International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

J.206

(03/2013)

SERIES J: CABLE NETWORKS AND TRANSMISSION OF TELEVISION, SOUND PROGRAMME AND OTHER MULTIMEDIA SIGNALS

Application for Interactive Digital Television

Architecture for an application control framework using integrated broadcast and broadband digital television

Recommendation ITU-T J.206

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Architecture for an application control framework using integrated broadcast and broadband digital television

Summary

Consumer electronics devices are more and more connected every day. This tendency has also reached digital television (DTV) receivers, Blu-ray players, personal video recorder (PVR) devices and even games consoles.

Taking advantage of the increasing broadband availability, consumer electronics manufacturers are embedding in their products applications that are able to retrieve content from proprietary services available through the Internet. Additionally, computational capabilities and increasing persistent storage availability in these devices will allow end users to customize their devices by installing new applications; this is already occurring with mobile phones, tablets and games consoles.

In the same way, DTV broadcasters are extending their systems in order to use broadband availability to improve their services by adding interactive non-linear and on-demand content to the services they traditionally offer.

However, most of the current solutions are closed/proprietary solutions and focused on each industry's specific problems.

In alignment with Recommendation ITU-T J.205, *Requirements for an application control framework using integrated broadcast and broadband digital television*, this contribution proposes a study on the architecture and implementation for an application control framework for DTV enabled devices. This framework would be responsible for managing and controlling the interactive content and applications available through DTV services, installed by the end user or embedded by the device manufacturer, and providing a unified execution environment for them.

History

Edition	Recommendation	Approval	Study Group
1.0	ITU-T J.206	2013-03-01	9

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

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1 Scope

This Recommendation defines a high-level architecture for an application control framework based on integrated broadcast and broadband (IBB) digital television (DTV) services intended to harmonize the behaviour and the interaction of a variety of types of applications, provided by network agnostic delivery mechanisms which include broadcast delivered, broadband delivered, pre-installed, delivered via application repository and home area network delivered.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T J.200] Recommendation ITU-T J.200 (2010), *Worldwide common core – Application environment for digital interactive television services*.

[ITU-T J.205] Recommendation ITU-T J.205 (2012), *Requirements for an application control framework using integrated broadcast and broadband digital television*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 application [ITU-T J.205]: Any active DTV service content aimed at end-user interaction.

3.1.2 application catalogue [ITU-T J.205]: Data structure listing available applications (interactive content). This data structure is local to the IBB DTV receiver, and describes the IBB applications installed on the IBB DTV receiver.

3.1.3 application catalogue user interface [ITU-T J.205]: A user interface functionality over the IBB DTV receiver, intended to allow the end user to browse the available applications in the application catalogue or to query application catalogues exposed by application repositories. Also, it lists applications that are currently available in the selected IBB DTV service or broadcast DTV service.

3.1.4 application component [ITU-T J.205]: A block of data that forms part of an application. Application component types are: code, resources, metadata, control and user settings.

3.1.5 application control data structure [ITU-T J.205]: Data structures transmitted within the integrated broadcast and broadband (IBB) DTV service to control IBB applications (e.g., AIT in [b-GINGA-J], [b-MHP]).

3.1.6 application installation package [ITU-T J.205]: Application delivery mechanism in which several application components are bundled together in a single file.

3.1.7 application repository [ITU-T J.205]: Entity, reachable through the broadband channel, that provides access to integrated broadcast and broadband (IBB) applications contained in it. These IBB applications can be downloaded and installed on the IBB DTV receiver, manually, by the end user, or, in case of being signalled within an IBB DTV service, launched or installed automatically under the IBB DTV service's control using the IBB application control mechanism. An application repository can be managed by IBB service providers, IBB DTV receiver manufacturers, or other third party entities.

3.1.8 bridge elements [ITU-T J.200]: A mechanism for applications that allows bidirectional mapping between execution engine and presentation engine.

3.1.9 broadband channel [ITU-T J.205]: A medium used to deliver interactive content. Usually this medium is based on the Internet and allows the delivery of non-linear and on-demand content. A broadband channel allows access to servers that may be located in the Internet.

3.1.10 broadcast channel [ITU-T J.205]: A medium used to deliver digital television (DTV) services. Examples: free to air, satellite and cable.

3.1.11 broadcast DTV service [ITU-T J.205]: Any digital television (DTV) service, delivered through a broadcast channel.

3.1.12 cable IBB DTV service [ITU-T J.205]: An integrated broadcast and broadband digital television (DTV) service managed by cable operators.

3.1.13 DTV service [ITU-T J.205]: This is the unit for delivering audio-visual content to the end users. In a more extensive definition (the one adopted in this Recommendation), this unit also comprehends the delivery of interactive content. It constitutes an editorially consistent whole and it is an aggregation of different kinds of service components.

3.1.14 DTV service component delivery mechanism [ITU-T J.205]: Used to refer to any mechanism, channel or medium to deliver digital television (DTV) service components to an integrated broadcast and broadband (IBB) DTV receiver.

3.1.15 DTV service content [ITU-T J.205]: Audio/visual/interactive components delivered within a digital television (DTV) service as single editorially consistent whole.

3.1.16 execution engine [ITU-T J.200]: A subsystem in a receiver that evaluates and executes procedural applications consisting of computer language instructions and associated data and media content. An execution engine may be implemented with an operating system, computer language compilers, interpreters and application programming interfaces (APIs), which a procedural application may use to present audiovisual content, interact with a user, or execute other tasks that are not evident to the user. A common example of an execution engine is the JavaTV software environment, using the Java programming language and byte code interpreter, JavaTV APIs, and a Java virtual machine for program execution.

3.1.17 IBB application [ITU-T J.205]: An application that is meant to be handled and executed within an integrated broadcast and broadband (IBB) application control framework defined by this Recommendation. Such applications can have their application contents delivered using different application component delivery mechanisms.

3.1.18 IBB application control mechanism [ITU-T J.205]: A mechanism used by integrated broadcast and broadband (IBB) digital television (DTV) service providers to signal and control IBB applications associated to their respective IBB DTV services. The mechanism contemplates the transmission of an IBB DTV service's application control data structure within the IBB DTV service. Such data structure can support the signalling of IBB applications that are retrievable from the broadcast channel or through the broadband channel from HTTP servers or application repositories.

3.1.19 IBB DTV receiver [ITU-T J.205]: A device capable of receiving and displaying DTV services as well as integrated broadcast and broadband (IBB) DTV services.

3.1.20 IBB DTV service [ITU-T J.205]: A service that simultaneously provides an integrated experience of broadcasting and interactivity relating to media content, data and applications from multiple sources, where the interactivity is sometimes associated with broadcasting programmes.

3.1.21 IBB DTV service provider [ITU-T J.205]: An entity (i.e., broadcasters) making available and delivering IBB DTV services.

3.1.22 IBB installable application [ITU-T J.205]: An integrated broadcast and broadband (IBB) application that can be downloaded and saved onto the IBB DTV receiver's persistent storage for later usage.

3.1.23 IBB resident application [ITU-T J.205]: An integrated broadcast and broadband (IBB) application embedded into the IBB DTV receiver by the device manufacturer.

3.1.24 presentation engine [ITU-T J.200]: A subsystem in a receiver that evaluates and presents declarative applications consisting of content, such as audio, video, graphics, and text, primarily based on presentation rules defined in the presentation engine. A presentation engine also responds to formatting information, or "markup", associated with the content, to user inputs, and to script statements, which control presentation behaviour and initiate other processes in response to user input and other events. A common example of a presentation engine is an HTML browser, capable of displaying text and graphic content formatted in HTML [b-W3C HTML], with interactive behaviour programmed in ECMAScript [b-ECMAScript].

3.1.25 remote application catalogue [ITU-T J.205]: application catalogue exported from an application repository. This differs from the normal application catalogue in that, if the remote application catalogue is very large, there must be a mechanism for querying it and retrieving it in small parts that can be handled in an efficient way by the integrated broadcast and broadband (IBB) DTV receiver.

3.1.26 service associated IBB application [ITU-T J.205]: An application that is part of the integrated broadcast and broadband (IBB) DTV service tuned by the user at a given time.

3.1.27 service exclusive IBB application [ITU-T J.205]: An application that is listed as a component of an integrated broadcast and broadband (IBB) DTV service and its life cycle is strictly tied to the exhibition of such an IBB DTV service.

3.1.28 service shared IBB application [ITU-T J.205]: An application that is listed as a component of several different integrated broadcast and broadband (IBB) DTV services. Its life cycle is for as long as any of those IBB DTV services are being exhibited.

3.1.29 stand-alone IBB application [ITU-T J.205]: Resident or downloaded integrated broadcast and broadband (IBB) installable application that is not part of an IBB DTV service. Such an application can be created by an authorized IBB application provider, and typically delivered through the application repository.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 application descriptor file: A file containing metadata information for an application.

