REPORT ITU-R BT.2049

Broadcasting of multimedia and data applications for mobile reception

(Question ITU-R 45/6)

(2004)

Appendix 1 – Launching of digital terrestrial sound broadcasting services in Japan.

Appendix 2 – Experiments of terrestrial digital multimedia broadcasting services in Korea.

Appendix 3 – IPDC[1]/DVB-H[2] technology details, trials/pilots on mobile broadcasting.

Appendix 4 – Terrestrial Mobile Multimedia Multicast (TMMM[3]) technology overview.

Appendix 5 – Implementation of interactivity.

1 Introduction

The analogue-to-digital switchover of terrestrial broadcasting services is under way in all ITU Regions. Some countries have not yet taken a decision when to start, whilst other countries have already passed the 50% penetration level of digital TV reception within the household segment.

The development of in-vehicle entertainment systems based on stored content such as games, music and movies is about to reach its state of technology maturity.

IMT-2000 network offerings have begun to include on-demand streaming to handsets of TV-news, sports etc., and specifications within 3GPP/3GPP2 are well under way to include an optimized transport mechanism[4] for consumption of multimedia content via the IMT-2000 Node B network and associated mobile radio spectrum in multicast mode.

The gap still not addressed at ITU level is the predicted large segment of digital broadcasting to handheld terminals via broadcast spectrum in a mobile environment including in-door, in-vehicle and in-transit reception at speeds matching at least IMT-2000 characteristics.

Broadcasting of multimedia and data applications to mobile devices will also elaborate the expanded service opportunities offered by the inclusion of interactivity through the application of wireless networks such as those of the IMT-2000 family.

These developments form the major background for Question ITU-R 45/6 with its request for a global view on this new market, which is about to emerge around a few major regional standards/specifications.

This Report is a first attempt to answer Question ITU-R 45/6 on broadcasting multimedia and data applications for mobile reception. It identifies a number of application and system requirements for broadcasting of multimedia and data applications for mobile reception that encompass types of mobile receivers, the system characteristics, possible data transmission mechanisms, content

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[1] IP Datacast (IPDC) specification is under development stage in DVB.

[2] DVB-H specification has been approved as ETSI EN-302 304 (10/04).

[3] TMMM is in the early stage of standardization and will be referred to as Terrestrial Mobile Multimedia Multicast.

[4] 3GPP MBMS (Multimedia Broadcast Multicast Service); 3GPP2 BCMCS (Broadcast/Multicast Services).

formats, interoperability between telecommunication services and digital broadcasting services, and display patterns. It is recognized that these high-level application and system requirements may be met by a number of different technologies and communications platforms.

2 User requirements

Specific user requirements in the case of mobile reception of broadcasting multimedia and data arise because of the differences in receiving terminals and usage scenarios. In the following, specific user requirements are highlighted.

2.1 Types of receiving terminals

Currently the terminals used for the stationary reception of broadcasting signals are either fixed or nomadic. Fixed terminals are, for example, television sets, set-top-boxes, desktop PCs, etc. Nomadic terminals are devices that may be transferred from place to place but the reception is meant to be stationary. In the mobile reception there are two main types of terminals: handheld or mounted in a vehicle. Especially in the case of handheld devices the user requirements are very much different from the stationary case. The handheld devices have lower computing power, smaller screens, different user interface, smaller antenna, and limited battery for operation.

2.2 Types of usage scenarios

In the stationary reception the terminal and the user do not move, whilst in the mobile reception, both move.

Case 1: Neither user nor terminal move (nomadic case).

Case 2: User moves and carries the terminal (pedestrian case).

Case 3: Terminal and user are moved by a vehicle (vehicular case).

These three cases of mobility imply possible different usage scenarios, and consequently different end-user requirements.

2.3 Service requirements from ISDB[5] family use cases

Requirements for ISDB family, which has the plan to provide digital terrestrial sound broadcasting services, are shown at first. The following items are derived from typical service applications in this class of broadcasting system.

Item 1: For mobile receivers, informative contents will be provided by using streaming sound and associated data. There are three typical cases in this class. The first one is informative contents which provide practical and useful information of a specific geometric area or areas. The second one is broadcasting of traffic information including road traffic data and public transportation information. The third one is local news.

Item 2: A streaming image (less than 15 frames/s in this case) is a distinctive programme in this broadcasting service. Two applications are considered, i.e. music programmes and live sport programmes. It is necessary to use medium-speed bit streaming, such as a few hundred bits per second, in order to broadcast a streaming image with associated sound and data. Because total bit rate per one terrestrial sound broadcasting service when using one frequency segment (500 kHz bandwidth) with most powerful error-correcting capabilities is

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[5] ISDB family includes System C of Recommendation ITU-R BT.1306, System F of Recommendation ITU-R BS.1114 and IDSB-S of Recommendation ITU-R BO.1408.

about 280 kbit/s, this type of digital sound broadcasting systems can provide only one streaming image.

Item 3: For vehicular receivers, there are two major services. The first one is providing informative programme contents such as location-oriented information. The second one is real surround stereo sound services because car audio systems could provide real surround stereo sound effects more easily than home audio systems.

Iem : For the fixed receivers, high-fidelity music programmes and informative contents are provided.

Analysing these requirements in the above, multimedia and data applications are very important even for audiences and/or viewers using mobile receivers. The requirements in this class are about the same as those for fixed receiver case while there are a few specifically different requirements between the mobile case and the fixed case. Multimedia and data applications for mobile reception would be a subset of those for fixed reception, however there are a few additional extensions designated specifically for mobile receptions.

Furthermore, these observations are almost true for the digital satellite sound broadcasting (BSS (sound)) system in Japan. Of course there are several differences in detailed parts between them due to the differences of their service areas, regional or national. However, we observe that the baseline requirements for broadcasting of multimedia and data applications are almost the same between them.

2.4 Service requirements for DVB-H use cases

IP Datacast over DVB-H (Digital Video Broadcast – Handheld) is an end-to-end content delivery system consisting of a terrestrial DVB-H broadcast part and a bidirectional mobile cellular (2G/3G) part.

The service requirements (in the European market) for broadcast of digital content to mobile handheld devices are dominantly driven by the idea to deploy synergies with the broadcast and mobile cellular networks. The broadcast channel is best suited for delivery of several parallel[6], (real-time) scheduled services (e.g. TV channels) for large audiences in wide area coverage. Cellular channel can be best utilized for personalized point-to-point services and offering the interactivity between the consumer and the IPDC system. The complementary nature of the system is also a basis for more versatile and new services that would not be possible without this synergy. Expected services for IPDC grow from the existing broadcast offering (TV programmes) towards more versatile interactive services.

The purpose of a typical terminal for the IPDC/DVB-H system is to combine digital multimedia broadcast receiving capability into mobile phone terminals. Mobile phone terminals have many physical limitations. Taking into consideration the situation of handheld terminals, service requirements for this system are provided below.

2.4.1 The Electronic Service Guide (ESG)

In the mobile environment it is especially important for the user to be able to navigate through the various broadcast service offerings in an easy and formalized way. The Electronic Service Guide (ESG) contains information of the available services and how those can be accessed. The concept of

[6] The system's capability to provide multiple service (TV) channels in parallel is based on the lower bandwidth requirements of small screen size terminals per service channel compared to large screen TV. For example, a DVB-H broadcast carrier with capacity of 10 Mbps could deliver 50 TV channels of 200 kbps each for mobile broadcast reception.

the ESG has been found to be a well-accepted way for the user on the move to discover, select, and purchase the broadcasted services he/she is interested in.

2.4.2 Mobile TV

Mobile TV services consist of traditional TV programmes or TV-like programmes. TV type of services presented to mobile handheld devices with small screens is predicted to be designed different from content offered to large screen receiving terminals in a stationary broadcasting environment.

Instead of users watching a two-hour movie on the smaller screen of a handheld terminal, a more typical usage scenario would be to watch news flashes, sports features, music videos, weather forecasts, stock exchange reports and other such content, which is suitable for "ad hoc" consumption during smaller time slots.

The mobile TV programmes may be supplemented by auxiliary data associated with the basic service. Such information could be part of the broadcast or can be accessed on demand via the interactivity link, which is described in § 2.9.1.

The additional background information may include links to the service provider's web pages, video clips, sound tracks, games, etc.

2.4.3 Enhanced mobile TV

Online TV shopping, chat, gaming and quiz plus voting are examples of functionalities, which may be introduced as enhancements to the mobile TV to allow a true interactive mobile broadcasting experience.

2.4.4 Scheduled download of audiovisual content or executable software modules

Within this category of services, the terminal receives and stores scheduled (information via the ESG) downloads of media files or any other kind of digital data files for later consumption (video clips, newspapers, games, maps, etc.). Broadcasting offers an efficient way to deliver such downloads to a large audience throughout a wider area.

2.4.5 Service purchase, service access and content protection

Some stationary broadcast systems today offer pay-per-view facilities. A fundamental requirement foreseen for the mobile broadcasting segment is that the system has to support purchase and charging of broadcasted content.

Both subscription and pay-per-view-type online purchase models for services are foreseen to become more lucrative than consumption of free-to-air content only.

Service purchase and delivery of service access rights may in a simple way be realized by the applied mobile telephone two-way connection. Standardized service access and content protection is a prerequisite to obtain inter-operable solutions and for users to access payable broadcast services also in the case of global roaming.

2.4.6 Roaming

A user requirement associated with the mobile environment only is the ability to access services even outside the home network, and the solution to this is to establish mechanisms that allow users to access broadcast content even outside national or regional territory.

Roaming has proven to be maybe the most important of all basic mobile system characteristics. The swift implementation of roaming within mobile telephone networks has in the past proven to be a major contributor to the overall success of mobile telephony worldwide.

In this context, the mobile broadcasting service offerings will be no exception. Mobile broadcasting networks will have to offer ways to support mobile broadcasting terminals outside their primary service areas.

It seems obvious that the application of roaming capable mobile telephony technologies within mobile broadcasting systems may bring broadcast roaming to a reality at a much faster pace.

2.4.7 Interference free reception in the mobile environment

Having been experiencing for many years the quality of service (QoS) of stationary (analogue) terrestrial broadcasting, future users of mobile broadcasting services will not only demand a higher level of QoS (clearer TV pictures, higher sound quality) but also demand, that this is sustained in the mobile environment, where multipath-reflections and Doppler-shifts introduce substantial BER in the broadcasted data stream.

Here it is important to note, that these systems will not only be used to receive broadcast content in the traditional sense, but also be capable of offering error free downloads of purchased source code and even executable code, which of course has to reach the target clients uncorrupted.

The practical implementation of mitigating such interference is not trivial, but has already found different solutions in some of the new standards/specifications emerging.

2.4.8 Long battery lives

Compared to stationary reception of broadcasting, the mobile broadcast receiver is introducing this new user requirement, which can only be met, if the broadcasting link system allows for low power consumption of the receiving handheld terminals.

This has been taken into account through different means in some of the standards/specifications, which have already been elaborated on a regional/national basis.

2.4.9 Implementation of interactivity

An interactive environment for users of mobile services has today become a basic requirement.

Short message services form part of major core digital mobile standards and email facilities along with web browsing are found even in legacy handheld mobile telephone terminals.

Such facilities cannot easily be made available to users of stationary terrestrial broadcasting receivers until the terrestrial radio broadcasting delivery networks have been digitized along with stationary receivers.

It is therefore natural for the mobile user community to expect interactivity as a basic characteristic of future mobile broadcasting services, an expectation that several ongoing trials have confirmed.

2.4.9.1 Digital mobile telephony

As the major part of the world standards of digital mobile telephony including IMT-2000 offer two-way data services, one approach to implement interactivity seem to be the incorporation of such mobile technology in the user terminals.

Apart from offering the user all state-of-the-art mobile telephone services, this way of implementation of interactivity with the broadcasting service offerings provide immediately a reliable control link for all such broadcasting services. It allows the user to respond and interact with the broadcasting system and to receive control codes through a secure environment.

This approach may also take advantage of the global roaming characteristics of many mobile technologies as well as of the wide-area coverage characteristics of mobile telephone technology throughout the world.

Further information is provided in Appendix 5.

2.5 Service requirements for T-DMB[7] use cases

The Digital Sound Broadcasting (DSB) system was originally designed to provide high quality audio services. It is also pursued to provide multimedia services including video and interactive data services for mobile reception. Mobile multimedia service has been developed based on the DSB System A in Korea, which is named as Terrestrial Digital Multimedia Broadcasting (T-DMB).

In order to accomplish the purpose of multimedia broadcasting for mobile reception, some of the additional key requirements are as follows:

2.5.1 General requirements

– complete backward compatibility with the DSB System A;
– robust reception of video in mobile environments at the speed of up to 200 km/h;
– power-up delay no greater than 2 s (NOTE – The delay does not include start-up time of the operating system in a receiver);
– delay of audio objects relative to the corresponding video objects in the range of –20 ~ +40 ms;
– delay of auxiliary data relative to the corresponding video objects in the range of –300 ~ + 300 ms;
– RF channel change delay not exceeding 1.5 s (NOTE – When the program is changed within the same ensemble, the delay shall not exceed 1 s).

2.5.2 Video objects

– video quality comparable to VCD on 7-inch display devices;
– display resolution up to 352×288;
– frame rates up to 30 frames/s;
– random access period no greater than 2 s.

