INTERNATIONAL STANDARD

ISO/IEC 24793-2

First edition
2010-12-15

Information technology — Mobile multicast communications: Protocol over native IP multicast networks

Technologies de l'information — Communications de diffusion groupée mobile: protocole sur des réseaux natifs IP de diffusion groupée

Reference number
ISO/IEC 24793-2:2010(E)

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Published by ISO in 2011

Published in Switzerland

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Foreword

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ISO/IEC 24793-2 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 6, *Telecommunications and information exchange between systems*, in collaboration with ITU-T. The identical text is published as ITU-T Rec. X.604.1 (03/2010).

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*

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RECOMMENDATION ITU-T

Information technology – Mobile multicast communications: protocol over native IP multicast networks

1 Scope

This Recommendation | International Standard describes the specification of mobile multicast control protocol (MMCP) over native IP multicast networks for mobile multicast communications. The MMCP can be used to support a variety of multimedia multicasting services in the IP-based wireless mobile networks. The MMC is targeted at the real-time one-to-many multicast services and applications over mobile communications networks. This Recommendation | International Standard describes the procedures and packet formats of the MMCP protocol.

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.604 (2010) | ISO/IEC 24793-1:2010, *Information technology – Mobile multicast communications: Framework.*

3 Definitions

This Recommendation | International Standard uses the terms and definitions that are defined in the MMC framework, Rec. ITU-T X.604 | ISO/IEC 24793-1.

4 Abbreviations

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

AAA	Authentication, Authorization and Accounting
ACK	Acknowledgement
ASR	Aggregation Status Report
CTT	Context Transfer Time
HCT	Handover Context Transfer
HIC	Handover Initiation Confirm
HIR	Handover Initiation Request
HIT	Handover Initiation Time
HTA	Handover Transfer ACK
ID	Identifier
IGMP	Internet Group Management Protocol
JWT	Join Waiting Time
LJC	Local Join Confirm
LJR	Local Join Request
LMC	Local Mobility Controller
MCS	Multicast Contents Server
MLD	Multicast Listener Discovery

MMC	Mobile Multicast Communications
MMCF	MMC Framework
MMCP	Mobile Multicast Control Protocol
MN	Mobile Node
MR	Multicast Router
PoA	Point of Attachment
QoS	Quality of Service
SJC	Session Join Confirm
SJR	Session Join Request
SM	Session Manager
SPT	Status Probe Time
SRT	Status Report Time
TLV	Type-Length-Value
ULC	User Leave Confirm
ULR	User Leave Request
USP	User Status Probe
USR	User Status Report

5 Overview

The MMCP provides the control functionality for multicast data channels: Session Join, Status Monitoring and Handover Support. A multicast data session consists of an MCS (sender) and many MNs (receivers). The MCS will transmit multicast data packets to many prospective receivers, according to a predetermined program schedule. To receive the multicast data in the network, an MN will first perform the IGMP/MLD operations with the corresponding access router in the IP subnet. The MMCP can be used for control of multicast sessions together with any multicast data channels. The details of multicast data transport mechanisms are outside the scope of MMCP.

For Session Join, a prospective MN shall send a session join request message to the MMCP session manager (SM). The join request message shall include the following information: Session ID and MN ID. MN ID is an identifier allocated to the MN, which may be given *a priori* by a services provider. On receipt of the session join request message, the SM shall respond to the MN with a session join confirm message. The responding confirmation message will indicate whether the join request is accepted or not. In case that a local mobility controller (LMC) is allocated to the MN, the session join confirm message will also contain the contact information of the associated LMC. In case that an LMC is assigned to the MN, after receiving the join confirm message, the MN shall also join the designated LMC by sending a local join request message. On receipt of the local join request message, the LMC shall respond to the MN with a local join confirm message.

For User Leave, during the multicast session, an MN may want to leave the session. For this purpose, the MN may send a user leave request message to the LMC (in case that an LMC is assigned to the MN) or to the SM (in case that no LMC is assigned to the MN). The LMC (or SM) may respond to the MN with the user leave confirm message. It is noted that this user leave operation is optional. That is, a certain MN may leave the session without any notice.

Status Monitoring is used by the SM to monitor the dynamics for group/session membership and the status of multicast data channel (e.g., statistics such as total number of packets received during the session). For status monitoring, each MN shall send a periodic status report message to its upstream LMC or SM (in case that no LMC is assigned to the MN). Each LMC will aggregate the status information for its downstream MNs, and send a periodic aggregate status report message to the SM. In the meantime, the status report messages may be lost in the network. In this case, the upstream LMC or SM may solicit a status report message to the concerned MN or LMC by sending a status probe message.

