PUBLICATION P6

C. Herrero, P. Cesar, and P. Vuorimaa. Delivering MHP applications into a real DVB-T network, Otadigi. In *Proceedings of the 6st IEEE International Conference on Telecommunications in Modern Satellite, Cable, and Broadcasting Services*, Nis, Serbia and Montenegro, October 1–4, 2003, pages 231–234. IEEE.

DELIVERING MHP APPLICATIONS INTO A REAL DVB-T NETWORK, OTADIGI

Carlos Herrero[1], Pablo Cesar[2] and Petri Vuorimaa[3]

Abstract - **OtaDigi is a DVB-T broadcast experiment run by the Helsinki University of Technology and other partners. This paper studies the behaviour of MHP applications, delivered through OtaDigi, using different broadcast configurations. The results show how under optimised configurations, broadcasters can use their bandwidth more efficiently and users can download the applications faster.**

Keywords – **Digital Terrestrial Television DVB-T, Interactive MHP Applications, Object Carousel**

I. INTRODUCTION

Digital transmission was the only option for fitting the extra services into the frequency bands already filled up with analogue television services. Thanks to the audiovisual content digitalization and compression technologies, it is now possible to deliver together two or more television services into the same VHF or UHF frequency band. Moreover, digital audio and video signals show obvious advantages in terms of quality and robustness.

The European Telecommunications Standards Institute, ETSI, handles the Digital Video Broadcasting Project, DVB, family of standards and specifications [1]. DVB satellite and cable transmissions have been in use worldwide for nearly a decade. DVB-T, the terrestrial variant of DVB, offers to users "plug and watch" simplicity, as compared with satellite and cable systems where a new dish aerial or cable connection may also be required. However, few European countries have launched their DVB-T transmissions, as can be seen in Fig 1.

Besides to the audiovisual content, DVB systems allow the delivery of multiple interactive services. These downloadable applications can be developed using any of the closed operating systems (e.g., OpenTV [2], MEDIAHIGHWAY [3]) or following the Multimedia Home Platform specification [4], MHP, produced at the DVB Project. The MHP specification represents a movement to an open horizontal marketplace, where viewers can freely choose their DVB-MHP receivers.

[1]Carlos Herrero is with the Telecommunication Software and Multimedia Laboratory, Helsinki University of Technology, P.O. Box 5400, FIN-02015 HUT, Finland, Email: Carlos.Herrero@hut.fi

[2]Pablo Cesar is with the Telecommunication Software and Multimedia Laboratory, Helsinki University of Technology, P.O. Box 5400, FIN-02015 HUT, Finland, Email: pcesar@tml.hut.fi

[3]Petri Vuorimaa is with the Telecommunication Software and Multimedia Laboratory, Helsinki University of Technology, P.O. Box 5400, FIN-02015 HUT, Finland, Email: Petri.Vuorimaa@hut.fi

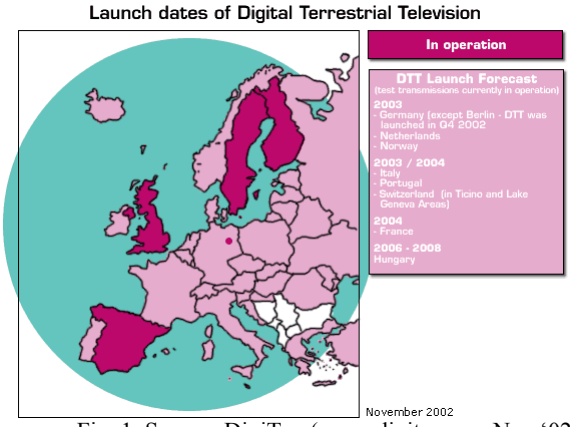

Fig. 1. Source: DigiTag (www.digitag.org, Nov '02).

Finland is the first country in the world with a totally working DVB-MHP compliant transmission network. Three terrestrial multiplexes started their operation in Finland on August 27th, 2001, which deliver now 18 digital television channels altogether and 4 radio channels. To ensure that the basic functions are the same and easy to learn for the viewers, Finnish multiplex operator and digital television channels have decided to run the electronic program guide and digital teletext services collectively [5].

OtaDigi [6] is a recent DVB-T broadcast experimenting project, run by Helsinki University of Technology, HUT, and the Technical Research Center of Finland, VTT. This paper describes how this DVB-T network delivered MHP applications [7] using different configurations. The tested applications are described in Section V.

