

World of Digital Interactive TV

2.1 Broadcast Multimedia

Broadcast multimedia is discussed here in the context of digital television standards. Europe, North America and Japan have established the basic standardization efforts for digital television. The basic technology for realizing digitalization in broadcast services is the MPEG-2 standard. MPEG-2 defines the basic concepts for the provision of digital A/V services in all the digital TV standardization efforts. MPEG-2 defines a signal compression, packetization and multiplexing standard for digital audio and video as well as rudimentary mechanisms for conveying other data in a digital A/V stream.

2.1.1 MPEG-2

The systems part of the ISO/IEC 13181 standard, which defines MPEG-2, addresses the combination of single or multiple *elementary streams (ES)* of video, audio, and other data into streams suitable for storage or transmission. The specification basically enforces syntactical and semantic rules for systems coding and establishes two stream definitions for packet-oriented multiplexes: *transport stream (TS)* and *program stream (PS)*. Both stream definitions have a specific set of application areas. The most important application area of the TS is digital TV [1].

The basic packet-oriented multiplexing approach for video, audio, and other data defined in MPEG-2 is illustrated in Fig. 2.1. Digital video and audio data is encoded into compressed MPEG-2 video and audio elementary streams as defined in the ISO/IEC 13181-2 and 13181-3, respectively. These elementary streams are packetized to produce video and audio *packetized elementary stream (PES)* packets. Private data is fed directly to the PES packetizer. PES packet streams are multiplexed to single transport or program streams depending on the application.

The program stream is designed for use in relatively error-free environments such as DVDs. On the other hand, transport stream is a stream defini-

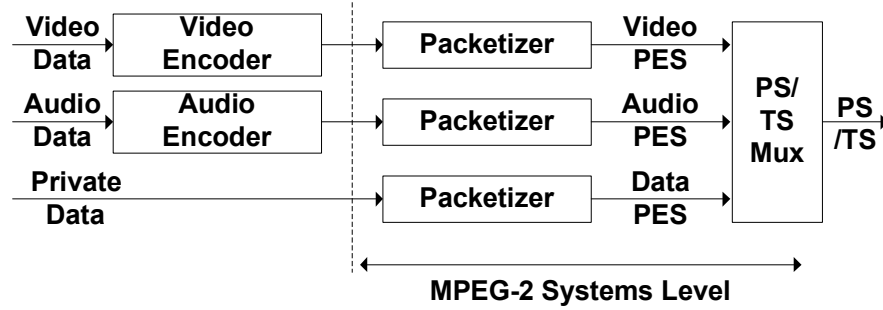


Fig. 2.1. MPEG-2 video, audio and data multiplex

tion tailored for communicating or storing streams of PES packets in error-prone environments. The errors may appear as bit value errors and loss of packets. The 188 byte transport stream packets begin with a 4 byte prefix containing a 13 bit *packet ID (PID)*. The PID identifies, via *program specific information (PSI)* tables, the elementary streams carried in the 184 byte payload of a TS packet. There are four PSI tables carried in the MPEG-2 transport stream [1]:

- *program association table (PAT)*
- *program map table (PMT)*
- *conditional access table (CAT)*
- *network information table (NIT)*

These tables contain information needed for demultiplexing and presenting programs carried in the TS at the digital TV receiver. The PSI tables are carried in the MPEG-2 TS packet payloads using the MPEG-2 sections mechanism.

Many applications of MPEG-2 require storage and retrieval of ISO/IEC 13818 streams on various *digital storage media (DSM)*. A *digital storage media command and control (DSM-CC)* protocol is specified within ISO/IEC 13818 to facilitate the control of such media [1]. The applications of the DSM-CC protocol, including the DSM-CC sections mechanism and DSM-CC data and object carousels, are described in [2]. These applications enable the conveyance of private data in MPEG-2 transport streams.

This basic service provision defined by the ISO/IEC 13818 is augmented in the respective digital TV standards through the introduction of MPEG-2 TS transmission technologies for various physical transmission media, including satellite, cable, and terrestrial systems and high-level mechanisms for broadcasting application data in the TS. The standards also define how interactive services are realized in the respective platforms including software APIs for end-user terminals and standards for the utilization of interactive media. The APIs for end-user terminals define a platform for the deployment of value-added services, with support for accessing resources from the digital

TV broadcasts and through a feedback network. The Sun Microsystems JavaTV API serves as a fundamental building block for the end-user terminal software APIs. As MPEG-2 is the basic technology for unidirectional digital TV broadcasts, an ‘all-IP’ approach is the basic networking standard for interactivity-enabled services.

2.1.2 DVB

The European *digital video broadcasting (DVB)* consortium has developed a set of standards for MPEG-2 based digital TV establishing a platform currently being adopted in most of Europe, Asia and Australia. Basically, DVB has defined a system reference architecture for digital TV. An extension of the architecture is illustrated in Fig. 2.2.

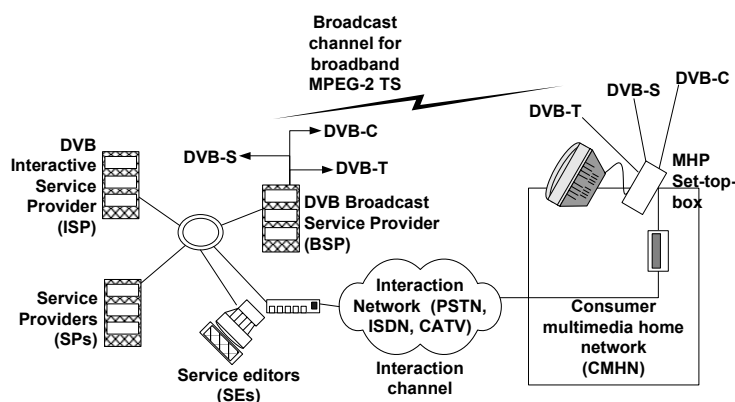


Fig. 2.2. An extended DVB system architecture (adapted from [133])

This extended DVB architecture has the following central components: a DVB broadcast service provider (BSP), a DVB *interactive service provider (ISP)*, *service providers (SPs)*, *service editors (SEs)*, a *broadcast channel*, a *feedback channel* and the *consumer multimedia home network (CMHN)*.

