HbbTV learning for beginners

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HbbTV learning for beginners

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Foreword

Growth of internet penetration, an increasing number of OTT services and the penetration of smart TV devices are changing the traditional media industry. The era broadcasters’ control of content and services is over and now the broadcasters must look for new ways to be one of the winners of the new media competition. HbbTV gives them a powerful tool to keep their viewers and maintain relevance in this new space.

A complete HbbTV implementation involves many different aspects, it’s the standard itself, the needed infrastructure, new services, service development, test tools, receiver requirements, national regulations and conformance testing of the receivers. Because these issues are not independent from each other and directly or indirectly has effect on each other, knowing them is essential for successful implementation of HbbTV.

This book will take the reader into the world of HbbTV. It is meant for beginners who are interested in Hybrid TV and HbbTV, but who have a grasp of digital TV standards and technologies. It contains explanations of all issues related to HbbTV implementation. It offers help for beginners with the concept of HbbTV and how to start an HbbTV deployment project. For more details and information about each part, the reader should refer to HbbTV specification and standards.

Juha Joki
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1- Introduction

We are in a new age of TV, when TV industries have moved on from analogue TV to Digital switchover, which has happened in most countries. SD channels have changed to HD and now there are demands to broadcast UHD material, even if we ignore NHK’s efforts on producing and broadcasting 8K contents in Japan. Terrestrial broadcasting had to free up parts of the UHF spectrum because of WRC-07, WRC-11, and WRC-15. Meanwhile, new demands of higher quality content (HD or UHD with HDR and HFR) is leading countries to use heavy compression and develop next-generation modulation technology to be able to broadcast this higher quality content. Therefore, we are witnessing the gradual expansion of the second digital TV switchover from DVB-T/MPEG-2 and MPEG-4 to DVB-T2 and HEVC all around the world. That is not the whole story—fixed and mobile internet is growing fast worldwide. The Figure 1-1 shows the growth of Internet penetration rate in 2019 based on Internet World state portal [1]. The Figure shows that Internet penetration in most regions is more than 50%.

![Figure 1-1 Internet World Penetration Rate in March 2019 by Geographic Region [1]](image)
Along with the growing internet penetration rate, the number of connected devices is also growing. Among the connected devices, the penetration of connected TVs is increasing in many regions. The Figure 1-2 shows the penetration of smart TV in different regions.

![Figure 1-2 Smart TV shipment in Q4’18 based on IHS Market research][2]

Internet created many opportunities for offering new services. It makes having a personalized TV possible, so that viewers access to a large number of videos and audios, watch their favorite programs whenever they like, watch past episodes of TV programs (catch-up TV), move forward and backward in the movie (start over), and watch higher quality of video and audio via internet. This has created opportunities for new players in the media ecosystem: OTT service providers.

The internet provides plenty of opportunities to offer new services, the possibility of using a personal TV, viewers will be able to access a large number of video and audio, watch their favorite programs, watch the previous episodes (start over), move forward and backward in the movie, and look at the higher quality of video and audio via the internet.

The era of the kingdom of broadcasters on content and services is over. New players, OTT service providers, are offering wide ranges of content with higher quality and many attractive services by using the capacity of the Internet and its penetration. They are attracting many viewers already. Amazon and Netflix are two of the very big and successful examples of new OTT service providers, but it is not limited to the OTT service providers. The Number of local OTT providers in all local markets is growing.

![Figure 1-3 Global OTT TV &video revenues by source ($ million) based on Digital TV research][3]

[Figure 1-3 Global OTT TV &video revenues by source ($ million) based on Digital TV research][3], shows the result of a new study from Digital TV research, which is predicting that global online.
TV episode and movie revenues will reach $159 billion in 2024. It is more than double of $68 billion recorded in 2018 and approximately $17 billion more recorded in 2019. [3]

Of course, there is another important fact that shapes the strategy of service offering: “Big screen is winner”. Maybe years ago, some thought that personalization demands would encourage people to replace TV with a mobile device, but the evaluation of viewers’ behavior shows that TV is still the main device for watching the video. It is reasonable; the size of TV screen is increasing, TV technology is developing and watching the movie on the big screen is not comparable with the small screens such as mobile or PC. Actually, PC and mobile are used as gateways to increase TV screen on-demand viewing. Consumers only use mobile devices or PCs to try new services, but they use TV screen for long time viewing. Out-of-home usage does not compete with TV, but it creates a new audience opportunity.[2] This is the reason that broadcasters are trying to develop ways of accessibility to their services through different receptive ways (broadcast and broadband) on the different devices (Mobile, PC, TV, STB) and OTT service providers are trying to bring their services to TV.

As an example, the report of Netflix about the viewers’ behavior in 2018 shows, although most of the viewers submit to its service on phone or tablet, they migrate to TV for watching movie after two months. The Big screen is a winner and this is an important point for the planning of services for all. [4] Figure1-4 shows most of OTT services such as Netflix’s OTT are watched on the “big screen” (Living room TV devices).
It is unavoidable that broadcasters feel threatened by OTT service providers for losing viewers to them. Mentioned issues are challenges of broadcasters in whole world. Maybe in some regions and countries, because of the internet growth and presence of OTT service providers, broadcasters are struggling with these challenges now. It is inevitable for other broadcasters in other regions too. They have to face the challenges of losing the audience and their attraction to OTT service providers in the future. Broadcasters have found out that they must use the Internet to offer new and attractive services to keep hold of their viewers, but how can broadcasters convert internet and new environment to an opportunity for themselves? Broadcasters have developed TV broadcasting infrastructure in each country. Usually, their services are available in the whole of country. Moreover, this is their unique position in each country. Are there any ways to add internet advantages to their infrastructure to increase their viewers? If a broadcaster is going to use internet capacity for offering new services, how should it bring its OTT services on TV? There are different ways to follow:

- **Adding the OTT services to App store of receiver manufacturers:**
  Bringing an OTT service to the receiver needs negotiation with the receiver manufacturer. Each receiver manufacturer has its special middleware, browser, key navigation, and video player, so a special application should be developed for each of them. Although there are some similarities for app development of some main TV brands and some activities have started to increase convergence between manufacturers, the main problem remains. The new service will be available only on the agreed receivers and it is a big limitation for the development and accessibility of the service.
• **Accessing to the portal via browser in TV:**
There is a belief that it is a valid approach to develop a web portal for PC and ask
the user to open a browser and types its portal address to access to the services, but
obviously, this is not reasonable. Application and service should be designed for TV
screen and remote control, not mouse and keyboard should do navigation. This way
of offering the service does not encourage viewers for using this new service. Simple
accessibility of a service is the main key to usability of it.

• **Offering of service in android app store:**
Android is an open platform and therefore development of an application is easily
accessible and well documented. In this way, OTT service is reached by installation of
the application in the android TV. It means that the user should be aware of application
availability; they should find it and install application on TV to access to the service.
If a new version of application is developed, the users again should be aware of it
and update it to access the new service. Otherwise, some limited manufactures are
implementing android TV. Thus again there is a limitation on the receiver side. We
should also be aware of limited security of android platform. A Fraudulent application
can damage security.

Of course, the problems of informing the viewers about the existence of new services
and difficulty of accessing them are common between all of the mentioned methods.
In all of the ways above, Broadcaster’s OTT service is an application same as all the
other applications in the receiver. Probability of using this app is like other apps on the
receivers. The Viewer should be informed about availability and usability of this app.
In addition, there are two separated environments on the TV, internet environment
and broadcast environment.

Is there another way with the following features, to use internet capacity by
broadcasters [5], [6]?

