H. Lamminen, and A. Lugmayr. Letters to the Editors: Technical Framework for using digital interactive television in home telecare. Journal of Telemedicine and Telecare. Volume 7, Number 4, July, 2001.

Technical framework for using digital interactive television in home telecare

Sir, New applications in telecommunications and digital media will have a big effect on the health-care sector. They should improve the quality of life and health of individuals and communities in the same way that improvements in general hygiene and disease prevention occurred at the beginning of the twentieth century. To receive these benefits we need to have policies based on practical experience. So far telemedicine has mainly been conducted between two units or with small groups of patients and there have been few large experiments, even in education. The availability of digital interactive television offers new possibilities. It could be used by patients and doctors as an information channel, and individual patients could be remotely monitored by sensors in a telecare application.

Television development

Monochrome television was first publicly broadcast in 1936 in England. Colour television was launched in 1967 in most European countries, although the underlying idea of using the three primary colours for image representation had been developed in 1904. Various analogue standards arose, the main ones being NTSC (used in the USA), SECAM and PAL (both mainly used in Europe). These standards define television pictures in terms of their colour information, refresh rate and frame size. Well defined and open standards allowed market forces to operate, which resulted in better equipment and cheaper products for the consumer. In 1998 over 90% of European households had a television set and were receiving analogue television through cable, terrestrial or satellite broadcasts. The total coverage in Europe ranged from 74% to 95% in 1998[1]. In the next few years, digital interactive television will be introduced and may represent the biggest revolution in broadcasting since the introduction of colour television[2].

Digital interactive television — system overview

A generic model for digital interactive television is illustrated in Fig 1. The user is connected to a broadcast service provider (BSP) and an interactive service provider (ISP) via a broadcasting network (unidirectional) and an interaction network (bidirectional). In the usual system the link between home, the Internet and the BSP is provided by an Internet service provider. In a home telecare system, a health-care provider offers several

Correspondence: Heikki Lamminen, Digital Media Institute, Tampere University of Technology, Hermiankatu 3 A, 33101 Tampere, Finland (*Fax: +358 3 458 7358; Email: heikki.lamminen@uta.fi*)

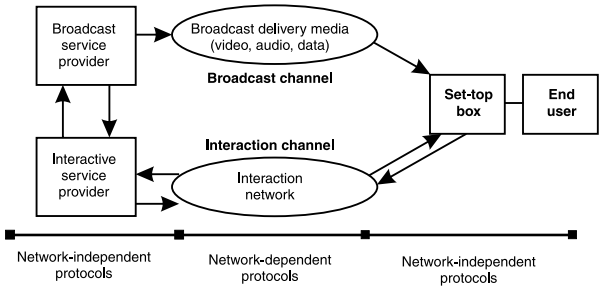

Fig 1 A generic model for digital interactive television, consisting of a broadcast service provider (BSP) and an interactive service provider (ISP) connected to the user through a broadcasting network (unidirectional) and an interaction network (bidirectional).

health-care services to the user, who is the patient to be treated.

The broadcast channel transmits video, audio and service information[3]. The responsibility of the BSP is to encode and multiplex video, audio and services into a MPEG2 data stream, for terrestrial or satellite broadcast, or transmission by cable or the Internet. The interaction channel allows interaction between the user and the ISP. Interaction channel protocols are well defined for transmission over cable, fibre optic and wireless media. IP is the basic protocol. This system allows video and audio streaming at high quality. New channels are possible by decreasing the bandwidth utilization per channel.

The set-top box (STB) consists of three major parts: the broadcast interface module is responsible for receiving and decoding the MPEG2 data; the interactive interface module is used to establish the interaction channel between the user and the ISP; and a set-top unit is the central component for receiving, decoding and outputting the broadcast data. The STB is directly connected to display hardware, such as a television screen. However, the equipment and configuration of the STB is arbitrary. It could be a PC or other dedicated hardware to which other devices can be connected. These include display screens, video-cameras, headphones, microphone for communication between the user and a third party, storage media and a chip card reader. In telecare applications, devices for obtaining and transmitting biomedical signals might be needed. As suggested by Lee *et al.*[4] these include blood pressure devices, three-channel electrocardiogram monitors, emergency service devices, and video-conferencing devices for face-to-face interactive dialogue between the patient and health-care provider.

Multimedia services

Besides basic television applications, such as television broadcasts, programme subscriptions, and pay-per-view programmes, digital interactive television allows multimedia applications. These include interactive

entertainment, digital audio, video on demand, home shopping, financial transactions, interactive single- and multi-user games, educational and instructional services, digital multimedia libraries, and electronic versions of newspapers, magazines, television programme guides and yellow pages[5]. One popular interactive service seems to be video on demand[6]. However, many others are possible and remain to be explored. All applications rely on Java with extensions such as the Application Programming Interface (API) and the Java Virtual Machine (Java VM).

A useful way of categorizing interactive services is by their use of the network channel, which represents the sum of all channels involved in the system, that is the broadcast and interaction channels. The four categories are as follows:

(1) *Enhanced broadcast applications* (EBA) have full access to the broadcast channel and are used to retrieve high-quality pictures and sound, to access new channels, to switch between camera viewpoints, for service navigation and for personalization. The last guarantees that the right people receive the information they want to obtain at the right time, and can include content filtering.
(2) *Interaction channel applications* (ICA) are Internet-based applications, based on IP as the transmission protocol, and they do not access the broadcast channel at all. Multiprotocol encapsulation allows transmission using other protocols, such as TCP, UDP and RTP. This permits all common asynchronous applications like email, database access and tools to retrieve Web content and videoconferencing.
(3) *Interactive broadcast applications* (IBA) are based on the interaction and broadcast channel and allow interactive communications, such as transactions with content, user feedback for the BSP, involvement with online teachers or medical personnel during broadcasts. Various Java extensions and interactive transport protocols, like those used in the ICAs, can be utilized.
(4) *Non-networked applications* (NNA) are stand-alone applications that do not require network connectivity. They are comparable with any applications of a stand-alone PC.

