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Radiocommunication Sector of ITU

Recommendation ITU-R BT.2075-1
(01/2017)

Integrated broadcast-broadband system

BT Series
Broadcasting service
(television)

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Note: This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.

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RECOMMENDATION ITU-R BT.2075-1*

Integrated broadcast-broadband system

(Question ITU-R 131/6)

(2015-2017)

Scope

This Recommendation provides guidance in choosing an integrated broadcast-broadband (IBB) system. The guidance is described in terms of service capabilities and technical elements of the IBB systems.

Keywords

Integrated Broadcast-Broadband (IBB), HbbTV, HybridCast, TOPSmedia, Ginga

The ITU Radiocommunication Assembly,

considering

- a) that Question ITU-R 131/6 has invited the ITU-R to study, *inter alia*, what data structure(s) is(are) most suited to conveying multimedia information to digital broadcast receivers and what application programming interfaces (APIs) should be specified for multimedia applications in broadcasting and webcasting platforms;
- b) that Report ITU-R BT.2267 describes several IBB systems;
- c) that Recommendations ITU-R BT.2037 and ITU-R BT.2053 define requirements of IBB systems;
- d) that devices with broadband Internet access are becoming widely available and offer multimedia applications;
- e) that an ability to provide connected-TV enabled devices with already integrated off-the-shelf applications is of relevance to the end-user;
- f) that an addition of content delivery over broadband network to the broadcast channel optimizes the bandwidth usage of the broadcast channel;
- g) that common platforms are desirable for production and international exchange of IBB content and applications,

recommends

- 1 that administrations, broadcasters, and related industries wishing to implement an IBB system should consider the service capabilities and technical elements of the IBB systems described in this Recommendation;
- 2 that the IBB systems listed in the Annex should be considered for the choice of an IBB system and implementation of IBB services.

* Radiocommunication Study Group 6 made editorial amendments to this Recommendation in March 2017, in October 2017 and in April 2018 in accordance with Resolution ITU-R 1.

Annex

1 Introduction

This Recommendation provides guidance information for administrations, broadcasters, and related industries to consider implementing an IBB system. Section 3 describes the IBB systems while §§ 4 and 5 describe the service capabilities and technical elements of the IBB systems.

2 Abbreviations

ACAP	Advanced common application platform
CEA	Consumer Electronics Association ¹
DAE	Declarative application environment
DASH	Dynamic adaptive streaming over HTTP
DRM	Digital rights management
DTV	Digital Television
DVB	Digital video broadcasting
IBB	Integrated broadcast-broadband
MMT	MPEG media transport
MPEG	Motion picture expert group
OIPF	Open IPTV forum
VOD	Video on demand
W3C	World Wide Web Consortium

3 The IBB Systems

3.1 System definition

The IBB Systems considered in this Recommendation are defined by the following specifications or standards.

HbbTV	For HbbTV1.5: ETSI TS 102 796 V1.2.1 (2012) http://webapp.etsi.org/ewp/copy_file.asp?wki_id=39272
	For HbbTV 2.0.1: ETSI TS 102 796 V1.4.1 (2016) http://www.etsi.org/deliver/etsi_ts/102700_102799/102796/01.04.01_60/ts_102796v010401p.pdf ²
Hybridcast	IPTVFJ STD-0010 and STD-0011 http://www.iptvforum.jp/en/download/ ARIB STD-B62 V1.0 http://www.arib.or.jp/english/html/overview/sb_ej.html

¹ In 2015, CEA was renamed CTA (Consumer Technology Association).

² NOTE – HbbTV version 2.0.1 supersedes HbbTV 2.0, published by ETSI in 2015.

TOPSmedia	HTML5 based Smart TV Platform, TTAK.KO-07.0111/R1 http://www.tta.or.kr/eng/new/standardization/eng_ttastddesc.jsp?stdno=TTAK.KO-07.0111/R1
Ginga	ABNT NBR 15606 (2016) series http://www.abntcolegao.com.br/coltv.aspx?Q=CING45WV08&ID=361668 http://www.abntcolegao.com.br/coltv.aspx?Q=CING45WV08&ID=361857 http://www.abntcolegao.com.br/coltv.aspx?Q=CING45WV08&ID=361860 http://www.abntcolegao.com.br/coltv.aspx?Q=CING45WV08&ID=361862 Recommendation ITU-T H.761 (2014), Nested Context Language (NCL) and Ginga-NCL http://www.itu.int/rec/T-REC-H.761

3.2 System summary

3.2.1 HbbTV

HbbTV (Hybrid Broadcast Broadband TV) is an industry standard providing an open and business neutral technology platform that seamlessly combines TV services delivered via broadcast with services delivered via broadband and also enables access to Internet only services for consumers using connected TVs and set-top boxes.

The HbbTV specification is based on existing standards and web technologies including OIPF (Open IPTV Forum), CEA, DVB and W3C. The standard provides the features and functionality required to deliver feature rich broadcast and internet services. Utilizing standard Internet technology, it enables rapid application development. It defines minimum requirements simplifying the implementation in devices and leaving room for differentiation, this limits the investment required by CE manufacturers to build compliant devices.

