RECOMMENDATION ITU-R BT.1833*

Broadcasting of multimedia and data applications for mobile reception by handheld receivers

(Question ITU-R 45/6)

(2007)

Scope

This Recommendation provides an answer to the specific objectives of Question ITU-R 45/6 in order to guide administrations, as well as the broadcasting and radiocommunication industries, in the development of mobile broadcasting multimedia and data solutions. The scope of this Recommendation deals with the special aspects of end user requirements for handheld receivers.

The ITU Radiocommunication Assembly,

considering

a) that digital television and sound broadcasting systems have been implemented in many countries and will be introduced in many more in the coming years;

b) that multimedia and data broadcasting services have been introduced, or are planned to be introduced, using the inherent capability of digital broadcasting systems;

c) that mobile telecommunication systems with advanced information technologies are planned to be implemented in some countries, and will be implemented in other countries in the near future;

d) that the characteristics of mobile reception are quite different from the fixed reception cases;

e) that digital broadcasting services are expected to be offered in a variety of reception environments including those aimed at indoor, portable, handheld and vehicular receivers;

f) that the display sizes and receiver capabilities of handheld, portable and vehicular receivers are different from those of fixed receivers;

g) that a special case of mobile reception by handheld receivers requires specific technical characteristics;

h) the need for interoperability between the mobile telecommunication services and interactive digital broadcasting services;

j) the need for technical methods to ensure cyber security and conditional access solutions,

noting

a) that there are telecommunication systems not explicitly dedicated to broadcasting services, such as Multimedia Broadcast/Multicast Services (MBMS) as shown in Appendix 1 that fulfil the requirements for interoperability between mobile telecommunication services and interactive digital broadcasting services,

---

* *Note by the BR Secretariat* – This Recommendation was amended editorially in April 2008.

recommends

1 that administrations wishing to implement broadcasting of multimedia and data applications for mobile reception by handheld receivers are invited to consider the end user requirements as stated in Annex 1 for the evaluation and assessment of the respective system characteristics of multimedia systems as described in Tables 1, 2 and 3 for the type of applications that meet these end user requirements;

2 that Multimedia Systems listed in Annex 1 and further described in Annexes 2 through 5, may be applied for broadcasting of multimedia and data applications for mobile reception by handheld receivers.

NOTE 1 – Appendices 1 and 2, attached to this Recommendation, are for information.

Annex 1

1 Introduction

The end user experience and the related applications for handheld reception are different from those already available, for portable and vehicular reception. In addition, the physical limitations of handheld receivers imply specific system characteristics to meet the end user requirements.

Therefore the scope of this Recommendation on broadcast multimedia and data applications for mobile reception is in particular dealing with the special aspects of the operation of handheld devices.

1.1 Handheld receivers

Handheld receivers are battery operated devices which have significant physical limitations inherent in their dimensions (small antenna, screen sizes, etc.), screen resolution, computing power, battery capacity, etc.

1.2 Portable receivers

Portable receivers are devices which are less power-constrained and therefore might offer higher computing power. As an example, this might result in the offering of higher picture resolution applications than possible with handheld receivers.

1.3 Vehicular receivers

Vehicular receivers do not have the same physical and power-related limitations as handheld receivers have. However, the speed at which vehicular receivers may operate, on average, may be much higher. Vehicular receivers might be connected to vehicular mounted external antennas.

2 Abbreviations

3GPP	3rd Generation Partnership Project #1
AAC	Advanced audio coding
ALC	Asynchronous layered coding
AMR NB/WB	Adaptive multi rate narrow band/wide band

AVC	Advanced video coding
ARIB	Association of Radio Industries and Businesses (Japan)
BCAST	OMA mobile broadcast services
BER	Bit error rate
BIFS	Binary format for scene description
BMP	Bit map
BM-SC	Broadcast multicast service centre
BSS (sound)	Broadcasting-satellite service for sound
CDM	Code division multiplex
CDMA	Code division multiple access
CIF	Common interchange format
C/*N*	Carrier to noise ratio
CLUT	Colour look-up table
CRC	Cyclic redundancy check
DAB	Digital audio broadcasting
DQPSK	Differential QPSK
DSB	Digital sound broadcasting
DVB-H	Digital video broadcasting – handheld
DVB-T	Digital video broadcasting – terrestrial
ECMA	ECMA International (former European Computer Manufacturers Association)
ER-BSAC	Error resilience – bit sliced arithmetic coding
ESG	Electronic Service Guide
ETSI	European Telecommunications Standards Institute
ETSI EN	ETSI European Norm
ETSI ES	ETSI Standard
ETSI TS	ETSI Technical Specification
FCC	Federal Communications Commission
FEC	Forward error correction
FLO	Forward link only
FLUTE	File delivery over unidirectional transport
GERAN	GSM Enhanced Radio Access Network
GGSN	Serving GPRS Support Node
GIF	Graphics interchange format
GSM	Global System for mobile communications
GTP	General Packet Radio Service (GPRS) Tunnelling Protocol
HE-AAC	High efficiency advanced audio coding

HLR	Home location register
JPEG	Joint Photographic Experts Group
IEC	International Electrotechnical Commission
IETF	Internet Engineering Task Force
IMT-2000	International mobile telecommunications 2000
IOD	Initial object descriptor
IP	Internet Protocol
IPDC	Internet Protocol Data Cast
IPTV	Internet Protocol Television
ISDB-T	Terrestrial integrated services digital broadcasting
ISO	International Organization for Standardization
LOC	Local Operation Centre
MBMS	Multimedia broadcast/multicast services
MCCH	MBMS point-to-multipoint control channel
MICH	MBMS notification Indicator channel
MPE	Multi Protocol Encapsulation
MPEG	Motion Picture Experts Group
MSCH	MBMS point-to-multipoint scheduling channel
MTCH	MBMS point-to-multipoint traffic channel
NOC	National Operation Centre
OD	Object descriptor
OFDM	Orthogonal frequency division multiplexing
OIS	Overhead Information Symbols
OMA	Open mobile alliance
OSI	Open System Interconnect model
PC	Personal COMPUTER
PDA	Personal digital assistant
PDC	Packet data convergence protocol
PES	Packetized elementary stream
PHY	Physical Layer
PLMN	Public land mobile network
PNG	Portable networks graphics
PSI	Program Specific Information
QAM	Quadrature amplitude modulation
QCIF	Quarter CIF
QoS	Quality of service

QPSK	Quadrature phase shift keying
QVGA	Quarter video graphics array
RF	Radio Frequency
RS	Reed Solomon
RTP	Real time protocol
S-DMB	Satellite-digital multimedia broadcasting
SFN	Single frequency network
SI	Service information
SL	Sync Layer
SNR	Signal to noise ratio
SP-MIDI	Scalable polyphony MIDI
SQVGA	Sub quarter video graphics array
SGSN	Serving GPRS support node
SVG	Scalable vector graphics
T-DAB	Terrestrial digital audio broadcasting
TDM	Time division multiplexing
T-DMB	Terrestrial-digital multimedia broadcasting
TS	Transport Stream
TTI	Transmission time interval
UE	User Equipment
UMTS	Universal Mobile Telecommunications System
UTRAN	UMTS Terrestrial Radio Access Network
VC-1	SMPTE 421M-2006 Video Codec Standard
WDF	Wide DMB Format

3 User requirements

Some user requirements are very different to those for fixed reception scenarios. In the case of mobile reception of broadcast multimedia and data by handheld receivers, specific aspects arise because of the differences in the usage scenarios of the receiving devices. The following requirements should be considered when implementing broadcast multimedia and data applications for mobile reception to handheld devices:

– delivery of high-quality multimedia content including video, audio and/or data services;
– flexible configuration of a large variety of services (audio/video, ancillary and auxiliary data);
– access to content and services may be controlled via conditional access/service access protocols and other content protection mechanisms;
– seamless service access to content and services across networks;

– support for fast discovery and selection of content and services characterized for example, by channel acquisition time, service switching time[1], scheduled content delivery mechanisms, etc;

– support for efficient mechanisms to minimize power consumption and physical dimensions of the handheld receivers;

– support for stable and reliable service coverage for handheld receivers in various reception environments;

– support for interactivity, e.g. interactive content and applications, and/or interaction channel capabilities on handheld receivers, etc.;

– support for efficient and reliable delivery (transport) mechanisms of services; and

– technical aspects enabling interoperability of the services between broadcast and telecommunication networks, for example, content format, audio/video codecs, encapsulation methods, etc.

Additional informative user requirements:

– support for stable and reliable reception and provision of quality of service comparable to fixed reception in the mobile environment, where multipath-reflections and Doppler-shifts introduce unrecoverable errors in the broadcast data stream. Such requirements are further addressed in Appendix 2 as an informative reference.

The Tables 1 to 3 provide lists of system characteristics and the technical performance of multimedia broadcasting systems for mobile reception in response to the user requirements in § 3.

In Tables 1 to 3, the following systems are described:

– Multimedia System “A” is based on Terrestrial Digital Multimedia Broadcasting (T-DMB, ITU-R BS.1114 System A, ETSI TSs 102 427 and 102 428),

– Multimedia System “C” is based on Integrated Services Digital Broadcasting-Terrestrial (ISDB-T one segment),

– Multimedia System “E” is based on digital System E of Recommendations ITU-R BO.1130 for satellite component and ITU-R BS.1547 for terrestrial component,

– Multimedia System “F” is based on Integrated Services Digital Broadcasting-Terrestrial Sound Broadcasting (ISDB-T_{SB}),

– Multimedia System “H” is based on Digital Video Broadcasting-Handheld (DVB-H, ETSI EN 302 304),

– Multimedia System “M” is based on Forward Link Only Air Interface Specification for Terrestrial Mobile Multimedia Multicast (TIA-1099).

[1] The service switching time is the time between the user selection of a new real-time streaming service and the initial display of this delivered service to the end user.

TABLE 1

System characteristics of multimedia broadcasting for mobile reception by handheld receivers

	Multimedia System "A"	**Multimedia System "C"**	**Multimedia System "E"**	**Multimedia System "F"**	**Multimedia System "H"**	**Multimedia System "M"**
System characteristics description	This system, also known as terrestrial digital multimedia broadcasting (T-DMB) system, is an enhancement of T-DAB system to provide multimedia services including video, audio, and interactive data services for handheld receivers in a mobile environment. Multimedia System "A" uses T-DAB networks and is completely backward compatible with T-DAB system for audio services.	The stream signal of this system can be multiplexed with the signal for the stationary reception that co-exists within a single stream. And rich content format such as script program support provides good interactivity on a small device.	Target receivers are typically handheld type with a 3.5 inch wide display for QVGA video and data broadcasting in addition to high quality audio. Satellite section covers nation wide and gap-fillers augment shadow areas from the satellite path. Suitable broadcasting system is digital System E of Recommendation ITU-R BO.1130.	Video, high-quality audio and data services can be configured flexibly. In addition, support of script interpreter for rich content format provides content and service flexibility in multimedia broadcasting for handheld receivers.	An end-to-end broadcast system for delivery of any type of digital content and services using IP-based mechanisms, such as those included in the IP Datacast (IPDC) or OMA BCAST specifications. It is based on DVB-H, which is an enhancement, optimized for handheld terminals, of the DVB-T digital broadcast standard, with which it shares the physical radio environment.	An end-to end system that enables broadcasting of video streams, audio-only streams, digital multimedia files, and data-casting to mobile devices, including handheld receivers. The system is designed to optimize coverage, capacity and power consumption as well as overall user experience for handheld receivers using TIA-1099 air interface standard.

TABLE 2

User requirements of multimedia broadcasting systems for mobile reception by handheld receivers

User requirements	Multimedia System "A"	Multimedia System "C"	Multimedia System "E"	Multimedia System "F"	Multimedia System "H"	Multimedia System "M"
High quality multimedia for handheld receivers a) Media type with quality characteristics – Resolution – Frame rate – Bit rate	Video: – QVGA, WDF – Up to 30 fps – Up to 768 kbit/s – Various resolutions and frame rates supported Audio: – Stereo – Up to 192 kbit/s Data: – Binary data, text, still images – Subtitling (synchronized hypertext with A/V) – Typical combination of AV is QVGA at 30 fps with 368 kbit/s, and stereo audio 48 kbit/s	Video: – Normally, QVGA (320 × 240) or 320 × 180 size – 15~30 fps – Various resolutions and frame rates supported Audio: – Stereo Others – Still images – Text – Closed caption	Video: – Normally, QVGA (320 × 240) size – Various resolutions and frame rates supported Audio: – Stereo Others: – Still images – Text – (Closed caption)	Video: – QVGA (320 × 240) and SQVGA (160 × 120) size – Various resolutions and frame rates supported Audio: – Stereo Others: – Still images – Text – (Closed caption)	Video: – QVGA, WQVGA – Up to 30 fps – Up to 768 kbit/s* per service stream – Various resolutions and frame rates supported Audio: – Stereo – From ~20 kbit/s up to 192 kbit/s Data: – Binary data, text, still images – Subtitling (synchronized hypertext with A/V) – Typical combination of AV is QVGA at 30 fps with 300 kbit/s, and stereo audio 48 kbit/s	Video: – QVGA, WQVGA as well as other display resolutions – Up to ~2.25 Mbit/s per stream – Up to 30 fps Audio: – Stereo and mono – ~12 kbit/s and higher bit rate can be supported Data: – Binary data – Text, closed captions – Still images – Subtitling – Data, audio/video file distribution – Quality of service per media type Video and audio data rates range from ~2.25 Mbit/s down to 12 kbit/s

TABLE 2 (*continued*)

