP for HDMI output connectors must be always ON

- In case of HD video signal, the downsampled SD version has to be presented to SCART or RCA connectors, if present

A Marlin license can define the output restrictions that need to be enforced by the device for the target content. The levels of the restrictions to be enforced are usually part of the agreement with the rights holders.

The Marlin Compliance Rules (included in the Marlin Client Agreement and amendments [85]) define the default value for output controls in case of playback of Marlin content. Those default values may be overridden by further output control restrictions embedded in the license.

In addition to the protection mechanisms defined above, the device SHALL be able to enforce the output control restrictions defined in a Marlin license associated with content. If the device does not support a specific output control restriction on an Analogue Output Connector, then the device SHALL disable the related output connector.

The status of the outputs SHALL be verified before the content is played back.

G.7 Authentication

G.7.1 User Authentication

User Authentication associates a session between a service and a device with a user account or a payment account by any service-specific proprietary method such as conventional user ID and password over TLS. A purchase transaction is typically performed under the user authenticated session and it needs to be associated with DRM compliant authenticated session through which the right to consume content is provided.

G.7.2 DRM Compliant Device/Service Authentication

For traditional DRM scenarios, DRM device and service authentication are performed using Marlin (NEMO) device/service signing certificates to ensure that both the device and the service are legitimate from Marlin's perspective. The authentication procedures are performed as a part of Marlin BB protocols defined in [84] or through TLS in case of Marlin MS3 [83]. Association between this DRM authenticated session and user authenticated session described in section G.7.1 are realized through exchange of a BusinessToken.

An example of usage of the Business Token in a MS3 Compound URL is the following:

ms3://ms3.example.com/getsas?bt=CAFEBEE#http://www.contentserver.net/stream/get-content?cid=8967F56D

An example of usage of the Business Token in a Marlin BB Action Token is the following:

```
<LicenseAcquisition xmlns="urn:marlin:broadband:1-
2:nemo:services:action-token" id="1">

<Type>personality</Type>

<BusinessToken>CjBsR09EbGhjZ0d</BusinessToken>

<CertificationStandard
name="urn:marlin:organization:sp1:CERTIFICATION_STANDARD_NAME"
use="must" validity="P1M"/>
```

```
</LicenseAcquisition>
```

G.8 Protected Content Delivery Scenarios

A set of different mechanisms to protect the content (either access to the content or the content itself) can be defined:

- Platform device authentication with MS3
- Platform device authentication & content encryption with MS3
- Marlin Broadband protected content

G.8.1 Platform device authentication with MS3

The server sends, through the secure TLS connection, a compound URL that includes the URL for the Marlin MS3 server and the URL of the content (this URL can be optionally obfuscated with a token placeholder that need to be replaced once MS3 authentication is successfully completed).

The compliant device authenticates itself against the MS3 server using the Marlin certificate and retrieves a Stream Access Statement (SAS) including a token string that need to be replaced in the content URL and the set of restrictions on the output controls that need to be enforced.

Once the complete content URL is built, the content is available as clear content (i.e. without encryption).

G.8.2 Platform device authentication & content encryption with MS3

The authentication procedure follows the steps defined in the previous scenario. The content is encrypted through an appropriate encryption algorithm. The compliant device uses the content key provided in the SAS received from the Marlin MS3 server to decrypt and playback the content.

G.8.3 Marlin Broadband Protected Content

The authentication procedure follows the steps defined in the previous scenario. The possible DRM-related actions are triggered by action token messages sent to the DRM client by the application through the DRM API.

The action tokens activate the interaction between the DRM client and the Marlin BB Server for instance performing a license acquisition or a device registration procedure.

A DRM API is required from the application layer as specified in §G.5.1.

H Nagra DRM (Informative)

H.1 Introduction

This Annex provides information about NAGRA DRM, aka PRM (Persistent Rights Management), that can be integrated in STB and TV. It supports both Streaming and Download Device profiles.

Following sections go in more details on the different requirements for integrating PRM in a device. It describes content and device compliance.

H.2 Media Format and Containers

PRM does not have specific restrictions on content format or content encryption. While PRM does support MPEG CENC 'cenc' scheme with ISOBMFF content format, it can support also other content format and encryption algorithms like MPEG-2 TS based ATIS [91].