For a Connected TV set that is equipped with the HbbTV function, the consumer just has to push the red button on the TV's remote control to make the HbbTV launch page of the corresponding broadcaster visible. Subsequently, the end-user can select all services (incl. video-on-demand (VOD) and search functions) that are offered by or via this broadcast service specific portal. Example: A user would like to have more information on, say "Napoleon". The result of the search will be a list of all Napoleon-related video clips that are stored and offered by the collaborating broadcasters. Potentially, sound radio programmes and adapted Web-pages (incl. pictures and text files) could also be included in the result list. Viewing of the retrieved content is currently accomplished on the TV set but may in future also happen on a second screen, e.g. on a tablet computer.

HbbTV was developed in 2009 and first standardized by ETSI in 2010. Version 1.5 of the HbbTV specification has been published by the HbbTV Consortium in April 2012. Standardization of HbbTV 1.5 as ETSI TS 102796 v1.2.1 took place by ETSI in November 2012. Amongst other new features, adaptive streaming (in line with MPEG-DASH³) is supported. The latest version is HbbTV 2.0.1, published by ETSI as ETSI TS 102 796 V1.4.1 in August 2016. It includes an HTML browser profile and a number of additional features (many of them in the domain of companion screen integration and stream synchronization).

HbbTV is used for information, education and entertainment (e.g. catch-up TV). It is also used for commercial applications (music download, online shopping, (targeted) advertisement, etc.). HbbTV is very suited to provide access services for people with disabilities: signer video, audio description, spoken subtitles, multi-lingual text subtitles, multi-language sound tracks or additional sound tracks with clear(er) audio dialogues, etc. It was also demonstrated that HbbTV represents a prime means to alert the general public in case of a crisis (automatic popup of alert messages).

³ The acronym DASH stands for "Dynamic Adaptive Streaming over HTTP", an MPEG standard for adaptive bit-rate media streaming (ISO/IEC 23009).

3.2.2 Hybridcast

Hybridcast, the IBB system that uses HTML5, was standardized in Japan for versions 1.0 and 2.0 in March, 2013 and June, 2014 respectively. The system facilitates the offering of services through a combination of broadcast and broadband telecommunication resources and features. The latest specifications considered most of the requirements in Recommendations ITU-R BT.2053 and ITU-T J.205 including broadcast centric scenario. To achieve the required functionalities, the specifications define system model, application model, application control signals, receiver behaviour, additional APIs etc. The specifications also define mechanisms and functionalities for companion device collaboration, non-broadcast-oriented managed application, application programming interfaces (APIs) for accurately synchronized presentation of video or graphics with broadcast video, application invocation for playing back of VOD or recordings, and support for MPEG-DASH.

In addition, to support interactive ultra high definition television (UHDTV), ARIB STD-B62, ‘the second generation multimedia coding scheme for digital broadcasting’, was standardized in July 2014. ARIB STD-B62 defines Hybridcast application environment for UHDTV with MPEG2-TS and MPEG media transport (MMT). When using MPEG2-TS, existing digital broadcasting standards can be used for interactive UHDTV services. When using MMT, ARIB STD-B62 states how Hybridcast application environment works with MMT.

One of the system specifications, IPTVFJ STD-0010, defines system model, application model, application control signals, transport protocols, behaviour for using VOD, monomedia coding, and receiver functions. IPTVFJ STD-0011 defines HTML application structure, behaviour and syntax of elements, and additional objects and APIs.

In Hybridcast standards, two types of applications are defined to allow flexible and varied IBB services. One of the types, broadcast-oriented managed application, is an application which is strictly associated to broadcast channels. This type of applications is controlled by an application control signal delivered over broadcast signals to launch and terminate such applications. The other type, non-broadcast-oriented managed application, is an application authorized by broadcasters and allowed access to broadcast resources. Non broadcast-oriented managed applications are allowed to be presented with broadcast programmes simultaneously, and end-users can control the launch and termination of the applications at any time regardless of the selection of broadcast channel.

All Hybridcast applications are under control of application control information. When providing service associated IBB services which is tightly combined with broadcasting services and can be provided by broadcast-oriented managed applications, providing a retrieval chain of application control information initiated by broadcast services is required. For stand-alone IBB services independent from broadcast channels and provided by non-broadcast-oriented managed applications, it is assumed that a receiver obtains application control information from repository servers. Application control information for this type notifies broadcast and receiver resources the application accesses. Broadcasters provide application control information that contains information on execution condition and access restriction to broadcast resources. A receiver evaluates application control information from both application repository and broadcasters, and determines how to manage the application. Formats of application control information are defined in ARIB STD-B24, IPTVFJ STD-0011 and ARIB STD-B60 each of which is used for relevant delivery channels and services.

Hybridcast services were launched in September, 2013. Hybridcast is used to offer a variety of information including news, weather, stock market information, Electronic Program Guide (EPG), and VOD as well as program related services for quiz shows. HTML5 allow the provision of rich and useful services by involving existing web servers and thus the number of services that use Hybridcast is increasing rapidly.

3.2.3 TOPSmedia

TOPSmedia (TV Open Platform for Smart media) is an open smart TV platform standard that specifies the web runtime environments for smart TV application based on state-of-the-art HTML5 technologies. (The official title of the standard is “HTML5 based Smart TV Platform, TTAK.KO-07.0111/R1”) An application in compliance with this specification can be developed and deployed taking advantage of HTML5 features and interfaces, and will provide the same user experience on smart TV receivers from various broadcasting systems like terrestrial, cable, satellite and IPTV.

This specification suggests four criteria to define smart TV application’s types considering smart TV’s specific features different from PC or smart phone. They consist of execution method, application packaging, broadcasting resource relation and channel bound.

