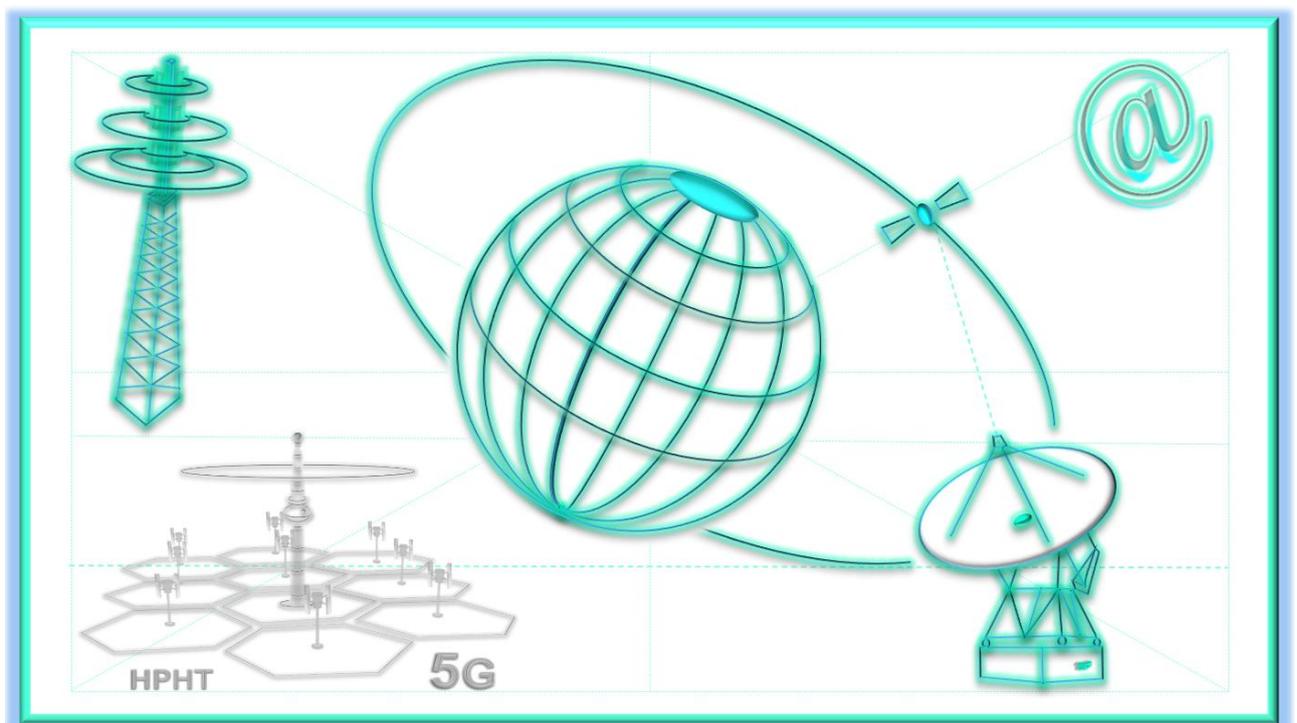


UHD Book

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



Final 2.2

UHD Book Collection

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Foreword (DVB-I related)

In continuity with UHD Book 2.1, published in December 2023, this new volume v2.2, does maintain **MANDATORY** support of the new DVB-I standard, which is a candidate to play an important role in linear TV distribution over IP.

DVB-I is a significant step forward for the European and Italian television scenario, while being aware that its implementation on mass-market receivers is by far to be initiated. Nevertheless, some DVB-I receivers' implementations made available by selected manufacturers, have permitted in the last 4 years the rollout of some DVB-I Test Pilots across Europe. Their results have been disseminated and showcased in various international events like IBC, DVB World, HbbTV Symposium and HDFI Annual Conference.

Therefore, it is confirmed the need to achieve the widest possible involvement and consensus of the entire value chain, with a process of planning and coordination between radio and television operators, transmission networks, receivers' manufacturers, regulatory authorities as well as certification bodies, in order to develop the most stable conditions to launch a real 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.
[completed] in November 2020 DVB-I became ETSI Standard TS 103 770 "Service Discovery and Programme Metadata for DVB-I Services". Since then, the specification has been progressively refined and it's now at Revision 7 (A177r7), the one which UHD Book 2.2 is aligned to.
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.
[completed] outcomes from PoCs initiated in early 2020 have led to significant updates to DVB-I and related specification, with the creation of the Interoperability Point- IP2 in Revision 5, as endorsed by UHD Book 2.1. This allowed, in Q3 2023, the establishment in Italy of an on-field DVB-I Market Trial, participated on voluntary basis by broadcasters, manufacturers, telcos, and other stakeholders in the TV supply chain. The evolution of the standard requires PoCs to continue running in different Countries.
3. On completion of successful trials as per 2. above, the results of the trials will be used to develop the conditions for a new reference Italian "bollino" for the certification of receivers compliant with the requirements included in the current UHD Book 2.2 release.
[completed] DVB-I Market Trial, running since 2023, has demonstrated that DVB-I can successfully coexist and interoperate with the well-established Italian DTT ecosystem. The UHD Book sets the conditions for a future Italian "bollino"
4. The conditions for the launch of a new "bollino" requiring DVB-I specs and testing, will be published after ruling definition by AGCOM on the matter. The market implementation will follow the standard "sunrise period" of 18 months.
[pending]

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.

HDFI hopes 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.

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.

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/m² and black level of 0.05 cd/m² or 540 cd/m² and black level of 0.0005 cd/m²



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 very demanding in terms of computational resources on the receiver side and bandwidth.

For this reason, whilst usage of HFR in broadcasting is quite unlikely, it might instead succeed in the OTT context, including within HbbTV apps.

1.2.2. Content protection solutions

1.2.2.1. CI Plus Overt Watermarking

In the content protection world, the CAM (Conditional Access Module), thanks to its versatility, is a well-known and well-deployed standard and easy-to-use concept. It still plays a significant and active role in the panorama of the devices aimed at the decryption of the important and live-more-than- ever broadcasted contents.

CI Plus LLP, following its intent of improving the content protection on the CAM, has taken into serious consideration this topic and created a dedicated specification that allows operators to track the leak source: the CI Plus Overt Watermarking (AKA Fingerprinting) [37][75].

The “watermarking” technology offers the opportunity to “mark” the content to be shown on the screen. This technology is versatile, since it can be “tailor made” upon Operator’s specification (type and color of the fonts used, position on the screen, persistence time on the screen etc.). Then, once the source is detected, the operators may have different ways to disturb (or stop) the re-distribution of illegal contents.

The adoption of this technology is very important and more and more operators are looking to it to decrease the number of illegal re-distributions.

The CI Plus Overt Watermarking specs are already available today and they are already implemented on CAM side. On the TV manufacturer side it is an optional feature to pass CI Plus certification.

1.2.3. Catching-up with HbbTV

1.2.3.1. Targeted Advertising

Addressable TV advertising, based on HbbTV technology, is now a reality, aiming to differentiate and innovate in the advertising market, together with enhanced adverts, L-shaped banners overlaid using HbbTV which are already a commercial reality in Germany and Italy. 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 [83][84][85][86].

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 supported by HbbTV Core technology in today’s receivers, through both server and client-side technologies.

DVB has published the DVB Document A178-3 which provides specification for dynamic substitution/insertion of content in linear OTT services. That can be achieved both through Client Side and Server-Side support.

1.2.4. Improvements in Video Coding Technologies

The set of video coding technologies currently specified in the UHD Book includes 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 The latest revision 2.8.1 of the ETSI Specification TS 101 154, published in July 2023, includes two new video codecs, which passed the DVB evaluation process: VVC/H.266 “Versatile Video Coding” (VVC), jointly developed by ITU-T and MPEG, and AVS3 developed by the Audio and Video Coding Standard Workgroup of China.

All new 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.

VVC/H.266 is the most recent video codec standardized by the Joint Video Experts Group, a joint group of ITU-T SG16 VCEG and ISO/IEC JTC1 SC29 MPEG. It is available from ISO as MPEG-I Part 3 or ISO/IEC 23090-3 or Versatile Video Coding (VVC) and also from ITU-T as

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 Audio and Video Coding Standard Workgroup of China has developed several generations of AVS. The latest version AVS3 (TA/I 109.2-2021) provides up to 40% improvement over HEVC. Patent pool for this version was kicked off in August 2020 and the terms are not yet published. AVS3 is mainly targeted for the Chinese market.

In 2018, the Alliance for Open Media (AOM) published the first version of their video codec named "AV1". Aiming at achieving 30% of bitrate reduction over VP9. AV1 has already been deployed in a number of production TV devices since 2020. A patent pool has been formed to manage the related essential patents. After running the usual evaluation process, DVB has decided that AV1 wasn't worth of being added to DVB codec toolbox [9].

LCEVC, developed by MPEG as MPEG 5 Part 2 Low Complexity Enhanced Video Codec, ISO/IEC 23094-2, is not a codec itself but provides an enhancement layer that applied to a base layer bitstream generated by other codecs (including those specified in UHD Book, as AVC and HEVC) allows the upgrading of existing services to higher resolution formats while maintaining unaltered the user experience for the legacy decoders. 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.

1.2.5. Ongoing DVB activities

1.2.5.1. 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, which resulted in the DVB-NIP specification [79], aimed 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 DVB-NIP system architecture, designed to be applicable to DVB-S2X, DVB-S2 and DVB-T2 based broadcast networks, leverages service discovery and programme metadata according to DVB-I, ABR packaging and delivery technologies according to DVB-DASH and multicast file transfer mechanisms according to DVB-MABR for the distribution of audio-visual content.

