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Information technology — Mobile multicast communications: Framework

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of the joint technical committee is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

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ISO/IEC 24793 consists of the following parts, under the general title *Information technology — Mobile multicast communications*:

— *Part 1: Framework*

— *Part 2: Protocol over native IP multicast networks*

INTERNATIONAL STANDARD
RECOMMENDATION ITU-T

Information technology – Mobile multicast communications: Framework

1 Scope

This Recommendation | International Standard describes the mobile multicast communications (MMC), which can be used to support a variety of multimedia multicasting services in IP-based wireless mobile networks as well as wired fixed networks. MMC targets real-time, one-to-many multicast services and applications over mobile communications networks. This implies that MMC focuses on multicast services rather than broadcast services, and that only authenticated users could be allowed in the multicast session. MMC also considers the one-to-many multicast session wherein a single multicast sender is allowed in the session rather than many-to-many multicast services. In addition, MMC is targeted in the real-time multicast session rather than the reliable multicast session; the timely delivery of multicast data is considered a key factor.

This Recommendation | International Standard specifies the MMC framework as part of the MMC standard describing the framework and functional architecture of MMC. Based on this framework, the two protocols for MMC will be developed in two parts of the MMC project: protocol over native IP multicast networks and protocol over overlay multicast networks.

2 Normative references

The following Recommendations and International Standards contain provisions which, through reference in this text, constitute provisions of this Recommendation | International Standard. At the time of publication, the editions indicated were valid. All Recommendations and Standards are subject to revision, and parties to agreements based on this Recommendation | International Standard are encouraged to investigate the possibility of applying the most recent edition of the Recommendations and Standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards. The Telecommunication Standardization Bureau of the ITU maintains a list of currently valid ITU-T Recommendations.

- Recommendation ITU-T X.603 (2004) | ISO/IEC 16512-1:2005, *Information technology – Relayed multicast protocol: Framework.*
- Recommendation ITU-T X.603.1 (2007) | ISO/IEC 16512-2:2008, *Information technology – Relayed multicast protocol: Specification for simplex group applications.*

The following IETF standard track RFCs specify the multicast forwarding capability in IP multicast networks:

- IETF RFC 2236 (1997), *Internet Group Management Protocol, Version 2, Proposed Standard*.
- IETF RFC 3810 (2004), *Multicast Listener Discovery Version 2 (MLDv2) for IPv6, Proposed Standard*.
- IETF RFC 4601 (2006), *Protocol Independent Multicast – Sparse Mode (PIM-SM): Protocol Specification (Revised), Proposed Standard*.

3 Definitions

This Recommendation | International Standard uses the terms defined in the relayed multicast protocol (Rec. ITU-T X.603 | ISO/IEC 16512-1). The following terms are also used in this Recommendation | International Standard:

3.1 multicast network: Multicast network refers to any of the networks wherein legacy IP multicasting schemes are enabled with the help of multicast routing protocols, multicast forwarding capability of multicast routers in the networks, link-layer multicasting of the points of attachment in the network, and multicast membership signalling in the subnet such as IGMP/MLD. MMC services could be provisioned over the multicast network.

3.2 overlay multicast network: An overlay multicast network pertains to a network wherein legacy IP multicasting schemes are not fully supported. In this network, multicast application data are delivered using unicast transport such as TCP, UDP, or IP-in-IP tunnelling schemes. In particular, the unicast delivery of multicast data may be done in backbone networks. In the overlay multicast network, IP multicast transport may be used in a portion of the network. For example, as shown in the RMCP protocol (Rec. ITU-T X.603 | ISO/IEC 16512-1), subnet multicasting may be used in the end subnets where the multicast sender or receiver is located. In the overlay multicast network,

multicast data may be delivered using the unicast relay of multicast agents and subnet multicasting capability. MMC services could be provisioned over the overlay multicast network.

