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# Bringing All Users to the Television: A Platform Based on Java for Building Interactive Television Applications

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## 1. Introduction

Evolving technologies for the treatment of audio and video along with the improvement of techniques for data communication systems for Digital Television (DTV) has provided, at first, the improvement in the quality of video and audio signals (images), enabling For example, experiments such as surround sound (surrounding) the resolution of images in high definition (HDTV). In a complementary way, tools that involve the viewer/user more actively with the access terminal cause that system to be characterized as interactive (iDTv). At this point, applications can be built to explore different forms of services, ranging from the popular Electronic Program Guides (EPG) via typical applications and voting polls, and reaching the portals of public services and/or e-commerce portals in the same way as in other interactive platforms, as is the case of the WWW (World Wide Web), accessible via the Internet infrastructure. Surely, the development of interactive applications and services for environments of Digital Television is a considerable challenge (Vrba & Sykora, 2006; Kyriazis et al, 2011), characterized by new standards that must be understood by application developers. As a complement, which are commonly used tools for developing applications in client/server and web does not fit (fully or partially) the development of applications/services for iDTv (Jianmin et al, 2011). The Interactive Digital TV systems are presented, truly, as a new paradigm for computer systems, imposing technological challenges to software companies and telecommunications. New areas of application such as electronic commerce (t-commerce), e-governance (t-gov), distance (t-learning), and others that can take advantage of potential resources of a system iTVD may benefit from technologies for building applications for this new model (Batista et al, 2003; Peng, 2002).

This chapter is organized with the following structure. In the next section, the main concepts, problems and motivations for this research are presented. The main assumptions and challenges in the context of the Brazilian Digital Television System are presented in the section three. The section four discuss on interactivity scenarios identified to develop applications in the Brazilian Digital Television System. The BluTV (Bringing All Users to the Television) Platform is presented in the section five, specially in terms of design and

implementation. The section six presents the Interactive Television Application Guide for Citizenship, built with components of the BluTV Platform. The scenarios for testing and future directions of this research are presented in the section seven, and the final remarks and conclusions are discussed on last section.

## 2. Problems and motivations

As part of research in digital television and interactive digital television, there are efforts on the definition of development platforms for interactive applications, both with generic features and specifications covered in the middleware of SBTVD-T and for specific purposes and functions of equipment manufacturers and software industry and services (SBTVD Forum, 2010).

In the context of SBTVD-T, the middleware supports the development of interactive applications through its two environments: the first one, an imperative, called Ginga-J (Filho, 2007); the second, named Ginga-NCL (Soares, 2007), is declarative. This work focuses on the environment Ginga-J, especially in regard to the specification JavaDTV (JavaDTV, 2010), having the following basic assumptions: a) your TV as access terminal (screen) to the basic interactive applications, b) the remote control as main device (remote device) to the viewer/user interaction, c) the automatic identification of the characteristics of the access terminal (memory, disk and network interfaces) available for operating of the back channel (interactivity channel) (Meloni, 2007).

As a complement, whereas SBTVD-T is being implemented in its operations for transmission and reception of television content, people and organizations interested in developing applications and services for Digital TV, especially those need to work with interactivity, are exposed to five essential problems:

a. the Ginga (middleware of SBTVD-T) is a complex system and still needs a consistent regulation so as to be implemented fully, turning more difficult the development of iDTv applications compliant to it; the Ginga Common Core (Ginga-CC) is not available; Ginga Ready is the one Ginga implementation, powered by MOPA Embedded Systems (Clarasó et al, 2009);
b. since JavaDTV was specified, for developing iDTv applications the tendency concerns on Ginga-J instead Ginga-NCL;
c. limited availability of simplified platforms for prototyping iDTv applications and services;
d. services and platforms for Internet Video (like YouTube) and NetCast (GoogleTV, by example) are growing in Brazil, while the interactivity from Digital Television System is stopped;
e. limited availability of minimum hardware platforms for testing iDTv applications, including the infrastructure necessary to explore the back channel for testing the complete life cycle of iDTv applications and services (Santos Junior et al, 2010);
f. the Java Virtual Machine (JVM) is embedded as an *engine* into several TV (like Bravia model from Sony), allowing the execution of Java *bytecodes*, without to consider the presence of middleware Ginga; in addition, researches have been made in order to use Java Platform as a complete middleware to execute iDTv applications in the set-top boxes (Dong-Heon et al, 2010).

The research reported in this chapter is within the context of interactivity in a digital television system, including problems that occur in all stages of the life cycle of a program for interactive digital TV. The life cycle begins with the production and distribution of audio and video streams that are multiplexed to form structures in Transport Stream (TS), besides objects carousel (audio, video, images, text, graphics and executable/interpreted applications). These structures are received and presented at the access terminal of the viewer/user. The last stage is focused on the interaction of the viewer/user with resident applications without using the back channel; the interaction is completed using the back channel via any communication infrastructure. In this work, it also presented a proposal to implement a communication service that can be executed in the environment of the access terminal of the viewer/user, regardless of the middleware used/embedded in this terminal. The main function is the establishment of interfaces for data communication between the iDTv applications and the Interactive Service Provider (ISP), using the communication resources available for back channel.

## 3. Assumptions and challenges in the Brazilian digital television system

One of the most promising technologies of interactive video – the Interactive Digital Television – has as one of its objectives to provide new interaction ways to the viewer, like is the case of non-linear navigation as occurred on the Internet browsing. One of the main advantages of the advent of the Interactive Digital Television, especially in the brazilian context, is the possibility of the increase of the interaction between the viewer and the access terminal (like television) through services and applications, like games, video-on-demand, t-commerce, Internet browsing, among others. However, due to be a new technology, having few established standards and too many researches in progress, the building of applications for Digital Television still is challenge.