PRM makes no assumption on the content codecs and supports both video and audio content. It allows separate or combined protection of audio and video streams. In case of DASH adaptive streams, it supports

- Different keys per resolution (allowing having a different key for UHD and other resolutions for example)
- Key rotation for Live content with either renewal of authorization by requiring acquiring a new license or by using key hierarchy (à la Broadcast mode)

H.3 DASH Adaptive Streaming Support

PRM follows the DASH-IF IOP recommendation for signaling and using DRM information. It means:

- Content is ISOBMFF based encrypted with one of the supported CENC schemes following recommendation provided in Section H.2.
- The DRM system Id SHALL be `adb41c24-2dbf-4a6d-958b-4457c0d27b95`
- Content contains PSSH boxes in the moov and moof if required. In more details:
    - PSSH in the moov is not recommended.
    - PSSH in the moof is present if key rotation is used.
    - PRM PSSH SHALL be compliant with the PRM Signaling specification [92] Section 3.1.1. In more details
        - The SystemID SHALL be the DRM system Id defined above.
        - The DataSize SHALL be the size of the protection specific data that is provided to the PRM license server for accessing the content, obtaining a right and then a key for decrypting. It is a 4 bytes integer in MSBF representation.
        - The Data SHALL be a table of bytes containing the PRM data and which size is DataSize. It is provided as is to the PRM client.
- The MPD SHALL contain a ContentProtection element when content is protected by PRM. In more details:
    - It SHALL be added in the AdaptationSet or Representation element depending on the scope of the key(s), either the full adaption set or just one resolution.
    - The schemeIdURI SHALL be equal to "urn:uuid:adb41c24-2dbf-4a6d-958b-4457c0d27b95"
    - The value attribute is optional and SHOULD be omitted. As a remark this is not following the optional recommendation from DASH-IF IOP but this attribute is not interpreted by the PRM client, it is useful mainly for debugging as it allows a human readable name of the DRM to be inserted in the MPD.

    - It SHALL be compliant with the PRM Signaling specification [92] Section 3.1.2. In more details:
        - A cenc:pssh element box SHALL be added under the PRM ContentProtection element. It contains a base64 encoded ‘pssh’ box as specified above.
        - A cenc:default_KID attribute SHOULD be added.
        - A PRM specific element with PRM opaque data SHALL be added.
- Following the DASH-IF IOP specification, in the case where the PSSH box element is present in the MPD and in the moov box, the ‘pssh‘ box element in the MPD SHALL take precedence, because the parameters in the MPD will be processed first, are easier to update, and can be assumed to be up to date at the time the MPD is fetched.

In the case where the PSSH box element is present in the MPD and in the Initialization Segment, the PSSH box element in the MPD SHALL take precedence, because the parameters in the MPD will be processed first, are easier to update, and can be assumed to be up to date at the time the MPD is fetched.

Below is an example of a ContentProtection Element with PRM data.

```
<ContentProtection schemeIdUri="urn:uuid:adb41c24-2dbf-4a6d-958b-4457c0d27b95">
        <!-- PRM specific signalization  -->
        <prm:PRM>
                <prm:PRMSignalization>
                        eyJjb250ZW50SWQiOiJHb25lIGluIHRoZSB3aW5kIiwia2V5SWQiOiI5MWExZTQ0Ny02ODRiLTRhY
                        2UtYjZjZS00MDExNjBmMDdmMDEifQ
                </prm:PRMSignalization>
        </prm:PRM>
        <!-- base64 encoded ‘pssh’ box with this PRM SystemID -->
        <cenc:pssh>
                AAAAinBzc2gAAAAArbQcJC2/Sm2Vi0RXwNJ7lQAAAGpleUpqYjI1MFpXNTBTV1FpT2lKSGIyNWxJR2x1SUhS
                b1pTQjNhVzVrSWl3aWEyVjVTV1FpT2lJNU1XRXhaVFEwTnkwMk9EUmlMVFJoWTJVdFlqWmpaUzAwTURF
                eE5qQm1NRGRtTURFaWZR
        </cenc:pssh>
</ContentProtection>
```

H.4 Protocols and License Acquisition

Devices SHALL be activated before been able to decrypt content. This requires a unique connection to an activation server available in the Cloud. This step is typically performed at set-up of the device by the corresponding initialization application triggered by the DRM client.

License format and license acquisition protocols are described at [93].

The device SHALL support the Authorization Token mode and SHOULD support the Authorization Server and Authorization Callback modes. In the Authorization Token mode, the JWT Content Authorization token is described at [94]:

- It SHALL contain at least one right and COULD contain Content Usage Rules.
- It SHALL be signed with keys provided by NAGRA. Keys are provided as part of the deployment kit.