2.5.3 Audio objects associated with the video

– audio with the maximum sampling rate of 48 kHz;
– audio quality up to CD-quality;
– random access period no greater than 50 ms.

2.5.4 Auxiliary data (optional)

– supplemental information shall be provided;
– interactive services shall be provided;
– random access period shall be no greater than 0.5 s.

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[7] T-DMB is a new subsystem of DAB (Recommendation ITU-R BS.1114 System A/Eureka 147), which makes use of DAB sub-channel for MPEG-2 Transport Stream. T-DMB has been proposed to ITU-R for future Recommendation. This system is identified as TTAS.KO-07.0026 in Korea.

2.6 Service requirements for Terrestrial Mobile Multimedia Multicast (TMMM) use cases

The Terrestrial Mobile Multimedia Multicast (TMMM) technology is designed specifically for mobile reception of broadcast multimedia content and is optimized to address the physical limitations of the terminal, including power consumption, memory and form-factor constraints.

Key TMMM service requirements include:

– reception of real-time broadcast video and audio streams as well as clip-casting and IP data-casting with similar high efficiency;
– access to multimedia services controlled via conditional access protocols, which apply cryptography techniques to prevent unauthorized access;
– reception of wide area and localized content in the same carrier;
– flexible service subscription on a per package basis via the cellular device or other IP connection;
– other public safety, disaster relief, or public service applications.

A TMMM-capable terminal is defined as a traditional wireless handset with a TMMM-receive capability. Whenever possible, this additional capability does not impact any of the existing characteristics of the handset, such as voice, data, short messaging service, processing, etc. In accordance with the goals mentioned in a preliminary draft new Recommendation the TMMM system is designed for one-way broadcasting networks and simultaneously permits two-way wireless operation. TMMM devices include the following features:

– support for access control, subscription management, and interactive services via IP;
– support for multi-mode and multi-band operations;
– ability to receive and initiate calls while receiving content through the TMMM physical layer;
– optimized utilization of hybrid networks based on the type of application and the number of subscribers supported.

3 Types of mobile receivers

This section provides several types of receiver for mobile reception with comparison to fixed reception. In the mobile reception there are three main types of terminals: nomadic, pedestrian and vehicular terminals. Especially in the case of handheld devices for pedestrian case, the user requirements are very much different from the fixed case.

3.1 Nomadic receivers

Nomadic receivers are devices that may be transferred from place to place but the reception is meant to be stationary.

Nomadic reception means that receivers are used in fixed position while the receivers can be carried easily in a nomadic receiver case. Figure 1 shows an example of nomadic receivers.

Nomadic rceivers: TV/radio/CD combo, lap-top-PC
Use indoor antenna, may be operated using battery power.

FIGURE 1

An example of prototype nomadic receivers

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3.2 Pedestrian receivers

Pedestrian devices have several physical limitations, for example, weight, size, computing power, battery capacity, etc. These limitations imply two types of devices.

Basic handheld receivers: Pocket radio with limited display capability (see a) in Fig. 2), mobile phone like (see b) in Fig. 2)

Enhanced handheld receivers: PDA like (see c) in Fig. 2)

These terminals have lower computing power, smaller screens, different user interface, smaller antenna, and limited battery for operation.

FIGURE 2

Several types of handheld receivers

a) b) c)

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3.3 Vehicular receivers

This type of device has less physical limitations than pedestrian cases however the moving speed is much higher than pedestrian reception.

Vehicular receivers: Car radio/CD with limited display capability
Car navigation combo with 6.5/7-inch full colour screen.

Vehicular receivers would require sophisticated man-machine interface for operation. There may be many restrictions when the transmitted contents are displayed to vehicular driver.

3.4 Vehicular reception using nomadic and pedestrian receivers

In some cases, nomadic and/or pedestrian devices are used in fast-moving transportation equipment, such as cars and trains. In this case, nomadic devices and pedestrian devices are required to receive the signals under more severe receiving conditions.

3.5 An example of enhanced handheld receivers

Figure 3 shows an experimental model of a digital BSS (sound) receiver in Japan. The size of this receiver is 75 mm (H) × 112 mm (W) × 22 mm (D). Weight is about 200 g including a battery. It has a 3.5-inch diagonal LCD screen for data- and video-broadcasting services.

This receiver model makes use of the second-generation chip set for this digital satellite broadcasting system.

FIGURE 3

An example of enhanced handheld receivers for digital BSS (sound)

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4 System characteristics and network planning aspects

On a system level there are several characteristics that are required for broadcasting multimedia and data applications for mobile reception. Again, the requirements are best explained in comparison to fixed reception.

4.1 Distribution network

Mobile and handheld reception of broadcast signals necessitates consideration of limitations inherent to the receiving devices. Mobile and handheld devices will have small antennas, which require that the broadcast signal be stronger than that used in typical above-rooftop receiver configurations, in particular to achieve indoor coverage. Whenever available, the use of broadcasting bands III, IV and V together with the use of higher emission power and antenna heights than traditional cellular networks, results in greater coverage per transmitting site and lower per-bit delivery cost. In addition, the radio transmission parameters and signalling protocol methodology may need to be modified to support mobile reception, such that the effects of multipath reflections and Doppler shifts can be effectively mitigated, and to compensate for the expectation that the receiving power level and signal quality reaching the mobile antennas may be far less than that feeding the fixed receivers (which are often serviced by a fixed outdoor directional (Yagi) antenna).

There are different ways to optimize the broadcasting link budget: either to increase the transmitting power or have a denser transmission network. Depending on the national market sizes and the regulatory environment, both approaches could be envisioned but increasing the transmitting power may efficiently improve the link budget in country where the interference environment and the regulatory rules are favourable. In other regions of the world, this approach may complicate the network planning both nationally as well as on the international level due to cross-border frequency coordination and multiple frequency implementations of traditional broadcasting networks. In these cases the optimal approach to an efficient distribution network for mobile reception seems to be the establishment of a low power, smaller footprint type of transmitter grid. This approach will also allow for a higher degree of frequency reuse, in particular in the new digital broadcasting domain.

4.2 Some network planning and radio frequency aspects

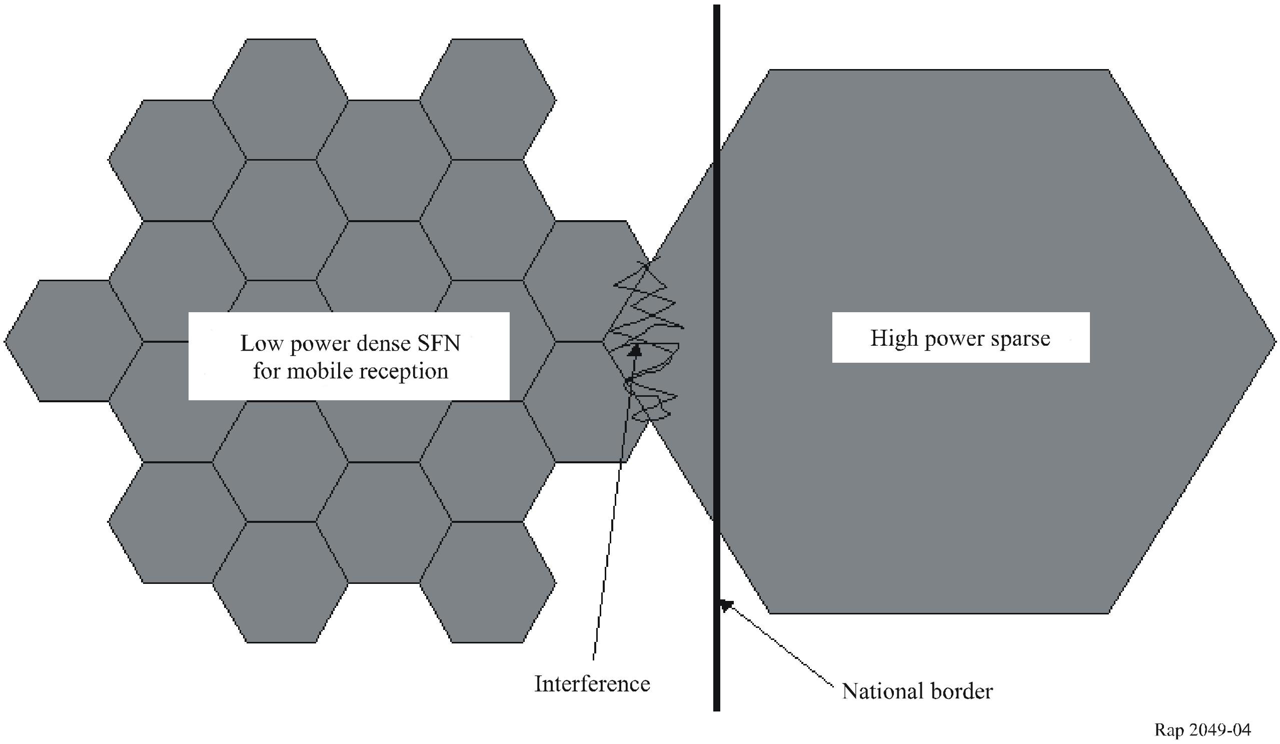
4.2.1 The RRC planning area (Region 1 and some part of Region 3)

The work on the coordinated introduction of digital broadcasting in the current analogue bands as was undertaken by RRC-04 is indeed very complex and requires careful consideration of all aspects, which may have impact on the planning methodologies being considered and finally adopted. As the following example illustrates, RRC-04 was invited to discuss and resolve a particular interference situation which might be encountered in the future.

As Fig. 4 illustrates, the low power single frequency network (SFN) is a victim of interference from a neighbouring transmitter operating a different multiplex on the same broadcast channel.

FIGURE 4

An example of interference between a low power SFN distribution network for mobile broadcasting and an adjacent traditional high power cell transmitting on the same broadcast channel



By the introduction of low power broadcasting an allotment plan should be considered to ensure equal treatment of all broadcasting services including the broadcasting distribution networks optimized for mobile and handheld reception.

4.2.2 Region 2

One administration has developed technical and service rules for the upper UHF bands, which enable the delivery of multimedia services using higher emission power and antenna heights than traditional cellular networks. This results in greater coverage per transmitting site and lower per-bit delivery cost. In markets where similar spectrum and power limits are available the TMMM technology is a suitable option for mobile broadcast solutions.

4.3 Receiver characteristics

In comparison to fixed reception there are several elements in the receiver characteristics that are affected by specific requirements of the mobile reception. These specific requirements are especially relevant for the above-mentioned cases of mobile reception. First, reasonable size for receiver antenna is in the order of a few centimetres compared to large aerials of current fixed terminals. Second, mobile receivers use non-directional antennas which imply a loss in the antenna gain as opposed to fixed directional antenna. Third, the displays of these terminals are likely to be much smaller than traditional fixed terminal like television. Fourth, the operating time of pedestrian terminal is limited by the battery capacity. Last, there may be differences in radio receiver and signal processing required to support time-varying channel and interference conditions.

4.4 Content manipulation and distribution

Currently, the content encoding, encapsulation and distribution systems are required to process mainly audio/video content and supplementary data that is related to enhanced broadcast services. Similar requirements have been stated for the receiving system that performs content decoding, processing and display. Considering mobile reception of multimedia and data applications, those systems need to allow and support encoding/decoding, encapsulation, processing and distribution of arbitrary data, end to end.

4.5 Managing mobility

Due to user mobility and possibly limited coverage of a single broadcasting signal, the transmitting end has to facilitate end users' hand over (for example, through some kind of announcement signalling) in the case of multi-frequency networking. The receiving end has to be aware of possible loss of signal during the reception and react in a feasible manner if that happens.

In the case of single frequency networking, suitable transmission parameters should be selected for this purpose.

4.6 Error characteristics

Comparing fixed and mobile receptions of multimedia and data applications, there are differences in channel error characteristics. The transmitting end may need to make the transmission more robust by using, for example, forward error correction (FEC) techniques and/or deeper time domain interleaving. The receiving end has to be aware of possible loss of data. Further, the severity of the loss of fragments of data has different impact on user experience. For example reception of audio/video stream is more tolerant to partial data loss than reception of a data file.

4.7 Interoperability between mobile telecommunication services and digital broadcasting services

This issue should be approached by defining clear levels or parts of total system and service functionality for which we envisage interoperability. Two main levels are interoperable on content format level and interoperability on service level.

For interoperability on content format level the approach could be the following. First, given the inherent limitations of mobile devices such as display sizes, processing power, battery life, etc., content formats used in mobile telecommunication systems, should be optimized in order to design the appropriate systems. Then it is necessary to list the existing and planned content formats used in (interactive) broadcasting systems. Last, the content formats should be based on the considerations mentioned above.

The interoperability on service level needs further studying.

5 Transmission mechanisms for broadcasting of multimedia and data applications for mobile reception

Several types of transmission mechanisms are proposed for this purpose; ARIB STD-B24, T-DMB, DVB-H, and TMMM are possible candidates.

There are several methods for so called "encapsulation" using either MPEG-2 TS, IP-Packets, or other generic packet data methodologies.

In Table 1, an overview of currently known mobile broadcasting transmission mechanisms is provided. The technical characteristics shown are subject to change and are by no means exhaustive but provided for comparison only.

