Interactive Digital Television in Brazil: Technical and Social Aspects

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ABSTRACT

The Digital TV in Brazil has started at São Paulo city in 2007 and since then has been implanted to the rest of the country. It will be available to most of Brazilians households, including those without access to other Information and Communications Technologies. The Interactive Digital TV is a potential tool to deal with the digital divide issues. The recent development of the research on digital terrestrial television in Brazil has led the country´s government to state a series of premises in which the government shows to care not only for technology improvement, but also to use this development as a tool for improving the Brazilian social context, in what concerns digital divide. These premises and necessities have generated some peculiarities in the development process, which directly influenced the functionalities provided by the Brazilian´s middleware choice, called Ginga. Its NCL language and its Ginga-NCL presentation engine became an ITU-T Recommendation in 2009. This paper presents the Brazilian Digital Terrestrial Television System (SBTVD-T) and seeks to explain the architecture of the Ginga middleware, highlighting the main features, especially the interactivity. It also discusses their social aspects in terms of the digital divide context.

Keywords

Digital TV, Interactivity, Middleware, Ginga, Digital Divide.

1. INTRODUCTION

With 190 million people, Brazil is the most populous country in Latin America. However, less than twenty percent of Brazilian people have Internet access. Nowadays, São Paulo is the city where the major part of Information Technology is concentrated.

On the other hand, the lack of access to digital services by most part of the population, or digital divide, is worst in poor regions of the Brazilian northeast. The State of Ceará is an example of the low penetration of the Internet, because most of the people who live in rural areas have never even used a computer. The main reasons for that are the costs to buy a computer and hire an Internet Service Provider (ISP). Several efforts are being made by the Brazilian government in order to solve this digital divide problem. Ten years ago, the GESAC (Electronic Government - Customer Service to the Citizen) program [1] was created, in which 3,200 locations were connected to the Internet via satellite to serve schools and the so called "telecenters[1]".

In this context, the impact of the digital TV (DTV) in Brazil would be much more significant than the simple change from an analogical transmission system for a digital one, improving better quality of image and sound. An important component is the ability to expand the functions of the new system for applications, specifically interactive ones. DTV technology allows the interaction of the viewing user, which could be delegated the control of the flow of a televising program, determining the form as one content must be shown. These interactive applications are new services, such as electronic guides of programs, the banking services (T-banking), health services (T-health), educational services (T-learning), services of government (T-government), etc.

Considering that 95% of Brazilian people have TV sets in their homes, but only 20% use computers and Internet [1], bringing interactivity to TV is an excellent way to promote digital and social inclusion. For this reason, governmental initiatives have promoted the development of the Brazilian Digital Television System (SBTVD) [2], from the acronym "*Sistema Brasileiro de Televisão Digital*".

[1] It is any environment with computers and free (or very low-cost) Internet access, which anyone in community may use. There is a telecenter in the State of Ceará where an hour of book reading in the library, "pays" for an hour of Internet access [3].

Indeed, the current international standards (ISDB, DVB and ATSC) have not taken into account the Brazilian cultural peculiarities and social-economic aspects, which deserve to be investigated in order to validate any technical and economical solution.

In addition, there are serious interoperability problems. Solutions have to consider restrictions concerning transmission constraints, such as the fact that some specific content could not be available in all Brazilian homes, especially for people who do not have a good information and communication technology (ICT) structure [4], nor a good DTV or set-top-box.

These are the reasons why Brazil has decided to develop its own digital TV system. As a matter of fact, the SBTVD undertakes the focus on a sort of interactivity that all Brazilian people could have the opportunity in accessing this new technology and all the huge variety of digital services aiming at social inclusion.

In this paper, we present the technical approach comprised in SBTVD, as well as we discuss the social aspect of the Brazilian digital TV model. Both aspects are linked to the interactivity, the main feature of the Ginga, the middleware developed for the Brazilian model [5]. The remainder of this paper is organized as follows. Section 2 presents the methodology used and the context in which the idea of the Brazilian TV system (SBTVD) was born. In Section 3, some technical aspects of the Brazilian DTV standard are outlined. Section 4 provides information about the Ginga middleware, especially on how this middleware improves interactivity. Section 5 discusses interactive DTV modeling. Sections 6 and 7 present some applications and social aspects related to the Brazilian Digital Terrestrial TV (SBTVD-T), respectively. The paper concludes highlighting the importance of the Brazilian initiative to develop its own DTV model in Section 8.