4 Abbreviations

For the purposes of this Recommendation | International Standard, the following abbreviations apply:

AAA	Authentication, Authorization, and Accounting
AS	Authentication Server
BCMCS	Broadcast Multicast Services
BWA	Broadband Wireless Access
ECTP	Enhanced Communications Transport Protocol
FMC	Fixed Mobile Convergence
IGMP	Internet Group Management Protocol
IP	Internet Protocol
IPTV	IP-based TV
MA	Multicast Agent
MBMS	Multimedia Broadcast Multicast Services
MCS	Multicast Contents Server
MLD	Multicast Listener Discovery
MMC	Mobile Multicast Communications
MMCF	MMC Framework
MN	Mobile Node
MS	Mobile Station
NGN	Next Generation Networks
RMCP	Relayed Multicast Protocol
SDO	Standards Development Organization
SM	Session Manager
WLAN	Wireless Local Area Network

5 Introduction

This Recommendation | International Standard deals with mobile multicast communications (MMC). MMC is targeted to enable and support a variety of multimedia multicast applications and services over the wireless/mobile networks as well as the wired/fixed networks.

This Recommendation | International Standard describes the MMC framework (MMCF). Based on this framework, the two protocols required for MMC will be developed. This clause will first describe the rationale for MMC from the perspective of market trends and evolving network environments. In addition, some related works that have been made in other SDOs will be reviewed.

5.1 Market trends

From the market perspective, the work on MMC is driven by the following observations:

a) Growth of IP-based multimedia broadcast/multicast services markets

In telecommunications markets, there is a crucial need to provide multimedia multicasting and broadcasting services all over the world. With the help of broadband networks, efficient multimedia platforms including audio/video codecs, and IP-based network transport and application technologies, the

markets for IP-based multimedia broadcasting and multicasting services are expected to grow in next generation communications networks.

Examples of these multimedia multicast/broadcast services include Internet TV (IPTV), remote education, broadcasting of special live events, etc.

b) Increasing needs of multimedia broadcast/multicast services over wireless mobile networks

The recent trend in the mobile communications industry reflects the increasing demands of multimedia multicast/broadcast applications and services over wireless/mobile networks. In fact, IP-based multimedia broadcasting/multicasting services will be some of the primary killer applications from the perspective of mobile service providers.

Examples of these mobile multicast applications/services include mobile IPTV, mobile commerce (m-commerce), and digital multimedia broadcasting (DMB) using mobile devices such as cellular phone, PDA, handheld PCs, etc. These mobile multicasting services are expected to be provisioned through a variety of wireless access networks such as cdma2000, W-CDMA, wireless LAN (WLAN) based on IEEE 802.11, and broadband wireless access (BWA) based on IEEE 802.16. Most of the mobile service providers are expected to provide IP-based multimedia multicasting services over these various wireless networks.

c) MBMS and BCMCS standardizations in 3GPP and 3GPP2

Given the demand for mobile multicasting, 3GPP and 3GPP2 are working on standardization to develop the relevant protocols or schemes. In 3GPP, the "Multimedia Broadcast and Multicast Services (MBMS)" is being developed to support IP-based multimedia multicasting services in its own systems. On the other hand, 3GPP2 started to come up with standardization works on the "Broadcast & Multicast Services (BCMCS)" for their own cdma2000-based networks and systems.

5.2 Network environments

In next generation communications networks, a variety of heterogeneous access networks using different wireless/wired access technologies are expected to coexist under the same administrative domain or network operator. In this environment, those heterogeneous access networks may be interconnected with each other via the IP-based core network; thus ensuring that identical multimedia multicast/broadcast services could be provided to users regardless of the access network where the user is connected.

With this trend of fixed mobile convergence (FMC), there is a crucial need to provide multimedia multicasting services/applications over wireless/mobile networks as well as wired/fixed communications networks.

Figure 1 illustrates the network environment to be considered in the MMC.