TABLE 1

Summary of mobile digital broadcasting transport mechanisms

Standard or Specification	Modulation	Transport stream	RF channel (MUX) size (MHz) From technical view point	International broadcast bands	Receiver power reduction methodology
ISDB-T	QPSK or 16-, 64-QAM OFDM	MPEG-2 TS	0.429 or 3×0.429	IV and V	One/three segment(s) reception
Digital System E	QPSK CDM	MPEG-2 TS	25	2.6 GHz in Region 3. Satellite link plus terrestrial augmentation	Optimized receptions of CDM codes
T-DMB	DQPSK COFDM	MPEG-2 TS	1.5	III	Originally optimized bandwidth
DVB-T	QPSK or 16-QAM COFDM	MPEG-2 TS	6, 7, 8	IV and V	For vehicular receivers
DVB-H	QPSK or 16-QAM COFDM	IP/MPE-FEC/ MPEG-2 TS	5, 6, 7, 8	IV and V	Time slicing
TMMM	QPSK or 16-QAM COFDM	Generic packet data	5, 6, 7, or 8	IV and V	Time slicing

Further technical details are provided in the Appendices.

5.1 ARIB STD-B24

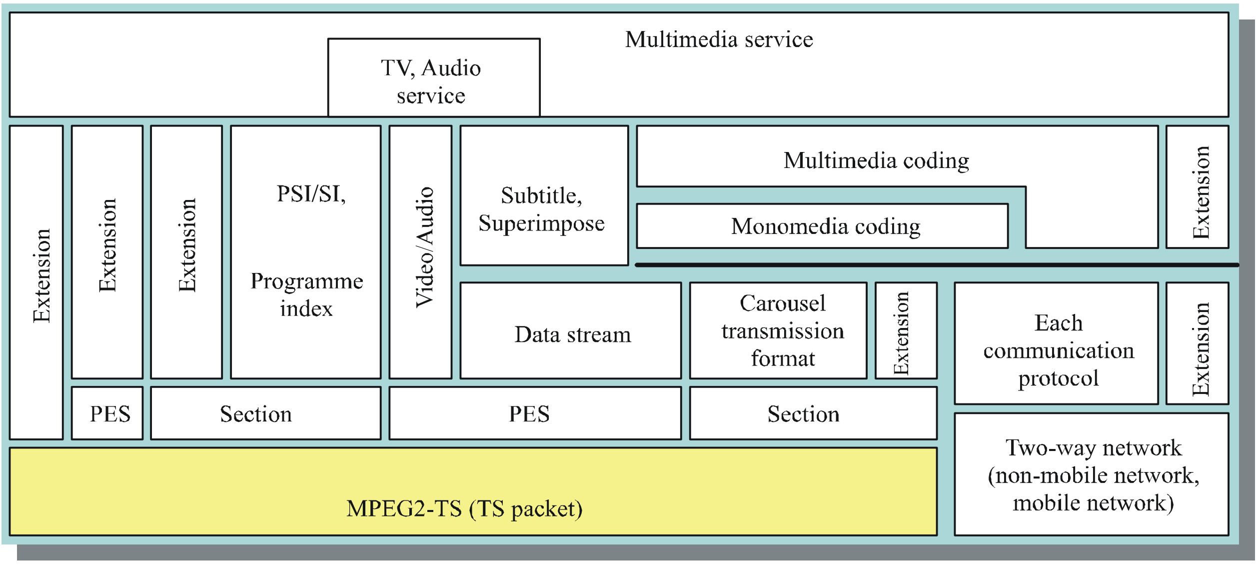
5.1.1 Current multimedia and data transmission system

ARIB STD-B24 would allow the creation of content for digital broadcasting in a mobile environment, as such, it is a possible candidate system specification for transmission of multimedia and data over a broadcasting channel to handheld and vehicular receivers. A layered protocol stack for ARIB STD-B4 is shown in Fig. 5. This protocol stack is applied to all systems of the ISDB family including Digital System E[8] for the hybrid broadcasting system. The text for ARIB STD-B24 is available on the ITU website: http://www.itu.int/md/meetingdoc.asp?type=sitems&lang=e&parent=R03-WP6M-C-0062 (Document 6M/62). Annex 4 and 5 to ARIB STD-24 Part 2 are relevant to this subject.

[8] Digital System E is recommended in Recommendations ITU-R BO.1130 and ITU-R BS.1547.

FIGURE 5

Protocol stack for ARIB STD-B24



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In order to fulfil the specific requirements especially for mobile reception, some extensions are added for this purpose.

In ARIB STD-B24, mobile receptions are divided into two parts depending on the type of receivers, basic handheld receivers and enhanced handheld (including vehicular) receivers. Annexes 4 and 5 to Part 2 of ARIB STD-B24 provide the specifications for basic handheld receivers, and enhanced handheld receivers and vehicular receivers, respectively.

Question ITU-R 45/6 refers the only one technical term “mobile reception” in its title however it is better to use both handheld receivers and vehicular receivers when we consider the difference of physical implementation of digital broadcasting receivers.

Figure 6 explains the interrelations between three types of digital receivers, i.e. handheld, vehicular and fixed receivers for categorizing the specifications for broadcasting of multimedia and data applications. As indicated in Fig. 5, ARIB STD-B24 is the typical example for MPEG-2 TS encapsulation.

Table 2 provides the list of applicable ARIB standards and technical reports for the ISDB family and interoperability among these systems. Mobile broadcasting systems are also completely embedded in the ISDB family.

FIGURE 6

Interrelations between fixed, handheld and vehicular receivers in the aspect of broadcasting of multimedia and data applications in ARIB STD-B24

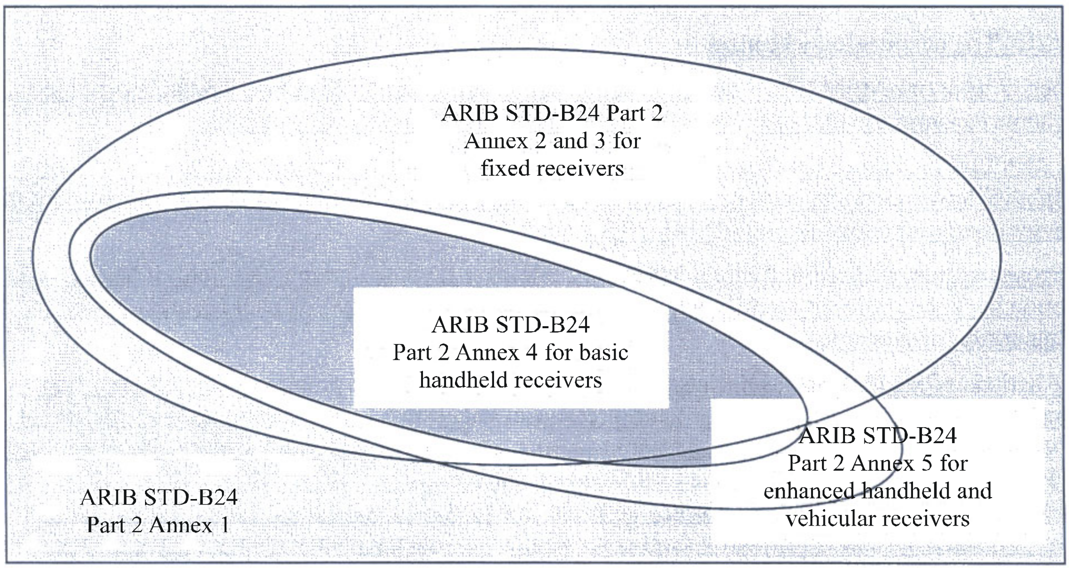

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TABLE 2

Applicable ARIB STDs/TRs for the ISDB family and interoperability among these systems

	BS (ISDB-S) / CS 110	Terrestrial television (ISDB-T)	Terrestrial sound (ISDB-TSB)	Satellite sound using 2.6 GHz (Digital System E/MSB)
Physical layer	STD-B20	STD-B31	STD-B29	STD-B41
Service multiplexing	STD-B10 and STD-B32 (part)			
Video/audio coding	STD-B32 (Audio and Video)		STD-B32 (Audio)	
Multimedia broadcasting	STD-B24 including video streaming			
	Annex 2	Annex 3	Annex 4	Annex 5
Access control	STD-B25			
Receivers	STD-B21		STD-B30	STD-B42
Operational guidelines	TR-B15	TR-B14	TR-B13	TR-B26

STD: Standards TR: Technical Report

5.1.2 Experimental data transmission mechanisms for mobile reception

It is important for mobile reception cases to cope with relatively worse receiving conditions than the fixed reception cases. Especially, data broadcasting receptions in relatively worse receiving conditions need longer acquisition time than the error-free reception cases due to the characteristics of the applied retransmission mechanisms.

5.1.2.1 The carousel mechanism

When at least one MPEG-2 TS packet has at least one bit error, all MPEG-2 TS packets related to the same carousel are discarded by current carousel data transmission protocols.

All MPEG-2 packets are protected by Reed-Solomon code with 8-byte forward-error-correcting capability however errors may be detected by CRC in MPEG-2 TS Section type packet if more than 8-bytes errors are added to one MPEG-2 TS packet.

The proposed system adds an individual MPEG-2 TS Packet ID in the adaptation field of MPEG-2 TS Section packet in order to identify which packets are error free or which packets are affected by transmission data errors.

The actions of the first carousel transmission period of the current and proposed systems are almost the same, however the second period or later of the carousel data transmission period are quite different between those two systems. At the beginning of the second period, the current system simply discards all MPEG-2 TS packets if there is at least one error packet using CRC error-detecting capability. On the contrary, the proposed system keeps all error-free packets but discards error-detected packet only. The proposed system fills up all vacant parts with error-free packets from the second or later carousel cycles.

Figure 7 shows where the MPEG-2 TS Packet ID is implemented. Table 3 gives the syntax for MPEG-2 TS Packet ID.

FIGURE 7

Proposed modification to add packet ID using 8 bytes in a private data field

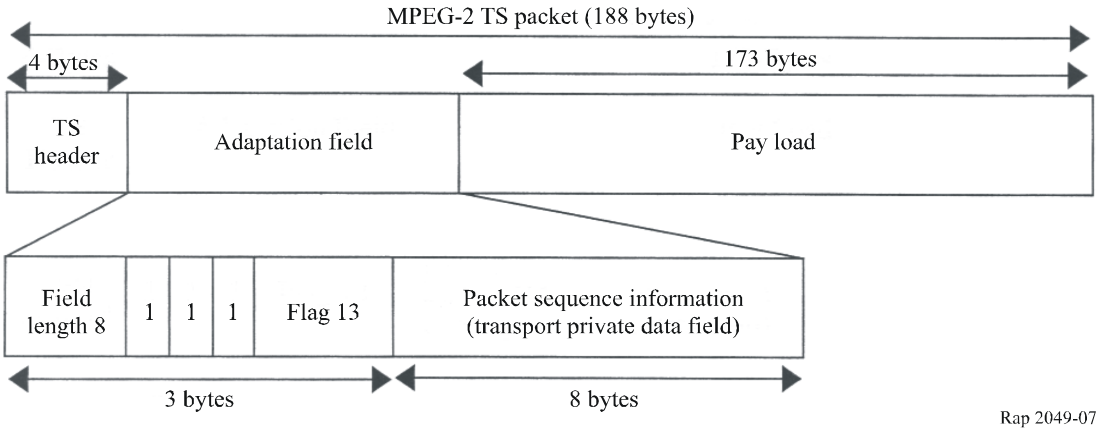


TABLE 3

Additional data descriptions for TS Packet ID

Syntax	The number of bits	Mnemonic
Private_data_byte () {		
Private_data_type	8	uimsbf
If(Private_data_type==1){		
Table_id	8	uimsbf
Table_id_extension	16	uimsbf
Version_number	5	uimsbf
Section_number	8	uimsbf
Last_section_number	8	uimsbf
TS_Packet_Number	5	uimsbf
Last_TS_packet_number	5	uimsbf
Reserved	1	bslbf

Further information is provided in Appendix 1.

5.2 IPDC/DVB-H

5.2.1 IP as a content bearer for the broadcasted data

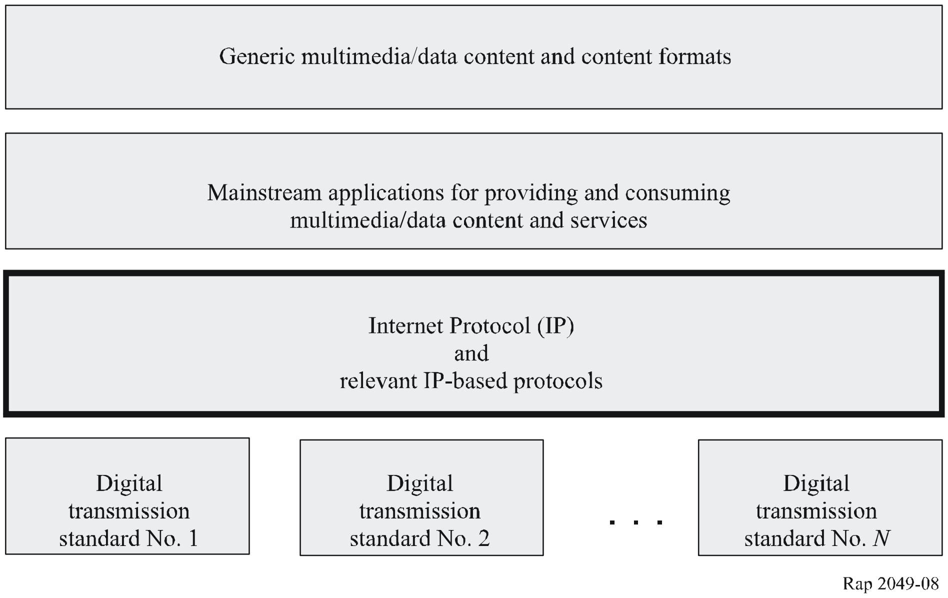
One of the ways to carry content to mobile terminals could be to broadcast content in the form of IP encapsulated data packets on top of the actual broadcast (radio) bearer. This is in order to facilitate maximum efficiency in the establishment of inter-working with the Internet and other systems deploying IP and to make maximum use of the substantial number of existing transmission and security methodologies based on the IP protocol.

