A PLATFORM BASED ON JAVA AND XML FOR PROTOTYPING INTERACTIVE DIGITAL TELEVISION PROGRAMS

Interactive Multimedia Systems and Human-Computer Interaction

João Benedito dos Santos Junior, Iran Calixto Abrão, Marcos Augusto Loiola, Paulo Muniz de Ávila
Hérick Marques and Bruno Tardiole Kuehne
Pontifical Catholic University of Minas Gerais – PUC Minas, Poços de Caldas – MG, Brazil
TVDILab – Interactive Digital Television Laboratory

André Bretas Nunes de Lima
TOTVS S.A. – Belo Horizonte – MG, Brazil
TOTVS TV – Platform for Innovation on Technology for Digital Television System

Keywords: Interactive Digital Television, Java, XML, Software Agents, Context-Awareness Systems.

Abstract: This work presents the JiTV (*Java Interactive Television*) as a proposal of an integrated development platform that can be used for authoring of Digital Interactive Television Programs, discussing its implementation aspects. Among the main requirements of the JiTV, we can put light on description of scenarios using XML and the implementation of interaction controls using Java. In this scenario, the JiTV platform supports the specification of context-awareness aspects, acquiring of contextual data from software agents, building of data carroussel from the both recorded and real-time video and audio streams, tagging of multimedia objects with XML schema, allowing also the information retrieval. Furthermore, context-awareness aspects are being added for providing personalization in the television environment.

1 INTRODUCTION

With the dissemination of the technologies associated to the interactive multimedia, new applications and forms of interaction is appearing. The different ways with that the viewer (as user in traditional computing systems) can interact with a multimedia application (or with multimedia objects) demand the adaptation of the applications (eventually of automatic form) to the determined situations, with the objective to improve the interaction in several levels. Moreover, the presence of the computation in ubiquitous form offers the viewer the expectation of that is possible to access the information at anytime and anywhere, what to introduce the context-awareness aspects in the computational systems (Santos Jr. et al, 2001).

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 (Peng, 2002; Santos Jr. et al, 2005). 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, especially for the persons that have interest on television systems, but do not dominate technologies and software tools for building these applications. In

Benedito dos Santos Junior J., Calixto Abrão I., Augusto Loiola M., Muniz de Ávila P., Marques H., Tardiole Kuehne B. and Bretas Nunes de Lima A. (2007).
A PLATFORM BASED ON JAVA AND XML FOR PROTOTYPING INTERACTIVE DIGITAL TELEVISION PROGRAMS - Interactive Multimedia Systems and Human-Computer Interaction.
In *Proceedings of the Ninth International Conference on Enterprise Information Systems - HCI*, pages 245-252
DOI: 10.5220/0002401402450252

this direction, concepts and technologies applied to the traditional computing systems can be also applied to the interactive television systems, but is relevant to consider specific aspects of this new environment, especially in terms of the expectations of interaction of the viewer (HAVI, 2000).

In this context, this work presents the JiTV platform (*Java Interactive Television*), which is under development in the Interactive Digital Television Laboratory at PUC Minas (Santos Jr. et al, 2001; Santos Jr. et al, 2005), providing the validation of requirements to the Brazilian Terrestrial Digital Television System (SBTVD-T) (Lemos, 2005). The JiTV environment allows the development of applications for Interactive Digital Television through a set of authoring tools, distribution mechanisms and presentation/interaction players. To the author, it is enough to define the components of the television program (media objects, *timeline control*, information elements, interaction procedures); so, the JiTV Studio generates an XML schema that represents the television program (Lemos, 2005). From this XML schema, another JiTV component (JiTV Streamer) builds the data carroussel (program description, audio/video streams and interaction schema) and sends it to the communication infra-structure (Batista et al, 2005). In the viewer side, using a kind of set-top box (STB), the television program (audio, video and data) is presented to the viewer via access terminal, which contains a JiTV Player (Sun, 2005; Harren et al, 2004).

2 TELEVISION PROGRAMS

The current stage of the development of interactive television applications, in world-wide level, is focused on the increasing of some aspects of interaction to the traditional television programs (*enhanced television*) (ATSC, 2001; ISDB, 2001; DVB, 2002). However, this work proposes a new model of interactive television program that considers new interaction criteria as a part of the program, instead of to add new interaction criteria to the program (*enhanced television*).

In the **Figure 1** a television program (and its multiple objects) is presented. It is focused on case of the several forms to present the program to the viewer, depending on the available viewer's profiles.