According to four criteria, application can be divided into signal application, store application and broadband application, or divided into package application and non-package application, or divided into broadcast activated application and broadcast inactivated application, or finally divided into channel bound application and channel unbound application. These kinds of applications types define the specific smart TV receiver’s behavior according to these types of requirements.

Furthermore, it defines smart TV extended APIs that is the set of interfaces to support smart TV specific features such as smart TV application, broadcasting resources, smart TV devices and other advanced functionalities.

Through the extended APIs, smart TV application can use interfaces to manage current running application like create, destroy and key/permission control, to control broadcasting video, channel and program, to get information about manufacturer, model and version. Besides, the extended APIs also supports multiscreen interfaces to communicate and work together with companion devices like smart phone or tablet and digital rights management (DRM)⁴ interfaces to present protected contents.

Finally, to support the application’s lifecycle control according to application signal provided by broadcaster, this specification defines an application signal profile based on AIT of ETSI TS 102 809. It defines application package profile for configuration and compression format to support download and install from application repository. Furthermore, it has other features like protocol and contents formats, receiver minimum requirements and own profile definitions. This specification has been developed in continuous relationship with the standardization committee of TTA (Telecommunications Technology Association). The next version will include new features like content synchronization, remote application control, advanced user input like gesture and voice control, T-commerce and so on. This future version is expected to be completed during the year 2015.

Currently, a few of the cable and IPTV broadcaster in Korea have been developed and tested smart TV receivers compliant with this specification, and it is expected that they will start an official launch of the TOPSmedia during the year 2015.

3.2.4 Ginga

Since its first version, Ginga middleware targets the integration of DTV and broadband services. Ginga was developed in 2006 and firstly standardized by ABNT (Associação Brasileira de Normas Técnicas) in November, 2007. IBB support in Ginga is provided by functional components and APIs defined throughout its subsystems, which include the Ginga Common-Core, Ginga-NCL and Ginga-J. Their current specifications, standardized under the ABNT NBR 15606 (2016) series, fully address IBB requirements as specified in Recommendation ITU-R BT.2053.

⁴ The term “digital rights management” (DRM) refers to the management of user access to protected content and protected services.

In Ginga, application signalling and life-cycle control is delivered by using application information table (AIT), in accordance with ABNT NBR 15606-3. The AIT can signal applications bounded to the DTV Service or Service Associated Application. The signalling and life-cycle control are managed by selected broadcaster.

DSMCC Object Carousel is used as transport protocol for applications delivered within the DTV Signal. Alternatively, applications can be retrieved through a broadband channel by using the HTTP protocol. The transport protocol mechanism is signalled in the AIT by using the transport protocol descriptor in accordance to ABNT NBR 15606-3.

Once the application is being executed in the receiver, it can use protocols such as HTTP, HTTPS, or more basic IP-based protocols such as TCP sockets and UDP, to communicate with servers or retrieve additional resources (code, images, video, audio, etc.) through a broadband channel.

Ginga-CC delivers applications with their associated media content that can come from broadcast channels or broadband IP services to Ginga-NCL (nested context language) or Ginga-J, depending on the type of application.

Ginga-NCL is tasked with running NCL applications. NCL applications are collected inside a data structure known as private base. Ginga associates at least one private base with each TV channel (set of services) in which service associated applications are stored. Stand-alone applications are managed in specific private bases: one for resident applications and another for installed applications. Applications in a private base may be edited, started, paused, resumed, aborted, stopped, saved and may refer to each other.

A private base manager component is tasked with supporting signalling mechanism (NCL editing commands and control delivered using AIT table control code field) used to control when and how the application must be active/inactive, installed/removed, available/unavailable, visible/hidden, etc., or even if control must be left completely to the end-user. The AppCatUI is an extension of the Ginga middleware that must be provided by the IBB receiver, intended for listing the available applications in the private base data structure that can be launched by the end user, adding, moving and removing applications, in agreement with Recommendation ITU-T J.205.

NCL is the declarative language of Ginga. Its characteristics make it a sound declarative solution for IBB services: the language flexibility; its reuse facility; multi-device support (companion device collaboration); presentation and application content adaptability; API for building and modifying applications on-the-fly; and, mainly, its intrinsic high-level ability for easily defining spatiotemporal synchronisation among media assets (including viewer interactions). For particular procedural needs, e.g. when more complex dynamic content generation is required, NCL provides support to the Lua scripting language. NCL applications have a stricter separation between its content and its structure. NCL does not define itself any media content. Instead, it defines the glue that holds media objects together in multimedia presentations. An NCL document (NCL application code) only defines how media objects are structured and related, in time and space. Each media object of NCL specifies the URI Scheme used to retrieve its content. Depending on the specified scheme, Ginga-NCL knows if it has to get the content from the broadcast signal, from the IP network or from local storage.

Ginga-J is the procedural environment of Ginga, based on the Java language. Its stack includes the core API from Recommendation ITU-T J.202 and Recommendation ITU-R BT.1722 (specifically, CDC 1.1, FP 1.1, PBP 1.1.2 and JavaTV 1.1), the JavaDTV set of API as defined in ABNT NBR 15606-6, and a set of system-specific API defined in the ABNT NBR 15606-4.