The BSP delivers broadband MPEG-2 transport streams over satellite, cable or terrestrial physical broadcast media to the consumer. The streams include standard MPEG-2 audio-visual content, *DVB service information (DVB-SI)* extending MPEG-2 PSI and annotating the stream contents, and value-added applications and data. The latter are transported over the TS with DVB data broadcasting. DVB enables the play-out of different profiles for *high definition television (HDTV)* or *standard definition television (SDTV)* at frame rates of 30 Hz or 25 Hz. PAL or SECAM compliant deployment requires the latter, which is the MPEG-2 *main profile at main level (MP@ML)*.

MPEG-2's bit-rates range typically from 4 Mbit/sec up to 9 Mbit/sec (CCIR-601 studio quality), at aspect ratios of 4:3, 16:9, and 2.21:1, and at luminance resolutions of 720x576, 544x576, 480x576, 352x576, or 352x288.

Service providers (SPs) create content and act as feedback network partners. A SP might be a travel agency, subcontracting an electronic ticket selling to a BSP. The BSP would multiplex advertisements into the broadcast stream, upon which the consumer could buy electronic tickets from the travel agency directly over the feedback network.

At the consumer-side the consumer multimedia home-network (CMHN) interconnects multimedia equipment in a home setting. The consumer accesses the TS services with a Multimedia Home Platform (MHP) compliant set-top-box, a standard part of the CMHN. MHP is an extension of the DVB digital TV standards for consumer set-top-boxes. It basically defines a Java API for value-added services in a digital TV set-top-box. For value-added applications implementing non-local interactivity, DVB interactive services, a feedback channel is available for two-way information exchange. The feedback channel is provided by the ISP through various wired and wireless networks. IP-based protocols are typically used in the feedback channel.

Service editors (SEs) are responsible for creating the overall services, thus implementing the applications delivered by the broadcaster. The service editor creates advertisement materials and initializes movie production among other things.

The DVB system reference architecture (including the BSP, ISP, the consumer STB and the broadcast and feedback channels) relies on the following key standards:

- MPEG-2 TS transmission technology standards for different physical broadcast media
- DVB-SI service information standards augmenting the standard MPEG-2 PSI information
- DVB data broadcasting standards based on MPEG-2 and the DSM-CC protocol
- DVB interactive service standards including DVB feedback channel standards for network independent and network dependant protocols
- Miscellaneous other standards

DVB has defined standards for the transmission of MPEG-2 transport streams in three physical broadcast media: satellite (DVB-S), cable (DVB-C) and terrestrial (DVB-T). The standards share many common technical elements enabling a high integration level for digital TV broadcasting and receiver equipment. However, due to the dissimilarities of the physical media, different signal modulation techniques are used resulting in different transmission capacities. DVB-S for satellite systems is the oldest and most widely used of the standards utilizing QPSK (Quadrature Phase-Shift Keying) modulation. DVB-C for cable systems is similar to DVB-S but uses QAM (Quadrature Amplitude Modulation) modulation. DVB-T for terrestrial digital TV utilizes

yet another modulation technique known as COFDM (Coded Orthogonal Frequency Division Multiplexing).

DVB-SI [5] augments the standard MPEG-2 PSI with additional service information tables. These tables enable the identification of audio-visual and value-added services and events in a DVB streams. In contrast to the MPEG-2 PSI tables, DVB-SI tables can contain information about services in other multiplexes (or even networks) than they are contained in. As for PSI tables, the DVB-SI tables are segmented to sections before insertion into TS packets of the multiplex.

DVB data broadcasting [3] is an extension of MPEG-2-based DVB transmission standards. This extension provides ways to transport data other than standard MPEG-2 A/V data in DVB broadcast systems. Examples of data broadcasting include the download of software or the delivery of Internet services over a broadcast link. Four data broadcasting profiles are described within the standard based on the corresponding application areas with varying requirements for data transport:

- *data piping*: a simple and asynchronous mechanism for the end-to-end delivery of data in DVB broadcasts. Data is carried directly in the payloads of the MPEG-2 TS packets.
- *data streaming*: a mechanism for streaming-oriented end-to-end delivery of data in DVB broadcasts. Data is carried in MPEG-2 PES packets. Synchronization is also possible.
- *Multiprotocol encapsulation*: a mechanism for the transmission of datagrams of communication protocols (e.g. TCP/IP) via DVB broadcasts. Datagrams are encapsulated in DSM-CC sections compliant with the MPEG-2 private sections format.
- *data carousels*: a mechanism for the periodic transmission of data modules in DVB broadcasts. The data carousel mechanism enables the update, removal and addition of modules to the data carousel. The DVB data carousel mechanism is based on the DSM-CC data carousel.
- *object carousels*: a mechanism for the periodic broadcasting of DSM-CC user-user objects in DVB broadcasts. The mechanism is based on the DSM-CC data carousel and DSM-CC object carousel mechanisms defined in MPEG-2 DSM-CC.

DVB specifies a number of network independent protocols for DVB interactive services and defines guidelines for their implementation and usage in [8] and [66], respectively. The DVB feedback channel allows the upstream flow of data from the users to the interactive service provider. Network dependant protocols for various physical feedback channel media are defined separately, e.g., for PSTN/ISDN in [7] and for CATV in [6]. The network independent protocols accessible in the feedback channel are either IP-based, MPEG-2 DSM-CC-based or service specific. Network independent protocols in broadcast channel for interactive services rely on the DVB data broadcasting standards.