• This way should be open and standard to permit efficient development of
  service independent of manufacturers or platform operators. One app for all
  receivers
• This way should be based upon standardized technologies as far as possible.
• This way should specify the minimum required components and functionalities,
  so that as many market players as possible support the specification.
• This way should allow the combination of all broadcasting systems (satellite,
  cable, terrestrial) with all Internet access technology (DSL, cable, wireless).
• This way should permit connection between linear television content and additional
  interactive services.
• This way should permit the use of the broadcasting channels for the distribution
  of additional services.
• This way should not influence the integrity of broadcast programs, i.e. not
  combining services from the Internet with the screen image in an uncontrolled way.
• The Service should be accessible without installation by viewers.
• The Viewer can be informed about availability of the service on the program screen.
• Navigation in service should be easily possible by remote control.
• Control of service and the decision of what application and when it can be available in a TV program, should be in the broadcaster’s hands.

In this way, broadcasters can use internet to enrich their valuable contents while offering their own OTT services. They can bring their OTT services to the TV. This will prevent other OTT service providers from stealing their viewer’s eyes and ears. Hybrid broadcast and broadband TV (HbbTV) makes all of the mentioned features possible.

The general introduction of HbbTV will be explained in the following.

1-1 HbbTV

1-1-1 HbbTV Consortium

The First activities of development of a standard specification with mentioned objectives and requirements were started in 2009 by co-operation of ANT, APS, France Televisions, IRT, OpenTV, Philips and TF1, Sony and Samsung [7]. HbbTV consortium was established in 2010 with five members and now there are more than 70 members in the consortium as shown in Figure 1-5. In 2014 OIPF was merged with HbbTV consortium and all its documents and activities are now a part of HbbTV standard. [8]

![HbbTV consortium members by end of 2018](image)
Members of HbbTV consortium are representatives of TV ecosystem including broadcasters; Consumer equipment manufacturers, technology providers, and network providers. Then HbbTV is specified with participation and agreement of all TV ecosystem members. The purposes of HbbTV consortium are the following [8]:

• Developing and promoting open specifications and solutions for hybrid broadcast/broadband and IPTV television systems, with the ultimate public interest objective to allow harmonization of broadcast and broadband, delivered entertainment services and consumer equipment
• Defining market driven requirements
• Defining HbbTV Specification
• Reviewing test assertions
• Publishing Test suite follows publications

1-1-2 HbbTV deployment

HbbTV has been deployed by different countries in the world (Figure1-6). It is implemented in 27 countries and 26 broadcasters and operators are using it. HbbTV technology reaches almost 587 million people worldwide. Almost 60 companies are developing and marketing HbbTV services and applications. [8]

Figure1-6 HbbTV deployment by end of 2018 [8]

By now, many different versions of the standard have been published. The first version of HbbTV specification was published by ETSI as TS 102 796 in 2010 [9] and the latest version of HbbTV standard, called HbbTV 2.0.2 [10], was published by ETSI in 2018. Figure1-7 shows a brief history of different HbbTV versions.
HbbTV 1.5 is selected by leading countries in hybrid service delivery such as Germany and France. HbbTV 2.0.1 is selected by countries that have recently decided to provide hybrid services. Some countries such as UK and Italy have been introducing interactive services on digital TV based on MHEG and MHP respectively, for several years, and they are migrating their services to the HbbTV 2.0.1. Leading countries in hybrid services delivery are switching from HbbTV 1.5 to HbbTV 2.0.1, such as countries in the Nordic region. It is necessary to mention that version 2.0 of the standard is not used anywhere, but version 2.0.1 was issued quickly to fix the mistakes of version 2.0. Figure 1-8 shows some HbbTV platforms in different European countries.

As shown in Figure 1-6, HbbTV has been adopted in some Asian countries, also. For example TRT ARTI by TRT in Turkey, Media plus and Tonton by media prima, Myklík in Malaysia, and Toggle in Singapore. Iran, Vietnam and Indonesia are trialing HbbTV services.
1-1-3 HbbTV Receiver

Eight main Receiver manufacturers are supporting HbbTV and 170m HbbTV sets sold in 2017 that means about 60% of global sales. Figure1-9 shows share of HbbTV receivers at smart TVs.

Along with the development and implementation of HbbTV, support of HbbTV in the receivers has become mandatory in the receiver requirement specifications. For example in Germany, France, Spain, UK, Australia, Italy, Malaysia, Singapore and many other countries where HbbTV services are offered, the requirement for HbbTV is mandatory. This strategy grows penetration of HbbTV reception so its receivers are high in countries that have a certification regime for HbbTV receivers and services. This topic will be discussed further.

For example in Australia HbbTV was started by all five major broadcasters with HbbTV1.5 as Freeview plus in 2014, and its certification regime was managed by Freeview. In 2018, around 85-90% of all receiver sales and 100% of all major and medium size manufacturers were fully certified. HbbTV was used in around 41% of all Australian households.[12]

Freeview play is an HbbTV service deployed in the UK in 2015. Based on a report presented in HbbTV Symposium in 2018, it is used in around 2.6 million UK homes and almost 54% of all TV sales in UK support Freeview Play. It is predicted that FVP TV and STB annual retail sales will get to 4.3 million and the number of active FVP receivers will increase by 11.1 million in 2022.[13]
This book describes how broadcasters can implement HbbTV standard and benefit from it. Different HbbTV services is explained in detail in chapter 2. The concept of standard is described in chapter 3. Equipment and required changes in the traditional DVB head-end are described in chapter 4. Application development issues is explained in chapter 5. Receiver issues and test suite regimes are explained in chapter 6. Finally, the success factors of HbbTV is listed and explained in chapter 7.
2- Services

2-1 Introduction

Typically, the red button displays HbbTV services. In order not to annoy the viewer with undesired overlays and to allow a uniform experience for the application start, first a small icon on the TV is displayed which informs the viewer that HbbTV services are available, as shown in Figure2-1. This notification will be disappeared after a few seconds. Although the application is active from a technical perspective but it does not show anything on the screen until the user presses the red button in Remote control as shown in Figure2-2. The full ranges of services are then accessible by the red button.

Figure2-1 Red button is displayed on the TV and informed about availability of services. (sample is HbbTV service of IRIB in IRAN)

Figure2-2 Red button launcher is displayed after pressing the red button on remote control. (sample is HbbTV service of IRIB in IRAN)
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HbbTV service is divided into two types based on their relationship with the content of TV programs: related to the content of on-air TV programs and non-related to the content of on-air TV programs. These two types are described as follows:

- HbbTV services related to the content of on-air TV program: these services are related to content of on-air TV program such as quiz, voting, addressable advertisement and integrity with social media and so on. These services are only accessible or available during the time of broadcasting of related TV program.
- HbbTV services non-related to the content of on-air TV program: These services are not related to the content of any on-air TV programs same as VOD, Catch-up, game, weather information, road camera information, news agency, and many other OTT services that are explained in this chapter. Usually, these services are accessible in all times by the red button and they are not limited to broadcasting time of any TV program.

2-2 HbbTV service related to the content of on-air TV program

One of the distinguished differences between HbbTV services and other OTT services is the possibility to synchronize HbbTV services to a specific on-air TV program so that the service is available only in the time of broadcasting the TV program. Some examples of deployed services are as follows:

2-2-1 Quiz show and voting service

This service usually contains additional information related to the TV program such as actor’s information, clip or music of program, possibility of participating in the TV competition by using the remote control, and so on. Different broadcasters such as Idols and Kingi in Finland have implemented many of these types of services.