Below is an example of a Content Authorization token:

```
{
  "header":{
    "typ":"JWT",
    "alg":"HS256",
    "kid":"263953"
  },
  "claims":{
```

```
    "typ":"ContentAuthZ",
    "ver":"1.0",
    "exp":1463326662,
    "jti":"e72782ef-8b1d-4f9f-8bdf-02fe55d1d5a0",
    "contentRights":[
      {
        "contentId":"LYS001990",
        "start":"2015-05-19T19:42:18Z",
        "end":"2016-05-21T19:42:18Z",
        "defaultKcIds":[
          "ffffffff-aaaa-bbbb-cccc-000000000501"
        ]
      }
    ]
  }
}
```


H.5 Device Compliance

PRM system is made of 2 parts:

- A head component (the license server)
- A device client library (installed on devices) processing licenses and granting access to content. A device capable to receive PRM's protected contents SHALL support the NAGRA CONNECT Client.

The following goes in details on needed compliance.

H.5.1 Device Integration

H.5.1.1 *CONNECT Client*

The CONNECT client (CCL) is the set of libraries provided by NAGRA to be integrated in devices for supporting PRM. It is provided as binaries to licensed Device manufacturers. NAGRA provides support for integration and testing. Documentation, called "CCL Integration Kit" is also provided with the binaries.

The Device SHALL be compliant to the following NAGRA specifications:

- The software environment shall comply with either SST3 (Security Specification for TEE-enabled devices on 3rd party root of trust) or SSTN (Security Specification for TEE-enabled devices on NOCS chipsets) specifications base on the available root of trust.
- The manufacturing process shall comply with the Nagra manufacturing specification.
- The CONNECT client shall access device resources following The Nagra Host platform requirements.
- The device shall enforce the usage rules obtained from the delivered license.

H.5.2 HbbTV

The device SHALL support for the PRM agent for the DRM features defined in HbbTV specification [6], in addition to the protocol specification available from [95].

H.5.3 Content Usage Rules

NAGRA has defined a set of Content Usage Rules allowing the operator to define for each piece of content what can be done on the device (allow recording or not, allow timeshift or not…) and on the output of the device (with or without protection, which type of protection, with or without downscaling…).

The definition of the rules is under the operator responsibility, some can be mandated by the content owners for example. The rules can either by applied to all pieces of content, hence becoming default values or be provided as part of the PRM license.

The device SHALL the usage rules obtained from the delivered license. The following needs to be noted:

- A Streaming Device SHALL not consider the usage rules related to storage of content.
- A device SHALL only consider usage rules relevant for its capabilities. For example, a device without analog output SHALL not consider analog output restrictions.
- A device SHALL implement all default values for all usage rules relevant for its capabilities.
- Usage rules SHALL be evaluated before content is processed (processing can be either playback, storage, export …)

H.5.4 Device Security

In case of an integration with the CONNECT Client, the Client needs a Root of Trust in the device. It can also support either software root of trust or 3rd party root hardware root of trust from SOC vendors. It can also support the NAGRA's On-Chip Security (NOCS).

It is recommended to support NOCS on the device and therefore to follow Nagra Advanced Security Certification (NASC) when designing the device.

NASC is a specification and certification process for device manufacturers to ensure their devices properly leverage the NOCS security features in the chipset in order to provide the required security for DRM, Device and Content protection. It is a set of security requirements to be implemented by Device and MW providers to be protected against certain number of attacks. In basic terms, NASC allows to protect DRM assets, the device itself, boot loaders, software download mechanisms and other software stacks.

NASC comes with a certification process through which NAGRA checks the compliance of its requirements by Devices and Middlewares in their implementation. Such a NAGRA led certification ensures a minimum standard and prevents weak implementations from entering the market. This also helps service providers to align to a standard, different device vendors and middleware providers as they are not all created equal.

H.6 System Integration for User and Device Authentication

For device and user management, NAGRA Security Service Platform (SSP) offers a set of services that SHOULD be supported:

- Account & Device & Users Management Service (ADM): IT offers the possibility to manage Accounts and Devices. An Account is the logical entity that represents a household in which multiple devices and users can be associated. An Account can be a subscription account or an anonymous account. A Device can be a closed device, an open device- mobile, an open device-tablet or an open-device STB/TV. User represents the subscriber. Account information usually comes from service provider’s Business Platform (SMS/CRM). Service Provider’s SMS/CRM needs to provision Account information into ADM. ADM provides web services for Account information provisioning as well as for management of devices per Account (creation, deletion of devices). There is a common Device and Domain console for SAS and ADM that allows operators to seamlessly manage 1-way and 2-way devices.
- Right Manager (RMG): It contains the Product/Right information and knows which Subscriber has access to which Products/Rights. RMG is interfaced with Operator’s SMS/CRM and Purchase server.
- Secure Session Management Service (SSM). It allows service providers to securely manage concurrent playback sessions. SSM creates/manages active sessions and

enforces security usage rules related to session management such as max number of sessions (per stream or per account) and session group management etc…
- Device Authentication Service (DAS). The goal of DAS is primarily to offer a CA/DRM based device authentication service.