The first commercial Ginga implementations appeared in 2008. In 2009, NCL 3.0 and its presentation environment Ginga-NCL became part of Recommendation ITU-T H.761 for IPTV services and Recommendation ITU-R BT.1699 and the Ginga-J environment became part of Recommendations ITU-T J.202 and ITU-R BT.1722. Since then, many countries, particularly in South America, have adopted Ginga as the middleware of their terrestrial DTV standards, based on the ISDB-Tb

International Standard. More recently (2014), the latest version of Recommendation ITU-T H.761 for IPTV services defines NCL 3.1 and its presentation environment Ginga-NCL which introduces new features to better support IBB DTV services. Currently, work is underway towards NCL Version 4.0.

At the present time, consumer equipment manufacturers offer a large number of models of Ginga-enabled TV sets, set-top boxes and smartphones. There are open source implementations for Linux, Windows, MAC OS, and Android platforms which can be embedded in desktop computers, tablets, smartphones, etc. Some consumer equipment manufacturers offer these open source implementations in their products. Ginga-based applications have been used for information, education, entertainment, online shopping, advertisement, government services, early warning services, etc.

4 Service capabilities of the IBB systems

This clause describes what service capabilities are provided in each system. It has to be noted, however, that this list is not exhaustive and the systems may incorporate more technical elements and that they may differ in which additional elements they provide.

4.1 Items to be considered

Recommendation ITU-R BT.2053 – *Technical requirements for integrated broadcast-broadband systems*, defines requirements for IBB applications and their environments. From technical perspective, some important requirements to characterize the system are chosen. Furthermore, other items are added from the view point of service provisioning.

– Relationship with interactive TVs

If the IBB system works with digital TV services which already provide interactive services from other systems, it is important to manage IBB application and interactive content. For example, interactive Digital TV (DTV) service launches first then interactive content switches to the IBB application, or vice-versa. This item describes the capability of managing both services for the system.

– Support various types of IBB services

IBB services are provided by functions of IBB applications and there are some application types. As described in Recommendations ITU-R BT.2053 and ITU-T J.205, service associated applications are those applications that are part of IBB DTV service. They are delivered or listed as a component part of the DTV service. In addition, within service associated applications, there are two types of applications.

- Service exclusive applications

Execution of service exclusive applications (service bounded) must be terminated when the service exhibition is stopped.

- Service shared applications

Service shared applications (service unbounded) execution should continue in case the same application is also signalled in the service that is selected next.

Stand-alone applications are those applications that are not part of IBB DTV service. Stand-alone applications can be launched and terminated at any time through end-users instructions regardless of the broadcast service that is selected.

Third-party applications are those applications delivered by service providers other than broadcasters. Such applications may or may not have relationship with broadcast programs.

The type of services, such as programme-related services by service associated applications that are supported conditionally should be described in these items.

– **Application lifecycle control**

Lifecycle control is the control of when to start and terminate an application. Lifecycle should be controlled properly in accordance with application context and IBB services. Some applications should be controlled by broadcasters, while others can be controlled by end users.

– **Service integrity and security**

Broadcasting content is a subject of rights management. Unintended presentation should be avoided. At minimum, content presentation should be distinguished from other presentation material of applications that are outside the control of broadcasters.

– **End user privacy protection**

Applications can be accessed by certain areas in a receiver where personal information is stored. Unauthorized access to such areas should be prohibited.

– **Content protection**

A mechanism to protect broadcast content against malicious activity of the applications, including piracy.

– **Companion device collaboration**

Companion devices are those devices used with an IBB receiver for presentation and interaction. Collaboration with companion devices is considered an effective presentation method, and user interaction is controlled by applications.

– **VOD playback**

This describes possible user experience for VOD playback, such as the capability of offering the same or equivalent user experience as that for live broadcasting.

– **Applicability to UHD TV**

This describes applicability of IBB services with UHD TV broadcasting.

4.2 Consideration on service capabilities

TABLE 1
Comparison of service capabilities

	Hybridcast	HbbTV	TOPSmedia	Ginga
Relationship with interactive TV	Hybridcast can work as an interactive TV environment by delivering of applications and required resources over broadcast signals. In addition, Hybridcast can switch to another interactive TV environment such as broadcast markup language (BML), thus a service can be built by using both. A broadcaster can choose which one should be used first.	HbbTV can work as interactive TV environment with and without broadband connection. Interactive content can be program associated or stand-alone application. HbbTV is usually activated via RED button on a remote control.	It can work as interactive TV environment by running various types of smart TV applications. However, it does not consider to work with another interactive system like ACAP. They work exclusively by the policy of broadcaster.	Ginga can work as interactive TV environment with and without broadband connection. Service associated applications and stand-alone applications are supported. The type of application is signalled by broadcasters and thus identifies if IBB functions will be needed or not.
Support of service associated IBB services	Supported by using broadcast-oriented managed application.	Supported by using broadcast related applications.	Supported by using broadcast activated application.	Supported by using broadcast managed (signalled) applications.
Support of stand-alone IBB services	Supported by one of the available application types called non-broadcast-oriented managed application which can be started and stopped by end-users at any time. Execution of and access to broadcast resource by non-broadcast-oriented managed applications are required to be permitted by broadcasters for simultaneous presentation.	Supported A broadcast-independent application is not associated to any broadcast channels. A broadcast-independent application is not allowed to access to broadcast resources.	Supported by using broadcast inactivated application. While the application is running, broadcasting resources like demultiplexer and decoder are suspended and access to them is not allowed.	Supported. Stand-alone applications can be signalled as broadcast managed applications, by using the UNBOUNDED control code in the AIT. Otherwise, stand-alone applications are not allowed to access to broadcast resources.