### 3.1 Channel of Citizenship

On March-25-2010, was published in the Brazilian Official Press an order of the Ministry of Communications with the guidelines for the operation of the Canal of Citizenship, provided in Presidential Decree on the deployment of SBTVD-T. The Channel of Citizenship is one of four channels that the Brazilian government could exploit the broadcasting service of sounds, images and data in digital technology. According to the decree, the channel will offer applications focused on citizenship (such as t-learning, t-gov and t-health) and the programming will be made by agreements signed by the Ministry of Communications and civil entities. The proposal is to make programming with local independent productions, giving visibility to the culture of each of the 5,564 municipalities in Brazil, according to the goals of the Ministry of Communications. The programming of Channel of Citizenship, in each municipality, will be prepared under the supervision of a media council, with the participation of diverse segments of the community. As already happens with community channels, the Channel of Citizenship cannot run commercial advertising or religious or political proselytizing. The content must disclose acts of government, and observe the social and cultural diversity, having artistic and educational purposes, among other principles. In this context, it is observed that the research reported here can contribute effectively to the Channel of Citizenship, serving as infrastructure for interactivity, allowing the viewer/user interaction with the television content and promoting digital inclusion actions.

### 3.2 National Survey by Household Sampling

Recently, the IBGE (Brazilian Institute of Geography and Statistics) released the results of the new National Survey by Household Sampling (PNAD) for the year 2009 (PNAD, 2009). The survey showed that in Brazil, 35% of households has computers and 27% has access to Internet. Some other results of the survey are worth mentioning in the context in which this research is inserted, namely:

a. in 58.6 million households surveyed in 2009, almost 35% (20.3 million) had computers (PC – Personal Computers), of which 16 million have access to Internet (27.4%);
b. the South-East region remained with the highest proportion of households with personal computer (43.7%) and computer with access to Internet (35.4%); the North region (13.2%) and North-East region (14, 4%) had the lowest proportion of households with personal computer with access to Internet; the Southern region had 32.8% and the Midwest region, 28.2%;
c. all age groups showed an increase in the proportion of people who used the Internet; the largest increases between 2005 and 2009, there were those who were in the younger age groups, the proportion of people 10 to 14 years of age increased 34.5%, reaching 58.8% in 2009;
d. for the age group 15 to 17 years the increase was 37.4%, and for 18 or 19 years was 35.9%, reaching so these groups 71.1% and 68.7% who used the Internet, respectively, during the reference period;
e. the national average of residents in a single household heads is 3.3%, with more than 26 million people consume TV programming by subscription;
f. an increase in the share of households with television, from 95.1% (in 2008) to 95.7%, reaching 56 million households;
g. the percentage of homes with DVD player skipped from 69.4% to 72%, totalling 42.1 millions of homes.

According to PNAD, it is observed that the TV and the television system elements are strongly present in the lives of Brazilian citizens, the most accurate and consistent than the computers and other electronic communications equipment (except mobile phones, but they are characterized as equipment for individual use). In this context, it is important to the citizens to use these elements for purposes of interactivity and access to information.

### 3.3 National broadband Plan

According to the National Plan which provides broadband, the digital cities and *telecentres* are much more than tools to access the Internet, since the digital divide is one of the axes of the formation of the Information Society. The "digital cities" can be developed into an important instrument of democratization of information, requiring investments of both public and private initiative.

The all levels (federal, state and city) of government should invest in the installation of infrastructure for communication networks that are available across a geographical area, exploiting the same infrastructure used by the *telecentres* for educational purposes, for example. *Telecentres* are rooms with computers, Internet and printer, where activities are developed for children and adults.

In the context of PNBL, entities such as the Telebras has a fundamental role in the task of inclusion, bringing the Internet to Brazilians who still do not have access to the network. But

the outlook for next 5 to 10 years - until a possible connection to 100 Mbps - provides for preparing the country for the information economy based on the tripod of investment, efficiency and innovation. The issue of investment is obvious and this is to eliminate the bottlenecks that impede access in remote areas. On the efficiency side, the logic is to leverage the infrastructure work - such as new dams - as vectors of the expansion of telecommunication networks. Recently, the Telebras submitted the list of top 100 cities in the country - in addition to 15 state capitals and Federal District - which will rely on state provision of back haul and, therefore, Internet access within the ceiling price of US$15.00, as defined by the National Broadband Plan. The initial focus is in the North-East and South-East regions, but beyond that, there are also towns in the states of Goiás and Tocantins. Besides that, there is poorest cities, but some can be considered successful, like Campinas and São Carlos, both in the state of São Paulo. Apart from the capital, the affected population reaches 14 millions of people.

It is observed that actions such as PNBL pointing practical possibilities of using this communication infrastructure for services that require a back channel for interactivity in the actions of SBTVD-T, which reinforces the relevance of the theme explored in the context in which this research project is inserted.

### 3.4 Grand Challenges in Computing

As shown in the *Grand Challenges in Computing* document, prepared by the Brazilian Computer Society for the period 2006 to 2016, one of the six pillars of scientific research in computing to explore the theme of to provide participative and universal access to knowledge to the Brazilian citizen.

The Information Technology introduced a revolution in communication between people and their way of work. There are technological barriers, educational, cultural, social and economic structures that impede access and interaction. So the goal of this challenge is, therefore, to overcome those barriers, through the design of systems, tools, models, methods, procedures and theories able to address, so competent, the issue of access to knowledge of the Brazilian citizen. This access should be universal and participative, in that the citizen is not a passive user, which receives information, but also participates in the generation of knowledge. Only through the opportunity to participate in knowledge building is that access will be able to lead a full and conscious use of knowledge available.

The IBGE (Brazilian Institute of Geography and Statistics) recorded in 2003, 32.1 million functional illiterates, defined as the population over 15 years of age and less than 4 (four) years of schooling (26% of the population). Still, according to the same source, 24.5 million people have some type of disability (14.5% of the population). Government sectors, universities and the private sector can seek technological solutions that seek to reduce social impact such differences and salvage values of citizenship in our society.

Furthermore, it is also to produce computer-based technology that enables and motivates the participation of users in the process of knowledge production and decision on its use. Moreover, one should take into account legal, social and anthropological studies of Brazilian citizenship, precisely to reduce the risk of serious problems of this order, or even create new problems arising from their mere existence, exacerbating the "digital divide".