In addition to the key standards introduced earlier, DVB digital TV standardization covers also DVB subtitling [65] and provision of standard ITU teletext services in DVB bit streams [64].

2.1.3 MHP

The *multimedia home platform (MHP)* adds a technical solution for the consumer receiver or STB enabling the reception and presentation of applications in an open and vendor, author and broadcaster neutral framework. Applications from various service providers will be interoperable with different MHP implementations in a horizontal market, where applications, networks and MHP terminals can be made available by independent providers [67]. In practice, MHP defines a Java-based STB API for value-added services in DVB broadcast systems. It relies on the DVB digital TV system reference model with standardized broadcast and feedback channels.

MHP covers three profiles: *enhanced broadcasting*, *interactive broadcasting* and *internet access*. Enhanced broadcasting combines digital broadcast of audio/video services with downloaded applications that may use local interactivity. A feedback channel is not required in this profile. Interactive broadcasting enables a range of interactive services associated with or independent from broadcast services. This application area requires a feedback channel. Internet access is intended for the provision of Internet services. It also includes links between Internet services and broadcast services [67].

MHP Receiver

A layer model for an MHP receiver or set-top-box, combining software and hardware components, is illustrated in Fig. 2.3.

The blocks on the right-hand side of the figure describe access to and use of basic digital TV A/V broadcast services (i.e. viewing different TV channels) of the MHP receiver. An MHP receiver includes as a standard feature a navigator application for selecting and tuning digital TV A/V services which may include interactive value-added services.

The layer model for value-added MHP applications is shown through the blocks on the left-hand side of the figure. Interactive application code and data is typically transported to the receiver through the DVB data broadcast DSM-CC object carousel mechanism over the broadcast MPEG-2 TS. The application code and data can also be uploaded over the interactive channel. An MHP receiver can support two types of interactive applications controlled by its application manager:

- Procedural DVB-J applications
- Declarative DVB-HTML applications.

DVB-J is an adaptation of the Sun Microsystems' Java programming language and J2SE API to MHP receivers. DVB-J defines a DVB-J application model and a DVB-J platform.

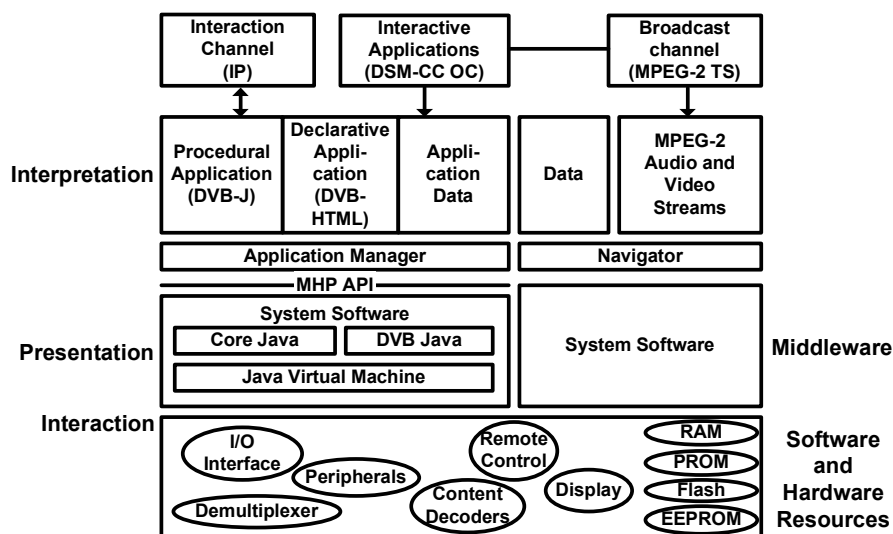


Fig. 2.3. MHP compliant receiver architecture

The DVB-J application model defines a life-cycle and signaling model for DVB-J applications. The application model is based on the JavaTV API. The life-cycle control of a DVB-J application is based either on user interaction or on MHP application signaling carried in the broadcast *application information table (AIT)*. AIT is an extension of the DVB-SI to provide support for interactive value-added applications.

A DVB-J application is executed in the Java virtual machine, which is a standard part of system software of an MHP receiver. The DVB-J platform consists of multiple APIs some of which are part of the standard J2SE API (Core Java) and which are specific to MHP (DVB Java).

The Core Java APIs include a subset of standard Java AWT graphical user interface classes and interfaces and other packages from J2SE such as networking and standard I/O services. Additional TV oriented GUI components are depicted in the HAVi and JavaTV APIs. Components for playing streamed media are taken from the Java Media Framework API. Other classes and interfaces from the DAVIC and JavaTV APIs provide access to the DVB data broadcasting resources (e.g. DSM-CC object carousel file systems) and DVB-SI information. The DAVIC API also enables the tuning of digital TV services from DVB-J applications. The platform also includes other APIs for such matters as *conditional access (CA)* control.

The declarative DVB-HTML application is basically a set of DVB-HTML compliant HTML documents and content objects. DVB-HTML applications can be considered an adaptation of the World Wide Web to digital TV. MHP

defines an application, life-cycle, and signaling model for DVB-HTML applications similar to those of DVB-J applications.¹

The system software for both standard digital TV A/V services and interactive value-added applications relies on the hardware and software resources available in an MHP receiver. These resources include the physical broadcast and feedback channels, other I/O interfaces and local hardware for data storage, processing and display. Some of these components are illustrated in Fig. 2.3. Different MHP profiles and options enable the delivery to hardware platforms ranging from 30 MHz, 1–2 MB RAM and 1–2 MB Flash/ROM up to high-end devices [141].