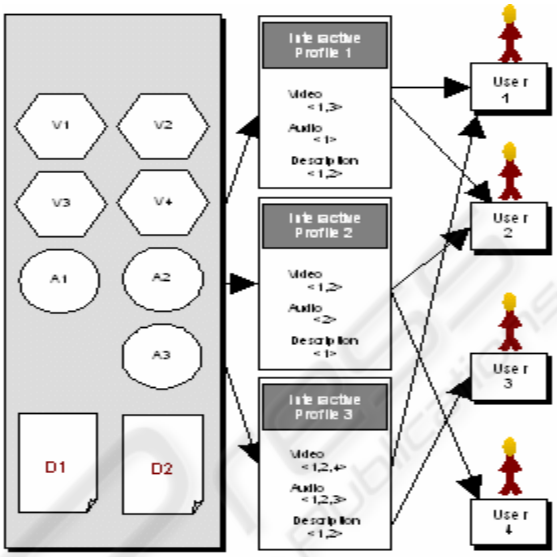

Figure 1: Proposed Structure for a Television Program in a Television System.

This kind of architecture is common to the video-on-demand applications; however, new interaction criteria are not fundamentally important (*personalization* is important).

2.1 Interactive Programs

In this proposal, the interactive program is the central element of an interactive television system. The interactive program can be defined as the set of all the medias (and its descriptions), scenes (and its descriptions), a summary (or synopsis) and its programming, as it shows the **Figure 2**.

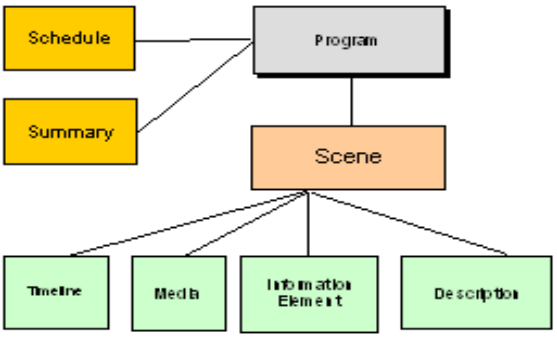

Figure 2: Entities that compose an interactive television program.

As cited, in this proposal, the interactive program is structured using XML schema. The entities `Schedule` and `Summary` are defined based on TV Anytime Forum (TVA, 2001). A simplified version of the description schema of a scene is presented in **Figure 3**; details of the description of scenes and programs were defined in the proposed complete model (Santos Jr. et al, 2001).

From the media objects and its descriptions, it is possible to build different interfaces or ways of presentation of the interactive program to the viewer. This possibility is named *profile* in this proposal. For the coding of the both media and the scenes, this proposal considers the use of MPEG technology (MPEG-2 and MPEG-4), which is sufficiently flexible and efficient for the compressing of video and audio. Besides that, MPEG-4 standard allows the representation of media elements as objects (OMG model), what is important to apply new interaction criteria in each one these objects (Chiariglione, 2001). This characteristic is sufficiently significant for the case of the implementation of different profiles for an interactive television program. It is important to highlight that this work considers the use of MPEG technologies for the coding, transmission and presentation of the interactive television program, independent of the transport mechanism, being able to use different standards of the Digital Television, like is the case of Multimedia Home Platform (MHP) for the presentation of the multimedia content (ATSC, 2001; ISDB, 2001; DVB, 2002).

```
<element name="Scene">
  <complexType complexContext="true">
     <element name =”Measured”>
       <complexType complexContext="true" >
          <attribute name="type"
                     type="mpeg7:DSType"/>
          <attribute name="id"
                     type="string"/>
          <attribute name="filelocation"
                     type="mpeg7:DSType"/>
       </complexType >
     </element >
   </complexType >
</element >
```

Figure 3: XML Schema for description of a scene.

This work uses XML schema for the description of television program data (scenes and media), allowing the creation of tools for searching in multimedia content.

On the other hand, the summary and schedule have fundamental importance for some applications, like EPG (*Electronic Program Guide*), once that is using the EPG that the viewer chooses operations (live viewing or recorder, by example) and interacts with the programming. Another excellent use of schedule is to allow the automatic adaptation of the programs to the viewer interests, using contextual information (*where, when, what, who* and *how*).

2.2 The Profile

The broadcaster manages the viewer's profile. In the player tool, the viewer has access to JiTV Profile, which is an assistant tool for managing the profile data. In the broadcaster studio, JiTV Studio offers a set of tools for crossing of the programming data and viewer profile data, generating several levels and categories of viewers (for example, the table of interactive channels that one viewer can be access).

