Analysis of Coexistence of Ginga and HbbTV in DVB and ISDB-Tb

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***Abstract*—In this paper, we examine the possible coexistence of Ginga and HbbTV as interactive TV (iTV) systems in the Brazilian and European broadcasting systems, ISDB-Tb and DVB, respectively. We compare both systems architectures, in particular with respect to their functional modules. Our analysis provides the necessary information to assess the possibilities of a joint framework that includes both Ginga and HbbTV, consequently leading to a potential foundation of a system that supports both Ginga and HbbTV applications.**

***Keywords*—coexistence, HbbTV, Ginga, DTV, DVB, ISDB-Tb**

I. Introduction

Around the world consumers are changing the way they interact with audio and video content, while devices provide solutions that combine passive and interactive aspects in new and more individual multimedia experiences [1]. Moreover, increasingly the segregation of content according to device types becomes blurred. New usage scenarios are implemented and users are offered content using different device types e.g. live video is not constrained to TV sets and applications are not only found on computers any more. With the digitalization of the television broadcasting, TV sets became smarter by integrating an Internet connection and by offering interactive TV (iTV) service. Such TVs are often called Smart TVs, Connected TVs or more generally Internet TVs. Through this transition, the TV set became a corner-stone in broadcast-broadband convergence.

Already earlier generations of Digital TV standards supported interactive applications, defining middlewares, such as MHP in DVB and Ginga in ISDB-Tb. On the other hand, current generations of Smart TV applications are not supported by a common standard. Each manufacturer implements its own broadband middleware specifications. This fragmentation hinders the proliferation of innovative experiences on these technically different systems [2]. Considering this background, hybrid broadcast broadband TV (HbbTV) was developed, focusing on generating a common platform for Smart TV applications. In addition, it specifically targets a common platform for combined applications from broadband or broadcast, enabling true hybrid scenarios. HbbTV has its roots in Europe and was designed in the context of DVB, focusing on the European broadcasting market and the related regulatory requirements. Interoperability with other interactive TV platforms was not covered in the original specification release.

In this work, we present an analysis of a possible coexistence of the Brazilian iTV system Ginga and the European iTV system HbbTV in the context of their corresponding broadcasting systems, ISDB-Tb and DVB, respectively. Our aim is to evaluate the feasibility of a joint framework that can support both Ginga and HbbTV applications on consumer devices.

This paper is organized as follows: in Section II we present an overview of the Ginga and HbbTV iTV systems, followed by a discussion of the architectural and technical similarities of HbbTV and Ginga in Section III. Section IV presents the possibilities of a global DTV interactivity platform that allows for the coexistence of HbbTV and Ginga. After that, Section V explores the challenges to enable coexistence for different iTV systems. Finally, Section VI concludes this analysis and point out the next steps.

II. Ginga and HbbTV System Overview

Ginga is a solution to provide interactivity for digital TV in the Brazilian digital television system (SBTVD, *Sistema Brasileiro de Televisão Digital*) consisting of the Ginga-NCL (declarative) and Ginga-J (procedural) modules [3]. Ginga is divided into two major integrated subsystems: The common core module (Ginga-CC) and the application execution environment. The Ginga-CC is a layer which contains software modules for MPEG-2 TS parsing as well as mount System Information Tables (SI Tables), file systems received by DSM-CC and signaling for new applications ready to play by application layer. The execution environment supports the execution of declarative NCL applications (Ginga-NCL) integrated into the runtime environment of Java applications (Ginga-J). Both environments are required by the Brazilian Terrestrial Digital TV standard ISDB-Tb for stationary receivers, while the Ginga-J is optional for mobile receivers. Thereafter, the Ginga iTV system supports a TCP/IP protocol stack where it is possible to accept different Internet services for broadband communication as well as receive applications and establish connections for returns channels (for instance, an Internet connection for applications which needs to send user feedbacks to a information server). In addition, some research involving Ginga and SBTVD are recently developed as shown in [4], [5] and [6]. Fig. 1a shows a typical Ginga application and Fig. 2a shows the Ginga architecture.