H.7 System Integration Conformance

Integrating these services require integration with the Operator head-end that are out of the scope of this specification. More information can be found at [96].

A device SHALL support the following:
- For using the DAS service, the device SHALL support the API defined at [97].
- For using the SSM service, the device SHALL support the API defined at [98].

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I PlayReady DRM (Informative)

I.1 Introduction

This Annex provide directives to integrate the PlayReady DRM System into device compliant to this document. It also specifies the way the PlayReady DRM System shall be integrated within the Application Environment supported by this document, i.e. HbbTV [6].

I.2 PlayReady DRM system

Devices compliant to this document SHALL implement Microsoft PlayReady DRM version 3.0 (or later).

Devices compliant to this document SHALL support Microsoft PlayReady as per [99] and as defined by documentation available to PlayReady Licensees to allow Content Protection operations and Protected Content consumption.

For PlayReady signaling to the HbbTV application, the CA System ID to be used is provided in [99] .

All mandatory features of PlayReady SHALL be supported.

HTTP and HTTPS SHALL be supported for license acquisition requests.

For PlayReady signaling in MPEG-DASH assets, the format and values to be used (including SystemID) are provided in [99] .

I.3 PlayReady License Acquisition URL Override

Devices SHALL support setting the license acquisition URL for license post-delivery using PlayReadyInitiator messages sent via the sendDrmMessage function of the oipfDrmAgent.object

I.4 Application environment

Devices SHALL integrate PlayReady DRM System in agreement to HbbTV specification [6],

- Section 9.6.7 in relation to playback failure
- Section 10.2.4 in relation to capabilities reporting
- Annex F in relation to DRM Integration

Devices SHALL support the sendDRMMessage function of the oipfDrmAgent object, and SHALL use “PlayReadyInitiator” messages with the message type “application/vnd.ms-playready.initiator+xml”.

Devices SHALL support the onDRMMessageResult function of the oipfDrmAgent object, and SHALL use “PlayReadyResponse” messages in the message result of the function.

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J Widevine DRM (Informative)

J.1 Introduction

This Annex provides information for the integration of a Google's Widevine DRM client into devices compliant to the Application Environment described in section 9.3.

Some specifications and details are provided by Widevine only to Certified Widevine Implementation Partners (CWIP) or at least under MLA (Master License Agreement).

Widevine DRM is Google's content protecting system. It provides the way to securely distribute and protect playback of premium contents on consumer devices. The Widevine DRM platform today uses standards-based royalty-free solutions for encryption, adaptive streaming, transport, and player software [100].

There are two versions of Widevine DRM: Widevine Modular and Widevine Classic.

Widevine Classic is the former Widevine DRM version. It requires content to be packaged into a proprietary format. The Classic version today is typically supported only by legacy consumer devices (e.g. Android 3.1 – 5.1, Google TV).

Widevine Modular is today the preferred Widevine DRM, with support for open standards [100] such as DASH, HLS, Common Encryption (CENC), Encryption Media Extension (EME) and Media Source Extensions (MSE).

In the following wherever "Widevine DRM" is mentioned it must be read as "Widevine Modular".

J.2 Widevine DRM Architecture

The following diagram shows a Widevine architecture overview [101]. All the client architecture components, such as OEM Crypto Module and Content Decryption Module (CDM) are defined in [102].