User requirements	Multimedia System "A"	Multimedia System "C"	Multimedia System "E"	Multimedia System "F"	Multimedia System "H"	Multimedia System "M"
b) Monomedia coding: – Video – Audio – Others	Video: – MPEG-4 – H.264/AVC Audio: – MPEG-4 ER BSAC/MPEG-4 HE-AAC audio – MPEG-2 Audio Layer II Data format: – MP4 file – JPEG, PNG, MNG, BMP, etc. – ASCII text, etc.	Video: – MPEG-4 AVC/H.264 Audio: – AAC (SBR optional) – AIFF-C – Stream and file type playback supported Still images: – JPEG – GIF	Video: – MPEG-4 – MPEG-4 AVC/H.264 Audio: – AAC (SBR optional) – AIFF-C Still images: – JPEG – PNG – MNG	Video: – MPEG-4 – AVC/H.264 Audio: – AAC (SBR optional) – AIFF-C – Stream and file type playback supported Still images: – JPEG – GIF	Video: – H.264/AVC – VC-1 (optional) Audio: – HE AAC v2 – AMR-WB+ (Optional for improved low data rate and especially speech service performance) Data format: – 3GP and MP4 file – JPEG, GIF, PNG – Character encoded (3GPP Timed text) or bitmap based subtitling	Video: – H.264/AVC Audio: – HE AAC v2 Data format: – MPEG4 files – JPEG – BMP – Timed text subtitles based on 3GPP – Auxiliary data capability providing extensibility to support of additional data types

TABLE 2 (*continued*)

User requirements	Multimedia System "A"	Multimedia System "C"	Multimedia System "E"	Multimedia System "F"	Multimedia System "H"	Multimedia System "M"
Flexible configuration of services: – Audio/video – Ancillary and auxiliary data	– Real-time audio and video – Digital radio – Multimedia object file casting via carousel system – Electronic Program Guide (EPG) – Subtitling (synchronized hypertext with A/V via MPEG-4 BIFS – Any combination of the previous contents in the same multiplex and with T-DAB services – 5 real-time streaming services (QVGA at 30 fps with 368 kbit/s, and stereo audio 48 kbit/s) per 1.536 MHz spectrum of DMB ensemble – National/local broadcast using combination of SFN and MFN	– Any combination of real-time audio, video and data broadcast is available – Electronic Program Guide – Appropriate service that fits to licensed service area can be offered	Two or more CDM channels are combined into one logical channel. This mechanism provides flexible configuration using audio, multimedia and data services Because of the nature of BSS (sound) system, the licensed area is national, however gap fillers can provide local services technically	– Any combination of real-time audio, video and data broadcast is available – Electronic Program Guide – Appropriate service that fits to licensed service area can be offered	– Real-time audio and video – Digital radio. – Scheduled content and file download/ file carousel. – Electronic Service Guide (ESG) – Subtitling (synchronized hypertext with A/V) – Any mix of the previous contents in the same multiplex and with DVB-T services. – 30 real-time streaming services (QVGA at 30 fps with 300 kbit/s, and stereo audio 48 kbit/s) per ~11 Mbit/s channel (8 MHz spectrum) – National/local area content with SFN network	– Real-time audio and video – Scheduled content and file download based on network load – IP data streams – Electronic programme guide – Support of national and local area coverage within one single or multiple RF carriers – Up to 30 real-time video plus audio streaming services at QVGA, 30 fps, 34 dB minimum PSNR (16-QAM 1/2, C/N = 13.5 dB in typical urban mobile environment)

TABLE 2 (*continued*)

User requirements	Multimedia System "A"	Multimedia System "C"	Multimedia System "E"	Multimedia System "F"	Multimedia System "H"	Multimedia System "M"
Conditional access	Supported	Applicable	Supported	Applicable	Standardized service purchase and protection supported over IP	Supported
Seamless service access	Supported	Applicable	Applicable	Applicable	Supported; end user moving from one (home) mobile broadcast network to another network is able to access broadcast services provided by the visited network, using the authorization of the original (home) service provider	Supported
Fast discovery and selection of content and services	– T-DAB Electronic Program Guide supported: Support for fast discovery and selection of services based on various criteria, acquisition information for services access	Electronic Program Guide support for discovery and selection of services	Electronic Program Guide support for discovery and selection of services based on various criteria, acquisition information for services access and content consumption, purchase information	Electronic Program Guide support for discovery and selection of services	Standardized Electronic Service Guide over IP: Support for fast discovery and selection of services based on various criteria, acquisition information for services access and content consumption, purchase information	Network independent service discovery and Electronic Program Guide supported over broadcast network supported IP data services over broadcast and interactivity channel Support for fast service acquisition, and service switching time, scheduled content delivery

TABLE 2 (*continued*)

User requirements	Multimedia System "A"	Multimedia System "C"	Multimedia System "E"	Multimedia System "F"	Multimedia System "H"	Multimedia System "M"
Low power consumption for handheld receivers	– Low power consumption feature of DAB is applied – Optimized narrow bandwidth allows low system clock frequency and simple FFT calculation. Supports sub-channel decoding for selected service	Narrow bandwidth allows low system clock frequency	The broadcasting system has a mechanism for using limited number of CDM channels for receiving broadcast services. This allows for lower power consumption of receivers	Narrow bandwidth allows low system clock frequency	Time slicing (~90% power saving compared to continuous reception in the DVB-H receiver part) The viewing time is not limited by the DVB-H receiver but by the video/audio decoders, displays and speakers	Supports selective access to desired content (partial signal demodulation) which is achieved in both time and frequency domains Data is transmitted (synchronously) from the transmitter station to the handset every second. Each transmission has therefore 1 second duration and includes the information required by the receiver to demodulate only that portion of the data (service) that the user is interested in
Provision of interactivity	Supports hypertext linkage using mobile telecommunication network and Internet MPEG-4 BIFS provides frame-synchronized overlay of animated text and graphics objects upon natural scenes	BML supports both local and bidirectional interactivity	BML supports both local and bidirectional interactivity	BML supports both local and bidirectional interactivity	Supports local and remote interactive applications using IMT-2000 and/or digital cellular networks or other IP connections Electronic service guide provides the basic access information to enable interactive services	Interactivity content and applications use: – References to interactive services available on the devices or remotely located – Return channel using IMT-2000 networks, and/or other IP connections

TABLE 2 (*continued*)

User requirements	Multimedia System "A"	Multimedia System "C"	Multimedia System "E"	Multimedia System "F"	Multimedia System "H"	Multimedia System "M"
Interoperability with mobile telecommunication networks	Support for traditional and mobile telecommunication network and Internet, e.g. IMT-2000 networks, IEEE 802.1x, etc.	Delivery networks such as communication or broadcasting network are clearly identified	Delivery networks such as communication or broadcasting network are clearly identified	Delivery networks such as communication or broadcasting network are clearly identified	Same IP-based solutions, optimized for handheld device reception, used to enable delivery of services over both broadcast and mobile cellular networks (3GPP) Maximum harmonization with e.g. A/V codecs, payload formats, content delivery protocols	Support for traditional voice and data services over mobile telecommunication networks such as IMT-2000 systems Platforms harmonization enabled via IP
Support for efficient and reliable delivery (transport) mechanisms of services	MPEG-2 TS transport protocol compatible with digital television – MPEG-4 SL for adaptation of MPEG-4 – Streaming to MPEG-2 TS – Allows guaranteed RS code in digital broadcasting as FEC code	Transport protocol based on MPEG2-TS	Transport protocol based on MPEG-2 TS	Transport protocol based on MPEG2-TS	Standard IP-based technologies fully deployed: RTP for streaming, FLUTE/ALC for file download delivery Optional application layer FEC supported for file delivery	Transport protocol similar to MPEG2-TS – Real-time streaming media is delivered directly to a sync layer – IP is used for delivery of "non real-time" content or data (text and graphics)

TABLE 2 (*end*)

User requirements	Multimedia System "A"	Multimedia System "C"	Multimedia System "E"	Multimedia System "F"	Multimedia System "H"	Multimedia System "M"
Support for efficient and reliable delivery (transport) mechanisms of services (*cont.*)	– Any IP based contents can be delivered by IP tunnelling method – Aggregate bit rate for total real time streaming service is 1.25 Mbit/s for mobile environment – Small overhead for data delivery (MPEG-2 TS and MPEG-4 SL					

* Maximum bitrates limited for handheld receivers through profiling the general specifications to enable cost-efficient implementations of devices.

TABLE 3

Normative References for Multimedia broadcasting systems for mobile reception by handheld receivers

	Multimedia System "A"	**Multimedia System "C"**	**Multimedia System "E"**	**Multimedia System "F"**	**Multimedia System "H"**	**Multimedia System "M"**
Physical Layer	BS.1114 System A	BT.1306 System C	BO.1130 System E and BS.1547 System E	BS.1114 System F	ETSI EN 302 304	TIA-1099
Encapsulation and protocols for transmission of content	ETSI EN 300 401 ETSI TS 102 427 ISO/IEC 13818-1 ISO/IEC 14496-1 ISO/IEC 14496-11 ETSI TR 101 497 ETSI TS 101 759 ETSI ES 201 735 ETSI TS 101 499 ETSI TS 101 498-1 ETSI TS 101 498-2	BT.1207, 1209 and BT.1300 ISO/IEC 13818-1 MPEG-2 Systems ISO/IEC 13818-6 ARIB STD-B24 Volume 3 Data Carousel			ETSI EN 302 304 ETSI TS 102 470 ETSI TS 102 472	TIA-1099
Multimedia Content Format	ETSI EN 301 234	BT.1699 and ITU-T J.201 ARIB STD-B24 Volume 2 BML			ETSI TS 102 005	ISO/IEC 14496-14

TABLE 3 (*end*)

		Multimedia System "A"	**Multimedia System "C"**	**Multimedia System "E"**	**Multimedia System "F"**	**Multimedia System "H"**	**Multimedia System "M"**
Mono-media Coding	Audio Coding	ISO/IEC 11172-3 and 13818-3 ISO/IEC 14496-3 for MPEG-4 ER BSAC/MPEG-4 HE-AAC ETSI TS 102 428	BS.1115 ISO/IEC 13818-7 MPEG-2 AAC (optional SBR enhancement)			ETSI TS 102 005	IEO/IEC 14496-3/2001: Amd. 4
	Video Coding	ITU-T Rec. H.264 and ISO/IEC 14496-10 MPEG-4 AVC ETSI TS 102 428	ITU-T Rec. H.264 and ISO/IEC 14496-10 MPEG-4 AVC			ETSI TS 102 005	ISO/IEC 14496-2 /10 MPEG-4 AVC
	Others e.g. binary data/ text, still picture, etc.	ETSI EN 301 234 (Note 2)	ARIB STD-B24 Volume 1 Part 2 (Note 1)			ETSI TS 102 005 ETSI TS 102 471 ISO/IEC 10918 (JPEG)	ISO/IEC 10918 (JPEG)

NOTE 1 – ARIB STD-B24 Volume 1 Part 2 defines available encoding schemes and encoding parameters for still pictures, animation and characters in addition to audio and video. It covers JPEG, PNG, MNG, MPEG 2-I, MPEG 1 video, PCM sound, JIS8bit character and UCS.

NOTE 2 – ETSI EN 301 234 defines the multimedia object transfer protocol that delivers MP4 files (ISO/IEC 14496-14) in addition to multimedia files such as JPEG, PNG, MNG and BMP.

NOTE 1 – The Standards and Recommendations which are normatively or informatively referenced throughout this Recommendation are freely available at the websites of the respective Standards Development Ortganizations, as indicated below:

– www.etsi.org
– www.tiaonline.org
– www.arib.or.jp
– www.ietf.org.

4 Summaries of Multimedia Systems

4.1 Multimedia System "C" (ISDB-T) and Multimedia System "F" (ISDB-T_{SB})

The System C of Recommendation ITU-R BT.1306, also known as ISDB-T, provides hierarchical transmission features. This enables allocation of signals for mobile reception, requiring greater robustness, in the same channel as that for stationary reception. Use of "OFDM segment", a unit of OFDM carriers corresponding to 1/13 of a channel, is a key technique for this.

In ISDB-T, the transmission parameters of the modulation scheme of OFDM carriers, the coding rates of inner error correcting code and the length of the time interleaving can be independently specified for each segment. One or more segments form a segment group, of up to three per channel. A segment group is the basic unit to deliver broadcast services, hence transmission parameters of the segments are common within the group.

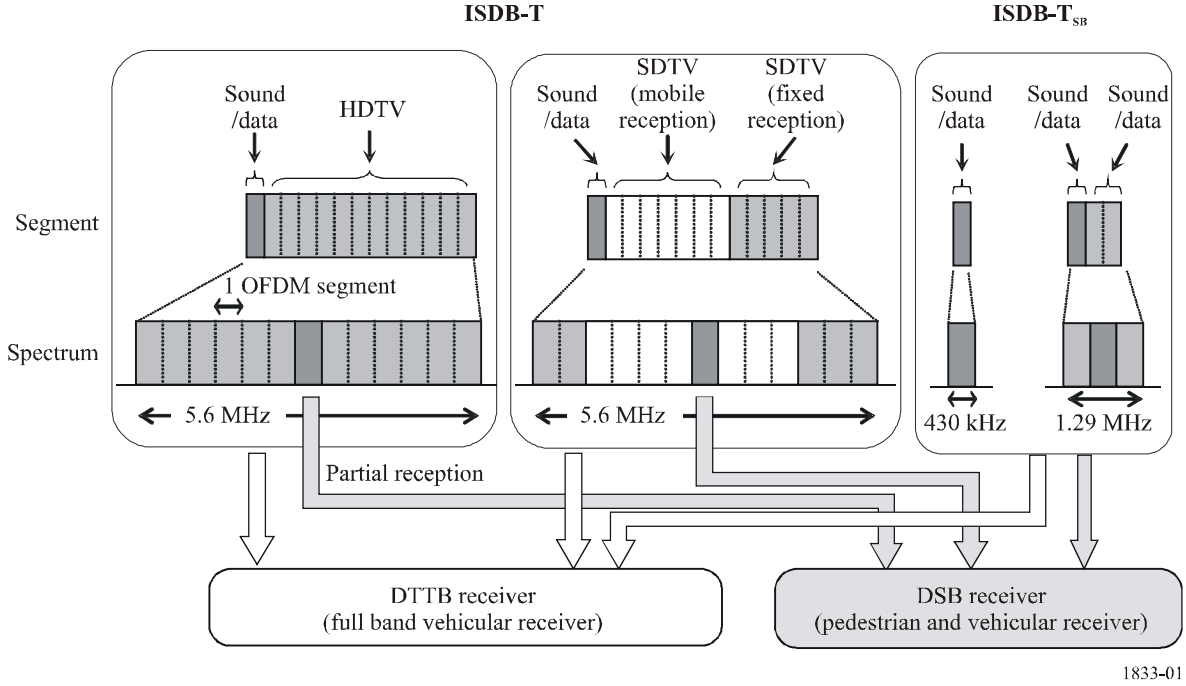
The centre segment is a special segment that is suitable to establish a segment group having only one segment. When only the centre segment forms a segment group, the segment can be received independently. This is called partial reception.

