PUBLICATION P5

J.L. Lamadon, P. Cesar, C. Herrero, and P. Vuorimaa. Usages of a SMIL player in digital television. In *Proceedings of the 7th IASTED International Conference on Internet and Multimedia Systems and Applications*, Honolulu, Hawaii, August 13–15, 2003, pages 579–584. IASTED.

USAGES OF A SMIL PLAYER IN DIGITAL TELEVISION

J. Luc Lamadon, Pablo Cesar, Carlos Herrero and Petri Vuorimaa
Telecommunications Software and Multimedia Laboratory
Helsinki University of Technology,
P.O.Box 5400, FI-02015 HUT
Finland
{lamadon, pcesar, cherrero, pv}@tml.hut.fi

ABSTRACT

This paper describes the experiences of developing a SMIL player targeted to digital television and studies its benefits. In addition to user interface issues, interaction methods to access multimedia content, such as the use of an interaction channel, were considered. To test the proposed solution, the player was transmitted through a broadcast system, called Otadigi. Using SMIL, a great variety of light applications, such as specific multimedia presentations enriching television video content, can be easily developed and updated. Finally, the support of SMIL in digital television supposes a step towards the real convergence of the Internet and broadcast.

KEY WORDS
Multimedia Tools and Architectures, Java Technology and Applications, Digital television, GUI, interaction channel, SMIL

1 INTRODUCTION

The importance of digital television is unquestionable. It will provide high broadband transmission to almost every household [1]. Hence, the number of services, along to the normal television content, will increase in the following years. In Finland, digital terrestrial television broadcast started on August 27th 2001, so it is not yet possible to predict the final outcome of such enterprise. Anyhow, it seems reasonable that users will use the set-top box as another multimedia terminal.

Synchronised Multimedia Integrated Language (SMIL) is the World Wide Web Consortium's (W3C) standard for multimedia presentations. The number of stand-alone players and browsers that support it shows its importance and acceptance. Enabling set-top boxes with SMIL support is a challenge, which opens many possibilities for viewers, broadcasters and content developers.

This paper describes the development of digital television applications using SMIL presentations. It presents, as well, how to develop a valid and usable SMIL player in the digital television environment. In addition, the proposed solution was tested through a digital television broadcast system, called Otadigi [2].

2 DIGITAL TELEVISION

Digital television refers to the transmission of the television signal by digital means. It will supply more channels, better signal quality and enhance the television viewing experience by providing new services. But digital television, as well, requires new equipment both at the broadcast companies (e.g., MPEG-2 video encoder) and at home (e.g., set-top box).

Digital television services can be divided into resident to the receiver and downloadable. Resident services include the navigator and the Electronic Program Guide (EPG). Downloadable applications consist of services being broadcasted along the video and audio content. SMIL support in digital television will provide the viewer access to multimedia presentations in the Internet (i.e., using interaction channel). Moreover, SMIL language permits the development of synchronised multimedia applications simply as eXtensible Markup Language (XML) documents. Since no compilation is needed, they are easy and fast to develop. Finally, SMIL as other XML languages allows the same content to be configured for a wide range of devices.

2.1 Broadcast

Digital Video Broadcasting (DVB) [3], the European digital television standard describes a system designed to transmit high quality video, audio and ancillary data, over the same frequency channels used by analogue television systems. The system can deliver reliably about 22 Mbps of throughput in an 8 MHz terrestrial broadcasting channel and about 38 Mbps of throughput in a 6 MHz cable television channel. This means that encoding a video source (e.g., PAL signal) requires a bit rate reduction by a factor of 50 or higher. To achieve this bit rate reduction, the system exploits a complex video and audio compression technology; DVB systems are based on MPEG-2 compression standards.

The basic digital television broadcasting model can be seen to consist of three subsystems: source coding, service multiplex and transmission.