3.2.2 IBB application provider: An organization that makes available an IBB application; in the most common case, it is the application developer.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

ACF Application Control Framework

AIP Application Install Package

AIT Application Information Table

API Application Programming Interface

AppCatUI Application Catalogue User Interface

DAV Distributed Authoring and Versioning

DRM Digital Right Management

DSMCC DC Digital Storage Media Command and Control – Data Carousel

DSMCC OC Digital Storage Media Command and Control – Object Carousel

DTV Digital Television

EPG Electronic Programme Guide

HAN Home Area Network

HTTP Hyper Text Transfer Protocol

HTTPS Secure Hyper Text Transfer Protocol

IBB Integrated Broadcast and Broadband

NFS Network File System

OSD On-Screen Display

PVR Personal Video Recorder

ROM Read-Only Memory

RTP Real Time Protocol

RTSP Real Time Streaming Protocol

URL Universal Resource Locator

5 Conventions

None.

6 Overall architecture

Based on the system analysis described in clause 7 of [ITU-T J.205], a system covered by this Recommendation should implement the overall architecture shown in Figure 6-1.

The DTV service provider broadcasts the DTV service in which IBB application components can be multiplexed for one or more IBB applications. At the same time, the DTV service provider can make available the same or different sets of IBB application components in a server or IBB application repository reachable through the Internet.

In the same way, other entities can make available IBB application components, as well as IBB application repositories.

The IBB DTV receiver has the capabilities to decode the DTV service and also support an implementation of the IBB application control framework (IBB ACF). The IBB ACF is the system's

component in charge of collecting IBB application components from several possible sources and interpreting and/or executing them in the IBB DTV receiver.

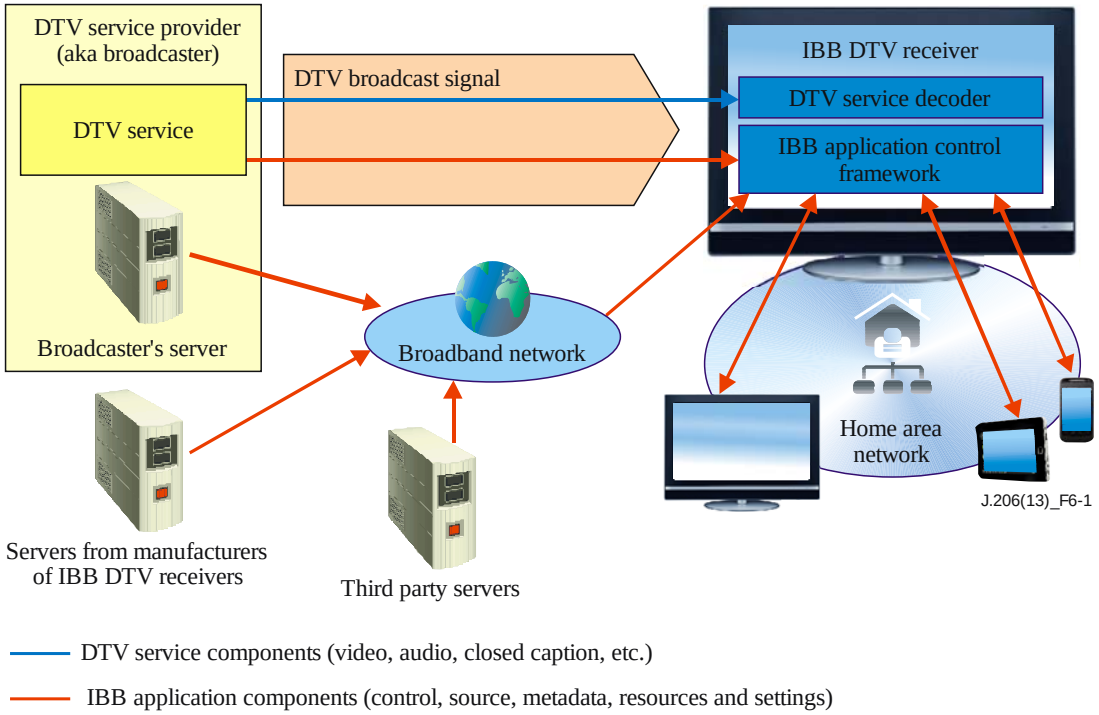

Figure 6-1 – Overview of the integrated broadcast and broadband system architecture

When the DTV service provider delivers the control type of the IBB application component, the IBB ACF will present the IBB application seamlessly integrated with the DTV service. In another case, if the user launches an IBB application that is not related to the DTV service (a stand-alone IBB application), the IBB ACF will handle the application in such a way that it is completely separate from the DTV service.

Figure 6-1 also depicts how the IBB application components can be delivered to the IBB DTV receiver using different channels and shows that they can also be shared among devices in the same home area network (HAN). For more details, refer to clause 8.3.

The architecture recommended in [ITU-T J.200] is used as a basis (FR-ACF-01 of [ITU-T J.205]) and extended by this Recommendation in order to fulfil additional requirements listed in this document.

This Recommendation also defines extensions to the presentation and execution engines as proposed by [ITU-T J.200] and described in [b-ITU-T J.201], [b-ITU-T H.761] and [b-ITU-T J.202].

6.1 The IBB application structure

An IBB application usually consists of a set of IBB application components (see Figure 6-2) classified in any of the following types:

- **Code**: compiled binary, byte code, script (etc.) executables.
- **Resources**: data files, fonts, images or any other content consumed by the application during code execution.
- **Metadata**: additional information associated with the application, containing information for the user and for application execution. Metadata can be classified as:

- **Metadata (info)**: comprising application description (unique identification, version, name, icon, provider, language, settings, etc.), location for retrieving an application's components, how it should be presented (dimensions on the screen, position, states, etc.), minimal requirements (minimal middleware version, minimal receiver capabilities, etc.), etc.
- **Metadata (security)**: information used for application authentication, permissions declaration and authorization for access to the receiver's functionalities and/or DTV service integration (signature, certificates, policy files, etc.).

- **Control**: signalling mechanism used by the IBB DTV service provider in order 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.
- **User settings**: configuration parameters that may define some application customization or store users' preferences for using this application. As an example, user settings can be used to customize the application user interface, the application behaviour and personal data of the user (name, age, gender, email, address, etc.).

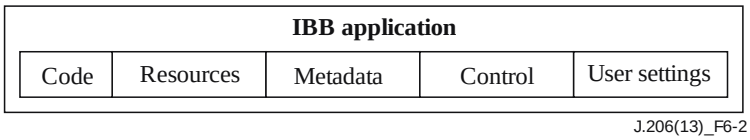

Figure 6-2 – IBB application components

Unlike conventional DTV applications, IBB application components can be delivered by a combination of multiple delivery channels. Metadata or any other information of an IBB application should be aligned with its delivery scenario.

6.2 Accessibility considerations

The architecture defined in this Recommendation allows any applications to control, present and interact with users in any way the applications intend. Hence, any applications which are aware of accessibility can be built upon this architecture.

7 IBB DTV receiver architecture

This clause provides an overview of the IBB DTV receiver architecture consisting of diagrams and summary descriptions of each of its functional blocks and components.

7.1 High level architecture based on the ITU-T J.200-series of Recommendations

The ITU-T J.200-series of Recommendations already provides a major number of definitions for the functional requirements, architecture and application programming interface (API) that can also be used in the context of IBB applications and IBB DTV services.

The architecture recommended in [ITU-T J.200] is used as a basis, and extended by this Recommendation in order to fulfil additional requirements listed in this document.

This Recommendation also defines extensions to the presentation and execution engines proposed by [ITU-T J.200] and described in [b-ITU-T J.201], [b-ITU-T H.761] and [b-ITU-T J.202].

Figure 7-1 illustrates the high-level architecture proposed for an IBB DTV receiver.