Concrete examples of target application/domain that would benefit from research in this challenge include, among others, electronic government systems, systems for lifelong learning, communities of practice related to work, community supported by network (networked communities) in several areas. In special case, *e-government* is understood here as not only the provision of services via the Internet, but also the possibility of citizen participation in the generation of knowledge to be shared in the discussion of matters that directly affect them.

Among the important research problems in computing this challenge are: a) creation of back-office systems - internal infrastructure needed to provide services to citizens, which may include long-term processes, involving several entities and interoperability issues; b) provision of an infrastructure necessary for direct interaction between the citizen and his communication with the process to be carried out in the back office.

## 4. Interactivity scenarios in the Brazilian digital television system

From the identification of the actors who could/should be involved in interactive scenarios, some instances of scenarios can be included in the scope of this work, as described in the following. From the perspective of broadcaster, the broadcast system for broadcasting is the only way for broadcaster to make with that data and interactive applications reach the viewer/user. Given the nature of the broadcasting system (the same information is sent to all receivers), it is not possible to customize information flow (Audio, Video and Data) for every viewer/user and/or groups of viewer/users.

From the perspective of the viewer/user, the Communication Providers are used exclusively to provide the resources necessaries to access the back channel (unidirectional), used to take information from viewer/users to broadcaster and/or interactive services providers, there is no possibility of transmission content streams (audio, video and data) from the broadcaster to the viewer/user (video on demand).

From the perspective of availability of communication resources in the viewer/users' access terminals, a viewer/user 1 (V1) has an access terminal without resources for communication with the communication providers. Thus, only resident applications may be implemented in the access terminal. In a complementary way, viewer/user depends solely on the broadcasting system, to send them data, applications and interactive services. A viewer/user 2 (V2) has an access terminal with intermittent access to communication networks (shared mode) to explore the back channel provided by a communication provider. Thus, both resident and broadcasted applications can be used in the access terminal. The intermittent access (shared) is characterized by the media that are not dedicated to a specific purpose, as in the case of the telephone (dial) network and cable to access the Internet over the broadband system. The viewer/user 3 (V3) has an access terminal with specific and dedicated resources to explore the back channel provided by a communication provider. Thus, all types of applications may be implemented in the access terminal. Dedicated access is characterized by the media dedicated to a specific purpose, as is the case of an ADSL network or PLC, offered by a communication provider, solely for interactivity in the context of SBTVD-T.

From the viewpoint of the relationship between the Communication Providers, Interactive Services Providers and Broadcasters, a communication provider ensure access (a public and

free of charge and/or on payment of special taxes established in the contract of service) to the back channel for using by the viewer/user, and to maintain both hardware and software infrastructure necessary to ensure the delivery of information from viewer/users to the interactive services providers and/or directly to the broadcaster. It is for an interactive service provider to ensure the necessary infrastructure to collect information from the viewer/user (using the infrastructure provided by communication providers), organize it, store it (using a data center, by example) and to apply filters in this information to provide appropriated reports to the broadcaster.

From the viewpoint of the relationship between External Entities and Broadcasters, the external entities, such as government (at all levels - local, state and federal), commercial organizations (banks, by example), non-governmental organizations and other broadcaster can establish a partnership with a broadcaster to develop and provide iDTv applications and services to the viewer/user. In terms of classification, we can establish the following, regarding the nature of the external entity that wants to offer interactivity: a) t-gov (e-governance via interactive digital television): when an instance of government is the external entity that originated the interactive service; b) t-commerce (electronic commerce via interactive digital television): when a commercial organization (such as banks, shops, service businesses, among others) is the external entity that gave rise to the interactive service; c) t-learning (electronic education via interactive digital television): when an organization for educational purposes (schools, universities, research centers, among others) is the external entity that gave rise to the interactive service.

Finally, an advanced scenario can be defined based on another scenarios. The main change that occurs in this scenario is that the broadcasting system is not one and exclusive way to disseminate audiovisual content to the viewer/user; the channel of interactivity can be used for this purpose. However, at this phase of implantation and consolidation of SBTVD-T, the possibility of using the back channel (interactivity) to download data and applications is still undefined in its general form and specifications, without approval and publication of specific standards for this case.

## 5. The BluTV platform: Design and implementation

The research reported here is within the context of interactivity in a digital television system, including problems that occur in all stages of the life cycle of a program for interactive digital TV. The life cycle begins with the production and distribution of audio and video streams that are multiplexed to form structures in Transport Stream (TS), besides objects carousel (audio, video, images, text, graphics and executable/interpreted applications). These structures are received and presented at the access terminal of the viewer/user. The last stage is focused on the interaction of the viewer/user with resident applications without using the back channel; the interaction is completed using the back channel via any communication infrastructure (Meloni, 2007).

In this work, it also presented a proposal to implement a communication service that can be executed in the environment of the access terminal of the viewer/user, regardless of the middleware used/embedded in this terminal. The main function is the establishment of interfaces for data communication between the iDTv applications and the Interactive Service Provider (ISP), using the communication resources available for back channel.

In this context, this chapter intends to present the BluTV (Bringing All Users to the Television) Platform, developed in the Interactive Digital Television Laboratory at PUC Minas. This platform has been used to develop applications for the Brazilian Terrestrial Digital Television System (SBTVD-T). BluTV allows the development of interactive television applications using a set of tools and components. To the broadcaster (author), it is allowed to define the components of the television program (media objects, information elements and interaction controls).

This approach should be sufficient to allow the communication between viewer/user and broadcaster (content provider) (Carvalho et al, 2007). At this point, this work is adherent to JavaDTV specification, which is part of the standard Ginga-J of the Brazilian System of Digital Terrestrial Television (SBTVD-T).

The BluTV (*Bringing All Users to the Television*) Platform – developed since 2002 in the context in that work is inserted – is being used for both building and testing of iDTv applications (Santos Junior et al, 2008a, 2008b).