ISBN: 0-88986-380-6 © 2003 IASTED

Source coding refers to the bit rate reduction methods, also known as data compression, appropriate for application to the video, audio and ancillary digital data streams. The term "ancillary data" includes control data (i.e., service information tables) and data associated with the program audio and video services, such as the before mentioned downloadable services.

Service multiplex refers to the means of dividing the digital data stream into packets of information. DVB networks employ the MPEG-2 transport stream syntax for the packetisation and multiplexing of video, audio and data signals.

Transmission refers to channel coding and modulation. The channel coder adds information to the data stream. After that, the receiver can reconstruct the data from the received signal that, due to transmission impairments, may not accurately represent the transmitted signal. The modulation creates the final modulated transmission signal.

2.2 Set-top box

Digital television requires of a DVB receiver at home (e.g. a set-top box). The set-top box is designed to receive and decode the broadcasted television services. It tunes to the required channel, extracts and decodes the selected data, check the access right of the user, and outputs picture, sound and other services [4].

Multimedia Home Platform (MHP) is the standard for digital television terminals adopted in Europe and several other countries. It defines a common set of Application Program Interfaces (APIs), which must be included in every set-top box [5]. A generic standard, like MHP, allows content providers to address all kind of terminals, restricting the use of proprietary APIs.

MHP includes Home Audio/Video Interoperability (HAVi) standard as the Graphical User Interface (GUI) specification. HAVi does not only define the set of widgets to be used in digital television applications, but also provides the means to access the set-top box graphical resources. It specifies three layers, called devices, which make the final television output: background, video and graphics.

A two ways communication between the receiver and the broadcaster is enabled by the MHP support for a return path. Even though it does not define any particular physical connection, it specifies that the interaction channel must be based on TCP/IP protocol. MHP adds an extension (i.e. org.dvb.net.rc) for managing connection sessions as java.net presumes that connections are already established [6].

MHP defines two application languages: DVB-Java and DVB HyperText Markup Language (HTML). The former is based on Java MHP APIs. The latter one is based on Extensible HTML (XHTML), including other W3C specifications, such as Cascading Style Sheets (CSS), ECMA Script and Document Object Model (DOM). Due to the complexity and difficulty to implement DVB-HTML, current set-top boxes lack of reliable support. For this reason, most of the available digital television services are Java based. Implying the use of complex timer based programs or costly authoring tools for multimedia application development.

2.3 Services

Digitalisation of television offers a large spectrum of services. Nevertheless, three main categories can be defined: enhanced programming services, stand-alone applications and Internet over TV related services.

Enhanced programming services consist in enriching the current broadcasted program by providing additional information triggered by users' interactions. It may, besides, include the use of a return path. Enhancements may be additional text, graphics, animation or hyperlinks offering additional program-related information. Advertises enabling the viewer to access to a virtual shop is one example of these services.

Stand-alone applications are either totally independent of the broadcast or provide assistance to the viewer. Two examples are the EPG and the digital teletext. The former displays information about the available programs. And the latter is an enhanced version of the current teletext, where multimedia format information is broadcasted to the receiver [7].

Internet services over TV open opportunities for connectivity and communication applications. E-mail and chat are instances of Internet applications, which could be available in digital television environment. Nevertheless, adaptation of the Internet content for digital television faces several challenges: diversity of devices, Internet standards and policies. Therefore, a heterogeneous network exploiting the complementary features of each technology will result in value-added services and new revenues streams.