2.1.4 Emerging DVB Standardization Efforts

As digital convergence breaks boundaries between the various digital media platforms, the DVB consortium is currently pursuing ways to bring the digital TV experience to a wider range of consumer devices.

May 2001 was the starting point for envisioning the future of DVB and its related standards. A strategy was developed to adapt DVB standards for the challenges of this century. The initiative is known as DVB 2.0 and its key-points are: *further development of existing DVB standards, digital convergence, mapping of migration paths and globalization of DVB* [134].

Two specific action points related to DVB 2.0 are the *Globally Executable MHP (GEM)* specification and DVB-H.

GEM is a specification that harmonizes existing interactive digital TV initiatives under the umbrella of MHP. It seeks to make MHP a global and universal standard for interactive digital TV [71].

The DVB-H ('H' for hand-held) standard seeks to provide access to broadband digital TV services from various mobile platforms. Digital TV on mobile platforms provides a possibility for broadcasters to reach their customers time and location independently while it enables mobile operators to implement data broadcast services in mobile service provision. For consumer the availability of all modalities of digital communication in a hand-held device is a big step towards digital convergence.

2.1.5 ATSC-DASE and Open Cable

The *Advanced Television Systems Committee (ATSC)* is the digital TV standard of choice for North America and South Korea. A U.S organization, ATSC defines standards for terrestrial and cable digital TV broadcasting. Similarly to DVB, MPEG-2 is utilized for video encoding. However, non-MPEG encoding is used for digital audio. Also, the used signal modulation techniques differ from those of DVB. As in DVB, ATSC supports such methodologies as

¹ It is important to note, that in current MHP compliant consumer device implementations, the whole DVB-HTML application environment is not supported.

data broadcasting. DASE or DTV Application Software Environment is similar to MHP in providing a platform for interactive value-added application on ATSC digital TV receivers. DASE is similar to MHP in its structure and implementation.

OpenCable is another US standard for digital cable TV. It includes both a hardware specification for physical cable digital TV receivers and a software specification. The software specification known as *OpenCable applications platform* or OCAP creates a common platform upon which interactive services can be deployed. The current versions of OCAP have adopted parts of the MHP specification. Furthermore, the harmonization of DASE and OCAP is an ongoing process. The OpenCable initiative is managed by Cable Television Laboratories, Inc (CableLabs) which is a US-based nonprofit research and development consortium.

Version 1.0 of OCAP was published in December of 2001. OCAP is basically a software middleware layer providing access to operating system and hardware resources of an OpenCable digital TV host device (see Fig. 2.4). The primary business objective of OCAP is the introduction of a hardware and operating system agnostic interface for interactive digital TV application development for US cable TV market. OCAP enables service and application portability between different OpenCable manufacturers' digital TV consumer devices and hopes to accelerate the development and deployment of interactive digital TV services in the US.

OCAP 1.0 includes a Java-based *execution engine (EE)* for interactive digital TV services and is similar to the MHP efforts of the European DVB consortium. In fact, OCAP 1.0 is built heavily on the DVB-MHP specifications with several OCAP specific extensions.

OCAP 2.0 released in April 2002 includes a *presentation engine (PE)* which includes an HMTL and ECMAScript engine for interactive hypertext-based applications. It also includes a bridge between the EE and PE for sharing programming environment resources between the engines.

2.1.6 ISDB-BML

Integrated services digital broadcasting (ISDB) has been adopted in Japan as the national digital TV standard. It includes specifications for satellite, terrestrial and cable digital TV systems. As for DVB, video and audio encoding is based on MPEG-2. However, the signal modulation techniques for the supported physical broadcast media differ again from those of DVB. The Japanese digital TV standard for interactive service provision is BML, which is basically an XML-based broadcast multimedia coding scheme and is similar in functionality to DVB-HTML.

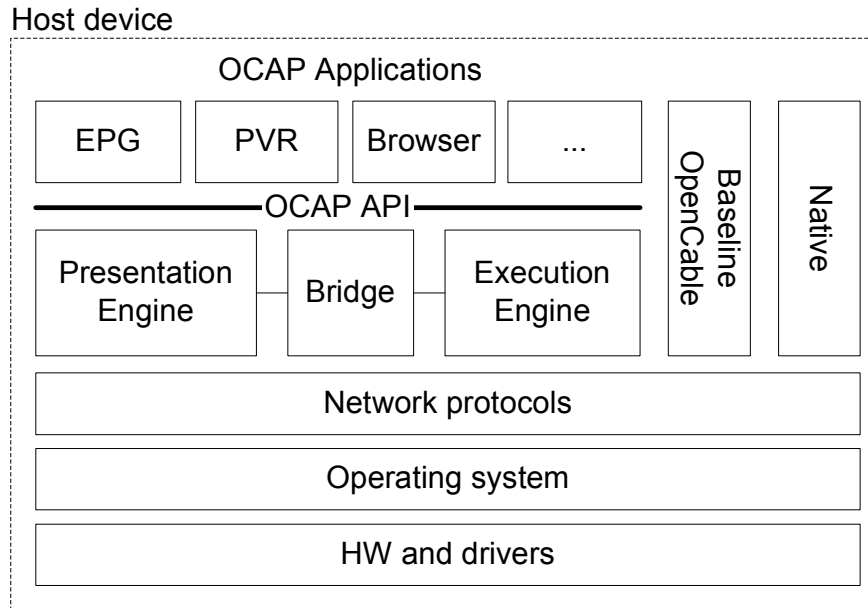


Fig. 2.4. The OCAP host device software architecture (adapted from a figure in “OpenCable Overview” presentation available at www.opencable.com)

2.1.7 Adoption of the Standards

Figure 2.5 illustrates the adoption of the various digital TV standards world-wide in the spring of 2003. As evident DVB-MHP is the most widely adopted standard.