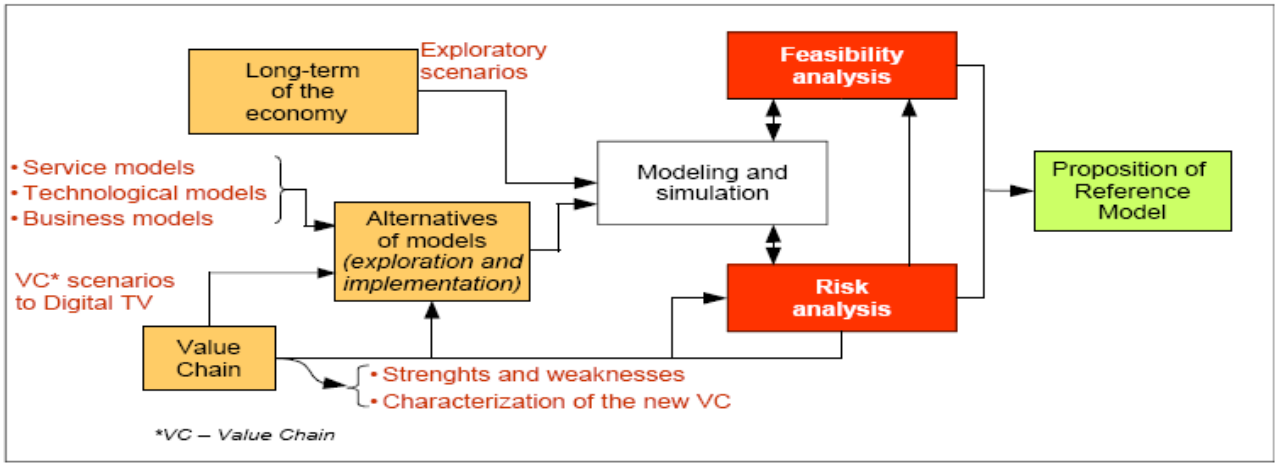

Figure 1. Methodology for the Brazilian Digital Terrestrial TV Reference Model (SBTVD-T).

2. THE BRAZILIAN DIGITAL TV SYSTEM

Before President Lula da Silva, Brazil was about to adopt one of the Digital TV international standards available (DVB, ATSC or ISDB). However, since Lula was invested in 2003, the country began thinking about DTV as a way for social inclusion.

Consequently, at the end of 2003, the Presidential Act #4,901 [6] was published, in which the first article highlights its social objective. This act launched the SBTVD call for projects with the following requirements:

- Wide access to all social classes;
- Interoperability;
- Mobility and portability;
- Robustness considering geographical placement;
- environment;
- Usability;
- Digital Inclusion.

The SBTVD project engaged more than 1,500 researchers from 78 Brazilian universities and research centers. Its activities involved the research of the elements that compose a DTV architecture and the development of new characteristics to fit into the Brazilian requirements defined by the Presidential Act commented above.

In July, 2006, the decision about the terrestrial core of SBTVD technologies was made and published in the Presidential Act #5,820 [7]. The ISDB-T modulation [8] was chosen as the reference transmission platform for the SBTVD system. The main criteria adopted to select this modulation platform were robustness and flexibility. As a result of the SBTVD project, a new standard, named International Standard for Digital Television Terrestrial (SBTVD-T), was created and adopted in Brazil.

Figure 1 illustrates the methodology taken for developing the Brazilian Digital Terrestrial TV Reference Model[2], which is based on the value chain of the Brazilian "free-to-air" television sector.

The aim of this methodology is identify the participation of the different players in this market, and to characterize possible future scenarios of the introduction of the Brazilian Digital Terrestrial TV and new value chain. The proposition of the SBTVD Reference Model is resulted from the Feasibility and Risk analysis. As shown in the Figure 1, the exploratory scenarios exert great importance in this methodology.

In the following, some comments about these scenarios are presented. They illustrate the desire to develop a Brazilian model

[2] The Reference Model is the resulting combination of an exploration model with a deployment model, minimizing as much as possible the risks and maximizing opportunities in view of the established goals and conditions defined by the Brazilian Government.

adapted to the opportunities, risks and peculiarities of the new value chain, identifying relevant strategies of their activities [9]:

> "The knowledge about the current market dimensions helps to identify the sources, flow and volume of agents... Consequently, it is possible to identify future opportunities and foresight, not only in qualitative terms, the impacts ..."
>
> "... several elements comprising the value chain result in two analytical benefits: better knowledge about the modus operandi of the sector and, consequently, the articulation among players and the identification of key variables in cause and effect linking between chain stages..."
>
> "These scenarios aid subsequent studies integrating the analysis methodology of the reference model for the SBTVD. The general methodology for analysis of the reference model describes the exploration and deployment models comprise the normative scenarios[3]..."
>
> "... these scenarios are simulated, having as background the exploratory scenarios for the long-term view of the economy and the service and technological models. Its represent the environment for the project and comprise exogenous variables, ..."
>
> "Under the effects of each exploratory scenario and the political guidelines for the sector, it is possible to simulate the behavior of alternatives of exploration and deployment models, ultimately supporting the choice of reference model, which will be the most suitable alternative in terms of robustness[4] and flexibility[5]."

As we can observe, the SBTVD is the result of a detailed study in order to propose a reference model that is able to guide the main decisions in the architecture creation. As shown in the architecture of the Brazilian DTV (Figure 2), the adoption of Ginga middleware and MPEG-4 are important examples of the SBTVD technical and social model. In addition, it is important to remark that ISDB, DVB and ATSC standards have not taken into account in their design the Brazilian cultural peculiarities and our social-economic aspects. Indeed, Brazil has important issues to consider, such as technical restrictions concerning signal transmission constraints, due to the fact that Brazil is a continental country, and especially people who do not have any information technology access.