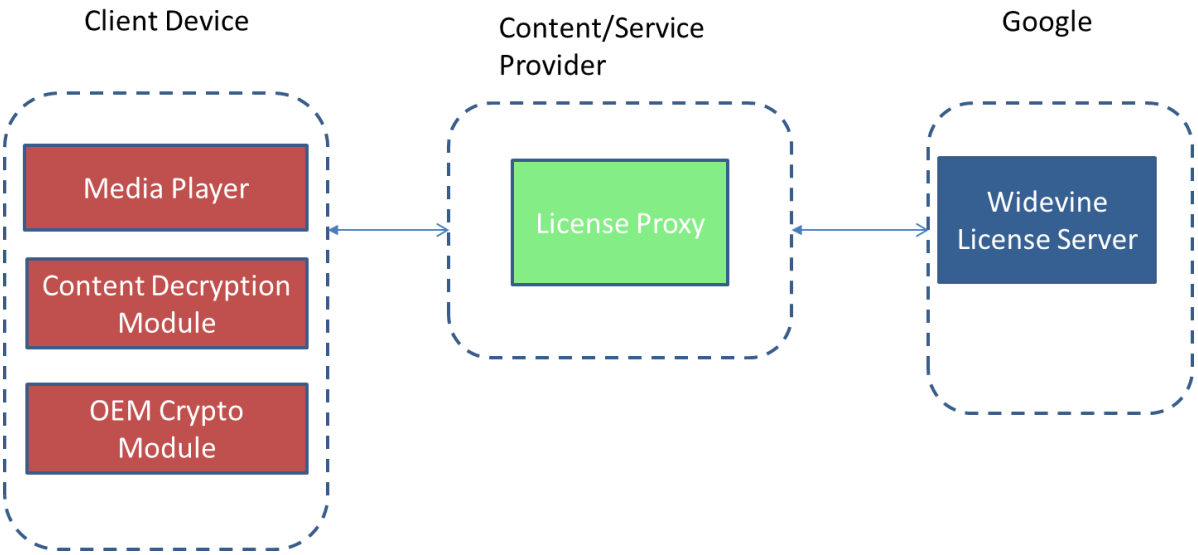

Figure 5: Widevine DRM Architecture

J.3 Client device requirements

Devices compliant to this document SHALL support Widevine DRM version 7 (for CDM and DASH implementations) [100].

The following table summarizes the Widevine Device Security Level and HDCP Version required to protect contents at different resolutions [102]:

Content resolution	Widevine Security Level	HDCP Version
Less than 720p	L3	1.4
720p to 1080p	L1	1.4
4k or UHD	L1	2.2

Table 52: Widevine DRM requirements for the various content resolutions

Devices compliant to this document SHALL include an OEMCrypto component that complies with Level 1 (L1) Widevine Device Security.

J.4 License proxy

All the interactions between client devices and Widevine License Server SHALL be via a license proxy. The license proxy component can be implemented only by a Certified Widevine Implementation Partner (CWIP).

All the interactions between client and proxy and license server SHALL be via HTTPS [103].

The Widevine License Server interface is defined by Widevine [103].

The interface between client devices and license proxy is not defined by Widevine but, being it handled at application level, interoperability between services and client devices can be achieved without specifying it here.

J.5 HbbTV

Usage of Widevine DRM System by HbbTV applications SHALL be supported by client devices through the Widevine APIs mapping to the OIPF DRM Agent APIs specified in [104].

J.6 Adaptive Streaming for Protected Contents

This section describes usage and extensions for receivers which are compliant with Widevine [83] to enable HTTP Adaptive Streaming of protected content, using media formats and containers specified in the main document.

J.6.1 DASH

Delivery of Widevine DRM protected contents with MPEG-DASH SHALL be compliant to [100].

If the schemeIdUri attribute of one of the <ContentProtection> elements in the MPD equals to "urn:uuid:edef8ba9-79d6-4ace-a3c8-27dcd51d21ed", the protected media segments are signaled as Widevine DRM.

J.6.2 CENC

For Widevine DRM protected content, the Common Encryption for ISO Base Media file format SHALL be used as defined in [100]. The coding of the PSSH box defined in [105] SHALL be supported, in particular with reference to the algorithm, key_id, provider, content_id and protection_scheme fields.

K 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.

K.1 Stream Event management

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

- error-free reception and processing also of multiple Stream Events containing any binary payload;
- error-free (re-)initialization of Stream-Event-Listener

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

K.2 Http User Agent

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

```
HbbTV/1.6.1 (<capabilities>; <vendorName>; <modelName>;
<softwareVersion>; ; <familyName>; <reserved>)
```

The <modelName> field SHALL be representative of the consumer-facing model name to allow log messages to be matched up with user reported problems.

K.3 AIT version fields

As described in HbbTV specification ([6] clause 7.2.3.1) and in the official HbbTV test suite, terminals SHALL NOT 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 SHALL have $\texttt{version.minor} \geq 4$.