Figure 2-3 A sample of HbbTV quiz service that is synchronized to related to the TV show (sample is HbbTV service of MTV3 by Digita in Finland)
Figure 2-3 shows the Idols service. This service is related to a popular TV show that is broadcast in Finland. When the TV program is on-air, a notification will be displayed on TV screen. It informs viewer that the Idols service is available. The app is accessible by the blue button on remote control. After pressing the blue button by viewer, HbbTV application will be run on TV. TV video will be scaled in the corner of TV screen and application will be overlaid on the screen. This service contains information about participants and judges of TV program, viewers can watch past episode of program, clips and vote to the players easily by using remote control while they are watching the TV program, too. Service is linked to twitter and can read the related tweets to the program.

2-2-2 Different views of scene

It is possible to have different views of a sport match and for the user to choose between them and watch the match from different camera angles as desired. An example of such an application has been developed by CCMA and is shown in Figure 2-4. Application is available in the time of the match and viewer is informed about the availability of the service by displaying a notification on the TV screen. The output of the different cameras is accessible in this service. The viewer can watch it larger by a click of an RCU button. In addition, they have access to this service on the mobile and can select the desired view on their phones and watch it.
2-2-3 Sport

The sport TV program is one of the most popular TV programs. Different applications related to sport contents can be developed that enhance the viewer experience. Additional information about a race, seeing the results of different competitors, prediction of result of the race and many other information are possible by HbbTV. Two examples of application related to a sport TV program are shown in Figure2-5 , Figure2-6.

Figure2-5 shows an application related to a horse race in Finland. The application is available when the TV program is on air and like in other services mentioned, a notification is displayed on the TV screen and the viewer will be informed about availability of the service and can access it by pressing the defined button.

Figure2-5 Horse race service show (sample is HbbTV service by Digita in Finland)

Figure2-6 shows a Hungarian application that was developed for FIFA 2018 and shows the results of football matches, players, and so on. This service was available during the football world cup 2018; a notification on the TV screen displayed when a match started in another TV channel.
2-3 HbbTV service non-related to the content of on-air TV program

Many OTT services are possible by HbbTV such as news, weather, prayer time, Catch-up, VoD, games, and all kinds of subjects that are not related to any specific TV program content. Some of the most popular applications are described here.

2-3-1 VoD

Video on demand (VOD) is a service that offers a large collection of movie and audio to viewer and allows users to select and watch/listen to video or audio content every time that they like. Usually, there are different categories or videos based on gender, rating and so on. Some additional information about video same as the year of production, producer, actors, and a short description of movie are available. HbbTV adds DRM and payment process to this service too.

For better quality and performance, streaming is based on MPEG DASH standard. Advanced video codecs and formats like UHD and HFR/HDR, are possible in VoD services and supported in HbbTV 2.0.2. Figure2-7 shows a typical VoD service in Finland.
This service is one of the popular services. It provides possibility of watching past episodes of programs at the desired time. Usually, it includes episodes of past programs of the previous and current month. Figure 2-8 shows an example of a catch-up service in Singapore. Most of the time Catch-up and rich EPG are integrated in a system to which past episodes of a program, the viewer can have the access.
2-3-2 Rich EPG
This application provides more information about TV program same as image, description, rating and so on. Usually, it includes EPG of 7 days and connects to the catch-up service. User can watch past episodes by choosing a program in the rich EPG. Figure 2-9 shows EPG of Bazar channel in IRAN. This application contains further information of programs such as time and date of program broadcasting, and the last episode of program.

![Figure 2-9 EPG service (sample is for IRIB in IRAN)](image)

2-3-3 Informative application:
A wide range of applications containing different kinds of information are possible by HbbTV, for example weather app that provides climate information, road camera that gives information about conditions and traffic of the road network, news that is fed by different news agencies and so on, Figure 2-10, Figure 2-11 and Figure 2-12 show different informative applications.

![Figure 2-10 Weather application (sample is HbbTV service of Levira in Estonia)](image)
Figure 2-11 Road camera (sample is HbbTV service in Finland)

Figure 2-12 News application (sample is HbbTV service of IRIB in IRAN)
2-3-4 Game

Different games are possible by HbbTV and they can be played by remote control. Figure 2-13 shows a variety of games in Estonia.

![Game application (sample is HbbTV service of Levira in Estonia)](image)

2-3-5 Addressable advertisement

Addressable TV advertising is the ability to show different advertisements to different households while they are watching the same TV program. With the help of addressable advertising, advertisers can move beyond large-scale traditional TV and blocks and focus on relevance and impact. Addressable advertising is implemented on the player side by replacing the ads from the broadcast stream with that of the broadband connection.

A simple advertisement application is also possible. In the time of advertisements, broadcasting a message is shown on the TV and viewers will be informed about the application.

By clicking on the green button, additional information about the advertisements will be accessible, and viewers can even do direct shopping from that page. Figure 2-14 shows advertisement service.

For example in Finland, partner of Idols program is Pagen and has an advertising space for their product on the page.
Figure 2-14 A Sample of advertisement in an HbbTV application (sample is HbbTV service of MTV3 by Digita in Finland)

Figure 2-15 is an example of HbbTV advertisement application that is provided by Levira in Estonia as “coop”. Viewer can see the price of different goods and products in this service.

Figure 2-15 A sample of advertisement in an HbbTV application (sample is HbbTV service of Levira in Estonia)
All the above applications are only some examples of possible applications by HbbTV. Actually, there is not any limitation for development of application and services. The only limitation is that they should be developed for TV screen and be functionally defined in remote control. Usually, general applications are available through the red button launcher. In addition, when the red button launcher is available on TV channels the viewer will have access to a wide range of services only by clicking it. (Figure2-1 and Figure2-2) Applications related to on-air content usually are available through the second key like the blue or green one. This key will be activated only when the program is started and application is available. As shown in examples, applications can be developed in a way that TV screen stays scaled on one corner of the TV screen, so that the viewers do not lose the broadcast service and simultaneously access the broadband service as well.
3- The concept of standard

3-1 Introduction

The HbbTV specification is developed by industry leaders to improve user experience for consumers by enabling innovative, interactive services over broadcast and broadband networks. The specification uses elements of existing specifications from other standards including OIPF, CEA, DVB, MPEG-DASH, and W3C. [8] Different versions of HbbTV standard published by ETSI as TS 102 796 is shown in Table 3-1. At the end of 2017, HbbTV published a new specification called OpApp that describes how a “virtual STB” can be run on HbbTV receivers. OpApp was published by ETSI as TS 103 606[17].

Table 3-1- Different versions of HbbTV standard

<table>
<thead>
<tr>
<th>Informal Name</th>
<th>Formal Name</th>
<th>Date of publish</th>
</tr>
</thead>
<tbody>
<tr>
<td>OpApp</td>
<td>TS 103 606</td>
<td>2018</td>
</tr>
<tr>
<td>HbbTV 2.0.2</td>
<td>TS 102 796 V1.5.1</td>
<td>2018</td>
</tr>
<tr>
<td>HbbTV 2.0.1</td>
<td>TS 102 796 V1.4.1</td>
<td>2016</td>
</tr>
<tr>
<td>HbbTV 2.0</td>
<td>TS 102 796 V1.3.1</td>
<td>2015</td>
</tr>
<tr>
<td>HbbTV 1.5</td>
<td>TS 102 796 V1.2.1</td>
<td>2012</td>
</tr>
<tr>
<td>HbbTV 1.0</td>
<td>TS 102 796 V1.1.1</td>
<td>2010</td>
</tr>
</tbody>
</table>

3-2 System overview

HbbTV system is a combination of two networks, broadcast and broadband. Its broadcast network is a DVB network (DVB-T/T2, DVB-S, and DVB-C). A hybrid receiver has the capability of connecting to broadband and broadcast networks in parallel.

In HbbTV system, in addition to standard A/V content, signaling information application is transmitted via broadcast signal. Receivers by receiving this application can find which application, from where and how it should be synchronized to DVB service. Usually, in an HbbTV system, Application data and non-linear A/V content (e.g. content streaming on demand) are sent via internet network. If the receiver is connected to an internet via broadband connection, it will display the application according to signaling information application.