This means that, in principle, any kind of IP-based content could be made available to users through the mobile broadcast system.

Another characteristic of an IP-based service delivery system is, that it is to a great extent network agnostic (see Fig. 8) allowing service providers and network operators the freedom to choose the best-suited distribution path for the content and services.

FIGURE 8

Internet protocol and related protocols provide common platform for multimedia and data broadcasting



5.2.2 Content formats

Content formats should be generic and scalable. By generality of content formats it is meant that any suitable content available in the Internet or through any other system should be supported when considering broadcasting multimedia and data applications for mobile reception. By scalability, content formats allow scaling for different levels of processing power and for different sizes of screen.

Especially useful are content formats that are resilient towards transmission errors and that utilize content encoding that is efficient in terms of used bandwidth.

Content formats should be harmonized as far as possible with the current work of different broadcasting systems and well as with the IMT-2000 systems and other wireless systems.

The content formats are needed for the reception of audiovisual content as a direct view (real-time) or as a download (scheduled) as well as for other downloadable (scheduled) content like software modules aimed at gaming, maps, newspapers and other data files according to market demands.

In terms of media types the content formats are needed for: audio (sampled and synthesized); video; still images; bitmap graphics; text (unstructured, structured, hypertext), and supported generic binary objects.

Further information is provided in Appendix 3.

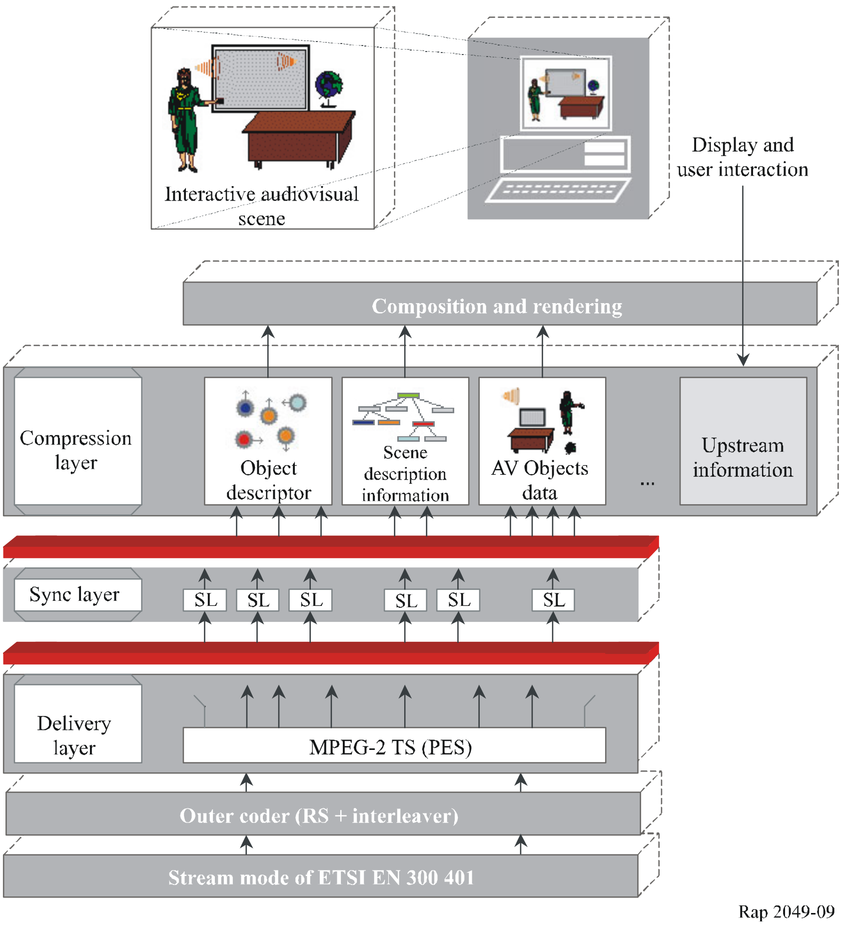
5.3 Transmission mechanisms of T-DMB

5.3.1 System architecture

The system for the T-DMB video services has the architecture that transmits MPEG-4 contents encapsulated using “MPEG-4 over MPEG-2 TS” specification as illustrated in Fig. 9.

FIGURE 9

Conceptual architecture for the video services



Video service is delivered through the stream mode of DSB System A transmission mechanism. In order to maintain extremely low bit error rates, this service uses the error protection mechanism described in § 5.3.5. This video service is composed of three layers: contents compression layer, synchronization layer, and transport layer. In the contents compression layer in § 5.3.6, ITU-T H.264 | ISO/IEC 14496-10 AVC is employed for video compression, ISO/IEC 14496-3 ER-BSAC for audio compression, and ISO/IEC 14496-1 BIFS for auxiliary interactive data services.

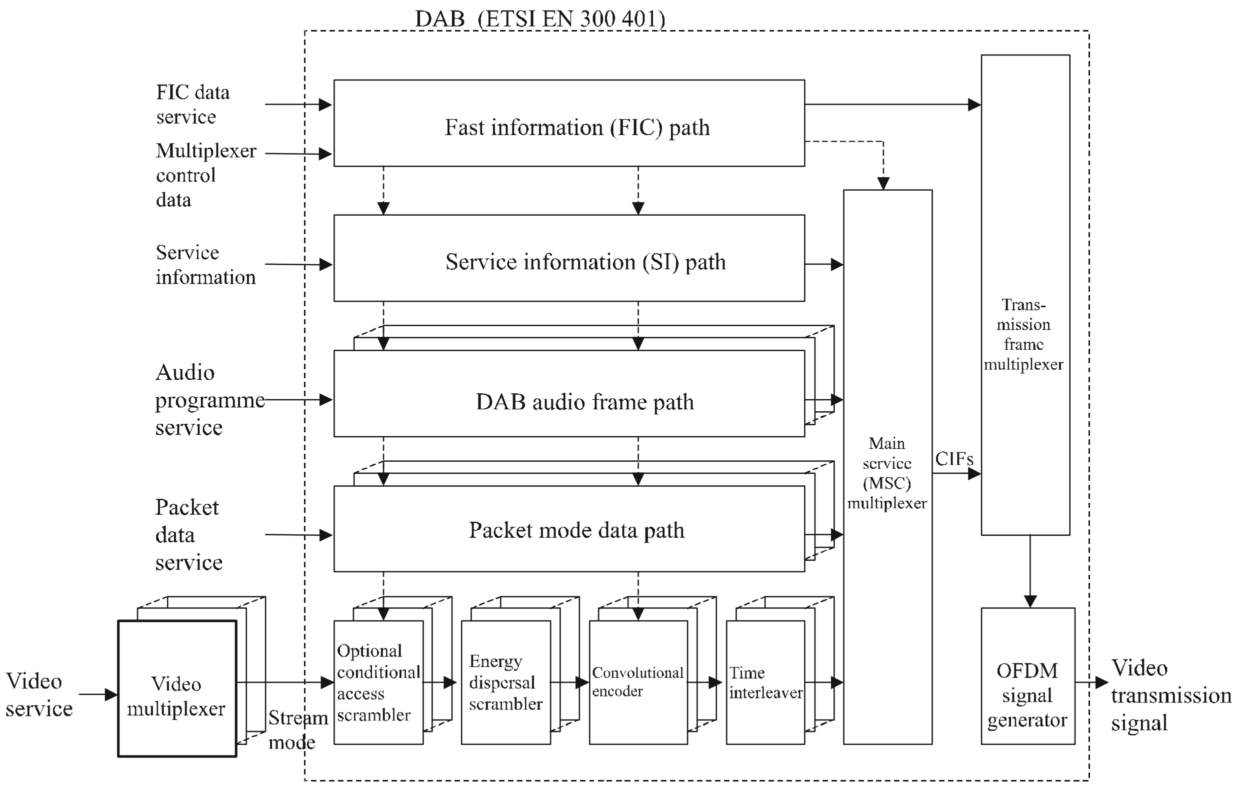
To synchronize audio-visual contents both temporally and spatially, ISO/IEC 14496-1 SL is employed in the synchronization layer. In the transport layer specified in § 5.3.4 some appropriate restrictions are employed for the multiplexing of compressed audiovisual data.

5.3.2 Video service transmission architecture

The conceptual transmission architecture for video services is shown in Fig. 10. The video, audio, and auxiliary data information for a video service are multiplexed into an MPEG-2 TS and further outer-coded by the video multiplexer. It is transmitted by using the stream mode specified in DSB System A. The video multiplexer is described in § 5.3.3.

FIGURE 10

Conceptual transmission architecture for the video services



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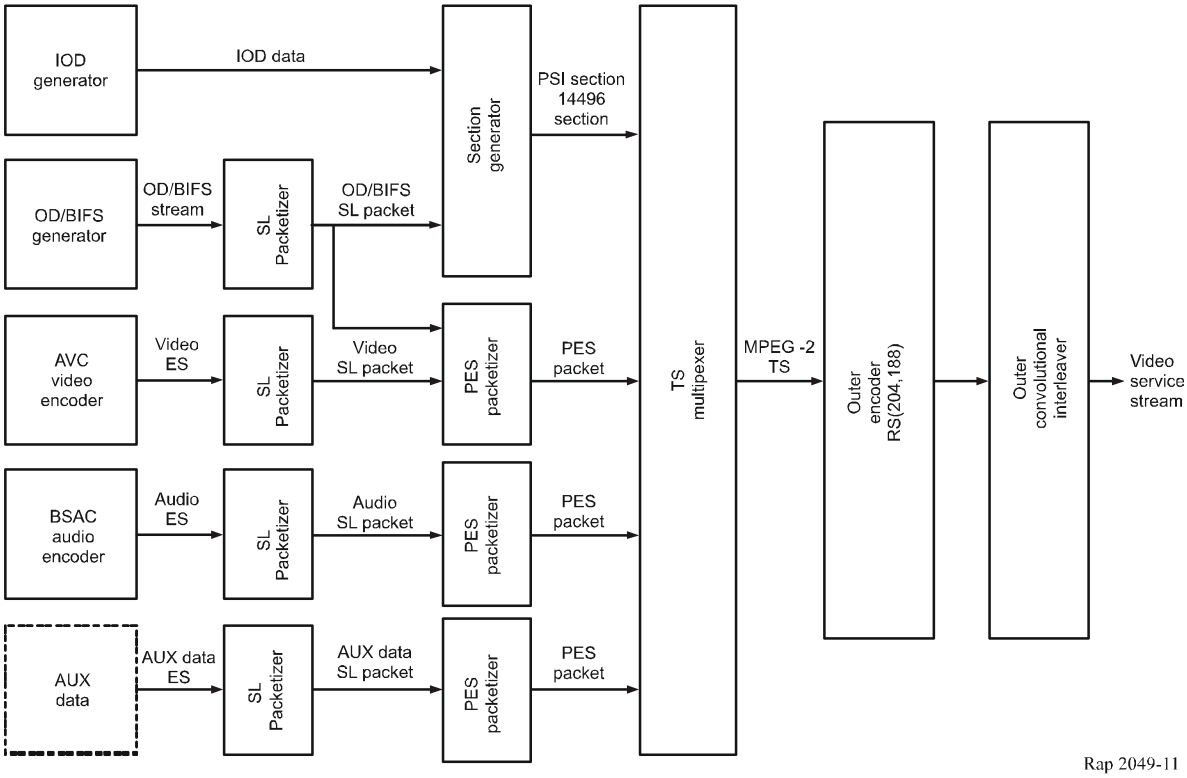
5.3.3 Video multiplexer architecture

The conceptual architecture of the video multiplexer for a video service is shown in Fig. 11.

FIGURE 11

Architecture of the video multiplexer



– The IOD generator creates IODs that comply with the ISO/IEC 14496-1 Standard.
– The OD/BIFS generator creates OD/BIFS streams that comply with the ISO/IEC 14496-1 Standard.
– The video encoder generates an encoded bit stream compliant with the ITU-T H.264/AVC standard by performing data compression processing of the input video signal.
– The audio encoder generates an encoded bit stream compliant with the ISO/IEC 14496-3 ER-BSAC Standard by performing data compression processing of the input audio signal.
– Each SL packetizer generates an SL packetized stream compliant with the ISO/IEC 14496-1 System Standard for each input media stream.
– The section generator (PSI generator) creates sections compliant with the ISO/IEC 13818-1 Standard for the input IOD/OD/BIFS (refer to Appendix 2).
– Each PES packetizer generates a PES packet stream compliant with the ISO/IEC 13818-1 Standard for each SL packet stream.
– The TS multiplexer combines the input sections and PES packet streams into a single MPEG-2 TS compliant with the ISO/IEC 13818-1 Standard.
– The outer encoder attaches additional data, generated by using the RS code for error correction, to each packet in the MPEG-2 TS multiplexed data stream.
– The outer-coded data stream is interleaved by the outer interleaver, which is a convolutional interleaver (refer to § 5.3.5), and is output as a video service stream.