The foreseen use cases include both B2B scenarios (for example, targeting professional receivers/caches installed at the edge of telecom network providers 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) and B2C scenarios, expected later, with DVB-NIP broadcast signals either directly addressing next generation TV sets implementing Native IP reception capabilities as a part of their built-in broadcast stack, or relying on a Native IP Gateway function being available at home, residing in a separate device (such as a STB) possibly shared among multiple clients, such as TV sets and IP personal devices (e.g. smartphones, tablets).

1.2.5.2. DVB-I Implementers Task Force

Following the increasing diffusion of DVB-I among different Countries, DVB has recognized the need to create a new Group aiming to bring together DVB-I stakeholders to share real-world implementation experiences, identify specification gaps, and work toward harmonized deployment strategies across markets.

Activities under the umbrella of this Group are:

1. Experience Exchange

Share implementation challenges and best practices for DVB-I. Create a platform where broadcasters, manufacturers, app developers, and service providers can share their deployment experiences, challenges, and solutions, highlighting key technical and deployment challenges, inconsistencies, and proposed solutions. This activity could identify inconsistencies or missing elements in the DVB-I specification that hinder cross-market deployments, providing structured, real-world insights to DVB groups to support specification evolution and updates.

2. Best Practices Guidelines.

Outcome from the “Experience Exchange” activity, will create Recommendations for consistent and effective DVB-I implementation across diverse markets – a document compiling strategies, tools, and learnings from various trials and implementations.

3. Harmonized Feature Profile

The Group will Facilitate cooperation and understanding between countries, technology vendors, device manufacturers, broadcasters and SDOs. Facilitate understanding of local deviations and align them with common standards, exploring and proposing the creation harmonized of DVB-I profile to minimize fragmentation and promote unified device features.

1.2.5.3. DVB-I Accessibility Task Force

DVB-I represents the intersection of linear broadcast television and internet media streaming, offering the possibility for linear television services to be delivered to internet connected devices.

A new Group has been created aiming to define the mechanisms to be used when signaling accessibility services in DVB-I. In 2025, the Group published the “Accessibility Implementation Guidelines” [69], which provides supportive information and recommendations pertaining to the operational deployment and use of accessibility features introduced in DVB-I specification [15]. The Guidelines currently provide indication about management of personalization, multi audio tracks, subtitles and signing features.

Accessibility can be richer when implemented by means of an HbbTV application, as defined by "Accessibility Framework" in HbbTV specification [6], chapter 15. The application provides access to specific media components including accessibility features or implement them within

their GUI, such as screen readers, the option to use a larger font size for subtitling and other text shown within the application.

Such a document will also include accessibility implementation guidelines for other DVB specifications in future revisions.

1.2.5.4. DVB-I Security Task Force

Work has started in a new Task Force to provide specification updates and/or recommendations ensuring that DVB-I services and associated metadata (e.g., MPEG DASH manifests, Service Lists, Content Guide, etc.) can be delivered robustly over public IP networks, preventing possible security issues and enabling authentication.

1.2.6. 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 enhancements to multicast and broadcast modes starting from Release 14, and then Release 16, in compliance with the broadcaster requirements for media distribution to mobile devices. Further additions are provided in Release 17 and 18, to enable the operation of LTE-based 5G Terrestrial Broadcast in UHF broadcast spectrum, with system definition for bandwidths of 6, 7 and 8MHz. Finally, in Release 19 two subsets of the UHF band are defined: Band 112 (470–608 MHz) and Band 113 (606–698 MHz). In addition, Time and Frequency Interleaving is introduced to improve mobile reception robustness under time-varying propagation conditions and frequency-selective channels (e.g., in SFN deployments), as well as the CAS Muting approach, intended to enable time-division multiplexing (TDM) between different broadcast technologies. This mechanism provides a pathway for the low-barrier market introduction of 5G Broadcast, even in countries where little or no free spectrum is available in the UHF band.

1.2.6.1. 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 in 5G-MAG is concentrated at supporting the standard development with feedback from software implementation of the delivery chain functionality and maintenance of the ETSI 5G-Broadcast specification, and 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.

1.2.6.2. DVB

In 2021, the DVB Project has approved Commercial Requirements for DVB-I service support over 5G networks and systems, 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.

Subsequently, a Joint Task Force of DVB and 5G-MAG was established to map the identified commercial use cases and requirements into deployment guidelines, including a reference deployment architecture. In 2023, the work resulted in the publication of document [81], detailing a set of service scenarios including standalone DVB-I Service using 5G Broadcast, DVB-I service using 5G Media Streaming, DVB-I service offering simultaneously over broadcast and unicast. Ongoing work aims at further updating document [81], aligning it with the latest DVB-I specification.

1.2.7. Enhancing monitoring of streaming services

Common Media Client Data (CMCD), is a technical specification published by Consumer Technology Association (CTA) [80], aiming at reducing the existing gap of data visibility between media player clients and Content Delivery Networks (CDN).

The delivery chain required by any commercial video streaming service typically requires multiple components, usually under responsibilities of different actors. This complexity turns into difficulties in ensuring high levels of reliability and fast reactions in case of misbehaviours, in particular for live services. Content providers can collect a significant amount of data about their client applications playback performances but struggle to link them to network-side events and CDNs analytics. On the other hand, CDNs providers and network operators has limited visibility on the actual consumption experience on client side, often limiting the opportunities to fine-tune parameters and configurations.

CMCD defines a data model and a mechanism for clients to provide useful information to CDNs providers about playback experience. Information can be used to identify issues, support troubleshooting activities, improve delivery performances and plan proactive enhancements. CMCD allows the use of a set of data and exchange mechanisms that would work with different service providers and CDN providers.

An increasing number of ABR streaming player implementations are including support for CMCD and several service providers are exploiting this feature in their streaming applications. CDNs providers are including CMCD capabilities in their platforms, complementing analytics data offered to their customers with insights based on CMCD inputs. CMCD support in DASH is currently being pursued by MPEG.

Adding CMCD capabilities to media streaming players for connected receivers will help improving the overall QoE offered to viewers, a key element to enable the transition to IP-based TV services.

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 have faced a drastic 30% reduction of the UHF frequency spectrum available for digital terrestrial transmission due to the refarming of the 700 MHz Band in favour of 5th generation mobile services.

In Italy, to cope with the spectrum reduction for TV broadcasting, a complete transition of DTT transmissions to DVB-T2 has been planned by the Government after 700MHz Band was released to mobile operators on July 1st 2022. The first step was to migrate one of Rai

multiplexes to DVB-T2 on August 28th 2024. Transition of the rest of the system is still ongoing, with no firm deadline set yet.

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

In Italy, services on DTT currently operate with DVB-T/AVC (SD and HD) and DVB-T2/AVC/HEVC (SD and HD). In the next few years a growing penetration of DVB-T2/HEVC/UHD-HDR services is expected, with resolutions ranging from 1080p up to 2160p, thanks also to a law mandating the presence of DVB-T2 and HEVC in all the receivers sold after 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 700 MHz Band release completed in June 2022, the Italian Digital Terrestrial platform is going to migrate 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 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 combinations¹ 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 quality²:

- 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

1.3.2.2. 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.

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

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 H. 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. 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.

February 2026

2. Document History

Document	Revision	Changes	Date
UHD-Book 1.0	0	<ul style="list-style-type: none"> - 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 	12/2017
	1	<ul style="list-style-type: none"> - Section 8.2 revised and extended - New section 9.3.3 on certified terminal identification - Informative Annexes G, H, I, 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 	12/2018
UHD Book 2.0	0	<ul style="list-style-type: none"> - 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 	10/2020

Document	Revision	Changes	Date
		<ul style="list-style-type: none"> - 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 	
	Errata #1	<ul style="list-style-type: none"> - Headers (delays) in Table 39 fixed (were wrongly equal to those in Table 37) - Duplicated or unnecessary references [46], [62] and [69] made Void - References for SI Guidelines and HD Subtitling fixed 	07/2021
	1	<ul style="list-style-type: none"> - Document aligned to latest DVB-I and HbbTV revisions - Clarified parental control receiver's behaviour in absence of any rating or in case rating is missing for the installation country - DVB M-ABR mentioned as a standard solution for efficient streaming distribution of linear events transparently supported at no cost by UHD Book compliant receivers - CMCD and Overt Watermarking introduced in the Technology Outlook - Technology Outlook revised - Informative DRM Annexes revised to avoid usage of "SHALL" - Foreword (DVB-I related) updated 	12/2023
	2	<ul style="list-style-type: none"> - Document aligned to latest DVB-I and HbbTV revisions - AGCOM resolutions 294/23/CONS, 259/24/CONS and 250/25/CONS introduced - DRM Annexes dropped. PlayReady and Widevine support aligned with HbbTV. Marlin and Nagra discontinued due to lack of market demand - Chapter 7 restructured to avoid repetitions - MPEG-2 video decoding no more required after it was switched-off in Italy since 20/12/2022 - AFD support no more required in a whole 16:9 world - DVB-T Hierarchical Modulation support dropped - Compliance notation now refers to ETSI Drafting Rules - Sunrise period and Accessibility isolated in new ad-hoc clauses - Table 46 (National TS_ID in use) updated 	

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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.

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.

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
ABR	Adaptive Bit Rate
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
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
FQDN	Fully Qualified Domain Name
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
IPR	Intellectual Property Rights
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
M-ABR	Multicast ABR
MFN	Multi Frequency Network
MHP	Multimedia Home Platform
MIME	Multipurpose Internet Mail Extensions
MPD	Media Presentation Description
MPEG	Moving Picture Experts Group
MSE	Media Source Extensions
NGA	Next Generation Audio
NID	Network ID
NIT	Network Information Table
NTP	Network Time Protocol
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
SIG	Servizi di Interesse Generale
SIM	Security Identity Module
SLR	Service List Registry
SOGI	Services of General Interest
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: Ateme, Dolby Laboratories Inc., EI Towers, Elettronica Industriale, Engineering – Ingegneria Informatica, Eutelsat, Fastweb, Fincons Group, Fondazione Ugo Bordoni, Fraunhofer IIS, Gruppo Industriale Vesit, Kineton, LG Electronics, Lutech, MainStreaming, Mediaset, Nagra, Panasonic, Persidera, RAI, Samsung, Sisvel Technology, Sky, Sony Europe, TIM, Tivù and TP Vision.