K.4 Application Priority through AIT

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

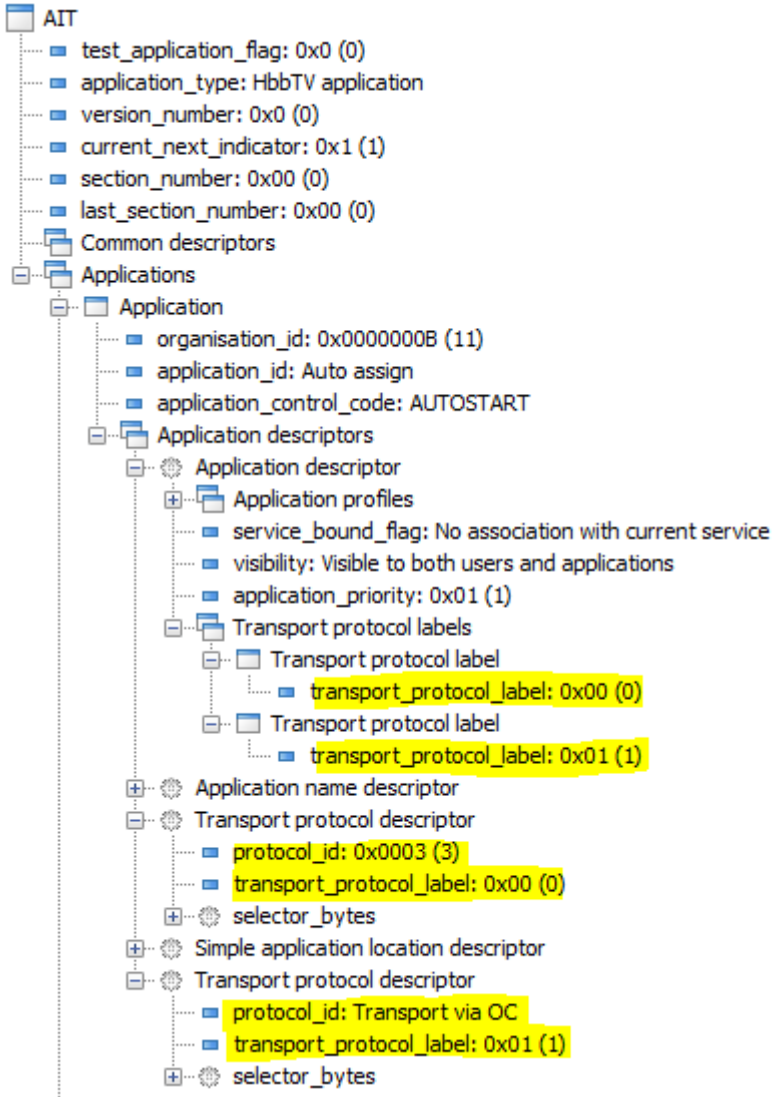

Figure 6: Sample usage of AIT application_priority

K.5 Cookies and WebStorage

In agreement to HbbTV specification ([6] clause 12.1.4) and as described in HbbTV specification ([6] clause 10.2 – table 11) a terminal compliant with this specification SHALL store in persistent memory both “Cookies with an expiry date” and “data stored through the Web Storage API”.

K.6 DASH Event Signaling

As described in HbbTV specification ([6] clause 9.3.2) a terminal compliant with this specification SHALL provide support for both “MPD Events” and “Inband Events”.

Terminal compliant with this specification SHALL manage in the correct way the notation for which an example is provided here below (please refer to [6]):

```
<EventStream timescale="10000000" schemeIdUri="urn:scte:scte35:2014:xml+bin">
<Event>
<scte35:Signal>
<scte35:Binary>/DA9AAAAAAAAAP/wBQb+F7Y9qwAnAiVDVUVJAAAKdX//AAEqjbAMEU1EU05CMDAx
MTMyMjE2Ml9ONAAA7Y8JWg==</scte35:Binary>
</scte35:Signal>
</Event>
```

```
</EventStream>
```

K.7 HTML5 <video> element

As described in HbbTV specification [6] a terminal compliant with this specification SHALL provide support for <video> element. In particular:

- Correctly performing (i.e. error-free execution of) switch from broadband to broadcast by means of `bindToCurrentChannel` method
- Completely flushing media buffer before starting video presentation when switching from broadband to broadcast
- Correctly firing `canplay` events
- Correctly firing `canplaythrough` events

Terminal compliant with this specification SHALL implement “type” attribute, as described here below:

```
<video>
  <source type=”video/mp4” …>
</video>
```

Terminal compliant with this specification SHOULD maintain compatibility with legacy in relation to “type” attribute. Here below an example:

```
<video type=”video/mp4” src=”……/file.mp4”>
```

K.8 Companion Device

As described in HbbTV specification ([6] clause 14) a terminal compliant with this specification SHALL provide support for Companion Device management in relation to following features:

- To allow an HbbTV® application and a Companion Screen application to communicate directly by establishing a communication channel onto which text or binary messages can be exchanged.
  Precondition is to have both on TV terminal and Companion Device an application up and running able to implement companion device use cases.
- To enable a companion screen to locate the services and User Agent String, provided by the HbbTV® terminal.
- To enable a companion screen to launch an HbbTV® application from a Companion Screen application.