The BluTV Studio generates the data/object TV carousel with data information represented on XML schema. BluTV Streamer sends this carousel via communication infrastructure. In the TV viewer side (access terminal), the BluTV contains a set of tools, including a player, for receiving data carousel and to process/present data information contained into carousel.

The Figure 1 shows the Ginga Architecture and also highlights the Ginga-J Subsystem. It is observed in Figure 1 that there is space for specification and implementation of additional API, which allows increasing the functionality of the middleware and thus provide special and/or essential features to the applications that should be presented to viewer/user. In this sense, the Figure 2a shows the BluTV architecture inserted into Ginga architecture and also highlights the structural positioning of the JavaDTV API.

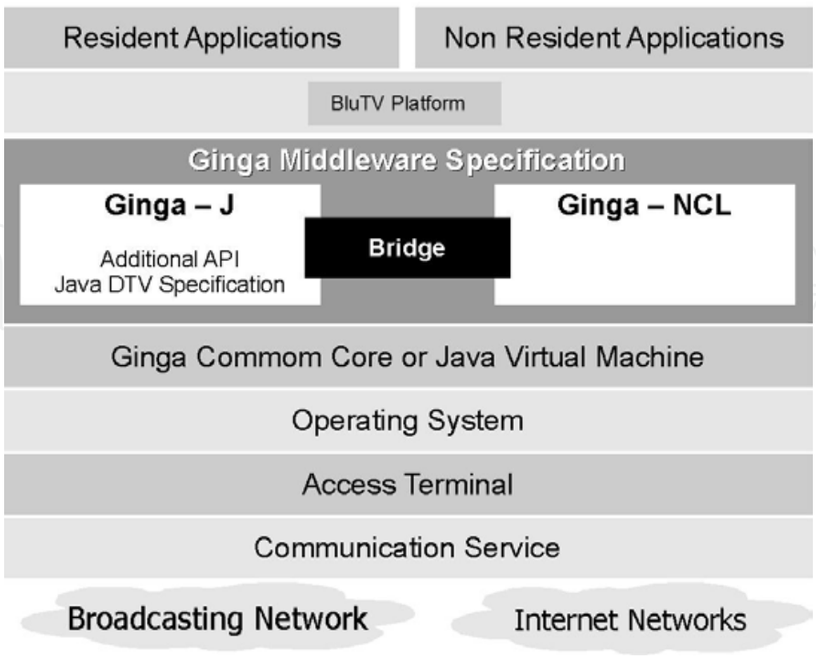


Fig. 1. JavaDTV on Ginga-J Context

The Figure 2b shows the layers of BluTV architecture, having main focus on the exploitation of the back channel for applications that make up an *Service Guide for Citizenship*.