Receiver via broadcast signal without an internet connection can receive application data, non-real time A/V content and signals of stream events. To put it simply, HbbTV application can be transmitted via broadcast signal by using DSM- CC carousel. The hybrid terminal may also support non-real time download of A/V content over this interface. The broadband interface may also connect to Companion Screen Devices or other HbbTV® terminals on the same local network as the hybrid terminal.

Content of this chapter was written based on HbbTV standard and HbbTV consortium portal materials.
More details about HbbTV signaling and system will be explained in chapter 5. Figure 3-1 depicts the system overview with a hybrid terminal with DVB-S as an example of the broadcast connection.

Figure 3-1 HbbTV system overview [10]

3-3 Specification overview

As mentioned in chapter 1, HbbTV is based upon open standardized technologies. As HbbTV is hybrid Broadcast and Broadband, it is based on DVB and internet standards. It specifies only the minimal required components and functionalities, so that as many market players as possible will support the specification. Role and importance of each part of the specifications are explained in the following:

3-3-1 DVB standards

Most important components that are provided by DVB:
• Important additional functions are provided by DVB standard in ETSI TS 102 809[18] as” Signaling and carriage of interactive application and services in hybrid broadcast/broadband environment”. This standard describes the way of starting an application in a DVB service and its signaling issues in DVB multiplexes. This is
performed via Application Information Table (AIT), listed in Program Map Table (PMT) of the related program. TS 102 809 [18] specifies the transmission of application via broadcast network by DSM-CC standard, too.

- Support of HbbTV signaling components such as AIT, DSMC-CC and stream event in DVB-SI as EN 300 468.[19]

3-3-2 DASH profiles

MPEG-DASH provides adaptive streaming for the different internet connection speeds of end user. In other words, it is a way for bit rate adaption in the streaming to provide better user experience with different internet speed.

DASH profile is defined in ISO IEC standards as CENEC 23001-7 [20] and 23009-1[21] DASH profile and DVB DASH standard in TS 103 285.[22]

3-3-3 Subtitle standards

Subtitle in HbbTV services is based on EBU-TT- D[5] and TTML [23].

3-3-4 Content protection standards

HbbTV uses TS 103 235; and OIPF vol 7[24]( content and protection) integration with content protection / DRM technologies and CI Plus [25] for content protection.

3-3-5 APIs for application running in a TV environment

JavaScript API for Application running in a TV environment. For example, broadcast video presentation; channel change is defined in OIPF DAE specification [26]

3-3-6 Navigation of input keys in the applications

Common set of input keys for application control (red button, color button and etc.) is defined and based on CEA-2014.

3-3-7 HTML component.

- The HTML markup language itself.
- The <video> and <object> element for presenting broadband delivered video in an HTML page.
- The APIs for manipulating the contents of an HTML page from JavaScript.

More details about the specification are available in HbbTV consortium portal [8] and specifications. [10]

Figure 3-2 shows a graphical overview of the relationship between the different specifications:
HbbTV 2.0.1 was published in 2016 and it is extensively deployed as described in 1.1.2. The new features that are added to HbbTV 2.0.1 are as follows:

- HTML5 support
- Media synchronization between broadband and broadcast
- HEVC video via broadband, enabling 4k and more efficient OTT
- Subtitles via broadband, EBU TTML
- Privacy, possibility to block cookies and tracking websites
- Better defined MPEG DASH, DVB-DASH and better support for live TV
- Ad insertion into VOD content, seamless ad breaks
- Push VOD, is supported by FDP, personalized and bandwidth efficient
- Companion Screen in 2 ways; launching a companion screen app from TV or Launching an HbbTV app from a companion screen. Push VoD and Companion screen haven’t been implemented.

Figure 3-2 Specification overview [10]

3-4 HbbTV 2.0.1
3-5 HbbTV 2.0.2

HbbTV 2.0.2 was published in 2018, and it supports integration of HbbTV with HDR (HLG10, PQ10), HFR (100 Hz, 120 Hz) video and Next Generation Audio, both AC-4 and MPEG-H audio.

DVB-DASH (TS 103 285 V1.2.10 in HbbTV 2.0.2 specification describes how to include HDR, HFR, and NGA in the DASH profile. New Audio and video codec spec (TS 101 154 V2.4.1) in HbbTV 2.0.2 specification defines new video codec for the broadband profile. [28]

In addition to new features, bugs of HbbTV 2.0.1 are fixed in the new version.

3-6 OpApp

By the change of viewing behavior and increasing penetration of connected TVs, operators are starting to move into apps and to offer new services by using broadband capacity. Like broadcasters, they would like to make their services possible anytime and anywhere, and provide easy accessibility for their consumers.

However, there are some challenges for them to bring their services to a wide variety of devices and directly to the TV set regardless of brand and model.

Regarding these demands, HbbTV started evaluation of how operator functionality could be brought into an HbbTV terminal in 2015 [29]. Finally, Operator Application specification (OpApp) was published by HbbTV at the end of 2017. OpApp was standardized by ETSI as TS 103 606 in May 2018. [17]

OpApp is an “Operator Application” that provides an STB-like experience without the STB. It provides an opportunity for operators to bring their services on any device, while keeping their uniform branded experience, and provides easy access to content. Operators can manage the platform UX remotely and deploy software updates over broadcast or broadband without the complex middleware upgrades. OpApps are independent of the TV channel being watched, device, and remote control keys. [30]

As it is standardized by HbbTV and can be interoperable across brand, and benefit from HbbTV’s testing regime. It can coexist with “regular” HbbTV Apps running on the same device.

3-6-1 Ways of Implementing of OpApp

The main deployment scenarios are as follows [30], [17], [31]:

- **Standard operator applications:**

  Standard operator applications cannot replace UI elements of the terminal but may provide alternatives to some of them such as: EPG, Channel list, List of other applications of the operator, and Promotion of the operator and its content.
• **Privileged operator application:**
   It is running in TVs and retail STBs that have their own TV watching UI. A privileged operator application replaces some parts of the user interface of the terminal. Typically, that includes content related UI elements in TV watching mode.

• **Operator-specific operator applications:**
   In “Operator specific” scenario, the OpApp provides the “whitelabel” user interface for the STB. An operator-specific operator application can implement all features of privileged operator applications but it can also replace further parts or even the entire user interface of the terminal. Its user experience can be comparable to that of set-top boxes of PayTV providers. This scenario simplifies the deployment and integration for STBs.

### 3-6-2 Discovery and installation

To facilitate users’ access to content, the HbbTV OpApp can behave like a TV input source, right next to common input sources such as HDMI, SCART or antenna. OpApps are capable of taking control of the remote control keys available in regular HbbTV applications, as well as the use of the P+/P- keys that are essential for a good linear TV user experience. Subject to the bilateral agreement, OpApps can take control of some additional keys such as the “guide” and “menu” keys. It can define these or other remote control keys, for instance, to land the user straight into the HbbTV OpApp. Thus, it increases additional entry points for the TV Operator’s service. [30]
An easy discovery of the HbbTV OpApp application by the user is important to encourage users to access the TV Operators branded TV, seamlessly. The HbbTV OpApp specification describes several ways to facilitate discovery of an OpApp, either via a pre-installed application, via a broadcast signaled application launching or via DNS/IP. [30]

![Diagram showing different methods of discovering an OpApp](image)

**Figure 3-4 Scenario for App discovery in OpApp [31]**

At the time of writing this book, the latest version of HbbTV Test suite (V 2019-1) is contained OpApp Tests.
4- Implementation guideline

4-1 Introduction

For understanding HbbTV implementation method, you should look at it from the receiver side.