For Handover Support, after movement detection, the MN begins the handover operations by sending a handover request message to the current LMC. The handover request message shall include the information about the new point of attachment (PoA) such as the link-layer MAC address or ID of the PoA. On receipt of a handover request message from the MN, the LMC will first identify which subnet the MN is going to move into. The current LMC can identify the new LMC by using the address of the ID of the new PoA that is indicated in the handover request message. For handover support, the current LMC shall send a handover context transfer message to the new LMC. Then, the new LMC will perform the IGMP/MLD join operation to the new MR, instead of the MN. This will ensure that the MN can receive the multicast data packets in the newly visited subnet as fast as possible. After that, the new LMC will respond

to the current LMC with a handover transfer ACK message. In turn, the current LMC will send a handover confirm message to the MN. This will complete the handover operation of the MMCP. After further movement, the MN will complete the establishment of a new L2 and L3 connection (for a new IP address of the MN). Then, the MN performs the local join operations with the new LMC.

6 Considerations

6.1 Protocol model

The MMCP is based on the mobile multicast communications framework (MMCF) specified in Rec. ITU-T X.604 | ISO/IEC 24793-1. The MMCP is designed to support one-to-many real-time multicast applications running over IP multicast-capable wireless/mobile networks. MMCP operates over IPv4/IPv6 networks with the IP multicast forwarding capability such as the IGMP/MLD and IP multicast routing protocols. As a control protocol, the MMCP provides a mobile user with the session join and user leave, status monitoring, and handover support for multicast data channels.

The MMCP is a control protocol that is used for control of the mobile multicast sessions over native IP multicast mobile/wireless networks. It is assumed that the multicast data channels are provided with the help of the UDP/IP multicasting in the network. That is, the MMCP is independent of multicast data channels, as depicted in Figure 1.

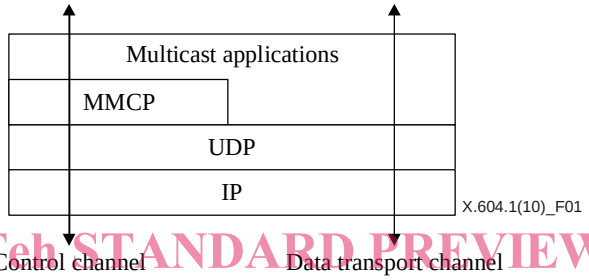

Figure 1 – Protocol model

A multicast data channel can use the MMCP protocol for the control of multicast sessions. For this purpose, the MMCP provides a set of application programming interfaces (APIs) for any multicast data channels/applications. In the protocol stack point of view, an MMCP message is encapsulated into the UDP datagram.

6.2 Protocol entities

This clause describes the protocol entities associated with the MMCP.

6.2.1 Mobile node (MN)

An MN represents an end user that receives multicast data transport services from multicast contents server. To receive the multicast data from the network, the MN should be equipped with the multicast capability such as the IGMP/MLD protocol. The MN is also required for the MMCP functionality. With the help of MMCP, an MN can benefit from the control services such as session join, status monitoring, and handover support.

6.2.2 Multicast contents server (MCS)

In MMCP, an MCS represents the sender of the multicast data channel/session. The MCS will continue to transmit the multicast data streams over the network, and a lot of MNs will receive the data packets after session join. The MCS is associated with the multicast data channel only rather than the MMCP control channel. The MCS could exchange some session-related information with the MMCP session manager, possibly using a dedicated communication channel, which is outside the scope of this Specification.

6.2.3 Session manager (SM)

The SM is responsible for the overall operations of the MMCP. In Session Join, the SM will respond to the join request of a promising MN. For authentication, the SM may contact with an AAA-related database or user profile that has been preconfigured by services provider, which is outside the scope of the MMCP. In Status Monitoring, the SM will monitor the overall status of the membership and session for all of the MNs. For this purpose, each MN will send periodic control messages to the SM, possibly by way of a local mobility controller. The SM may be implemented with the MCS on the same system, which is an implementation issue.

6.2.4 Local mobility controller (LMC)

The LMC is used to locally control the movement of the MN. In the mobile wireless networks, when an MN moves into the other network region during the multicast session, the handover support is required for seamless multicast services. The LMC is used to support the seamless handover for the MN in the wireless/mobile networks.

For handover support, the movement of the MN will be informed to the associated LMC. To provide the seamless services, an LMC may interact with other LMCs that are newly visited in the network by the MN. With the help of the LMC, an MN can be given seamless multicast services against handover. The LMC is also used for status monitoring of the MNs. Each MN will send a periodic message to LMC, and the LMC aggregates the status of its downstream MNs and forwards the aggregated status information to the SM. It is noted that an LMC acts as a network agent for MNs in the MMCP.

