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Foreword

This Technical Specification has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

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- x the first digit:
 - 1 presented to TSG for information;
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- y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
- z the third digit is incremented when editorial only changes have been incorporated in the document.

Introduction

MBMS is a point-to-multipoint service in which data is transmitted from a single source entity to multiple recipients. Transmitting the same data to multiple recipients allows network resources to be shared.

The MBMS bearer service offers two modes:

- Broadcast Mode.
- Multicast Mode.

MBMS user services can be built on top of the MBMS bearer service. Further, the MBMS User Services may use other UMTS bearer services to deliver data. The present document specifies four delivery methods for the MBMS user services: download, streaming, GC, and Transparent. Examples of applications using the download delivery method are news and software upgrades. Delivery of live music is an example of an application using the streaming delivery method. Transparent delivery method allows the distribution of generic IP applications over MBMS bearers.

There can be several MBMS user services. The objective of the present document is the definition of a set of media codecs, formats and transport/application protocols to enable the deployment of MBMS user services. The present document takes into consideration the need to maximize the reuse of components of already specified services like PSS and MMS.

1 Scope

The present document defines a set of media codecs, formats and transport/application protocols to enable the deployment of MBMS user services either over the MBMS bearer service or other UMTS Bearer Services within the 3GPP system.

In this version of the specification, only MBMS download and streaming delivery methods are specified. The present document does not preclude the use of other delivery methods.

The present document includes information applicable to network operators, service providers and manufacturers.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

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- [147] 3GPP TS 36.104, "Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) radio transmission and reception".
- [148] ETSI TS 103 720 "5G Broadcast System for linear TV and radio services; LTE-based 5G terrestrial broadcast system".
- [149] 3GPP TR 36.976 "Overall description of LTE-based 5G broadcast".
- [150] 3GPP TS 26.511 "5G Media Streaming (5GMS); 5G Media Streaming (5GMS); Profiles, codecs and formats".
- [151] 3GPP TS 26.512 "5G Media Streaming (5GMS); Protocols".
- [152] IETF RFC 6335: "Internet Assigned Numbers Authority (IANA) Procedures for the Management of the Service Name and Transport Protocol Port Number Registry".
- [153] IANA (Internet Assigned Numbers Authority): "IPv4 Multicast Address Space Registry", <https://www.iana.org/assignments/multicast-addresses/multicast-addresses.xhtml>.
- [154] IANA (Internet Assigned Numbers Authority): "IPv6 Multicast Address Space Registry", <https://www.iana.org/assignments/ipv6-multicast-addresses/ipv6-multicast-addresses.xhtml>.
- [155] IETF RFC 9110: "HTTP Semantics", June 2022.
- [156] IETF RFC 3551: "RTP Profile for Audio and Video Conferences with Minimal Control", July 2003.
- [157] IETF RFC 5124: "Extended Secure RTP Profile for Real-time Transport Control Protocol (RTCP)-Based Feedback (RTP/SAVPF)", February 2008.

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1] and the following apply:

Application content component: An individual content component of an MBMS User Service, such as a video or audio media stream, or a non-real-time file, delivered by an MBMS transport session, and is available to and can be used by the MBMS application.

Application Service: An end-user service for which the entry point document is contained in the User Service Description and whereby all associated content components are delivered through one or more MBMS User Services via broadcast and/or unicast bearers.

Broadcast session: See TS 22.146 [2].

Forward Error Correction (FEC): in the context of MBMS, a FEC mechanism is used at the application layer to allow MBMS receivers to recover lost SDUs.

FLUTE channel: equivalent to an ALC/LCT channel. An ALC/LCT channel is defined by the combination of a sender and an address associated with the channel by the sender (RFC 3926 [9]).

Frame-packed stereoscopic 3D video: a video consisting of two views in which both views were packed into a single stream before compression.

Hybrid DASH/HLS service: a media streaming service which can be consumed both by DASH clients and HLS clients.

Multicast joining: See TS 22.146 [2].

Multicast session: See TS 22.146 [2].

Multimedia Broadcast/Multicast Service (MBMS): See TS 22.146 [2].

MBMS application: The application which resides in or interfaces with the UE, and which provides to the end-user an application service by using one or more application content components of one or more MBMS User Services.

MBMS over a Single Frequency Network: See TS 25.346 [5].

MBMS User Service: The transport-level service, comprising one or more application content components, delivered by the MBMS bearer service across one or more Broadcast and/or Multicast sessions, and/or delivered by the unicast bearer service. The application content components of the MBMS User Service, in part or in whole, are provided to the MBMS application.

NOTE: See TS 22.246 [3].

MBMS User Service discovery/announcement: user service discovery refers to methods for the UE to obtain the list of available MBMS user services along with information on the user service and the user service announcement refers to methods for the MBMS service provider to make the list of available MBMS User Services along with information on the user service available to the UE.

MBMS User Service initiation: UE mechanisms to setup the reception of MBMS User Service data. The initiation procedure takes place after the discovery of the MBMS user service.

MBMS delivery method: mechanism used by a MBMS User Service to deliver content. An MBMS delivery method uses MBMS bearers in delivering content and may make use of associated procedures.