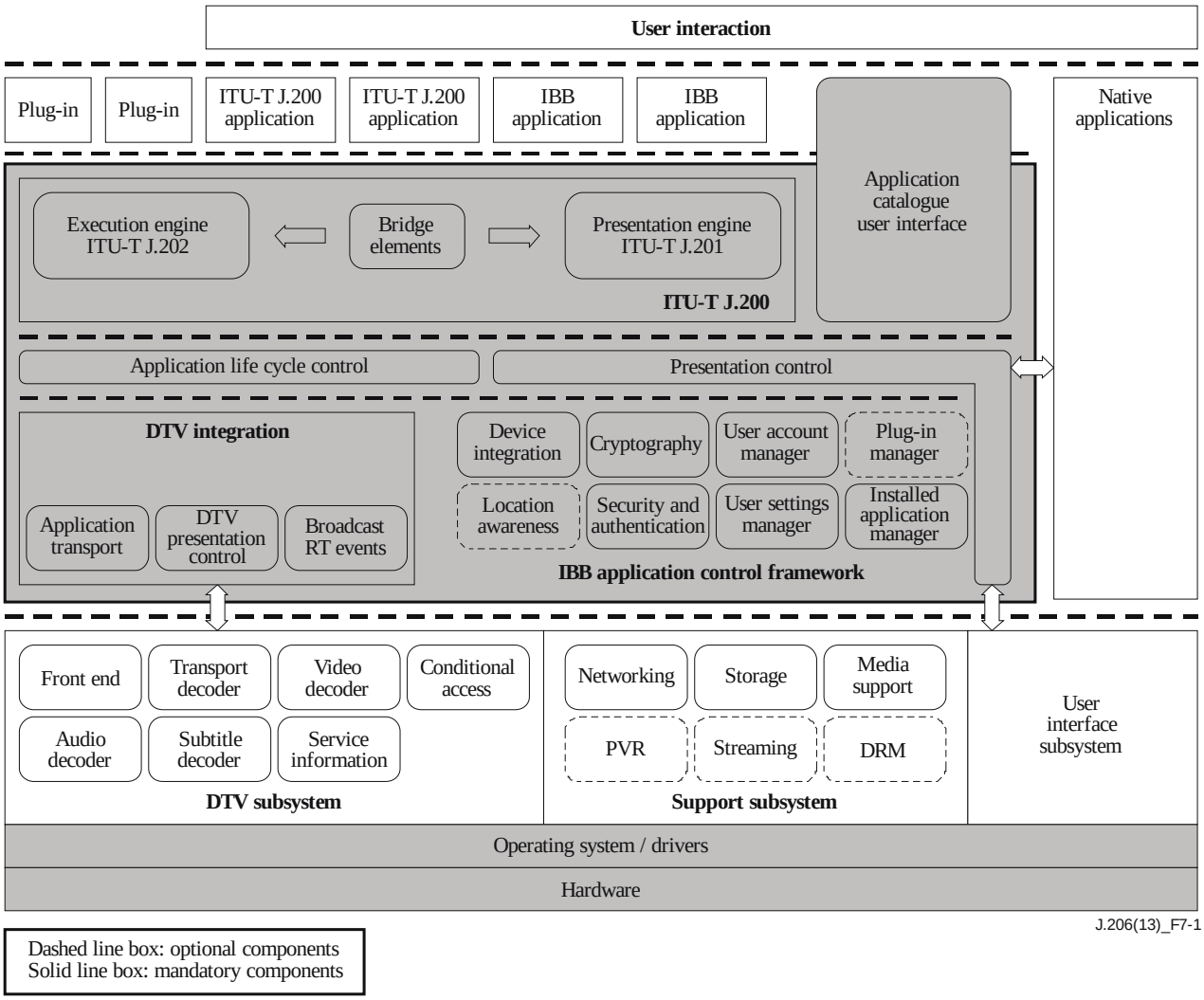

Figure 7-1 – Proposed high-level architecture for an IBB DTV receiver

- **Hardware**: physical components of the IBB DTV receiver, comprising processing and decoding units, memory, display, remote control, tuner, etc.
- **Operating system/drivers**: basic software stack in charge of low-level tasks and low-level access to the hardware components.
- **DTV subsystem**: stack of software components responsible for the reception and exhibition of the DTV service. Usually, these software components act as proxies for specific physical components in the hardware which do the actual work:
    - **Front-end**: This is the component in charge of selecting and receiving a certain DTV service.
    - **Transport decoder**: component that does the decoding of the transport signal and breaks it in separate DTV service components. For example, this can be an MPEG-2 system demultiplexer.
    - **Conditional access**: security component that checks user credentials/permissions to access a certain DTV service. Also it descrambles scrambled signals (FR-ACF-16 of [ITU-T J.205]).
    - **Video decoder**: component responsible for decoding the DTV service's video content.
    - **Audio decoder**: component responsible for decoding the DTV service's audio content.

- **Subtitle decoder**: component responsible for decoding the DTV service's subtitle or closed-caption contents.
- **Service information**: component in charge of decoding the information contained in the DTV service signal, such as the electronic programme guide and service structure description.

- **User interface subsystem**: This subsystem handles low-level functions for the user's interaction. Among the components of this subsystem are the IBB DTV receiver's on-screen display (OSD), remote control handling, etc.
- **Support subsystem**: This subsystem aggregates a series of general purpose components used by the IBB application control framework.
  - **Networking**: handles access to IP networks, providing support for Internet access and home area networks.
  - **Storage**: handles access to the persistent storage area in the device or any other external storage device (FR-ACF-24 of [ITU-T J.205]).
  - **Media support**: provides decoding/encoding support for different kinds of media such as images, audio, video, text, etc. (FR-ACF-23 of [ITU-T J.205]).
  - **PVR**: provides access to the personal video recording functionality that may be present in the IBB DTV receiver (FR-ACF-25 of [ITU-T J.205]).
  - **Streaming**: provides capabilities for decoding streamed content from external sources or encoding and streaming out content (FR-ACF-26 of [ITU-T J.205]).
  - **Digital right management (DRM)**: support for decoding/re-encoding media (FR-ACF-16 of [ITU-T J.205]).
- **Native applications**: This is a placeholder for any application that may be present in the IBB DTV receiver and that is not related to the IBB ACF.
- **IBB application control framework**: The IBB ACF subsystem is composed of the following components:
  - **DTV integration**: This component handles the integration of the IBB ACF with the DTV subsystem. It is sub-divided into the following components:
    - **Application transport**: is responsible for decoding the IBB application components transmitted in the DTV service. An example of this component is a DSMCC Object Carousel decoder (FR-ACF-03 of [ITU-T J.205]).
    - **DTV presentation control**: allows both the IBB ACF and the IBB applications running on top of it, to control the presentation of the DTV service components such as audio, video or subtitles.
    - **Broadcast real time (RT) events**: support for decoding application-level signalling sent by the IBB DTV service provider in the DTV service signal. For example: DSMCC stream events (FR-ACF-22 of [ITU-T J.205]).
  - **Installed application manager**: in charge of managing all the IBB application components installed in the IBB DTV receiver, updating such application components whenever applicable and handling the installation of new ones. This component answers requests from the application catalogue interface or the application life cycle control (FR-ACF-05, FR-ACF-07 and FR-ACF-08 of [ITU-T J.205]).
  - **Plug-in manager**: This component manages the plug-ins installed in the IBB DTV receiver, making them available to the requesting IBB applications. Plug-in updating, installing and uninstalling are also functions in the scope of this component (FR-ACF-28 and FR-ACF-29 of [ITU-T J.205]).

- **User accounts manager**: This component manages the access to the different user accounts that can be registered within the IBB DTV receiver, and securely handles all the user information and credentials associated with such accounts. This component enables the secure sharing of access to user information, data and services that can be present in other devices or servers. Refer to clause 8.11 for further details (FR-ACF-17 of [ITU-T J.205]).
- **User settings manager**: manages the settings information stored by the IBB applications in order to allow user customization (FR-ACF-18 of [ITU-T J.205]).
- **Cryptography**: component that provides cryptography services such as digital signature and encryption to any other component in the IBB ACF or the IBB applications (FR-ACF-27 of [ITU-T J.205]).
- **Security and authentication**: responsible for verifying the authenticity and origin of the IBB application, identifying whether the application is provided by a trusted source and whether the application is granted permission by the IBB DTV service provider to be integrated with its DTV service. Having resolved the IBB application permissions, it is responsible for sandboxing the application, allowing access only to the functions that have been granted to it (FR-ACF-13, FR-ACF-14 and FR-ACF-15 of [ITU-T J.205]).
- **Device integration**: This component is responsible for handling the discovering and interaction with other devices in the home area network (FR-ACF-20 of [ITU-T J.205]).
- **Location awareness**: This is in charge of making available to the IBB application information related to the location of the IBB DTV receiver (FR-ACF-19 of [ITU-T J.205]).
- **Application life cycle control**: This is the most important component in the IBB ACF. Its responsibility is to manage the life cycle and states of each one of the IBB applications that the IBB ACF is aware of at a given time (FR-ACF-09, FR-ACF-11 and FR-ACF-12 of [ITU-T J.205]).
- **Presentation control**: This component manages the presentation and focus control between the different IBB applications that can be in execution, the application catalogue user interface and coordinates presentation with native applications. It acts as a synchronization agent between the IBB ACF, the user interface subsystem and other native applications that may require access to the screen and user input.
- **Application catalogue user interface**: This is the user interface component provided by the IBB ACF intended for listing the available applications that can be launched by the user. It also allows the user to browse IBB application repositories, and install, update or uninstall IBB applications (FR-ACF-04 and FR-ACF-10 of [ITU-T J.205]).
- **ITU-T J.200 components**: IBB applications execute on top of the execution engine or presentation engine, as defined by [ITU-T J.200] and described in [b-ITU-T J.201], [b-ITU-T H.761] and [b-ITU-T J.202] (FR-ACF-01 of [ITU-T J.205]).