2.2 Digital TV Asset Life-Cycle

A common digital TV asset life-cycle is illustrated in Fig. 2.6.² Its structure corresponds to the asset life-cycle of a generic networked multimedia asset life-cycle consisting of five parts:

- pre-production
- production
- post-production
- delivery
- consumption

² Andreas Mauthe and Oliver Morgan have used this figure in various presentations and publications.

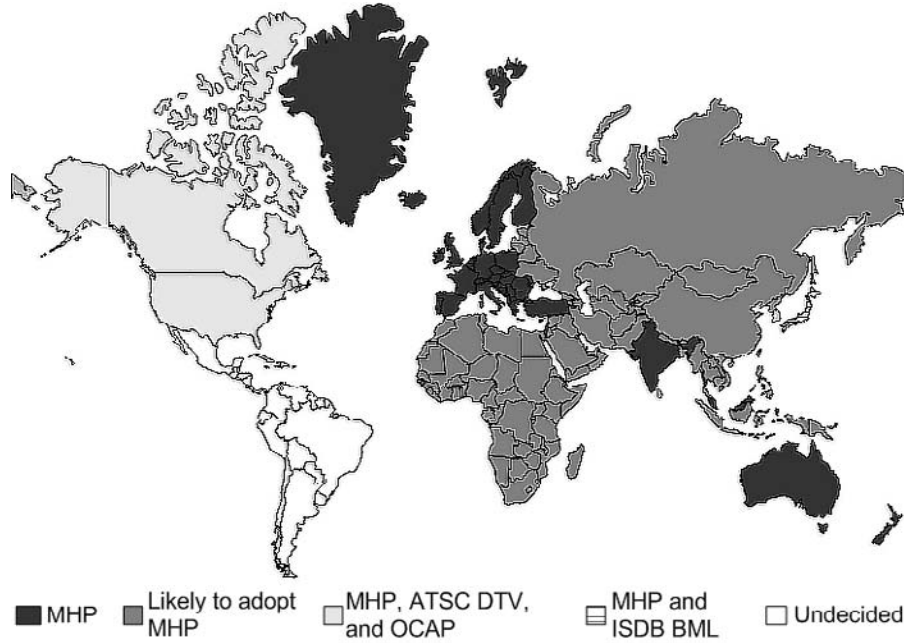


Fig. 2.5. Adoption of digital TV standards according to the DVB consortium [56]

- interaction and transaction

We consider the asset life-cycle here in the context of a DVB-MHP digital TV where each part consists of actions needed to produce the generic service type: a digital A/V service combining value-added applications.

In the pre-production part the target service is defined and its product cycle is defined. Production part consists of the capture the digital A/V content (i.e. the TV program) and development of value-added applications (i.e. MHP value-added applications) bound to it. In post-production the captured digital A/V content is edited to its final form. In delivery, the finalized A/V content and the value-added applications are combined to a standard broadcast form, an MPEG-2 TS, for play-out in DVB-MHP digital TV system using the facilities of the DVB broadcast service provider or BSP. The service is delivered to the consumers' MHP set-top-boxes via a broadcast network. In the delivery stage the facilities of the ISP are also set up to provide full functionality for services implementing non-local interactivity. Consumption is the stage where the consumer uses the developed service in different interaction modalities depending on the service type.

Service provision can be roughly divided into three basic business transaction scenarios within the asset life-cycle:

- *business-to-business (B2B)*
- *service provider-to-service provider (S2S)*

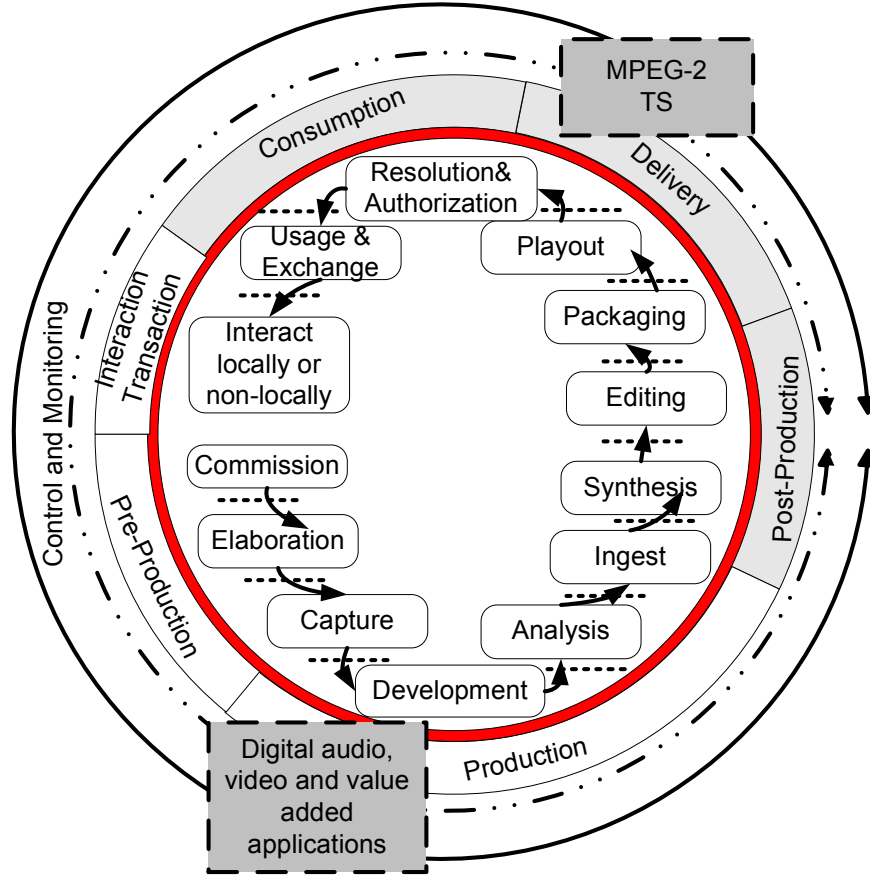


Fig. 2.6. Digital TV asset life-cycle (adopted from Andreas Mauthe and Oliver Morgan)

- *Business-to-consumer (B2C)*

In business-to-business (B2B) service provision the transaction is between two or more commercial entities. The entities have established a media service provision model within a digital TV system with the digital TV service providers realizing the technological solutions for the model. An example of B2B service provision in digital TV is a scenario where a digital content producer provides content for value-added services to be included in standard broadcast services.