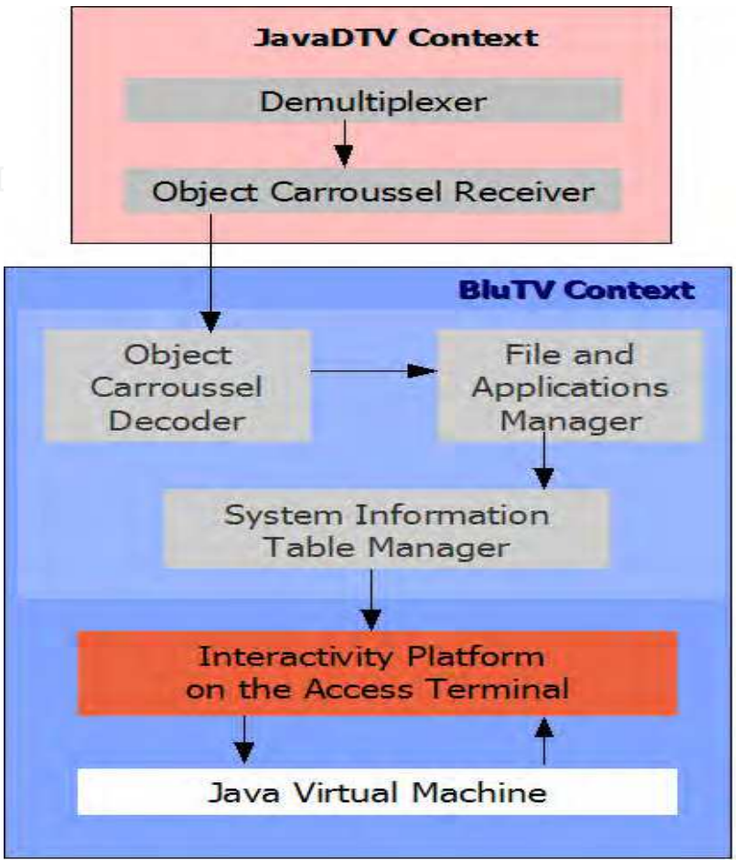


Fig. 2. The BluTV Architecture and its relations with Ginga Architecture

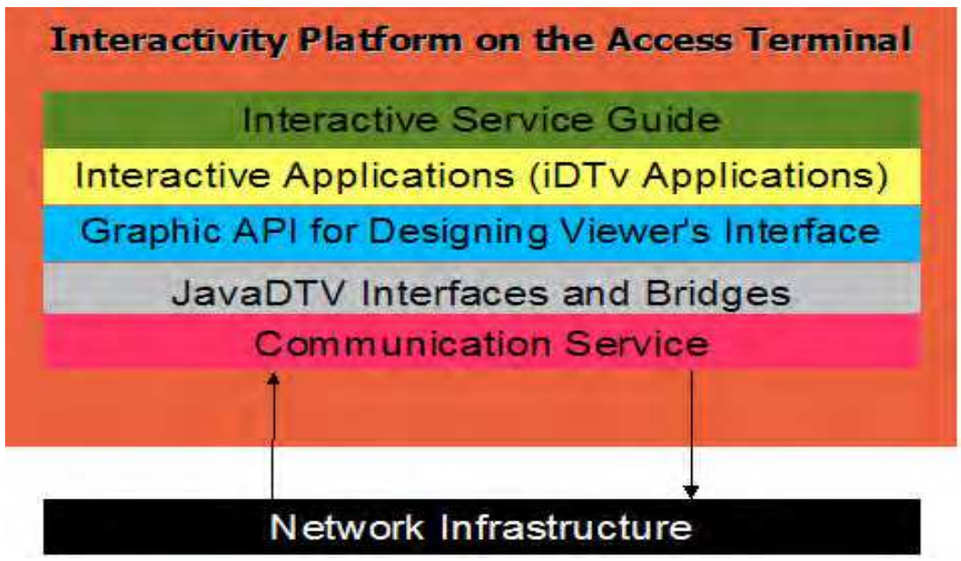


Fig. 3. Layers of the BluTV Architecture

### 5.1 Interactivity via back channel

Unlike what happens in other countries, where the back channel can be established using existing cable networks, in Brazil the situation is more complex (Meloni, 2007; Carvalho et al, 2007). Remote communities in the interior of a huge country like Brazil cannot attract operators of fixed or mobile telephony because of the high cost of installation and maintenance of equipment in comparison with the lack of prospect of back on investment in these regions.

Thus, in terms of infrastructure, yet efforts must be made towards the implementation of access means that do not deprive the less privileged economic classes open access to information. Experiences with the deployment of broadband networks with ADSL technology have been made in the same way that attempts to exploit the PLC (Power Line Communication) as a potential infrastructure for back channel in the context of SBTVD-T.

### 5.2 Implementing a communication service

A communication service is a software layer that has the ability to communicate with external servers to provide various interactive services, such as synchronous and asynchronous text messaging, download/upload files, exchange of information controlled by specific protocols and schemes based on XML description (Harren et al, 2004). In the context of iDTv, a communication service must provide integration with the interactive service provider, to enable tasks such as provision of feedback to the broadcaster and/or storage in the database (or file system using some persistence mechanism).

In the BluTV Platform, the software components of the communication service were implemented using Java technology, in accordance to the JavaDTV classes to explore the back channel, and maintaining compatibility (in terms of interfaces and integration mechanisms) with other components Ginga-J architecture, as indicated in the technical documents of the SBTVD-T. As a result of this work done from 2007 to 2010, we created a component called BluTVCommService, that was developed in order to suit any digital television system. Thus, it is possible use/adequate it to the specific frameworks, such as occurred with the specification JavaDTV in the context of Ginga-J (using the API of interactivity in the package br.org.sbtvd.net.rc) (Santos Junior et al, 2011), as illustrated in **Table 1**. The interactivity API must allow the manipulation of network devices of the receiver (access terminal). The **Table 1** shows, in summary, the main classes of the API for manipulation of network devices. Tests of the implementation of the classes BluTVCommService (which lists the network interfaces) and ConnectionRCController (which connects to an interface) have been made in the BluTV Platform. The classes to manipulate network devices were implemented using the concept of mocks, which simulate the behaviour of real objects in a controlled manner.

This implementation was done in a simulated process because the Ginga-J does not have a complete reference implementation. In a complementary way, the API of interactivity should control the deployment of synchronous and asynchronous messaging to the outside through the back channel. The class RCMessage for synchronous messaging is responsible for encapsulating a serializable object that represents the message being sent, and a locator, which contains the service of sending and destination address of the message. The constructor method of this class takes as parameters a RCMessage message to be sent as a serializable object from the Java language and a java.net.URL object, which is the locator.

| Classes Ginga-J (JavaDTV) | Classes ReturnChannelCommService |
|---|---|
| br.org.sbtvd.net.rc.ReturnChannel | br.pucminas.jitv.net.rc.ReturnChannel |
| br.org.sbtvd.net.rc.ReturnChannelManager | br.pucminas.jitv.net.rc.ReturnChannelManager |
| br.org.sbtvd.net.rc.ConnectionReturnChannel | br.pucminas.jitv.net.rc.ConnectionReturnChannel |
| br.org.sbtvd.net.rc.ConnectionRCController | br.pucminas.jitv.net.rc.ConnectionRCController |
| br.org.sbtvd.net.rc.ConnectionParameters | br.pucminas.jitv.net.rc.ConnectionParameters |
| br.org.sbtvd.net.rc.ConnectionListener | br.pucminas.jitv.net.rc.ConnectionListener |
| br.org.sbtvd.net.rc.ConectionRCEvent | br.pucminas.jitv.net.rc.ConectionRCEvent |
| br.org.sbtvd.net.rc.ConnectionEstablishedEvent | br.pucminas.jitv.net.rc.ConnectionEstablishedEvent |
| br.org.sbtvd.net.rc.ConnectionFailedEvent | br.pucminas.jitv.net.rc.ConnectionFailedEvent |
| br.org.sbtvd.net.rc.ConnectionTerminatedEvent | br.pucminas.jitv.net.rc.ConnectionTerminatedEvent |
| br.org.sbtvd.net.rc.ReturnChannelException | br.pucminas.jitv.net.rc.ReturnChannelException |
| br.org.sbtvd.net.rc.IncompleteTargetException | br.pucminas.jitv.net.rc.IncompleteTargetException |
| br.org.sbtvd.net.rc.NoFreeInterfaceException | br.pucminas.jitv.net.rc.NoFreeInterfaceException |
| br.org.sbtvd.net.rc.NotOwnerException | br.pucminas.jitv.net.rc.NotOwnerException |
| br.org.sbtvd.net.rc.RCMessage | br.pucminas.jitv.net.rc.RCMessage |
| br.org.sbtvd.net.rc.RCAsynchronous | br.pucminas.jitv.net.rc.RCAsynchronous |
| br.org.sbtvd.net.rc.AsynchronousMessageTable | br.pucminas.jitv.net.rc.AsynchronousMessageTable |

Table 1. Comparison between Ginga-J API (JavaDTV) and BluTVCommService

The intention in having a communication service is to ensure that each application has to implement its own form of negotiation with the interactive service provider. The layer of software has the ability to communicate with an external server to provide a wide variety of interaction services. As a complement, the HSQLDB database was incorporated into the implementation (HSQLDB, 2010), providing a persistence layer for information, both in situations of temporary lack of communication via the back channel and in situations where data persistence is necessary for logic operations provided in the application.