3. BRAZILIAN DTV ARCHITECTURE

Figure 2 presents the architecture of the SBTVD-T [10], resulted of the SBTVD Reference Model. It highlights a prominent Middleware layer. It is this layer that makes the main difference between the Brazilian Digital TV model and other international models. It allows digital TV interactivity, the main feature of Ginga.

The applications to be executed over Ginga are classified into Procedural and Declarative. Procedural applications are written using the Java language, while declarative applications are written using the NCL (Nested Context Language). Ginga application execution environments are similarly classified into two categories depending upon whether they process procedural or declarative applications, and are called Ginga-J [11] and Ginga-NCL [12], respectively.

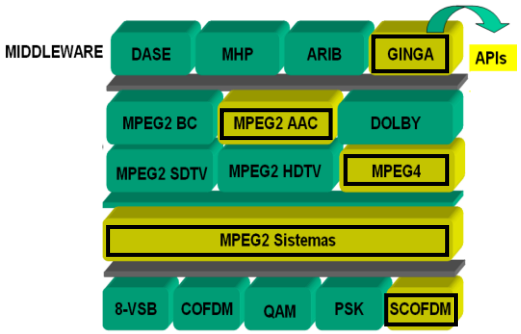

Figure 2. Architecture of the Brazilian Digital TV.

The SBTVD-T, the Brazilian model, uses in the Compression Layer the H.264 video codec instead of ISDB-T's MPEG2 and an improved tuner[6]. DVB and ISDB also provide for other video compression methods to be used, including JPEG and MPEG-4, although JPEG is only a required part of the MHEG standard. In fact, Brazil is using ISDB for terrestrial broadcasting (ISDB-T). This video is encoded with MPEG-4 AVC (H.264) and the audio with MPEG2-AAC [13].

The ISDB-T modulation scheme, also called BST COFDM (Band Segmented Transmission Coded OFDM), was developed to broadcast digital terrestrial TV with the use of flexible modulation. The 6MHz channel band is divided into 13 segments of 429 KHz width each. In those segments, it is possible to transmit simultaneous programs with different robustness and modulation techniques. The BST-OFDM (Band Segmented Transmission Orthogonal Frequency Division Multiplexing) system proposed for the Japanese system improves upon COFDM by exploiting the fact that some OFDM carriers may be modulated differently from others within the same multiplex [8]. Hence, the 6 MHz television channel may therefore be "segmented", with different segments being modulated differently and used for different services. It is possible to send an audio service on a segment that includes a segment comprised of a number of carriers, a data service on another segment and a television service on yet another segment.

4. GINGA MIDDLEWARE

The Ginga concept was thought to be different from common middlewares for terrestrial digital TV. Application environments are classified into two categories depending upon whether they process declarative or procedural applications: Ginga-J and

[3] Future situations configured by specific solutions that can be submitted to policies and corrective actions.

[4] Robustness refers to the degree of sensitivity that the exploration and deployment models present in face of changes imposed by external factors or not controllable by the players involved.

[5] Flexibility means how easily the models adapt themselves to changes in direction, both caused by external factors or even by initiative of one or more players involved.

[6] Argentina, Peru, Venezuela and others Latin American countries are considering ISDB-T-based SBTVD, which could provide common market benefits from the regional development of the technology instead of importing it.

Ginga-NCL. Figure 3 illustrates the architecture of the Ginga Middleware.

Ginga-J is the middleware's subsystem in charge of defining all the Java Application Program Interfaces (APIs), content and data formats, besides protocols up to the application level. In comparison to the middleware systems conceived for the other Digital TV standards, some features of Ginga are innovative.

These features arise from the synergy resultant from the conjunction of two previous projects: FlexTV [14] and Maestro [15].

4.1 ITU-T H.761 Recommendation

Ginga-NCL became a H.761 Recommendation on the International Telecommunications Union (ITU-T). This Recommendation brings the specification of the Nested Context Language (NCL) and an NCL presentation engine called Ginga-NCL in order to provide interoperability among multimedia application frameworks [16].

NCL is a language that holds media objects together in a multimedia presentation, no matter which object types they are. It treats an HTML document as one of its possible media objects. Thus, NCL does not replace but embed XHTML-based documents. The same reasoning applies to other multimedia objects. Ginga-NCL is an NCL presentation engine built as a component of an IPTV middleware. A very special NCL object type defined in Ginga-NCL is NCLua, an imperative media-object with Lua code [12].

A Ginga application needs not to be purely declarative or procedural. In particular, declarative applications often make use of script content, which is procedural in nature. Furthermore, a declarative application may reference an embedded Java Xlet. Similarly, a procedural application may reference declarative content, such as graphic content, or it may construct and initiate the presentation of a declarative content. Therefore, either type of Ginga application may make use of facilities of both declarative and procedural application environments.

Ginga-NCL is a logical subsystem of the Ginga System that processes NCL documents. Key components of Ginga-NCL are the declarative content decoding engine (NCL formatter) and its Private Base Manager module. The NCL Formatter is in charge of receiving an NCL document and controlling its presentation, trying to guarantee that the specified relationships among media objects are respected.

The formatter deals with NCL documents that are collected inside a data structure known as private base. Depending on the XHTML implementation, Ginga-NCL can be compatible with other declarative standards. Ginga-J is a logical subsystem of the Ginga that processes active Java based object content. Thus, it has as a key component the procedural content execution engine composed by a Java Virtual Machine.