TABLE 1 (continued)

	Hybridcast	HbbTV	TOPSmedia	Ginga
Support of third-party provided IBB services	By using service associated IBB applications, broadcasters or associated service provider can switch to or involve third-party provided IBB services. Third-parties can offer their own services by stand-alone applications as far as broadcasters permit for execution by giving execution and presentation condition to them.	Third-party can provide any application and broadcaster can authorize it by signalling. Under these circumstances, broadcasters signal that application's lifecycle by using AIT.	Third-party can make smart TV application compliant with this standard. To obtain a broadcaster's authorization to access broadcasting resources, a broadcaster can define a policy for the permission of broadcast activated applications.	Service-associated IBB applications can involve third-party IBB services, when signalled by the broadcaster. They must be signalled as broadcast managed applications in the AIT.
Application lifecycle control by provider	Supported	Supported	Supported	Supported
Application lifecycle control by end-user	Stand-alone applications by non-broadcast-oriented managed applications allow control application lifecycle by end-users.	Stand-alone applications can be controlled by end-users.	End-users can download and install applications from an application repository ("app store"). End-users can control the lifecycle for such applications.	Service associated applications can be signalled with specific AIT control codes that enable lifecycle control by the end user. Stand-alone applications can be controlled by end-users.

TABLE 1 (continued)

	Hybridcast	HbbTV	TOPSmedia	Ginga
Service integrity and security	Service associated applications by broadcast-oriented managed applications are considered as under the control of signals provided by broadcasters at all times. For stand-alone applications by non-broadcast-oriented managed applications, broadcasters can grant permission and conditions for execution of each application.	Service associated applications by broadcast related applications are considered as under the control of signals given by broadcasters at all times.	Service associated applications by signal applications and broadcast activated applications are considered as under the control by broadcasters at all times. On the other hand, service associated applications downloaded from a store and broadcast activated applications are considered as under the permission and control of broadcasters.	Service associated applications and stand-alone applications are under control of signals issued by broadcasters at all times. Broadcasters can explicitly grant permissions to specific stand-alone applications to behave as if they were part of the service by signalling through the AIT.
End-user privacy protection	Same as typical web browsers, i.e. local resource access from an application is prohibited.	Same as typical web browsers, For object carousel's resources, original domain definition using DVB schema is specified for CORS.	Same as typical web browsers.	Same as typical in the Web. In the case of Ginga-J applications, they are executed in a sandboxed environment with limited and controlled access to the file system and user properties. Ginga-J applications can use TLS/SSL Sockets for server authentication and securing user communication.

TABLE 1 (continued)

	Hybridcast	HbbTV	TOPSmedia	Ginga
Content protection	Audio and video content are protected by (DRM). In addition, a dedicated object to access to broadcast video images is defined to avoid image capture by an application.	Using DRM (MPEG CENC) Actual DRM system is defined by each service provider.	DRM-protected contents can be presented by applications using DRM APIs.	Ginga relies on content protection mechanisms as provided by the underlying IBB service provider. For example, in ISDB-Tb, Ginga relies on ABNT NBR 15605-1, which specifies content protection for broadcast A/V.
Companion device collaboration	Supported. APIs for communication between applications on a receiver and a companion device allow the creation of a basic service that uses companion devices. In addition, models for communication between many functional entities in a receiver and a companion device such as built-in functions will allow more useful services.	Supported from V2.0.	Supported. The smart TV application using multiscreen APIs can discover companion devices like smart phone or tablet and communicate with them.	Supported. Different abstraction levels are supported. In Ginga-NCL, multi-device API allows for easy device collaboration by identifying devices as classes (groups) that can be used to render synchronized media transparently for the programmer. Ginga-J applications can use the available network API to implement discovery and communication protocols (such as UPnP, Multicast DNS, DNS-SD) between DTV receiver and user devices.

TABLE 1 (*end*)

	Hybridcast	HbbTV	TOPSmedia	Ginga
VOD playback	The application bundled with VOD content can be started by 'tuning to' the content. It is the same for the recordings.	Supported	Supported	Supported
Applicability to UHDTV	Maximum resolution for Hybridcast is not determined thus UHDTV is supported. ARIB STD-B62 defines how the Hybridcast application environment works with MMT or MPEG2-TS based UHDTV signals.	Supported for the broadcast part. Supported for the broadband part from V2.0.	Not supported yet.	Maximum resolution for video is not determined by Ginga.

5 Technical elements of the IBB systems

This clause describes how technical elements are designed in each system. It has to be noted, however, that this list is not exhaustive and the systems may incorporate more technical elements and that they may differ in which additional elements they provide.

5.1 Items to be considered

a) Coexistence with interactive TV systems

As described in § 3.1, an IBB system can be built over existing digital broadcasting systems. In some cases, an IBB system is required to coexist with interactive TV systems already deployed. For such cases, information on whether an IBB system is designed with such considerations, and how to do it, is required.

b) Transport related items

These items describe the delivery channels that are available for service components, i.e. application, content, metadata, and application control signals, on each system. There may be some conditions for combination.

c) Supported application types

In Recommendations ITU-R BT.2053 and ITU-T J.205, several application types are defined. Supported application types are fundamental system designs of the IBB systems. Hence, describing supported application types to characterize IBB systems is useful.

d) Application format

Application format is that format used for creating applications such as HTML or Java. Selection of application format affects the capability of IBB systems, ease of deployment and implementation, etc. Future work will identify a common core of the application formats of the IBB systems described in this Recommendation.