8 IBB DTV receiver behaviour

This clause describes how the requirements defined in [ITU-T J.205] are achieved by the architecture described in clause 7.

The following clauses detail the behaviour of the main architectural functional blocks, which should be implemented by an IBB DTV receiver that supports the proposed architecture for the IBB ACF.

8.1 Coexistence and backward compatibility with existing DTV receivers, which adhere to Recommendations [ITU-T J.200], [b-ITU-T J.201], [b-ITU-T H.761] and [b-ITU-T J.202]

The IBB DTV receivers should support seamless interoperability with conventional broadcast applications as supported in [ITU-T J.200], [b-ITU-T J.201], [b-ITU-T H.761] and [b-ITU-T J.202] and IBB applications (FR-ACF-02 of [ITU-T J.205]). Gradual evolution of existing DTV services to IBB DTV services must be possible in such a way that:

1. IBB application components should be ignored or not detected by already deployed receivers intended for conventional DTV services and with no support for IBB applications. This also applies to IBB receivers that are not connected to a broadband connection.
2. IBB receivers should be capable of exhibiting content and applications from conventional DTV services.

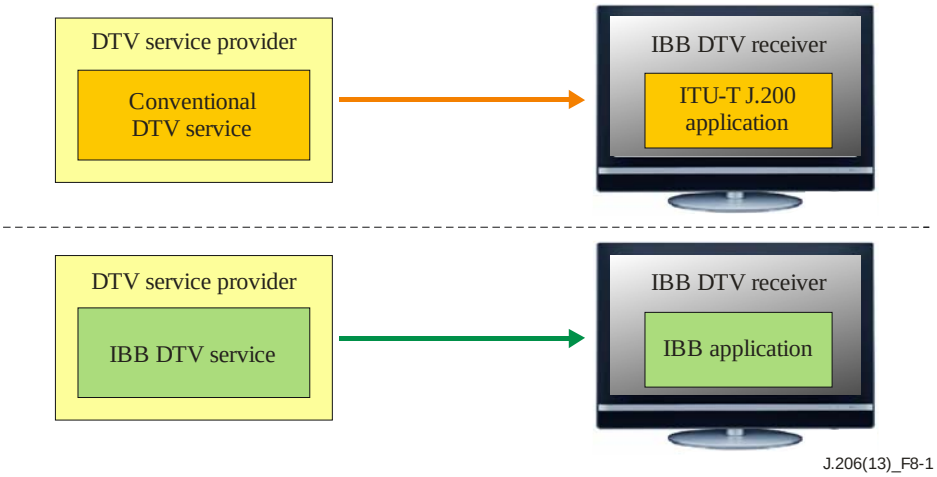

Figure 8-1 – IBB DTV receiver should support interoperability with conventional DTV applications (based on [ITU-T J.200])

The end-user experience when navigating through DTV services and IBB DTV services must be as transparent as possible (FR-ACF-02 of [ITU-T J.205]). See Figure 8-1.

8.2 System expandability: plug-in support (optional)

The ACF capabilities can be extended by the installation of plug-in modules into the IBB DTV receiver (FR-ACF-28 and FR-ACF-29 of [ITU-T J.205]).

Plug-in modules should register themselves and the interfaces for the services they provide into the IBB DTV receiver's extensions registry.

IBB applications can query the extensions registry looking for some specific functionality or interface, and then make use of such extended functionality.

8.3 Support for delivering IBB applications using any combination of delivery mechanisms

IBB application components from the same application can be delivered through different channels (FR-ACF-03 of [ITU-T J.205]).

Delivery of an IBB application can be classified in the following cases:

a. All the IBB application's components are delivered by the broadcast channel.

In this case, they can be transmitted using the mechanisms already provided by middleware specifications in conformance with [ITU-T J.200] such as [b-MHP], [b-ARIB B.24], [b-ARIB B.23], [b-GINGA-J] or [b-GINGA-NCL], for example:

- Code and resources: delivered using DSMCC Carousel.
- Metadata: delivered using DSMCC Carousel (e.g., signature and permission information), AIT table (e.g., application name, application arguments, application type, middleware version required, etc.) and/or DSMCC stream events.
- Control: IBB application delivered using AIT table control_code field or any other equivalent mechanism.

b. All the IBB application's components are delivered by the broadband channel. In this case, these components can be retrieved as an AIP containing the code, resources and metadata. Alternatively files for code, resources and metadata can be retrieved individually from an HTTP server. Control may still be obtained from the broadcast signal or a network server through the broadband channel.

c. Integrated delivery of an IBB application. This occurs when some parts of its components are retrieved from the broadcast channel and other parts from the broadband channel in any combination of the two previous cases.

d. IBB installable applications. IBB DTV receivers may have a persistent storage space for installing IBB installable applications. Once installed, these applications are available to the user at any time. IBB installable applications can be downloaded into the receiver in the following ways:

d.1. Automatically, when signalled in a selected service (broadcast or broadband), a special signalling mechanism can be used in order to indicate that the application is to be installed in the receiver. Such a mechanism is provided by the AIT's UNBOUND control code in [b-GINGA-J] or [b-GINGA-NCL]. In this case, application components delivery can happen in any of the modalities described in a, b or c. In the case of IBB installable applications, they are not required to be available to receivers or continuously transmitted in the broadcast signal during the time they are signalled as available by the IBB DTV service provider.

d.2. Manually by the user (user installed application), through an AppCatUI provided by the receiver. In this case, the IBB installable application's sources can be diversified (i.e., an application repository, another device in the HAN, pluggable storage device, etc.).

e. IBB resident applications. These are applications embedded in the IBB DTV receiver by its manufacturer (FR-ACF-08 of [ITU-T J.205]). Usually they are stored in the receiver's ROM, or bundled within the receiver's firmware. These applications may not be uninstalled by the end user. Installation, updating and removal of these applications should be exclusively the right of the IBB DTV receiver's manufacturer.

In the case of the user settings, a default set of values can be transmitted with the application using any of the methods described above. For actual values (customized by the user), the following alternatives are possible:

- stored in the receiver's persistent storage (most usual case); or
- shared among several devices present in the HAN.

Table 1 summarizes the above-described cases:

Table 1 – Application components and applicable delivery transports

Application component	Delivery channel				
	Broadcast channel	**Broadband channel**	**Previously installed in the receiver's persistent storage**	**Via application repository**	**Home area network (HAN)**
Code	DSMCC DC/OC	Delivered within AIP[a)]	Storage mechanism is implementation dependent	Delivered within the AIP[a)]	Delivered within the AIP[b)]
Resources	DSMCC DC/OC	1. Delivered within the AIP[a)] 2. HTTP/HTTPS protocols in the case of single file 3. RTP/RTSP protocols in the case of streams	Storage mechanism is implementation dependent	1. Delivered within the AIP[a)] 2. HTTP/HTTPS protocols in the case of single file 3. RTP/RTSP protocols in the case of streams	1. Delivered within the AIP[b)] 2. Using the file sharing protocol defined for HAN
Metadata (info)	1. AIT table 2. Application descriptor file in DSMCC Carousel	1. Application descriptor file retrieved using HTTP protocol 2. Contained in the AIP[a)]	Application descriptor file contained in the AIP must be stored together with other AIP content	Application descriptor file contained in the AIP	Application descriptor file contained in the AIP[b)]
Metadata (security)	Application descriptor file and other files in DSMCC Carousel				
Control	AIT as in [b-MHP], [b-GINGA-J] or [b-GINGA-NCL]; or any other equivalent mechanism	Service associated IBB applications	Stand-alone IBB applications Launched by the user from the AppCatUI		
User settings	–	See remote user settings	See user settings and user persistent storage	See remote user settings	User settings Sharing protocol Defined for HAN

a) AIP is retrieved using the HTTP protocol.

b) AIP is retrieved using an application sharing protocol defined for HAN.

When using an AIP, code, resources and metadata would usually be bundled together in the same package.

Table 2 provides a high-level mapping of which ACF functional blocks are responsible for handling each type of IBB application component.

Table 2 – Functional block map for handling of IBB application components

IBB application component	ACF functional block
Code	Execution engine [b-ITU-T J.202]/Presentation engine [b-ITU-T J.201]
Resources	IBB application in general. They can be used for many purposes, depending on the resource type
Metadata (info)	Application catalogue user interface, presentation control, application transport
Metadata (security)	Security and authentication
Control	Application life cycle control, application catalogue user interface
User settings	User settings manager, user account manager

Figure 8-2 summarizes the several mechanisms available to deliver and store the IBB application's components.