For the description of the profiles, this work also uses XML schema for describing program elements, like `layout`, `context`, `profile` and `interaction`, as is showed in the **Figure 4**.

The information relative to the `profile` is inside of an element `<profile>`. This element is composed by other elements, which have been defined in the complete proposed model (Santos Jr. et al, 2001). For space reasons, only some these elements will be described in the following.

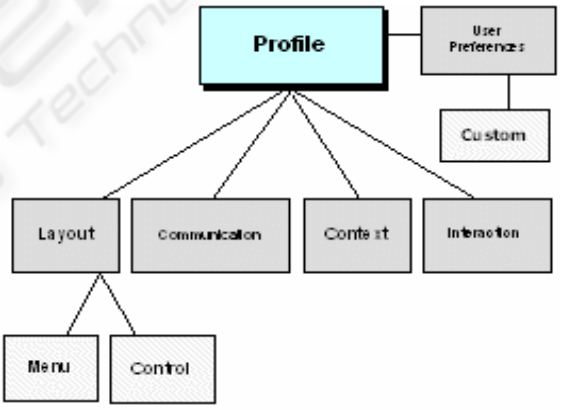

Figure 4: Entities that compose an interactive program into television system.

The defined aspects of presentation, which are part of the element `<Layout>`, are relative to the colors of deep, of the sources and position of the medias. Inside of the layout still, one has the possible controls of media for one determined profile, the type of menu and its content. A simplified version of the Schema of description of the element `<layout>` is presented in **Figure 5**. Details of the projects of description of profiles are found in complete model of this proposal (Santos Jr.

et al, 2001), in terms of an instance of interactive application, in the case the interactive television.

```
<element name="Layout">
  <complexType complexContext="true">
     <attribute name="bgcolor"
                type="string"/>
     <element name =”Object”>
        <complexType complexContext="true">
          <attribute name="id"
                     type="string"/>
          <element name =”ObjectPosition”>
          </element >
          <element name =”ObjectSound”>
          </element >
        </complexType >
     </element >
     <element name="Menu" >
     </element >
     <element name="Control" >
     </element >
   </complexType >
</element >
```

Figure 5: Description Schema of the Layout element.

The communication infrastructure requirements of one profile are specified into element <Communication>, where communications requirements are stored for each media object, decoders and access terminals (like STB). **In Figure 6**, is presented a simplified version of the XML description schema of the <communication> element.

```
<element name="Communication" >
  <complexType complexContext =”true”>
    <element name="CommRequirements" >
      <complexType complexContext =”true”>
        <attribute name="medianame"
                   type="string"/>
        <element name =”Bandwith”>
           <simpleType >
              <restriction base =
                 ”to nonNegativeInteger”>
                 <minInclusive value =”0”/>
              </restriction>
           </simpleType >
        </element >
        <element name =”Codec”
                 type =”string”/>
      </complexType>
    </element>
  </complexType>
</element >
```

Figure 6: Description schema of the Communication element.

Inside of the element <Context>, are inserted all context information, which can excellent form to determinate one profile. This element was defined from context-awareness aspects, such as <who>, <where>, <when>, <what> and <how> (Dey and Abowd, 2000). This element has the actions that must be carried under specific situations. In **Figure 7**, an example is presented of the <context> element.

```
<Context >
   <who =”mr. 1“> action 1</who>
   <who =”mr. 2“>
      <where =”bedroom“>
         <when =”24:00“>
            openProgram(news1)
         </when>
         openProgram(news2)
      </where>
      openProgram(music1)
   </who>
   <what =”24:00“> turnoff() </what>
</Context>
```

Figure 7: Description schema of the Context element.

The last element showed here is <Interaction>, in which will be all the actions that must be carried when each interaction defined for a profile occurs. These interactions are described in **Figure 8**.

```
<element name="Interaction" >
   <complexType complexContext =”true”>
     <attribute name="on" type="string"/>
     <attribute name="media"
                type="pratic:Media"/>
     <attribute name="button"
                type="pratic:Button"/>
     <attribute name="action"
                type="string"/>
   </complexType >
</element >
```

Figure 8: Description schema of the Interaction element.