3 SMIL

W3C is in charge of defining standards for the Web. It released, in 1998, a first recommendation setting the premises of a multimedia presentation language for the Web: SMIL. Soon the main actors of the Web scene broadly adopted the standard. In August 2001, W3C released version 2.0 of SMIL. The second recommendation is a broader approach than the first one and reveals several main additions articulated around 4 profiles divided in 50 modules. SMIL 2.0 includes increased interaction, enhanced animations and transition sequences as well as content adaptation. It enables to

ISBN: 0-88986-380-6 © 2003 IASTED

structure, present and synchronise various multimedia objects (audio, video, text, graphics and animations) into a single composition [8].
For its simplicity, adaptability, interactivity and extensibility, SMIL has several benefits over other mark-up and programming languages. First, as it is HTML like, SMIL is easy to program. Nothing but a text editor is required to create the structure of a SMIL presentation. Then, SMIL is a real multimedia cross platform language as it supports content adaptation to various device configurations, user preferences and environments. In addition, DOM Events can be embedded in SMIL presentations providing a quality user interaction [9][10]. Finally, SMIL is a XML language and thus it can be combined with other W3C standards, such as XForms or Scalable Vector Graphics (SVG), taking advantages of each specific features, as X-smiles has demonstrated [11].

There are several implementations of SMIL player. The most widespread is the RealOne player. Microsoft Internet Explorer 6.0 supports HTML+SMIL 2.0 profile, which is one of the four different profiles of SMIL. Oratrix, a small company, released its Grins player, which is a full implementation of the SMIL Language Profile. Lately, Access and InterObject released players running over Pocket PC. They both implement the Basic Profile of SMIL 2.0.

4 SMIL IN DIGITAL TELEVISION

Cesar et al. presented Future TV (FTV) in [12], a Java package, which includes digital television oriented widgets based on HAVi specifications. Then, Pihkala et al. presented in [13] the theoretical background to develop a cross platform SMIL player. Further research on the topic lead to the setting up of a digital television broadcast system, called Otadigi [14]. In this paper, the possible uses of the SMIL player in Otadigi are studied. Two digital television applications were developed using SMIL: a digital teletext as stand-alone and an enhanced program. Moreover, the player was tested by accessing the presentations in three different ways: transmitting them along the player through the broadcast channel, using the interaction channel, and combining both approaches.

4.1 Otadigi

The Finnish Ministry of Transport and Communications granted a multiplex to the Helsinki University of Technology (HUT) and other Finnish research institutes, to implement a local digital television network. The Otadigi broadcast system is located at the Technical Research Centre of Finland (VTT) at the Helsinki University of Technology campus area. Due to the transmission parameters used in Otadigi, (cf., table 1), the resulting total bit rate is 13,27 Mbps.

Table 1. Otadigi transmission parameters.

Modulation	16-QAM
Code-rate	2/3
Guard interval	¼
Channel Bandwidth	8 MHz

The "source coding" subsystem (i.e., MPEG-2 video encoder) is mounted in a mobile rack, but most of the broadcast equipment is located at VTT premises. Thus the multiplexer, one object carousel generator and the DVB-T modulator are located in the same rack. An overall architecture of Otadigi equipment is depicted in figure 1.

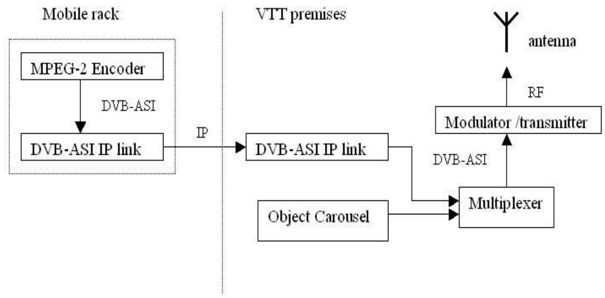

Figure 1. Otadigi broadcast system architecture.

In Otadigi multiple MHP interactive applications are delivered together with video and audio streams. These applications are stored in the Object Carousel, which generates the Digital Storage Media Control Command (DSM-CC) data stream and some System Information (SI) tables, including the Application Information Table (AIT).