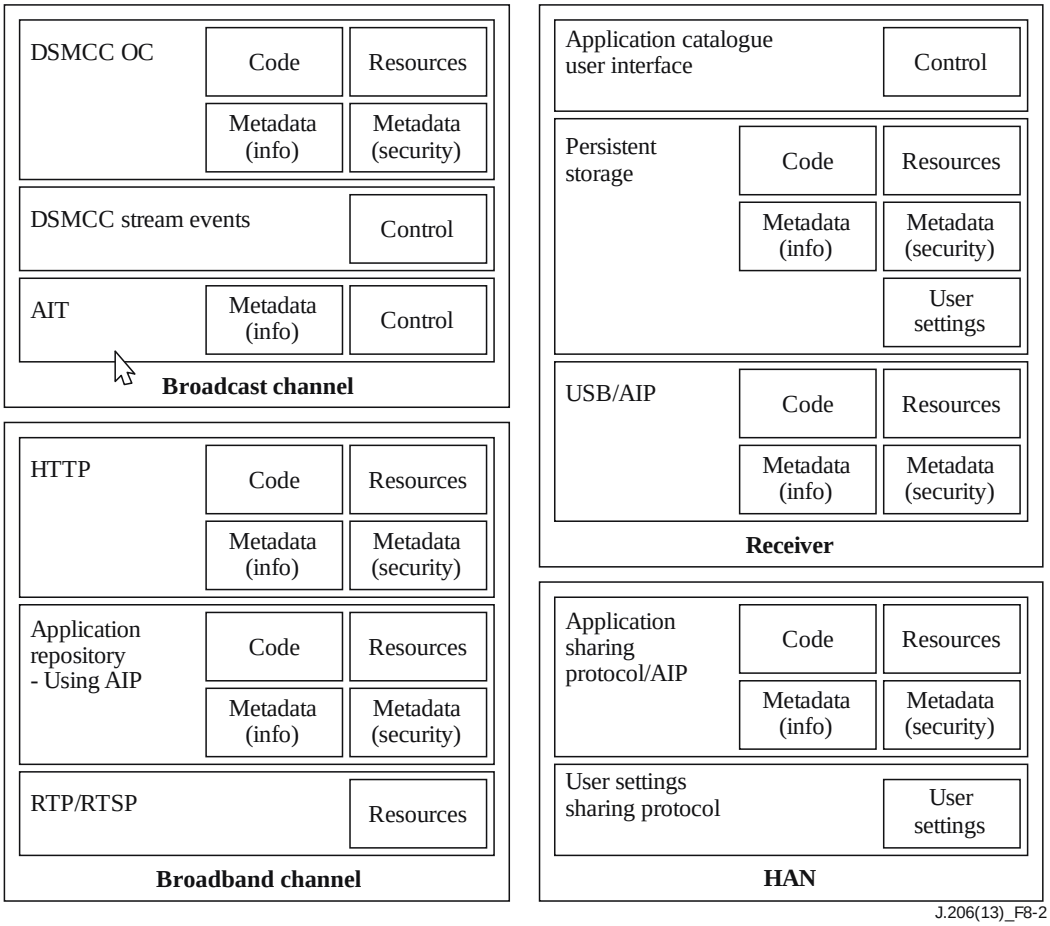

Figure 8-2 – IBB application component delivery and storage mechanisms

8.3.1 Application descriptor file

In the case of IBB applications delivered through the broadcast channel some metadata (info) is contained in the broadcast data structures (e.g., the AIT or other equivalent signalling mechanism).

On the other hand, when delivering the application through other delivery mechanisms, such metadata must be delivered in an application descriptor file. Optionally, it should be possible to use the application description file for delivering metadata through the broadcast channel, by including such a file within the DSMCC Carousel.

Optionally, the metadata (security) may also be included in the application description file, allowing the delivery of all metadata in a single data structure.

8.3.2 Rules for choosing the service associated IBB application's source

The same IBB application can be made available through different channels (or delivery mechanisms) at the same time. From the end-user viewpoint, the IBB application delivery mechanism should be as transparent as possible.

Table 3 should be supported by the IBB DTV receiver:

Table 3 – Application source decision table

ACTION	Already INSTALLED or RESIDENT	Version of the installed IBB application is the same or newer	Is it an installable IBB application?	Is the IBB application transmitted in the current selected service?
Download from the available source, avoiding interruption of the service exhibition	No	–	No	No
Download from the current selected service	No	–	No	Yes
Download from the available source, avoiding interruption of the service exhibition, and install	No	–	Yes	No
Download from the current selected service and install	No	–	Yes	Yes
	Yes	No and application is not resident	Yes	Yes
Use the installed application	Yes	Yes	Yes	–
	Yes	No or application is resident	Yes	No and service exhibition needs to be interrupted to download the latest version, or application is not currently available for downloading
Download and install	Yes	No and application is not resident	Yes	No. Service exhibition can continue for downloading the latest version

8.4 Application life cycle model

The IBB application life cycle model should support the models used by middleware implementations adherent to [ITU-T J.200]. For example, the Xlet life cycle model defined by [b-CDC] and adopted in [b-MHP], [b-ARIB B.23] and [b-GINGA-J] or also the application life cycle model used in [b-ARIB B.24] and [b-GINGA-NCL].

As commonly defined by most of the middleware specifications conformant with [ITU-T J.200] ([b-MHP], [b-ETSI TS 102 728], [b-GINGA-J], [b-GINGA-NCL], [b-ACAP], [b-OCAP], [b-ARIB B.23]), applications can be signalled as being bounded to the service or not. Defined rules are:

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

– In the case of service-shared (service unbounded) applications, execution should continue in the case of the same application being also signalled in the service that is selected next.

Both service exclusive and service shared IBB applications are to be considered service associated IBB applications and must be terminated in the case of no longer being signalled within the currently selected IBB DTV service.

8.5 IBB application control

The IBB DTV service provider can control the execution, availability and visibility only of the service associated IBB applications, using the control component of the application (e.g., AIT) (FR-ACF-11 of [ITU-T J.205]).

The ACF should allow that, in the case of the IBB application model, IBB applications could be launched in any of the conditions described in Table 4.

Table 4 – IBB application launching conditions

Launching condition	Stand-alone IBB application	Service associated IBB application	
		Service exclusive	Service shared
Signalled to be auto-started in the currently selected IBB DTV service	Launch[a)]	Launch	Launch
Started by an already existing application using a middleware-provided API	Launch[b)]	Launch[b)]	Launch[b)]
User started from the AppCatUI	Launch	Launch	Launch

a) In some cases, the launch of stand-alone IBB applications may be allowed for resident and/or installable applications. Applications dedicated for an emergency situation are an example of this case.

b) In some cases, the launched application may not be allowed to keep the original application's context.

IBB application termination should occur according to the conditions described in Table 5.

Table 5 – IBB application termination conditions

Launching condition	Stand-alone IBB application	Service associated IBB application	
		Service exclusive	Service shared
Signalled to be KILLed or DESTROYed in the current selected IBB DTV service	–	Terminate	Terminate
Has been removed from the service's AIT	–	Terminate	Terminate
Stopped by another service associated IBB application (with proper permissions) using a middleware-provided API	–	Terminate	Terminate
User stopped from the AppCatUI	Kill, whenever the application has been started from the AppCatUI		

Table 5 – IBB application termination conditions

Launching condition	Stand-alone IBB application	Service associated IBB application	
		Service exclusive	Service shared
Service change occurs	–	Terminate	Terminate if conditions to keep the application alive are not met (application is not signalled in the new selected service)
The IBB application terminates itself by calling a specific middleware-provided API	Terminate		
An exception is raised and it is not handled by the IBB application	Terminate		
The IBB DTV receiver runs out of enough resources to execute the IBB application	Terminate		

Most of these mechanisms are already defined in [b-MHP], [b-GINGA-J], [b-GINGA-NCL] and [b-ARIB B.23]. In such cases, the pre-existing definitions are adopted.

The ACF framework should support two or more IBB applications to be executed simultaneously. The AppCatUI must allow the user to bring the different applications to focus. Additionally, the ACF must grant the isolation between the running applications within its scope, but the IBB DTV receiver must provide isolation from other platform applications. This is important for stand-alone IBB applications that may not be aware of other native applications executed in the system.

The ACF must be capable of handling service associated and stand-alone IBB applications at the same time.

In the case of service associated IBB applications, it should be possible for the ACF to handle both service exclusive and service shared IBB applications.

8.6 The application catalogue user interface (AppCatUI)

The application catalogue user interface (AppCatUI), see Figure 8-3, is a functionality provided by the IBB DTV receiver intended for listing the available applications that can be launched by the user (FR-ACF-10 of [ITU-T J.205]). This concept is already present in DTV middleware standards such as [b-GINGA-J], [b-GINGA-NCL] or [b-MHP]. As an extension to the concepts in current DTV middleware specifications, the AppCatUI in the ACF must include the following functionalities:

– Listing applications available to the user including:
  - Conventional DTV services' applications that can be launched by the user. For example: signalled with AIT control codes AUTOSTART ([b-MHP], [b-GINGA-Data Transmission]), PRESENT ([b-MHP], [b-GINGA-Data Transmission]), STORED ([b-GINGA-Data Transmission]), REMOTE ([b-GINGA-Data Transmission]), UNBOUND ([b-GINGA-Data Transmission]), etc., and the visibility flag enabled ([b-GINGA-Data Transmission], [b-MHP]).
  - Service associated IBB applications meeting the same signalling requirements as for conventional DTV services' applications.
  - Stand-alone IBB applications (both installed IBB applications and resident IBB applications).