It is assumed that a set of LMCs have been deployed in the wireless networks by the services provider.

6.3 Reference network configuration

Figure 2 shows a reference configuration of the MMCP entities in the network.

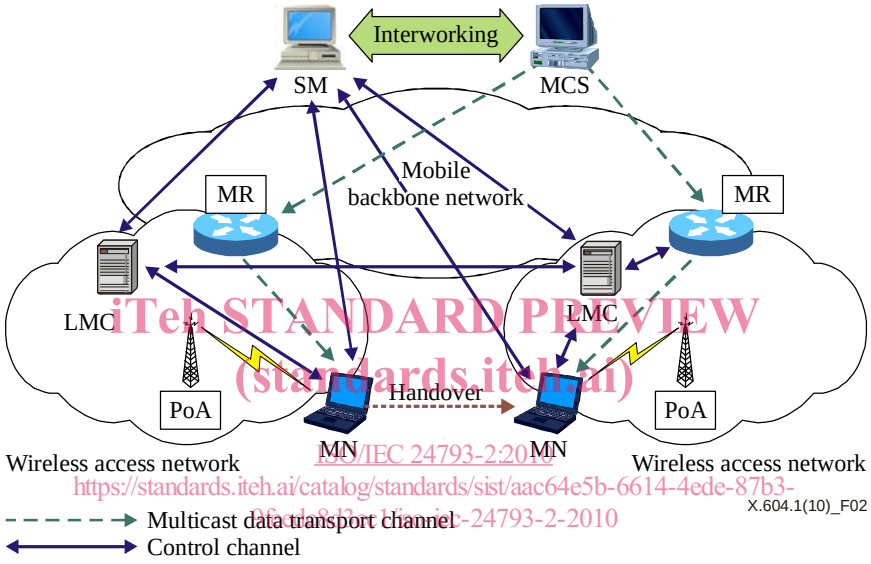

Figure 2 – Configuration of MMCP protocol entities

As shown in the figure, the multicast data channels operate between the MCS and the MNs with the help of multicast routers (MRs) and point of attachments (PoAs) in the network. The MMCP operates independently of the data channels. The MMCP operations are performed between the SM and the LMC, between the SM and the MN, and between the LMC and the MN.

It is assumed that an LMC is located within the IP subnet controlled by an MR. For effective handover support, an LMC needs to operate in the same IP subnet with the concerned MNs. In a certain case, an LMC may be implemented with an MR over the same equipment, which is a deployment issue.

For mobility support, an MN detecting its movement will inform the LMC for mobility control. The MN's movement types include the change of PoA (at the link layer) or MR (IP layer). The information on such movement shall be used to support seamless handover by LMCs, in which the LMCs will interwork with each other and the new LMC interacts with the corresponding MR.

6.4 Messages

The protocol messages used for MMCP are summarized in Table 1.

Table 1 – Messages used in MMCP protocol

Message name	Acronym	Type value	From	To
Session Join Request	SJR	0000 0001	MN	SM
Session Join Confirm	SJC	0000 0010	SM	MN
Local Join Request	LJR	0000 0011	MN	LMC
Local Join Confirm	LJC	0000 0100	LMC	MN
User Leave Request	ULR	0000 0101	MN	LMC or SM
User Leave Confirm	ULC	0000 0110	LMC or SM	MN
User Status Report	USR	0000 0111	MN	LMC or SM
Aggregation Status Report	ASR	0000 1000	LMC	SM
User Status Probe	USP	0000 1001	LMC	MN
			SM	LMC or MN
Handover Initiation Request	HIR	0000 1010	MN	LMC or SM
Handover Context Transfer	HCT	0000 1011	Old LMC	New LMC
Handover Transfer ACK	HTA	0000 1100	New LMC	Old LMC
Handover Initiation Confirm	HIC	0000 1101	LMC or SM	MN

As described in the table, SJR and SJC are used for session join to the SM. LJR and LJC messages are used for local join to the LMC. ULR and ULC are for user leave. The USR, ASR, and USP messages are used for status monitoring during session. On the other hand, HIR, HCT, HTA, and HIC messages are used for handover support.

7 Procedures

7.1 Multicast data transport

The MCS will transmit multicast data packets to many prospective receivers, according to a predetermined program schedule, as shown in the IPTV electronic program guide. The multicast data packets transmitted by an MCS will be delivered toward many MNs over IP multicast networks with the help of the multicast routing protocols such as source specific multicast (SSM) or protocol independent multicast (PIM), etc.