As mentioned before, HbbTV provides the possibility for synchronization of an application to a service (channel TV) or a TV program. There are basic and important questions that can help to understand how HbbTV should be implemented.

First, let’s look at it from the receiver side:
1- How can a receiver understand an application is synchronized to a TV service (channel)?
2- How can a receiver understand an application is synchronized to a TV program?
3- How can a receiver understand from where application is accessible?
4- How can a receiver understand when application should be started and when should be killed? In another word, how can receiver understand the lifecycle of application?
5- How can a receiver understand to make different limitations of accessing to its DVB resource for different applications?

All of the questions above can be repeated from broadcaster sight, too:
1- How can it synchronize an application to a service or to a TV program?
2- How can it define life cycle of application (when and how it be started and finished)
3- How can it define different limitation of accessing to their resources for different applications?
4- How can it send application via broadcasting without the need to broadband?

These questions will be answered in this chapter. Only first, for a better understanding, we had better start with some simple and basic concepts.

4-2 Overview of MPEG-TS

Broadcast part of HbbTV is based on DVB standard so understanding DVB helps understanding the concept. Figure 4 1 shows a typical broadcast system: The services are encoded by an encoder and multiplexed by the Multiplexer. The output of the multiplexer will be a Transport Stream in MPEG-TS format and it will be fed into the DVB transmitter and after modulation, it will be broadcast by Antenna.
MPEG-TS contains several services (MPTS, multi program transport stream), where each service contains several elementary streams. There are different SI tables, descriptors in MPEG-TS that help receiver to understand what services are broadcast, which elementary stream belongs to which service, and what the type of an elementary stream is; video, audio, subtitle, private sections, tables, and applications. Figure 4-2 shows Multiplexing of services.

There are different SI tables based on ISO 13818 and EN 300 468 [19] for example PAT, PMT, NIT, EIT, SDT, TOT, TDT.

PAT contains PID of PMTs of all services in Transport stream. PMT contains PIDs of different components of each service, and descriptors define the type of each component. Thus, receiver by using these tables can find related components of each service.
After this introduction, we can focus on HbbTV solution.

4-3 AIT

Application can be synchronized to a service or to a program. The concept is shown in the Figure4-4.

**A: Application is synchronized with the TV program (content)**
Assume that App #1 is synchronized with program 1 of Channel 1 and App#2 is synchronized with the program 2 of channel 1.
When the viewer selects channel1, app#1 that is synchronized with the program one will be started. When program 1 is finished, App #1 will be destroyed and stopped, too. At the time of the start of program 2, App #2, which is synchronized with this program 2, will run. If the user changes the channel 1 to channel2, App #2 will stop and App #3 that is synchronized to program 3 of channel 2 will start.
In a simple word, App#1 is available only during program 1 and App#2 will be available only during program 2.

**B: App is synchronized with the TV channel (service)**
In this situation, App# 4 is synchronized with the TV channel and this App will be available on the channel regardless of program. The start and stop of App #4 is not dependent on any TV program and content. Only if a viewer changes channel 1 to channel 2, App #4 will be destroyed.
In the following, the method of this synchronization will be explained. DVB standard of “Signaling and carriage of interactive application and services in a hybrid broadcast broadband environment” defines how applications are signaled in the DVB- multiplexer. It is performed via Application Information Table. AIT contains following information that are the answers to some questions in the introduction part:

1- List of the service or program- related applications that should be run simultaneously with that service or TV program.
2- Address of applications, Broadband or broadcast: The address of application that browser of TV should use to run application, should be written in the AIT. By using this address, the receiver knows from where it should launch the application, from a webserver or a MPEG-TS. Two types of path for applications, broadband or broadcast will be explained in the following.
3- Life cycle of applications: control code of application should be written in the AIT. The Control code tells to the HbbTV receiver browser that how the application should be started and stopped. The control of presentation of application is possible with HbbTV. Broadcaster can decide to destroy application suddenly or kill the application.
4- Applications related to Security issues: defining different boundaries for applications is possible with HbbTV. For example, defining a DRM acquisition URL or analytics server for an application in the red button launcher while other applications in the launcher do not have any DRM or analytics.

**4-4 HbbTV server**

HbbTV server produces AIT. The Output of HbbTV server is connected to Multiplexer. A Reference to AIT is added into the PMT of related service and the AIT itself is added as an elementary stream in the multiplexer. Figure4-5 shows AIT insertion into the Multiplexer.
HbbTV server based on TS 102 809 [18] does following tasks:
• management of applications
• control of life cycle of an application by Producing and updating AITs
• Signaling and packaging the Application data for transmission via broadcast carousel
• Transmission of the stream event

4-5 Two ways of application delivery

HbbTV standard defines two ways for application delivery:
• Application delivery over the internet
• Application delivery over the broadcast
The mentioned ways are explained in the following:

4-5-1 Application delivery over the internet

In this way, applications should be hosted on a web server and URL of application should be written in AIT. The service will be accessible only if receiver is connected to the internet.

4.5.2 Application delivery over broadcast

HbbTV standard makes it possible to deliver application over broadcast, also. In this way, receiver will run HbbTV services without connection to internet. Of course, there is limitation in size of broadcasted application. In HbbTV 2.0.2 maximum size of application for broadcast delivery is around 3 M Bytes.
Broadcast delivery of application is done by object carousel and Digital Storage media-Command and Control (DSM-CC) standard in TS 102 809 [18]. DSM-CC makes the transmission of application in MPEG-TS possible.

In an object carousel, the files and directories of an application will be divided to modules and then to data blocks. These blocks are transmitted periodically inside Transport stream as DSMCC elementary stream. Each carousel is defined by component tag and carousel ID. Carousel server will transmit these parameters and other informative parameters as control signal.

When an application is transmitted via broadcast, AIT contains some parameters about carousel such as component tag, carousel ID and other controlling parameters related to carousel. After parsing the AIT, the receiver will read application data and files from a specific component in MPEG–TS.

4-6 Stream event

Stream event is a way for synchronization of an application to a program at a specific point in time. In HbbTV standard “Do it now’ stream event is defined for synchronization of an event to the stream. Stream event is sent via carousel and receiver will receive stream event through broadcast and launch it immediately after reception of the “Do it now” stream event. Consideration related to stream event is described in TS 102 809 [18].

One of the usages of the stream event is in advertisement. By using of stream event at the time of advertising, traditional and linear advertisement will be replaced with addressable advertisement. Stream event makes it possible to synchronize application not only with the program as a whole, but also with a specific content in the program. Certain application functionality can be enabled, triggered and disabled using the stream event signaling.

4-7 HbbTV solution in one look

Figure 4 6 shows a scheme of HbbTV solution. HbbTV applications (3rd party apps and Broadcaster apps) are loaded on HTTP servers. AIT in HbbTV server should be produced for every application that broadcaster is going to synchronize to a DVB service; the output of HbbTV server is connected to MUX in DVB Head End. Related AT to every DVB service (TV channel) should be added to PMT of that service. In this way, application can be synchronized with a specific TV service.

Usually, for synchronization of an application to a specific TV program is done by using data of EPG server. First, a launcher should be synchronized to TV service in the way that explained above. This launcher is sending a quarry to EPG server to know when a specific TV program will be present. At the time of broadcasting a specific TV program, the launcher will run application related to TV program.