The hybrid broadcast broadband TV (HbbTV) iTV system was originally developed for the use in DVB broadcasting systems and is based on widely used web technologies [7], [8]. It utilises the functionality provided in existing web standards by defining sub-sets of these standards, also called profiles. Standards profiled in HbbTV include specifications from the Open IPTV Forum (OIPF), CEA, DVB and W3C, in particular CE-HTML and JavaScript. The HbbTV specification

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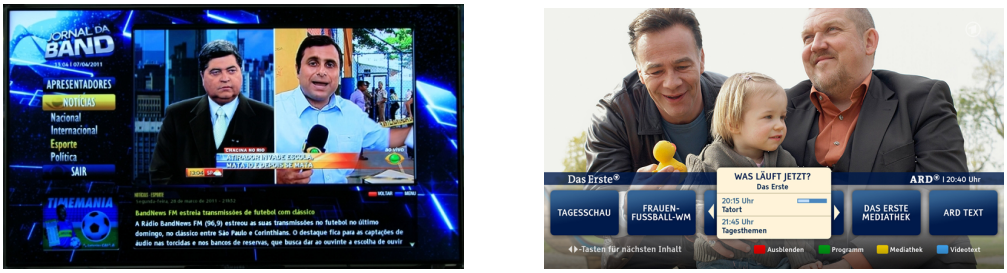


(a) Ginga (b) HbbTV

Fig. 1: Examples of typical broadcast-related interactive TV content for HbbTV and Ginga

encompasses the necessary broadcasting signaling and specifies the requirements on the browser integrated in the Smart TV sets. HbbTV combines data and applications received via the broadcast signal, with services, applications and content provided via the Internet. Currently he next release of HbbTV, commonly referred to as HbbTV 2.0, is being specified by the HbbTV Assoication. It will further align HbbTV with HTML5, CSS3 and current DOM specifications, providing for an even tighter interoperability between traditional internet applications and iTV. Fig. 1b shows a typical HbbTV application and Fig. 2b shows the overall HbbTV architecture.

The application and information for managing the application is received by a hybrid broadcast broadband schema. The broadcast interface consists of a stack of modules that demultiplex MPEG2-TS packages and parses the SI tables, looking for an Application Information Table (AIT). The AIT provides the information needed for application signalling and application reception either via broadband using Internet protocols or via the broadcast signal using a DSM-CC carousel.

III. Ginga and HbbTV Modules Analysis

In order to be able to assess the possibility of a coexistence of Ginga and HbbTV, we analyze in this section the similarities and differences between Ginga and HbbTV modules with respect to their functional modules and common interfaces, both from an architectural point-of-view, but also with respect to the technical implementation details.

A. Architecture comparison

The basic structure of both frameworks as illustrated in Fig. 2a and Fig. 2b for Ginga and HbbTV, respectively, is roughly similar: a module for receiving broadcast data, a second module for broadband data communication and lastly a module representing the application layer.

The broadcast data receiving module receives commands to control the application and although Ginga and HbbTV are specified for different broadcasting systems, both Ginga and HbbTV obtain their signalling via information provided in a MPEG-2 transport stream (TS) based on a parsed AIT. Moreover, for both iTV systems data can be received via the broadcasting signal through a TS-based aggregation processes, such as DSM-CC. Both the Ginga and HbbTV broadcast data receiving module support commands to control the application life-cycle. For both systems, Ginga and HbbTV, application signaling, application receiving and application handling methods are based fundamentally on Globally Executable MHP (GEM) as described in the standards [7], [9] and also in a study carried out in [10]. For Ginga, the SBTVD standard describes the guidelines for application signalling, receiving and controlling by referring to GEM as a baseline [11] and for HbbTV, the signaling, receiving and controlling originally defined for MHP [12] that is also related to GEM has been modified in [13].