4.2 SMIL player as an Xlet

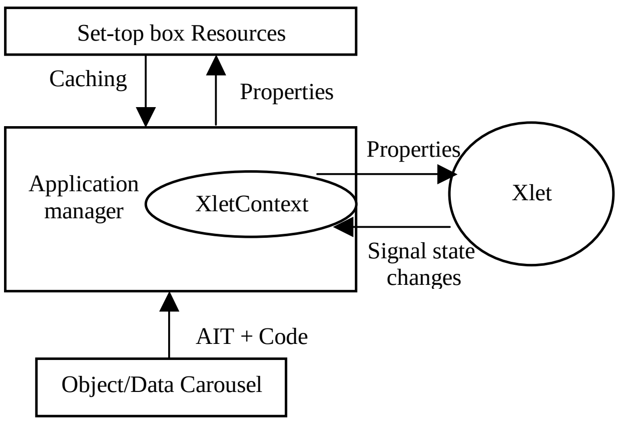

Figure 2. Application manager behaviour.

DVB-Java applications are called Xlets, which can be resident or downloadable. The set-top box's application manager downloads and controls the life cycle of the Xlets (i.e., initialise, start, stop and destroy). Figure 2

ISBN: 0-88986-380-6 © 2003 IASTED

depicts the communication protocol between the Xlet and the set-top box. The application manager accesses the data carousel to get the necessary information (i.e., AIT and code) of the Xlet and launches it. Once the Xlet is started, it communicates with the set-top box through an interface called XletContext.

When developing applications for digital television, there are certain restrictions to take into account. Both the SMIL player and its GUI were designed to meet the digital television requirements such as remote control usage, viewing distance, screen size and resolution. Some examples are the following:

- **Number of Java colours**: current set-top boxes provide very limited number of Java colours. For that reason, it was decided to make as much use as possible of I-frame background images in the GUI. Besides, to minimise the uncontrolled effects of the colour management over the pictures within the application, these were dithered.
- **Screen size, resolution and viewing distance**: digital television is viewed from a long distance. Hence, the minimal size used for the fonts was 18.
- **Widgets**: several digital television oriented widgets (e.g., buttons) from the FTV package presented in [12] were employed. These widgets, allows the use of the remote control to navigate among them.

One of the biggest restrictions in the use of SMIL in digital television is its lack of support for remote control events. SMIL, like other XML languages, relies on the DOM events model, in which interaction depends essentially on mouse events. Consequently, colour and Ok buttons inputs are mapped to DOM click event. In the proposed solution, links within the presentation are implemented as FTV buttons, so the user can navigate and activate them. In addition, a new attribute (i.e., actionable/focusable) for SMIL links is defined to determine their characteristic: actionable (e.g., colour button) or focusable (e.g., normal link accessed by navigation). These links accesses multimedia content via interaction channel [6] (external link, i.e. http://) or broadcast channel (internal link, i.e. file://).

4.3 Scenarios

To assess the feasibility of the proposed solution, two digital television applications, a digital teletext and a football-enhanced program, were implemented using SMIL. These presentations are accessed by three different means, broadcast channel, analogue modem and broadcast channel with possible use of interaction channel, constituting six different scenarios of the possible uses of SMIL in digital television. Each of the proposed scenarios is available via the six FTV navigable buttons composing the main menu of the GUI as shown in Figure 3.

Figure 3. GUI of the SMIL player.

An enhanced teletext that contains graphics, text and animations was developed as a stand-alone application. A first SMIL document displays a menu, which lists informative topics. Headlines relative to each topic become available by simple user interaction. Later, the user can access to particular information (i.e., actual news), included in a second document, and navigate among the pages using the colour buttons (i.e., back, next and home) as depicted in figure 4.

Figure 4. SMIL presentation as a digital teletext.

In addition, a sports program related service illustrates how a SMIL player can enrich the current viewing experience. The SMIL player is synchronised with the broadcasted program (i.e., a football game). A first SMIL document displays a menu on the left (e.g., statistics and roster), while the broadcasted video is maintained on the right side of the screen. A second document, triggered by user interaction, contains additional information about the players, teams' composition and statistics of the game, as well as animation replaying the latest goal as depicted in figure 5.