5.3.4 Transport stream specification

The transport stream layer plays the role of multiplexing video, audio, and auxiliary data for a single program. It does not support the conditional access scheme defined in the ISO/IEC 13818-1[9] Standard. PCR is used for system synchronization.

The ISO/IEC 14496-1 MPEG-4 System layer provides synchronization among ESs using OCR, CTS, and DTS together with the PCR described above. In addition, the layer provides linkage among ESs that constitute a video service, and uses scene description information for the composition of a video service. It uses the SL packetization, but does not utilize the FlexMux multiplexing.

5.3.4.1 Transport stream packet specification

A TS packet shall have the structure shown in Table 4[10].

TABLE 4

Structure of a TS packet

Syntax	Number of bits	Restrictions
Transport_packet(){		
Sync_byte	**8**	
Transport_error_indicator	**1**	
payload_unit_start_indicator	**1**	
Transport_priority	**1**	
PID	**13**	
Transport_scrambling_control	**2**	**‘00’**
adaptation_field_control	**2**	
continuity_counter	**4**	
if(adaptation_field_control = = '10' || adaptation_field_control = = '11'){		
adaptation_field()		
}		
if(adaptation_field_control = = '01' || adaptation_field_control = = '11') {		
for (i=0; i<N; i++){		
Data_byte	**8**	
}		
}		
}		

The adaptation field within a TS packet shall have the structure shown in Table 5.

[9] Among PSI, CAT is not used.

[10] In the Table, restrictions are described only when they are to be imposed.

TABLE 5

Structure of the adaptation field of a TS packet

Syntax	Number of bits	Restrictions
adaptation_field() {		
adaptation_field_length	8	
if (adaptation_field_length>0) {		
Discontinuity_indicator	1	
random_access_indicator	1	
elementary_stream_priority_indicator	1	
PCR_flag	1	
OPCR_flag	1	‘0’
splicing_point_flag	1	
transport_private_data_flag	1	
adaptation_field_extension_flag	1	‘0’
if (PCR_flag = = '1') {		
program_clock_reference_base	33	
Reserved	6	
program_clock_reference_extension	9	
}		
if (OPCR_flag = = '1') {		**not used**
}		
if (splicing_point_flag = = '1') {		
splice_countdown	8	
}		
if (transport_private_data_flag = = '1') {		
transport_private_data_length	8	
for (i=0; i<transport_private_data_length; i++) {		
Private_data_byte	8	
}		
}		
if (adaptation_field_extension_flag = = '1') {		**not used**
}		
for (i=0; i<N; i++) {		
stuffing_byte	8	
}		
}		
}		

5.3.4.2 PES packet specification

A PES packet shall have the structure shown in Table 6.

TABLE 6

Structure of a PES packet

Syntax	Number of bits	Restrictions
PES_packet() {		
packet_start_code_prefix	**24**	
stream_id	**8**	**0xFA**
PES_packet_length	**16**	
if (stream_id !=program_stream_map		
&& stream_id !=padding_stream		
&& stream_id !=private_stream_2		
&& stream_id !=ECM		
&& stream_id !=EMM		
&& stream_id !=program_stream_directory		
&& stream_id !=DSMCC_stream		
&& stream_id !=ITU-T Rec. H.222.1 type E stream) {		
'10'	**2**	
PES_scrambling_control	**2**	**‘00’**
PES_priority	**1**	
data_alignment_indicator	**1**	
Copyright	**1**	
original_or_copy	**1**	
PTS_DTS_flags	**2**	**‘10’ or ‘00’**
ESCR_flag	**1**	**‘0’**
ES_rate_flag	**1**	**‘0’**
DSM_trick_mode_flag	**1**	**‘0’**
additional_copy_info_flag	**1**	**‘0’**
PES_CRC_flag	**1**	**‘0’**
PES_extension_flag	**1**	**‘0’**
PES_header_data_length	**8**	
if (PTS_DTS_flags = = '10') {		
'0010'	**4**	
PTS [32..30](1)	**3**	
Marker_bit	**1**	
PTS [29..15]	**15**	
Marker_bit	**1**	
PTS [14..0]	**15**	
Marker_bit	**1**	
}		
if (PES_extension_flag = = '1') {		**not used**
}		
for (i=0; i<N1; i++) {		
Stuffing_byte	**8**	
}		
for (i=0; i<N2; i++) {		
PES_packet_data_byte	**8**	
}		
}		
}		

(1) The PTS field is included in a PES header only when the encapsulated SL packet header contains an OCR. Otherwise, the PTS field is not used.

The following rules are applied at the transmitting side in order to allow random accesses at the receiving side:

– A PAT (Program Association Table) shall describe only one program, and its transmission period shall be no greater than 500 ms.

– A PMT (Program Map Table) shall have the structure shown in Table 7 and adhere to the following rules:
  – A group of descriptors with Restriction "A" in the Table shall include an IOD_descriptor.
  – A group of descriptors with Restriction "B" in the Table shall include an SL descriptor for an ES_ID.
  – The transmission period of a PMT shall be no greater than 500 ms.
– The transmission period for scene description information and object description information shall be no greater than 500 ms.

TABLE 7

Structure of a PMT

Syntax	Number of bits	Restrictions
TS_program_map_section() {		
table_id	**8**	
Section_syntax_indicator	**1**	
'0'	**1**	
Reserved	**2**	
Section_length	**12**	
Program_number	**16**	
Reserved	**2**	
Version_number	**5**	
current_next_indicator	**1**	
Section_number	**8**	
Last_section_number	**8**	
Reserved	**3**	
PCR_PID	**13**	
Reserved	**4**	
Program_info_length	**12**	
for (i=0; i<N; i++) {		
descriptor()		A
}		
for (i=0; i<N1; i++) {		
stream_type	**8**	'0x12' or '0x13'
Reserved	**3**	
elementary_PID	**13**	
Reserved	**4**	
ES_info_length	**12**	
for (i=0; i<N2; i++) {		
descriptor()		B
}		
}		
CRC_32	**32**	
}		

To ensure the audio-visual synchronization, the following rules shall be applied:

– The transmission period of a PCR within a transport stream shall be no greater than 100 ms.

– The transmission period of an OCR in the ISO/IEC 14496-1 SL layer shall be no greater than 700 ms.

The transmission period of a CTS in the ISO/IEC 14496-1 SL layer shall be no greater than 700 ms.

5.3.5 Error protection

5.3.5.1 Outer coding

The shortened RS (204,188, $t = 8$) derived from RS (255,239, $t = 8$) is used for encoding.

The code and field generator polynomials of RS (255,239, $t = 8$) are as follow:

– code generator polynomial: $g(x) = (x+\lambda^0)(x+\lambda^1)(x+\lambda^2)...(x+\lambda^{15})$, λ = 02(HEX)

– field generator polynomial: $p(x) = x^8 + x^4 + x^3 + x^2 + 1$

In order to obtain the shortened RS code, the first 51 input bytes for the RS (255,239, $t = 8$) encoder are assumed to be zero. After encoding, the 51 zero bytes, which precede the valid 204-byte RS codeword at the output of the RS (255,239, $t = 8$) encoder, are discarded.

The 16-byte parity of the shortened RS code shall be located at the end of an MPEG-2 TS packet as shown in Fig. 12.

FIGURE 12

Stucture of an MPEG-2 TS packet encoded by RS (204, 188, $t = 8$)

204 bytes

Sync byte (1 byte)	MPEG-2 TS data (187 bytes)	Parity bytes (16 bytes)

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5.3.5.2 Outer interleaver

The convolutional byte-wise interleaver based on the Forney approach shall be used with the interleaving depth $I = 12$ bytes as shown in Fig. 5.

Figure 6 shows the data structure after applying the outer interleaving process to the RS-encoded TS packets.

5.3.6 Content formats

The contents of the service are composed of video objects (ITU-T H.264 | MPEG-4 AVC), audio objects (MPEG-4 ER-BSAC), and auxiliary data objects (MPEG-4 BIFS). All the objects are packetized and synchronized using MPEG-4 SL. Compressed multimedia data are multiplexed by using MPEG-2 TS. To improve efficiency, some appropriate restrictions specified in this Annex apply to the multiplexing mechanism based on MPEG-2 TS.

For the instantiation of a video service, the additional error protection mechanism specified in § 5.3.5 shall be applied to the multiplexed data before delivery through the stream mode.

5.3.6.1 Composition of MPEG-4 contents

Among several OD profiles defined in the ISO/IEC 14496-1 Standard, tools defined in the "Core Profile" are used for the composition of the contents in the T-DMB video services. However, the IPMP tool is not used.

There are restrictions imposed on the MPEG-4 descriptors that are used for the composition of contents in the T-DMB video services.

The following descriptors shall always be used:

– Object Descriptor

– Initial Object Descriptor

– ES Descriptor
– Decoder Config Descriptor
– SL Config Descriptor

The following descriptors are not used:

– IPI Descriptor Pointer
– IPMP Descriptor Pointer
– IPMP Descriptor

Object types that can be used to compose contents for video services are listed in Table 8.

TABLE 8

Object types

ObjectTypeIndication	Object type
0×02	Systems ISO/IEC 14496-1
0×21	Visual ISO/IEC 14496-10
0×40	Audio ISO/IEC 14496-3
0×6C	Visual ISO/IEC 10918-1
0×C0-0×FE	User private

Stream types that can be used to compose contents for the T-DMB video services are listed in Table 9.

For the broadcasting where only a combination of a single video object and a single audio object is used, refer to Appendix 2 of this Annex for IOD/OD/BIFS.

TABLE 9

Stream types

streamType value	Stream type
0×01	ObjectDescriptorStream
0×02	ClockReferenceStream
0×03	SceneDescriptionStream
0×04	VisualStream
0×05	AudioStream
0×20-0×3F	User private

For the content access procedure at the receiving terminals playing a video service, refer to Appendix 3 of this Annex. For video services, only one video object and one audio object shall be rendered simultaneously in a scene.

5.3.6.2 Packetization of MPEG-4 contents

– MPEG-4 contents shall be packetized as Sync Layer (SL) packets as defined in the ISO/IEC 14496-1 Standard. The following rules are applied to SL packet headers:
– The “useAccessUnitStartFlag” field has no restriction on its value.

– The “useAccessUnitEndFlag” field has no restriction on its value, but shall always be used with the “useAccessUnitStartFlag” field.
– The “useRandomAccessPointFlag” field should be set to “0”.[11]
– The “hasRandomAccessUnitsOnlyFlag” field should be set to “0”.
– The “usePaddingFlag” field should be set to “0”.[12]
– The “useTimeStampsFlag” field should be set to “1”.
– The “useIdleFlag” field should be set to “1”.
– The “durationFlag” field has no restriction on its value.
– The “timeScale” field shall always be used if the “durationFlag’ field has the value of “1”.
– The “accessUnitDuration” field shall always be used if the “durationFlag” field has the value of “1”.
– The “compositionUnitDuration” field shall always be used if the “durationFlag” field has the value of “1”.
– The “timeStampResolution” field shall be set to 90 000 Hz.
– The “OCRResolution” field shall be set to 90 000 Hz.
– The “timeStampLength” field shall be less than or equal to 33 bits.
– The “OCRLength” field shall be less than or equal to 33 bits.
– The “AU_Length” field should be set to “0”.
– The “instantBitrateLength” field has no restriction on its value.[13]
– The “degradationPriorityLength” field should be set to “0”.
– The “AU_seqNumLength” field should be set to “0”.
– The “packetSeqNumLength” field should be set to “0”.

The recovery and usage of timing information shall refer to the following:

– Paragraphs 2.11.3.3, 2.11.3.4 and 2.11.3.6 in the ISO/IEC 13818-1 Standard: 2000(E).
– The OCR defined in the ISO/IEC 14496-1 Standard shall synchronize all the objects necessary for the description of a scene.

5.3.6.3 Audio object

Audio object specification conforms to the ER BSAC Audio Object Type with ObjectType ID 22 defined in the ISO/IEC IS 14496-3 Standard.

Audio object bit stream has the following restrictions:

– In AudioSpecificConfig(),
  – epConfig: set to 0
– In GASpecificConfig()
  – frameLengthFlag: set to 0
  – DependOnCoreCoder: set to 0

---

[11] Random access is supported by using the “random_access_indicator” field within the TS packet.

[12] Padding is employed in PES packets.

[13] This field shall be used if an OCR is encoded within an SL packet header since the “instantBitrate” field shall also be encoded in the case.

– In bsac_header(),
  – sba_mode: set to 0 so that the error resilience tool is not supported
– In general_header(),
  – ltp_data_present: set to 0

The restrictions in Table 10 shall be applied.