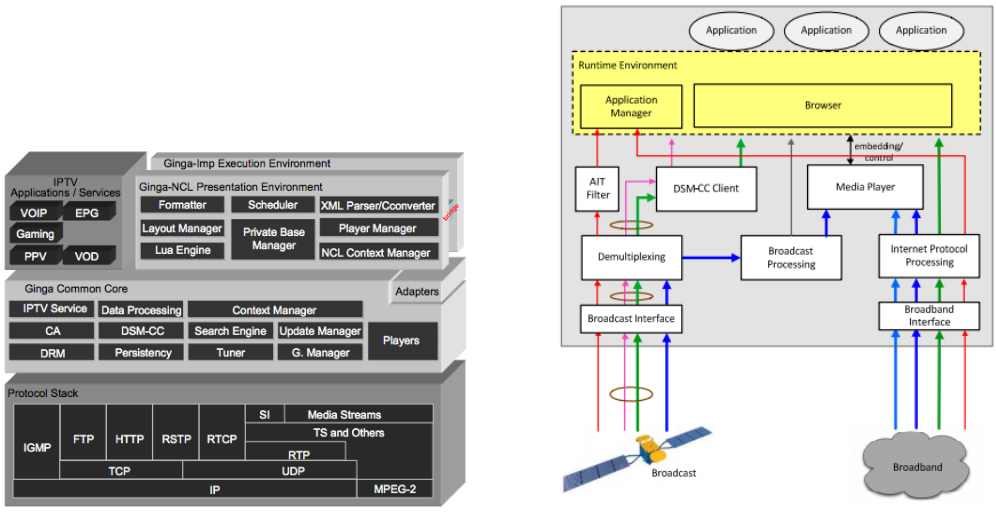
The broadband data communication module of Ginga-NCL and Ginga-J contains network interfaces for TCP/IP connections to provide data for scenarios using a return channel. The return channel is used when a Ginga application needs to send data to a central server (e.g., quiz apps, user feedback, etc). In addition, the Brazilian SBTVD standard allows for the receiving of applications via the broadcast signal, depending on information provided in the AIT [11]. Similar to Ginga, HbbTV also utilizes traditional Internet protocols for the return channel. Moreover, the Internet connection is considered an integral part of the HbbTV framework and is therefore used in most applications not only to send data back to the server, but also to receive the applications and corresponding data in the first place. Still, similar to Ginga, HbbTV also allows for providing applications only via the broadcast signal.

The application layer is responsible for the application execution and rendering. In the case of Ginga, Ginga-NCL has an application player with audio and image rendering interface to be implemented with most of software APIs. Thereafter, Ginga-NCL has a support for Lua applications and a basic support for HTML. Especially about Ginga-J, the functional requirement is that the Java Virtual Machine (JVM) implementation is available to the target platform. In contrast to the specialized application players in Ginga, HbbTV applications are implemented as web applications using CE-HTML and JavaScript that are executed in a browser running on the TV platform. Access to the TV platforms functionality is provided via JavaScript APIs defined by OIPF that expose essential features like channel tuning to the HbbTV applications.

B. Technical comparison

Besides the architectural comparison of Ginga and HbbTV in the previous subsection, it is also important to examine the technical implementation of both Ginga and HbbTV.

Clearly, some technical aspects of Ginga and HbbTV are fundamentally different. Ginga uses NCL and Java, compared



(a) Ginga architecture (from [14])

(b) HbbTV architecture (from [7])

Fig. 2: iTV system architecture: Ginga (left) and HbbTV (right)

to HbbTV that uses HTML and Javascript. Although Ginga and HbbTV uses AIT as an information base for application signalling, there are some differences regarding the content transmitted.

For examining the possible coexistence of Ginga and HbbTV, however, it is sufficient to focus on the system aspects of both iTV systems and not on how the interactive content itself is described. In Table I, we compiled the key system features for both systems. On the one hand we compare aspects of the application transmission and signalling, but on the other hand also the supported media types, as one key feature of coexistence is the use of the same media and (non-interactive) content in different iTV systems.

IV. Coexistence Aspects

Taking into account the analysis in the previous section, the concept for an interoperable system emerges that can transmit, receive and execute Ginga and HbbTV applications based on a hybrid broadcast broadband model, allowing the coexistence of both iTV platforms in each broadcasting system. A high-level description of the most important aspects regarding the coexistence are given in Table II.