e) Application authentication

Authentication of an application is to ensure execution of a proper application. In IBB systems, this mechanism contributes to mitigate the risk of inconsistent simultaneous presentation of applications and broadcast programmes. Inconsistent presentation may lead to misunderstanding the intention of broadcast programmes. In addition, this mechanism contributes to mitigate the risk of malicious applications. There are several methods for authenticating applications, such as authentication based on the trust chain using delivery channel combinations, or using cryptography. Whereas there are various approaches and mechanisms, having information on a mechanism and/or concept of application authentication in each IBB system is useful.

f) Security and permission control to access resources

An IBB application requires the access of various resources, including those provided through broadcast channels. An appropriate access control should be essential to maintain copyright, privacy of end users, presentation consistency, etc. Conditions to access control may vary by application, broadcaster, or service provider. This item is to describe mechanisms or related information of each IBB system in order to achieve appropriate security and access control.

g) Protocols available for broadband access

In IBB systems, various types of information are delivered over broadband channels. This item describes the protocols used over broadband channels for both downward and upward directions.

h) Protocols for broadcast channel, including delivery of application data

This item describes the protocols for broadcast channels for various data and applications.

i) Available delivery channels for application triggering and messaging

The use of application triggering and messaging to notify and/or update information processed by IBB applications is an important aspect for IBB services. This item describes how the signal is delivered to applications.

j) Supported video formats and encoding

This describes supported video formats and their encoding schemes. When an IBB system is capable of video streaming over broadband channels, usable bandwidth consideration may be a factor for selection video formats and their encoding scheme.

k) Supported audio formats and encoding

Similar to supported video formats and encoding, supported audio formats and their encoding scheme should be described.

l) Subtitle control and formats

Subtitle or closed caption is an important component and service for broadcast services. This item describes how an IBB system supports this feature.

m) Storage access and management

Some IBB applications may require local storage in a receiver. When using local storage, functions to access it are required for applications. In addition, storage management mechanisms are required regardless of the required capacity for local storage or IBB services. This item describes how to access and manage local storage by IBB applications or IBB receiver functions.

n) Signalling format and delivery

In general, application signalling is used to advertise the existence of applications, control of application lifecycle, to provide metadata or property information of an application, etc. Describing the information contained in signalling and its delivery method to characterize an IBB system is useful.

o) Synchronization between applications and broadcast programmes

For applications that make progress in accordance with the progress of broadcast programmes, synchronizing with such broadcast programmes is important. In addition, if an application that manages multiple time-constrained materials, such as broadcast stream and streaming content over broadband network, controlling the synchronization between such materials might be required. In device integration, it is important to maintain synchronization between a broadcast programme, an application on a broadcast receiver, and an application on a second screen device in order to provide an integrated user experience to viewers. This item describes the mechanism and purpose of synchronization features of each IBB system.

p) Protocol for device integration

Device link is achieved through communication between devices and/or applications. Protocol for such communication is the subject for standardization in some cases. This item describes information on this.

q) Device discovery protocol for device integration

Device discovery is one of the most important functions for device integration. Device discovery is normally performed in an early stage of the establishment of device integration to find a device or application with which to communicate. There may be various mechanisms for it. The entity, such as an application or preinstalled function in a receiver, that is responsible for device discovery affects the application behaviour and structure of the APIs of IBB systems.

r) VOD Playback

Playing back VOD content controlled by an IBB application is natural behaviour. However, time shift for watching a TV programme by using VOD playback instead of selection of a broadcast channel is different, because normally, the IBB application does not start at the moment playback starts. If an IBB system can offer the same user experience for time shift watching as that for live watching, there might be a need for mechanisms that allow to start the same or equivalent application as that for live events. In addition, consideration for 'trick' play is also required.

5.2 Consideration on technical elements

TABLE 2
Comparison of technical elements

	Hybridcast	HbbTV	TOPSmedia	Ginga
Coexistence with interactive TV systems	An API to switch to other interactive TV environment(s) is defined. Application control signals can provide prioritization information that designates what should start first.	To be developed by broadcasters or with associated service provider	It is assumed not to work together with another interactive system like ACAP. They work exclusively by the policy of broadcaster.	Ginga IBB-enabled receivers are capable of presenting interactive content from conventional Ginga DTV services. Application signalling defines the type of application (IBB or DTV)
Available delivery channels for application	Broadcast and/or broadband.	Broadcast and/or broadband.	Broadband only.	Broadcast and/or broadband.
Available delivery channels for content (Note)	Broadcast and/or broadband.	Broadcast and/or broadband.	Broadcast and/or broadband	Broadcast and/or broadband.
Available delivery channels for metadata	Broadcast and/or broadband.	Broadcast and/or broadband.	Broadcast and/or broadband	Broadcast and/or broadband.

TABLE 2 (continued)

	Hybridcast	HbbTV	TOPSmedia	Ginga
Available delivery channels for application control signal	Broadcast and/or broadband. Delivery of application control signals over broadband is for cases of application invocation call by another application, including that of other interactive TV standards, such as broadcast markup language, and stand-alone applications	Broadcast and/or broadband. Acquisition of AIT through broadband channel is used for starting broadcast-independent applications. For broadcast-related applications, AIT will be received through broadcast interface.	Broadcast only An application can be signalled and launched via AIT information provided by broadcast.	Broadcast and/or broadband (Rec. ITU-T H.761 specifically). Delivery of application control signals uses (broadcast and broadband) mechanisms available through the AIT and through NCL Editing Commands.
Support of service associated application	Supported This type of application can be started by an application control signal transmitted over a specific broadcast channel to which the application belongs.	Supported This type of application can be started by an application control signal transmitted over a specific broadcast channel to which the application belongs.	Supported This type of application can be started by an application control signal transmitted over a specific broadcast channel to which the application belongs. An application downloaded from a store can also be started by end-users as an application that is configured to broadcast activated application (access to broadcast resources are limited by application permission).	Supported. This type of application can be started by an application control signal transmitted over a specific broadcast channel to which the application belongs.