The Digital System F of Recommendation ITU-R BS.1114, also known as ISDB-T_{SB}, is designed for sound and multimedia and data broadcasting with a concept of a narrow-band edition of ISDB-T. The number of the segments for ISDB-T_{SB} is one or three. In the case of one segment, a receiver for this is compatible with partial reception of ISDB-T.

Figure 1 shows services and usage of ISDB-T/T_{SB} transmission signals.

FIGURE 1

Services and usage of ISDB-T/T_{SB} transmission signals



4.2 Multimedia System "E"

The system is designed to provide satellite and complementary terrestrial on-channel repeater services providing high-quality digital audio, medium quality video, multimedia and data services for portable, vehicular and fixed reception. It has been designed to optimize the performance of satellite and terrestrial on-channel repeater services in the 2.6 GHz band that is allocated in some countries, including Japan. This is achieved through the use of CDM (code division multiplex) based on QPSK modulation with concatenated code using Reed-Solomon code and convolutional error correcting code. The Digital System E receiver uses state-of-the-art microwave and digital large-scale integrated circuit technology with the primary objective of achieving low-cost production and high-quality performance.

The main features of this system are as follows:

1. It is the first digital sound broadcasting system that has been launched since October 2004 for commercial broadcasting services using the 2 630-2 655 MHz band, which is assigned to BSS (Sound) in some countries.
2. MPEG-2 Systems architecture facilitates multiplexing of many broadcasting services and interoperability with other digital broadcasting services. This is the first BSS (sound) system to adopt MPEG-2 Systems.
3. MPEG-2 AAC, optionally plus SBR (spectral band replication), is adopted for audio source coding. It gives the most efficient audio compression performance for high quality digital audio broadcasting services at targeted transmission speeds of this system.
4. Portable reception is one of the major targets of this system. Handheld receivers have been developed with 3.5 inch wide LCD display.
5. Vehicular reception is another of the major targets of this system. Listeners/viewers can enjoy stable reception in high-speed vehicles in a broadcasting environment.

6. Satellite signals can be received by mobile receivers using an omnidirectional single-element antenna in the horizontal plane and a two-antenna diversity reception scheme.

4.3 Multimedia System "A" (T-DMB)

Multimedia System "A", also known as Terrestrial digital multimedia broadcasting (T-DMB) system, is the extended system compatible with digital sound broadcasting system A[2], which enables video services using T-DAB networks for handheld receivers in a mobile environment. This system uses spectrum in Band III and L-Band in which T-DAB networks are in operation.

T-DMB provides multimedia services including video, audio, and interactive data. For audio services it uses ISO/IEC 11172-3 and 13818-3 for MPEG-2 Audio Layer II as specified in DSB System A, MPEG-4 ER-BSAC or MPEG 4 HE AAC. For video services ITU-T H.264 | MPEG-4 AVC standard is used for video, MPEG-4 ER-BSAC or MPEG-4 HE AAC for the associated audio, and MPEG-4 BIFS and MPEG-4 SL for interactive data. Outer channel coding of Reed-Solomon code is applied to provide stable performance of video reception.

Field test results and the summary of T-DMB specification are included in the Report ITU-R BT.2049. The specification of T-DMB was standardized by ETSI in 2005. ETSI TS 102 427 and ETSI TS 102 428 describe the error protection mechanism and the A/V codec of the T-DMB system, respectively. A variety of receivers are on the market: PC (laptop) type, vehicular type, and PDA type, as well as mobile phones.

4.4 Multimedia System "H" (DVB-H)

Multimedia System "H", also known as IP Datacast over DVB-H (IPDC/DVB-H) system is an end-to-end broadcast system for delivery of any types of digital content and services using IP-based mechanisms optimized for devices with limitations on computational resources and battery. It consists of a unidirectional DVB-H broadcast path that may be combined with a bidirectional mobile cellular (2G/3G) interactivity path. IP Datacast is thus a platform that can be used for enabling the convergence of services from broadcast/media and telecommunications domains (e.g. mobile/cellular).

The system specifications can be divided into the following categories:

– General end-to-end system description.
– DVB-H radio interface.
– IP Datacast over DVB-H service layer.
– IP Datacast codecs and content formats.

DVB-H is an enhancement of the widely accepted DVB-T digital broadcast standard for mobile broadcast reception. DVB-H is RF-compatible with DVB-T and can share the same radio environment. The DVB-H radio interface specification is ETSI EN 302 304.

DVB-H level system signalling specification defines the exact use of PSI/SI information in case of an IPDC system.

For video services H.264/AVC and for audio HE AAC v2 codecs and respective RTP payload formats are used. Several types of data are supported including e.g. binary data, text and still images.

---

[2] Digital sound broadcasting System A of Recommendation ITU-R BS.1114 has also been used to broadcast IPTV in some countries by allocating part of the DAB multiplex for audio, visual and interactive services.

RTP is the IETF protocol used for streaming services. Delivery of any kind of files in an IPDC system is supported by the IETF FLUTE protocol.

Electronic Service Guide has been specified to allow fast discovery and selection of services for the end user.

Versatile Service Purchase and Protection mechanisms have been defined for broadcast-only and interaction capable handheld receivers.

Examples of field tests and pilots are included, e.g. in the Report ITU-R BT.2049. In 2006 IPDC over DVB-H has a global base of pre-commercial pilots and first commercial deployments exist.

4.5 Multimedia System "M" (Forward Link Only (FLO))

Multimedia System "M", also know as FLO, is designed specifically for mobile applications and for wireless multimedia services. It was designed for the efficient distribution of multimedia content to multiple users.

The technical characteristics of the Forward Link Only physical layer are described in the context of the identified requirements. The result is a new mobile broadcast technology, known as FLO technology.

Standardizing of the FLO technology has been achieved by the Telecommunications Industry Association (TIA) as Standard TIA-1099 and is further coordinated through the FLO Forum, www.floforum.org.

Annex 2

Multimedia System "C" (ISDB-T one segment), Multimedia System "F" (ISDB-T_{SB}) and Multimedia System "E"

System specifications for Multimedia System "C" (ISDB-T one segment), Multimedia System "F" (ISDB-T_{SB}) and Multimedia System "E" are defined in the Recommendations or specifications in Table 3.

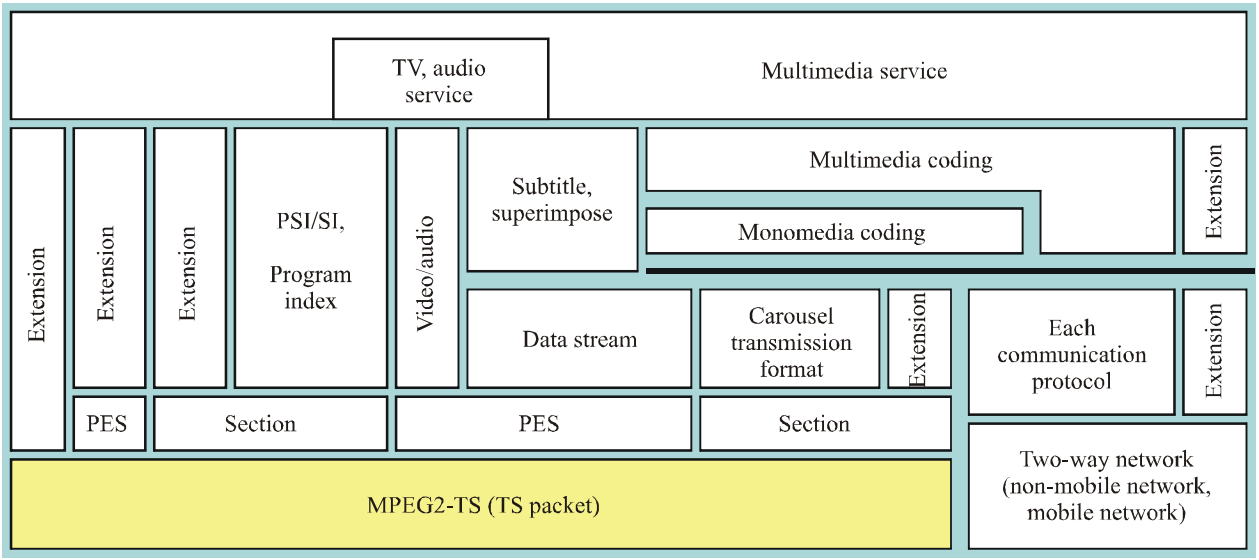
The following provides the additional information for multimedia and data broadcasting for ISDB-T one segment, ISDB-T_{SB} or Multimedia System "E".

The physical layer specifications of these systems are well described in Recommendations ITU-R BT.1306, ITU-R BS.1114 and ITU-R BO.1130 as well as ITU-R BS.1547, respectively. ISDB-T one segment and ISDB-T_{SB} are designed for terrestrial transmission and Digital System E of ITU-R BO.1130 is designed for mainly mobile reception directly from the broadcasting satellite augmented by terrestrial gap fillers in 2.6 GHz band (in Japan). Protocol stack on the physical layer and above is common among all the ISDB family systems, as shown in Fig. 2. ARIB STD-B24 in Recommendation ITU-R BT.1699 provides its specification.

As described in Table 2, ARIB STD-B24 covers all types of receivers. Its Appendices give the profiles for all types of receiver, from fixed HDTV to basic handheld receiver. The relationship of those Appendices is illustrated in Fig. 3. Appendix 4 gives a profile for the basic handheld receiver that ISDB-T one segment and ISDB-T_{SB} employ, upon consideration of its receiver performance.

FIGURE 2

Protocol stack of ARIB STD-B24



1833-02

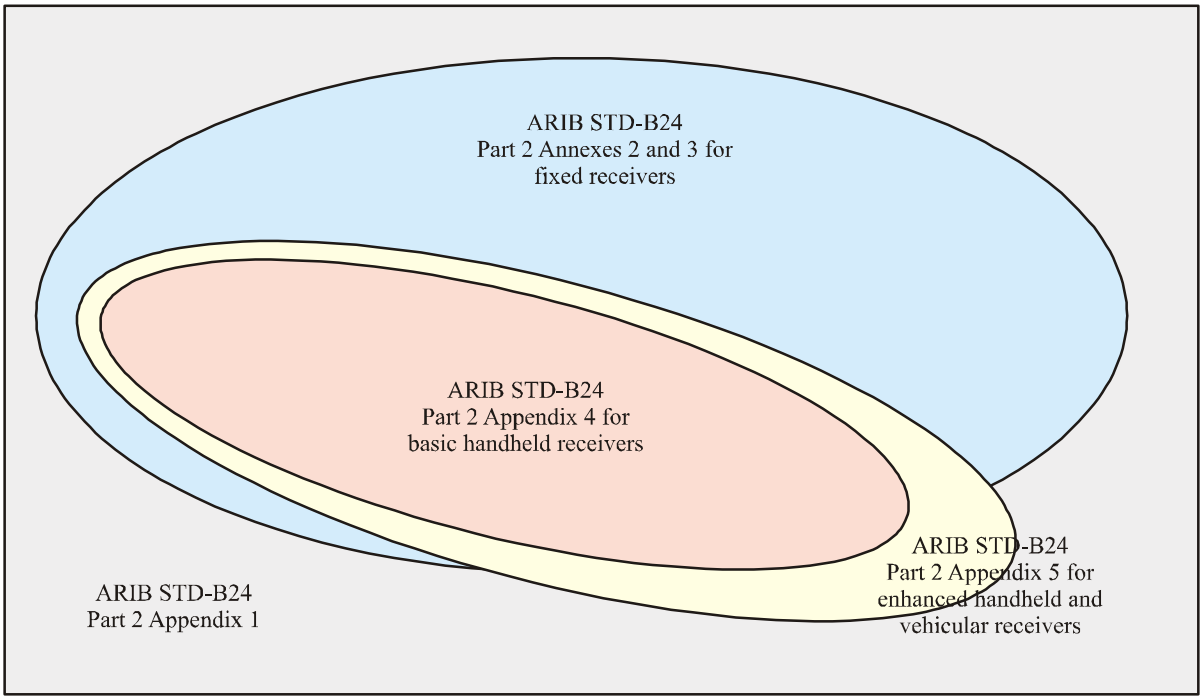
The profile defined in Appendix 4 supports 240 × 480 logical screen. Resolution of video is 320 × 180 (16:9 aspect ratio), 320 × 240 or 160 × 120 (4:3 aspect ratio). Actual presentation depends on receiver implementation, for example, screen rotation is a means to obtain larger display area, sufficient to display video without scaling. When displaying multimedia content, a receiver for this profile is mandated to support such logical screen size by any technical measures where scrolling is a major tool.

For multimedia broadcasting, this profile supports a wide variety of media types. H.264/AVC for video, MPEG2-AAC LC for audio, JPEG, PNG and GIF for still images, GIF and MNG for animation and text by Shift-JIS character are the supported media. Those media are placed on logical screens instructed by tags and stylesheet attributes in BML document(s), whilst interactivity is controlled by ECMAScript and anchor tags in BML document(s).