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 tivù, 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 UHD Book 2.0 has been that the prototypal Linear IP Service specification present since HD-Book 3.0 has been replaced by the new DVB-I standard.

UHD Book 2.1 was simply meant to align with latest DVB-I and HbbTV revisions.

The 3 key drivers of the present UHD Book 2.2 are:

1. alignment with latest DVB-I and HbbTV revisions
2. endorsement of AGCOM resolutions on accessibility of DTT services and prominence of Services of General Interest
3. removal of obsolete features (Hierarchical Modulation, MPEG-2 video coding, Active Format Display)

5.3. Sunrise period

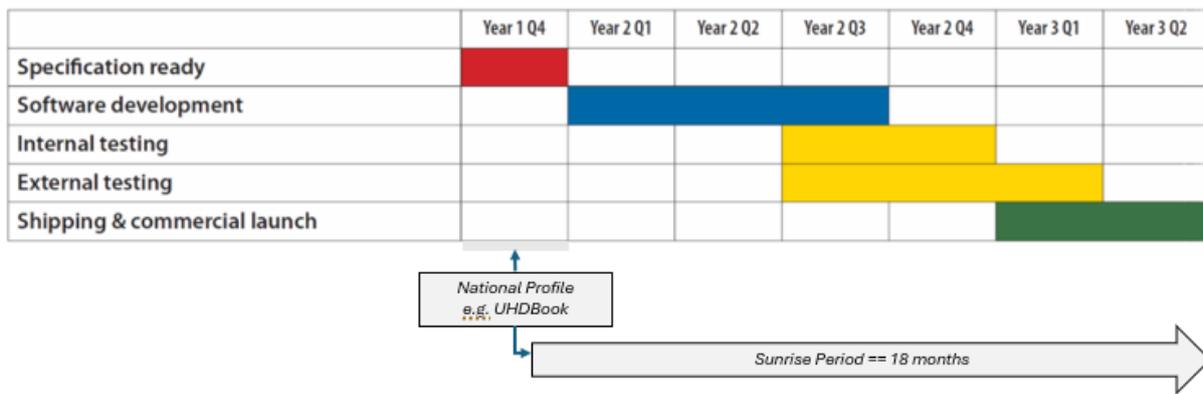
The complexity for delivery of a new product underlines unusual complexity [88].

To meet manufacturer’s needs, aiming to have a profile really applicable:

1. UHD Book works starts as soon as possible in the publication year – “Year 1”, manufacturers are best welcome to join in the works
2. UHD Book is published within Year 1 Q4

3. UHD Book is based on the sunrise period concept, which gives manufacturers 18 months, starting from the UHD Book publication date, to implement new mandatory features.
4. Manufacturers can go to market earlier with respect to sunrise period expiration.

Product lifecycle and UHD Book sunrise period lead to a complete match, as highlighted by the following diagram



Above timing refers to requirements calling for software-only changes. In case of hardware changes further 12 months would be added to the schedule.

Requirements introduced by law/regulation usually have their own sunrise period to be met.

5.4. Accessibility

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 subtitles services.



Some optional features are also described that allow compatibility with the innovative services being introduced on the digital TV networks. See also clause 1.2.5.3.

5.5. 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

5.6. Compliance notation

In the present document "**SHALL**", "**SHALL NOT**", "**SHOULD**", "**SHOULD NOT**", "**MAY**", "**NEED NOT**", "**WILL**", "**WILL NOT**", "**CAN**" and "**CANNOT**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

"**MUST**" and "**MUST NOT**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

5.7. 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, MPEG, HbbTV, ISO, CEI, CEN, W3C). Furthermore, it follows the Italian legislation in force concerning DTT and reception equipment for Digital Terrestrial Television [2].

5.8. 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. Broadcast (DTT/SAT) 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] N.B AGCOM plans to allocate all VHF channels to DAB but the process is not finalized yet.
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]
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]
Minimum signal level	The demodulator operates on Gaussian channel at QEF performance (i.e. BER less than 2×10^{-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.

Feature	Specification	Comment
Maximum Signal Level	Greater than -28 dBm (80 dB μ V 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 dB μ V 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 specification, chapter 3.4.10.7.2 "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 μ s. 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
Demultiplexing	MPEG-2 System Transport Stream	Ref.: [9]

DVB-T2		
Channel Bandwidth	<ul style="list-style-type: none"> - 1.7 MHz (OPTIONAL) - 7 MHz (European VHF channel allocation) in Band III - 8 MHz in Band IV-V (UHF) 	<p>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] [2].</p> <p>N.B AGCOM plans to allocate all VHF channels to DAB but the process is not finalized yet.</p>
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	<p>Ref.: [47] [2]</p> <ul style="list-style-type: none"> - 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	<p>Ref.: [47] [2]</p> <p>The receiver is required to demodulate and present all and only the services that it is able to handle among those possibly available.</p> <p>Input Mode A (single PLP) or Input Mode B (Multiple PLPs – Common PLP, Type 1 and 2 up to the maximum allowed figure 255)</p>
Time interleaving	$2^{19}+2^{15}$ OFDM cells for a data PLP and its common PLP together	Ref.: [47] [2]

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: <ul style="list-style-type: none"> ▪ 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: <ul style="list-style-type: none"> • 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 <u>content</u> 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	

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

Table 1: Terrestrial front-end features

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][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	1/2 (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]
Pilot aided demodulation	Yes	[55]

Feature	Specification	Comment
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

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

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	<p>The following standards SHALL be supported:</p> <ul style="list-style-type: none"> - 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 <p>The following standards SHOULD be supported:</p> <ul style="list-style-type: none"> - AC-4 up to Level 3 ([9] – clause 6.7.2) <p>Receivers SHALL support audio description in the following formats as per [10]:</p> <ul style="list-style-type: none"> - MPEG-1 L2 broadcaster mix - MPEG-1 L2 receiver mix - HE-AACv1 and Enhanced AC3 receiver mix <p>Receivers SHOULD support audio description in the following format as per [10]:</p> <ul style="list-style-type: none"> - AC-4 receiver mix <p>Receivers MAY support other modes of audio description.</p> <p>Receiver MAY support "clean-audio" in broadcaster-mix format.</p>	<p>Ref.: [9] Full decoding of stereo transmissions is MANDATORY for any of the standards listed aside.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>Presentation of the transcoded or native AC-3 signal on SPDIF output (if present) is MANDATORY.</p>
Audio Multi-Language	Language shall be selectable.	Behaviour as specified in §7.6.2
Video Decoder (SD mode)	<p>H.264/AVC High Profile @ Level 3 (576i25) SHALL be supported.</p> <p>Colour space: according to BT.601 Video Format: 720x576i25 Chroma subsampling: 4:2:0 Video Aspect Ratio: 4:3; 16:9.</p>	<p>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.</p>

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)	<p>H.264/AVC High Profile @ up to Level 4 support is MANDATORY for the following conformance points:</p> <ul style="list-style-type: none"> - 1080i25 - 1080p25.⁷ - 720p50 - 720p25 - 576p50.⁸ <p>HEVC Main 10 Profile @ up to Level 4.1 support is MANDATORY.⁹ for the following conformance points (16:9 aspect ratio):</p> <ul style="list-style-type: none"> - 1080p50 - 720p50 - 540p50.¹⁰. <p>Colour space: according to BT.709 Chroma subsampling: 4:2:0 Video aspect ratio: 16/9</p>	Ref.: [8], [9]
UHD receivers		
Audio decoder	<p><i>Further to the audio formats specified above for HD receivers, UHD receivers SHALL also support the following standard:</i></p> <ul style="list-style-type: none"> - AC-4 up to Level 3 ([9] – clause 6.7.2) <p><i>Receivers SHALL support audio description in the following format as per [10]:</i></p> <ul style="list-style-type: none"> - AC-4 receiver mix 	<p>Ref.: [9] <i>Full decoding of stereo transmissions is MANDATORY for any of the standards listed aside.</i></p> <p><i>PCM Stereo downmix of AC-4 transmissions is mandatory. Presentation of the downmixed analog signal on SCART and RCA outputs (if present) is MANDATORY.</i></p> <p><i>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.</i></p> <p><i>Presentation of the transcoded or native AC-3 signal on SPDIF output (if present) is MANDATORY.</i></p>
Audio Multi-Language	Language shall be selectable.	Behaviour as specified in §7.6.2

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	<p>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]:</p> <ol style="list-style-type: none"> 1. "HEVC UHDTV IRDs" with the following parameter limitations: <ul style="list-style-type: none"> o Video formats: 3840x2160, 3200x1800, 2560x1440 o Frame rate: 25 and 50 Hz progressive scan 2. "HEVC HDR UHDTV IRDs using HLG10" with the following parameter limitations: <ul style="list-style-type: none"> o 3840x2160, 3200x1800, 2560x1440, 1920x1080, 1600x900, 1280x720, 960x540 o Frame rate: 25 and 50 Hz progressive scan 3. "HEVC HDR UHDTV IRDs using PQ10" with the following parameter limitations: <ul style="list-style-type: none"> o Frame rate: 25 and 50 Hz progressive scan 	<p>Ref.: [9]</p> <p>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.</p> <p>Conformance point 2) provides backwards compatibility with receivers that can receive signals compliant with conformance point 1).</p> <p>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.</p>

Table 4: Signal decoding features

6.2. Broadband (IP) Front-End

The broadband IP connection firstly introduced years ago in HD receivers as "return channel" for interactive TV, has nowadays become also a full-fledged interface for media delivery.