Ginga-J is GEM (Globally Executable MHP) complaint. GEM defines *Core* and *Specific* APIs (Application Program Interfaces). *Core* APIs must be supported by all GEM conformant middle wares: DVB MHP, ATSC ACAP and OCAP, ISDB ARIB and SBTVD Ginga [17].

In order to provide support for Brazilian specific requirements and to explore opportunities created by the new convergent digital TV hardware, in terms of processing power and Home Area Network interfaces, Ginga *specific* APIs provide support for multiuser, multidevice and multinetwork interactions. Ginga *specific* APIs also provide support for *unbound* applications, which can be received, saved and, later, accessed and executed.

Ginga Common Core supports both the Ginga declarative application environment (Ginga-NCL) and the Ginga procedural application environment (Ginga-J). It is composed by common content decoders (for the decoding and presentation of common content types such as PNG, JPEG, MPEG and other formats), and procedures to obtain contents transported in MPEG-2 Transport Streams and via the return channel. The DSM-CC is adopted in Ginga for carrying live editing commands in MPEG-2 TS elementary streams.

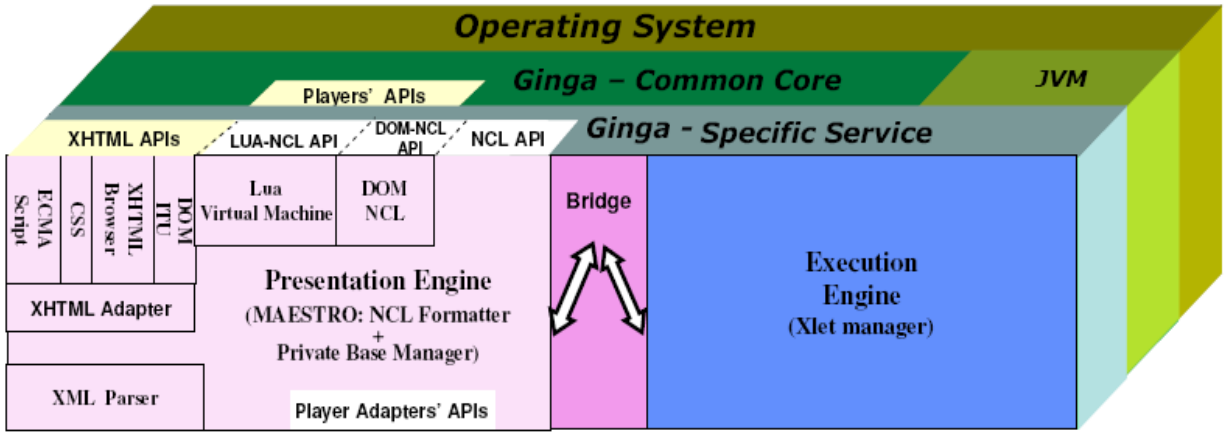

Figure 3. Architecture of the Ginga Middleware.

4.2 Ginga-NCL

Unlike HTML or XHTML, NCL has a stricter separation between content and structure and it provides non-invasive control of presentation linking and layout. As such, NCL does not define any media itself. Instead, it defines the glue that holds media together in multimedia presentations. NCL document only defines how media objects are structured and related, in time and space. It does not restrict or prescribe the media object content types.

In this sense, we can have image objects, video objects, audio objects, text objects, execution objects (e.g., Xlet, LUA, etc.)., as NCL media objects. Which are the media objects supported depends on the media players that are embedded in the NCL formatter. In the Brazilian DTV system, one of these players is the MPEG-4 decoder/player, implemented in hardware in the DTV receptor. In this way, note that the main MPEG-4 video and audio is treated like all other media objects that can be related using NCL. Another NCL media object required in SBTVD-T is the HTML-based media object [12].

4.3 Ginga-J

Ginga get access to streams of video, audio, data and other media assets through the Ginga Common Core. Ginga can receive input from users via conventional remote controls or any other peripheral having a keyboard, a cell phone, etc. In response to an input, Ginga may present visual information on the television set itself, on the screen of other output devices, or even as an audio output to loudspeakers. A single interaction device may have both input and output capabilities.

Usually, an interaction coming from these devices redirects the output answer to them. Many devices may interact with Ginga at the same time. In this case, the platform must distinguish the commands sent by and responses sent to each device [11].

5. INTERACTIVE DIGITAL TV

Designing applications for DTV requires also addressing interoperability and usability issues. Concerning the interoperability, the main challenge is to connect DTV content production from different content producers and distribute them in an interoperable way. There must be applied some mechanisms in order to structure information and protocols to accomplish efficiency in content management in DTV set top boxes. Usability notion refers to the user's ability to learn about the system and to use it in a creative way.

5.1 Personalization

Concerning the DTV application usability, it is important the users only visualize the contents which they really have access (avoiding, for instance, messages as "this service is not available at this moment"). This requirement addresses the personalization factor, which is particularly studied in the Human-Computer Interaction researches. Personalization implies that changes of the User Interfaces (UI) are often based on implicit user attributes such as localization, technical restrictions, in order to organize the information on the screen. In addition, users should modify the contents they visualize and/or the specifications of the UI based on their own interests or preferences. This kind of requirement addresses the customization factor, which requires that the application being customized be easy to use, by providing the users possibilities to be explored in a creative way.