TABLE 10

Restrictions on audio objects

Item	Value
Sampling rate	24 000 Hz, 44 100 Hz, 48 000 Hz
Number of channels	1, 2
Number of objects	1
Maximum bit rate	128 kbit/s

5.3.6.4 Video object

Video objects should be in compliance with ITU-T Recommendation H.264 | ISO/IEC 14496-10. Video bit streams shall comply with the items which will be described in the next subsections.

5.3.6.4.1 Profile and levels supported

Profile

Video bit streams shall comply with the "Baseline Profile" (ITU-T Rec. H.264 | ISO/IEC 14496-10 Annex A.2.1).

– "Arbitrary slice order" shall not be allowed.
– The "num_slice_groups_minus1" field should be set to "0" in the syntax of "Picture Parameter Sets".
– The "redundant_pic_cnt_present_flag" field should be set to "0" in the syntax of "Picture Parameter Sets".
– The "pic_order_cnt_type" field should be set to "2" in the syntax of "Sequence Parameter Sets".
– The "num_ref_frames"field should be set to "3" in the syntax of "Sequence Parameter Sets".

Level

– Level 1, 3 of Table A-1 in Annex A to ITU-T H.264 | ISO/IEC 14496-10 AVC shall be used with the following further restrictions.
– The formats listed in Table 11 shall be supported.
– Vertical MV component range (MaxVmvR) shall be [–64, +63.75].
– Maximum frame rate for the format shall be 30 fps.
– MaxDPB shall be 445.5 kbytes at maximum.

TABLE 11

The formats supported

Format	PicWidthInMbs	FrameHeightInMbs	PicSizeInMbs
QCIF	11	9	99
QVGA	20	15	300
WDF(1)	24	14	336
CIF	22	18	396

(1) Wide DMB Format. This format was newly introduced to support 16:9 screen aspect ratio.

5.3.6.4.2 Specification related to the transport of a video stream

To enable random access at the receiving side, IDR pictures shall be encoded within a video stream at least once every 2 s.

The "Parameter Set" shall be delivered through DecoderSpecificInfo or included in the video stream itself.

The specification related to the transport of a video stream after MPEG-4 SL packetization shall comply with Clause 14 of the ISO/IEC 14496-1 Standard: 2001 Amendment 7.

5.3.6.5 Auxiliary data specification

This specification is used only when auxiliary information is transported or synchronized interactive services are provided.

5.3.7 Scene description specification

The scene description specification complies with Core2D@Level 1 defined in the ISO/IEC 14496-1 Standard.

5.3.8 Graphics data specification

The graphics data specification complies with Core2D@Level 1 defined in the ISO/IEC 14496-1 Standard.

Further information is provided in Appendix 2.

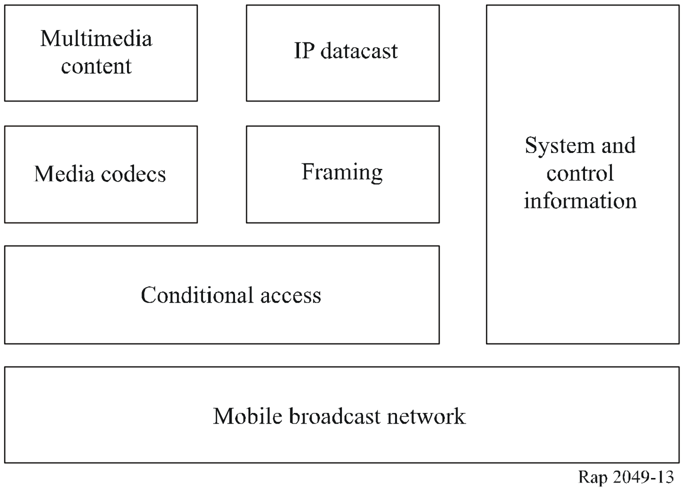
5.4 Transmission mechanisms of TMMM

The TMMM mobile broadcast network is designed to satisfy the demanding requirements of delivering broadband multimedia content to mobile devices. These requirements include spectral efficiency, battery efficiency, high-throughput, and cost effective infrastructure. The service layering shown in Fig. 13 enables the creation, transmission and reception of multimedia content in an efficient manner over a broadcast network to mobile terminal.

Figure 13 depicts the layering of the delivery service on the TMMM mobile broadcast network.

FIGURE 13

Service layering for the TMMM system



As shown in Fig. 13, the “System and control information” layer uses common communications protocols, which provide the receiving terminal with the information required to acquire, navigate and consume the services offered.

The transport mechanisms are based on open packet-data protocols, which efficiently support broadcast transmission of video or audio streams as well as IP data.

The TMMM system supports QVGA display resolution for mobile multimedia applications on handheld receivers. QVGA resolution is appropriate for mobile handheld display sizes given the characteristics of the human visual system. The TMMM system uses efficient compression technologies, such as ITU-T H.264 for video and MPEG-4 AACplus for audio, to support high quality multimedia services at an average of 360 kbps at QVGA resolution.

The system supports transmission with different levels of robustness in association with appropriate applications. The transmission coding can be optimized relative to a required quality of service.

The system also supports hierarchical, or layered, modulation. A layered codec can be utilized in conjunction with layered modulation. This approach provides acceptable quality with extended coverage when the channel conditions are poor and enhanced quality when channel conditions are more favorable.

Further information is provided in Appendix 4.

6 Display patterns on mobile receivers

It is helpful to consider how to use display to understand the specifications of multimedia and data applications. Figures 14 and 15 provide examples of display patterns for basic handheld receivers and enhanced handheld and vehicular receivers, respectively.

A basic handheld receiver has a simplified displaying capability. It is likely that such display patterns will not make use of overlapping of more than two planes. Figure 14 shows possible display patterns, which are implemented for basic handheld receivers depending on the considered resolution.

However, enhanced handheld and vehicular receivers may have a layout that is similar to a fixed receiver although it is likely to have a different display resolution as illustrated in Fig. 15. These receivers have resolution displays of 352 × 288 or lower, while a fixed receiver can have an HDTV display, i.e. 1 920 × 1 080 resolution.

FIGURE 14

Examples of display patterns of image and data on basic handheld receivers

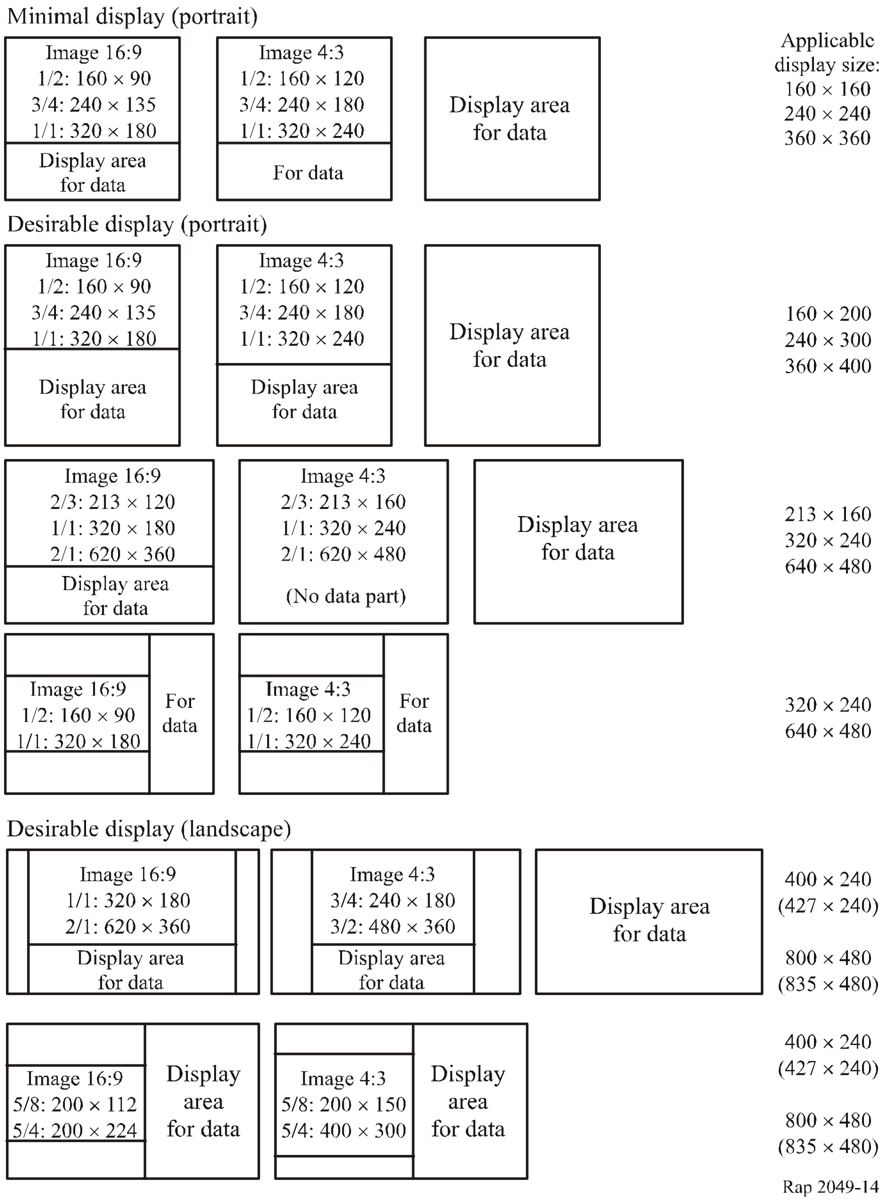
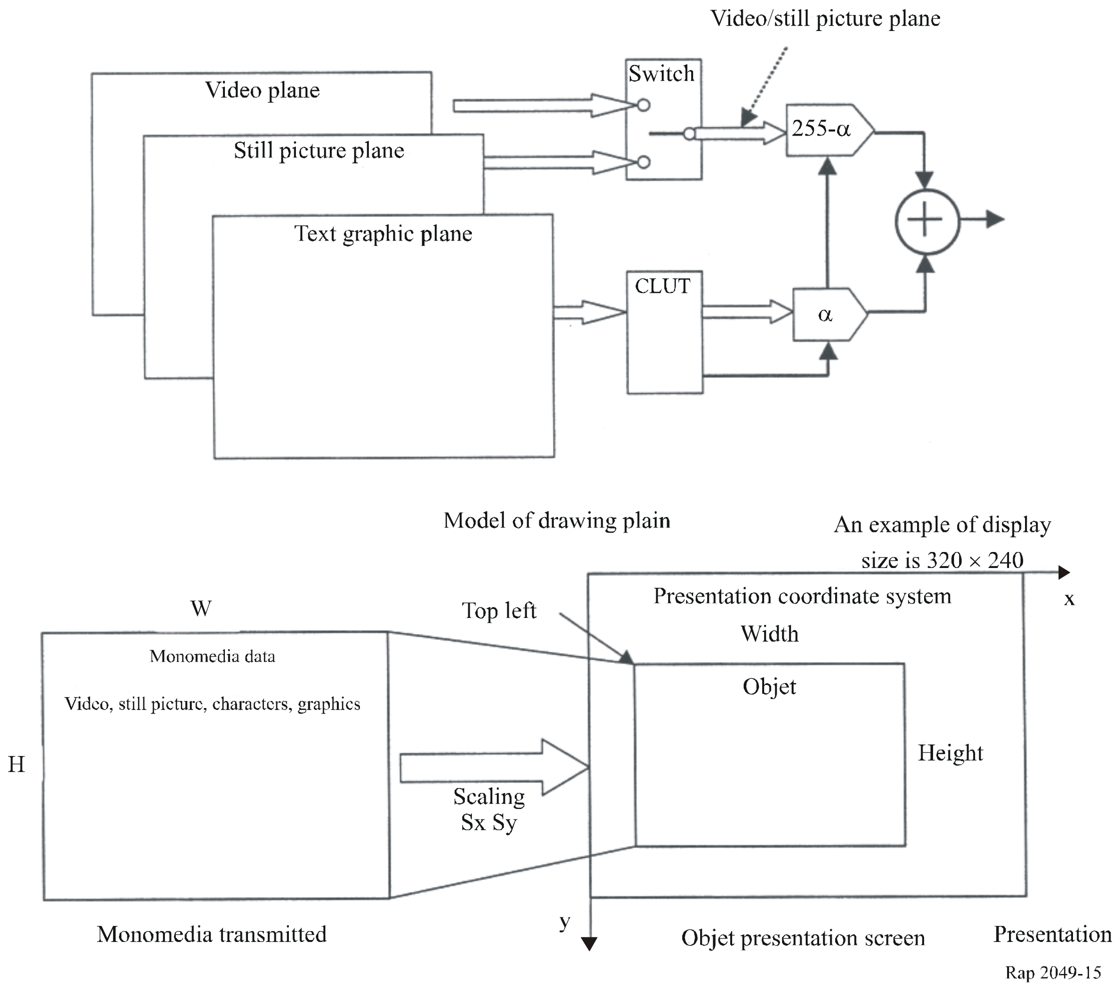


FIGURE 15

Layout patterns of image and data on handheld and vehicular receivers



7 Conclusion

This Report reflects different technologies and multiple implementation approaches. The possibility of soft-hand-over frequency change may be seen as an additional quality of service for the end-user.

Adding mobility to the traditional paradigm of broadcasting may not be sufficient to create a new global market for mobile broadcasting networks, terminals and services.