In particular, [6] clauses 14.5, 14.7, 14.6 and 14.8 SHALL be supported.

K.9 Query string

As described in HbbTV specification ([6] clause 9.2) a terminal compliant with this specification SHALL be able to start application with input parameters by means of “query string”. Here below an example

```
dvb://current.ait/360.8000?param1=1&param2=2
```

K.10 Privileged-Operator-Application and Regular Application coexistence

Terminal compliant with this specification, providing Privileged-Operator-Application as specified in [106], or others, SHALL guarantee Privileged-Operator-Application presence does NOT interfere in any way with a running Regular Application – visible or not –, if not requested by this one.

With reference to :

- A Privileged-Operator-Application is allowed to pass in foreground state only in agreement to [106] clause 6.5.3
- Terminal SHALL be compliant to [106] clause 6.5.
    - In particular, “application overlay descriptor” SHALL be supported
- Terminal SHALL be compliant to [106] clause 14.

As example of complete and correct Privileged-Operator-Application/Regular-Application coexistence, when running in background, a Privileged-Operator-Application SHALL NOT consume any event addressed to the running Regular-Application, e.g.:

- DSMCC stream event
- DASH trigger (“MPD Events” and “Inband Events”)
- Channel change notification
- Keys grabbed by the Regular-Application
- Play State Change notification
- AIT management

K.11 HbbTV SAS resource (Specific Application Support)

Terminals SHALL support the mapping of the `oipfDrmAgent` to the CI plus protocol (SAS resource) as specified in HbbTV specification [6] clause 11.4.1.

With regard to [111] clauses 4.2.3.4.1.1.5, 4.2.3.4.1.1.6, 4.2.3.4.1.1.8 and 4.2.3.4.1.1.9 are not required.

K.12 Mapping from broadcast requirements to DASH requirements

As described in HbbTV specification ([6] clause 7.3.1.1), “For each of the technologies listed in Table 9(a), terminals supporting the broadcast IRD from ETSI TS 101 154 [9] shall also support the related DASH requirement”.

Because of the present document (clause 6.1.3 – Table 4) requires:

1. HEVC HDR UHDTV IRD using HLG10
2. HEVC HDR UHDTV IRD using PQ10
3. AC-4 up to Level 3 ([9] – clause 6.7.2)

Terminals compliant with this specification shall provide DVB DASH [64] support, in particular for (per [6] clause 7.3.1.1 – table 9a):

- hevc_uhd_hlg10 player conformance point as defined in clause L.2 of ETSI TS 101 154 [9]
- hevc_uhd_pq10 player conformance point as defined in clause L.2 of ETSI TS 101 154 [9]
- AC-4 part 2 as defined in clause 6.3.2 of ETSI TS 103 285 [64]

L Event-based dynamic switching of content format in DTT UHD services (Informative)

L.1 Background

Transmission bandwidth and consequently bitrates are becoming more and more scarce resources especially on terrestrial distribution.

Broadcast contents are produced in a variety of formats, depending on several factors including best practice, available budget and equipment, desired artistic look, type of motion. The UHD specification as defined by ETSI TS 101154 allows for a family of formats made of a combination of several parameters including resolution, frame rate, colour space, dynamic range and audio capabilities that can be decoded by a single standard UHD receiver.

Therefore, broadcasters are investigating the possibility of transmitting contents on a given service in their native format without applying up/down conversion prior to transmission to keep the delivered format constant, as it is common practice today in the current SD and HD services.

The main reason is the maximum exploitation of the used transmission bandwidth while maintaining the ability to deliver the highest available quality to the user when needed. It is likely that the Mux capacity (bit budget) assigned to each broadcaster will be barely sufficient to deliver most of the existing services in HD resolution and therefore the use of higher UHD resolutions will be limited. The ability to dynamically switch the video and audio formats on event base would allow to increase the quality on prime contents viewed by the larger audience at the expense of temporarily reducing the quality of other services on the same mux.