TABLE 2 (continued)

	Hybridcast	HbbTV	TOPSmedia	Ginga
Support of stand-alone application	<p>Supported</p> <p>Non broadcast-oriented managed applications can be used for this type. Application control signals for non-broadcast-oriented managed applications can include additional information for resources and functions that the applications use. Broadcasters can provide information for execution conditions and access to broadcast resources over broadcast channels. A receiver evaluates information both with the application and from the broadcaster, and controls execution of the application and display management. In some cases, the application may be suspended. Evaluation is performed at every channel change.</p>	<p>Supported</p> <p>A broadcast-independent application can be used for this type. A broadcast-related application can transition or invoke a broadcast-independent application, and can go back to a broadcast-related application in some cases.</p>	<p>Supported</p> <p>A broadcast inactivated application can be used for this type. It can be invoked by a broadcast activated application or be launched by end-users as a downloaded application and broadcast inactivated application.</p>	<p>Supported by using broadcast managed applications, signalled with the UNBOUNDED control code in the AIT.</p> <p>Otherwise, stand-alone applications are not allowed to access broadcast resources.</p>

TABLE 2 (continued)

	Hybridcast	HbbTV	TOPSmedia	Ginga
Support of third-party application	Supported Non broadcast-oriented managed application types can be used for third-party application. An execution control mechanism for the case of third-party application is the same as stand-alone application, i.e. the mechanism is developed with consideration for this case.	Supported A broadcast-independent application can be provided by the third-party, which can be started via an Internet TV portal or transition from a broadcast-related application.	Supported A broadcast inactivated application can be provided by a third-party. If a third-party gets permission from broadcasters, downloaded applications and broadcast activated applications may be provided.	Supported Service-associated IBB applications can involve third-party IBB services, when signalled by the broadcaster. They must be signalled as broadcast managed applications in the AIT.
Application format	HTML5	HTML4/OIPF-DAE in V1.5 and HTML5 from V2.0	HTML5	– NCL 3.0/3.1 NCL applications can embed HTML, Lua and other NCL child applications – Java.
Application authentication	Authentication for service-associated applications is achieved by the fact that application control signals are provided by broadcasters. For stand-alone applications, three authentication methods are defined by the difference of the origin of trust chains, application repository, application control signal, or an application.	Authentication for service-associated applications is achieved by the fact that application control signals are provided by broadcasters.	Authentication for signal application and broadcast activated application is achieved by application control signals provided by broadcasters.	Authentication for service-associated applications is achieved by the fact that application control signals are provided by broadcasters.

TABLE 2 (continued)

	Hybridcast	HbbTV	TOPSmedia	Ginga
Security and permission control to access resources	Broadcasters can deliver permission information for access control over broadcast channels.	Broadcast-related applications are considered as trusted applications, and broadcast-independent applications are untrusted applications.	All applications have permission information to access broadcast resources	Broadcast-related applications are considered as trusted applications, and broadcast-independent applications are untrusted applications.
Protocols available for broadband access	HTTP, HTTPS, RTP and MPEG-DASH When MMT is used for broadcast channels, the use of MMT on broadband channels is also available.	HTTP, HTTPs and MPEG-DASH	HTTP, HTTPs, RTSP and MPEG-DASH	TCP sockets, UDP, HTTP, HTTPS, RTSP, RTP
Protocols for broadcast channel including delivery of application data	MPEG2-TS and MMT	MPEG2-TS	MPEG2-TS	MPEG2-TS
Available delivery channels of application triggering and messaging signals	When MPEG2-TS is used for broadcast channels, DSM-CC stream event is used for this purpose. When MMT is used for broadcast channels, the Event Message Table defined in ARIB STD-B60 is used. For broadband channels, HTTP, HTTPS, and web socket defined in RFC6455 can be used.	DSM-CC stream event can be used to deliver triggering and message information.	W3C web socket or server-sent event can be used for this purpose.	<ul style="list-style-type: none"> – DSM-CC stream event – MPEG2 private data sections – any other wrapping to transport NCL Editing Commands in IP networks (Rec. ITU-T H.761 specifically)

TABLE 2 (continued)

	Hybridcast	HbbTV	TOPSmedia	Ginga
Supported video formats and encoding	MPEG-2 video, MPEG-4 AVC and HEVC	For broadcast channels, no specifications for video encoding are defined, i.e. video encoding are defined by appropriate specifications for each market. (typically DVB systems) For broadband, MPEG-4 AVC and MPEG-4 SVC are used.	For the broadcast channel, no specification is defined for video encoding, i.e. it complies with the requirements of broadcast system being applied for. For the broadband delivery, MPEG-2 video and MPEG-4 AVC are supported.	Encoding is defined by appropriate specifications of each DTV system. As an example, ISDB-Tb International standard defines H.264 (MPEG-4 AVC) for broadcasted video.
Supported audio formats and encoding	MPEG-2 AAC, MPEG-4 AAC, and AIFF-C	For broadcast channels, no specifications for audio encoding are defined, i.e. audio encoding are defined by appropriate specifications for each market. (typically DVB systems) For broadband, MPEG4 HE-AAC and E-AC3 are used.	For broadcast channel, no specification is defined for audio encoding, i.e. it complies with the requirements of broadcast system being applied for. For the broadband delivery, MPEG-1 Layer 3, MPEG-2 AAC, AC-3 and MPEG-4 HE AAC are supported.	Encoding is defined by appropriate specifications of each DTV system. As an example, ISDB-Tb International standard defines MPEG-4 AAC for broadcasted audio.