File transmission protocol to deliver BML document(s) and other files, such as still images, is achieved by data carousel as shown in Fig. 2. This protocol is also defined in ARIB STD-B24.

FIGURE 3

Relationship of profiles of ARIB STD-B24



1833-03

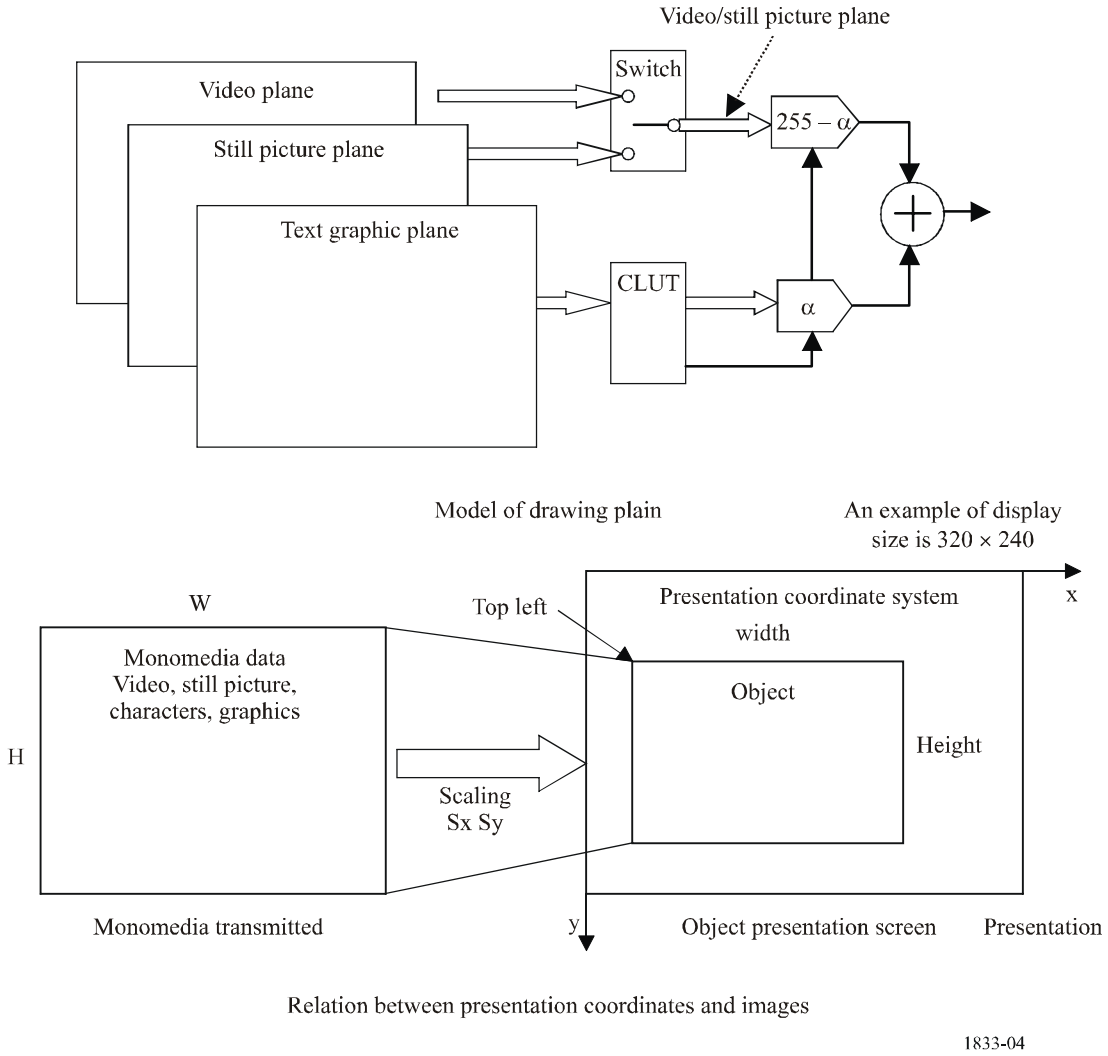
Appendix 5 gives the profile employed by Digital System E; video and audio stream data are transmitted using PES over MPEG-2 Transport Stream encapsulation as described in Fig. 2. Encoding methods are MPEG-4 Video including AVC and HE AAC, respectively, as described in Table 3. The display size of target receivers is 320 × 240 (QVGA) for handheld receivers, which is defined in Appendix 5 to Volume 2 of ARIB STD-B24. A common basic multimedia content structure and delivery mechanism for ISDB family systems, described in ISDB-T one segment and ISDB-T_{SB} systems, is also used for Digital System E.

Figure 4 provides display patterns for receivers of Digital System E. This type of receiver has a layout that is similar to a fixed receiver, although it is likely to have a different display resolution as illustrated in Fig. 4. A typical receiver has a display of 320 × 240 resolution, as defied in Appendix 5 to Volume 2 of ARIB STD-B24, while a fixed receiver can have an HDTV display, i.e. 1 920 × 1 080 resolution.

The text of ARIB STD-B24 is available at: http://www.arib.or.jp/english/html/overview/sb_ej.html.

FIGURE 4

Layout patterns of image and data on enhanced handheld and vehicular receivers



Annex 3

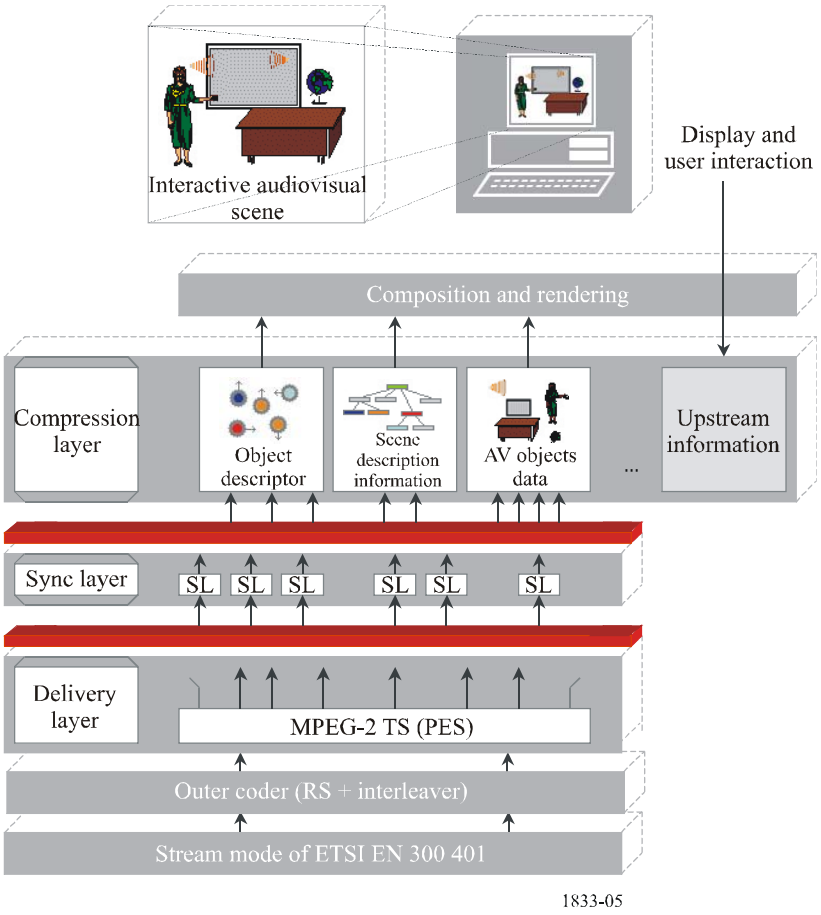
Multimedia System ”A” (T-DMB)

1 System architecture

The system for T-DMB video services has an architecture that transmits MPEG-4 content encapsulated using “MPEG-4 over MPEG-2 TS” specification, as illustrated in Fig. 5.

FIGURE 5

Conceptual architecture for the video services



Video service is delivered through th stream mode of the DSB System A transmission mechanism. In order to maintain extremely low bit error rates, this service uses the error protection mechanism described in ETSI TS 102 427. This video service is composed of three layers: content compression layer, synchronization layer and transport layer. In the content compression layer, ITU-T H.264 | ISO/IEC 14496-10 AVC is employed for video compression, ISO/IEC 14496-3 ER-BSAC/HE-AAC for audio compression, and ISO/IEC 14496-11 BIFS for auxiliary interactive data services. For system specifications, see Table 3.

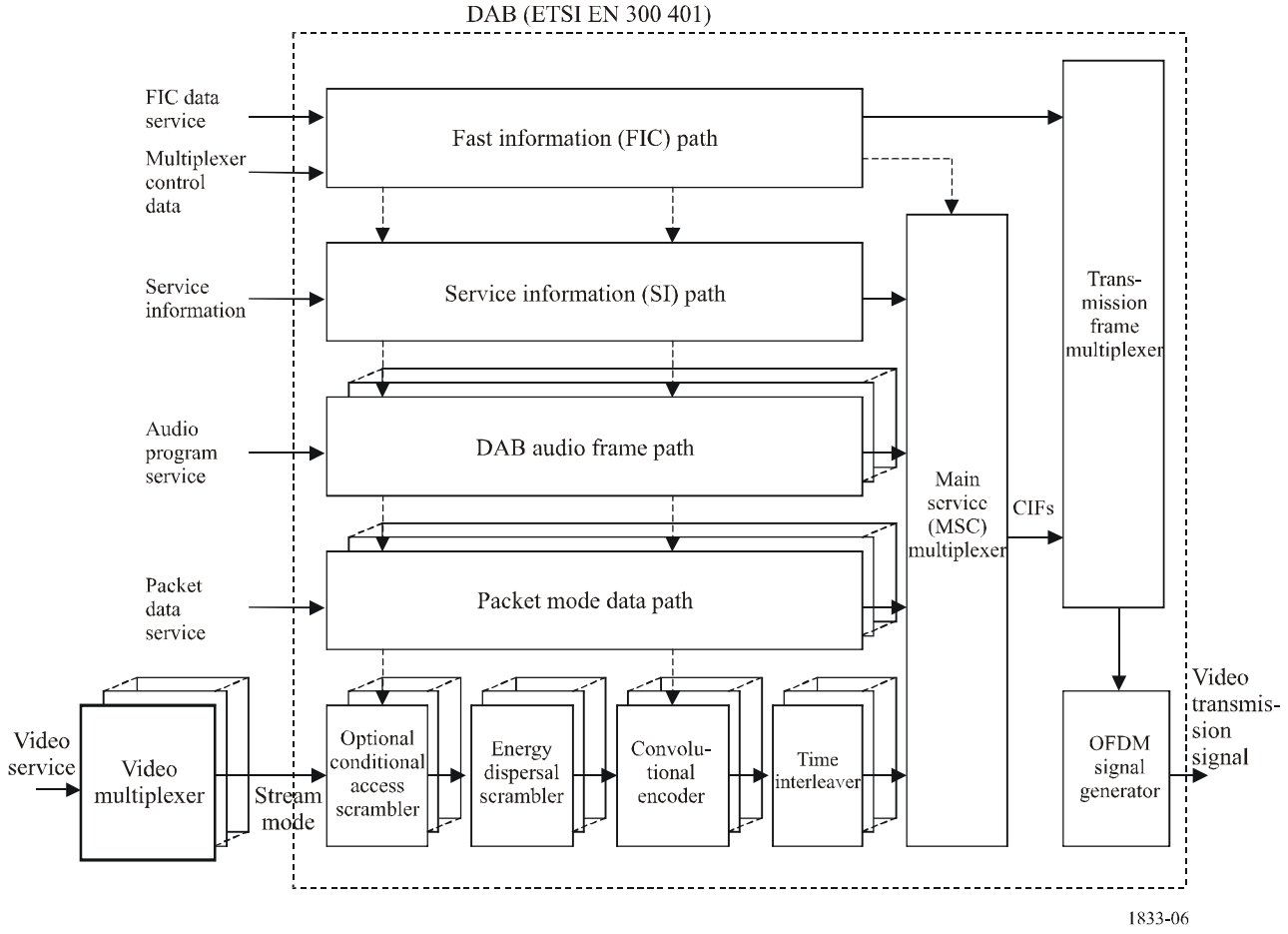
To synchronize audio-visual content, both temporally and spatially, ISO/IEC 14496-1 SL is employed in the synchronization layer. In the transport layer specified in ETSI TS 102 428, some appropriate restrictions are employed for the multiplexing of compressed audiovisual data.

2 Video service transmission architecture

The conceptual transmission architecture for video services is shown in Fig. 6. 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 using the stream mode specified in DSB System A.

FIGURE 6

Conceptual transmission architecture for the video services



3 Video multiplexer architecture

The conceptual architecture of the video multiplexer for a video service is shown in Fig. 7.

The following are the detailed descriptions:

– 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.

– Each PES packetizer generates a PES packet stream compliant with the ISO/IEC 13818-1 standard for each SL packet stream.