In addition, customized applications need to have a flexible structure to build and modify the UI in real time. We have explored the interoperability and usability issues of DTV applications to know how contents can be transmitted by content providers and/or TV broadcasters, and how the contents can be structured and presented to users in a personalized way. As we have presented in the section 3, the architecture of the SBTVD-T has taken in account the MPEG-4 (see Figure 2). Thus, we observed a need of add new metadata for the Brazilian system, beyond those applied to MPEG-2 standard. The metadata structure made it possible to organize the contents in a more general way to be manipulated by the access portal and EPG applications with focus on usability.

As a matter of fact, the increasing popularity of DTV metadata standards observed by our research team, which allows developers to know about services description and multimedia contents, has increased the need for having broadcast oriented metadata standards more flexible. It means, having some structure to complement the tables, called PSI, Shorthand for Program Specific Information.

In the commercial systems of modern DTVs, the information about the applications and about the schedules is structured in these tables. The DVB (Digital Video Broadcasting) and the ISDB (Integrated System Digital Broadcast) systems have denominated these combined tables as SI (Service Information) and the ATSC (Advanced Television System Committee) has denominated them PSIP (Program Specific Information Protocol). Those tables fill information about logical channels (means of virtual transmission), identification of audio, video and data elementary stream, description of the programs, locations, and many other streams referred to the delivery, transmission and treatment of the multimedia data. Residing in the user's terminal are the applications that manipulate the information of the referred tables, selectively extracting those needed by the user. In order to manipulate this information in an automated way, the applications need a standard.

These TV systems are considered limited and inflexible about the interactivity and usability, since the characteristics of the process of transmission, archiving, recovering and presentation of the multimedia data are restricted to a few possibilities allowed by the descriptors of the elements that compose the MPEG-2 media. Thus, it has become necessary to re-think the potential of metadata in enriching applications and programs and, consequently, to adjoin possibilities of reception of media in other formats, new open functionalities, that aggregate value to both mechanisms of codification and extraction of existing data and to the broadcast media interactivity itself.

5.2 Metadata to Structure DTV Services

An ordinary DTV access portal should be a more sophisticated sort of "mosaic" devoted to present all available services as well as to provide access to all other interactive applications in the DTV. For the SBTVD project, the access portal should be able to manipulate information received from the transmission system and present them in a visual and user-friendly format to the Brazilian user, considering our social issues.

In addition, it should have functionalities to support the personalization. These characteristics leaded recommendations to facilitate the interaction and reception of the services and applications that are available. Associated to this access portal, we find specific applications such as the program schedule, communication, education, entertainment, and others. By its turn, the program schedule, notably, the Brazilian EPG was developed considering the possibility of providing a large range of ways of interacting with information about the schedule and contents related to the services and interactive applications.

In fact, the EPG application is the efficient tool that helps users to browse through channels and services provided by the DTV, as well as book recording of TV shows. The EPG also needs metadata that contains pertinent information to a certain program schedule, and is able to provide interactive service content. Such metadata is crucial to make available TV interactive services and specific video, audio and image contents, which provides digital television a real paradigm change of traditional TV. For this reason, the use of metadata was fundamental for the operations to receive data, extract information, manipulate information and data, and specific operations of building presentations of screens full of icons, options, tips in SBTVD system.

To make available the interface generation in real time, a mechanism that could facilitate the modeling of eventual interface components has been made necessary. It should not pre-establish a unique interface to all users (final interface), but rather adapting it accordingly to user preferences. This modeling is usually called interface concept modeling and contains information about possible objects to be put in the interface, without considering, yet, "how" to show its visual aspects. There are many approaches to be used to transform a conceptual modeling in a final interface for a certain device (TV, Palm, mobile, PDA, desktop, etc.) through XML documents with objectives of allowing the definition of data in a clear and easy way. Thus, XML metadata, that allows those conceptual models, could be converted in definition of user interfaces for multiple devices.

Figure 4 illustrates such a proposal. It is important to point out that a basic architecture for interactive usage can be composed of essentially of the three basic elements: a production center, a broadcast system, and home reception system. This approach considers the existence of an interactive channel by which interactive programs can be accessed by the viewer, who handles the content either locally (pause, local storage, and so on) or remotely (exploring related services). In this approach, the scenario represents software components that have a part of their code embedded in the reception set, and a part in the application that supports interactions between user and producers.

Facing this challenge, we have proposed to SBTVD a hierarchic structure of metadata implemented in XML format and the generation of applications interfaces in real time. In a schematic way, the solutions aimed two main goals: i) Perform the assemblage of the application(s) interface in real time from an interface XML document; and ii) Facilitate the maintenance of the applications through metadata in a separate XML file. This structure was hugely explored in many applications for our Brazilian context mainly for value for social and education benefits [18].