Fig. 3 illustrates the potential general organization of a iTV terminal able to support multiple iTV frameworks: the yellow blocks represents the functionalities associated with the broadcasting signal processing, composed of a tuner, demultiplexer and specific blocks for TS and SI tables parsing, a DSM-CC client for implementing the carousel file system and a block for application handling commands. The blue blocks represent the broadband functionalities supporting Internet services and protocols. The application management layer processes the messages and data provided by the broadcast and broadband stacks to select the appropriate players to execute an application. This application could contain features only from one iTV system for pure coexistence or from different iTV systems for additional interoperability between the different frameworks. Form a conceptual level, each iTV system could be considered as a plug-in that provides a representation of the application suitable for a web browser.

TABLE II: Aspects for coexistence of Ginga and HbbTV

Module	Relevant Aspects
Broadcast data receiving	Ginga and HbbTV have similar procedures to get data and applications commands from the broadcast signal.
Broadband data	Ginga and HbbTV have TCP/IP modules where it is possible to connect to Internet services.
Application layer	Ginga and HbbTV have different concepts for playing applications. Ginga is based on NCL/Lua ou xlet applications. HbbTV is based on W3C standards. The execution of Ginga applications through a browser plug-in is under evaluation and can provide the necessary coexistence.

The broadcast data receiving for Ginga and HbbTV, considering the application signalling via SI tables and application receiving via DSM-CC, has similar procedures and both generally comply with GEM. The application payload injection in the DTV transmission has a similar MPEG2-TS structure as well as SI tables structure and software stack for data parsing and data binding. Thus, Ginga and HbbTV applications can in principle be transmitted and received in a proposed coexistent system based on DVB or ISDB-Tb.

Regarding the broadband data, both Ginga and HbbTV support TCP/IP protocols and associated Internet services. It means that a platform offering a Ginga and HbbTV coexistence could accept any Internet requests for data transfer with the terminals' hardware limits. Applications with a return channel concept and other Internet interaction schema are supported by both Ginga and HbbTV.

Considering a coexistence of Ginga and HbbTV, the application layer is the most interesting point in this analysis and requires special attention. Although both iTV systems have different concepts for application development, a browser-focused

TABLE I: Comparison of the technical aspects of Ginga and HbbTV in the context of ISDB-Tb and DVB, respectively, with focus on the key system features

	Ginga and ISDB-Tb	HbbTV and DVB
Signalling and application transport		
Application type ID	0x01 (Ginga-J) / 0x09 (Ginga-NCL)	0x10 (HbbTV)
Lifecyle states	AUTOSTART, PRESENT, DESTROY, KILL, PREFETCH, REMOTE, UNBOUND, STORE	AUTOSTART, PRESENT, KILL, DISABLED
Service bound flag	yes	yes
Application transport types	DSM-CC, broadband	DSM-CC, broadband
priority flag	yes	yes
XML AIT	no	yes
Broadcast independent applications	yes	yes
Stream events	yes	yes
Media types for broadband content		
Media formats		
Video	MPEG-4 AVC HP@L4 (full seg) MPEG-4 AVC BP@L1.3 (one seg)	MPEG-4 AVC HD/SD
Audio	MPEG-4 HE-AAC v1@L2 (stereo) MPEG-4 HE-AAC v1@L4 (5.1) MPEG-4 HE-AAC v2@L2 (portable)	MPEG-1 layer 3 (MP3), MPEG-4 AAC, Dolby E-AC3
Media container		
Video	MP4, MPEG-2-TS	MP4, MPEG-2-TS
Audio	MP4, MPEG-2-TS	MP4, MPEG-2-TS
Adaptive streaming	not supported	MPEG DASH [a]
DRM	no	integration rules and APIs for DRM systems[a]

[a] from HbbTV 1.5 on

plug-in concept instead of the regular, monolithic structure described in most standards could provide an opportunity for platforms and associated application that contain a diversity of features from different iTV systems, supporting global iTV applications.

Note that depending on the framework, the functionality and therefore complexity encapsulated in the different players may differ between the different iTV systems. For example, HbbTV applications consisting of HTML and Javascript are already in a format interpretable for the browser and the player only needs to provide the Javascript API to access the terminal's functions. In contrast, a Ginga-NCL player needs to interpret the NCL code of the application into an HTML compliant format so that the application can be presented in a W3C compliant browser.