After session join, an MN can receive the multicast data packets from the MCS. The MN may be allowed to receive the multicast data only after an appropriate authentication/authorization process with the SM, which is done in the Session Join operation. To receive the multicast data in the network, an MN will first perform the IGMP/MLD operations with the corresponding access router in the IP subnet.

The MMCP can be used for the control of multicast sessions together with any multicast data channel. The details of multicast data transport mechanisms are outside the scope of MMCP.

7.2 Session join

Session join is the operation for MN to join a multicast session, as depicted in Figure 3.

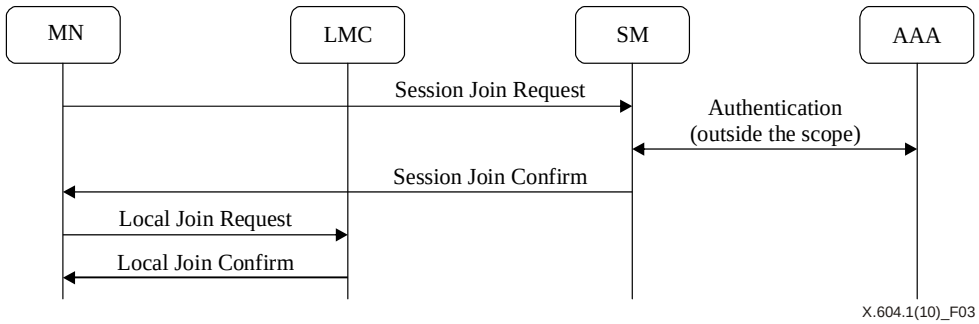

Figure 3 – Session join and local join

To join a session, a prospective MN shall send the SJR message to the SM. The SJR message shall include the following information: Session ID and MN ID. It is assumed that the Session ID has already been informed to the prospective MNs by using a different mechanism such as a web announcement. It is noted that the IP address and port number of the SM will also be announced to the prospective MNs, which will ensure that the MN can send an SJR message to the associated SM. The MN ID is an identifier allocated to the MN, which may be given by a services provider associated with the multicast services. The SJR message can also include the information of the PoA attached to the MN, which may be used for the SM to determine the best LMC for the MN.

On receipt of the SJR message, the SM shall respond to the MN with an SJC message. For this purpose, the SM may first check whether the MN is an authenticated/authorized user by contacting with an associated AAA server, which is outside the scope of the MMCP. The responding SJC message will indicate that the join request is accepted or not by using a flag bit of the message. In the successful case, the SJC message shall include the information about the corresponding multicast data channel: IP multicast address and port number. In case that an LMC is allocated to the MN, the SJC message will also contain the IP address and port number of the associated LMC.

In the MN point of view, after sending the SJR message, the MN will wait for the responding SJC message for the join waiting time (JWT). If the SJC message does not arrive at the MN during the JWT time, the MN concludes that the join request has failed. The associated indication may be delivered to the upper-layer application, which is an implementation issue.

In case that an LMC is assigned to the MN, after receiving the SJC message, the MN shall send an LJR message to the indicated LMC. The LJR message shall include the MN ID. On receipt of the LJR message, the LMC shall respond to the MN with an LJC message. The responding LJC message shall indicate that the local join request is accepted or not.

In the MN point of view, after sending the LJR message, the MN will wait for the responding LJC message for the join waiting time (JWT). If the LJC message does not arrive at the MN during the JWT time, the MN concludes that the local join request has failed. The associated indication may be delivered to the upper-layer application, which is an implementation issue.

7.3 User leave

During the multicast session, an MN may want to leave the session. For this purpose, the MN may send a ULR message to the LMC (in case that an LMC is assigned to the MN) or to the SM (in case that no LMC is assigned to the MN). The LMC (or SM) may respond to the MN with the ULC message. In this case, the LMC may send an ASR message to the SM so as to inform the changed group membership for the session. The User Leave operation is shown in Figure 4.

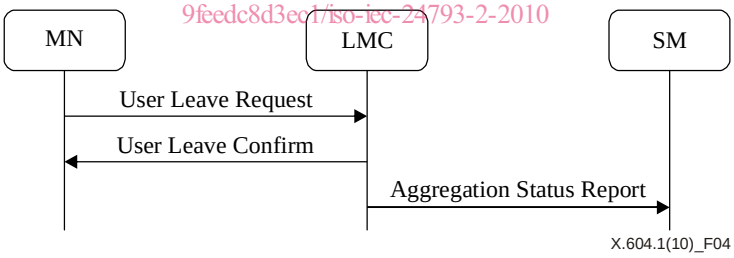

Figure 4 – User leave

It is noted that this User Leave operation is optional. That is, a certain MN may leave the session without any notice to its upstream LMC or SM. For example, an abnormal disconnection of the network may occur before the user leave operation. In this case, the information of the user leave will be detected by the upstream node via the subsequent Status Monitoring operations.