In service provider-to-service provider (S2S) provision the transaction is between two or more digital TV service providers (i.e. ISPs and BSPs). An example of such a scenario is an agreement between a broadcaster and an in-

teractive service provider to establish standard feedback channel functionality for digital TV services of the broadcaster.

The business-to-consumer (B2C) business transition is the scenario directly visible to the end-user. Here, a commercial entity and a consumer agree on a service to be provided to the consumer through digital television. Examples of such service include shopping, banking and health care services.

2.3 Examples of Digital TV Value-Added Services

Apart from the standard MPEG-2 audio-visual TV programming services, DVB-MHP compliant digital TV enables a range of value-added services. These services can fully utilize the rich content provision and interaction capabilities of the platform enabling truly innovative networked multimedia services.

2.3.1 Electronic Program Guide (EPG)

EPG or electronic program guide is the basic digital TV service including information about available TV programming. In conventional analog television EPG information is carried within the teletext services. In digital TV EPGs are directly based on the service information (SI) carried in the broadcast stream describing the available TV services. EPGs typically include service tuning functionality and simple content filtering based on e.g. program genre (see Fig. 2.7).

2.3.2 Information Portal

Conventional teletext services providing access to program information, news and other assorted simple text-based services have been the most popular value-added service in conventional analog television. Digital television helps to realize the next evolutionary step for teletext services with the introduction of information portal services also known as super teletext services. Realized as value-added applications information portal services provide significant improvements compared to conventional analog TV teletext. These include the availability of high-resolution graphics, improved formatting capabilities and a larger bandwidth available for carrying teletext data. In short, these services bring basic hypermedia capability to television. Typical contents of the information portal services include news(see Fig. 2.8), weather information and other simple hypermedia services.

2.3.3 Pay-per-View (PpV)

In PpV services the consumer purchases the rights to a one-time view of a particular piece of digital TV A/V content (e.g. a sports broadcast). Use of

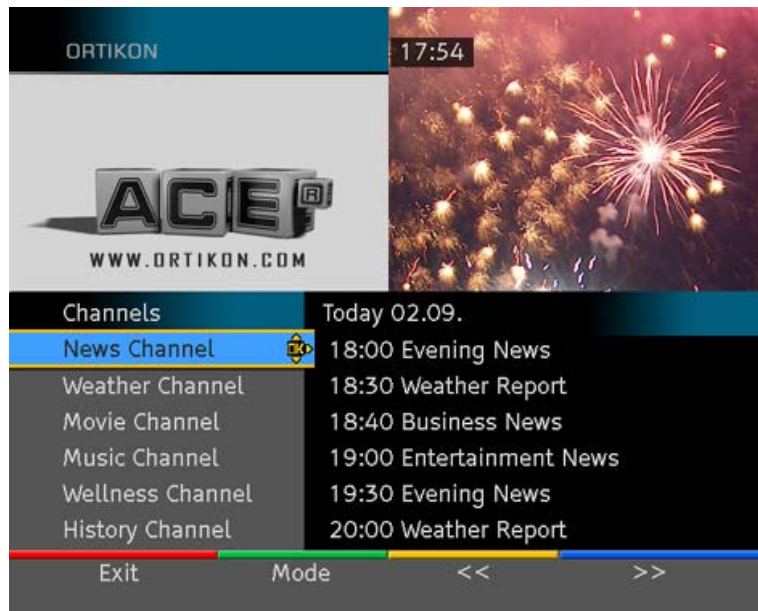


Fig. 2.7. Screenshot of a typical EPG (© Ortikon Interactive Ltd.)

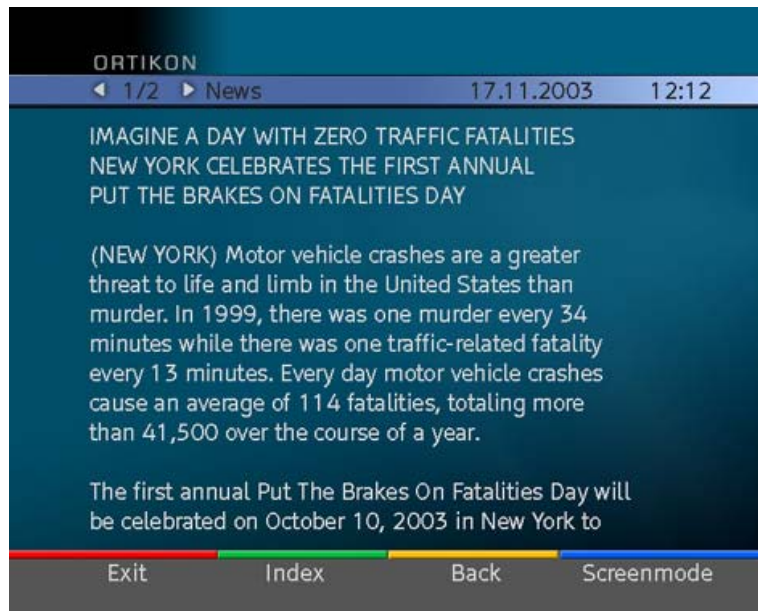


Fig. 2.8. Screen shot of a digital TV news service (© Ortikon Interactive Ltd.)