– Retrieving remote application catalogues from an application repository.
– Allow the end user to launch any listed application.
– Allow the end user to bring to focus any listed application already in execution.
– Allow the end user to terminate any listed application already in execution.
– Provide access to the available user-oriented application metadata (such as application name, provider, version, etc.).

The list ordering of the applications in the AppCatUI should change dynamically, according to the following priority rules:

- Firstly, the service associated IBB applications signalled within the IBB DTV service selected at current time must be shown differentiated and highlighted, so the user can clearly identify that such applications are part of the IBB DTV service content. Additionally, the user interface design should grant quicker access to these applications.
- Secondly, the ordering within service associated IBB applications is defined by the order in which applications are declared in the IBB DTV service (e.g., AIT).
- Stand-alone IBB applications available through the current selected IBB DTV service's application repository should be listed in second priority order. In this case, the installed applications should be listed first.
- Finally, the stand-alone IBB applications installed in the IBB DTV receiver are listed, following the items above.

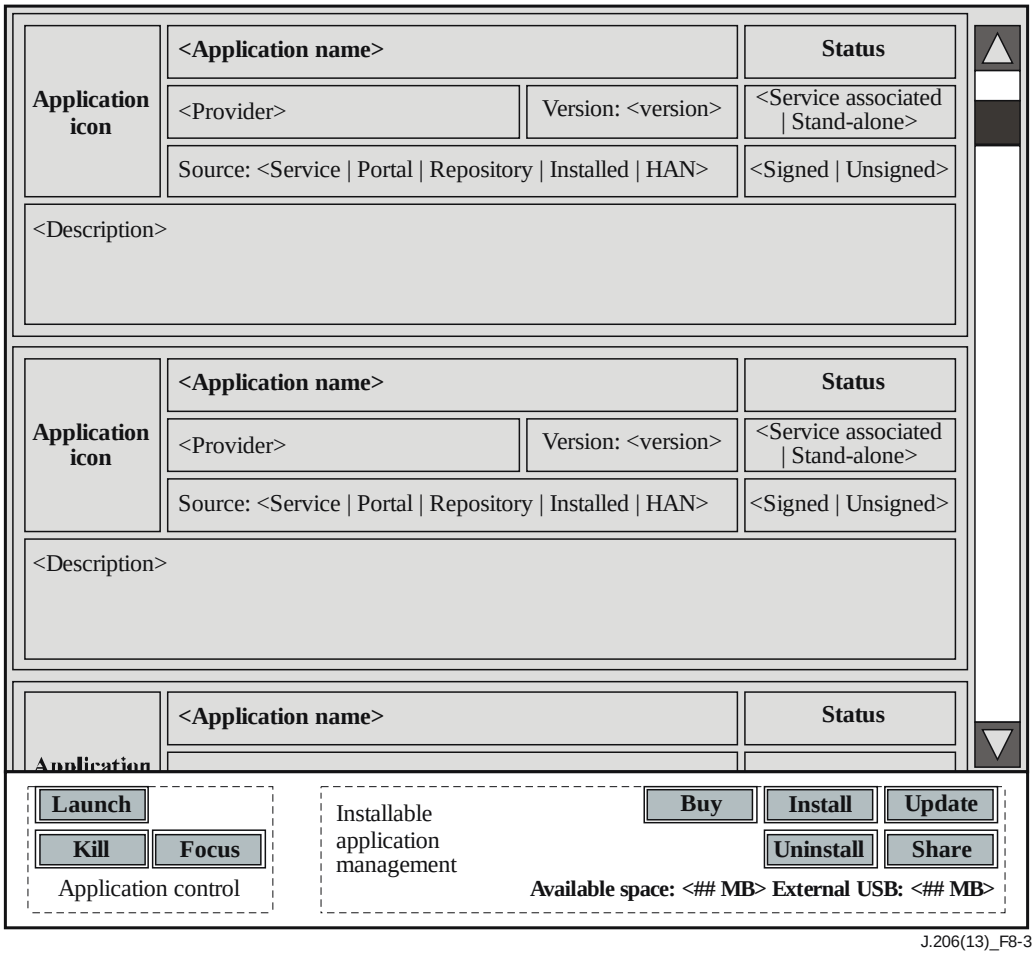

Figure 8-3 – Example of AppCatUI

8.7 IBB installable application management

IBB installable applications can be stored in the IBB DTV receiver. As described in clause 8.3, item d, installation could occur when indicated by the IBB DTV service provider or by a specific action from the user.

IBB applications can be installed in the IBB DTV receiver's persistent storage in the following ways:

– Automatically installed: when signalled in a selected DTV service, a special signalling must be used in order to indicate that the application is to be installed in the receiver.

  Such a mechanism is provided by the AIT's UNBOUND control code in [b-GINGA-Data Transmission]. Automatically installed applications may require confirmation from the end user.

  Other equivalent mechanisms can be used as well, especially when storing applications is used as a caching strategy. In this case, user confirmation is not required.

– User installed application. In this case, the IBB installable application's origin can be:

  • a server reached through the broadband channel
  • an application repository
  • another device in the HAN
  • a pluggable storage device (such as USB stick or external hard disk), etc.

  In the case of the application repository, the installable application manager should retrieve a remote application catalogue from the application repository.

  In the case of another device in the HAN or pluggable storage device (such as a USB stick or external hard disk), the device should be inspected looking for AIPs and a list should be presented to the end user in order to choose which IBB applications to install.

  In all cases, for a user-installed application, the IBB application should be installed from an AIP.

8.7.1 Rules for IBB installable application storage management

The following rules for application storage management must be considered by the IBB DTV service provider and the IBB DTV receiver for handling IBB installable applications:

– Under limited storage space conditions, in the case of automatically installed applications, the least recently used algorithm may be used for uninstalling IBB applications. If a user's confirmation was requested for installation, uninstalling would require another user's confirmation.

– In the case of user installed applications, IBB DTV receivers should provide a mechanism for the user being able to request the uninstalling of the IBB application.

– In both cases, when installing (updating to) a newer version of an IBB application, the older version must be removed.

8.7.2 IBB application updating

The IBB installable application management must also support the following application update mechanism:

• Periodically checking the installation source (i.e., the application repository from which the application has been downloaded) looking for recent versions of the already installed applications.

• Whenever a newer version of the application is being signalled in the selected IBB DTV service, the IBB DTV receiver should try to update it.

- If the original application is signed by the IBB application provider, a new IBB application should be signed also by the same IBB application provider.

If the user's confirmation was requested for installation, the updating of the IBB application will require another user's confirmation.

8.7.3 IBB application update criteria

In order to identify that an installed IBB application requires updating, the IBB DTV receiver should use the following criteria:

- match the Application_ID and Application_Provider_ID;
- ensure the application version field of the installed application should be lower than the version field of the IBB application being signalled or listed in the remote application catalogue retrieved from the application repository.

8.7.4 Organization of IBB installable applications (optional)

The IBB installable application management subsystem may allow the end user to arrange the installed IBB applications in a customizable hierarchical directory structure or in groups. This may become a usability issue that implementations adherent to this Recommendation may need to address.

8.7.5 IBB resident application updating (optional)

The ACF is also intended to manage resident applications, which are embedded in the IBB DTV receiver and controlled by the manufacturer. Resident applications may also be subjected to updates. Manufacturers may adopt the same update mechanism provided for IBB installable applications, (e.g., defining an Internet application repository for making available new versions of the resident applications).

Other mechanisms, such as firmware updates, may be applicable as well, but in these cases, the procedures to be used are not within the scope of this Recommendation.

8.7.6 Storage organization for IBB applications

Figure 8-4 defines a high-level division of the IBB DTV receiver's storage, and highlights how this storage is managed:

- ROM/FIRMWARE: This read-only memory stores the resident IBB applications. This is usually managed by the IBB DTV receiver manufacturer and usually updated by firmware updates.
- PERSISTENT READ/WRITE: This is general purpose non-volatile memory:
    - ACF managed storage: The ACF uses this area to store the automatically installed IBB application components and, optionally, do caching of service bounded IBB application components.
    - User managed storage: This is the area used to store the user installed IBB applications.
    - Application managed storage: This area is reserved for the applications to store files, settings and any other resource that may have been downloaded or created by the IBB application.
- RAM FILE SYSTEM: This is a volatile storage used to temporarily store any data. This is mainly used for in-progress downloads of IBB application components.