If application is delivered via broadcast and by using DSM-CC, HbbTV server delivers it to MUX in DVB H.E. Carousel data and parameters should be added to the PMT of related services in MUX.
Applications can be killed or destroyed easily by using HbbTV server. Of course, there are many others details and settings such as defining a specific security for application, defining an application in present mode, signaling stream event and so on that are not the subjects of this book. For more details, refer to HbbTV standard.
5- HbbTV Application development

5-1 Introduction

Since HbbTV relies on HTML and Javascript, development of HbbTV application is not difficult for web developers. Of course, there are differences between an HbbTV application and a web application. Followings are some special features of HbbTV application:

- The content type for HbbTV HTML documents is “application/vnd.hbbtv.xhtml+xml”.
- One important difference is the concept of “application” with a defined lifecycle. As mentioned before, life cycle describes how applications are started on DVB service, how one application can start another one and behavior when the TV program is changed. Application should be visible and invisible, start and stop based on OIPF Vol.5[2] / section 7.2.2
- Another important issue in HbbTV Apps is that navigation in HbbTV application is done by remote control’s functions instead of a pointer or a touch device.
- HbbTV application should be designed for TV screen; fixed browser window size (1280 x 720 pixels) and full screen on a 16:9 screen.
- HbbTV application has access to TV channel content and it can scale TV video. HbbTV application can be fully visible or partially cropped by TV scaling.
- HbbTV application has access to TS content, for example to TSID, SID and EIT. HbbTV application can read some data from TS and act based on it.
- The HbbTV terminal via broadband connection from standard http servers usually load applications. But as mentioned before, HbbTV applications can also be transmitted via the broadcast channel using the object carousel (DSM-CC)

5-2 Application development tools

HbbTV application is based on HTML, Javascript and CSS, thus all normal web programming and design tools for developing an application can be used. Of course, there are some tools that help people to have their app without any coding skills.

For example, Sofia digital HbbTV Authoring Tool makes application development and future management easy. It is possible to author application without any specific DVB, TV, HbbTV or coding skills.

In general, the core logic of the application and communication with backend resources can be identical to similar web applications. What separates HbbTV applications from normal web applications is the use of HbbTV specific APIs and the need of designing user interface to work with a remote control and fixed screen resolution. One thing to keep in mind is that the latest browser features tend to arrive later to TV devices.
Therefore, it is still recommended to use EcmaScript 5 standard for wider support. In addition, newer CSS3 features may not be supported. HTML5 is officially only supported starting from HbbTV version 2.0.1.

5-3 HbbTV emulator tools

Since HbbTV application development is different from web app development, some emulators emulate an environment like TV environment. These emulators simulate remote control key functionality; define TV safe area and digital tuner by adding a TS stream. Developer can see its app functionality in an environment similar to TV. For example, HbbTV viewer for Mozilla Firefox and Hybrid TV Viewer for Chrome are two examples of such an environment.

![HbbTV emulator tools](image.png)

**Figure5-1 HbbTV viewer, an example of HbbTV emulator**

5-4 HbbTV application development challenges

Since behavior and functionality of application in web environment are different with TV environment, sometimes some functionalities of application need to real TS parameters, the test of application in the real environment and TV is necessary. For this purpose, the functionality of application should be tested in the collection of standard receivers. The best way to do it is to make a white list of available receivers with right functionality and to test application on them.

Some simple HbbTV transmission kits for laboratory environment are available that can help with transmission of the application to TV with lower price.

In some countries, an interoperability session is held that receiver manufactures bring
their new products and app developers can test their developed or under development applications on those receivers. Finnish Plugfest and IRT workshop are such an event that is held by Digita in Finland and IRT in Germany, respectively.

![Figure 5-2 Finnish PlugFest 2019, Digita](image)

5-5 HbbTV Application example

While HbbTV apps are normal HTML and Javascript code served from a normal web server, there are some special methods and procedures to follow, when developing one’s first HbbTV App.

Firstly, the application itself needs to be served with the correct MIME type, which is application/application/vnd.hbbtv.xhtml+xml. Some receivers will refuse to load the application if this is not configured correctly. Most HbbTV AIT generators, like Sofia Digital’s Playout Manager, will check this automatically and warn the developer if the web server is configured incorrectly.

Secondly, the application itself needs to be initialized correctly. The code for this looks like the following:

```javascript
function showApplication()
{
try {
    var app = document.getElementById('appmgr').getOwnerApplication(document);
    app.show();
} catch (e) { // ignore }
}
```

First, the application object is fetched, and then the show method is called to display the application.

To register app to listen for remote control key e events the following code can be used:

```javascript
function registerKeyListener()
```
As discussed before, all this needs also the HTML page, which will act as the launch point for the application and its code:

```html
<meta http-equiv="content-type" content="application/vnd.hbbtv.xhtml+xml; charset=UTF-8"/>
<div style="position:absolute;top:0px;left:0px;visibility:hidden;"
    <object id="appmgr" type="application/oipfApplicationManager"></object>
</div>
```

This HTML code sets the content type and adds the HTML application object. Please note that the examples above follow the HbbTV 1.5 version of the specification, which still is the most widely supported version available.
6- Receiver certification

6-1 Introduction

One of the most important advantages of HbbTV is the diversity of receivers, but it is also one of the most damaging disadvantages of it. There are so many receivers that support HbbTV, but which one of them has the desired profile and correct behavior? The broadcasters need a way to be sure about it but why is this guarantee required? Chairman of the HbbTV Certification Group explains the reasons as follows [32]:

“There are fundamental differences in the product lifecycle between TVs and other high tech consumer equipment such as PCs. TV receivers are not so easily updated, or frequently replaced then it should be ensured that receivers will support a broader range of the specification that may be used, not just those for the currently deployed application.

There are also major differences in consumer expectation regarding the product performance between these sectors. There is no expectation by the consumer that every application will work perfectly on every PC in every configuration, but they expect broadcast applications (delivered as HbbTV applications) to be displayed correctly and to function as anticipated on their TVs.

Broadcasters need this insurance because they wish to ensure that the application which they are broadcasting will be handled in the same way on every TV, regardless of the manufacturer, the software architecture or the underlying hardware “. Based on mentioned points, a conformance regime should be setup in local market to ensure receivers in the market are compatible with local specification.

Case studies show three conformance methods in different countries as follows: [33]

● Without confirmation regime
In this model, there is not any confirmation regime. Market is uncontrolled and there is not any way for viewers to be sure about the correct functionality and quality of receivers. Broadcasters are not able to add new services because they do not know which features receivers support. Many bad receivers in the market will damage the platform brand.

● Confirmation by manufacturers without the supervision of another center
In this model, their manufacturers will confirm receivers. This model relies on manufacturer’s honesty and broadcasters cannot be sure about the receiver functionality.

● Confirmation by a test center under supervision of a broadcaster
In this model, broadcasters will announce test centers and there is a logo regime confirmation. Manufacturers submit receivers for testing in a test center. The Quality of receivers is ensured and interactive applications are verified to work correctly. Because receiver functionality and quality in the market is maintained, broadcasters can plan new services. By giving the logo to certified receivers, manufacturers can show their
customers that the TV is compliant with HbbTV specification and works well. Consumer will be sure about the functionality of receivers. Some examples of HbbTV logos are Freeview play in UK, Freeview plus in Australia, Freenet TV in Germany, Toggle in Singapore and Antenna Ready SMART HD in Finland.

As explained above the most reliable way to launch the service correctly is to control the market with a logo certification regime. The logo is a label that broadcaster or operator designs. This logo informs everyone, that the receiver is certified and it can launch applications and services correctly. Receivers for getting this logo should go through a specified process with specific steps. Fortunately, HbbTV Association provides an official Test Suite and materials to facilitate this procedure.