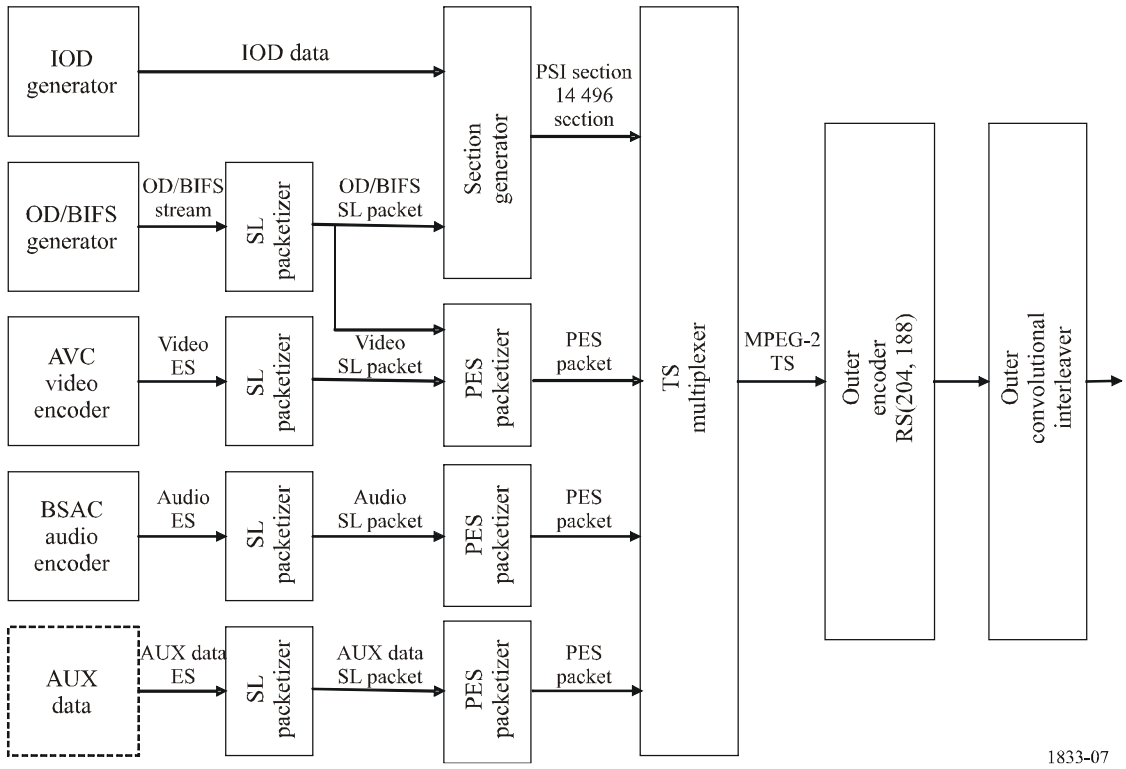
– The TS multiplexer combines the input sections and PES packet streams into a single MPEG-2 TS compliant with the ISO/IEC 13818-1 standard.

– 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, and is output as a video service stream.

FIGURE 7

Architecture of the video multiplexer



Normative references

[1] Recommendation ITU-R BS.1114 System A: System for terrestrial digital sound broadcasting to vehicular, portable and fixed receivers in the frequency range 30-3 000 MHz.

[2] ETSI EN 300 401: Radio Broadcasting Systems; Digital Audio Broadcasting (DAB) to mobile, portable and fixed receivers.

[3] ISO/IEC 13818-1: Information Technology – Generic Coding of Moving Pictures and Associated Audio Information: Systems.

[4] ISO/IEC 14496-1: Information technology Coding of audio-visual objects Part 1: Systems.

[5] ETSI TS 102 427: Digital Audio Broadcasting (DAB); Data Broadcasting – MPEG-2 TS Streaming.

[6] ETSI TS 102 428: Digital Audio Broadcasting (DAB); DMB video service; User Application Specification.

[7] ISO/IEC 14496-3: Information Technology – Coding of audio-visual objects: Part 3: Audio.

[8] ITU-T Recommendation H.264 | ISO/IEC 14496-10: Information Technology – Coding audio-visual objects: Part 10: Advanced Audio Coding.

[9] ISO/IEC 14496-11: Information technology – Coding of audio-visual objects – Part 11: Scene description and application engine.

Informative references

[10] ETSI TR 101 497: Digital Audio Broadcasting (DAB); Rules of Operation for the Multimedia Object Transfer Protocol.

[11] ETSI TS 101 759: Digital Audio Broadcasting (DAB); Data Broadcasting – Transparent Data Channel (TDC).

[12] ETSI ES 201 735: Digital Audio Broadcasting (DAB); Internet Protocol (IP) Datagram Tunnelling.

[13] ETSI TS 101 499: Digital Audio Broadcasting (DAB); MOT Slide Show; User Application Specification.

[14] ETSI TS 101 498-1: Digital Audio Broadcasting (DAB); Broadcast Website; Part 1: User Application Specification.

[15] ETSI TS 101 498-2: Digital Audio Broadcasting (DAB); Broadcast Website; Part 2: Basic Profile Specification.

[16] ETSI EN 301 234: Digital Audio Broadcasting (DAB); Multimedia Object Transfer (MOT) Protocol.

[17] ETSI TS 102 371: Digital Audio Broadcasting (DAB); Transportation and Binary Encoding Specification for DAB Electronic Programme Guide (EPG).

[18] ETSI TS 102 818: Digital Audio Broadcasting (DAB); XML Specification for DAB Electronic Programme Guide (EPG).

Annex 4

Multimedia System "H" (DVB-H)

The standardized "IPDC over DVB-H" end-to-end system is based on the following set of specifications (see also Table 3).

General end-to-end system description

The umbrella specification for all the "IP Datacast over DVB-H" specifications is:

– ETSI TS 102 468: Digital Video Broadcasting (DVB); IP Datacast over DVB-H: Set of Specifications for Phase 1.

The use cases applicable to IPDC system are described in:

– ETSI TR 102 473: Digital Video Broadcasting (DVB); IP Datacast over DVB-H: Use Cases and Services.

The end-to-end system architecture is described in:

– ETSI TR 102 469: Digital Video Broadcasting (DVB); IP Datacast over DVB-H: Architecture.

DVB-H radio interface

The following documents define the DVB-H radio interface.

The DVB-H radio transmission is specified in:

– ETSI EN 302 304: Digital Video Broadcasting (DVB); Transmission System for Handheld Terminals (DVB-H).

The DVB-H-related system level signalling, applicable both to DVB-H transmitter and to DVB-H receiver is specified in:

– ETSI TS 102 470: Digital Video Broadcasting (DVB); IP Datacast over DVB-H: Program Specific Information (PSI)/(Service Information (SI).

IP datacast service layer

The following documents define the IP Datacast service layer over DVB-H.

The Electronic Service Guide is specified in:

– ETSI TS 102 471: Digital Video Broadcasting (DVB); IP Datacast over DVB-H: Electronic Service Guide (ESG).

The Content Delivery Protocols are specified in:

– ETSI TS 102 472: Digital Video Broadcasting (DVB); IP Datacast over DVB-H: Content Delivery Protocols.

Service Purchase and Protection mechanisms are specified in:

– ETSI TS 102 474: Digital Video Broadcasting (DVB); IP Datacast over DVB-H: Service Purchase and Protection.

IP datacast codecs and formats

Audio and video codecs and formats supported are specified in:

– ETSI TS 102 005: Digital Video Broadcasting (DVB); Specification for the use of video and audio coding in DVB services delivered directly over IP.

For further information on the guidelines for deployment of DVB-H standard please refer to:

– ETSI TR 102 377: “Digital Video Broadcasting (DVB); DVB-H Implementation guidelines”.

– ETSI TR 102 401: “Digital Video Broadcasting (DVB); Transmission to handheld terminals (DVB-H); Validation task force report”.

Appendix 1
to Annex 4
(Informative)

OMA BCAST mobile broadcast services system

Open Mobile Alliance (OMA) organization has specified an end-to-end mobile broadcast system solution for handheld receivers. The OMA BCAST specifications are paying a specific attention to the broadcast bearer-independent technology enablers to enable the convergence of services between broadcast and mobile domain. Deployment of both the broadcast and mobile cellular (interaction) channels for the delivery of services information and services are taken into account in the specifications.

The topics covered include mobile broadcast services requirements and architecture, service guide, notifications (alert, general, service-related), stream and file distribution, service and content protection, service provisioning (service and content purchase and subscriptions), terminal provisioning (tools for operators to manage the terminal), interaction (interactive retrieval of service

guide and further service information, interactive delivery of services and content, service related interactivity), charging, roaming and mobility.

OMA BCAST is applicable to be used with the DVB-H broadcast bearer. Adaptation of OMA mobile broadcast services technology enablers when the underlying broadcast distribution system is DVB-H is described in the "Broadcast Distribution System Adaptation – IPDC over DVB-H" specification[3].

OMA BCAST Specifications:

– Enabler Release Definition for Mobile Broadcast Services, Draft Version 1.0 – 6 April 2007 (OMA-ERELD-BCAST-V1_0-20070406-D).

– Mobile Broadcast Services Requirements, Draft Version 1.0 – 27 March 2007 (OMA-RD-BCAST-V1_0-20070327-D).

– Mobile Broadcast Services Architecture, Draft Version 1.0 –18 April 2007 (OMA-AD-BCAST-V1_0-20070418-D).

– Mobile Broadcast Services, Draft Version 1.0 – 17 April 2007 (OMA-TS-BCAST_Services-V1_0-20070417-D).

– Service Guide for Mobile Broadcast Services, Draft Version 1.0 – 21 April 2007 (OMA-TS-BCAST_ServiceGuide-V1_0-20070421-D).

– File Distribution and Stream Distribution, Draft Version 1.0 – 4 April 2007 (OMA-TS-BCAST_Distribution-V1_0-20070404-D).

– Service and Content Protection for Mobile Broadcast Services, Draft Version 1.0 – 19 April 2007 (OMA-TS-BCAST_SvcCntProtection-Interim Draft-20070419-D).

– OMA DRM v2.0 Extensions for Broadcast Support, Interim Specification - Draft Version 1.0 – 13 April 2007 (OMA-TS-DRM-XBS-V1_0-20070413-D).

– Broadcast Distribution System Adaptation – IPDC over DVB-H, Draft Version 1.0 – 28 March 2007 (OMA-TS-BCAST_DVB_Adaptation-V1_0-20070328-D).

URL of OMA BCAST specifications is in the following: http://member.openmobilealliance.org -/ftp/Public_documents/BCAST/Permanent_documents/.

For Service and Content Protection for Mobile Broadcast Services: http://www.openmobilealliance.org/ftp/Public_documents/BCAST/2007/OMA-BCAST-2007-0022R07-INP_SPCP_Interim_Draft.zip.

For OMA DRM v2.0 Extensions for Broadcast Support: OMA\OMA-BCAST-2007-0336R03-INP_XBS_Interim_TS.zip.

---

[3] There are also adaptation specifications for telecommunications systems such as 3GPP/MBMS ("Broadcast Distribution System Adaptation – 3GPP/MBMS") and 3GPP2/BCMCS ("Broadcast Distribution System Adaptation – 3GPP2/BCMCS"):

– Broadcast Distribution System Adaptation – 3GPP/MBMS, Draft Version 1.0 – 19 April 2007 (OMA-TS-BCAST_MBMS_Adaptation-V1_0-20070419-D).

– Broadcast Distribution System Adaptation – 3GPP2/BCMCS, Draft Version 1.0 – 22 April 2007 (OMA-TS-BCAST_BCMCS_Adaptation-V1_0-20070422-D).

Annex 5

Multimedia System "M" (Forward Link Only)

Abstract

The technical characteristics of the Forward Link Only (FLO) physical layer are described in the context of the identified requirements. The result is a new mobile broadcast technology, known as FLO technology.

Standardizing of the Forward Link Only technology has been achieved in the Telecommunications Industry Association (TIA) as Standard TIA-1099 and is further coordinated through the FLO Forum, www.floforum.org.

Other informative references related the Multimedia system "M" performance include:

– TIA-1102: Minimum Performance Specification for Terrestrial Mobile Multimedia Multicast Forward Link Only Devices

– TIA-1103: Minimum Performance Specification for Terrestrial Mobile Multimedia Multicast Forward Link Only Transmitters

– TIA-1104: Test Application Protocol for Terrestrial Mobile Multimedia Multicast Forward Link Only Transmitters and Devices

1 Introduction

The capability of a cellular phone has increased dramatically over the past few years. A device that was originally conceived as a voice-only instrument has steadily evolved into a multi-purpose text and multimedia device.

The advent of video and other rich multimedia services on a cellular phone has been primarily delivered via existing 3G wireless networks. Until recently this delivery was primarily via unicast wireless networks, although the availability of multicast methods within the existing unicast networks is increasing.

The broadcast-multicast mechanisms of these 3G networks are basically added onto the existing unicast physical layer. For simultaneous wide distribution of content, typically beyond a few users per sector, it is generally accepted as economically advantageous to transition to broadcast-multicast delivery.

While the cost reduction that can be achieved by a broadcast mode within a unicast framework can be significant, even greater efficiencies can be achieved by a dedicated broadcast-multicast overlay. Freed from the restrictions imposed by support for unicast operation, a physical layer can be designed specifically for the purpose of delivering multimedia and applications to a large number of users at the lowest possible cost.

The following sections provide the key air interface characteristics of the FLO technology.

2 Requirements for delivery to mobile handhelds

Key requirements for a physical layer design for terrestrial broadcasting of multimedia and data applications for mobile reception include:

– Meeting consumer demands for multimedia services including

  – Ubiquitous coverage.

  - Local news, weather, and sports.
  - National and regional programming.
- Quality of service for all data types.
- Support for streaming audio and video.
- Low-cost, low-power consumption mobile devices.
- Efficient transmission characteristics.
- Cost-effective infrastructure.
- Does not interfere with normal phone functionality.

2.1 Required service types

- *Real-time:* real time multimedia is functionally equivalent to conventional television. The media is consumed as it is delivered.
- *Non-Real-time:* non real time is any type of content that is delivered as a file and stored. This type of delivery allows users to consume media at their convenience. The specific media type of the file is relatively unimportant to the physical layer.
- *IP Datacasting:* datacast supports any application on the handheld devices with an IP interface. The generic nature of IP to some degree limits the performance gains possible by matching the data type to the delivery mechanism, but an IP interface is convenient for the application.
- *Interactive Services:* any of the service types described above may incorporate interactivity that utilizes the unicast capability of a handheld receiver. Some of the more common interactive functions may be supported directly on the device via stored files.