Both STB and iDTV receivers SHALL have at least one RF (DTT and/or SAT) front-end and one wireline IP front-end.

Two families of IP front-end implementations are in fact considered¹¹:

- wireline IP front-end
- mobile IP front-end.

It is up to the manufacturer to implement, as an option, a mobile IP front-end 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 IP front-end 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.

Linear IP service support, as specified in the following, is MANDATORY (see the [Foreword](#)), in agreement to DVB-I specification and in particular to “Interoperability Point IP2” [15] clause 8.4.

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.

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 envisaged:

- 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 outside the scope of this document.

6.2.1. Wireline IP front-end

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: <ul style="list-style-type: none"> • via DHCP or • manually 	DCHP shall be the factory default. For manual configuration it shall be possible to insert from the resident menu: <ul style="list-style-type: none"> ▪ 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

Feature	Specification	Comment
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.	
Protocols for streaming	<p>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.</p> <p>Unicast streaming using HTTPS [63] SHALL be supported as well.</p> <p>HTTP REDIRECT SHALL be supported.</p> <p>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.</p>	<p>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.</p> <p>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).</p> <p>Receivers SHALL support the ISO/BMFF Live and On Demand Profiles defined in MPEG-DASH, as further profiled by DVB as DVB-DASH [64] and by HbbTV [6]. In particular, linear IP services are implemented using DVB-DASH Live Profile.</p> <p>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]). <i>Furthermore, UHD receivers SHALL support HDR extensions introduced in [64], which is aligned to [9].</i></p> <p>A receiver compliant with this Book SHOULD be able to transparently support via a suitable HbbTV app the DVB M-ABR solution [33], where DASH segments are encapsulated in multicast streams for efficient distribution of linear streams. Informative Annex I provides some recommendations for building an interoperable DVB M-ABR ecosystem.</p>

Feature	Specification	Comment
Media formats	See Table 6	Further to the constraints specified in [9], those specified for Video and Audio formats in clauses 5 and 8 of OIPF Media Formats specification [43] apply. Some restrictions on the media types allowed within some specific container may apply (see below).
Media container	For delivery of media contents over broadband (IP) lines the following standard container formats SHALL be supported: - MPEG-2 Transport Stream (TS) - MPEG-4 File Format (MP4) [42]	Further to the constraints specified in [9], those specified for “TS system layer format” in clause 4.1 of OIPF Media Formats specification [43] apply. In particular, only a single program SHALL be contained in the Transport Stream container. The TS SHALL contain only one Program Map Table (PMT).
Subtitles	For media contents delivered in TS container the DVB Subtitles format SHALL be supported. For media contents delivered in a MPEG-4 File Format (MP4) container the following subtitle format SHALL be supported: - EBU-TT-D [70]	Subtitles delivered via HTTP Progressive Download or via DASH SHALL be encapsulated in ISOBMFF container [61] in accordance to EBU Carriage of EBU-TT-D in ISOBMFF [71]. Delivery of EBU-TT-D subtitles as a separate document in a single file is supported in the context of HbbTV [6].

Table 5: Wireline IP front-end features

The media formats to be supported within each container type are the following ones (see also clause 7.3 in [6] and clause 8.5.2 in [15]):

Media Format		Container	
		TS	MP4/DASH
Video	All formats specified in Table 4 for HD receivers plus H.264/AVC Baseline Profile @ Level 2		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 [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 Table 4, delivered via IP (TS and MP4 container, including the DASH case),

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.

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).

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 IP front-end

Any advanced packet-switched mobile connection (e.g. GPRS over EDGE, HSDPA, LTE, ...) can be used as mobile IP front-end.

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.
SCART Connector (Primary)	Peritelevision standard [4] <ul style="list-style-type: none"> • RGB • CVBS: PAL Out • Audio Output A/V Control Pin 8	<p>For connection to old TV sets. Only applicable to STBs.</p> <p>As an option, the user menu may offer the possibility to output a Y/C signal instead of the RGB signal.</p> <p>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).</p> <p>The stereo output pins will carry one of the following:</p> <ul style="list-style-type: none"> • 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. <p><i>SCART Connector is OPTIONAL on UHD STBs.</i></p>

Connector	Specification	Comment
Output HDMI Connector with HDCP content protection	<p>Type A (Female) [38]</p> <p>Automatic audio/video sync is required.</p> <p>Support of HDMI-CEC is MANDATORY.</p> <p>HDCP [39] must be ON by default.</p> <p>1080p50 is the recommended default output format.</p> <p><i>HDMI output(s) on UHD STBs SHALL support HDMI version 2.0b [65] and HDCP version 2.2 Copy Protection [39] when they output with a resolution higher than 1920X1080 a UHD signal as specified in §6.1.2.1.</i></p> <p>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.</p>	<p>For digital connection of STBs to HD Ready or HD Ready 1080p or UHD displays.</p> <p>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.</p> <p>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.</p> <p><i>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).</i></p> <p><i>UHD capable STBs outputs UHD video signals, when set to do so:</i></p> <ul style="list-style-type: none"> - 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. <i>HDMI input(s) on UHD TV sets SHALL support HDMI version 2.0b [65] and HDCP version 2.2 Copy Protection [39].</i> <i>UHD capable inputs accept UHD video signals:</i> <ul style="list-style-type: none"> - 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 IP front-end 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

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]	<p>“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.</p>
Output RF connector (SAT pass-through)	Female, 75 Ohm [30]	<p>“Loop through” facility.</p>
SCART In Connector (1)	<p>Peritelevision standard [4]</p> <ul style="list-style-type: none"> • RGB In • CVBS: PAL In • Audio In • A/V Control Pin 8 	<p>Applicable only to iDTVs, for connecting legacy SD devices.</p>
SCART Connector (Secondary)	<ul style="list-style-type: none"> • CVBS: PAL Out • Audio: Output • Y-C (super VHS) 	<p>Useful to record Digital Channels on a VCR. Such output must not be affected by OSD (On Screen Display) graphics. Applicable only to STBs.</p> <p>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).</p> <p>The stereo output pins will carry one of the following:</p> <ul style="list-style-type: none"> • 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)	<p>Peritelevision standard [4]</p> <ul style="list-style-type: none"> • RGB • CVBS: PAL Out • Audio Output <p>A/V Control Pin 8</p>	<p>For connection to external legacy SD equipment.</p> <p>As an option, the user menu may offer the possibility to output a Y/C signal instead of the RGB signal.</p> <p>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).</p> <p>The stereo output pins will carry one of the following:</p> <ul style="list-style-type: none"> • 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)	<ul style="list-style-type: none"> 1 Video 2 Audio (left/ right) 	<p>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.</p> <p>The stereo output connector will carry one of the following:</p> <ul style="list-style-type: none"> 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)	<ul style="list-style-type: none"> 3 Video (YPbPr) as per CEA 770.3 2 Audio (left/ right) 	<p>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.</p> <p>The stereo output connector will carry one of the following:</p> <ul style="list-style-type: none"> 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 IP front-end. The slot may be either inside the receiver box itself or in an external device.
Mobile high gain antenna connector	<p>One of three possible standards</p> <ul style="list-style-type: none"> RP TNC female RP MC Card female RP SMA female 	For receivers with mobile IP front-end.
Output SPDIF Connector	As per [27] with Optical connector.	<p>A second SPDIF output with Electrical (RCA) connector is OPTIONAL.</p> <p>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.</p>
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

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.

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7. Service Information & Service 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 one of the DVB-I service lists available 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 services so that a numeric entry will always select the service with the corresponding LCN. However, viewers SHALL also be free to re-order and/or filter the service list as they require, creating their own favourite list(s). Handling of favourite list(s) is manufacturer-dependant.

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>.<slID>[.<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
	<i>Audio preselection descriptor</i>	<i>0x7F¹⁴ 0x19</i>	O
Private data (AC-3)	AC-3 descriptor	0x6A	C m
Private data (EAC-3)	Enhanced AC-3 descriptor	0x7A	C m
<i>Private data (AC-4)</i>	<i>AC-4 descriptor</i>	<i>0x7F¹⁴ 0x15</i>	<i>C m</i>

¹⁴ Indicating use of the extension descriptor in conjunction with the relevant descriptor_tag_extension [10]

Component	Descriptor	Tag	Status
Private data (AAC)	AAC descriptor	0x7C	C m
DVB Subtitles	Subtitling descriptor	0x59	C m
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) ¹⁵	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.

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

¹⁵ Indicating use of the extension descriptor in conjunction with the relevant descriptor_tag_extension [10]

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 use 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 use 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 tivusat 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)
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
<i>HD_simulcast_LCN_descriptor{</i>		
<i>descriptor_tag</i>	8	<i>uimsbf</i>
<i>descriptor_length</i>	8	<i>uimsbf</i>
<i>for (i=0; i<N; i++){</i>		
<i>service_id</i>	16	<i>uimsbf</i>
<i>visible_service_flag</i>	1	<i>bslbf</i>
<i>reserved</i>	5	<i>bslbf</i>
<i>logical_channel_number</i>	10	<i>uimsbf</i>
<i>}</i>		
<i>}</i>		

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.