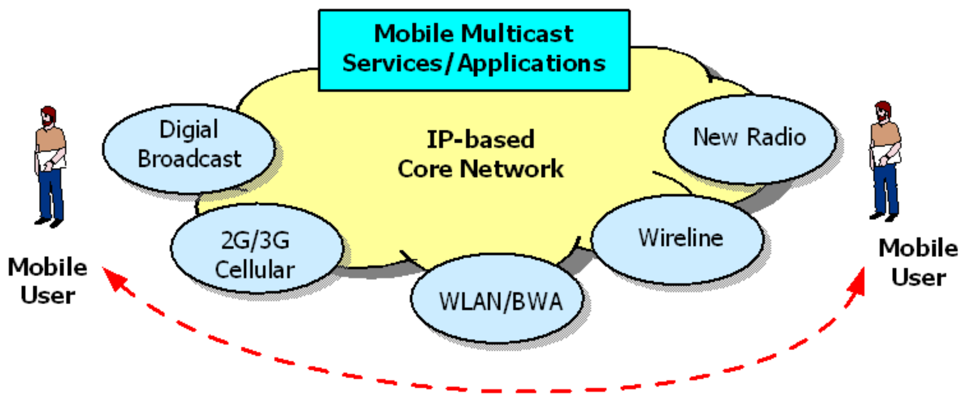

Figure 1 – Network environments in MMC

As shown in Figure 1, the NGN environment is featured in the "IP-based core network" and a variety of "heterogeneous access networks". In this scenario (Figure 1), the network operator (or service provider) will provide various multimedia multicasting services/applications for users over the IP-based core network. Each (mobile) user will benefit from such comprehensive services through the various access networks. Each access network could be a fixed/wired network such as the conventional PSTN, ISDN, and Internet or a mobile/wireless network such as WLAN, BWA, and 3G cellular networks. Under the FMC feature, users shall benefit from identical multimedia multicasting services regardless of the specific access network where they are connected.

Note that the user may move around across a variety of access networks in the NGN environment. Accordingly, the issue of mobility support for mobile users needs to be addressed from the MMC perspective, i.e., seamless mobility (specifically handover) shall be supported even when mobile users move across those heterogeneous networks. The mobility issue on MMC shall deal with how to support seamless multicast services against the movement of users (terminals).

These observations suggest the need for some schemes or protocols in providing seamless mobile multicasting services under FMC and mobility environments of NGN. Such schemes or protocols shall be commonly applied for a variety of heterogeneous wireless and wired access networks regardless of the movement of users.

5.3 Related Standards

This Recommendation | International Standard seeks to design the framework of MMC. MMCF shall be designed based on existing works that have been made to date in SDOs. Thus, this clause describes the relevant works in IETF, ITU-T, JTC 1, and 3GPPs.

5.3.1 IETF

As a leading SDO in the area of IP multicasting, IETF has so far developed the protocols required for multicast data transport including IGMP/MLD and multicasting routing protocols for multicast tree construction to deliver multicast data packets in the Internet.

IGMP/MLD protocols are used for signalling between multicast routers and hosts in the network. These protocols ensure that network routers can determine whether there is any multicast user (specific to the group IP address); this information will in turn be used by multicast routers to construct the multicast tree using the multicast routing protocols. To date, the following IGMP/MLD protocols have been developed:

- Internet group management protocol (IGMP) for IPv4: IGMPv2, IGMPv3
- Multicast listener discovery (MLD) for IPv6: MLDv1, MLDv2

Multicast routing protocols are used as signalling protocols to construct a multicast tree for a specific multicast IP address that will require multicast network routers to configure the associated multicast forwarding table as the routing path for multicast data packets. To date, the following multicast routing protocols have been developed:

- Distance vector multicast routing protocol (DVMRP)
- Core-based tree (CBT)
- Protocol-independent multicast – Dense mode (PIM-DM)
- Protocol-independent multicast – Sparse mode (PIM-SM)
- Source-specific multicast (SSM), which uses IGMPv3 (IPv4) or MLDv2 (IPv6)

In the IETF, further works are in progress for works on the deployment of IP multicasting (e.g., IGMP snooping in the MBONED WG). Based on the discussion above, works made in the IETF can be summarized as follows:

Table 1 – IETF protocols related to IP multicasting

Technical Areas	Protocols (year)	Reference (RFC)
IGMP/MLD	IGMPv2 (1997) IGMPv3 (2002) MLDv1 for IPv6 (1999) MLDv2 for IPv6 (2004)	IETF RFC 2236 IETF RFC 3376 IETF RFC 2710 IETF RFC 3810
Multicast Routing Protocols	DVMRP (1988) CBT (1997) PIM-SM (1998) PIM-DM (2005) SSM (2003)	IETF RFC 1075 IETF RFC 2189 IETF RFC 2362 IETF RFC 3973 IETF RFC 3569

5.3.2 ITU-T and ISO/IEC JTC 1

The main focus in JTC 1/SC6 and ITU-T Study Group (SG) 17 is on the protocols that can provide the reliable multicast transport and QoS management for IP multicasting in networks as described in the enhanced communications transport protocol (ECTP). The ECTP is a reliable multicast protocol designed to support Internet multicast applications running over multicast-capable networks. ECTP may be provisioned over UDP; it is designed to support tightly controlled multicast connections in simplex, duplex, and N-plex applications.