II. DIGITAL VIDEO BROADCAST

DVB networks are based on the MPEG-2 standard. MPEG-2 transport stream is form by multiple elementary streams containing video, audio and the ancillary data; including several types of Service Information tables, summarized in Table I. The PMT indicates the Packet Identifiers, PID, of all the streams that belong to a program. And the PAT links each program number with its PMT. These four tables make up the Program Specific Information.

TABLE I
MPEG-2 SERVICE INFORMATION TABLES

PAT	Program Association Table
PMT	Program Map Table
CAT	Conditional Access Table
Private tables	

ISBN: 0-7803-7963-2/03 © 2003 IEEE

The DVB standard adds four mandatory basic tables and three optional tables. These tables, summarized in Table II, can provide information about other networks and about events and programs carried by different multiplexes [8].

TABLE II
DVB SERVICE INFORMATION TABLES

NIT	Network Information Table	Mandatory
SDT	Service Description Table	Mandatory
EIT	Event Information Table	Mandatory
TDT	Time and Data Table	Mandatory
BAT	Bouquet Association Table	Optional
RST	Running Status Table	Optional
ST	Stuffing Tables	Optional

III. MULTIMEDIA HOME PLATFORM

MHP introduces one additional table that must be present in the transmission stream whenever data services are to be used [9]. This table is the Application Information Table, AIT, which can be used for various signaling purposes. By accessing the information in this table, the receiver can find out the interactive services present in the data stream. The table includes information like application type, name, manufacturer and profile.

The goal of the MHP standard is to serve as an open platform to introduce new value added services into Broadcast Television Networks. MHP defines three different profiles [9] and each one requires a certain minimum set of features explained below.

The simplest profile, Enhanced Broadcasting, enables downloading of Java applications with local restricted interaction. The next profile, Interactive Broadcasting, requires an interaction channel (e.g. via modem) and presents the MHP-HTML applications, but as an optional feature. The most advanced profile, Internet Access, is intended for accessing Internet services. By dividing the MHP standard into these profiles the manufacturers can quickly provide to clients simple MHP receivers.

IV. OTADIGI SYSTEM OVERVIEW

In addition to the national digital terrestrial television operating licenses, the Finnish Ministry of Transport and Communications granted a multiplex to HUT and VTT, to implement a local digital television network. As a main requirement, it must be dedicated to academic and research purposes. The OtaDigi broadcast system is located at VTT premises, close to the HUT campus area, showed in Fig 2.

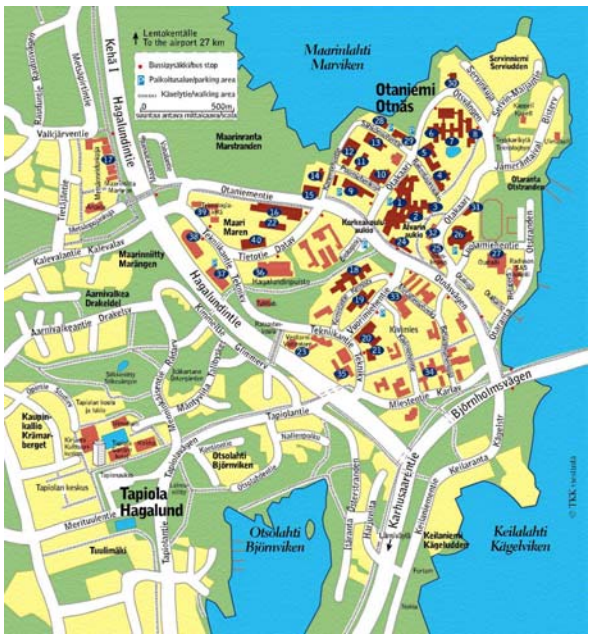

Fig. 2. HUT campus area in Otaniemi, Finland.

Due to the transmission parameters [10-11] used in OtaDigi, listed in Table III, the resulting total bit rate rises a value of 13,27 Mbps, and also allows mobile reception. The transport stream, sent in 188-bytes packets, contains a single program called OTADIGI CHANNEL. Its elementary streams, together with their associated PIDs, are listed in Table IV.

TABLE III
OTADIGI TRANSMISSION PARAMETERS

Modulation	16-QAM
Code-rate	2/3
Guard interval	1/4
Channel Bandwidth	8 MHz

TABLE IV
OTADIGI CHANNEL ELEMENTARY STREAMS

Elementary Stream	**Packet Identifier**
Program Map Table (PMT)	100
MPEG-2 Video	101
MPEG-2 Audio	102
Application Information Table	105
Object Carousel data	106

Most of the broadcast equipments are located at VTT premises, but the video encoder is mounted in a mobile rack. It can be located in any place connected to the Broadband IP Network installed in Otaniemi. The video and audio streams generated by the encoder are converted within two IP/ASI links. The receiver link is in the same rack than the Multiplex. A general schema of the connections between OtaDigi equipments can be seen in Fig 3.