### 5.3 Main middleware aspects on interactive digital TV systems

Similar to what occurs in other technology segments, in the context of SBTVD-T we can find a good variety of digital television signal receivers, with different characteristics in terms of resources that support interactivity. This diversity of platforms suggests the existence of a layer of software, called middleware, responsible for isolating the interactive applications of the peculiarities and complexities of the hardware platform (equipment). The middleware provides a unique form of communication between applications and the operating system of the receiver, so that applications can easily use the resources of the devices. Each DTV system has its own middleware. As cited, a new system (Ginga) was built in Brazil, having implementations under development at both the industry and academy. However, the Ginga model is not well accepted and adopted by the broadcasters, specially. Thus, an interactive platform is lacking and there is space for implementing of new approaches.

The SBTVD-T middleware supports both applications with declarative languages (Ginga-NCL) and procedural languages (Ginga-J). Ginga-J incorporates many innovations and, as mentioned, became recently JavaDTV compatible with the specification developed by Sun. This work has strong links with JavaDTV.

Interactive services may require different levels of communication between the viewer/user and service provider (Soares, 2007). The, it is possible to classify a system according to the way they interact with the viewer/user. This interaction can be a local way, in which the back channel in the access terminal is not required in this case (pseudo-interactivity) (Soares, 2007). In this form of interaction, the viewer/user can interact with applications, but there is no back of information to a provider/server accessible over the communication infrastructure.

On the other hand, the full interactivity occurs when requiring the viewer/user to send information through a communication network. The information generated by applications can be transmitted freely or with restrictions (such as aspects of privacy) to the TV station (broadcaster), often having a service provider as an intermediary entity. This entity may be a component of the company itself or a broadcaster company it hired for this specific purpose.

In the context of the application, an answer / opinion of the viewer/user may be in the form of a simple command to vote or buy a product or in the form of media such as audio and video/image. Anyway, on the other end of the communication infrastructure, the interactive service provider, which may be associated with broadcaster from a business model, should be able to "hear" and react to information received by viewers, according to an interaction model defined by the broadcaster. According to Smity (Morris & Smity-Chaigneau, 2005), yet fully interactive system can be divided into unidirectional and bidirectional. The application allows only one way to send data to the viewer/user, while the application allows the bidirectional transmission of data.

### 5.4 Communication service interfaces and extensions to the middleware

The service BluTVCommService consists on software modules (components) and its architecture shown in **Figure 4**. These modules are: Communication Monitor Service (BluTVCommServiceMonitor); Send List Monitor (BluTVSendListMonitor); and Database Monitor (BluTVDataBaseMonitor).

The BluTVCommServiceMonitor has the aim to monitor a communication infrastructure in search of flows of serialized bytes in XML format, which represents messages being sent over the back channel. The service is materialized as a specific directory on the file system of the operating system embedded on access terminal.

The messages are collected, handled by a parser structural duly represented in accordance with the communication protocol and, finally, are placed on a waiting list to be sent. By definition, the monitor "wheel" every 30 seconds, but this time value is parametrized. Thus, a message added to the service of communication will lead up to the time stipulated by the parameter to be captured and forwarded to the sending subsystem.

The module BluTVSendListMonitor monitors the list of messages to be sent. The subsystem attempts to send each message on the list for back channel considering its parameters. Messages that are on the list are new messages or send messages whose previous attempts to have failed. If any of the messages cannot be sent, either by a failure in the back channel

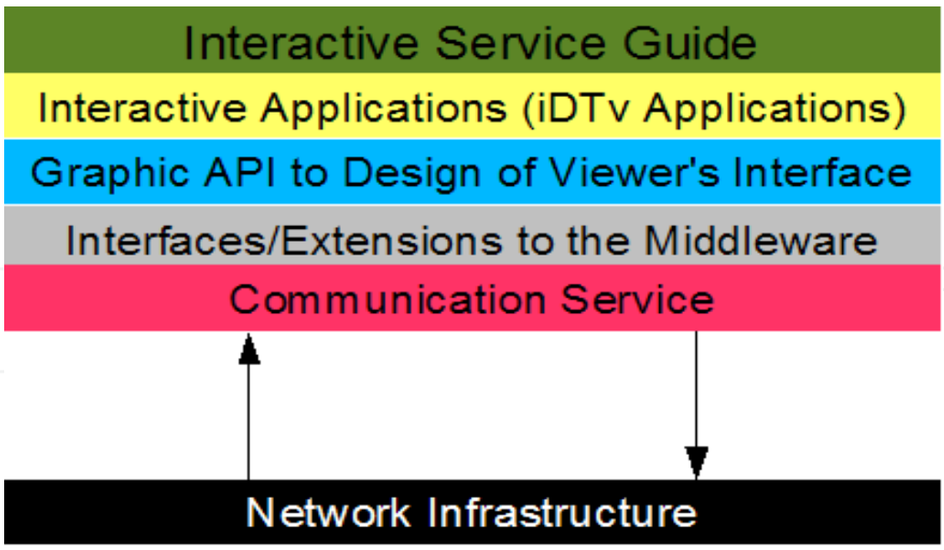


Fig. 4. BluTVCommService Components

for parametrization error message or a lack of communication service in the remote location (service provider), only the failed message will be stored in a database, to retry sending is performed when possible.

The module BluTVDataBaseMonitor is responsible for retrieving the messages that were stored in a database and put them on the list for sending. Messages that are stored in the database correspond to those which have failed to send at least once.

In terms of implementation, these monitors are threads (processes) that run independently on a recurring basis according to the time defined. So there is no problem of competition between the various threads on the mailing list, a timing system was implemented to control access to the list of messages. The various applications running on an access terminal can use the services BluTVCommService, simply by adding an XML file corresponding to the message being sent.

The first part, represented by the transport element corresponds to the configuration needed to send the message, as email addresses, socket server, web server, and others. The second part, represented by the bookmark element, is the content of the message being sent. The transport systems allowed are: email, socket, HTTP (posting on the form), FTP and web service.