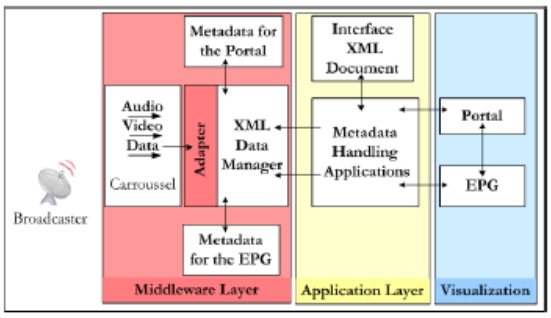

Figure 4. Metadata flux into applications and program Schedule.

We have considered the inclusion of an adaptive interface, in the TV reception in order to not have to deal, in an inconsistent way, with the metadata and the data stream of the programs created in a pattern different from SBTVD.

The adaptation component is important in this system. Depending on the type of data the set-top box (STB) receives, it should be able to interpret it without ambiguity. In short, we could identify three software layers for the SBTVD set-top-box resident application:

i) The Middleware layer, responsible for recover information coming from the broadcaster in form of transport stream and provide metadata required by interactive applications, through the implementation of some APIs. If the application that requires information is the Access Portal, the API should pass the information about applications and programs available and arranged in categories.

ii) The application layer, responsible for the adequacy of the information to be manipulated by the user. The application, to benefit from the interface and personalization maintenance facility resources, should also structure its keys in accordance with the XML metadata;

iii) The visualization layer, which consists in the TV screen seen by the user. The true interactivity will happen through it. The SBTVD specification for the access portal and EPG, both interactive programs reinforced the feature of interactivity. Thus, we have proposed solutions on interactivity that is not visible the net separation between user's services and producers' programs.

6. SOME SBTVD APPLICATIONS

In this section are described "T-Voto" and "Virtual Supporters", two applications developed at the SBTVD Consortium context and DIGA-Ginga [19], one applications which is been implemented for CTIC (Center for Research and Development on Technology for Digital Information and Communication)[7].

6.1 T-Voto

The T-Voto is an application that provides to the viewer interactivity with the program that this being transmitted. During

[7] Project incubated by the National Network of Education and Research (RNP). In its first phase, the focus is digital TV.

the exhibition of a television program he is requested to the viewer to reveal its opinion through a vote.

As it is made in the programs of Reality Shows, where one is carried through voting to eliminate a participant of the program, or a survey that it is made during the presentation of a program. The manifest viewer its opinion directly of the remote control, where it informs which is its option and sends its vote for the TV sender.

A TV station (Serving as Content Generator) will transmit (saw satellite, terrestrial or handle) the video signal, for the receivers of interactive digital television, during this moment the viewer while it attends the program, it will be able to execute the application to reveal its vote, and for intermediary of a return canal (Internet connection) will be able to register its vote in the Servers of Interactive Applications, as it illustrates the diagram of functioning in Figure 5, which details the characteristics of a real environment.

Figure 5. T-Voto application.

6.2 Virtual Supporters

The experiment aims at to allow that using of the net they have access to the one grating of canals of TV through its navigating application of canals - EPG (Electronic Program Guide), being able in accordance with to attend the programming of same the parameters as availability and quality (that they are defined by the monitor of the service), in different platforms.

Through the service it will be possible also, when used in one set-top box, to add conventional canals (transmitted for handle, satellite or it saw terrestrial) to the EPG, used through the device television set. The transmission of an open canal of TV has its scope limited for physical factors, however, with the advent of the Internet, some senders had started to make available its programming through the net, what, in the theory, she allows that to its hearing pass to be world-wide.

However the net potential can be used in more ostensive way, since the transmission of the programming many times is only one attractive one in the page of the sender, not offering to quality nor trustworthiness next to the tried ones in the use of the conventional open TV. However, paid TV networks have invested heavier in transmission of TV for the Internet, as in the case of the model of business ADSL TV, where it has transmission of TV through the Internet, similar to the TV model the established handle already.

The considered working group has as objective to create solutions that make possible the transmission of open TV through the Internet, with available resources in the scope of digital TV (interactivity also). The results of this study are an application called Virtual Supporters (from the portuguese, "*Torcida Virtual*") that permits the user at home participates of a match, virtually, as a supporter at the stadium (Figure 6).

6.3 DIGA-Ginga Project

DIGA Ginga project [20] proposes the use of set-top-box that is beginning to be made to the Brazilian System of Digital TV (SBTVD) model.

The major idea of the project is, therefore, to share the computational structure of the set-top-box adding services to citizens at their residence, such as the tracking of the physical environment (residential security), the monitoring personnel (vital signs) and other applications for home automation. Although compatible with any type of set-top-box, the DIGA is oriented to the Ginga, the middleware, result of research carried out by SBTVD.

Figure 6. Virtual Supporters Application.

This study adds to the DIGA Ginga an environment of applications for home care. In it we present its implementation, the DIGA Doctor, which has as its premise provide the monitoring and support for people who are in their state or the healthy carriers of diseases that require intensive medical supervision. This takes advantage of the fundamental characteristic of the Ginga's interactivity, to stay in the set-top-box applications developed for the residential environment.