Figure 5. SMIL presentation as enhanced program service.

As said above, each presentation was retrieved via broadcast channel, analogue modem or the combination of both. The first one is the broadly used method on current digital television systems. This procedure limits the diversity and quantity of services provided to the users. The second one consists of retrieving the content pages through the interaction channel. This approach is time consuming, since current set-top boxes are equipped with analogue modems. Finally, the last method consists of broadcasting generic sections and retrieving particular pages susceptible of user personalisation with the interaction channel.

5 RESULTS

This section presents results of transmitting the SMIL player through Otadigi in the following configuration: Otadigi broadcast system with 3Mb/s dedicated bandwidth, interaction channel modem connection at 56Kb/s and ADB's I-CAN set-top box.

Table 2 shows the storage memory of the components needed to run the player: parsers, player, images, I-frame and GUI components. Then, table 3 shows the loading and starting time of the GUI of the SMIL player, in total less than 30 seconds.

Table 2. Storage memory of SMIL player.

Components	Memory (KB)
XML parsers (xml-apis.jar)	106 KB
DOM parsers (xerces.jar)	843 KB
SMIL player (smil.jar)	352 KB
Images	55.5 KB
I-frame	45 KB
FTV components (ftv.jar)	26.4 KB

Table 3. Loading and starting time of player's GUI.

Action	Time (s)
Loading	19 sec
Starting	7 sec

As said before, there were implemented two different digital television applications using SMIL language: digital teletext and enhanced program. In order to minimised the loading time of the SMIL presentations, in both cases these were divided into two SMIL files. Table 4 shows the storage memory for both applications. Table 5 shows the corresponding starting times depending on the content access mechanism.

Table 4. Storage memory of SMIL presentations as digital teletext and enhanced program.

	Component	Size file 1	Size file 2
Teletext service	Images	23.3 KB	72.4 KB
	Presentation	6.3 KB	9.7 KB
Enhanced program	Images	25.2 KB	84.7 KB
	Presentation	2.9 KB	5 KB

Table 5. Starting time of SMIL presentations as digital teletext and enhanced program.

	Type of access	Time file 1	Time file 2
Teletext service	Broadcast	27 sec	19 sec
	IC	90 sec	70 sec
	Broadcast + IC	24 sec	120 sec
Enhanced program	Broadcast	23 sec	11 sec
	IC	120 sec	60 sec
	Broadcast + IC	23 sec	97 sec

The results presented in this section highlight certain issues, which need further research. First, as shown in table 2, the XML and DOM parsers need to be minimised (i.e., currently take around 1MB). Second, as shown in table 5, the use of the interaction channel (i.e., analogue modem) was extremely slow, unusable in current real environments. Finally, the goal would be to integrate the player in the set-top box, resulting in minimal loading time and reducing the starting time.

6 CONCLUSION

In this paper, different uses of a digital television SMIL player are studied. SMIL provides the means to develop

ISBN: 0-88986-380-6 © 2003 IASTED

synchronised multimedia applications. Moreover, SMIL allows the easy, fast and lighter development of a great variety of digital television applications. In order to argue this statement, SMIL language was used to develop a digital television teletext and an enhanced program. Moreover, due to the importance of SMIL in the Internet, any serious attempt of convergence between broadcast and the Internet should take this standard into account.

In this paper, another important issue in relation to the convergence of the Internet and broadcast was studied: the usage of the interaction channel. The interaction channel provides the means to access remote information and communicate with other platforms (e.g., e-mail, chats). But it is, also, a main component of a system providing personalisation. In this paper, it was shown a case study, in which both the SMIL player and generic information (e.g., list of topics in the teletext case) were broadcasted. On the other hand, particular information (e.g., the actual news in the teletext case) was stored in a server, accessible via links within the presentation. This way, each user, could access to the specific content of his interest.