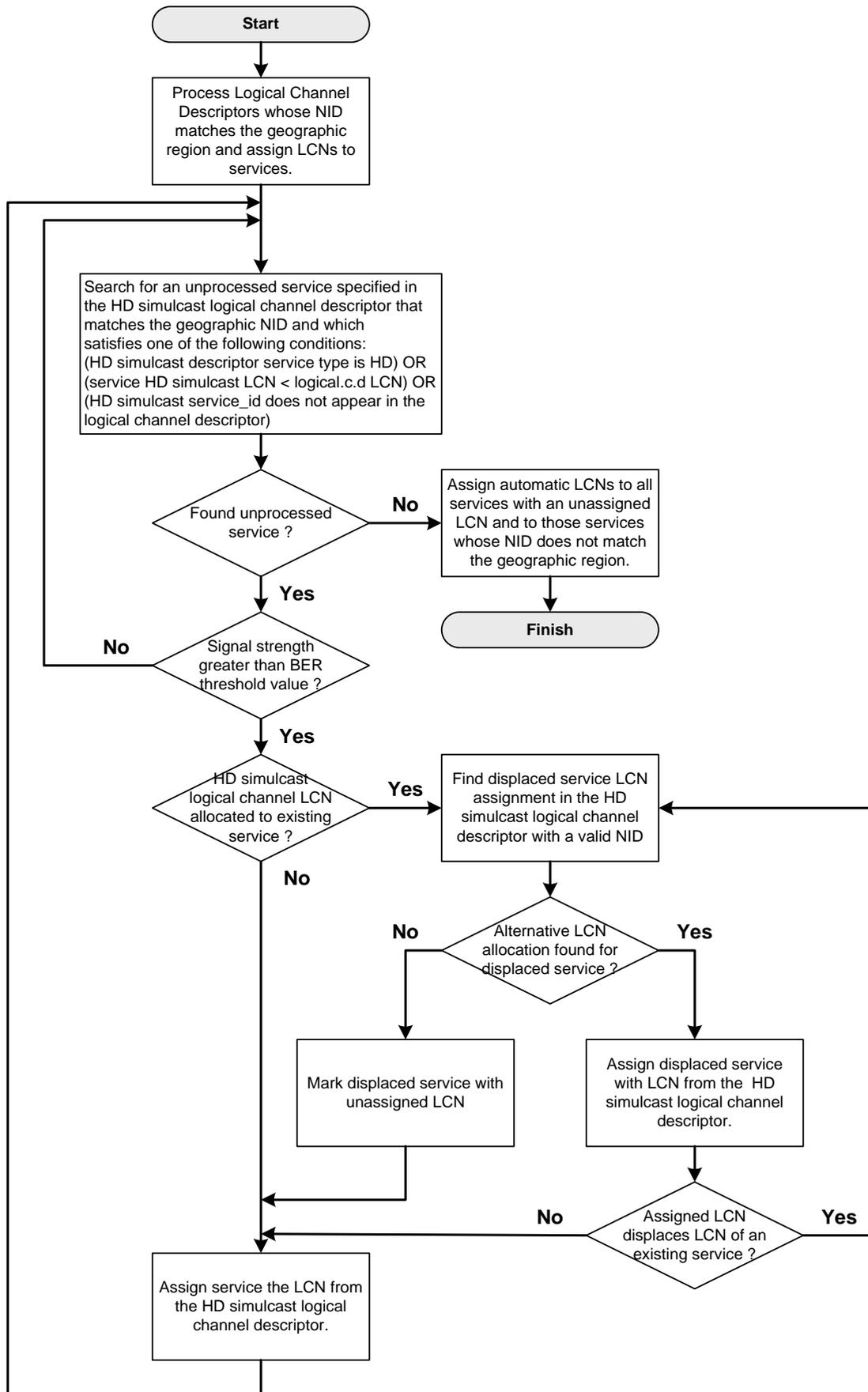


Figure 1: HD_simulcast_LCN operation

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	ext(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

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 §7.5 DTT receivers SHALL apply the following priorities to service variants and services:

Priority (8 is highest)	service_type	stream_content	stream_content_ext	component_type	Service	Delivery System	See notes
1	0x16	any	any	any	AVC SD	DVB-T	1 & 3
2	0x16	any	any	any	AVC SD	DVB-T2	1 & 3
3	0x19	any	any	any	AVC HD	DVB-T	1 & 3
4	0x19	any	any	any	AVC HD	DVB-T2	1 & 3
5	0x1F	0x09	0x00	0x00	HEVC Main HD	DVB-T2	3 & 4
6	0x1F	0x09	0x00	0x01	HEVC Main10 HD	DVB-T2	3 & 4
7	0x1F	0x09	0x00	0x04	HEVC UHD	DVB-T2	2 & 3 & 4
8	0x20	0x09	0x00	0x05	HEVC UHD PQ10	DVB-T2	2 & 3 & 4

Table 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[20]:

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*
Extended event descriptor	0x4E	C m	C m	O	O

Descriptor	Tag	Status			
		Present/Following		Schedule	
		Actual	Other	Actual	Other
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	PDSID	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

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.

Aiming the creation and maintenance of the hybrid channel list, the complete set of mandatory metadata required to a receiver to be compliant with this document are listed in [15] “Interoperability Point 2”. They are described in clause 8.4 and related 8.5.3.

Terminal compliant with this document SHALL implement requirements related to linked application as described in [15] clause 5.2.3

Terminal compliant with this document SHALL implement requirements related to Service Instance precedence as described in [15] clause 5.2.13

For what concerns EPG and channel banner, with regards to [15], clause 6.5, support for ScheduleInfoEndpoint is required. In particular, following information, if present, SHALL be provided to the User through native UI:

- Service Name
- Now/next
- Synopsis
- Parental Guidance (in agreement to the following §9.2.3)
- Event Image (optional)

From content manifest:

- Available audio tracks
- Available Subtitles tracks

Service Logo, if present, SHALL follow [15] clause 5.2.6.2. Image endpoints SHOULD support the width parameter as mentioned in [15] clause 5.2.8, otherwise return a 16:9 png/jpeg image that can be scaled by the native UI.

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.

Specification of a comprehensive DVB-I profile for SAT within UHD Book is left for further study.

7.4.1.3. DVB-I service discovery

DVB-I Service Lists provide 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 the authorizations received by each service provider from the Italian Authority for digital terrestrial television.

Following clause 7.5 describes how the implementation of “Interoperability Point 2” allows maintaining the well-established DTT environment with the introduction of linear broadband services, guarantying the management of Regional Services too.

Receivers may handle LCN conflicts within a DVB-I Service List at their discretion, as each DVB-I service lists should not contain any internal LCN conflict. Merging different Service Lists is not required.

7.4.1.4. Invisible services

Invisible services MAY be given a service number for various reasons (e.g. operational constraints at the head-end or hidden HbbTV applications).

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.

Receivers SHALL always perform automatic service numbering on the basis of logical channel numbers for DVB-I installations, regardless of the user setting if provided.

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.

7.4.3. 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. Service list initialization and maintenance

A general principle is that any scanning¹⁶ 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.

As previously noted, for the time being DVB-I applies only in conjunction with terrestrial delivery.

7.5.1. 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 service list(s) 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;

¹⁶ Here and in the following the term “scan”, strictly applicable to broadcast, is used also for linear IP services

- **automatic full scan:** the procedure is initiated automatically by the receiver; it performs a full (automatic) scan of the spectrum and processes 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).

As a consequence of the planned migration of DTT in Italy to T2/ HEVC, during the transition period many service variants with the same LCN or HD_simulcast_LCN (see §1.3.2) might be received.

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

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

7.5.1.1. Access to DVB-I SLR

The mechanism the receiver shall apply to access the Service List(s) is completely defined in the context of “Interoperability Point IP2” in [15] clause 8.4.

The DVB-I specification provides mechanism to define a Service List composed by trusted services, i.e. a Service List being maintained by a national authority (or by an entity on behalf of it) according to the rules, specified by the same entity,

Acquisition of other DVB-I Service Lists is not prevented. It will be manufacturer dependent how these are displayed to users, under the rules possibly set by the regulator, whilst not disrupting the default list above.

“Interoperability Point IP2” in [15] clause 8.4 describes:

- How to retrieve the URL to access Italian Service List Registry
- How to merge the results of the RF scan and the content of the applied Service List, aiming at the creation of a unique hybrid service list
- Basically, mechanism defined in [15] clause 8.4 shall be applied once the usual scan on digital terrestrial signal has been performed.

In addition:

- The receiver SHALL query the Italian SLR (as an example <https://CSR-URL/query>) using the following parameter:
 - TargetCountry=ITA
- The query SHALL specify the referred RF Delivery as parameter. As an example:
 - [https://CSR-URL/query?TargetCountry=ITA&Delivery\[\]=dvt](https://CSR-URL/query?TargetCountry=ITA&Delivery[]=dvt)
- The receiver shall implement versioning functionality as described in [15] clause 4.6

7.5.1.2. First Installation Procedure

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

- The receiver SHALL provide an interface allowing the user to access the list and move or discard services from the 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 below. Otherwise the lists will be organised according to frequency scan order for broadcast services. In case of a DVB-I installation the receiver SHALL NOT disable automatic ordering.
 - 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 “Interoperability Point IP2” [15] Clause 8.4. Namely
 - It SHALL select an LCN Table matching the region and subscription package chosen by the user, if any. The receiver SHALL allocate a service number equal to the LCN specified for each service in the LCN Table.
 - It MAY offer the user to optionally select alternative additional service packages provided by the receiver
 - 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 §7.5.1.67.5.1.6.
 - 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 (see §7.5.1.7). 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”¹⁷.
 - 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.¹⁸
 - If a service does not have an associated logical_channel_number, it SHALL be allocated an available number in the Main Overflow.

¹⁷ The Main Overflow occupies service numbers 850 to 999. Services transmitted with legitimate LCNs in this range, according to [46], SHALL anyway get the requested position. In case Main Overflow space would get filled up, free positions from 849 backwards SHALL be used)

¹⁸ 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

- When installing a DVB-I Service List, the receiver SHALL follow the installation procedure described in “Interoperability Point IP2” [15] clause 8.4, matching the TargetRegion and SubscriptionPackage chosen by the user, if any.

7.5.1.3. Manual Full Scan Procedure

7.5.1.3.1 Update

When the receiver performs the scan, 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 installations what specified in “Interoperability Point IP2” in [15] clause 8.4 will apply once the RF update has been completed.