Ongoing system trials and market studies across all three ITU Regions show that requested content may be different and easier to consume from that of stationary broadcast service offerings.

Appendix 1

Launching of digital terrestrial sound broadcasting services in Japan

The following parts provide the current status of preparations for Japanese terrestrial sound broadcasting services.

The first one is a schedule of broadcasting services. The timetable for launching terrestrial sound broadcasting services in the future is shown in the following:

April 2003: Starting test transmission using precommercial broadcasting facilities.

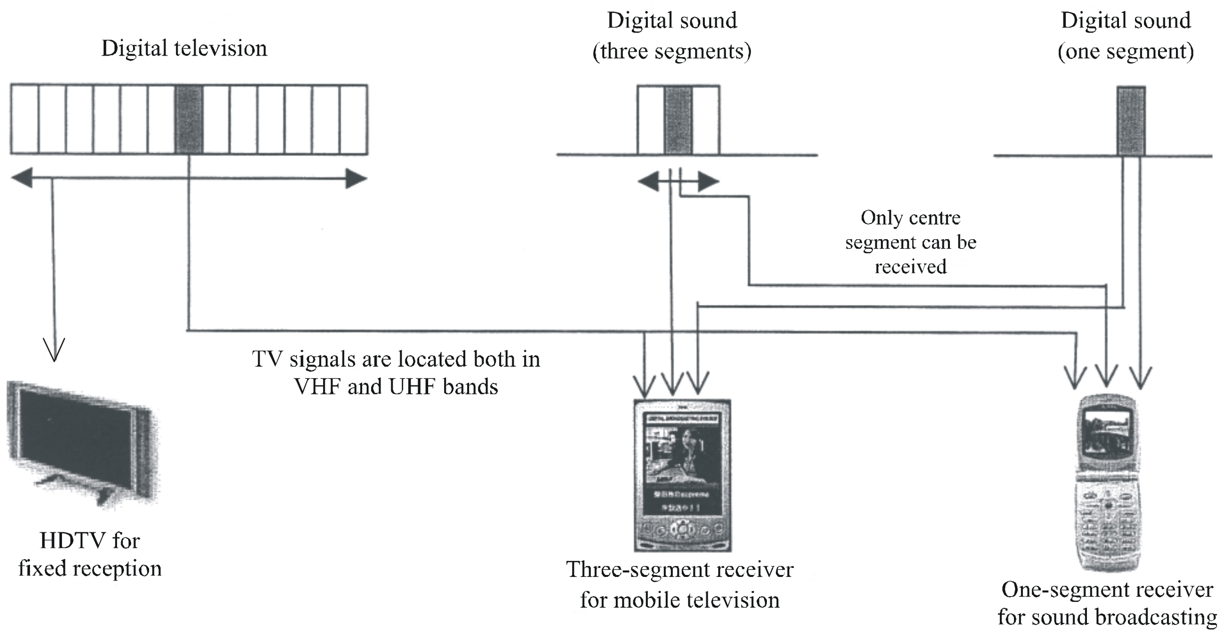
October 2003: Starting pre-commercial broadcasting services in both Tokyo and Osaka areas using VHF Channel 7 (4 MHz bandwidth around 220 MHz).

After 2011: Grand opening of terrestrial digital sound broadcasting services all over Japan.

Interoperability between three types for terrestrial broadcasting systems is shown in Fig. 16. Basic portable receivers could receive three types of digital broadcasting services. The first one is one-segment digital terrestrial sound broadcasting services that use one frequency segment. The second one is the case using the centre segment of three-segment digital sound broadcasting systems. The third one is the case using the centre segment of digital terrestrial television broadcasting services that make use of thirteen segments in total.

FIGURE 16

Relations between 13-segment television receiver, three-segment sound receiver and one-segment sound receiver



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Enhanced receivers can receive three-segment sound broadcasting services with their three-segment receiving capability. In this case, rich contents are available for portable and mobile receivers by using enhanced receivers.

Broadcasting services planed by Tokyo FM station

The following are the current planning of digital terrestrial sound broadcasting services created by the Tokyo FM Radio Station. Figure 17 shows a typical application for three-segment receiver.

A streaming sound programme with various kinds of associated data is the typical case of this FM radio station. In order to satisfy bandwidth requirements for such rich multimedia and data broadcasting services, three frequency segments are required. It is noted that one segment has 432 kHz frequency bandwidth.

FIGURE 17

A typical application for enhanced receivers

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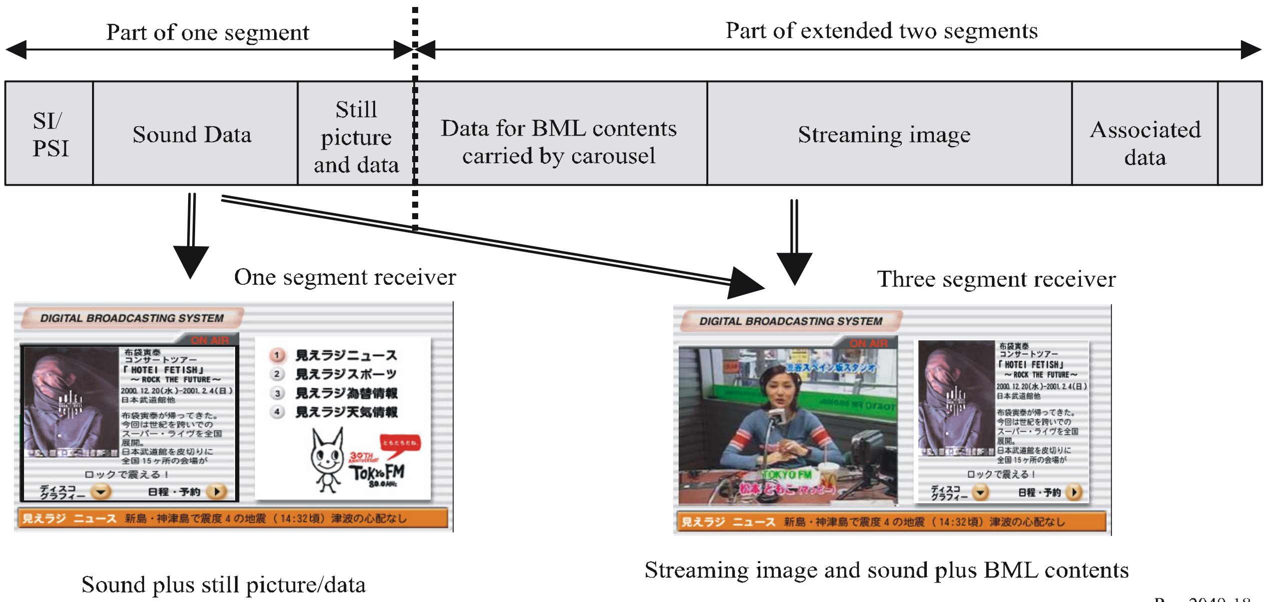
One segment receiver and three-segment receiver

Figure 18 shows the difference of displayed visual contents between one-segment receiver and three-segment receiver.

FIGURE 18

Relations between three-segment sound receivers and one-segment sound receiver



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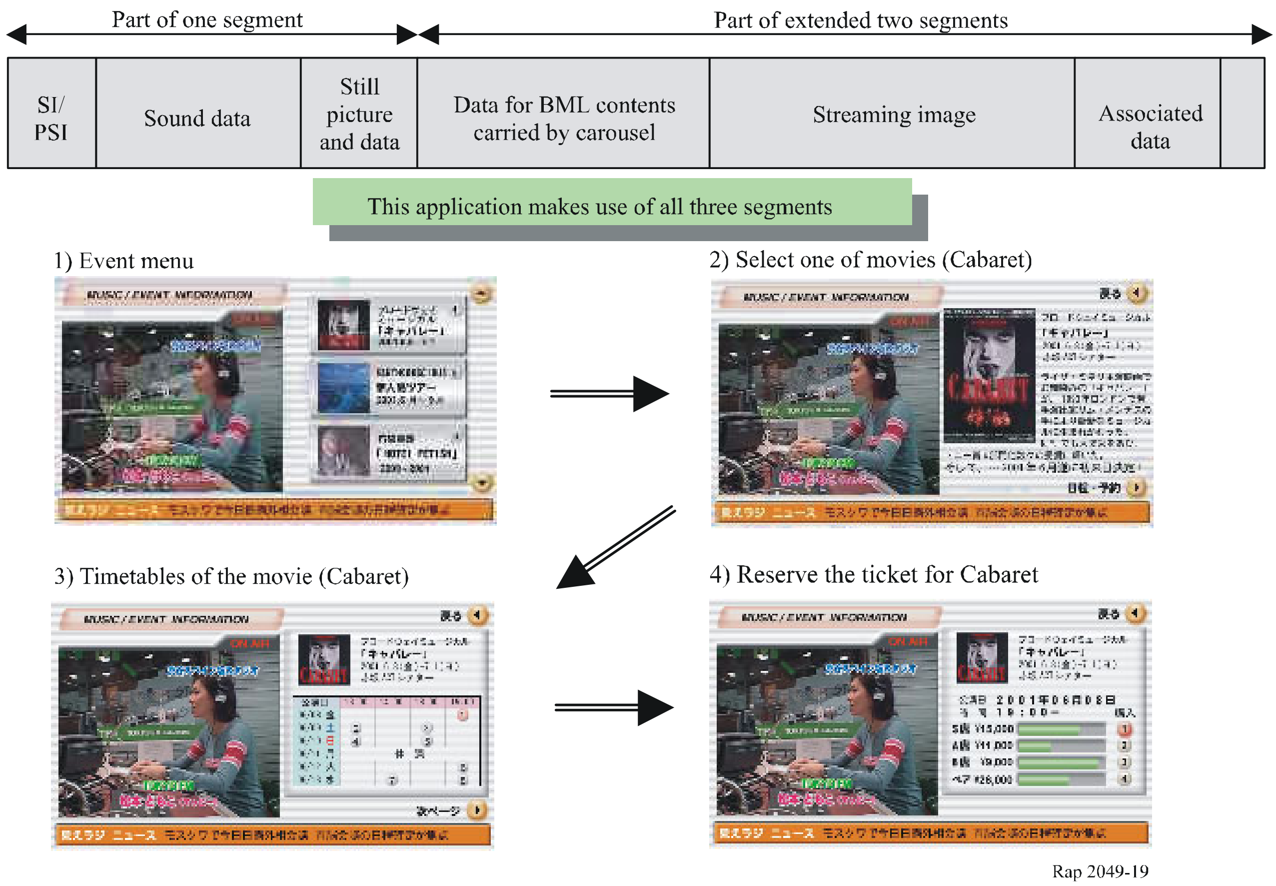
Interactive broadcasting service for portable receiver

Interactive applications are also important for portable receivers. Figure 19 shows one example of ticket reservation by using interactive capability provided by ARIB STD-B24.

FIGURE 19

An example of interactive broadcasting application for ticket reservations

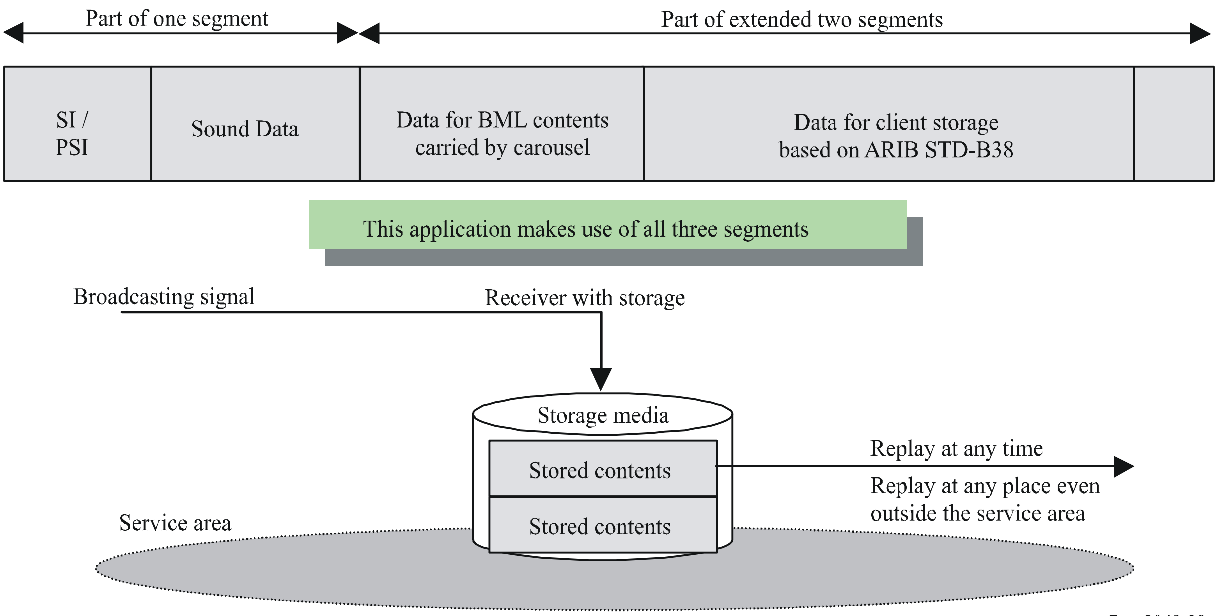


Data broadcasting for client storage

Recently, new ARIB STD-B38 for broadcasting to client storages was approved formally. Figure 20 provides the conceptual diagram of this type of broadcasting services.