2.2 Quality of service (QoS)

Each of the services described above have slightly different QoS requirements. Real-time services require fast channel change and rapid recovery from brief channel outages. File delivery-based services need mechanisms to recover from the impact of similar fading and other channel outages, but are not constrained by rapid acquisition requirements i.e. quick program channel changes or recovery from signal loss. The entire file is received and stored prior to consumption. IP-delivered services appear as a hybrid of the real-time and file delivery types. However, if file delivery is achieved via other non-real time delivery mechanisms, the IP services share much of the characteristics of real time, e.g. an IP delivered “stock ticker” is a real time service with a slightly less stringent time delivery deadline.

2.3 Audio and video support

Audio and video are required media types.

2.4 Functionality, cost, power consumption

The basic mobile device form factor, function, and cost should not be significantly impacted by the addition of the new physical layer. The normal phone functions should not be obstructed by the mobile multimedia functionality.

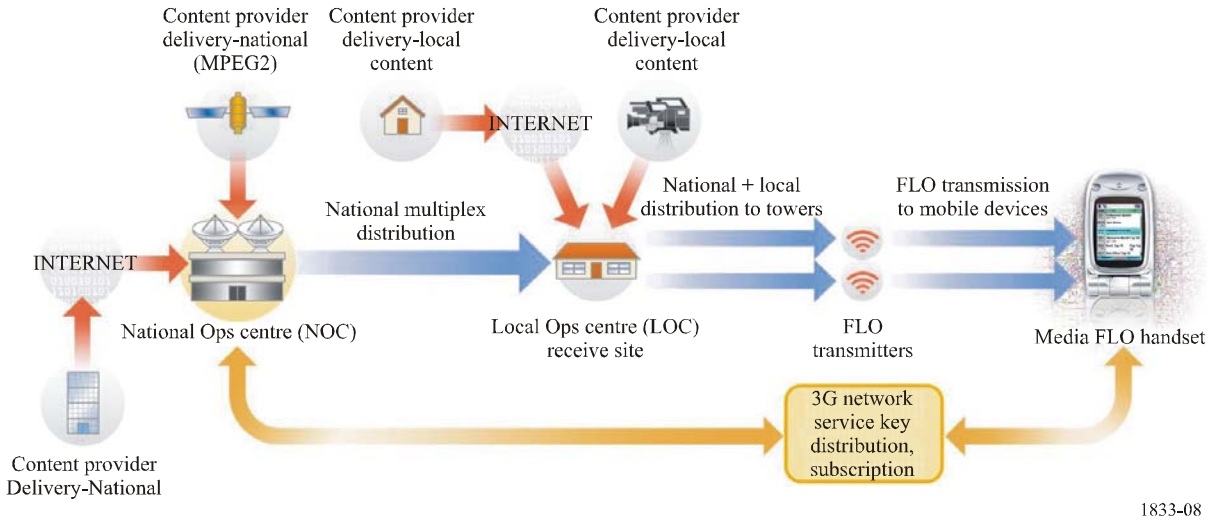
3 Forward Link Only (FLO) system architecture

A Forward Link Only (FLO) system is comprised of four sub-systems namely Network Operation Centre (NOC – which consists of a National Operation Centre and one or more Local Operation

Centres), FLO transmitters, IMT-2000 networks, and FLO-enabled devices. Figure 8 shown below is a schematic diagram of an example of FLO system architecture.

FIGURE 8

FLO system architecture example



3.1 Network operation centre

The Network Operation Centre consists of a central facility(s) of the FLO network, including the Nation Operation Centre (NOC), also referred to as Wide area Operation Centre (WOC), and one or more Local Operation Centres (LOC). The NOC can include the billing, distribution, and content management infrastructure for the network. The NOC manages various elements of the network and serves as an access point for national and local content providers to distribute wide area content and programme guide information to mobile devices. It also manages user service subscriptions, the delivery of access and encryption keys and provides billing information to cellular operators. The Network Operation Centre may include one or more LOCs to serve as an access point for local content providers to distribute local content to mobile devices in the associated market area.

3.2 FLO transmitters

Each of these transmitters transmits FLO-based waveforms to deliver content to mobile devices.

3.3 IMT-2000 network

The IMT-2000 network supports interactive services and allows mobile devices to communicate with the NOC to facilitate service subscriptions and access key distribution.

3.4 FLO -enabled devices

These devices are capable of receiving FLO waveforms containing content services and programme guide information. FLO-enabled devices are primarily cell phones: multipurpose devices that serve as telephones, address books, Internet portals, gaming consoles, etc. FLO technology strives to optimize power consumption through intelligent integration on the device and optimized delivery over the network.

4 FLO system overview

4.1 Content acquisition and distribution

In a FLO network, content that is representative of a linear real-time channel is received directly from content providers, typically in MPEG-2 format, utilizing off-the-shelf infrastructure equipment. Non real-time content is received by a content server, typically via an IP link. The content is then reformatted into FLO packet streams and redistributed over a single or multiple frequency network (SFN or MFN). The transport mechanism for the distribution of this content to the FLO transmitter may be via satellite, fibre, etc. At one or more locations in the target market, the content is received and the FLO packets are converted to FLO waveforms and radiated out to the devices in the market using FLO transmitters. If any local content is provided, it would have been combined with the wide area content and radiated out as well. Only users of the service may receive the content. The content may be stored on the mobile device for future viewing, in accordance to a service programme guide, or delivered in real-time for live streaming to the user device given a linear feed of content. Content may consist of high quality video (QVGA) and audio (MPEG-4 HE-AAC)[4] as well as IP data streams. An IMT-2000 cellular network or reverse communication channel is required to provide interactivity and facilitate user authorization to the service.

4.2 Multimedia and data applications services

A reasonable FLO -based programming line-up for 25 frames-per-second QVGA video, with stereo audio, in a single 8 MHz bandwidth frequency allocation, includes 25 to 27 real-time streaming video channels of wide area content including some real-time streaming video channels of local market specific content. The allocation between local and wide area content is flexible and can be varied during the course of the programming day, if desired. In addition to wide area and local content, a large number of IP data channels can be included in the service delivery.

4.3 Power consumption optimization

The FLO technology simultaneously optimizes power consumption, frequency diversity, and time diversity. The Forward Link Only air interface employs time division multiplexing (TDM) to transmit each content stream at specific intervals within the FLO waveform. The mobile device accesses overhead information to determine which time intervals a desired content stream is transmitted. The mobile device receiver circuitry powers up only during the time periods in which the desired content stream is transmitted and is powered down otherwise.

Mobile users can channel surf with the same ease as they would with digital satellite or cable systems at home.

4.4 Wide and local area content

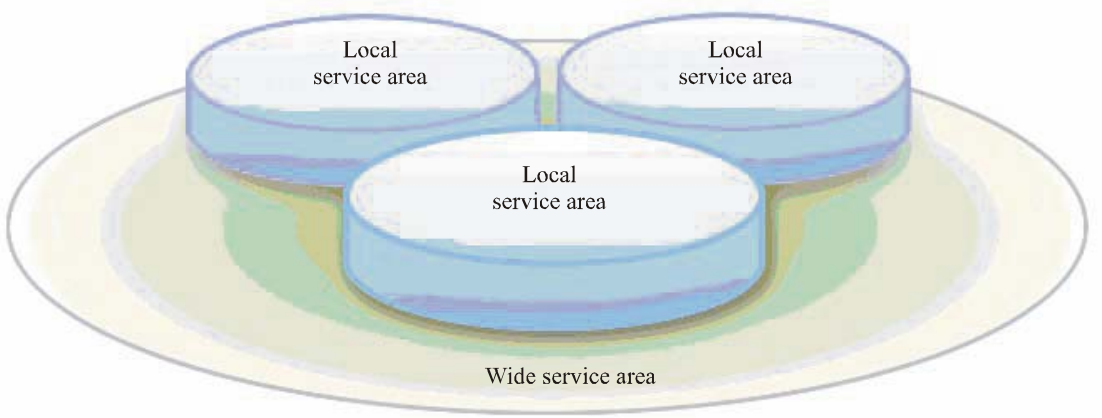
As shown in Fig. 9, FLO supports the co-existence of local and wide area coverage within a single Radio Frequency (RF) channel. When utilizing a SFN, it eliminates the need for complex handoffs for coverage areas. The content that is of common interest to all the receivers in a wide area network is synchronously transmitted by all of the transmitters. Content of regional or local interest can be carried in a specific market.

---

[4] High Efficiency AAC (HE AAC) audio profile is specified in “ISO/IEC 14496-3:2001/AMD 1:2003” and is accessible through the ISO/IEC website. The performance of the HE-AAC profile coder is documented in the publicly available formal verification test report WG 11 (MPEG) N 6009.

FIGURE 9

Hierarchy of local and wide area SFNs



1833-09

4.5 Layered modulation

To provide the best possible quality of service, FLO technology supports the use of layered modulation. With layered modulation, the FLO data stream is divided into a base layer that all users can decode, and an enhancement layer that users with a higher signal to noise ratio (SNR) can also decode. The majority of locations will be able to receive both layers of the signal. The base layer has superior coverage as compared to non-layered mode of similar total capacity. The combined use of layered modulation and source coding allows for graceful degradation of service and the ability to receive in locations or speeds that could not otherwise have reception. For the end user, this efficiency means that a FLO network can provide a better coverage with good quality services, especially video, which requires significantly more bandwidth than other multimedia services.

5 FLO air interface

See Standard TIA-1099 at: www.tiaonline.org/standards/catalog: search.

Appendix 1

Additional information on the telecom network based Multimedia Broadcast/Multicast Services (MBMS)

There are telecommunication systems not explicitly dedicated to broadcasting services, such as Multimedia Broadcast/Multicast Services (MBMS") as shown in this Appendix, that fulfill the requirements for interoperability between mobile telecommunication services and interactive digital broadcasting broadcasting services. The MBMS system is intended to work within services other than broadcasting.

MBMS key characteristics

MBMS standards (see Table 5) specify broadcast/multimedia radio bearers; the MBMS system contains the following features:

– The MBMS routing of information/data flows in a core network.

– The radio bearers for mobile A/V multimedia services for point-to-multipoint radio transmission.
– A set of functions that control the MBMS delivery.

Key aspects of the MBMS system are summarized in the following list:

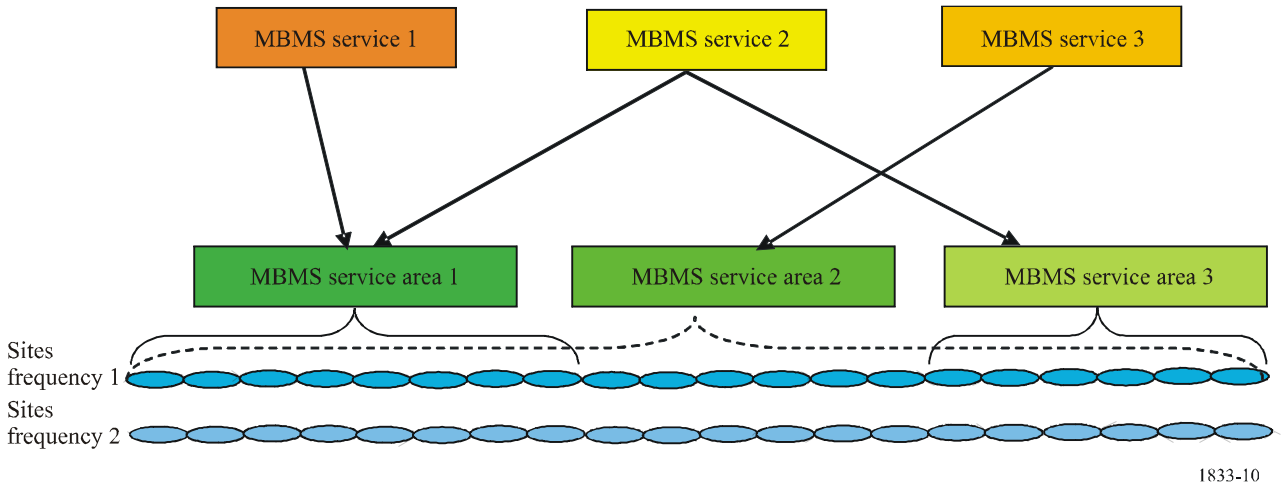
– Mobile A/V multimedia services transmission capabilities in a network infrastructure
  – Allows over-the-air mobile A/V multimedia services (allowing for mobile A/V multimedia services without the need for reception acknowledgement).
  – Reuses IP multicast framework.
– Supports streaming
  – Enables mobile A/V multimedia service streaming.
  – Reuses already specified protocols for media delivery (RTP).
  – FEC protection of single flows and entire channel bundles.
  – Reception reporting is supported.
– Supports download
  – Enables information/data push services.
  – Uses FLUTE as File-Delivery Protocol (RFC 3926).
  – Forward Error Correction (FEC) to protect entire files.
  – Repair function to increase reliability of file delivery.
  – Reception Acknowledgment is supported.

One important aspect of MBMS is flexibility. It should be set to use only a portion of a carrier, leaving the rest transmission capacity for other information based and data services, but it is certainly possible to devote a carrier frequency entirely for MBMS mobile A/V multimedia service radio bearers. The MBMS comprises a variable number of MBMS radio bearers. Moreover, each radio bearer can have a different bit rate, up to 256 kbit/s. The performance of MBMS is described in [5] and in Table 4.

The geographical area in which a particular MBMS service is provided is called a Service Area. Service Areas can be as large as an entire country or as small a single radio site with a limited coverage of a few 100 m or even smaller if desired. Each radio transmission site can deliver different services, even if the same radio channel of 5 MHz is used for all transmission sites. Due to the possibility for small in size coverage areas, mobile A/V multimedia services can easily be customized to deliver different content with very fine granularity in different areas of the network. Figure 10 gives an example of MBMS service area configurations and relations between MBMS bearer service and MBMS service areas.