### 5.5 Platform for prototyping

The BluTV Platform is a form to validate requirements of the interactivity in iDTv applications. This platform enables development of applications for Interactive Digital TV, with authoring tools, middleware, media distribution and media players for viewing and interaction with the viewer/user. On the viewer/user side, the BluTV Platform contains a set of tools and applications that encourage interaction. There is a multimedia player (implemented with JMF 2.1) based on multiple channels of programming, which allows control of the presentation of an audio channel and recorded video, one channel of live audio and video, an audio-only channel, a connection from a web browser, as well as areas

for visualization of interacting objects and component interface such as menus, buttons, icons, among others. It is also possible to launch applications (Java bytecodes).

### 5.6 Graphic API for visual design and interaction

The BluTV Platform has a set of graphic widgets to design visual interfaces with the viewer/user. This API, called BluTViewer, is compatible with the LWUIT API, which is part of JavaDTV.

The **Figure 5** presents the BluTVPlayer application implemented with BluTViewer widgets, which, besides allowing interaction via remote control, also provides accessibility features for people with special needs (Santos Junior et al, 2009; CENELEC, 2003).


Fig. 5. Screenshot of the Main Application (Player) on Access Terminal (Set-top Box)

## 6. Interactive television application Guide for Citizenship

The Interactive Service Guide (*Citizen Portal*) is composed by nine applications. All applications are already in a state of functional prototype, with the first full version of the guide could be tested early in 2011. From the moment that all applications were properly developed and tested, the Interactive Service Guide can be embedded in equipment receptors (set-top boxes), reaching the homes of viewers/users. New features and applications can be developed and aggregated into the guide. The next sections present a summary for each one of the nine applications that make up the first version of the *Service Guide for Citizenship*. All applications are already in a state of functional prototype, with the first full version of the guide could be tested early in 2011 (Santos Junior et al, 2011).

### 6.1 Understanding Dengue

The application **Understanding Dengue** encourages the participation of the viewer/user through a survey of health factors to his residence in order to help identify impending risk of outbreaks of the *mosquito* that transmits the disease there. Using the remote control, the viewer/user answers a questionnaire with four questions, each one with three possible answers (Yes, Maybe and No). After collecting the responses from the viewer/user, the application takes one of two possible decisions: a) if there is no back channel available, the application reports the results on the TV screen and alert the viewer/user about these results, providing additional information about the disease; b) if there is a back channel available: the application asks for confirmation as to allow the viewer/user to send this information to relevant health authorities, particularly those at the municipal level.

### 6.2 Doctors in Your Home

The application **Doctors in Your Home** encourages the participation of the viewer/user by allowing the appointments through a table of medical specialities, in comparison with the needs of any patient. Using the remote control, the viewer/user needs to inform medical and query data on the availability of care in a given period, considering, including issues such as the proximity of his residence and office/clinic/hospital where exists the service. After gathering information from the viewer/user, the application takes one of two possible decisions: a) if there is no back channel available, the application displays a table with information about the availability of care, warning viewers about the fact that information may change over a period and that the request for an appointment should be made using other media such as telephone network, for example; b) if there is a back channel available: the application asks for confirmation of the viewer/user as permit the submission of information to an interactive service provider, which will provide the proper referral to the sectors responsible for scheduling the appointment.

### 6.3 Health Tests

The application **Health Tests** encourages the participation of the viewer/user to allow it to perform simple tests to identify risk factors for certain diseases affecting much of the population, namely: a) Hypertension; b) Obesity; c) Diabetes; d) Migraine; e) Stress. Using the remote control, the viewer/user selects the disease to which you want to perform the test and, in addition to obtaining information sheets about this disease, answered a questionnaire about their risk factors. After gathering information from the viewer/user, the application takes one of two possible decisions: a) if there is no back channel available, the application displays the test results and alert the viewer/user about these results; b) if there is a back channel available: the application displays the test results and inform viewers about the availability of health programs (at any level of government) for which the test results could be useful, where the viewer/user agrees with the submission of your test results, information will be sent to an interactive service provider, which will provide the proper referral to specific health programs.

### 6.4 In Case of Emergency

The application **In Case of Emergency** encourages the participation of the viewer/user by providing access to detailed information on situations of risk to health that can reach the

population, namely: a) what to do in case of bites of poisonous insects; b) how to avoid domestic accidents; c) how to perform breast self-examination to identify breast nodules; d) how to perform first aid in cases of myocardial infarction and seizures; e) what to do in emergencies involving floods, fires and other natural phenomena. Using the remote control, the viewer/user selects the situation that interests you and, in addition to obtaining information on slides illustrative of this situation, also have access to telephone and contact with experts and specialized agencies in the treatment of each case.

### 6.5 Comprehending the Public Administration

The application **Inside Public Administration** encourages the participation of the viewer/user to allow access to information about activities, events and programs from any of the three levels of government: a) Municipal; b) State; c) Federal. Using the remote control, the viewer/user selects the level of government over which you want information. According to the selected level, information sheets are presented with details of: a) functional organizational chart of government; b) telephones and other forms of contact with government agencies and its officers; c) political and administrative agenda, especially in meetings, seminars and other events open to the public; d) job opportunities and to enter contests.

### 6.6 The Community Sends News

The application **The Community Sends News** is a complementary application to the **Inside Public Administration**, encouraging participation of the viewer/user by allowing the establishment of a communication channel between citizens and public administrations in any of three levels of government: a) municipal; b) state; c) federal. Using the remote control, the viewer/user selects the level of government with which to communicate. According to the selected level, the following contact options are allowed: a) claim; b) requests; c) advice; d) additional information. The viewer/user must select the type of contact and inform the data needed for each case. Fill in the contact data from the viewer/user, the application, considering the availability of a back channel and forward a copy of such data to an interactive service provider, which will provide the proper referral to the government authorities recipients. At any time, viewers/users can track the status of your contact.