MBMS download delivery method: delivery of discrete objects (e.g. files) by means of a MBMS download session.

MBMS group communication delivery method: delivery of group communication service data by means of the BM-SC ingesting UDP/IP packets from a group communications server and forwarding them over the MBMS path provided by the MBMS Bearer Service.

MBMS streaming delivery method: delivery of continuous media (e.g. real-time video) by means of a MBMS streaming session.

MBMS transparent delivery method: transparent delivery of application data by means of an MBMS Transparent session.

MBMS download session: time, protocols and protocol state (i.e. parameters) which define sender and receiver configuration for the download of content files.

MBMS streaming session: time, protocols and protocol state (i.e. parameters) which define sender and receiver configuration for the streaming of content.

MBMS Transparent session: time, area, protocols, and protocol state (i.e. parameters) which define sender and receiver configuration for the transparent delivery of application data flows.

Partial-File-Accept Request: HTTP GET request that includes a partial-accept header in the HTTP request header.

Receive Only Mode: See TS 23.246 [4].

Receive-Only Mode (ROM) service: A type of eMBMS broadcast service receivable by a UE configured in Receive Only Mode. A TMGI associated with a ROM service shall contain a standardized [MCC+MNC] value. See annex E of TS 23.246 [4] and TS 24.116 [131] for further details on Receive-Only Mode.

RTP Session: The RTP and RTCP traffic sent to a specific IP multicast address and port pair (one port each for RTP and RTCP) during the time period the session is specified to exist. An RTP session is used to transport a single media

type (e.g. audio, video, or text). An RTP session may contain several different streams of RTP packets using different SSRCs.

Stereoscopic 3D video: a video bitstream consisting of two views.

Unicast Bearer Service: Synonymously used as the term "UMTS Bearer Services with interactive and/or streaming traffic classes".

3.2 Abbreviations

For the purposes of the present document, abbreviations given in 3GPP TR 21.905 [1] and the following apply:

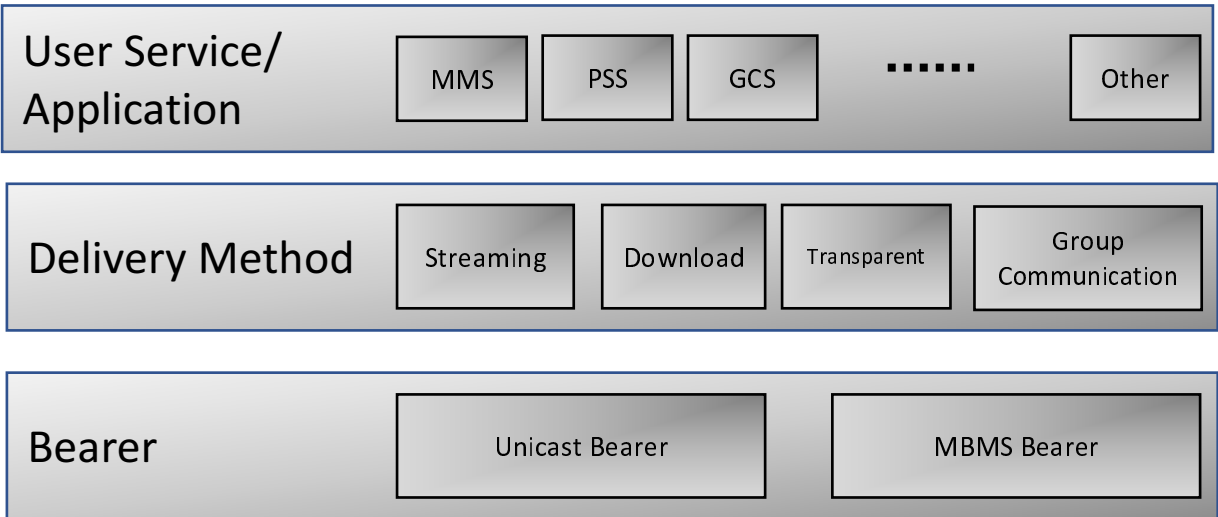
ADPD	Associated Delivery Procedure Description
ADU	Application Data Unit
ALC	Asynchronous Layered Coding
API	Application Programming Interface
AS	Application Server
ASD	Application Service Description
AVC	Advanced Video Coding
BM-SC	Broadcast-Multicast - Service Centre
CC	Congestion Control
CPB	Coding Picture Buffer
CVS	Coded Video Sequence
DASH	Dynamic Adaptive Streaming over HTTP
ERT	Expected Residual Time
ESI	Encoding Symbol ID
FDT	File Delivery Table
FLUTE	File deLivery over Unidirectional Transport
FMT	Feedback Message Type
GCS	Group Communication Service
GCSE	Group Communication Service Enabler
HDR	High Dynamic Range
HDTV	High-DefinitionTeleVision
HEVC	High Efficiency Video Coding
HLS	HTTP Live Streaming
IANA	Internet Assigned Numbers Authority
IDR	Instantaneous Decoding Refresh
IRAP	Intra Random Access Point
ISD	Initialization Segment Description
LCT	Layered Coding Transport
LI	Leap Indicator
MBMS SAI	MBMS Service Area Identity
MCPTT	Mission Critical Push to Talk
MIME	Multipurpose Internet Mail Extensions
MMS	Multimedia Messaging Service
MooD	MBMS operation on Demand
MPD	Media Presentation Description
MSK	MBMS Service Key
MTK	MBMS Traffic Key
MUK	MBMS User Key
NAL	Network Abstraction Layer
NTP	Network Time Protocol
OMNA	Open Mobile Naming Authority
PAC	Proxy Auto-Config
PSS	Packet-switched Streaming Service
PTT	Push To Talk
RASL	Random Access Skipped Leading picture
ROM	Receive-Only-Mode
SA File	Service Announcement File
SACH	Service Announcement CHannel
SBN	Source Block Number