The key standard in digital interactive television applications is the Multimedia Home Platform (MHP), published by the European Telecommunications Standards Institute[7]. The MHP represents the convergence of broadcasting, telecommunication and computing technologies. The standard meets several requirements, such as equipment affordability, appropriate lifetime, interoperability and protection of privacy. Because it is an open standard, application development will be left to market forces. The MHP standard represents a composite of various others[8–12], namely MHEG-5, HAVi, MediaHighway, OpenTV and JavaTV.

The JavaTV API is a general-purpose API that allows applications to be based on a broadcast network. Besides television-specific functions it allows the management of the application life cycle, access to any broadcast services and data, conditional access, and control of the broadcast pipeline. MHEG-5 describes structures for the composition of different multimedia objects and provides a library for identifying object-coding techniques. The HAVi architecture is intended for implementation on consumer electronic devices and computing devices; it provides a set of services which facilitate interoperability and allows for the development of distributed applications on home networks[9]. OpenTV provides users with access to services and content in multiple network environments and is mainly based on XML technology to present multimedia content. MediaHighway is an interactive broadcasting system based on a virtual machine, whose architecture allows the development of hardware-independent applications in different languages, developed by the Canal+ company.

One major issue in the development of interactive television applications is the design of the user interface. It is completely different from designing a user interface for computers: the display technology is not high resolution like a computer display; colours, founts and screen layout are more restricted; user input has to be based on a simple remote-control device with a limited number of input keys; pointing, selection and navigation have to be realized with a simple remote-control device. There are different ergonomic issues and different usability evaluation and testing. Herigstad and Wichansky have published a tutorial to enable more effective user interfaces to be designed[13].

Digital television and health-care

Digital television can be used in two different ways in health-care. One is to transmit individual patient information. The other is broadcasting to multiple patients. The latter is not new. In 1978, a goal-directed television programme recommended social interventions attempted through television[14].

In another study, 17 elderly people were connected via a broadband video-communication system to a telecare centre. The service used video-phones based on domestic television sets, including set-top boxes with cameras and a microphone[15]. Service components included: remote response to emergencies; active information and care; information and assistance service; remote care on demand; remote access to expertise (counselling); training and exercise service; and support for carers. The important qualitative aspects were: clients' satisfaction; replacement of direct social contact; privacy and data protection; and improving the effectiveness of social services. For a successful market implementation of video-based social support and telecare services, it is essential to integrate them into existing outpatient services[16].

Digital interactive television can enhance home

telecare. From the technical point of view the system meets several requirements of home health-care applications, such as appropriate bandwidth utilization, secure transmission, scalability and home integration. It may also reduce the costs of health-care. For the patient it should represent an easy and cheap method of accessing health-care services in the home.

H Lamminen*† and A Lugmayr†
*Department of Ophthalmology,
Tampere University Hospital;
†Digital Media Institute,
Tampere University of Technology,
Tampere, Finland

References

1 Meyer L, Fontaine G. *Development of Digital Television in the European Union*. Reference report. Montpellier: Institut de L'audiovisuel et des télécommunications en Europe (IDATE), 2000
2 Kemm J, Close A. *Health Promotion. Theory and Practice*. London: Macmillan, 1995
3 Lugmayr A, Kalli S. Transmission of DVB service information via Internet, next generation networks: networks and services for the information society. In: Rao S, Sletta KI, eds. *Lecture Notes in Computer Science*. Berlin: Springer Verlag, 2000
4 Lee R, Chen H, Lin C, Chang K, Chen J. Home telecare system using cable television plants — an experimental field trial. *IEEE Transactions on Information Technology in Biomedicine* 2000;**4**:37–44
5 Furht B. *Interactive Television Systems*. Philadelphia: Association for Computing Machinery (ACM), 1996
6 Vecchi M. Broadband networks and services: architecture and control. *IEEE Communications Magazine* 1988;**33**:24–32
7 Available from http://webapp.etsi.org/pda
8 ISO/IEC. *DIS 13522-1. MHEG Part 1*. Geneva: International Organization for Standardization (ISO), 2000
9 HAVi Specification 1.0. Specification of the Home Audio/Video Interoperability (HAVi) Architecture. Version 1.0. San Ramon, CA: HAVi, Inc., 18 January 2000
10 MHEG-5. Canal+ MediaHighway API. http://www.canalplus-technologies.com/media/v7/html/main.htm. Last checked 29 March 2001
11 OpenTV. http://www.opentv.com. Last checked 29 March 2001
12 Calder B, Courtney J, Foote B, *et al*. *JavaTV API Technical Overview: The Java TV API Whitepaper*. Version 1.0, Release Candidate D. http://java.sun.com/products/javatv/jtv-1_0-spec_overview.pdf. Last checked 29 March 2001
13 Herigstad D, Wichansky A. *Designing User Interfaces for Television*. CHI 98 Tutorials. New York: ACM Press, 1998
14 Keegan C. Using television to reach older people with prevention messages: the over easy experiment. *Prevention in Human Services* 1982;**2**:83–91
15 Nakamura K, Takano T, Akao C. The effectiveness of videophones in home healthcare for the elderly. *Medical Care* 1999;**37**:117–25
16 Erkert T. High-quality television links for home-based support for the elderly. *Journal of Telemedicine and Telecare* 1997;**3** (suppl. 1):26–8