### 6.7 Banking

The application **Banking** encourages participation of the viewer/user to allow access to basic information of the bank account, and allows the simulation of loans and financing. Using the remote control, the viewer/user selects the bank with which it has business relationships. To ensure the minimum security for access and requires the user ID by verifying data registered with the financial institution. Allowed access, the viewer/user has available a list of options for consultation and quote. It is worth noting that, at this moment, only query transactions can be made, not possible for now, operations are characterized as financial transactions.

### 6.8 Repository of News

The application *Repository of News* encourages participation of the viewer/user by providing access to news in real time, from the widely know brazilian portals, such as UOL, Terra, G1,

among others. Using the remote control, the viewer/user selects the news class that wishes to view (**Figure 6**), namely: a) Lastest; b) News; c) Sports; d) Economy; e) Technology.


Fig. 6. Screenshot of the Repository of News Application Running on Access Terminal

According to PNAD (PNAD, 2010), this application could be used by 73% of brazilian population, that has no access to news by Internet. Using the remote control, after selecting a class of news, the viewer/user choose the news for viewing. Using the back channel, if it is available, comments about the news can be sent to an interactive service provider.

### 6.9 The School on TV

The application **The School on TV** encourages the participation of the viewer/user by providing access to data from the school life of a student, allowing parents and guardians may have a complementary form of monitoring of activities that are undertaken within the school. Using the remote control, the viewer/user selects the school and the series in which the student is enrolled. From that point, to inform the student's name, it is possible to get information about the transcript and also on the schedule of activities of the week. If desired, the viewer/user can communicate with the school, sending comments and questions through the back channel and an interactive service provider, which establishes the necessary communication with the provider responsible for maintaining the information the school wants to provide.

## 7. Scenarios for testing and future directions

As a cited, the BluTV is a platform for developing interactive digital television applications, specially in terms of context of the Brazilian Digital Television System Terrestrial (SBTVD-

T). The one of the most promising technologies of interactive video, the Interactive Digital Television has as one of its main objectives to allow high levels of interaction between the viewer and the interactive programs that are presented to him. From the point of view of the development technologies for interactive television, Java and XML blunt as good solutions contained into main international standards/systems for digital television (ATSC, DVB, ISDB). For testing BluTV Platform, several applications are being developed in the SBTVD-T scenarios, in partnership with the public brazilian broadcasters (*in portuguese* - TV Alterosa and Rede Minas de Televisão). In these tests, the both middleware requirements of SBTVD-T and BluTV functionalities are being validated. The usability heuristics are being used for usability tests.

According to Jacob Nielsen, there are ten general principles for user interface design, being used to test the usability of a system. For realizing tests with applications developed based on BluTV Platform, some these heuristics (five, more exactly) were both adapted and applied. In these tests, 500 (five hundreds) TV viewers are being used as subjects.

The *Visibility of Interactive Application Status* is the first heuristic on tests. The main objective is to identify if the interactive application always keeps the viewer informed on where in the application he is. In following, the *Match Between Interactive Application and the Real World* is the heuristic applied. The main objective is to identify whether the application has a language of communication appropriate to viewers, especially since Brazil has a large number of people with low education. The heuristic *TV Viewer Control and Freedom* is being used to identify whether the controls are clear enough for interaction, especially those selected to cancel operations wrong. Furthermore, the heuristic *Recognition Rather Than Recall* is being applied to identify whether the navigation in interactive applications cause the user to acknowledge the operations and actions, without having to memorize them, especially the fact that the remote control is the basic device to inputs and interaction. Finally, viewing aspects are being tested using the heuristic *Aesthetic and Minimalist Design of the Application Interface*. In this case, the main objective is to identify whether the information dialogue with the viewer is sufficiently clear and contains only the both essential and necessary elements.

Tests have been conducted both in laboratory and in specially created environments in broadcast television partner of the research projects in which this work is placed. Five hundreds subjects are being evaluated in these experiments. Results of these tests and developments in the implementation of the applications will be reported in further work.

## 8. Conclusions

This chapter has presented contributions related to the SBTVD-T, from the BluTV Platform, focusing on three main aspects: a) the architecture and implementation of the platform; b) the use of BluTV for building an Interactive Service Guide in the context of SBTVD-T, whose basic premise fundamental to building the infrastructure that supports the use of this guide on promotion of citizenship through digital inclusion via television; c) the scenarios for testing of this guide and validating of the platform components and tools.

This chapter also presents contribution related to the implementation of a *Service Guide for Citizenship* in the context of SBTVD-T, whose basic premise fundamental to building the

infrastructure that supports the use of this guide on promotion of citizenship through digital inclusion via television. Besides the aspects of infrastructure and management, applications that make up the guide were presented, as well as the stage of their development. As cited, tests have been conducted both in laboratory and in broadcasting environments, using the infrastructure provided by broadcaster partners of this research. The results of these tests and developments will be reported in further works.

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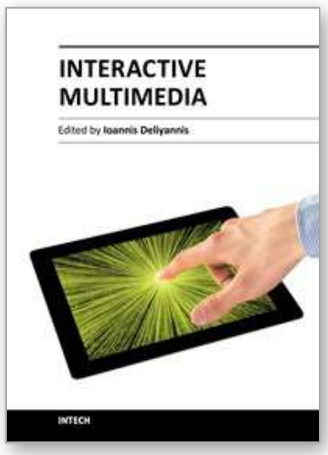


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Interactive multimedia is clearly a field of fundamental research, social, educational and economical importance, as it combines multiple disciplines for the development of multimedia systems that are capable to sense the environment and dynamically process, edit, adjust or generate new content. For this purpose, ideas, theories, methodologies and inventions are combined in order to form novel applications and systems. This book presents novel scientific research, proven methodologies and interdisciplinary case studies that exhibit advances under Interfaces and Interaction, Interactive Multimedia Learning, Teaching and Competence Diagnosis Systems, Interactive TV, Film and Multimedia Production and Video Processing. The chapters selected for this volume offer new perspectives in terms of strategies, tested practices and solutions that, beyond describing the state-of-the-art, may be utilised as a solid basis for the development of new interactive systems and applications.



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