Pay-per-View within a digital TV system necessitates the use of a conditional access (CA) system for handling viewing authorization.

2.3.4 Video-on-Demand (VoD)

VoD enables consumers to order and view a particular piece of A/V content (e.g. a motion picture) with instant availability. VoD service provision requires the use of a high-bandwidth channel to transfer the content to the consumer receiver.

2.3.5 Education

Educational digital TV services range from traditional educational TV programming to interactive value-added services operating either in an independent context or in combination with a A/V service. Scenarios such as enhanced distance learning and education can be easily established within digital TV. With the use of a feedback channel a direct link between the tutored and the educator can be established.

2.3.6 Shopping

Digital TV provides an excellent media to realize online shopping services where A/V content about products is combined with value-added services enabling their direct purchase. Basically, digital TV shopping enables, with a feedback channel available, full integration of TV shopping to the TV viewing experience. See Fig. 2.9 and Fig. 2.10.

2.3.7 Games

Simple computer games are easily implemented as digital TV value-added services (see Fig. 2.11 for an example of game service in digital TV).

2.3.8 Standard Internet Services

Digital TV value-added services can provide an interface to such standard Internet services as e-mail and limited web browsing. See Fig. 2.13.

2.3.9 Communication

Services integrating current mobile messaging technologies such as text-based SMS and MMS multimedia messages to the digital TV platform can be realized. The consumer can send and receive these messages with a digital TV receiver. Both private two-way messaging and interactive message forums in a community setting are possible. See Fig. 2.12.



Fig. 2.9. Shopping in digital TV with shopping carts (© Ortikon Interactive Ltd.)

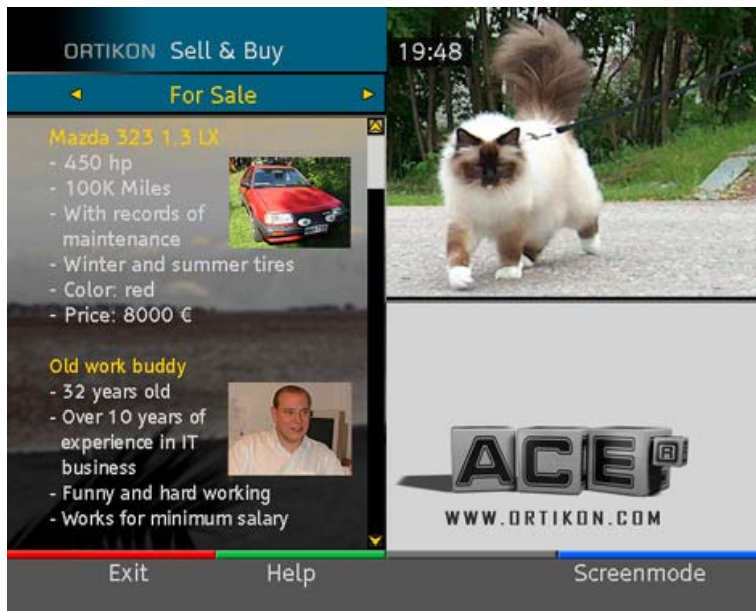


Fig. 2.10. Shopping in digital TV may involve both professional eShops and services for consumers to sell private goods (© Ortikon Interactive Ltd.)

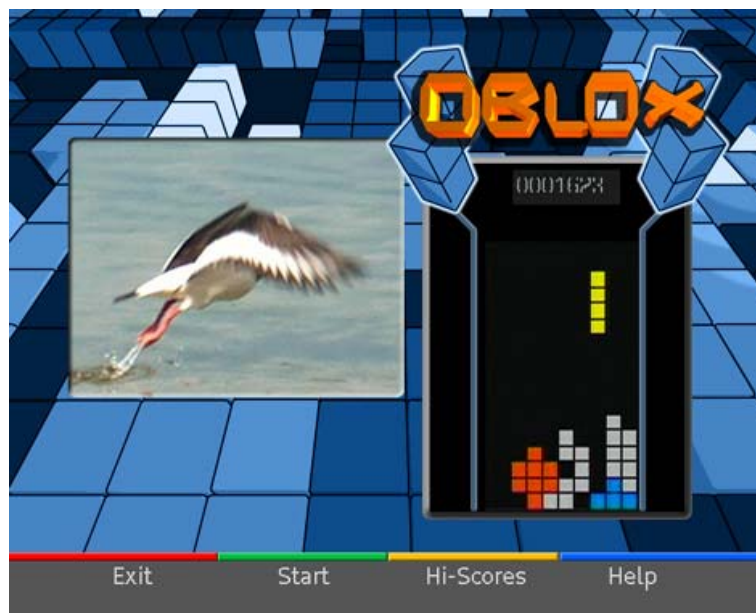


Fig. 2.11. Screen shot of a Tetris-like game in digital TV (© Ortikon Interactive Ltd.)

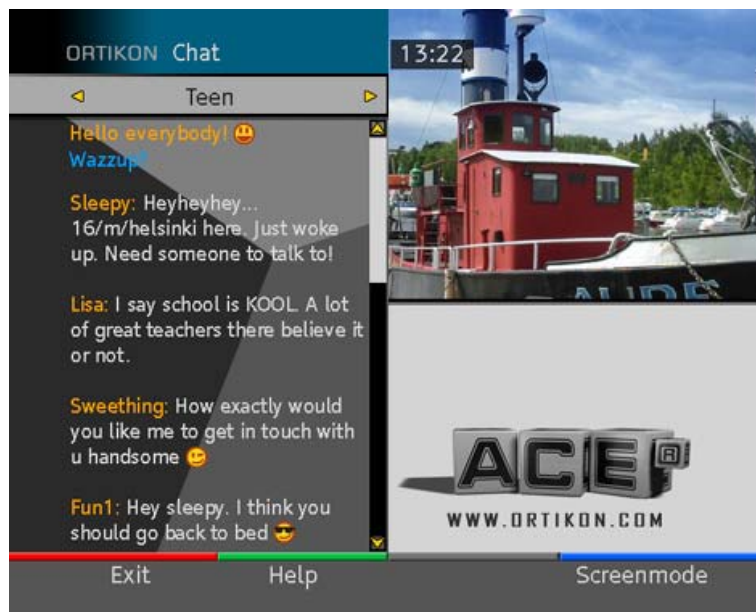


Fig. 2.12. A typical chatting service in digital TV (© Ortikon Interactive Ltd.)