ISBN: 0-7803-7963-2/03 © 2003 IEEE

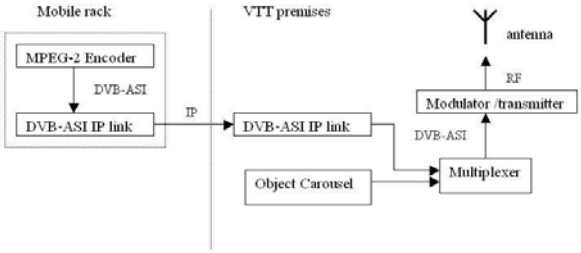

Fig. 3. OtaDigi Broadcast System Scheme.

In OtaDigi multiple MHP interactive applications are delivered altogether with video and audio signals. These applications are stored in the Object Carousel generator, which creates the DVB data carousel stream and some Service Information tables, including the AIT one.

V. Broadcasted MHP Applications

MHP applications developed using the Java language are called Xlets. The application manager, a set-top-box resident application, controls the life cycle of the applications [12]. At the viewer request, the application manager loads a single Xlet from the data stream and run it.

Peng, during the last years, presented several digital television applications, including a Navigator, a digital Teletext and an Ice Hockey related interactive downloadable service. Due to the lack of a real broadcast system, these were successfully integrated into an off-line digital television environment [7].

Both the Ice Hockey and the Navigator applications were upgraded to completely meet the MHP standard requirements. Later, they were delivered through OtaDigi network, under various broadcast configurations and data stream optimization schemes. Fig 4 depicts the Ice Hockey application and fig 5 the Navigator. For further information about the applications, refer to [7].

Fig. 4. Screenshot of the Ice Hockey Application.

The graphical user interface part of the MHP specifications is Home Audio/Video Interoperability (HAVi) standard. HAVi introduces a set of digital television graphical components and defines the television screen as a sum of three layers: background, video (i.e., actual video content) and graphics (i.e., application graphics).

The transmitted applications were upgraded following the HAVi specifications. First, an I-frame image was used as a background. Next, a video controller was implemented to locate and resize the video content as wished. Finally, some HAVi based graphical components, presented by Cesar et al. in [13] were employed within the applications (e.g., buttons in the main menu of the Ice Hockey application).

Fig. 5. Screenshot of the Navigator Application.

Table V shows the storage memory needed for the Ice Hockey application and the Navigator. In the table, each row corresponds to a group of components: images used within the applications, HAVi based graphical components (i.e., FTV Components), the I-frame image used as a background and the applications' actual Java classes.

TABLE V
Ice Hockey and Navigator Applications Storage Memory

Component	Ice Hockey	Navigator
Images	70.5 KB	589 KB
FTV Components	18 KB	19 KB
I-frame	43 KB	43 KB
Application	28 KB	153 KB

VI. Results

This section presents the behavior of the Navigator and the Ice Hockey application, delivered under different broadcast configurations through OtaDigi. The tests were performed taking into account broadband and narrowband scenarios, since DVB-T allows mobile reception. So, in the broadband scenario the Ice Hockey is transmitted at 100 kbps and the Navigator at 400 kbps. On the other hand, the narrowband scenario dedicated only 50 kbps to the Ice Hockey application and 160 kbps for the Navigator.

Especially in terrestrial digital television systems, such as OtaDigi, the available network bandwidth for data broadcast is very limited, and its efficient use is very valuable. Some

ISBN: 0-7803-7963-2/03 © 2003 IEEE

optimization techniques, to broadcast digital television applications, have been proposed in [14]. Now, this paper shows three different object carousel configurations, and how the application behavior varied with those. In the first configuration, the object carousel generator delivered the data without applying any optimization scheme. In the second one, the files were delivered with compression enabled. Finally, in the third one, the files were also divided in two collections with different priorities. Thus, the files required at the starting phase were sent into the object carousel five times more often that the others.

In all the cases the applications were tested in an ADB I-Can set-top box. Table VII shows the obtained download times in seconds, for both the Ice Hockey and Navigator applications, in the narrowband scenario. And Table VIII presents the download times in the broadband scenario.