SCT	Sender Current Time
SEI	Supplemental Enhancement Information
SNTP	Simple Network Time Protocol
TMGI	Temporary Mobile Group Identity
TOI	Transport Object Identifier
TSI	Transport Session Identifier
UHD	Ultra High Definition
URL	Uniform Resource Locator
USBD	User Service Bundle Description
USD	User Service Description
UTC	Universal Time Coordinated
VCL	Video Coding Layer
VR	Virtual Reality

4 MBMS system description

4.1 MBMS functional layers

Three distinct functional layers are defined for the delivery of MBMS-based service. They are Bearers, Delivery method and User service. Figure 1 depicts these layers with examples of bearer types, delivery methods and applications.



- Bearers:** Bearers provide the mechanism by which IP data is transported. MBMS bearers as defined in TS 23.246 [4] and TS 22.146 [3] are used to transport multicast and broadcast traffic in an efficient one-to-many manner and are the foundation of MBMS-based services. MBMS bearers may be used jointly with unicast PDP contexts in offering complete service capabilities.
- Delivery Method:** When delivering MBMS content to a receiving application one or more delivery methods are used. The delivery layer provides functionality such as security and key distribution, reliability control by means of forward-error-correction techniques and associated delivery procedures such as file-repair, delivery verification. Four delivery methods are defined, namely download, streaming, transparent, and group communication. Delivery methods may be added beyond the current release. Delivery methods may use MBMS bearers and may make use of point-to-point bearers through a set of MBMS associated procedures.
- User service:** The MBMS User service enables applications. Different applications impose different requirements when delivering content to MBMS subscribers and may use different MBMS delivery methods. As an example a messaging application such as MMS would use the download delivery method while a streaming application such as PSS would use the streaming delivery method, and a group communications application such as MCPTT would use the group communication delivery method.

Figure 1: Functional Layers for MBMS User Service

4.2 MBMS User Service entities

Figure 2 shows the MBMS User Service entities and their inter-relations. Relation cardinality is depicted as well.

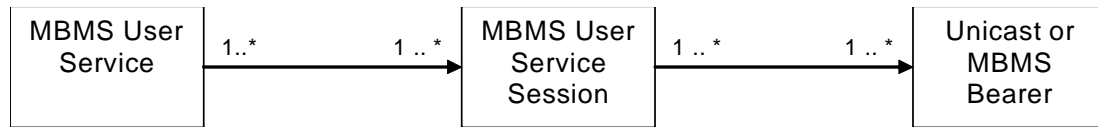


Figure 2: Entities and Relations

An MBMS User Service is an entity that is used in presenting a complete service offering to the end-user and allowing him to activate or deactivate the service. It is typically associated with short descriptive material presented to the end-user, which would potentially be used by the user to decide whether and when to activate the offered service.

A single service entity can contain multiple distinct multimedia objects, streams, or object flows, which may need to be provided over various MBMS download session, MBMS streaming session, MBMS transparent session, or MBMS group communication delivery method. A download session or a streaming session is associated with either a unicast bearer or one or more MBMS bearers and a set of delivery method parameters specifying how content is to be received on the mobile side. A delivery method for the carriage of a group communication service through the MBMS system is associated with one or more MBMS bearers. A transparent session is associated with exactly one MBMS bearer. The MBMS User Service Session may be mapped either on MBMS Bearer Services or on unicast bearer services.

A set of one or more MBMS bearers can be used for delivering data as part of an MBMS download or streaming session. As an example, the audio and visual parts can be carried on separate MBMS bearers. However, it is recommended to transfer MBMS download and/or streaming sessions, which belong to the same MBMS user service on the same MBMS bearer service.

An MBMS bearer service (identified by TMGI) may be used to transport data for one or more MBMS download, streaming, transparent, or GC sessions (TS 22.246 [3], clause 5).

4.3 MBMS bearer service architecture

The MBMS Bearer Service Architecture is defined in TS 23.246 [4]. The MBMS User Service interfaces to the MBMS system via three entities:

- The BM-SC.
- The GGSN (for GPRS) or MBMS-GW (for EPS).
- The UE.

In addition, for MBMS delivery of GCS (such as MCPTT application services), the group communication delivery method enables the MBMS Bearer Service to be accessed by the GCS Application Server (AS), via the MB2 interface between the AS and BM-SC, for carriage of application service data to the UE.