The receiver SHALL:

- update (where necessary) in the list those services which were already existing; for example, for non-DVB-I installations:
 - the receiver shall detect a service name (“service_name” in SDT) change of a given service and update it unless it was manually edited by the end user;
 - if automatic ordering is active, the receiver SHALL move, if possible based on the rules given above for allocation and conflict resolution, an existing service to the new position indicated by the LCN;
 - for DVB-I installations “Interoperability Point IP2” in [15] clause 8.4 shall be applied;
- insert newly available services in the relevant position:
 - if they carry an LCN and automatic ordering is active, the following rules apply;
 - 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 services which are 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 (§7.5.1.1). In particular, after signalling to the user that new services are available, 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.
 - 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;
 - for DVB-I installations “Interoperability Point IP2” in [15] clause 8.4 shall be applied;
- remove services no longer present in the NIT_{actual} and the SDT_{actual} and in DVB-I service list(s)
 - 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 §7.5.1.1;
 - for DVB-I installations “Interoperability Point IP2” in [15] clause 8.4 shall be applied;

7.5.1.3.2 Re-install

Same as §7.5.1.1.

7.5.1.4. Manual Scan Procedure (Single Channel)

Same as §7.5.1.3.1 on single channel.

7.5.1.5. 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, as also defined in “Interoperability Point IP2” in [15] clause 8.5.4.1.
- 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.
- Service list(s) will be updated according to the same procedure specified in §7.5.1.3.1 for manual full scan.
- 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).

7.5.1.6. 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).

7.5.1.7. Cross-border LCN conflicts resolution

The detailed expected behaviour for cross-border LCN conflicts resolution when Italy has been selected as country at first installation time 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
 - o if only 1 service has its NID within the range 0x3001 - 0x3100, it will automatically get the requested position
 - o 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)
 - o if all competing services have their NIDs outside the range 0x3001 - 0x3100 the conflict resolution is left up to the customer
 - o whatever the above case, all the other services which haven't got the requested position will be moved to Main Overflow range (850-999)

7.5.2. 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; 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);
- automatic full scan: the procedure is initiated automatically by the receiver; it performs a full (automatic) scan of the spectrum; 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.

7.5.2.1. First Installation Procedure

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:

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

- 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).
- At the end of the scan, all the services found (audio/video/data) are stored in the service list.
- 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.
- If a service does not have an associated logical_channel_number, likely because that service is not part of the platform's offer, it SHALL be allocated an available number in the 1000+ range.
- The receiver SHALL provide an interface allowing the user to access the list and move or discard services from the list.

7.5.2.2. Manual Full Scan Procedure

7.5.2.2.1 Update

When the receiver, as a result of a full spectrum scan or of an update check 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

- 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) change of a given service and update it unless it was manually edited by the end user;
 - if automatic ordering is active, the receiver shall move an existing service to the new position indicated by the LCN;
- insert newly available services (audio/video/data) in the service list at the proper position:
 - if they carry an LCN and automatic ordering is active, they will be put in the position indicated by the LCN;
 - if they don't carry any LCN or if automatic ordering is not, they will be appended at the end of the list in the 1000+ range.
- remove services no longer present in the NIT/SDT

7.5.2.2.2 Re-install

Same as §7.5.2.1.

7.5.2.3. Manual Scan Procedure (Single Channel)

Same as §7.5.2.2.1 on single channel.

7.5.2.4. 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 those services already registered in the service list, the receiver SHALL:
 - detect a “service_name” change and update it unless it was manually edited by the end user;
 - if automatic ordering is active, move an existing service to the new position indicated by the LCN;
- If any service is found with frequency, Ts_id, On_id or Service_id different from those of the services already registered
 - if they carry an LCN and automatic ordering is active, they will be put in the position indicated by the LCN;
 - if they don’t carry any LCN or if automatic ordering is not, 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).

7.5.3. 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)

N.	Settings / Italian Translation	Default settings
2	"Automatic search for new channels in operate mode" / "Ricerca automatica di nuovi canali a decoder acceso"	NO / NO (if available)
3	"Time" / "Ora"	04:30 AM
4	"Repetition" / "Frequenza"	"Daily" / "Quotidiana" = default ("Weekly" / "Settimanale" – other options possible)
5	DVB-I	YES / SI Because DVB-I is still in a Trial phase, it shall be provided to the user the way to not participate.

Table 26: Default settings for automatic scan

7.5.4. 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 procedures described in §7.5) and grouped into two categories in the following order:

- TV channels
- Radio channels

Interactive services linked to TV or Radio services SHALL NOT be shown.

7.5.5. 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.

7.5.6. Default channel numbering of services

Default service numbering SHALL NOT be implemented by manufacturers.

7.6. Receiver functions

7.6.1. 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.

7.6.2. 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.

7.6.3. 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.

7.6.4. 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.

7.6.5. 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.

7.7. User interface to SI carried data

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

The minimum lengths for text fields (if present) that shall be displayed by receivers are defined in the following table. Note that the figures given are for the number of displayable characters (including spaces) required to represent the text field. The number of bytes required will

depend on the use of control codes and whether one- or two-byte character representation is used.

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

Table 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 or Network Time Protocol (NTP) in case of hybrid service list.

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

7.8. Accessibility of DTT services

In 2023 Italian regulator AGCOM has issued a resolution addressing the accessibility of the automatic numbering system of services provided on digital terrestrial television [22]. Requirements contained therein SHALL BE met by compliant receivers.

The companion resolution [62] on the so called “TV Blue Icon” is introduced in the following section 9.2.2.

For convenience of the reader, some key articles of the subject resolution are copied in the following in their original Italian language as no official translation is available from AGCOM.

Article 3.1

Il sistema di numerazione automatica dei canali della televisione digitale terrestre è installato su tutti i dispositivi idonei alla ricezione del segnale televisivo digitale terrestre.

Article 3.2

I gestori delle interfacce utente e i produttori di dispositivi idonei alla ricezione del segnale televisivo digitale terrestre attribuiscono le numerazioni conformemente a quanto previsto dai piani di numerazione automatica dei canali della televisione digitale terrestre stabiliti dall'Autorità

Article 4.1

Almeno uno dei telecomandi forniti congiuntamente a un dispositivo idoneo alla ricezione del segnale televisivo digitale terrestre presenta i tasti numerici che consentono di accedere ai canali della televisione digitale terrestre. Qualsiasi telecomando aggiuntivo fornito che non preveda tasti numerici include un tasto che consenta all'utente di accedere alla selezione delle sorgenti video.

Article 4.2

I tasti numerici che consentono di accedere ai canali della televisione digitale terrestre sono abilitati, e quindi utilizzabili dall'utente, da qualsiasi ambiente, servizio, funzionalità o applicazione che l'utente stia utilizzando al momento della digitazione del tasto, ad eccezione degli ambienti o servizi in cui l'uso dei tasti numerici è necessario per consentire l'inserimento di caratteri alfanumerici.

Article 4.3

I canali della televisione digitale terrestre sono accessibili tramite un riquadro o icona immediatamente e chiaramente visibile, presente nella prima finestra delle home page, ossia nel primo livello di offerta all'utente, dei dispositivi idonei alla ricezione del segnale televisivo digitale terrestre, ad eccezione dei dispositivi destinati al solo uso tramite sintonizzatore per la ricezione della televisione su piattaforma digitale terrestre, quindi non connettabili a Internet, non dotati della possibilità di ricevere il segnale satellitare e che non presentano una home page di navigazione.

Article 4.4

L'immagine o la dicitura riportata sul riquadro o sull'icona di cui al comma 3 è identica su tutti i dispositivi idonei alla ricezione del segnale televisivo digitale terrestre e su tutte le interfacce utente.

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. *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.

8.1.2.2. 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.

8.1.2.3. 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.

8.1.2.4. 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.

8.1.2.5. Implementation requirements

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 E¹⁹ and in CI Plus Implementation Guidelines 1.0.6 [72].

8.1.2.5.1 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.

¹⁹ This Annex is not present in [37]

8.1.2.5.2 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. 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 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 support at least one CENC-compatible ISOBMFF-compliant UHD-grade DRM.

As a matter of fact, implementation of DRM systems in today's receivers can be accomplished only through a support at application level (see clause 9.3.1.1).

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.

9. Resident Software and API

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

9.1. Enhanced TV 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 [8].

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. Navigator

It SHALL be present. It is defined by the manufacturer.

9.2.1.1. 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. Home Page

Today's receivers use to present to users all supported applications and services in a sort of "Home Page". Its definition is manufacturer-dependant and outside the scope of this document but Italian regulator AGCOM has introduced specific requirements addressing accessibility of services provided on digital terrestrial television and prominence of Services of General Interest (SOGI).

9.2.2.1. Accessibility of DTT services

As described in previous section 7.8, AGCOM has introduced in [22] specific requirements concerning the presence in any Home Page of an icon to quickly access services provided on digital terrestrial television.

Such icon is depicted in the figure below and is further detailed in companion resolution [62].



Figure 2: TV Icon defined by AGCOM

For convenience of the reader some key articles are copied in the following in their original Italian language as no official translation is available from AGCOM.

Article 3.1

L'icona o il riquadro, di cui alla lettera h) dell'articolo 1, consente di accedere alla piattaforma digitale terrestre. Nel caso di dispositivi idonei alla ricezione del segnale televisivo digitale terrestre dotati anche di sintonizzatore satellitare e a discrezione del produttore del dispositivo e del gestore dell'interfaccia utente, l'icona o il riquadro, di cui alla lettera h) dell'articolo 1,

consente di accedere anche alla piattaforma satellitare che ritrasmette gratuitamente i canali della televisione digitale terrestre.

Article 4.2

L'icona o il riquadro, di cui alla lettera h) dell'articolo 1, è

- i. preselezionata/o, ossia immediatamente selezionabile dall'utente (in focus), nel momento in cui l'utente accede alla home page, oppure
- ii. inserita/o tra le prime tre posizioni del rail contenente le icone delle applicazioni OTT, di cui alla lettera i) dell'articolo 2, oppure
- iii. selezionabile con al massimo uno spostamento del cursore (uno spostamento a sinistra o a destra oppure uno spostamento in alto o in basso) nel momento in cui l'utente accede alla home page.