ECTP consists of the following parts:

a) ECTP-1: Simplex multicast transport (Rec. ITU-T X.606 | ISO/IEC 14476-1)

b) ECTP-2: QoS management for simplex multicast transport (Rec. ITU-T X.606.1 | ISO/IEC 14476-2)

c) ECTP-3: Duplex multicast transport (Rec. ITU-T X.607 | ISO/IEC 14476-3)

d) ECTP-4: QoS management for duplex multicast transport (Rec. ITU-T X.607.1 | ISO/IEC 14476-4)

e) ECTP-5: N-plex multicast transport (Rec. ITU-T X.608 | ISO/IEC 14476-5)

f) ECTP-6: QoS management for N-plex multicast transport (Rec. ITU-T X.608.1 | ISO/IEC 14476-6)

The JTC 1/SC6 and ITU-T SG 17 groups are also developing the relayed multicast protocol (RMCP). The RMCP is designed to ensure that multicast applications and services can be realized over the current Internet environments wherein IP multicast has not been deployed completely. Also known as application-level multicast, the RMCP is a multicast data transport protocol used for multicast applications wherein intermediate multicast agents (MA) are employed for relaying multicast data from a sender to many receivers over unicast networks.

RMCP consists of the following parts:

a) RMCP-1: RMCP framework (Rec. ITU-T X.603 | ISO/IEC 16512-1)

b) RMCP-2: RMCP for simplex group applications (Rec. ITU-T X.603.1 | ISO/IEC 16512-2)

c) RMCP-3: RMCP for N-plex group applications (Rec. ITU-T X.603.2 | ISO/IEC 16512-3)

5.3.3 3GPP/MBMS, 3GPP2/BCMCS, and WiMax/MBS

For the provisioning of multimedia multicast and broadcast services over wireless mobile systems, 3GPP is developing the "Multimedia Broadcast and Multicast Services (MBMS)" that can be used to support IP-based multimedia multicasting services in its own W-CDMA access networks and systems.

For the MBMS subsystem, 3GPP defines a new functional entity called "Broadcast and Multicast – Service Centre" (BM-SC) and two new interfaces: Gmb for the control plane (authorization and management) and Gi for the user plane (IP packet transmission). BM-SC is responsible for overall session management and multicast data transport in the 3GPP system. The MBMS of 3GPP is featured in the service-oriented, security-oriented multicast framework in 3GPP2's own networks and systems using legacy IP multicast protocols as much as possible.

The 3GPP documents associated with MBMS include:

a) 3GPP TS 22.246, MBMS User Services

b) 3GPP TS 23.246, MBMS Architecture

c) 3GPP TS 25.346, MBMS in RAN: Stage 2

d) 3GPP TS 26.346, MBMS Protocols and Codecs

e) 3GPP TS 33.246, Security of MBMS

On the other hand, 3GPP2 started to pursue standardization in "Broadcast & Multicast Services (BCMCS)" to provide broadcast/multicast services and applications over its own cdma2000 systems.

Similar to the MBMS of 3GPP, BCMCS plans to design a secure multicast in cdma2000 networks and to develop some technical specifications for provisioning multimedia multicasting services over 3GPP2's own networks and systems using legacy IP multicast protocols as much as possible. BCMCS can be regarded as the subsystems for adding the services-specific, security-oriented features to the IETF multicasting protocols.

For this purpose, BCMCS introduces new entities together with the security framework: BCMCS Controller for control purposes and BCMCS supporting node (BSN) for data transport purposes.