The BM-SC provides functions for MBMS user service provisioning and delivery to the content provider. It can also serve as an entry point for IP MBMS data traffic from the MBMS User Service source.

The GGSN (for GPRS) or MBMS-GW (for EPS) serves as an entry point for IP multicast traffic as MBMS data from the BM-SC.

4.4 Functional entities to support MBMS User Services

4.4.1 MBMS User Service architecture

Figures 3a and 3b depict the MBMS network architecture showing MBMS related entities involved in providing MBMS User Services.

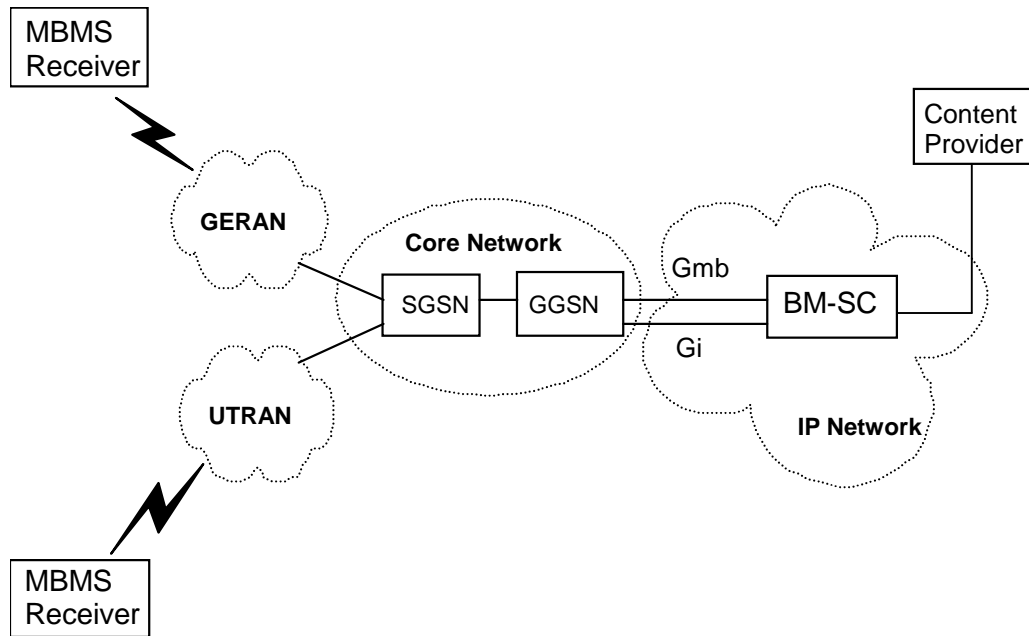


Figure 3a: MBMS network architecture model for GPRS

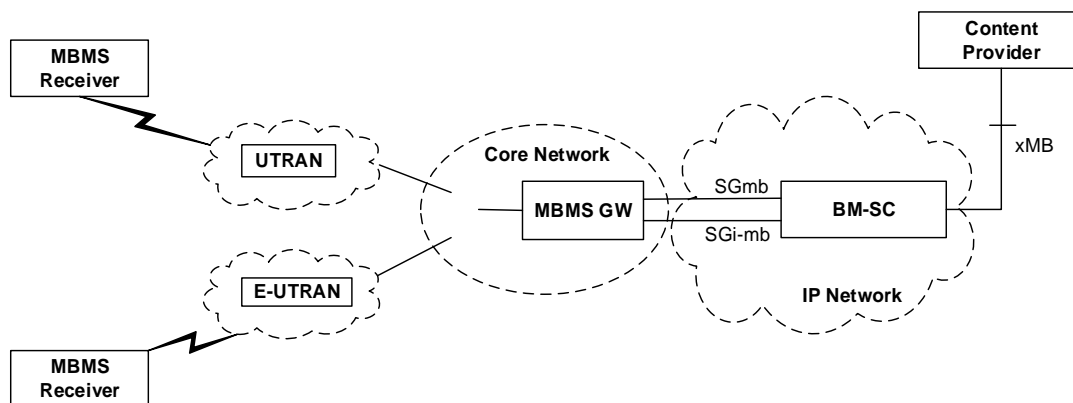


Figure 3b: MBMS network architecture model for EPS

MBMS User Service architecture is based on an MBMS receiver on the UE side and a BM-SC on the network side.

The use of the Gmb/SGmb and Gi/SGi-mb interface in providing IP multicast traffic and managing MBMS bearer sessions is described in detail in TS 23.246 [4].

Details about the BM-SC functional entities are given in figure 4.

Figure 3c depicts the MBMS network architecture showing MBMS related entities involved in providing Group Communication Services (such as MCPTT application services) delivery to the UE.