Article 4.3

I produttori di dispositivi idonei alla ricezione del segnale televisivo digitale terrestre e i gestori delle interfacce utente, così come definiti, rispettivamente, alle lettere f) ed g) dell'articolo 1, assicurano che l'icona o il riquadro, di cui alla lettera h) dell'articolo 1, non sia eliminabile dall'utente.

Article 4.4

Le previsioni di cui ai commi 1, 2 e 3 del presente articolo non pregiudicano la possibilità per l'utente di personalizzare la configurazione dell'interfaccia – come previsto dall'EMFA – e, quindi, di modificare la posizione delle applicazioni in accordo alle proprie preferenze tramite intervento autonomo ed esplicito dell'utente.

Article 4.5

In ogni caso la posizione dell'icona o riquadro non può essere modificata in base a logiche algoritmiche o automatiche.

Article 5.1

L'icona o il riquadro, di cui alla lettera h) dell'articolo 1, è di dimensioni non inferiori a quelle delle altre icone o degli altri riquadri, presenti in home page, nella porzione di schermo in cui è posizionata/o.

Article 6.1

L'immagine, comprensiva di dicitura, riportata sull'icona o sul riquadro, di cui alla lettera h) dell'articolo 1, è la seguente ed è identica su tutti i dispositivi idonei alla ricezione del segnale televisivo digitale terrestre e su tutte le interfacce utente.

Article 6.2

Nel caso in cui l'icona o il riquadro, di cui alla lettera h) dell'articolo 1, dia accesso ai soli canali trasmessi su piattaforma digitale terrestre, alla dicitura "TV" è aggiunto l'apice "DTT".

9.2.2.2. Prominence of SOGI

In 2025 AGCOM has issued guidelines on prominence of audiovisual and radio services of general interest [14].

9.2.3. 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)
- for DVB-I compliant devices:
 - ParentalGuidance provided by the content guide metadata as defined in [15] clause 6.10.15
 - ScheduleEvent.ActualStartTime and ActualDuration (if present) otherwise ScheduleEvent.PublishedStartTime and PublishedDuration, provided by the content guide metadata as defined in [15] Table 105, in agreement to Interoperability Point 2
- the DVB-DASH MPD (linear IP services or 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

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.

Events without any rating information SHALL be visible without any restriction. Events with rating information not applicable to the country selected at installation time, for instance because received via terrestrial broadcast from a neighbour country, SHALL be restricted based on the tighter (i.e. higher) rating signalled for other countries.

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 G. 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. DRM

Terminals compliant with this document SHALL comply with HbbTV specification [6] clause 10.2.1, Table 11.

9.3.1.2. CICAM

9.3.1.2.1 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. Interaction between Operator Application and Regular Application

Coexistence between an Operator Application and a Regular Application is fully specified in [82].

9.3.3. 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 with 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			
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			
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 Tables²⁰ (Normative)

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.

<i>Property</i>	<i>Value</i>
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.

²⁰ 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), $P_x=-33dBc$			
		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), P _x =-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 ρ_i [dB]	$\tau_i(\mu s)$	$\theta_i(deg)$
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 1.95 μs . 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 $\pm \mu s$ (8MHz channels)	120	150	200	230	260
Delay $\pm \mu s$ (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

<i>Delay +/- μs (7MHz channels)</i>	<i>266</i>	<i>298</i>	<i>400</i>	<i>512</i>	<i>608</i>
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

<i>Delay +/- μs (8MHz channels)</i>	<i>475</i>	<i>490</i>	<i>510</i>	<i>525</i>	<i>532</i>
<i>Delay +/- μs (7MHz channels)</i>	<i>540</i>	<i>560</i>	<i>580</i>	<i>600</i>	<i>608</i>
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

<i>Path (tap)</i>	<i>Delay (μs)</i>	<i>Relative attenuation (dB)</i>
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

<i>Path (tap)</i>	<i>Delay (μs)</i>	<i>Relative attenuation (dB)</i>
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 [78], chapter 3.4.10.6 "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 42 when 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 (Normative)

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).

Modulation	Code rate	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	
		"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 (Informative)

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_{obd} : $T_n - \text{timeShiftBufferDepth}$, 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 $(T_n - T_0) < \text{timeShiftBufferDepth}$, T_{obd} 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 (Normative)

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):
 - o **original_network_id (ON_ID)**: unique identifier of a network
 - o **transport_stream_id (TS_ID)**: unique identifier of a TS within an original network.
 - o **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:

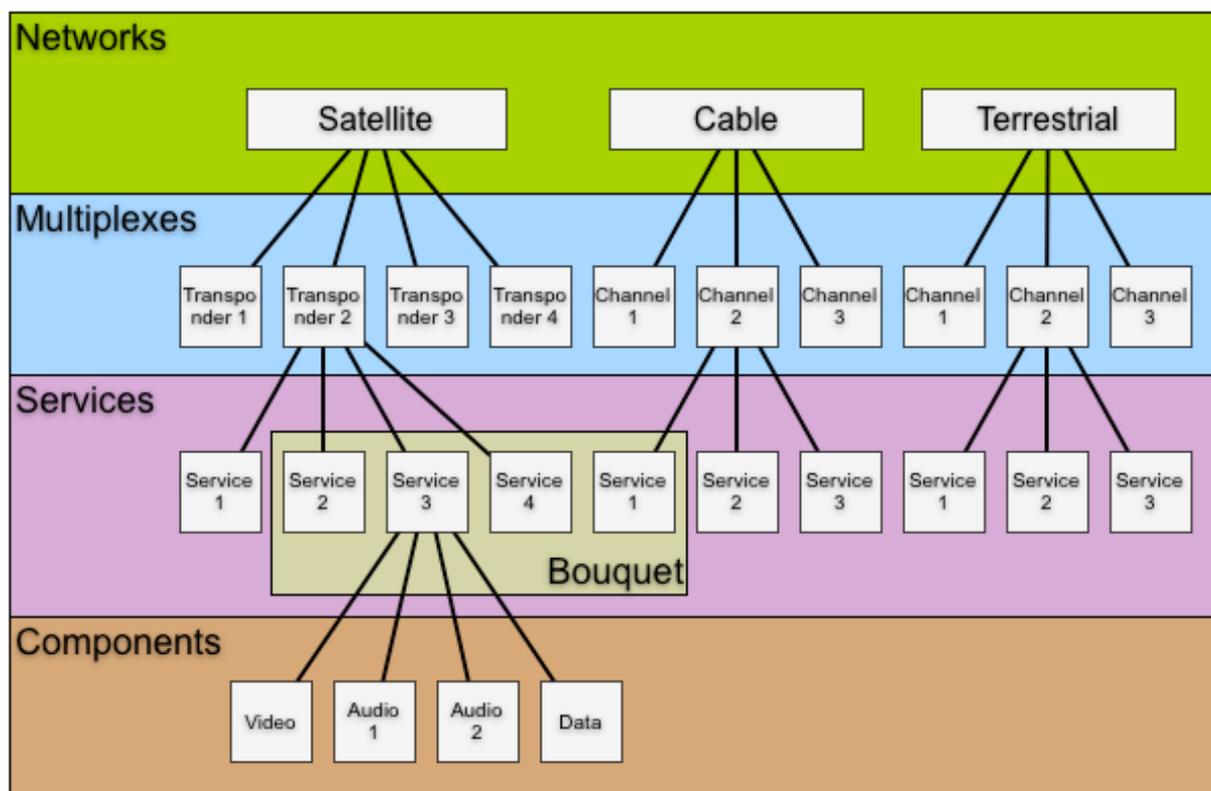


Figure 3: Service delivery model

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

transport_stream_id	Use
0x4800 – 0x4FFF	Region 8 (Emilia Romagna) – 2048 values
0x5000 – 0x57FF	Region 9 (Toscana) – 2048 values
0x5800 – 0x5FFF	Region 10 (Umbria) – 2048 values
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
0x0113	Rai
0x0123	Rai
0x0133	Rai
0x0143	Rai
0x0153	Rai
0x0163	Rai
0x0173	Rai
0x0183	Rai
0x0193	Rai
0x0200	Persidera
0x2003	Rai
0x0204	Persidera
0x0213	Rai
0x0384	D-Free
0x0385	Mediaset
0x0389	Mediaset
0x03A2	Mediaset
0x1000	RaiWay
0x10E1	Elettronica Industriale
0x7918	Persidera

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.