Taking into account the obtained results, it can be argued that the SMIL player developed is usable in a real digital television environment. Both the loading and starting time of the applications was within the limits of digital television requirements. The only problem, faced at the moment, is the use of the interaction channel, which took more time than expected because of the analogue modem used. This result lights up that future commercial set-top boxes should implement more efficient interaction channel capabilities.

One of the biggest restrictions in digital television is that the loading and starting time of the applications has to be minimal. These times depend, apart from the receiver capabilities, on the amount of information transmitted. In the proposed solution, the XML parsers had to be transmitted along the application. But, since MHP 1.1 specifications include DOM, CSS and ECMA Script support, in MHP 1.1 compliant set-top boxes, this will not be a problem in the future.

Finally, further research in the topic includes the study of stream events to synchronise the SMIL player and the broadcast (e.g., advertisements). A deeper study in the minimisation of the parsers' size is, as well, needed. Moreover, the combination of SMIL with other XML standards, such as XForms or CSS can provide the means to develop more complex and portable applications.

7 ACKNOWLEDGEMENTS

The author Pablo Cesar would like to thank Nokia Oyj foundation for their support during the research. The authors are grateful to the following people: M. Sc. Kari Pihkala for the original SMIL implementation, M. Sc. Aki Teppo for the help regarding the interaction channel and Mr. Jukka Santala for his work at the parser level.

REFERENCES

[1] M. Milenkovic, Delivering interactive services via a digital TV infrastructure, *IEEE Multimedia*, 5(4), 1998, pp. 34-43.

[2] Otadigi, http://www.otadigi.tv

[3] ETSI TS 102 812 v1.1.1, Digital Video Broadcasting (DVB), Multimedia Home Platform (MHP) Specification 1.1, *ETSI*, November 2001.

[4] T. R. Hurley, Evolution of the Digital Set-top box, *Proceedings of the International Broadcasting Convention*, Amsterdam, The Netherlands, 1996, pp. 277-282.

[5] J. Piesing, The DVB Multimedia Home Platform – MHP, *Proceedings of the IEE Colloquium on Interactive Television*, Digest 99/200, 1999, pp. 1-6.

[6] J. Jones, DVB-MHP/ Java™ data transport mechanisms, *Proceedings of the 40th International Conference on Tools Pacific: Objects for Internet and embedded applications*, Sydney, Australia, Volume: 10, 2002, pp. 115-121.

[7] P. Vuorimaa, A Digital television service architecture, *Proceedings of the IEEE International Conference on Multimedia and Expo*, New York City, USA, 2000, pp. 1411-1414.

[8] P. Hoschka, et al., Synchronized Multimedia Integration Language (SMIL 2.0), *W3C Recommendation*, August 7th 2001.

[9] D. C. A. Bulterman, SMIL 2.0 part 1: overview, concepts and structure, *IEEE Multimedia*, 8(4), 2001, pp. 82-88.

[10] D. C. A. Bulterman, SMIL 2.0 part 2: Examples and comparisons, *IEEE Multimedia*, 9(1), 2002, pp. 74-84.

[11] X-smiles, http://www.xsmiles.org

[12] P. Cesar and P. Vuorimaa, A Graphical User Interface Framework for Digital Television, *Proceedings of the 10th International Conference in Central Europe on Computer Graphics, Visualization and Computer Vision*, Plzen, Czech Republic, 2002, posters, pp. 1-4.

[13] K. Pihkala, P. Cesar and P. Vuorimaa, Cross-platform SMIL player, *Proceedings of the IASTED International Conference on Communications, Internet and Information Technology*, St. Thomas, USA Virgin Islands, 2002, pp. 48-53.

[14] C. Herrero, P. Cesar and P. Vuorimaa, Delivering MHP applications into a real DVB-T network, Otadigi, Accepted to the *6th International Conference on Telecommunications in Modern Satellite, Cable and Broadcasting Services*, Niš, Yugoslavia, October 1-4th 2003.