TABLE VII
XLET DOWNLOAD TIMES (BANDWIDTH SCENARIO 1, NARROW)

Object Carousel Configuration	Ice Hockey	Navigator
Not Optimization	49	48.8
Only compression	44.8	45.5
Priority Collections	30.4	33

TABLE VII
XLET DOWNLOAD TIMES (BANDWIDTH SCENARIO 2, BROAD)

Object Carousel Configuration	Ice Hockey	Navigator
Not Optimization	20.8	18.4
Only compression	12.1	11
Priority Collections	19.5	19.6

The time since the object carousel data is mounted into the set-top box until the application is ready to be used is the start-up time. For the Ice Hockey it was 4.6 seconds with the first configuration and around 4 seconds for the rest. The Navigator took about 5.1 seconds to start with configuration 3 and 5.5 seconds for the rest. For both applications, results did not vary between the broadband and narrowband scenarios.

VII. CONCLUSION

In this paper a DVB-T broadcast system, called OtaDigi, is presented. OtaDigi is an academic and research platform run by the Helsinki University of Technology and the Technical Research Center of Finland, which started its operations in January 2003. Because digital television is just starting, it seems worthy the possibility of taking part in a test platform, like OtaDigi, to research new ideas and approaches.

Two MHP-Java applications were transmitted through OtaDigi broadcast system. These applications were delivered using different broadcast configurations. The results show how the use of optimized configurations cause two main advantages for both broadcasters and viewers. The broadcasters can deliver more applications and data into the same bandwidth. And users can download the interactive applications faster, increasing their usability.

Further research in the topic includes deeper studies of optimization techniques. In addition, OtaDigi can broadcast digital television to other platforms, such as PDAs or mobile phones, opening new possibilities. Moreover, significant upcoming issues, as the convergence of broadcast and the Internet, can be researched using OtaDigi. Finally, enabling the set-top box with other communication protocols (e.g., SIP or Bluetooth) would increase the value of such platform.

ACKNOWLEDGMENT

The author Pablo Cesar would like to thank Nokia Oyj foundation for their support during the research work. In addition, the authors want to thank the following people: M. Sc. Jean Luc Lamadon because of his job in the look of the applications, Dr. Sc. Chengyuan Peng for the original applications implementation and OtaDigi technical group colleagues. Also to the Digital Terrestrial Television Action Group, for allowing the use of the DigiTAG WebPages and maps in this paper.

REFERENCES

[1] ETSI TR 101 200 v1.1.1, Digital Video Broadcasting (DVB); A guideline for the use of DVB specifications and standards, *ETSI*, September 1997.

[2] OpenTV, http://www.opentv.com

[3] MEDIAHIGHWAY, http://www.canalplus-technologies.com

[4] Evain J.P., The Multimedia Home Platform – an overview, *EBU Technical Review*, Spring 1998, pp. 4-10.

[5] DIGITA, Rules of Operation of Service Information in the DTTV Network v1.4, *DIGITA*, April 2002, 36 p.

[6] OtaDigi, www.otadigi.tv

[7] Peng C., *Digital Television Applications*, Doctor of Technology Thesis, Helsinki University of Technology, Finland, 2002.

[8] EN 300 468 v1.4.1, Digital Video Broadcasting (DVB); Specification for Service Information (SI) in DVB systems, *ETSI*, 2000, 83 p.

[9] ETSI TS 102 812 v1.1.1, Digital Video Broadcasting (DVB); Multimedia Home Platform (MHP) Specification 1.1, *ETSI*, November 2001, 1447 p.

[10] ETSI EN 300 744 v1.4.1, Digital Video Broadcasting (DVB); Framing structure, channel coding and modulation for digital terrestrial television, *ETSI*, January 2001, 49 p.

[11] ETSI TR 101 202 v1.1.1, Digital Video Broadcasting (DVB); Implementation guidelines for Data Broadcasting, ETSI, February 1999, 61 p.

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

[13] Cesar P. and Vuorimaa P., A Graphical User Interface Framework for Digital Television, *Proceedings of the 10th International Conference on Computer Graphics, Visualisation and Computer Vision*, February 2002, Czech Republic, Posters, pp. 1-4.

[14] Herrero C. and Vuorimaa P., Optimization Techniques for Digital Television Applications Broadcasting, *Accepted to the 7th IASTED International Conference on Internet and Multimedia Systems and Applications, IMSA 2003*, August 2003, Hawaii, USA.

ISBN: 0-7803-7963-2/03 © 2003 IEEE