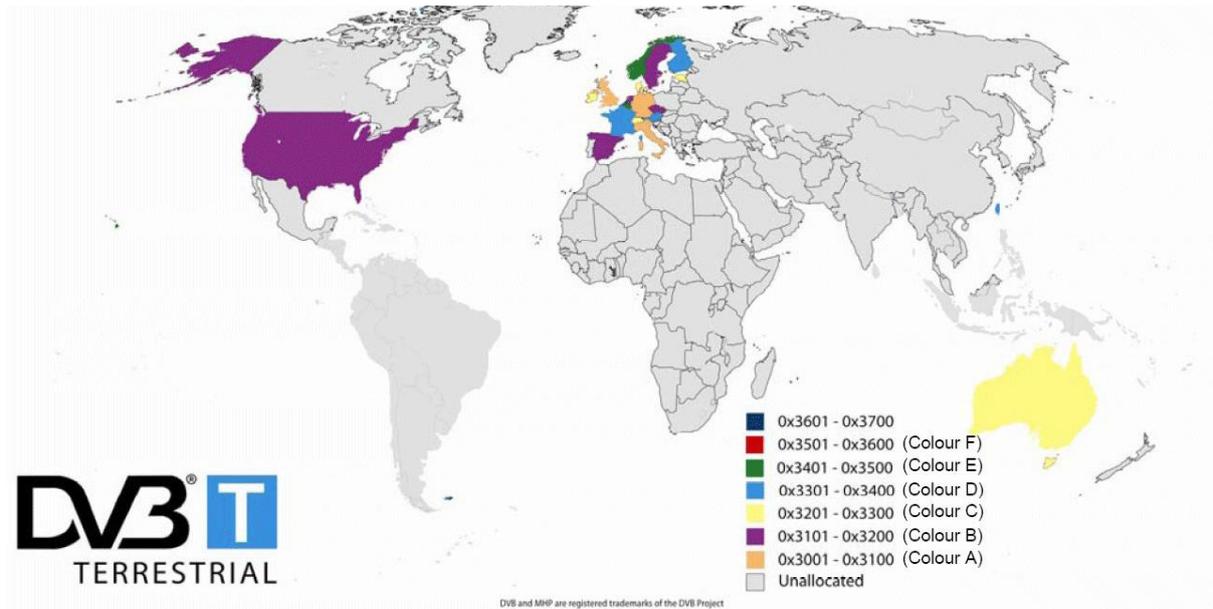


Figure 4: Colour map for allocating network_ids in terrestrial networks

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 ²¹
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 §7.5.1.7). In particular, if Italy has been selected as “Country” at first installation time, all networks whose network_id fits in the 0x3001÷0x3100 range shall be considered as belonging to Italy.

D.6 Network Name

No assumption is or shall be made for this parameter.

²¹ 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)

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E Home Channel concept and tivùsat implementation (Normative)

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	13°	13°
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 service 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 ignored²². 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.

²² 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 (Normative)

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 §7.5, in particular those dealing with conflicts, duly apply.

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

F.1.2 Seamless service lists

A "seamless service list", i.e. a single list including both satellite and terrestrial services, would be very valuable for end users, especially if services were automatically sorted out according to broadcasters' LCNs.

The problem is how to handle (potentially numerous) DTT-SAT LCN conflicts. They will in fact be of 4 kinds:

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

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

1. Manual resolution

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

2. Automatic resolution

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

3. Allotted list

Based on a dedicated menu preference, the seamless service list is allotted as follows:

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

- if the preference is set to DTT, DTT services are listed from position 1 to position 999 according to their LCN values. Satellite platform's (e.g. tivùsat) services are instead listed from position 1001 to position 1999 by adding a 1000 offset to their LCN value. All remaining satellite channels outside satellite platform's (e.g. tivùsat) bouquet are listed from position 2001 on.

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

G Highlights for HbbTV receivers in Italy (Normative)

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.

G.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.

G.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.

G.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 `version.minor ≥ 4`.

G.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:

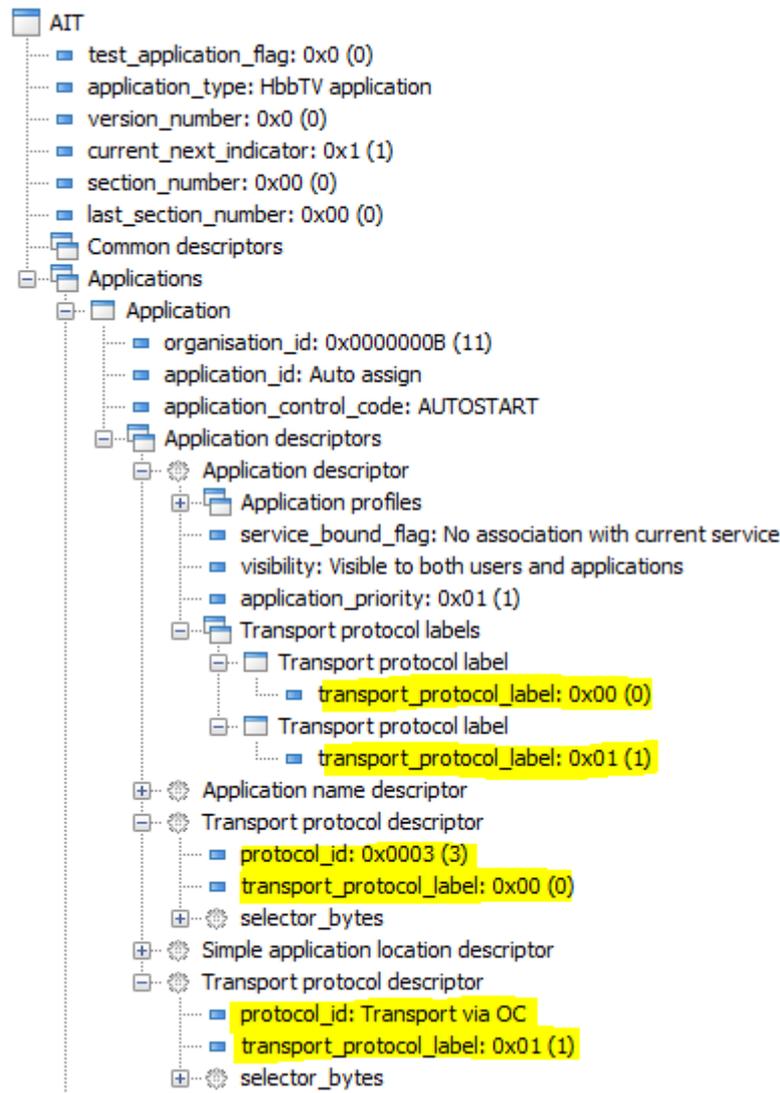


Figure 5: Sample usage of AIT application_priority

G.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”.

G.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>/DA9AAAAAAAAAAP/wBQb+F7Y9qwAnAiVDVUVJAAAKdX//AAEqjbAMEU1EU05CMDAx
MTMyMjE2M19ONAAA7Y8JWg==</scte35:Binary>
</scte35:Signal>
</Event>
```

```
</EventStream>
```

G.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">
```

G.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.

G.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
```

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

Terminal compliant with this specification, providing Privileged-Operator-Application as specified in [82], 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 [82] clause 6.5.3
- Terminal SHALL be compliant with [82] clause 6.5.
 - In particular, “application overlay descriptor” SHALL be supported
- Terminal SHALL be compliant with [82] 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

G.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 [87] 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.

G.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]

G.13 HbbTV in DVB-I context

A terminal compliant with this specification SHALL provide full support to DVB-I standard within HbbTV applications, as described in HbbTV specification [6] Annex O.

Such a normative Annex introduces mechanisms to extend functionalities already provided by HbbTV on broadcast only scenario to the hybrid one, introduced by DVB-I, taking care of the coexistence between native implementation and linked application.

G.13.1 Parental rating

In case a linked application controlling media presentation is running, Parental Rating shall be managed in agreement to [6] clause "O.3 Service and application model".

This is also in agreement to [15] and [69] clause 4.1.4

G.13.2 Native UI and MSE player

Terminal compliant with this specification SHALL match the requirements defined in HbbTV specification [6] clause 10.2.7.6), enabling the use of native UI for audio, video or subtitle component selection when media playback is via MSE [89] player.

G.14 Transition behaviour

Terminal compliant with this specification SHALL match the requirements defined in HbbTV specification [6] clause 9.6.3, under the conditions listed there.

G.15 Navigator class

Terminal compliant with this specification SHALL fully support Navigator class, as defined in HbbTV specification [6] clause A.1.

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

H.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.

H.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.

H.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 or 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.

H.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.

H.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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I Building an interoperable DVB M-ABR ecosystem (Informative)

I.1 Introduction

This annex defines how an interactive application running on a compliant receiver should interact with functions provided by the Multicast ABR platform run by an operator on its network to access content distributed in multicast.

Receivers can work with Multicast gateways deployed in home gateway devices as described in paragraph 6.2 of [33]. Multicast rendezvous service function is assumed to be co-located with the Multicast gateway as described in paragraph 7.2 of [33]. The following clauses ensure that a common set of operations are supported across different MABR platform implementations, assuming they are compliant with [33], and different multicast network groups owned and operated by network operators. Multicast network infrastructures and M-ABR platforms are typically managed by the network operator providing connectivity to the end user.

I.2 M-ABR Gateway discovery

When a M-ABR Gateway service is locally available in the user's home network, it can be reached with a specific FQDN. It should be the same across different M-ABR platforms provided by different network operators. The FQDN can be embedded in receivers, delivered as part of the service-related information or signalled to receivers by other means. The definition of such a FQDN is out of scope in this Annex.

Network operators providing M-ABR in their networks should ensure that the FQDN is correctly resolved pointing to an active M-ABR Gateway interface implementing the rendezvous service if this function is available. Applications should never assume that a M-ABR Gateway service is available in a home network.

A DNS response different from NOERROR (e.g. NXDOMAIN) signals that the M-ABR Gateway is not present nor reachable by the receiver. In this case the receiver or application will fallback gracefully to the original unicast URL to access content.

Other mechanisms providing information about availability of an active M-ABR Gateway in the home network may be implemented (e.g. a web API exposed by the network operator to service providers).

Receivers may support MDNS query for local system discovery according to paragraph 7.3 of [33].

I.3 Multicast rendezvous service operations

The Content Playback function will request a presentation manifest through the multicast rendezvous service with the request URL format defined in paragraph 7.5.1 of [33], using the M-ABR Gateway FQDN, with the following additional constraints:

- Ori field shall be present
- MGStatus, MGid, MGHost fields shall not be present.

The Multicast rendezvous service, when the required presentation manifest is available in Multicast, provides a redirect response, with a proper URL included in the Location response header according to 7.5.2.1 of [33].

Receivers should support rendezvous service error responses defined in paragraph 7.5.2.2 of [33]. If such error responses are received, the Content Playback function will assume that the content is not available in multicast and then request the presentation manifest file using the original unicast URL provided by the back-end system.

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