The 3GPP2 documents associated with BCMCS include:

a) 3GPP2 S.R0030-A, Broadcast/Multicast Services – Stage 1

b) 3GPP2 S.S0083-A, Broadcast-Multicast Security Framework

c) 3GPP2 X.S0022, BCMCS in cdma2000 wireless IP network

d) 3GPP2 A.S0019, Interoperability Specification for BCMCS

e) 3GPP2 C.S0054, cdma2000 High-Rate BCMCS Packet Data Air Interface Specification

The WiMax forum has been developing a set of standards for IEEE 802.16-based wireless access technology, which is also known as wireless broadband (WiBro). In particular, the network working group of the WiMax forum is considering the multicast broadcast services (MBS) that can be used for WiMax-based wireless access networks. MBS is aimed at developing the specification that enables multicast and broadcast transmissions over WiMax-based wireless

access networks. For this purpose, two kinds of MBS zones are being considered: embedded MBS and standalone MBS, which will be additionally defined in the MAC frame. In the embedded MBS zone, the downlink (DL) frame will be provided along with the unicast service; the standalone MBS will contain the entire DL frame dedicated to MBS transmissions.

5.3.4 DVB/CBMS and OMA/BCAST

In the digital video broadcasting (DVB) forum, a new broadcasting technology that includes DVB-H (handheld) devices and associated broadcasting transmission facilities has been developed. DVB-H can be viewed as a technology specific to broadcasting rather than telecommunications. The DBV forum is also developing the system-wide standard specifying the management and operating platform to provide broadcast and multicast services over 3G cellular networks as well as DVB-H-based broadcasting networks, i.e., convergence of broadcast and mobile services (CBMS).

On the other hand, the Open Mobile Alliance (OMA) forum is defining a set of standards for enabling mobile broadcasting and multicasting services called "BCAST". The OMA/BCAST can also be a kind of system-wide standard that defines the framework of mobile multicasting and broadcasting services over wireless networks such as 3GPP/MBMS and 3GPP2/BCMCS as well as the broadcasting network such as DVB-H.

5.3.5 Relationship between MMC and related standards

Figure 2 summarizes the relationship between the MMC standards and other standards related to mobile multicasting.

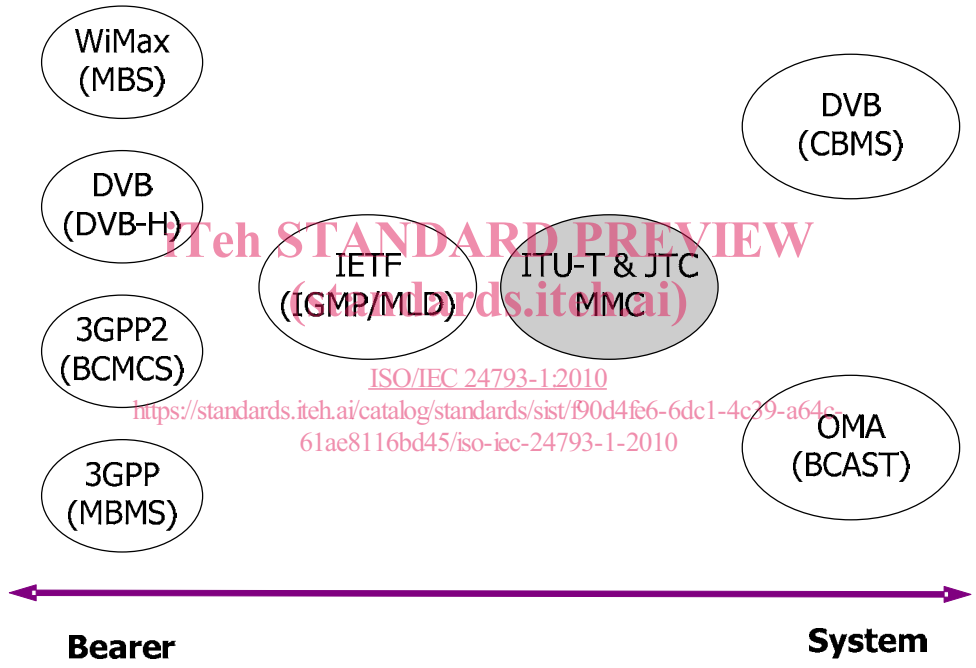

Figure 2 – Relationship between MMC and other related standards

As shown in Figure 2, the other standards related to mobile multicasting can be classified into three categories: multicast-enabling network technologies as the bearer (3GPP/MBMS, 3GPP2/BCMCS, WiMax/MBS, DVB/DVB-H), IP multicast protocols such as IGMP/MLD as defined in the IETF, and system-wide standards for defining the framework of mobile multicast services (OMA/BCAST, DVB/CBMS).