6-2 HbbTV Association test efforts
The HbbTV Association provides a Test suite to verify that devices or components of a device are compliant to the specification. Currently the latest Test suite includes tests for ETSI Specification v.1.4.1. Tests for HbbTV Specification v.2.0.2 was published in Q1 2019. [8]

HbbTV Test suite is accessible through an HbbTV Registered Test Center that is listed by the HbbTV Association. The list includes DTG Testing Limited, DTV Accredited Compliance Lab (part of Samsung Electronics), Eurofins Digital Testing, Labwise Oy, Sofia Digital Ltd., Sony Europe Ltd. and Vestel Electronic A.S. HbbTV Registered Test Centers can offer HbbTV testing services to assist with the deployment of new services and certification of devices or components of a device.

6-3 Other test materials
With the HbbTV official test suite, HbbTV provides some additional test materials to solve specific challenges in the market. One of these materials is the HbbTV Dash DRM Reference Application.

Interoperability concerning different DRM implementations, DASH profiles and video formats have been a long-standing issue in real-world HbbTV implementations and terminals. Thus, HbbTV defined a project to develop an open source application and tools that could be used by all interested parties. One of the main targets of this project was the reduction of time to market for new DASH/DRM apps and to solve the same repeated problems by providing a common platform for anyone to adapt. Sofia Digital developed the Dash DRM Reference Application and it is available for test.[34]
6-4 Set up a local certification regime

For setting up a local certification regime following steps should be defined:

6-4-1 Authoring the receiver specification

HbbTV standard includes many features and any country should define local HbbTV profile. The Broadcaster should write receiver specification based on country profile, but before it, they should be realistic in determining their country profile. HbbTV standard contains many features, not all of which have been implemented. Receiver specification must not be a wish; it should be a feasible one and the features must be listed clearly and to make sure that the manufacturers accept it, all stakeholders should review it.

6-4-2 Defining a logo

The logo should be unique and only receivers that support the receiver specification should be allowed to use it. Consumers, retailers and manufacturers should be informed about the Logo. The logo will then tell the consumers that receivers with this logo work correctly.
6-4-3 Creation the Legal procedures for logo confirmation

Legal procedures for logo confirmation should be established and a concession policy should be developed to encourage manufacturers to adopt the logo. In addition, market should be controlled to prevent selling nonstandard receivers. All receivers should be tested in the test center before availability in the market.

6-4-4 Determining a/some test center/s and producing the Test suite

A test center should be specified for testing the receiver functionality and minimum requirements of the receiver. This test center should work with a registered HbbTV test center to test with the official Test suite. In addition, the test center should create a local test suite according to the local receiver specification. The team behind the test suite should be well-established experts so that they provide help and support for a long time. Receiver specification should be updated regularly, so the Test Suite should be updated, as well. It is also a good idea to follow the original HbbTV Test Suite format to ensure easier take-up of the local test suite by different manufacturers. For example in Spain and Nordic countries, the country-specific test suite is compatible with the main HbbTV Test Suite.

A White list of confirmed receivers can be created and receivers that are certified and received the logo should be announced in a website.

6-4-5 Announcement of the logo conformance regime

The official body controlling the conformance regime should define clear registration instructions; instruct where to go for the certification testing, and enough of the details of certification process and documentation.

6-5 An example of certification regime: The certification regime in Finland

The Nordic IRD technical specifications are established to ensure that IRDs in the Nordic market satisfy a common set of minimum requirements, independent of operator/service provider and transmission media. This specification is publishing with cooperation of different companies and operators and broadcasters. Finland as a country of Nordic region follows NorDig IRD technical specification. However, in Finland some localization on NorDig specification was created based on the country profile for the Finnish market. Finnish Antenna Ready HD and Finnish Cable Ready HD are defined as logo for IRDs.

To ensure the proper functionality of hybrid services in TV sets, Antenna Ready RY and the Finnish Federation for Communication and Teleinformatics(FiCom) agreed to start testing smart TV receivers. Antenna Ready Smart HD testing ensures that Finnish broadcaster’s Hybrid TV services function properly in TV receivers that operate in a terrestrial broadcast network and include hybrid features.
The processes of certification for logo are as follows:
The manufacturer familiarizes itself with the Nordig specifications available from nordig.org. Then after settling on entering the Finnish market, the local representative for the brand instructs the factory or parent company to consult the website for Finnish certification available at https://www.testatutlaitteet.fi/manufacturers. In the website, the two test laboratories are listed, and the manufacturer is free to choose either one.

After agreeing to the contract, the project starts, and the manufacturer, typically submits 2-3 pieces of the devices under test. The test laboratory starts the tests, and in co-operation with the manufacturer, the tests are then passed. The process takes anytime from 4-8 weeks. After a successful passing of the tests, the finalized test report is submitted to the umbrella organization for Ficom. In there, the Ficom Receiver certification experts group reviews the report and decides whether the logo can be granted to the manufacturer device platform. After successful decision, the devices are listed on the above-mentioned website. There are separate lists for Cable, Antenna and Hybrid devices. The license is valid for three years.
7- Conclusion

HbbTV brings many benefits for broadcasters and gives them a unique power for competition in the new media century. However, maximizing the impact of the benefits of HbbTV same as any other technology or standard, needs some considerations which broadcasters should notice. They are as follows:

- **Offering of attractive services**
  Broadcasters should discover their viewers’ interests, popular programs, and think how a hybrid service can help them to bring in more viewers. Case studies show that VOD, catch up, TV show content, and sports programs are popular in all countries. Offering attractive services could help with the penetration of new service and encourage viewers to provide proper receivers to receive it.

- **Creation of the same look and feel for all applications**
  Broadcasters should create a brand for themselves with a similar look in different applications, same color theme, and display of the main keys in the same place across all applications. Applications should have a specific pattern for key functionalities in remote control units and assign similar keys for main functionalities such as start, exit, and back. In this way, viewers will be familiar with broadcasters’ applications and services and know where to find content and how to interact with the application. Following this advice prevents confusion in different applications.

- **Assurance of the application functionality**
  Broadcasters should specify which application with what specifications would be certificated. Broadcasters should set up a certification process and set up a real test environment for applications. They should test the functionality of applications in approved receivers. In addition, they should define a process to be sure that the contents of an application are always updated. Broadcasters should be sensible about permitting an application to be available on HbbTV. It is not important to have many applications. It is more important to have the right and attractive applications. Offering a bad application and a bad service will cause damage to the brand.

- **Provision of the needed infrastructure**
  Broadcasters should predict the number of customers correctly, and provide the needed infrastructure for its servers to handle the traffic. Experiences of unstable or unreachable service have a very bad effect on viewers, especially when new technology is introduced.
First impressions are extremely important. Broadcasters should always be sure about the availability of services and monitor their use. Analytics, and collecting enough statistics and usage behavior, are crucial to improving services.

- **Use of safe signaling**
  HbbTV standard contains many features but not all of them have been implemented. Broadcasters should use the standard way for signaling applications to be sure most receivers can show their services. In reality, HbbTV has some limitations for delivering the application via broadcast only, such as the size of the application and its downloading time. Sometimes using stream events for synchronization leads to complication in application signaling. There are alternative ways that can be used.

- **Development of a suite of desired specifications for receivers and recirculate it with manufacturers**
  One of the most important advantages of HbbTV is the diversity of receivers, but it is also one of the most damaging disadvantages of it. There are so many receivers that support HbbTV, but which of them have the desired profile and correct behavior? The broadcasters need a way to be sure about it.
  Broadcasters should write receiver specification based on country profile, but before it, they should be realistic in determining their country profile. HbbTV standard contains many features, but not all of them have been implemented.
  Receiver specification must not be a wish; it should be possible and the features must be listed clearly. To make sure that the manufacturers accept it other stakeholders should review it.

- **Standard considerations of the right receivers**
  Some receivers do not support even the primary features. Non-standard receivers harm the service penetration and even the brand of the service. It is important to ensure the availability of compatible receivers. Thus, broadcasters should do the following steps:
  - Define a logo regime
  - Introduce some test centers to test receivers based on official receiver specification.
  - Define a well-structured test process.
  - Give the logo to the certificated receivers.
  - Inform audience about the logo and guide them to buy right receivers that have the logo.