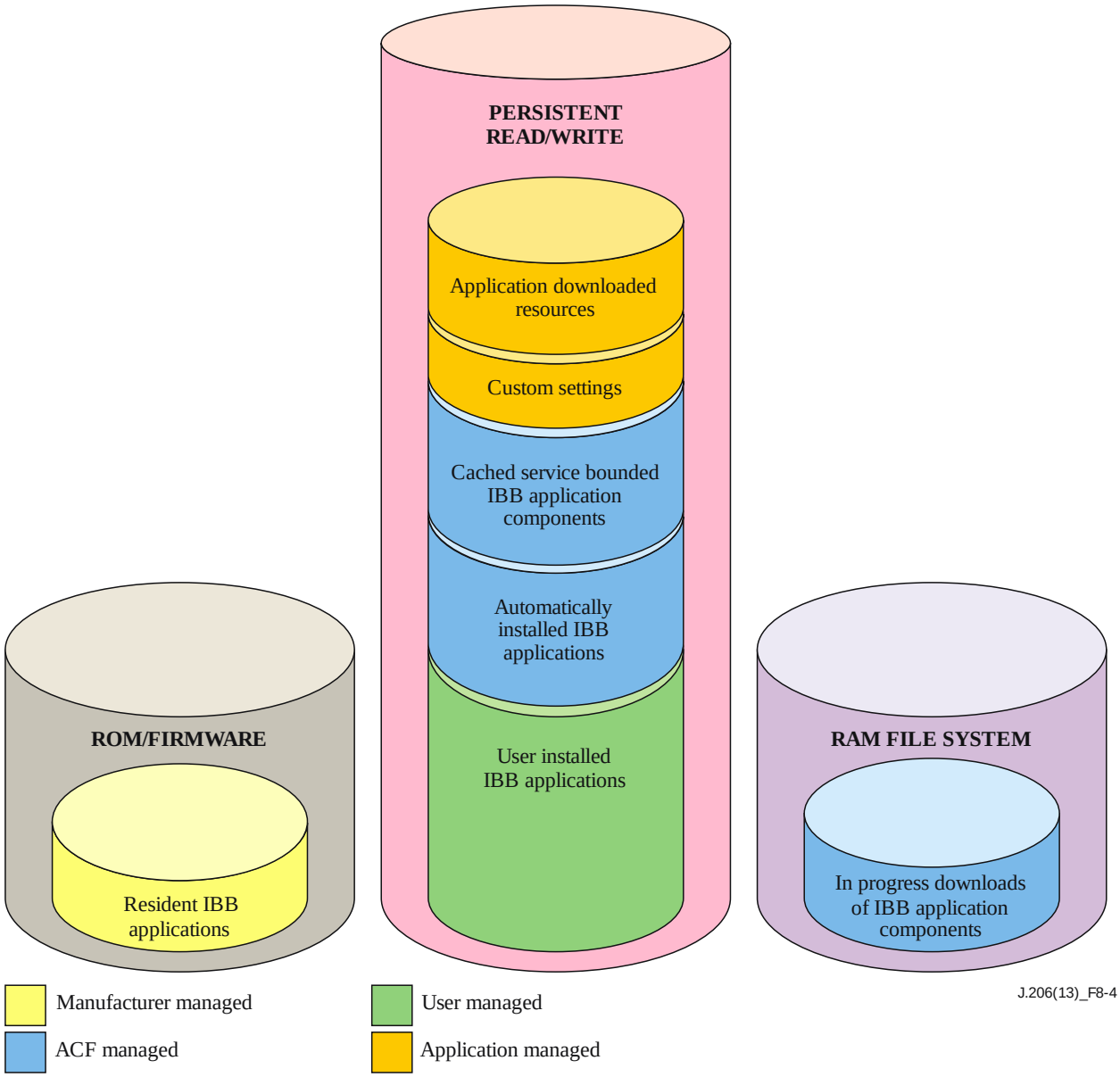

Figure 8-4 – IBB DTV receiver's storage organization

8.8 Internet application repository

Internet application repositories are Internet servers intended to distribute applications for on-demand installation (FR-ACF-06 of [ITU-T J.205]). Each Internet application repository must export a remote application catalogue. This catalogue is queried by the IBB DTV receiver in order to:

– Allow the end user to browse and search through the applications available in the Internet application repository, using the application catalogue user interface (FR-ACF-04 of [ITU-T J.205]).

  • The application catalogue user interface should display application information details such as name, a brief description, icon, screen shots, price, version, required storage space, vendor, etc. This information is contained in the remote application catalogue.

– Allow the end user to choose applications to install in the IBB DTV receiver. In this case, the IBB DTV receiver would download an application installation package from the Internet application repository and install it.

8.8.1 Internet application repository user account

Some Internet application repositories may require a user account to:

- query the remote application catalogue and/or
- download an application.

In these cases, a session must be established using the authentication protocol.

8.8.2 Application installation package (AIP) downloading protocol

For downloading the AIP, the HTTP1.1 or HTTPS1.1 protocols must be used. The downloaded AIP must be stored in the IBB DTV receiver's persistent storage in a special area not accessible by the applications.

Once the AIP downloading has been completed, the IBB DTV receiver should install the application, making it ready for execution upon user request.

Once the IBB application is installed, the IBB DTV receiver may choose to delete the AIP from its persistent storage or keep it for further sharing with other devices in the HAN (this second option is not a mandatory requirement but a highly recommended feature).

8.8.3 Internet application repository application purchase (optional)

Some content may not be free; in this case, the end user should be able to purchase the application with credits previously charged to his/her user account. Once the payment is confirmed, the application should become available for installing.

The ACF contemplates a user account identification mechanism that can be used as the basis for building custom payments and credit handling mechanisms at the IBB application level.

8.9 Ensuring DTV service integrity and IBB application permissions policy

As previously defined, a DTV service is a unit for delivering audio-visual-interactive content to end users, and constitutes an editorially consistent whole.

It is a requirement for the ACF to ensure that the DTV service is always consistent with the IBB DTV service provider editorial rules (FR-ACF-14 of [ITU-T J.205]).

The IBB DTV receiver must implement a different handling for service associated IBB applications and stand-alone IBB applications.

Service associated IBB applications

Service associated IBB applications are allowed to be displayed combined with other services' contents (audio, video, closed caption and other interactive content) belonging to the same DTV service and interact with them (the rationale behind this is that service associated IBB applications are part of the same editorial unit). In this case, application authentication and permission rules such as those defined by [b-MHP] or [b-JAVADTV] must be applied.

Stand-alone IBB applications

When executing stand-alone IBB applications or IBB applications from other service providers with no explicit permissions granted from the currently selected IBB DTV service provider, the IBB DTV receiver can take four different actions:

- the service exhibition can be stopped (video hidden, audio muted and any other service content hidden) as defined in [EBU-req]; or
- the screen can be divided in such a way that the IBB DTV service content exhibition and the IBB application are displayed in different and non-overlapping regions. In these cases, separation of the IBB application and the IBB DTV service content must be very clear to the end user; or

- the IBB application can be displayed on a secondary screen device associated with the IBB DTV receiver; or
- the IBB application may not be allowed to use an IBB DTV receiver's resource that the DTV service is using.

The above actions that can be taken by the IBB DTV receiver should follow the information that describes the IBB DTV service provider's intention for exhibition of stand-alone IBB applications, which may be delivered through the DTV service channel or should follow a predefined system design rule.

IBB DTV service providers may desire to explicitly grant permissions to specific stand-alone IBB applications (such as installed IBB applications) or applications associated with different services in order behave as if they were part of the service. To achieve this, stand-alone IBB applications must be distributed with a signature from the IBB DTV service provider in the AIP.

In this case, stand-alone IBB applications would be allowed to:

a. overlay over another service's contents such as the service's video or the other service's applications;

b. manage or change service exhibition such as video control (video freeze, stop, scaling, etc.), audio control (audio stop, volume level change, etc.) and starting or stopping any other service component (subtitles, closed captions, alternate audio, alternate video, etc.); and

c. interact, communicate or control (start/pause/destroy) other IBB applications in the DTV service.

A stand-alone IBB application can be distributed with signatures from different IBB DTV service providers. In this case, IBB DTV receivers should grant those applications the same execution rights as IBB applications associated with each one of the IBB DTV services delivered by the signing IBB DTV service providers.

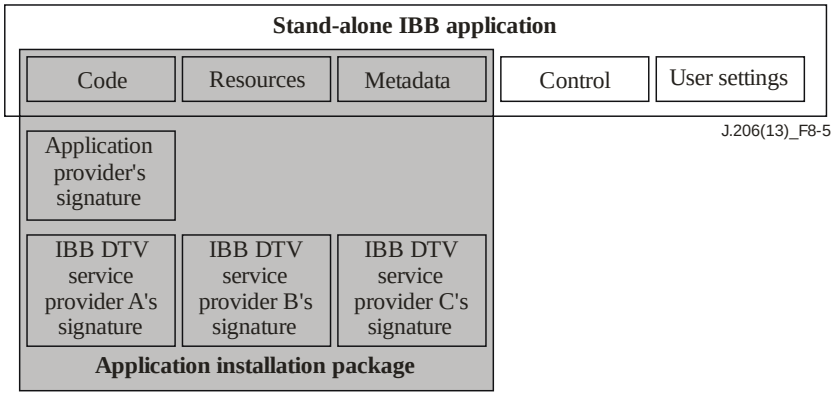

Figure 8-5 – Sample of distribution of stand-alone IBB applications signed by multiple IBB DTV service providers

In Figure 8-5 the given stand-alone IBB application must be granted the same executions rights as service associated IBB applications whenever any IBB DTV service from IBB DTV service providers A, B or C are selected by the IBB DTV receiver.