The standards for bearer capability specify how to enable multicast transmissions over the existing wireless and mobile networks. For example, the 3GPP/MBMS standard seeks to define the components of 3GPP-based wireless access networks for supporting the multicast transmission over the air interface; 3GPP2/BCMCS is for multicasting over 3GPP2-based radio access networks. WiMax/MBS is a technology designed to deliver multicast data over the IEEE 802.16-based wireless networks. In contrast, DVB/DVB-H is a broadcasting network.

The IETF has come up with several protocols supporting multicast routing and forwarding over the Internet such as IGMP/MLD and multicast routing protocols. Those protocols can also be used as IP-layer protocols over a variety of wireless networks such as MBMS, BCMCS, MBS, and DVB-H.

The OMA/BCAST and DVB/CBMS can be viewed as system-level standards that define the framework of multicast and broadcast services over several wireless/mobile networks. Such standard consists of a set of various components including service provisioning, stream distribution, service/contents protection, roaming, and handover. Note that such

framework standards define the service and session management for multicasting services as well as interfaces with multicast data transport using IGMP/MLD and multicast routing protocols over wireless access networks such as MBMS, BCMCS, etc.

On the other hand, MMC protocols will be running on top of IETF multicast-related protocols as well as a variety of wireless and broadcasting networks. Based on such IP-based protocols and networks, the MMC protocols will specify the session and membership management for multicast sessions and overlay multicasting functionality as described in the MMC-3 specification. MMC protocols also seek to provide the mobility functionality for mobile terminals such as handover.

In this respect, note that the MMC-2 and MMC-3 protocols can be used as the component protocols of OMA/BCAST or DVB/CBMS for supporting multicast transmission and services in wireless and broadcasting networks. For example, the MMC-2 or MMC-3 protocol may be incorporated into the framework of OMA/BCAST or DVB/CBMS standard to enable the session and membership management of multicast sessions and handover support for mobile terminals in multicast networks. More detailed usage scenarios of MMC protocols for OMA/BCAST and DVB/CBMS are described in Annex A.

6 Design considerations

This Recommendation | International Standard seeks to design the framework of MMC, which can be used to support a variety of multimedia multicast applications and services over wireless mobile networks as well as fixed networks in NGN environments.

For this purpose, this clause discusses the considerations in designing MMCF.

6.1 Target applications and services

The MMCF shall be designed to support IP-based multimedia multicast applications with the following characteristics:

a) Multicast applications/services

The MMCF will be targeted for multicast applications and services rather than broadcast applications and services. Multicast-based services will allow only the authenticated, authorized users to use the MMC services, whereas broadcast applications/services may be provided to any user without any authentication and authorization procedure.

To support the provision of MMC services to authenticated, authorized users only, MMCF shall be interworking with legacy AAA schemes. As such, MMCF shall also require appropriate steps for users such as "service subscription" and "session join".

b) One-to-many multicast applications/services

The MMCF will also be targeted for one-to-many multicast applications rather than many-to-many multicast ones. One-to-many multicast services shall consist of a single data sender – which is also called multicast contents server (MCS) – and many receivers (multicast users or clients). In other words, only a single sender shall be allowed in the multicast session.

Note that most of the commercial multicast applications and services are based on the one-to-many multicast scenario. The case of many-to-many application is intended for further study.

c) Real-time multicast applications/services

The MMCF shall be designed to support one-to-many, "real-time" multicast applications rather than non-real-time and/or reliable multicast applications. Note that a real-time multicast application focuses on the delivery of data in a timely manner, whereas a reliable multicast application exerts efforts to perform reliability control (e.g., error recovery through the retransmission of lost/corrupted packets) as shown in the ECTP protocol (Rec. ITU-T X.606 | ISO/IEC 14476-1).

MMCF is targeted for real-time multicast applications such as IPTV multicasting or live broadcasting of live events, since timely delivery is preferred to reliable delivery for such real-time applications and services. In MMCF, reliability control is assumed to be executed in the application itself.

6.2 Design principles

This Recommendation | International Standard describes the design of MMCF for MMC services and applications over wireless mobile networks as well as fixed communications networks. Based on MMCF, the development of one or more associated control protocols for MMC is planned.