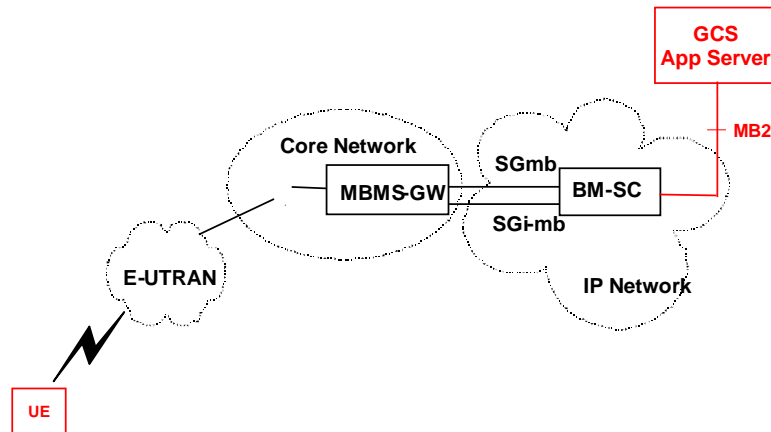


Figure 3c: MBMS network architecture model for GCS delivery

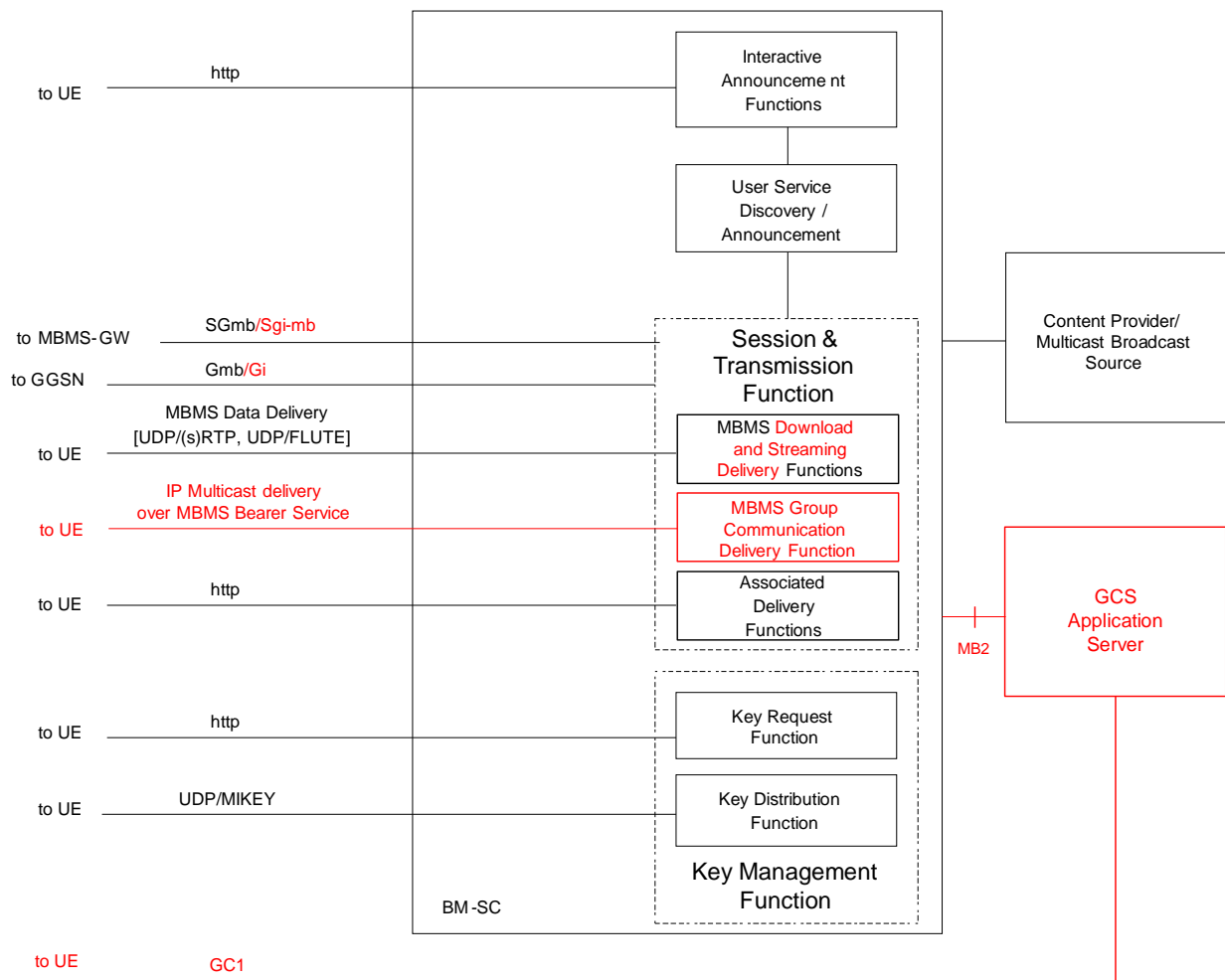


Figure 4: BM-SC sub-functional structure

The Session and Transmission function is further subdivided into the MBMS Delivery functions and the Associated Delivery functions.

The BM-SC and UE may exchange service and content related information either over point-to-point bearers or MBMS bearers whichever is suitable. To that end the following MBMS procedures are provided:

- User Service Discovery/Announcement providing service description material to be presented to the end-user as well as application parameters used in providing service content to the end-user.