FIGURE 10

MBMS service area configurations and relations between MBMS bearer service and MBMS service areas



More precisely, there is the following flexibility in the service to area mapping:

– One MBMS service area can consists of 1..x transmission sites(s).

– One MBMS bearer service can be configured for 1..y MBMS service area(s).

– One MBMS service area be allocated to 0..z MBMS bearer service(s).

Independently of the Service Areas, an unlimited number of special interest streaming mobile A/V multimedia service programmes that have a low penetration of users can be offered.

Further details about the characteristics and performance of MBMS can be found in Table 4.

MBMS requirements

According to the specification, the following high-level requirements apply to the MBMS [2]:

– MBMS architecture enables the efficient usage of radio-network and core-network resources, with the main focus on the radio interface efficiency. Specifically, multiple users should be able to share common resources when receiving identical traffic.

– The MBMS architecture supports common features for MBMS multicast and broadcast modes.

– The MBMS architecture does not describe the means by which the Broadcast Multicast Service Centre (BM-SC) obtains the service data. The data source may be external or internal to the PLMN e.g. content servers in the fixed IP network. Any UE attached to the PLMN MBMS shall support both IP multicast and IP unicast sources.

– MBMS architecture may reuse, to the extent possible, existing core network components and protocol elements thus minimizing the complexity to infrastructure and providing a solution based on known concepts.

– MBMS is a multimedia/broadcast point-to-multipoint bearer service for IP packets in the packet switched (PS) domain.

– MBMS is interoperable with IETF IP Multicast.

– MBMS supports IETF IP Multicast addressing.

– MBMS service areas are defined per individual service with a per transmission site granularity.

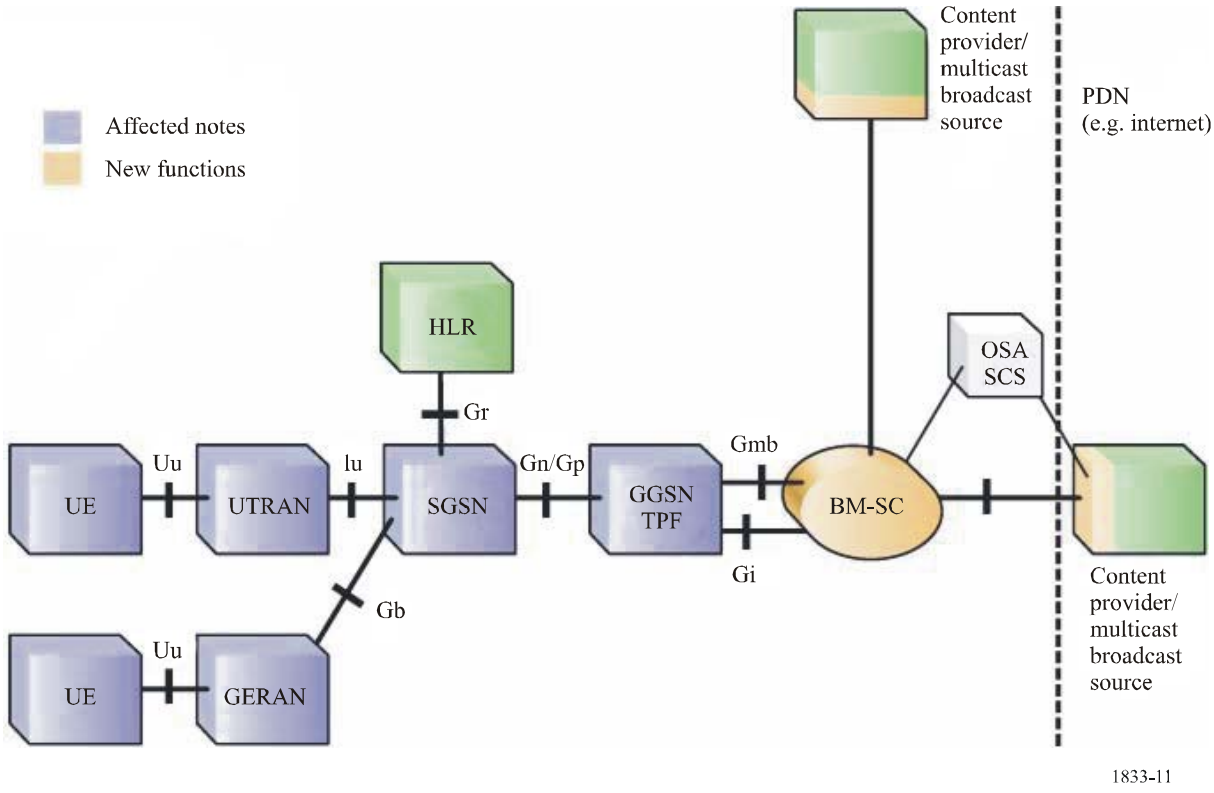
– MBMS is not supported in the circuit switched (CS) domain.

– Charging data shall be provided per subscriber for MBMS multicast mode.
– The MBMS bearer service concept contains the decision making process for selection of multimedia/broadcast point-to-point or point-to-multipoint configurations.
– The architecture is able to provide home network MBMS multicast services to users when roaming outside their home network as subject to inter-operator agreements.

The MBMS BM-SC (Broadcast Multicast Service Centre)

The MBMS network architecture and nodes affected by the introduction of MBMS are shown in Fig. 11.

FIGURE 11
MBMS network architecture



The BM-SC (see Fig. 11) includes functions for MBMS user service provisioning and delivery. It may serve as an entry point for content provider MBMS transmissions, used to authorize and initiate MBMS Bearer Services within the PLMN, and can be used to schedule and deliver MBMS transmission.

The BM-SC is a functional entity that must exist for each MBMS User Service. According to the specifications, the following requirements apply to BM-SC [1]:

– The BM-SC is able to authenticate third party content providers, providing content for MBMS transmission. Third party content provider may wish to initiate an MBMS mobile A/V multimedia service transmission. In such case, the BM-SC is able to authorize content provider to transmit data over MBMS bearer service depending on the policy.
– The BM-SC is able to deliver media and session description by means of service announcements using IETF specified protocols over MBMS multicast and broadcast bearer services.

– The BM-SC is able to accept content from external sources and transmit it using error resilient schemes (e.g. specialized MBMS code).
– The BM-SC might be used to schedule MBMS session transmissions, retrieve content from external sources and provide this content using MBMS bearer services.
– The BM-SC is able to schedule MBMS session retransmissions and label each MBMS session with an MBMS session identifier to allow the UE to distinguish the MBMS session retransmissions. These retransmissions are transparent to the RAN and MBMS user service.

MBMS user equipment (UE) handheld Terminal Capabilities

To be able to support/ receive the MBMS services the UE has the following requirements [13]:

– The UE supports functions for the activation/deactivation of the MBMS bearer services.
– Once a particular MBMS bearer service is activated, no further explicit user request is required to receive MBMS data although the user may be notified that data transfer is about to start.
– It is possible for UE to receive MBMS when the terminal is attached.
– It shall be possible for UE to receive MBMS mobile A/V multimedia services in parallel to other services and signalling (e.g. paging, voice call).
– The UE, depending on terminal capabilities, is to receive MBMS user service announcements, paging information (non MBMS specific) and support simultaneous services (for example the user can originate or receive a call or send and receive messages whilst receiving MBMS video content). Reception of this paging or announcements may however, create losses in the MBMS mobile A/V multimedia service reception. The MBMS user service should be able to cope with such losses.
– Depending upon terminal capability, UE may be able to store MBMS information and data.
– The MBMS Session Identifier contained in the notification to the UE enables the UE to decide whether it needs to ignore the forthcoming transmission of MBMS session (e.g. because the UE has already received this MBMS session).
– When the UE is already receiving mobile A/V multimedia services of an MBMS, it is possible for the UE to be notified about a forthcoming and potentially about an ongoing data transfer from other MBMS services.

MBMS Service and Application types

MBMS can be used as an enabler for various mobile A/V multimedia services. There are two types of MBMS User Service considered within this specification [3], [4].

– **Streaming services:** A continuous data flow providing a stream of continuous media (i.e. audio and video) is a basic MBMS User Service.
– **File download services:** This service delivers binary data (file data) over an MBMS bearer. The most important functionality for this service is reliability. In other words, it is necessary that the user receive all the data sent in order to experience the service.

MBMS radio bearer implementation

The CDMA MBMS mobile A/V multimedia service radio bearer implementation defines three logical channels and one physical channel. The logical channels are:

– MBMS point-to-multipoint control channel (MCCH), which contains details concerning ongoing and upcoming MBMS mobile A/V multimedia service sessions;
– MBMS point-to-multipoint scheduling channel (MSCH), which provides information on data scheduled on MTCH;

– MBMS point-to-multipoint traffic channel (MTCH), which carries the actual MBMS application data.

– The physical channel is the MBMS notification indicator channel (MICH) by which the network informs the MBMS user equipment (UE), handheld terminals, of available MBMS information on MCCH.

Two interleaving depths (TTI) are used in MBMS for the MTCH: 40 and 80 ms. The selection of a long interleaving depth (TTI) provides greater diversity in the time domain by spreading user data over the fading variations. This, in turn, yields improved MBMS capacity.

TABLE 4

Performance of Multimedia Broadcast/Multicast Services (MBMS) for mobile reception

User requirements	MBMS
High quality multimedia for handheld receivers	
1) Media type with quality characteristics – Resolution – Frame rate – Bit rate	– QCIF (176 × 144) – SQVGA (160 × 120) – 15 fps – QVGA@30 fps possible if supported by terminal Speech: – Stereo and mono – 6-24 kbit/s Audio – Stereo and mono – 24-48 kbit/s – higher bitrates only limited by terminal capabilities Other – Synthetic audio (SP-MIDI) – Still images – Bitmap graphics – Text

TABLE 4 (*continued*)

User requirements	MBMS
2) Monomedia coding: – Video – Audio – Others	Video: H.264 (AVC) Baseline Profile Level 1b decoder Speech: – AMR NB – AMR WB Audio: – Extended AMR-WB – HE AAC Still images: ISO/IEC JPEG Bitmap graphics: – GIF87a, GIF89a, PNG Vector graphics: – SVG Tiny 1.2 and ECMAScript Text – XHTML Mobile Profile in formats UTF-8, UCS-2
Flexible configuration of services: – Audio/video – Ancillary and auxiliary data	– Real-time audio and video – Digital radio – Scheduled content and file download – Service Discovery / Announcement (EPG): Broadcast Distribution or interactive retrieval – Subtitling (synchronized hypertext with A/V via MPEG-4 BIFS – 6 parallel real-time broadcast streaming services of 128 kbit/s each per 5 MHz radio channel. 12 services possible with advanced receiver (antenna diversity) An unlimited number of special interest streaming services that have a low penetration of users can be offered – National/local/hotspot local broadcast. Each radio site can broadcast different services, even if the same radio channel of 5 MHz is used for all sites – Multicast allows limiting the transmission to areas, which are known to host interested users
Conditional access	Supported
International roaming	Supported (home services accessible from visited/foreign networks)
Seamless portability access	Supported; user equipment (UE) handheld terminals moving from the home mobile multimedia/broadcast network to a visiting network is able to access multimedia/broadcast services provided by the visited network, using the authorization of the original home service provider
Fast discovery and selection of content and services	Electronic Program Guide support for discovery and selection of services. Service Announcement Information (EPG) may be broadcast periodically, but can also be requested by user terminal and is delivered immediately

TABLE 4 (*end*)

User requirements	MBMS
Stable and reliable reception and QoS control in various types of receiving environments	Use of the following techniques: – CDMA – Time domain interleaving of up to 80 ms on physical layer – Application layer FEC enables virtually unlimited time diversity, only bound by channel switching time – Code rate of application layer FEC is freely selectable – Transmit power can be adjusted per program stream to achieve desired coverage and QoS – (Soft) combining of signals from neighbouring sites always possible Provides – Variable QoS and robustness – High mobility up to 250 km/h
Network configuration	SFN is the default configuration. The geographical area in which a particular MBMS service is provided is called a service area. Service Areas can be as large as an entire country or as small a single radio site with a limited coverage of few 100 m or even smaller if desired. SFN is used even across adjacent service areas
Lower power consumption in comparison to stationary reception Mechanisms to achieve power consumption savings	MBMS system is designed for mobile reception and therefore for battery efficiency from the beginning
Provision of interactive content and applications	Support system for integrated interactivity with mobile multimedia telecommunication networks. Interactivity content and applications use: – References to interactive services available on the devices or remotely located
Interoperability with mobile telecommunication networks	Support for mobile multimedia over mobile telecommunication networks
Spectrum efficiency (bit/s/Hz)	The efficiency for MBMS broadcast mode given below is equal to the network spectral efficiencies. The efficiencies take into account that a single carrier frequency of 5 MHz is sufficient to provide full area coverage. For the lower end of the given spectrum efficiency range it is possible to provide different services in adjacent sites. 0.15-0.4 bit/s/Hz for broadcast mode up to 2.88 bit/s/Hz with 16-QAM code rate 1/1 for users in optimal reception conditions
Efficient transport mechanism (not highlighted in the User requirements section)	Standard IP based technologies fully deployed: RTP for streaming, FLUTE/ALC for file download delivery. Application layer FEC supported for file and stream delivery

TABLE 5

Specifications of MBMS for mobile reception

		MBMS
Bandwidth		5 MHz
Physical Layer		ETSI TS 125 346 TR 25.803
Encapsulation		PDCP and GTP (ETSI TS 125 323 and ETSI TS 129 060)
Data Transmission Mechanism		IETF RFC 3550 (RTP) IETF RFC 3926 (FLUTE) IETF RFC 768 (UDP/IP) IETF RFC 761 (IPv4) IETF RFC 2460 (IP v6)
Multimedia Content Format		ETSI TS 126 244 (3GP)
Mono-media Coding	Speech	AMR Narrowband: ETSI TS 126 071, ETSI TS 126 090, ETSI TS 126 073, ETSI TS 126 074 AMR Wideband: 3GPP TS 26.171, ETSI TS 126 190, ETSI TS 126 173, ETSI TS 126 204
	Audio Coding	Enhanced aacPlus:ETSI TS 126 401, ETSI TS 126 410, ETSI TS 126 411 Extended AMR-WB:ETSI TS 126 290 ETSI TS 126 304 ETSI TS 126 273
	Video Coding	ITU-T Rec. H.264 and ISO/IEC 14496-10 AVC
	Others	Synthetic Audio: Scalable Polyphony MIDI Specification Version 1.0, Scalable Polyphony MIDI Device 5-to-24 Note Profile for 3GPP Version 1.0 Vector Graphics: W3C Working Draft 27 October 2004: “Scalable Vector Graphics (SVG) 1.2” W3C Working Draft 13 August 2004: “Mobile SVG Profile: SVG Tiny, Version 1.2” Standard ECMA-327 (June 2001): “ECMAScript 3rd Edition Compact Profile” Still images: ISO/IEC JPEG Bitmap graphics: GIF87a, GIF89a, PNG

Informative references:

[1] ETSI TS 123.246 (3GPP TS 23.246), “MBMS Architecture and Functional description”.