In the example of the **Figure 9**, the attribute ”moves” is a XML description; the attribute video3 was presented in the television program and described in XML and the action moveMedia(video3) represents a command that will be performed by the STB as a task (this command depends on the both operating system embedded to STB and middleware/applications that supported, such as MHP or JavaTV (Sun, 2005).

```
<Interaction>
   <on =”moves” measured =”video3”
       action =”moveMedia(video3)”>
   <on =”click” button =”volume”
       action =”openVolumeBox()”>
</Interaction >
```

Figure 9: Description schema of attributes of the Interaction element.

With the presented elements and using the XML descriptions, an ample set of singular characteristics can be specified, allowing several personalization levels into interactive television program/system.

3 BUILDING PROGRAMS

Initially, the use of profiles allows better adaptation of interactive programs to the viewer. The **Figure 10** presents a UML sequence diagram, which shows the essential functionality of the actions the are performed between actors of the system (sender, STB, viewer).

As showed in the **Figure 10**, the sequence of events has beginning when the viewer (user actor) decides which interactive program will go to attend; chosen the program, STB (STB actor) requests the delivery (sender actor) of the authorized profiles; then, these profiles are sent to the STB, which presents the options to the viewer; the viewer chooses the profile then the STB makes the calling to the sender; in this solicitation is requested the audio/video streams and XML metadata for the desired program.

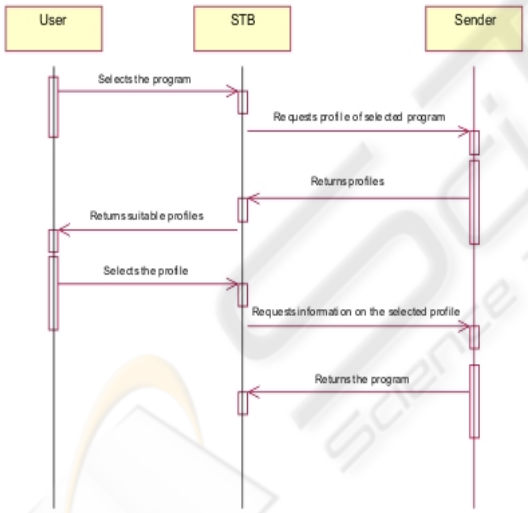

Figure 10: UML Sequence Diagram for the entities of an interactive program.

In this kind of environment, software agents can provide contextual information to the STB, enhancing the capabilities of the profile. Thus, the STB can use this information, described in the element `<Context>`, for the automatic adaptation of the interactive program to the viewer interests (*profile*).

In this scenario, one interactive program can manipulate several profiles. In the scope of this research, context-awareness aspects and ubiquitous computing have been strongly investigated.

4 JITV PLATFORM

To provide a platform for authoring of interactive programs, distribution of streams and interaction on the player, is required knowledge that *a television system is more than television as access terminal simply*, due to the fact that multiple devices (mobile phones, palms, PDA, among others) can be used to access to the digital television system. In this direction, this platform must be composed by authoring tools, streaming tools and player tools (Santos Jr. et al, 2005).

Since 2003, when this research was started as a part of the Brazilian Terrestrial Digital Television System (SBTVD-T), the platform has been named JiTV (*Java Interactive Television*), especially in terms of the use of the both Java and XML technologies. The **Figure 11** showed the JiTV Platform.

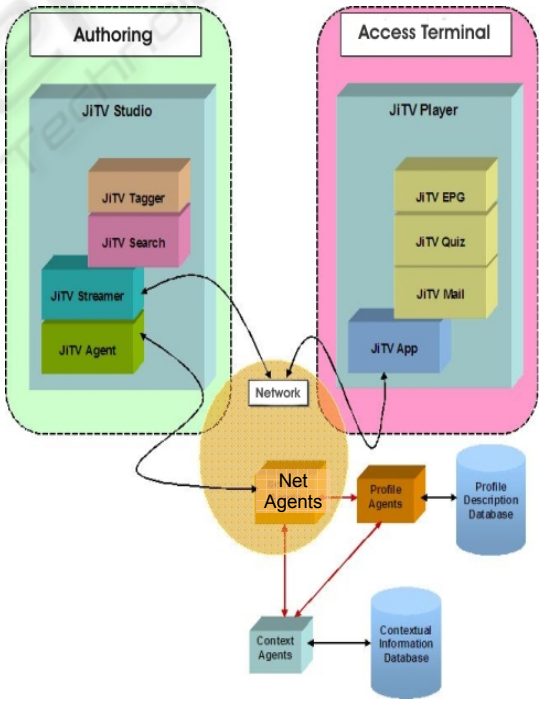

Figure 11: Architecture of the JiTV Platform.