- MBMS-based delivery of data/content from the BM-SC to the UE over IP multicast or over IP unicast.
- The data/content is optionally confidentiality and/or integrity protected
- The data/content is optionally protected by a forward error correction code
- IP multicast delivery of Group Communication application data (such as MCPTT), as an MBMS User Service which originates outside the BM-SC, over the MBMS Bearer Service.
- Key Request and Registration procedure for receiving keys and key updates.
- Key distribution procedures whereby the BM-SC distributes key material required to access service data and delivered content.
- Associated Delivery functions are invoked by the UE in relation to the MBMS data transmission. The following associated delivery functions are available:
 - File repair for download delivery method used to complement missing data.
 - Delivery verification and reception statistics collection procedures.

The interfaces between internal BM-SC functions are outside the scope of the present document.

A "Proxy and Transport function" may be located between the "Session and Transmission Function" and the GGSN (for GPRS) or MBMS-GW (for EPS). The "Proxy and Transport function" is transparent to the "Session and Transmission function". The "Proxy and Transport" function is defined in clause 5.1.3 of [4].

For Group Communication Service, the announcement of the MBMS bearer is performed by the GCS AS, when necessary. To enable the reception of Group Communication Service (such as MCPTT application service) data from the GCS AS for delivery through the MBMS system, the BM-SC shall support the MB2 interface between the GCS Application Server (AS) and the BM-SC as specified in TS 29.468 [121]. As described in [121], Diameter messages are exchanged over the MB2-C interface, pertaining to procedures for the allocation (deallocation) and activation (deactivation) of the MBMS Bearer Service in the MBMS system, with associated information (e.g. QoS, start time, Flow Id, service area, radio frequency, BM-SC IP address) for the delivery of application data from the AS. Over MB2-U, GCS user plane data, encapsulated in UDP and IP, are transparently transported between the GCS AS (such as an MCPTT server) and the application client at the UE. The BM-SC, using the group communication delivery method, forwards these protocol layers transparently to the MBMS-GW.

4.4.1a Content Provider/Multicast–Broadcast Source

The Content Provider/Multicast–Broadcast Source may provide discrete and continuous media, as well as service descriptions and control data, to the BM-SC to offer services at a time. An MBMS User Service may use one or several MBMS delivery methods simultaneously. The Content Provider/Multicast Broadcast Source may also be a third party Content Provider/Multicast Broadcast Source.

The Content Provider/Multicast Broadcast Source function may reside within the operator's network or may be provided from outside the operator's network. The Content Provider/Multicast Broadcast Source can also configure the Session and Transmission functions (e.g. delivery or associated delivery). The interface between the Content Provider/Multicast Broadcast Source and the BM-SC is specified in TS 26.348 [143].

4.4.1b Group Communication Service Application Server (GCS AS)

The GCS AS, as defined by TS 23.468 [120], uses the MBMS Group Communication delivery method on top of the MBMS bearers for MBMS delivery.

The GCS AS interfaces to the BM-SC using the MB2 interface. MB2 carries control plane signalling (via MB2-C) and user plane data (via MB2-U) between the GCS AS and BM-SC. The data transferred via MBMS bearer(s) is delivered from the BM-SC using the Group Communication delivery method. A GCS AS may transfer data from one or multiple GCS AS sessions via a single MBMS bearer. Description of the stage 2 procedures on MB2 between the GCS AS and the BM-SC is provided in TS 23.468 [120]. The stage 3 specification of the MB2 procedures and the protocol aspects of MB2-C and MB2-U are given in TS 29.468 [121].

4.4.2 MBMS Key Management function

The MBMS Key Management function is used for distributing MBMS keys (Key Distribution subfunction) to authorized UEs. Before the UE can receive MBMS keys, the UE needs to register to the Key Request subfunction of the Key Management function by indicating the MBMS User Service Id. Once registered, the UE can request missing MBMS keys from the BM-SC by indicating the specific MBMS key Id. In order for the UE to stop the BM-SC to send MBMS key updates a deregistration with the MBMS User Service Id is needed.

If the MBMS User Service does not require any MBMS data protection, then the UE shall not register for key management purposes.

A detailed description of all key management procedures is provided in TS 33.246 [20].

4.4.3 MBMS Session and Transmission function

The MBMS Session and Transmission function transfers the actual MBMS session data to the group of MBMS UEs using either MBMS Bearer Services or unicast bearer services. The MBMS Session and Transmission function interacts with the GGSN (for GPRS) through the Gmb Proxy function to activate and release the MBMS transmission resources. The MBMS Session and Transmission function interacts with the MBMS-GW (for EPS) through the SGmb Proxy function to activate and release the MBMS transmission resources.

The session and transmission function may compress headers of MBMS data in some cases. Further, the session and transmission function may need to add synchronization information for the MBMS payload e.g. in case of MBSFN transmissions. For details on usage of synchronization and header compression see TS 23.246 [4] and TS 25.346 [5].

The function contains the MBMS delivery methods, which use the MBMS bearer service for distribution of content. Further this function contains a set of Associated-Delivery Functions, which may be invoked by the UE in relation to the MBMS data transmission (e.g. after the MBMS data transmission).