V. Challenges for the coexistence

Even though Ginga and HbbTV share similar properties and a coexistence of both iTV systems in the same broadcasting signal is feasible, three principal challenges remain that need to be addressed in a coexistence scenario: *non-interference*, *interoperability* and *prioritization*.

The main challenge in the coexistence of different iTV systems within the same broadcast signal is clearly the aspect of *non-interference*. Non-interference in this context means that the addition of additional applications in the so-far not used iTV system does not interfere with both the existing terminals and applications of an iTV system already widely used in a broadcasting system. Considering Ginga and HbbTV, transmitting Ginga applications in a DVB TS should neither interfere with the functionality of existing DVB terminals and system components, nor should it negatively influence existing applications. Similarly, transmitting HbbTV applications in an ISDB-Tb TS should also not lead to any issued with existing ISDB-Tb terminals and systems components or Ginga applications.

The second challenge associated with the coexistence of different iTV systems within the same broadcasting system is the *interoperability* between applications implemented in the different systems. Considering that there has already been a significant investment into iTV applications by many broadcasters, the reuse of existing applications is an important factor in coexistence scenarios. Interoperability in its most simple form may just consist of the ability of an application created in one iTV system to start an application created in another framework e.g. a Ginga application starting and HbbTV application vice versa, where only one application regardless of the framework may be active at any time on a terminal. Re-using functions or libraries of one iTV system in another framework e.g. a Ginga function in HbbTV application or running applications of different frameworks simultaneously represent a more sophisticated, but also conceptually more demanding form of interoperability.

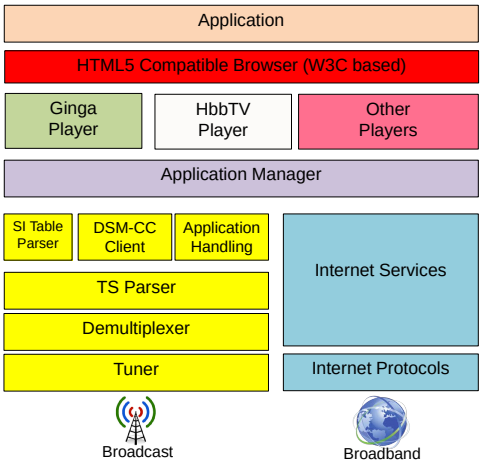


Fig. 3: Schematic block structure of a multi iTV system terminal for a coexistence approach

The last challenge that needs to be addressed for a broadcasting system in which multiple iTV systems coexist is *prioritization*: if the TS contains applications of multiple iTV systems that are all signaled as auto-start applications, how should a terminal that is able to present different iTV systems react e.g. a terminal capable of Ginga and HbbTV receives a TS with both the Ginga and HbbTV auto-start applications and then needs to decide to either autostart the Ginga or HbbTV application. One option is a pre-defined priority in the terminal for one specific iTV systems [15]. Another option is that the broadcaster signals an additional priority flag in the AIT, indicating which iTV system application shall be started [16].

VI. Conclusion

Our analysis provides us with the necessary information to assess the possibility of a joint framework that includes Ginga and HbbTV, and consequently how to design a system that supports both Ginga and HbbTV applications. In particular, we have illustrated that even though Ginga and HbbTV are rather different on first glance, both build on very similar building blocks, especially with respect to the signaling via MPEG-2 transport streams. Hence, the coexistence of both iTV systems within the same broadcasting standard is technically feasible.

Moreover, this analysis can also be extended in a next step to other broadcasting systems, allowing for a global interactive TV system. This enables us to pursue the ultimate goal of creating a framework for worldwide usable interactive TV applications based on HTML5-based web technologies, regardless of the underlying broadcasting technologies. In addition, a Global Interactive TV System could have positive impact on consumer electronics development, taking into account the interest from industry and content producers. It would make it possible to market DTV terminals globally and to have interactive features from a TV show produced in one region being reused in another region.

In future work, we intend to perform tests on selected software modules from Ginga or HbbTV, that can be used as an initial development baseline for such a global framework. Additionally, we are planning to explore the possibility of using Ginga applications via a browser plug-in.

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