The DIGA Doctor is the prototype of the DIGA Health Component. It integrates devices (Sun Spot, Set-top-box and sensors) to conduct the monitoring SVSP, i.e., DIGA Doctor is a program (run on the Digital TV's platform), which unites the Application Programming Interfaces (APIs) with the Sun Spot Ginga-J API (Digital TV) to provide services for Home Care[8].

As we can see in Figure 7, the Sun Spot consists of two facilities, a hub/transmitter (concentrator, placed near the body of the patient) and a receiver, whose size is similar to a cell phone. The concentrator has digital and analog ports, which serve to connect devices and sensors (oximeter, sphygmomanometer,

[8] Patients can receive home care services whether they live in their own homes, with or without family members, or in an assisted living facility. The purpose of home care is to promote, maintain, or restore a patient's health and reduce the effects of disease or disability.

accelerometer and blood glucose meter). The receiver obtains data from the transmitter and passes them to a computational device (in our case, the set-top-box) via USB port.

Taking ownership of these data, the DIGA Doctor will use the channel of return 9 of the set-top-box and sends that information to a health professional (responsible for the care of the patient) to take the appropriated decisions.

With DIGA Doctor it will be easy to notice when the vital signs monitored by a citizen are about to reach thresholds of life risk. In such cases, provide care in the timing of the need is a task of the DIGA Doctor. Thus, it is expected that the number of hospitalizations from public and private health care tends to fall, bringing economy to the Brazilian government and its citizens, especially those who require special medical care: people with chronic diseases will have their vital signs monitored remotely. Within the projection of the Interactive Digital TV in the Brazilian homes (in 2016, finishes the analogical transmission), the products generated by the project DIGA Doctor can help the Brazilian people.

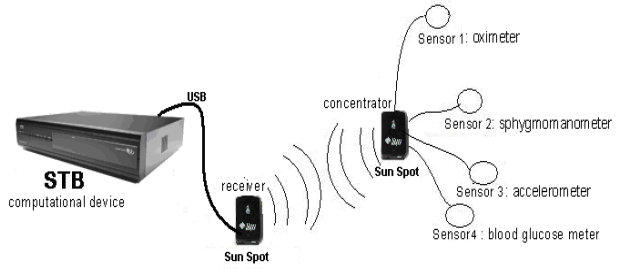

Figure 7 - Integration of the devices DIGA Doctor

Finally, the DIGA Ginga also serves as platform to other project related to Context Aware concept, an emerging field of research that has been advocated as a mechanism for providing the ability of an application or a service to reason about a situation and to adapt its behavior in response to environmental changes. In this case, DIGA Ginga has been used for the monitoring the context detection aspects in the RE-Invente [21], a researching project about Context Aware Ubiquitous Learning Environments [22,23].

6.4 T-learning Beacon Project

In the developed countries the penetration of Internet is unlikely to reach more than 60%. This situation is even more complicated when relating to countries such as Brazil where the scenario is quite serious: 95% of households own TVs with less than 20% owing computers and Internet.

The BEACON (Brazilian European Consortium for DTT Services) project [24] deals with themes related to educational problems and technology supported learning for disadvantaged groups in São Paulo, Brazil, particularly T-learning system. T-learning (learning through interactive digital television - DTV) is based on the integration of the both Digital Terrestrial Television and e-learning which can provide highly beneficial to regions where access to internet is low.

BEACON project has as objectives the interoperability between the European DVB system and the SBTVD, the study of a methodology for distance learning through DTV and the delivery of T-learning services related to social inclusion.

The project has an ambitious goal: run on different DTV platform worldwide. However, the project will face the interoperability issue on Interactive DTV Platforms evolving both Europe DVB and Brazilian SBTVD-T interoperability through a GEM-based solution .It is aimed to promote pedagogical innovation in training using ICT Technologies. The focus is implementing tools to support individuals undertaking learning; distance learning and language learning. Thus, the Brazilian government's fundamental objective with this project is to promote its development in order to diminish the discomforting conditions caused by the social exclusion.

A T-learning application must be devised and designed according to a didactical model to meet the end-user needs and be advantageous compared to other forms of training.

The focus on T-learning methodologies has been placed right away on the usage of the interaction element in that this factor has determined the popularity and fortune of training through technologies. On this respect, T-learning still evidences significant restrictions. One of these is represented by the user interface where the communication between the user and the set top box is implemented through a remote control, the performance of which is confined to the few buttons available. The remote control allows menu options' choices and numbers insertion. However it is a rather unpractical tool when it comes to text editing.

7. SOCIAL ASPECTS OF THE INTERACTIVE DTV

The Brazilian scientific community in broadcasting has worldwide been debating the technical, political and social aspects of the terrestrial DTV, since 1992. The conclusion is that interactive DTV is not merely an innovative signal representation. It represents a new broadcasting that affects not only the technological world, but also the society itself [25].

7.1 Education and Interactive DTV

Enhancing educational and training opportunities is one priority in the modern societies. The use of digital technologies in the fields of business, education and training has opened up a variety of opportunities to enhance learning processes. There are many ways as the services delivered through DTV can favor of education. The e-learning application, for example, is based on the idea that the use information technologies can facilitate the access to learning resources and contents, having the potential to overcome some social and physical disadvantages.