A set of streaming tools must allow to the broadcaster to define ways for distribution of interactive programs and delivering of this program

to the viewer. These tools must allow the managing of data carroussel, which includes audio, video and metadata. Mechanisms for coding and decoding of media objects must to be also included into streaming tools. In another side, a set of authoring tools must allow to the author (producer/broadcaster) to define the interactive program elements and the way that this program will be streamed to the viewer, including also the choose of viewer's profiles and interaction schema.

A set of player tools must allow to the viewer to interact with the interactive television program. A multimedia player must to present media objects in the screen (video and images) and in the speaker sound device (audio). Furthermore, in the context of JiTV Platform, the player has been implemented for multiple devices, allowing the receiving of interactive television programs also in mobile devices (like mobile phones, palms, PDA, among others).

4.1 JiTV Tools

As presented, the JiTV platform consists on three distinct sets of tools: 1) set of tools for authoring of interactive television programs; 2) set of tools for streaming (*broadcasting*) of interactive television programs; 3) set of tools for playing of interactive television programs.

The JiTV platform is based-on Java and XML technologies; all tools are enough to read/write/process XML schema, which have been defined in the SBTVD-T context. In the **Figure 11**, the relationship between these sets of tools is presented.

In terms of the set of tools for authoring, the follow practices have been developed:

1. `JiTVStudio`: central tool for authoring of interactive television programs;
2. `JiTVTagger`: tool for tagging of media objects for searching;
3. `JiTVAgent`: tool for specifying agent's behavior into digital television system;
4. `JiTVSearcher`: tool for searching in interactive programs for finding elements and components;
5. `JiTVStreamer`: tool for integrating streaming functionalities during the building of interactive television programs.

For streaming (broadcasting) of interactive programs, the follow practices have been developed:

1. `JiTVDataCarroussel`: tool that allow the building of data carroussel and its streaming in communication infrastructure.

For presentation and interaction, the follow practices have been developed:

1. `JiTVPlayer`: a multi-device player tool for presenting multimedia objects (audio, video and data) and to allow the viewer interaction;
2. `JiTVEPG`: a tool for presenting the Electronic Program Guide;
3. `JiTVQuiz`: a tool that contains an interactive application for voting and entertainment;
4. `JiTVMail`: a tool for sending/receiving text messages using e-mail service;
5. `JiTVApp`: framework that supports the presentation and running applications and services (Internet Browser, RSS service, mail service, among others).

The **Figure 12a** presents the interface of the player tool using the television access terminal, showing four channels of standard television; in the **Figure 12b**, a selected channel is presented.

Figure 12a: Interface of the JiTVPlayer tool with multiple programming channels for choosing.

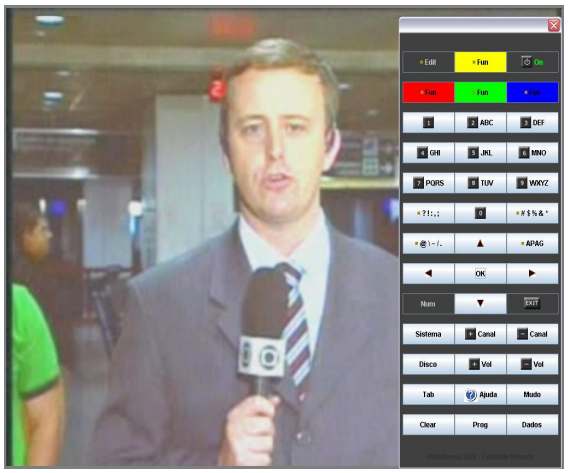

Figure 12b: Interface of the JiTVPlayer tool with selected channel in viewing.

In this player, it is possible to control the presentation of live/recorded audio and video, starting resident/broadcasted applications and to access return channel for interaction. The **Figure 13** presents the same player in a mobile device.

Figure 13: Interface of *the* JiTVMobilePlayer Emulator for viewing the television program.

The **Figure 14a** presents the list of applications that can be selected/performed by the viewer. This list is showed from XML schema, which describes the essential parameters for running each application. In conceptual terms, each application can be resident or downloaded from broadcaster application central. In the **Figure 14b** is showed the JiTVMail application as a communication service to the viewer.

Figure 14a: Interface of the JiTVApp Framework showing the application list.