The BM-SC Session and Transmission function is further described in later clauses of the present document as well as in TS 23.246 [4].

MBMS User Services data may be integrity and/or confidentiality protected as specified within TS 33.246 [20], and protection is applied between the BM-SC and the UE. This data protection is based on symmetric keys, which are shared between the BM-SC and the UEs accessing the service.

MBMS User Services may also be protected against packet loss between BM-SC and UE using a forward error correction code.

4.4.4 User Service Discovery/Announcement function

The User Service Discovery/Announcement provides service description information, which may be delivered via the Session and Transmission function or via the Interactive Announcement function. This includes information, which is necessary to initiate an MBMS user service as described in clause 5.3.1. Metadata for the service descriptions are described in clause 5.2.

4.4.5 Interactive Announcement function

An Interactive Announcement function may offer alternative means to provide service descriptions to the UE using HTTP or be distributed through other interactive transport methods.

4.4.6 MBMS UE

The MBMS UE hosts the MBMS User Services receiver function. The MBMS receiver function may receive data from MBMS bearer services or from unicast bearer services. The MBMS receiver function may receive data from several MBMS User Services simultaneously. According to the MBMS UE capabilities, some MBMS UEs may be able to receive data belonging to one MBMS User Service from several MBMS Bearer Services simultaneously. The MBMS receiver function uses interactive bearers for user service initiation / termination, user service discovery and associated delivery procedures.

In case the MBMS User Service is secured, the UE needs one or more cryptographic MBMS service keys, therefore the UE requests the relevant cryptographic MBMS service keys using the BM-SC Key Request function. The received keys (i.e. MSK) are then used for securing the MBMS session. The MBMS UE should support the Application Programming Interfaces (APIs) and URL as specified in TS 26.347 [136].

4.5 Usage of identity of MBMS session

The Session Identity of the MBMS session is provided with the MBMS session start procedure from the BM-SC to the GGSN (for GPRS) or MBMS-GW (for EPS) via the Gmb (for GPRS) or SGmb (for EPS) protocol in the MBMS Session Identity information element. The "MBMS Session Identity" information element is specified in [99]. The size of the Session Identity field is 1 octet. The MBMS Session Identity is forwarded with the MBMS SESSION START REQUEST message through the system and received by the MBMS UE with the paging message.

The usage of the MBMS Session Identity is optional. The MBMS Session Identity is only applicable to MBMS download sessions. The MBMS transmission resources are activated as described in clause 5.4. Each MBMS session of the MBMS User Service may be activated using a different MBMS Session Identity. The MBMS UE determines, based on the MBMS Session Identity value, whether the files of the upcoming MBMS download session were already received. If the files have already been completely received, the MBMS UE does not respond to the notification of the MBMS Session.

The association of MBMS Session Identities to files is determined by the BM-SC and communicated within the File Delivery Table. This association of a MBMS Session Identity to files is valid until a particular expiry time, also signalled within the File Delivery Table. If a UE has not received a File Delivery Table associating a given MBMS Session Identity to a specific file or set of files, or a previously received association has expired, then the UE shall assume that the MBMS Session Identity value is associated to new files which has not yet been received and shall respond as normal to MBMS notifications with that Session Identity value.

A single MBMS Session Identity value may be associated with a single file or with a set of files. Once a MBMS Session Identity value has been associated with a particular file or a set of files, this association shall not be changed before the expiry of the validity time for that MBMS Session Identity value. In particular, a File Delivery Table including some files that has previously been associated with a particular Session Identity value must include all files previously associated with that value, even if it is not intended to include all the files within the MBMS transmission session.

An FDT instance includes the MBMS Session Identity expiry time and associates the MBMS Session Identity expiry times with particular MBMS Session Identity values.

If the MBMS Session Identity is used by the BM-SC, the BM-SC shall also provide the session repetition number of that MBMS transmission session on the Gmb (for GPRS) or SGmb (for EPS) interface.

If the BM-SC starts using the MBMS Session Identity for one MBMS Bearer Service, the BM-SC may still decide not to use the MBMS Session Identity for a later MBMS transmission on that MBMS bearer service (e.g. when an MBMS download or streaming session is transmitted only once).

After determining that all files for a MBMS Session Identity value has been received, the UE shall not respond to MBMS notifications for the MBMS Bearer Service with that MBMS Session Identity value until the MBMS Session Identity is expired. Once the MBMS Session Identity has expired, the content is no longer guaranteed to be repeated, and therefore the UE may begin to respond to MBMS notifications for the associated MBMS Bearer Service.

The BM-SC may send FDT instances on a separate transmission session or interleaved with other data packets of the same transmission session. An FDT instance may describe more files than the files to be transmitted over the same transmission session as that FDT instance.