7.4 Status monitoring

Status monitoring is used to monitor the group membership of the session and the statistical status of the multicast data channel. In Status Monitoring, each MN shall send a periodic USR message to its upstream LMC or SM (in case that no LMC is assigned to the MN). Each LMC will aggregate the status information of its downstream MNs, and send a periodic ASR message to the SM. Figure 5 shows the normal status monitoring operations in MMCP.

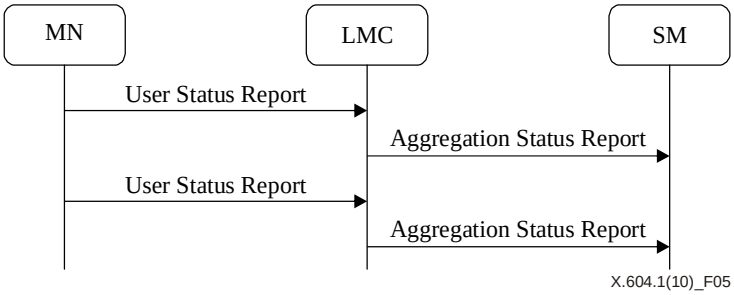

Figure 5 – User status report

While a session is active, each MN shall send a USR message to its upstream node for every status report time (SRT). The SRT value may be locally configured. The USR will contain the information about the MN ID and the measured statistics for multicast data channel such as the number of totally received packets and the elapsed time in the session. To get the status of the data channel, the MMCP control channel may need to interact with the multicast data channel. Such a detailed mechanism is outside the scope of the MMCP.

The LMC shall aggregate all of the status information from its downstream MNs, and it shall also send a periodic ASR message to the SM according to its own SRT timer. The ASR message includes the status information of its downstream MNs.

Depending on the network condition, a USR or ASR message may be lost in the network. In this case, the upstream node will request the status report message to the concerned downstream node by sending a USP message, as shown in Figure 6.

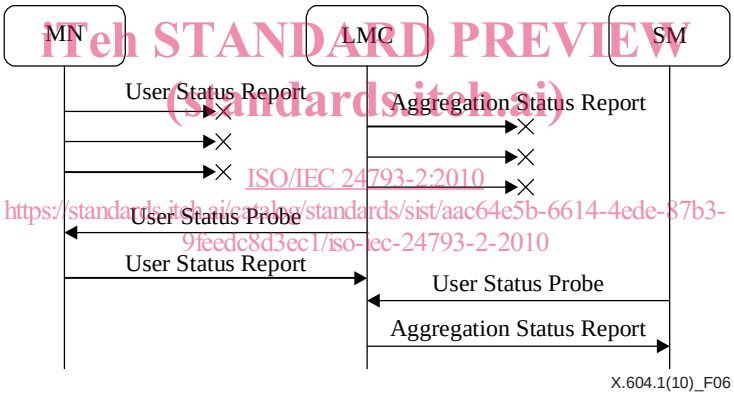

Figure 6 – User status probe

As shown in the figure, when an upstream LMC has not received any USR message from an MN for the preconfigured status probe time (SPT), it shall send a USP message to the concerned MN. The SPT value may typically be set to '3 x SRT'. The MN shall respond to its upstream LMC with the USR message, as soon as it receives a USP message. In a similar way, the SM may send a USP message to its downstream LMCs for status monitoring.

Nevertheless, a certain MN may not respond with a USR message in the viewpoint of LMC. In this case, the LMC will send another USP message again every SPT time. If an MN has not responded to three consecutive USP messages, it will be detected as a failed MN by the LMC. In a similar way, the SM detects a failure of its downstream LMC.

7.5 Handover support

The handover support is the key feature of MMCP. The MMCP provides handover support for the MN in the mobile multicast communications.

As already described in Figure 2 of clause 6.3, there are one or more PoAs in the subnet controlled by the multicast router (MR). When an MN moves within the same IP subnet, the IP handover for multicasting will not be required. In this case, only the link-layer handover (by change of PoA) will be performed, which is outside the scope of this Specification. The MMCP considers the handover scenario in which the MN moves into a new IP subnet and thus changes its associated MR as well as PoA.