However, it can be anticipated that such a transition in the delivery mode cannot happen in the short term because it requires a number of updates to the current head end infrastructures, including the ability in the encoders to switch seamlessly between different configurations and a new mode of operation for the stat mux. The required flexibility in production networks and video servers that must be able to work with mixed formats will be available with the transition to IP based production. It can be expected that such changes can be implemented in a time span of about 3 to 4 years.

L.2 Use cases

International sports events are more and more produced and distributed in UHD format at 3840x2160 pixel resolution, either in BT.709 colour space or BT.2100 HLG high dynamic range. As these events are generally viewed by a large audience, broadcasters are interested in delivering the highest quality to the public on the main channels, instead of distributing them on a side channel, maybe on satellite or digital with a reduced audience coverage.

Movies and fiction are traditionally shot at 24 or 25 frames per second in progressive format. This format is chosen for artistic reasons and is commonly referred to as the “cinema look”. Today they must be converted in 50Hz interlaced format for broadcast distribution but this operation may cause some alteration in the motion portrayal and cause an increase of the needed bit rate to keep a target quality after encoding. HEVC services will use natively progressive scan but it would be preferred to broadcast these contents at the original frame rate rather than converting them to 50Hz.

Archive contents are often available only in standard definition. There is little point in up-converting them to HD prior to transmission. It would be better to maintain the original format and save some capacity for more demanding contents on the same mux.
Switching between SDR and HDR dynamic range will be in any case unavoidable for some years as the HDR format is just starting to be adopted and it will take time to replace SDR, if ever. Furthermore, for artistic or practical reasons some contents (e.g. news) may still be preferably produced in SDR.

L.3 Preliminary Event-based dynamic switching requirements

For compatibility reasons with existing receivers, it can be anticipated that business cases for the dynamic switching of content formats can be found inside the UHD format family. That is, this option will not be applied to services that are targeted to the wider audience of T2 HEVC HD BT.709 receivers. Instead services that require a UHD receiver, because they adopt the HLG o PQ transfer characteristic even if the picture resolution is 1920x1080, are good candidates for dynamic switching.

Of course, the increase in quality (and thus of bit rate) on one channel of the mux implies a corresponding bit rate reduction on the other channels of the mux. Therefore, broadcasters must decide the appropriate balance on an event by even basis, e.g., in some cases intermediate resolutions like 2560x1440 or 3200x1800 could provide a sufficient boost in quality to the main service without imposing a too severe bit rate penalty to the others of the same mux.

The format switch will be event-based and can happen only at programme boundary. It will be synchronous between audio and video.

The parameters that can be varied include

- Picture resolution (see table 21a in ETSI TS 101154 v 2.6.1)
- Frame rate (between 25 and 50 Hz progressive scan)
- Colour encoding (between BT.709 and BT.2020)
- Dynamic range (either between HLG and SDR or PQ10 and SDR)
- Audio format

The impact on the signalling in the PSI should be carefully evaluated in consideration with the established practice in commercial receivers.

The receiver should ideally apply the switching seamlessly, without any noticeable artefact on screen or in the audio, however, it can be accepted, especially for existing receivers, that some minor artefacts can occur as instability in the picture or lack of sound. These disturbances should in any case be kept to a minimum. A target performance level is provided in EBU Tech 3372.

3 different types of behaviour can be considered:

1) Seamless
2) Clean mute
3) Visual/audible transients/artefacts

3) should not occur if the encoding is done properly (i.e. as defined in TS 101 154) and the changes occur at a RAP occurring at a programme boundary. May nevertheless occur with legacy receivers that don’t expect format switching.

2) should be expected in most cases. The duration of the mute will depend on the parameters of the A/V coding that change. E.g. SDR-to-HDR could result in only a couple of blank video frames, whereas a switch from 8-bit BT.709 to 10-bit BT.2020 may take longer.

1) may be possible for some changes, but will depend on receiver architecture and will not always be possible

A receiver that implements only partially the UHD specification should ideally continue to work “normally” even in the presence of unsupported format, that is, it should go black and inform the user of the unsupported format but should not crash or require a system reset. However, this assumption needs to be confirmed with appropriate field tests.

L.4 Assessment of current receiver implementations

It is advisable to provide some test bitstreams to assess the behaviour of some of the commercially available TV receivers in order to gather a preliminary idea of the problems that this feature could cause to legacy UHD receivers.

L.5 Future work

The study should aim to define which metadata, descriptors, best practices, conditions or workarounds shall be applied to a transmitted transport stream, to perform a correct "event-based switching" at the IRD side maintain a valid DVB syntax. Then the candidate solutions should be tested and verified by laboratory test on compliant and interoperable receivers with the items described above.

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