Furthermore, DTV can offer online learning services to people who cannot afford to buy a computer, or do not have Internet access. However, the learning services available for DTV make little use of feedback mechanisms. In general, the emphasis is placed on informal learning through education and entertainment,

[9] Canal of return is the channel of transmission of data from set-top-box of digital TV for broadcast television.

coherent with the consideration of TV as being a media for passive habits of users[10].

An example of the importance of interactive DTV for society is the T-learning application. It has reached a considerable potential in the last years and is emerging as an innovative media to allows users to get learning services at home. There are many differences between T-learning and e-learning that makes prohibitive just translate e-learning software's to DTV. T-learning programs can reach countries with high digital divide, and also with limitations of e-learning environments.

In conclusion, T-learning may represent an important opportunity to exploit new interactive DTV technology in lower social classes.

7.2 Digital divide and Interactive DTV

Accessing and using information is one of the key skills for someone to participate to the information age. Many recent studies indicate that access to Internet at home is the key to overcome the digital divide. Furthermore, there is a large technological gap across the countries. Official statistics in Brazil [1] indicates that 95% of Brazilian people have TV sets in their homes, but only 20% use computers and Internet.

In general, digital divide reserves the benefits of the information society for best economically provided communities. This situation can be surmounted by creating infrastructures that can provide all consumers with access to services and content in the communications landscape. The conclusion is that the penetration rate of Internet is drastically based on socio-economic status: a combination of household income, education level and age of people. The need to use computers, the inadequate computers distribution and the limited availability of broadband access infrastructure are some causes of these problems.

For these reasons, researchers are unanimous in acknowledging that digital divide exists in the world. The web-based learning (e-learning) has raised some problems related to digital divide issues. Hence, bringing interactivity to TV is an excellent way to promote digital and social inclusion.

7.3 Social Inclusion and Interactive DTV

Social exclusion is subject to many definitions and it depends on a variety of factors: gender, age, uncertainty, financial condition, employment and social instability. The access to digital technologies also affects the social exclusion. It depends on the relationship between the uses of ICT and socio-economical aspects of the emergent knowledge society. E-inclusion becomes, therefore, an important issue in the actions carried out by all actors from this new ICT Ecosystem [4]. Therefore, it becomes relevant to discuss about social exclusion when we take into consideration employment, housing, income, disability, education, skills and training, and the incoming new technologies.

The possibility to provide the user with ways to access interactive TV programs and interact with information is a key aspect for social inclusion. Another important aspect is the possibility to provide government services directly at home (the so-called *e-government*).

[10] In the migration from analogue to digital TV, should have been envisaged some mechanisms in order to help the users.

Therefore, in the Brazilian social context, the interactivity DTV plays an especially important role in the new information society, providing a precious support to initiatives to promote the fight against social inclusion. Interactive DTV can play a critical role in supporting policies addressing digital divide issues, by means of home care projects for disabled people (such as the DIGA Ginga project [20]), T-learning (such as RE-Invente project [21]), government programs and Internet access.

CONCLUSION

Television is a known media for information broadcasting. The advent of Digital TV has brought computational functionalities to the Television service, which is worldwide spread. The new TV environment becomes interactive, since applications can be transmitted and executed alongside with TV programs.

Digital TV technology has become a reality in Brazil. It has started at São Paulo city in the end of 2007 and since then has been implanted to the rest of the country. Conceived for terrestrial TV, the system took into account all other DTV system reference models without neglecting the political and social peculiarities of Brazil. Thus, the Brazilian Digital Terrestrial TV (SBTVD-T) took profit of being conceived when emerging technologies previously unfeasible were available. SBTVD-T is a variant of ISDB Japanese standard and the Brazilian Ginga middleware.

Ginga is composed by devices developed by different manufacturers. It allows content providers to develop an application that will run, adapted or not, on all Digital TV receivers. One of the building blocks of Ginga became a H.761 Recommendation on the International Telecommunications Union (ITU-T) in the first half of 2009. This Recommendation brings the specification of the Nested Context Language (NCL) and an NCL presentation engine called Ginga-NCL in order to provide interoperability among multimedia application frameworks. Ginga-NCL is an NCL presentation engine built as a component of an IPTV middleware. Its main goal is to provide interactivity.

The importance of Interactive Digital TV in Brazil is highlighted by the fact that their features are driving users towards more active profiles in the use of the television, not being passive spectators anymore. In terms of technical aspect, the Brazilian Digital TV makes it possible to start thinking on highly interactive services, based on the exploitation of return channels or interactivity channels. From the social point of view, the Digital TV in Brazil plays an especially important role in the new information society, giving a precious support to promote social inclusion.

After seven years, the decision of Lula government about DTV in Brazil can be evaluated over three different aspects: social, technical and political/economical. In the social role, the interactivity provided by Ginga has become a fundamental tool in order to fight against digital divide issues. Technically, the expertise created by the SBTVD project in universities and research centers has provided the Brazilian researchers with the competence needed to enhance national research community on DTV and to be internationally acknowledged for that. Finally, in terms of political and economical aspects, the successful royalties negotiation (ISDB, JavaDTV, etc.) driven by Brazilian government to implement part of the SBTVD-T was only possible due to the decision to enhance local culture on DTV instead of simply importing technologies.

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