TABLE 2 (continued)

	Hybridcast	HbbTV	TOPSmedia	Ginga
Subtitle control and formats	APIs to control subtitle presentation and to acquire subtitle data are defined. These APIs are designed to be applicable to both ARIB STD-B24 based subtitle format and ARIB-TTML defined in ARIB STD-B62.	A subtitling system which is used for broadcast is also available for broadband if TS container is used. HbbTV V 2.0 (and higher) supports EBU-TT.	APIs to control subtitle presentation and to acquire subtitle data are defined. Subtitle format specifications are defined by the broadcasting system being applied for.	Subtitle format specifications are defined by appropriate specifications of each DTV system.
Storage access and management	APIs to access non-volatile memory visible only through applications are defined.	Mass storage optionally available locally to the terminal - this is referred to as the "PVR feature".	W3C web storage API can be used for this purpose.	APIs to access non-volatile memory visible only through applications are defined. End-users can also access and manage the storage system through the AppCatUI.
Signalling format and delivery	Application control signals are described in the MPEG-2 private section, MMT-SI format, or XML. Information syntax is defined in ARIB STD-B24, STD-B60, and IPTVFJ STD-0011. MPEG-2 private section format and MMT-SI format are used for delivery of the information over broadcast channels. XML format is used for both broadcast and broadband delivery of the information.	AIT defined by ETSI TS 102 809 V1.1.1 is used.	AIT profiles are defined based on ETSI TS 102 809 V1.1.1.	AIT as defined by ABNT NBR 15606 and NCL Editing Commands are used.

TABLE 2 (continued)

	Hybridcast	HbbTV	TOPSmedia	Ginga
Synchronization between applications and broadcast programme	<p>Protocols for application triggering and messaging are used to synchronize applications and broadcast programmes.</p> <p>APIs to detect the time position in the programme for both live and VOD/recordings are available for applications.</p> <p>In addition, APIs for accurate synchronization of multiple streams are also available.</p> <p>The combination of these APIs allows an application developer or service provider to offer extremely flexible time dependent services.</p>	<p>Protocols for application triggering and messaging are used to synchronize applications and broadcast programmes.</p>	<p>To be developed in the next version of the specification.</p>	<p>Supported.</p> <p>Different abstraction levels are supported.</p> <p>Ginga provides access to DSMCC stream events and MPEG2 private data section filtering.</p> <p>NCL Editing Commands can be also used for synchronization.</p> <p>But mainly, an NCL document itself (NCL application code) defines how media objects (including broadcast programme) are structured and related, in time and space.</p>

TABLE 2 (continued)

	Hybridcast	HbbTV	TOPSmedia	Ginga
Protocol for device integration	<p>When using communication between applications on a receiver and a companion device only, proprietary protocols implemented by receiver manufacturers are mostly used. The communication APIs for this case are defined so that the protocols actually used are invisible to applications. Actual protocols for communication between other functional entities will be decided in consideration of the protection of users' interest and business schemes.</p>	<p>Direct device-to-device communication is part of HbbTV from V2.0. For integration over the Internet, existing web-based communications and relay servers enable for device integration as application level implementation.</p>	<p>When smart TV applications communicate with a companion device, W3C web socket can be used. Message are encoded according to the JSON format. The actual JSON message is defined in accordance with the multiscreen service providers.</p>	<p>When using communication between applications on a receiver and a companion device only, proprietary protocols implemented by receiver manufacturers are mostly used. The communication APIs for this case are defined so that the protocols actually used are invisible to applications. Actual protocols for communication between other functional entities will be decided in consideration of the protection of users' interest and business schemes. Ginga-J allows programmers to design their own protocols as part of an IBB application.</p>

TABLE 2 (end)

	Hybridcast	HbbTV	TOPSmedia	Ginga
Device discovery protocol for device integration	When using communication between applications on a receiver and a companion device only, the proprietary protocols implemented by receiver manufacturers can be used.	Supported by HbbTV from V2.0	Various zero conf. network like UPnP and mDNS can be used. And then, companion device shall use same network to communicate with smart TV application.	When using communication between applications on a receiver and a companion device only, the proprietary protocols implemented by receiver manufacturers can be used. Ginga-J allows programmers to design their own protocols as part of an IBB application.
VOD Playback	By sending application control information from a VOD server, a receiver can start the application indicated in the information. A mechanism to detect the playing back position in time by the application is also defined to support trick-play. If a recorder provides similar functions to provide application control information, the same mechanism can be applied to recordings.	By using the streaming API (the CEA-2014 AV Control object)	Basic VOD playback including play control and trick play is supported by HTML5 video element. For VOD playback, MPEG-DASH is also supported.	Supported By using the media-related APIs which by definition includes support for streaming and media control.

NOTE – Content’ means elements of IBB services of which presentation is controlled by applications, such as video, audio, graphics, either in a form of a file or stream.