[2] ETSI TS 125.346 (3GPP TS 25.346) Introduction of the Multimedia Broadcast/Multicast Service (MBMS) in the Radio Access Network (RAN); Stage 2.

[3] ETSI TS 122.246 (3GPP TS 22.246), “MBMS User Services (stage 1)”.

[4] ESTI TS 126.346 (3GPP TS 26.346), “Multimedia Broadcast/Multicast Service (MBMS); Protocols and codecs”.

[5] 3GPP TR 25.803, “S-CCPCH performance for MBMS”.

ETSI is a recognized Standards Developing Organization and partner in 3GPP (3rd Generation Partnership Project), ETSI publishes the 3GPP specifications at a certain stage of the standards developing process; MBMS is specified by the 3GPP.

Appendix 2

Requirements on emission and reception characteristics for Multimedia Systems “A”, “C”, “E”, “F”, “H” and “M”

Administrations who intend to introduce a Multimedia System for mobile reception by handheld receivers may select the physical layer part from Recommendations ITU-R BT.1306, ITU-R BS.1114, ITU-R BS.1547, ITU-R BO.1130, ETSI EN 302 304 and TIA-1099 based on the transmission parameters in Table 6.

Table 7 provides information about the applicability and the deployment of Multimedia broadcasting systems for mobile reception by handheld receivers in a real environment.

TABLE 6

Transmission parameters for multimedia systems

	Parameters	Multimedia System "A"	Multimedia System "C"	Multimedia System "E"	Multimedia System "F"	Multimedia System "H"	Multimedia System "M"
1	Channel bandwidths[(1)]	a) 1.712 MHz	1/14 of a) 6 MHz b) 7 MHz c) 8 MHz	25 MHz	3/14 of a) 6 MHz b) 7 MHz c) 8 MHz	a) 5 MHz b) 6 MHz c) 7 MHz d) 8 MHz	a) 5 MHz b) 6 MHz c) 7 MHz d) 8 MHz
2	Used bandwidth	a) 1.536 MHz	a) 432.5/430.5/ 429.6 kHz b) 504.6/502.4/ 501.2 kHz c) 576.7/574.1/ 572.8 kHz	19 MHz (occupied band for typical satellite system)	a) 1.290/1.288/ 1.287 MHz b) 1.505/1.502/ 1.501 MHz c) 1.720/1.717/ 1.716 MHz	a) 4.75 MHz b) 5.71 MHz c) 6.66 MHz d) 7.61 MHz	a) 4.52 MHz b) 5.42 MHz c) 6.32 MHz d) 7.23 MHz
3	Number of subcarriers or segments	1.536	1	At most 64 CDM channels	3	1 705 (2k mode) 3 409 (4k mode) 6 817 (8k mode)	4 000 (out of 4k)
4	Subcarrier spacing	a) 1 kHz	a) 3.968/1.948/ 0.992 kHz b) 4.629/2.361/ 1.157 kHz c) 5.271/2.645/ 1.322 kHz	Not applicable	a) 3.968/1.984/ 0.992 kHz b) 4.630/2.315/ 1.157 kHz c) 5.291/2.646/ 1.322 kHz	a) 2 790.179 Hz (2k), 1 395.089 Hz (4k), 697.545 Hz (8k) b) 3 348.21 Hz (2k), 1 674.11 Hz (4k), 837.05 Hz (8k) c) 3 906 Hz (2k), 1 953 Hz (4k), 976 Hz (8k) d) 4 464 Hz (2k), 2 232 Hz (4k), 1 116 Hz (8k)	a) 1.1292 kHz b) 1.355 kHz c) 1.5808 kHz d) 1.8066 kHz

TABLE 6 (*continued*)

	Parameters	Multimedia System "A"	Multimedia System "C"	Multimedia System "E"	Multimedia System "F"	Multimedia System "H"	Multimedia System "M"
5	Active Symbol or segment duration	a) 1.246 µs	a) 252/502/1 008 µs b) 216/432/864 µs c) 189/378/756 µs	A pilot symbol is inserted every 250 µs	a) 252/502/1 008 µs b) 216/432/864 µs c) 189/378/756 µs	a) 358.40 µs (2k), 716.80 µs (4k), 1 433.60 µs (8k) b) 298.67 µs (2k), 597.33 µs (4k), 1 194.67 µs (8k) c) 256 µs (2k), 512 µs (4k), 1 024 µs (8k) d) 224 µs (2k), 448 µs (4k), 896 µs (8k)	a) 885.6216 µs b) 738.018 µs c) 632.587 µs d) 553.5135 µs
6	Guard interval duration	246 µs	63, 31.5, 15.75, 7.875 µs 126, 63, 31.5, 15.75 µs 252, 126, 63, 31.5 µs	A pilot symbol length is 125 µs which acts as same as guard interval using RAKE receiver	63, 31.5, 15.75, 7.875 µs 126, 63, 31.5, 15.75 µs 252, 126, 63, 31.5 µs	1/32, 1/16, 1/8, 1/4 of active symbol duration	a) 110.7027 µs b) 92.2523 µs c) 79.0734 µs d) 69.1892 µs Supports path delays equals to 1.65*Guard Interval duration
7	Transmission unit (frame) duration	96 ms	204 OFDM symbols	12.75 ms	204 OFDM symbols	68 OFDM symbols. One super-frame consists of 4 frames	Superframe – exactly 1 second in duration. In OFDM symbols. a) 1 000 b) 1 200 c) 1 400 d) 1 600 Each superframe consists of 4 frames of equal duration (approx 1/4 second in duration)

TABLE 6 (*end*)

	Parameters	Multimedia System "A"	Multimedia System "C"	Multimedia System "E"	Multimedia System "F"	Multimedia System "H"	Multimedia System "M"
8	Time/ frequency synchroniza-tion	Null symbol and Centre frequency	Pilot carriers	Assign one CDM channel to Pilot	Pilot carriers	Pilot carriers	Time-division (TDM) and frequency-division (FDM) pilot channels
9	Modulation methods	COFDM-DQPSK	DQPSK, QPSK, 16-QAM, 64-QAM	QPSK	DQPSK, QPSK, 16-QAM, 64-QAM	QPSK, 16-QAM, 64 QAM, MR-16-QAM, MR-64-QAM	QPSK, 16-QAM, layered modulation
10	Coding and error correction methods	See Rec. ITU-R BS.1114 and additional RS (204, 188, T=8) code for video service	Convolution code (1/2 to 7/8) and RS (204, 188) with time interleaving utmost 0.5 second	Convolutional code (1/2 to 7/8) and RS (204, 188) with bit-interleaving up to 6 seconds	Convolution code (1/2 to 7/8) and RS (204, 188) with time interleaving utmost 1 second	Inner code: Convolutional code, mother rate 1/2 with 64 states. Puncturing to rate 2/3, 3/4, 5/6, 7/8 Outer Code : RS (204, 188, T = 8) IP outer channel code : MPE-FEC RS (255,191)	Inner code: parallel concatenated convolutional code (PCCC), rates 1/3, 1/2. And 2/3 for data, 1/5 for overhead information Outer code: RS with rates 1/2, 3/4, and 7/8
11	Net data rates	a) 1.728 Mbit/s	a) 0.281 to 1.785 Mbit/s b) 0.328 to 2.085 Mbit/s c) 0.375 to 2.385 Mbit/s	Maximum: 26.011 Mbit/sec Typical: 6.84 Mbit/sec	a) 0.842 to 5.354 Mbit/s b) 0.983 to 6.254 Mbit/s c) 1.124 to 7.154 Mbit/s	a) 2.33-14.89 Mbit/s b) 2.80-17.87 Mbit/s c) 3.27-20.84 Mbit/s d) 3.74-23.82 Mbit/s All with MPE-FEC 3/4	a) 2.3-9.3 Mbit/s b) 2.8-11.2 Mbit/s c) 3.2-13 Mbit/s d) 3.7-14.9 Mbit/s (Rates above do not include the overhead due to use of RS coding)

(1) All parameters that may vary depending on selected channel bandwidth are listed in the order of corresponding channel bandwidths as shown in row 1 using sub-references a), b), c) and d), as applicable.

TABLE 7

Technical performance comparison of Multimedia broadcasting systems for mobile reception

	Multimedia System "A"	**Multimedia System "C"**	**Multimedia System "E"**	**Multimedia System "F"**	**Multimedia System "H"**	**Multimedia System "M"**
Spectrum efficiency (bit/s/Hz)	From 0.396 (DQPSK, convolutional code rate 1/4) to 1.221 (DQPSK, convolutional code rate 4/5) bit/s/Hz	From 0.655 bit/s/Hz (QPSK 1/2) to 4.170 bit/s/Hz (64QAM 7/8)	Up to 1.369 bit/s/Hz using 63 payload channels and one pilot channel with 7/8 convolutional code rate *1 Typical 0.360 bit/s/Hz using 29 payload and one pilot CDM channels with 1/2 convolutional code rate *2	From 0.655 bit/s/Hz (QPSK 1/2) to 4.170 bit/s/Hz (64-QAM 7/8)	From 0.46 bit/s/Hz (QPSK 1/2 MPE-FEC 3/4) to 1.86 bit/s/Hz (64-QAM 2/3 MPE-FEC 3/4)	From 0.47 bit/s/Hz to 1.87 bit/s/Hz (No RS code) 0.35 to 1.40 bit/s/Hz with RS (16, 12) outer code
Stable and reliable reception and QoS control in various types of receiving environments	– QoS based reception availability under various environment – BER performance of 10^{-8} required for video services. – Reliable mobile reception up to 300 km/h (DQPSK, 1/2) based on field test results	– Variable QoS and robustness – High mobility up to 300 km/h in 2k/4k/8k (QPSK, 1/2 convolutional code rate, UHF band)	– Variable QoS and robustness – Reception of satellite signal by handheld and vehicular receivers as well as fixed receivers – High mobility up to aircraft speed for satellite signal reception	– Per group QoS – Variable robustness per group – High mobility up to 300 km/h in 2k/4k/8k (QPSK 1/2)	– Outdoor and indoor reception with high QoS even with integrated antennas in a terminal – Robust pedestrian and mobile reception with 8k/4k/2k QPSK and 16-QAM modes	– Per channel QoS – Statistical multiplexing – High mobility : – ~500 km/h (QPSK 1/2, C/N = 10 dB) – ~320 km/h (16-QAM, C/N = 16.5 dB) – Good performance at low speed

TABLE 7 (*end*)

	Multimedia System "A"	**Multimedia System "C"**	**Multimedia System "E"**	**Multimedia System "F"**	**Multimedia System "H"**	**Multimedia System "M"**
Stable and reliable reception and QoS control in various types of receiving environments (*cont.*)	Typical SFN cell size is about 70 km (DQPSK, 1/2, guard interval 256 µs) depending the frequency and transmission power. Support SFN configuration to extend the coverage and MFN configuration to provide the national/local services	SFN supported SFN is supported typically in 8k with selectable FEC code rate and carrier modulation scheme	A satellite signal covers nationwide area Terrestrial gap fillers cover shadow areas from a satellite signal	SFN supported SFN is supported typically in 8k with selectable FEC code rate and carrier modulation scheme Hierarchical transmission available	– Very high mobility (UHF, QPSK, CR 1/2 or 2/3): – 2k up to 1 185 km/h – 4k up to 592 km/h – 8k up to 296 km/h Typical SFN cell sizes are in the range of 60 to 100 km (8k, QPSK, 16-QAM) but even nationwide SFN is possible with 8k robust modes (QPSK) and limited Tx powers. With 4k and 2k the SFN-size is more limited or denser network is needed for wide SFN National/local services are supported Hierarchical modulation is possible	– 3 km/h up to 300 km/h (QPSK 1/2 C/N = 7 dB) – 3 km/h up to 200 km/h (16-QAM 1/2 C/N = 13.5 dB) Low and high power (300 m, 50 kW) SFN in UHF is supported with 4k mode, 16-QAM 1/2 MFN network configuration also supported

*1 and *2: In the case of CDM chip rate with 16.384 MHz, occupied bandwidth is 19 MHz for a satellite signal.

For the highest case: CDM 63 payload channels and one pilot channel. Viterbi rate is 7/8. A payload TS packet rate is 16.384 × 2 × 7/8 × 188/204 × 63/64 / 19 = 1.369 bit/s/Hz.

For a typical case: CDM 29 payload channels and one pilot channel. Viterbi rate is 1/2. A payload TS packet rate is 16.384 × 2 × 1/2 × 188/204 × 29/64 / 19 = 0.360 bit/s/Hz.