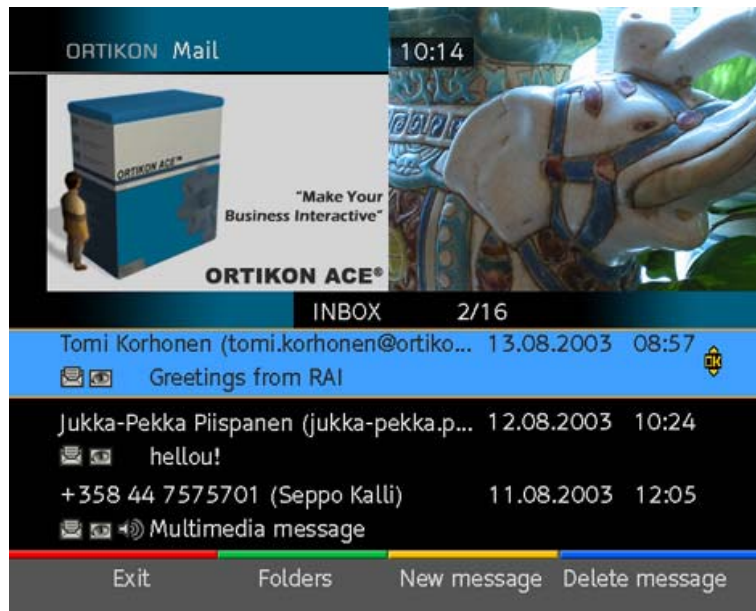


Fig. 2.13. Screenshot of an e-mail service in digital TV (© Ortikon Interactive Ltd.)

2.3.10 Community Services

Community services help building virtual communities in digital TV with the introduction of value-added services built for specific consumer groups with shared interests. They typically combine information portal and messaging services providing an avenue for specific audiences to observe value-added multimedia content relevant to their interests and to communicate with similarly oriented peers. See Fig. 2.14 for an example of a community service in digital TV.³

2.3.11 Government

Various governmental services currently available on the Internet can be similarly realized in digital television. These include online tax and voting services.

2.3.12 Health

In health care digital TV enables numerous innovative service schemes ranging from traditional health related TV programs enhanced with interactive value-

³ The concept of Sooda has been developed by Zento Interactive Ltd., Tampere, Finland. We would like to thank for providing the related materials and screenshots.



Fig. 2.14. Sooda is an online community service for young people in the age group 12 to 19 (concept developed by Zento Interactive Ltd.. of Tampere, Finland, www.sooda.com, © Zento Interactive Ltd.).

added services to the use of a digital TV receiver as a terminal for telecare applications (see Fig. 2.15). Typical telecare applications include the exchange of information related to follow-up of various health conditions through digital television utilizing the feedback channel.⁴

2.3.13 Finance and Banking

Simple account management and brokering services are easy to implement within digital TV. The services can provide access to bank account data and a possibility for making various financial transactions similarly to Internet banking.

⁴ The concept of health-care-TV has been developed by Terivan Ltd., Tampere, Finland (<http://www.terivan.com>). We would like to thank for providing the related materials and screenshots.

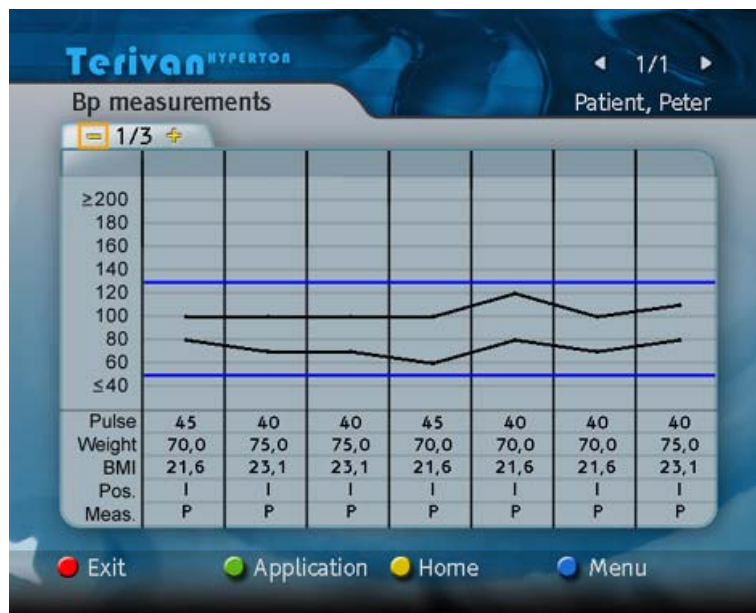


Fig. 2.15. Blood pressure monitoring in digital TV (concept developed by Terivan Ltd. of Tampere, Finland, <http://www.terivan.com>, © Terivan Ltd.)

Digital Interactive TV and Metadata

Future Broadcast Multimedia

Lugmayr, A.; Niiranen, S.; Kalli, S.

2004, XV, 258 p. 79 illus., 9 illus. in color., Hardcover

ISBN: 978-0-387-20843-5