FIGURE 20

An example of broadcasting applications for client storage



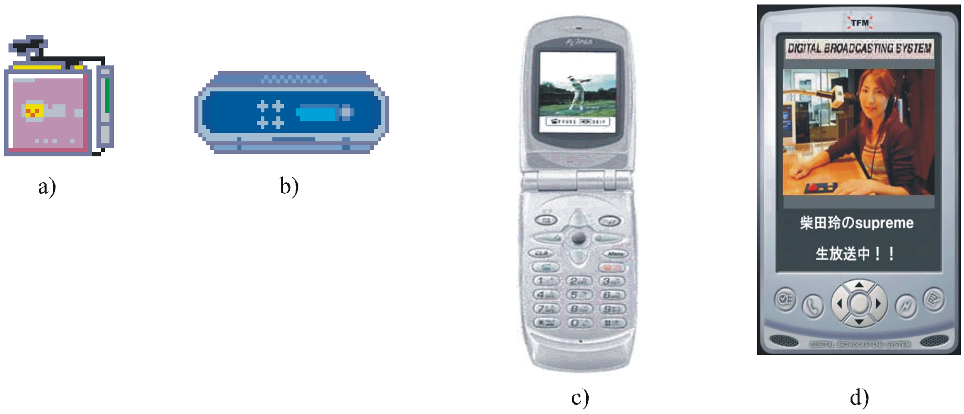
Rap 2049-20

Several types of portable receivers and mobile receivers

Typical types of receivers with brief explanations are shown in Fig. 21.

FIGURE 21

Several types of receivers



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The following are brief explanations for these four types of receivers.

a) Simple pocket radio: sound reception only.

b) Pocket radio/car radio with simplified display capability of a few lines of characters.

c) Portable phone type receiver.

d) Personal digital assistant (PDA) type receiver.

Three other types of receiver are considered without figures in this Report.

e) 5.1-channel surround stereo receiver for car audio system.

f) Fixed digital sound receiver for high-fidelity stereo sound system.

g) PCMCIA card type receiver for open-box type devices like PDA and note PC.

Appendix 2

Experiments of terrestrial digital multimedia broadcasting services in Korea

1 Introduction

In December 2002, the Republic of Korea announced its action plan to introduce digital radio service based on DSB System A with an extension of multimedia service in the VHF band, named Terrestrial Digital Multimedia Broadcasting (T-DMB.) The announcement was driven by the strong demand of mobile multimedia services both from broadcasters and manufacturers. For a couple of years before the announcement was actually made, a working group was in operation for the development of relevant standards. The working group included broadcasters, telecommunication operators, hardware/software manufacturers and research institutes.

The T-DMB standard is ready to be approved by Telecommunication Technology Association (TTA), the Korean telecommunication standard body. Commercial T-DMB service is scheduled to start at the end of 2004.

2 Test trial

The test trial has been conducted using transmission Mode I at channel 12 (204-210 MHz) which is divided into three blocks since the autumn of 2003. Two transmitters are under operation with 4 kW (e.r.p.) at Mt. Kwanak in metropolitan Seoul. Field test results showed that the T-DMB system provides successful mobile video reception. In particular, the system demonstrated robust video reception even while moving at the speed of 100 km/h. Figures 22, 23 and 24 show test systems used for the field test.

FIGURE 22

Reception comparison between NTSC and T-DMB

Rap 2049-22

FIGURE 23

A T-DMB transmission system developed for test trial

Rap 2049-23

FIGURE 24

A measurement vehicle for field test

Rap 2049-24

3 T-DMB receivers

Typical terminals for T-DMB would be portable or handheld receivers, e.g. mobile phones and PDAs. Commercial receivers and chipsets are expected to be available in the market this year. Figure 25 shows a prototype receiver announced in September 2003.

FIGURE 25

An example of prototype receiver

Rap 2049-25

Appendix 3

IPDC/DVB-H: Technology details and trials/pilots on mobile broadcasting

1 Description of DVB-H technology

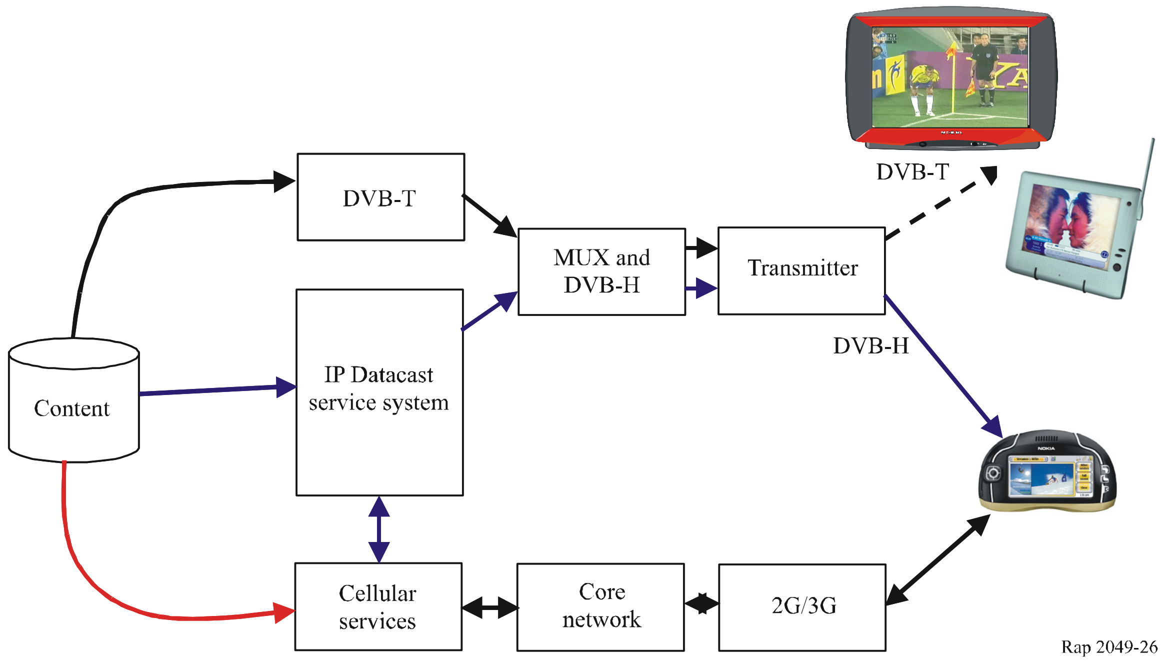
A detailed description of DVB-H technology can be found in the ETSI document EN 302304 and the references therein.

2 Schematic picture of IP Datacast over DVB-H system

Figure 26 is a general schematic view on IP Datacast over DVB-H system. Fig. 26 indicates also the possibility to multiplex DVB-H transport in the same carrier with DVB-T.

FIGURE 26

General schematic view on IP Datacast over DVB-H system



3 IP Datacast over DVB-H trials and piloting

Several IPDC/DVB-H system trials and piloting activities have been set up during the last couple of years. These have been a common effort between content providers, broadcasters, mobile operators and mobile equipment vendors.

The ”Finnish Mobile TV-pilot” in Helsinki, Finland is going to test (after a basic system trial) the consumer acceptance of payable services in a commercial pilot starting early 2005.

The “BMCO” project in Berlin has performed extensive market research clearly indicating that people want to have mobile TV services. Technical tests and basic user trial have shown that IPDC services over mobile optimized DVB-H can be multiplexed to the same broadband carrier with fixed terrestrial DVB-T services.

Another commercial pilot activity is also starting 2005 in Oxford, United Kingdom.

System trials and piloting of IPDC/DVB-H are under consideration in several other European countries. There is also an increasing interest to deploy DVB-H in the United States of America, Australia, Singapore, and so on.

Appendix 4

Terrestrial Mobile Multimedia Multicast (TMMM) technology[14]

1 Description of the TMMM air interface

A new OFDM-based technology has been developed specifically for reception of multimedia services by handheld devices. This new technology is not based on any existing legacy broadcast television standards, and therefore, avoids potential inefficiencies associated with supporting backward compatibility with fixed broadcast reception.

TMMM technology is optimized to address the physical limitations of the terminal, including power consumption, memory and form-factor constraints.

This technology is designed for significantly greater coverage per tower than cellular networks using higher power transmitters and fewer towers. This results in drastically lower cost per bit service delivery over cellular networks.

This technology is at an early stage in the standardization process and, until it receives its official standards development organization designation, will be referred to as the Terrestrial Mobile Multimedia Multicast (TMMM) technology. Further details on TMMM technology will be provided to this ITU Report at a later date.

2 Service areas and interoperability between TMMM and other systems

Figure 27 illustrates how the TMMM system can be deployed and integrated in existing traditional cellular networks. In this example, content that is representative of a linear real-time channel is received directly from content providers utilizing existing infrastructure. Non real time content (clips, etc) may be received over the Internet.

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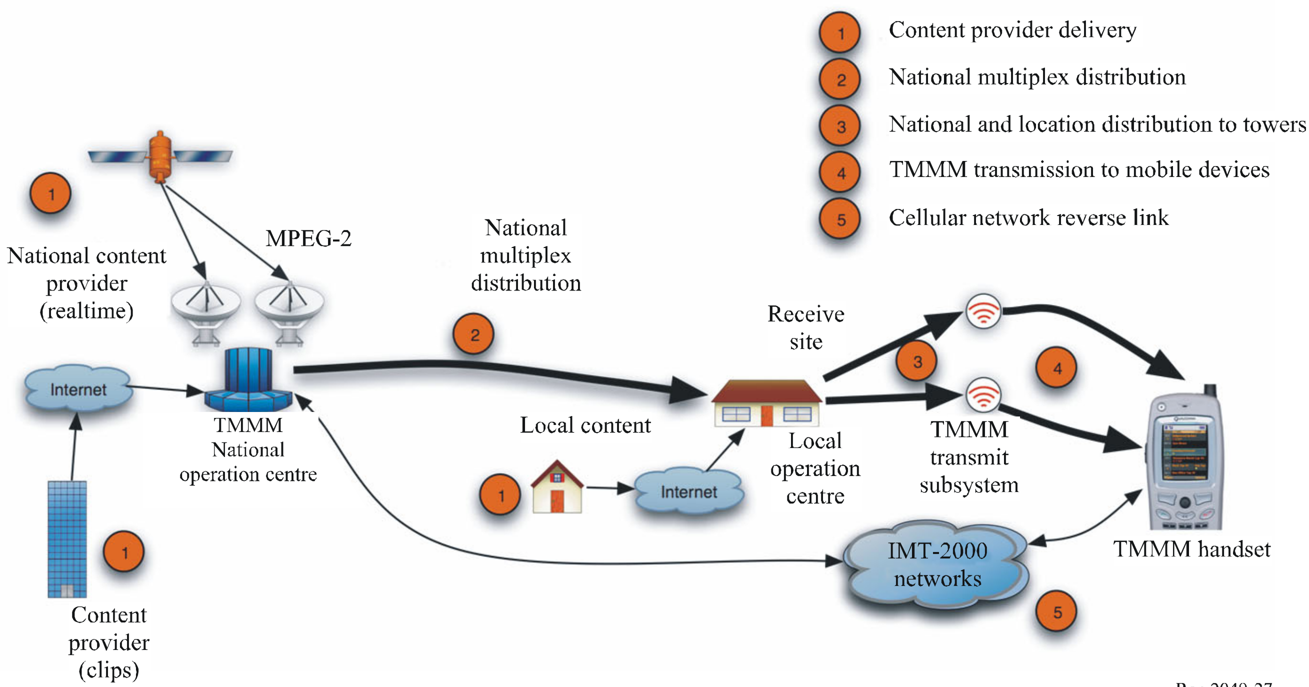
[14] TMMM is also known as the FLO™ technology.

FIGURE 27

An example of TMMM content delivery



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TMMM technology can support the coexistence of local and wide area coverage within a single RF channel. By utilizing a single frequency network, the need for complex handoffs for coverage areas is non-existent. The content that is of common interest to the subscribers in a wide area network is carried by the local area signals and synchronously transmitted by all of the transmitters within the local-area network of that particular market.

Appendix 5

Implementation of interactivity

Digital mobile telephony

Refer to § 2.4.9.1.

Interaction channel making use of the broadcast spectrum

This approach has been studied in the past, but major difficulties with global circulation of user equipment capable of transmitting into the broadcast spectrum have so far been a substantial hurdle. The development of a new two-way data transport standard may also delay the progress.

Other implementations of a mobile interaction channel

Summary of interaction channel methodologies

TABLE 12

General interaction channel methodologies for interactive mobile broadcasting systems

Methodology	Reference standards/Specifications		3GPP/3GPP2 Bearer service
Mobile telephony	IMT-2000	CDMA Direct Spread	HSDPA (Device Category 10)
			HSUPA (E-DCH)
			WCDMA R99
		CDMA Multi Carrier	1X EV-DV Rev D/C
			1X EV-DO Rev A
			CDMA2000 1X
		Other IMT-2000 family members	
	cdmaOne		IS95 Rev A,B
	Global system for mobile communications (GSM)		GPRS (Device Category 10)
			EGPRS
Broadcasting in-band	N/A		N/A