- **Selection of the right start point for introducing the service**
  The start point of service is important. Broadcasters should arrange all success
factors and start with the best service. More applications can be introduced later, but the main service must be sufficiently complete.

- **Identification of the position of new service management in broadcasters structure**
  It is important to identify the following issues related to the new service and technology:
  - Who is responsible for certifying the application? In addition, what is the process?
  - Who is responsible for signaling service?
  - Who is responsible for updating the content of applications?

- **Bringing of other OTT service provider and operators to their platform**
  Broadcasters could negotiate with other OTT service providers and operators and make a comprehensive and widely accepted platform. However, broadcasters should also make needed restrictions on broadcast resources for them by using the correct signaling.

**And the Last Word**, Broadcasters aren’t born losers, they should know new demands of their viewers, new competitors and new capacities and offer attractive hybrid services by using their unique capabilities and internet capacities. Future belongs to people who know the opportunities and challenges sooner, try to use the opportunities, and overcome the challenges before being late.
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Glossary of Terms

Definitions

For the purposes of the present document, the following terms and definitions apply:

**Advertising VOD**: in this model, accessing the VOD is free for user and this service is based on an advertisement.

**Application data**: A set of files comprising an application, including HTML, JavaScript, CSS and non-streamed multimedia files

**Broadband**: always-on bi-directional IP connection with sufficient bandwidth for streaming or downloading A/V content

**Broadcast**: classical uni-directional MPEG-2 transport streams based broadcast such as DVB-T, DVB-S or DVB-C

**Companion screen device**: (not another HbbTV® terminal) that can run applications that in turn link to and work with an HbbTV® terminal or HbbTV® application. For example, mobile phone or tablet

**Companion screen application**: An application running on a Companion Screen and either provided by a terminal manufacturer for linking to and work with the terminal (possibly including non-HbbTV® features) or provided by a service provider that can work in conjunction with an HbbTV® application running on the terminal

**Hybrid broadcast broadband TV application**: application conformant to ETSI TS 102 796 that is intended to be presented on a terminal conformant with ETSI TS 102 796

**Hybrid terminal**: terminal supporting the delivery of A/V content both via broadband and via broadcast

**Linear A/V content**: broadcast A/V content intended to be viewed in real-time by the user

**Non-linear A/V content**: A/V content that which does not have to be consumed linearly from beginning to end, for example, A/V content streaming on demand

**Near Video On Demand**: Near Video On Demand is a pay-per-view consumer video technique used by multi-channel broadcasters using high-bandwidth distribution mechanisms such as satellite and cable television.

**Network Personal Video Recorder**: in this state video is stored at the provider’s central location rather than at the consumer’s private home.

**Subscription VOD**: in this model, the user has access to the VOD service after subscription

**Transactional VOD**: in this model, the user should pay for watching of each content of VOD
**Video recorder**: User can record the program, store it on his/her device storage, and watch it later.

**Video on demand**: Video On Demand is a programming system that allows users to select and watch/listen to video or audio content such as movies and TV shows whenever they choose.

### Abbreviations

For the purposes of the present document, the following abbreviations apply:

- **A/V**: Audio Video
- **AIT**: Application Information Table
- **API**: Application Programming Interface
- **AV**: Audio Video
- **AVOD**: Advertising VOD
- **CAS**: Conditional Access System
- **CDN**: Content Delivery Network
- **CE-HTML**: Consumer Electronics - Hypertext Markup Language
- **CENC**: Common Encryption
- **CI**: Common Interface
- **CICAM**: Common Interface Conditional Access Module
- **CS**: Companion Screen
- **DAE**: Declarative Application Environment
- **DASH**: Dynamic Adaptive Streaming over HTTP
- **DIAL**: Discovery And Launch
- **DNS**: Domain Name System
- **DNT**: Do Not Track
- **DRM**: Digital Rights Management
- **DSM-CC**: Digital Storage Media - Command and Control
- **DTT**: Digital Terrestrial Television
- **DVB**: Digital Video Broadcasting
- **DVB-C**: Digital Video Broadcasting – Cable
- **DVB-S**: Digital Video Broadcasting – Satellite
- **DVB-SI**: DVB Service Information
- **DVB-T**: Digital Video Broadcasting – Terrestrial
- **EIT**: Event Information Table
- **EPG**: Electronic Program Guide
- **FDP**: File Delivery Protocol
- **HbbTV**: Hybrid broadcast broadband TV
- **HDR**: High Dynamic Range
- **HEVC**: High Efficiency Video Coding
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<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>HFR</td>
<td>High frame rate</td>
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<tr>
<td>HLG</td>
<td>Hybrid Log-Gamma</td>
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<tr>
<td>HTML</td>
<td>Hypertext Markup Language</td>
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<tr>
<td>HTTP</td>
<td>Hypertext Transfer Protocol</td>
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<tr>
<td>HTTPS</td>
<td>Hypertext Transfer Protocol – Secure</td>
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<td>IP</td>
<td>Internet Protocol</td>
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<td>IPTV</td>
<td>Internet Protocol Television</td>
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<td>IRD</td>
<td>Integrated Receiver Decoder</td>
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<tr>
<td>MHEG</td>
<td>Multimedia and Hypermedia Experts Group</td>
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<tr>
<td>NVOD</td>
<td>Near Video On Demand</td>
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<tr>
<td>MPEG</td>
<td>Motion Picture Experts Group</td>
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<td>NGA</td>
<td>Next-Generation Audio</td>
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<td>NPVR</td>
<td>Network Personal Video Record</td>
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<td>OIPF</td>
<td>Open IPTV Forum</td>
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<td>OTT</td>
<td>Over the Top TV</td>
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<td>PAT</td>
<td>Program Association Table</td>
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<td>PES</td>
<td>Packetized Elementary Streams</td>
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<td>PID</td>
<td>Packet Identifier</td>
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<td>PMT</td>
<td>Program Map Table</td>
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<td>PSI</td>
<td>Program Specific Information</td>
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<td>PVR</td>
<td>Personal Video Recorder</td>
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<td>SVOD</td>
<td>Subscription VOD</td>
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<tr>
<td>TTML</td>
<td>Timed Text Markup Language</td>
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<td>TV</td>
<td>Television</td>
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<td>TVOD:</td>
<td>Transactional VOD</td>
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<tr>
<td>UI</td>
<td>User Interface</td>
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<tr>
<td>URL</td>
<td>Uniform Resource Locator</td>
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<td>VOD</td>
<td>Video On Demand</td>
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<tr>
<td>XML</td>
<td>extensible Markup Language</td>
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IRIB Research and development

IRIB R&D develops innovative new products and technologies in broadcast/broadband industry that will shape tomorrow. Research and development activities could be classified in providing strategic and practical researches, technology trend monitoring, internal production, executing pilot experiments and cooperating technical committees. Till now, a lot of successful projects have been operated, such as DSNG antenna, Master Control System, DVBT transmitters, Comprehensive Intercom System, Industrial UPS, Switches, Comprehensive New Media Architecture, Social TV and Hbb trial.

Sofia Digital

Sofia Digital specializes in open standard TV platforms, over-the-top streaming services, and Internet technologies. Sofia Backstage® Platform is available for powering smart TV apps, interactive TV services including management of any DVB, EPG and HbbTV services as well as TV and VOD metadata integration. Its offering includes also application templates, standalone and customized TV applications. Sofia Digital in co-operation with TV industry and manufactures and as an active member of the HbbTV Association provides the best possible level of interoperability for HbbTV and MPEG-DASH deployed in global TV markets.