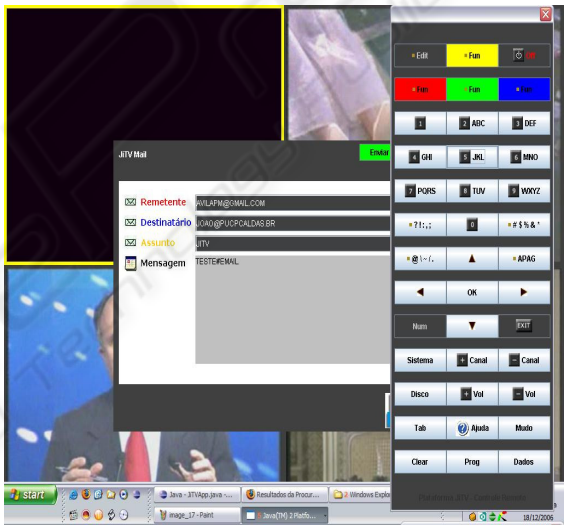

Figure 14b: Interface of the JiTVApp Framework showing the JiTVMail service.

5 CONCLUSIONS

This work has presented the JiTV as a platform for prototyping of interactive digital television programs in the context of Brazilian Terrestrial Digital Television System (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).

This work presented aspects of the modeling and implementation of the JiTV platform, discussing aspects of the prototyping of interactive television programs and applications. It is important to cite that several programs and applications are being developed in the SBTVD-T scenarios, in partnership with the TV Alterosa (broadcaster), TV Globo (broadcaster) and TOTVS (Software Solutions Company). In these tests, the both middleware requirements of SBTVD-T and JiTV functionalities are being validated and the results will be reported in future works.

REFERENCES

Advanced Television Systems Committee, 2001. *STANDARD DIGITAL ATSC TELEVISION (Revision).* April, 2001. Available on-line in http://www.atsc.org/Standards/A53/

Association of Industries Radio and Businesses, 2001. *Terrestrial Integrated Digital Services Broadcast – ISDB-T: Specification of Channel Coding, Framing Structure and Modulation* (ISDB-T).

Batista, C. E. C. F.; Salmito, T. L.; Leite, L. E. C.; Lemos, G. and Elias, G, 2005. Big Videos on Small Networks: A Hierarchical and Distributed Architecture for a Video on Demand Distribution Service. P*roceedings of the 1ST IEEE International Conference on Multimedia Services Access Networks (MSAN2005)*. June 2005.

Chiariglione, L.:, 2001. Standard technologies you develop the multimeasured applications. *MPEG-4 Conference.* Paris, 2001.

Dey, K. and Abowd G.D., 2000. Towards the Better Understanding of Context and Context-Awareness. *CHI 2000 – Workshop on The What, Who, Where, When, and How of Context-Awareness.* The Netherlands, 2000-April.

Digital Video Broadcasting (DVB), 2002. *Framing structure, channel coding and modulation will be digital terrestrial television*. Version 1.2.1 (2002). Available on-line in http://www.etsi.org/

Harren, M; Raghavachari, M; Shmuele, O; Burke, M; Sarkar, V; Bordawekar, R; XJ, 2004. Integration of XML Processing into Java. Proceedings of the 13th International World Wide Web Conference. May 2004.

HAVi, 2000. *Audio Home Video Interoperability*. Available on-line in http://www.havi.org.

Lemos, G., 2005. FlexTV: The Middleware of the Brazilian Terrestrial Digital Television System. *11st Brazilian Symposium on Multimedia and Web Systems (WebMedia 2005)*. Poços de Caldas-MG. Brazil. 2005.

Peng, C., 2002. Digital Television Applications, Ph.D. *Thesis on Science of Information*. Helsinki University of Technology, Espoo, 2002.

Sun Microsystems, 2005. *Java TV API.* Available on-line in http://java.sun.com/products/javatv. March, 2005.

Santos Junior, J. B.; Moreira, E. S.; Faria, G. B.; Goularte, R., 2001. The Modelling of Structured Context-Aware Interactive Environments. *SDPS Journal. Transactions of the SDPS.* USA, v. 5, n. 4, p. 77-93, 2001.

Santos Junior, J. B. ; Guglielmo, M., 2005. Using MPEG-Based Technologies for Building Personalized Multimedia Interactive Environments with Context-Awareness Requirements. *7th International Conference on Enterprise Information Systems.* 2005, Miami. USA.

TV Anytime Forum, 2001. Specification Series: S2 on System Description (Informative). April, 2001. Available on-line in ftp://tva:tva@ftp.bbc.co.uk/pub.