8.10 Ensure user privacy and user data protection

Authentication mechanism and permissions policies should be considered for IBB applications in order to protect user privacy and data (FR-ACF-15 of [ITU-T J.205]). Only IBB applications signed by IBB application providers will be allowed to:

- access user settings;
- access the IBB DTV receiver's persistent storage;
- access other devices in the HAN;
- use an Internet connection or establish a connection with another device outside the IBB DTV receiver;
- access resources from the broadband channel;
- communicate or interact with other IBB applications.

IBB applications not signed by their IBB application provider are strictly restricted to local execution, inside the IBB DTV receiver. It is strictly prohibited for them to communicate with other external entities through the broadband or HAN networks.

8.11 User account management

The user account is to be associated with:

- IBB application's custom user settings stored in an IBB DTV receiver device, other devices in the HAN or servers reached through the broadband channel;
- access rights to a set of applications and services.

At the application level, they can be associated with:

- a credit account or payment information for accessing non-free content.
- Other accounts used in Internet services (such as e-mail, social networks, instant messaging, voice and video calls, etc.).

Many devices are usually shared among several users (e.g., a TV set shared by the members of a family). On the other hand, some devices are mostly used by a single person (tablet, mobile phone, etc.). The ACF must be aware of this and support the ability to handle several user accounts in a single device.

From the IBB application viewpoint, it should only be possible to access resources and settings exclusively associated with the currently logged in account.

8.11.1 User identity

The user identity is a value (exposed as a user setting) that defines a unique universal identifier for the end user. This value must be used to unequivocally identify the user with any other entity within the system (i.e., application repository, any custom Internet service accessed by applications or even HAN devices). See Figure 8-6.

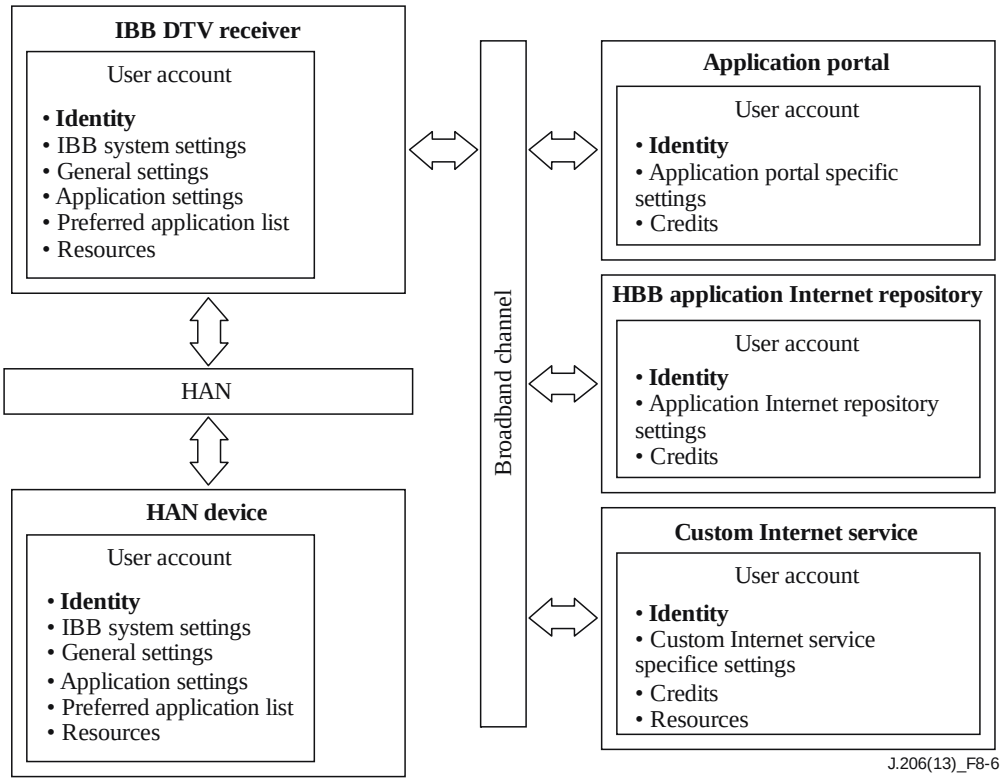

Figure 8-6 – User settings and resources associated by the user identity value

A user authentication protocol should be used in order to establish a secure session with a remote entity such as an application repository, a custom Internet service or a HAN device.

Once the secure session is established, IBB applications will be able to access remote stored settings, resources and other IBB applications.

8.11.2 Accessing settings and properties

Only two kinds of settings are considered in this specification:

- **IBB application settings**: This refers to a set of settings that constitute part of this specification and must be supported by any ACF compliant solution. Usually, these settings are stored in the IBB DTV receiver and can be shared among HAN devices using the HAN sharing settings protocol. The scope of these settings may be system wide: applied to all the IBB DTV receiver's users; or specific user settings; a different value must be stored for each user account.
- **Custom settings**: Any other user settings not in the IBB application settings must be considered application settings (or custom settings). Applications may store any custom setting in the IBB DTV receiver indicating its scope: whether it is a system wide setting or a user account setting. Additionally, applications may retrieve custom settings from other HAN devices, using the HAN user setting sharing protocol, or from custom Internet service entities using the protocol for querying remote user settings.

In every case, before retrieving user account settings from another device or entity, a secure session must be established for the user account.

In every case, settings are exposed to IBB applications as a pair of strings (property_name, value) in a table, indexed by the property_name.

8.11.3 Accessing resources

Resources are considered to be any file or stream accessed by any given IBB application. Some resources may require some kind of access restriction, and the user identity must be verified for granting access to such resources:

- In the case of external resources in the application repository, custom Internet services or HAN devices, the user authentication protocol must be used to establish a secure session so the IBB application can access non-public resources from these types of sources. This specification does not define how these resources are to be handled internally by these remote entities.
- In the case of resources stored in the IBB DTV receiver in the user account's exclusive persistent storage, access must be granted only to the resources stored in the exclusive persistent storage of the user account currently logged in the receiver. The same is required for saving resources or any other file in this storage space.

Verification of user identity is not required to access or store resources in the IBB DTV receiver's general persistent storage.

8.11.4 Accessing non-public applications and the remote application catalogue

Some IBB applications in application repositories can be non-public and require user authentication for listing or downloading.

The ACF must establish a secure session with the application repositories, using the user authentication protocol for gaining access to this kind of non-public content.

8.12 Location awareness (optional)

IBB applications can retrieve information about the geographical location of the IBB DTV receiver through the properties defined in the IBB application settings (FR-ACF-19 of [ITU-T J.205]).

8.13 DTV service synchronization (stream events)

The ACF must follow recommendations and mechanisms from [b-MHP], [b-GINGA-NCL] and [b-GINGA-J] for providing a functionality that allows the synchronization of IBB applications with the IBB DTV service content (FR-ACF-22 of [ITU-T J.205]).

8.14 Media content streaming (optional)

The IBB DTV receiver can provide a video capture capability from different sources such as:

- HAN device such as a connected webcam, tablet, smart phone, etc.
- A video camera and microphone plugged or embedded into the IBB DTV receiver.

Such a capability can be exposed to IBB applications as an API extension to [ITU-T J.200]. This would allow implementing IBB applications, such as VOIP and video calls, capable of capturing such input streams and forwarding them to external hosts (FR-ACF-26 of [ITU-T J.205]).

Stream playback capabilities can also be exposed to the interactive content and applications as API extensions to [ITU-T J.200], allowing the implementation of client applications and players for services such as Internet multimedia content providers and content aggregators.

8.15 Cryptographic API

An API for cryptography and certificate management, such as defined in [b-ITU-T J.202] must be made available to IBB applications (FR-ACF-27 of [ITU-T J.205]). These also should include an API for accessing functionalities available in devices such as smart cards or cryptographic USB tokens.

8.16 Persistent storage

A mechanism such as defined in [b-ITU-T J.202] must be used for IBB applications having read/write access to the IBB DTV receiver's persistent storage (FR-ACF-24 of [ITU-T J.205]).

8.16.1 Resource downloading

By combining the usage of an API for remote resource access and persistent storage access, an application can download and store resources in the IBB DTV receiver's persistent storage.

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Printed in Switzerland
Geneva, 2014