4.6 Time synchronization between the BM-SC and MBMS UEs

A number of MBMS metadata fragments and File Delivery Table (FDT) contain NTP encoded time values. NTP uses UTC as reference time and is independent from time zones. In order to process the time information from the BM-SC correctly, the MBMS UEs shall be time synchronized with the BM-SC with a tolerance of ± 1 second. The BM-SC shall offer an SNTP [84] time server. The MBMS UEs should use SNTP to synchronize the time with the BM-SC. It is expected that the MBMS UE periodically requests SNTP time synchronization in order to keep the ± 1 second tolerance. However, the MBMS UE should use the SNTP time synchronization service only as necessary to keep ± 1 second accuracy, and should at most use the SNTP time synchronization once every 24 hours to avoid scalability issues.

To further prevent scalability issues, the MBMS UE should randomize its periodic SNTP requests over 1 hour just preceding its determined SNTP request time.

SNTP time synchronization may be achieved either by using SNTP anycast [84], or SNTP unicast [84], depending on network support.

For network deployment where intermediate router nodes between the UE and BM-SC have anycast enabled, the BM-SC shall support the SNTP anycast mode. The MBMS UE sends a request to a designated IPv4 or IPv6 local broadcast address or multicast group address. One or more SNTP anycast servers reply and include a timestamp with their current time and its precision. BM-SC SNTP servers shall only respond if they have a valid synchronization time and shall not leave the timestamp blank, such that the SNTP Leap Indicator (LI) field shall not use the value 3 (warning: unsynchronised). The MBMS UE does not need to keep server address state data and changes in the SNTP server addressing will not affect each subsequent synchronization operation.

For IPv4, the Internet Assigned Numbers Authority (IANA) has assigned the multicast group address 224.0.1.1 for NTP, which is used by both multicast servers and anycast clients. For IPv6, the IANA has assigned the multicast group address FF0X:0:0:0:0:0:101. These NTP assignments apply to SNTP usage as well. The SNTP server will join these IP multicast groups.

For network deployment where intermediate router nodes between the UE and the SNTP servers do not have anycast enabled, the SNTP server(s) shall support unicast mode. The MBMS UE sends a request to the server using its pre-configured SNTP server address. The network may distribute the SNTP request traffic load to a pool of SNTP servers in the network, as long as the UE pre-configured SNTP server address is unchanged. The way the network performs this load distribution is out of scope of this specification. SNTP servers shall only respond if they have a valid synchronization time and shall not leave the timestamp blank, such that the SNTP Leap Indicator (LI) field shall not use the value 3 (warning: unsynchronized).

An MBMS UE shall select the SNTP mode to use as follows:

- 1) Attempt time synchronization using SNTP anycast;
- 2) If SNTP anycast procedure is successful then the UE should use SNTP anycast and continue using anycast for future periodic SNTP time synchronization over the same access network;
- 3) If the SNTP anycast procedure fails then it should use SNTP unicast and continue using unicast for future periodic SNTP time synchronization over the same access network.
- 4) In case of access network change detected by the UE, the UE should go to step 1 for its next periodic SNTP time synchronization.

5 Procedures and protocols

5.1 Introduction

This clause specifies the MBMS User service procedures and protocols.

5.2 User Service Discovery/Announcement

5.2.1 Introduction

User service discovery refers to methods for the UE to obtain a list of available MBMS user services or user service bundles along with information on the user services. Part of the information may be presented to the user to enable service selection.

User service announcement refers to methods for the MBMS service provider to announce the list of available MBMS user services and user service bundles, along with information on the user services, to the UE.

In order for the user to be able to initiate a particular service, the UE needs certain metadata information. The required metadata information is described in clause 5.2.2.

According to TS 23.246 [4], in order for this information to be available to the UE operators/service providers may consider several service discovery mechanisms. User service announcement may be performed over a MBMS bearer or via other means. The download delivery method is used for the user service announcement over a MBMS bearer. The user service announcement mechanism based on the download delivery method is described in clause 5.2.3. The user service announcement using interactive announcement function is described in clause 5.2.4. The user service announcement over point-to-point push bearers is described in clause 5.2.5. Other user service announcement and discovery mechanisms are out of scope of the present document.

5.2.2 MBMS User Service Description metadata fragments

5.2.2.1 Introduction

MBMS User Service Discovery/Announcement is needed in order to advertise MBMS Streaming, MBMS Download User Services, MBMS Transparent User Services and User Service Bundles in advance of, and potentially during, the User Service sessions described. The User Services are described by metadata (objects/files) delivered using the download delivery method as defined in clause 7 or using interactive announcement functions.

MBMS User Service Discovery/Announcement involves the delivery of fragments of metadata to many receivers in a suitable manner. The metadata itself describes details of services. A *metadata fragment* is a single uniquely identifiable block of metadata. An obvious example of a metadata fragment would be a single SDP file [14].

The metadata consists of:

- a metadata fragment describing details of a single or a bundle of MBMS User Services (defined in clause 11.2);
- a metadata fragment describing details of MBMS user service sessions (defined in clause 7.3 and 8.3);
- a metadata fragment describing details of Associated delivery methods for File Repair and Reception Reporting (defined in clauses 9.3 and 9.4, respectively);
- a metadata fragment object(s) describing details of Associated delivery methods for Consumption Reporting (defined in clause 9.4A);
- a metadata fragment describing details of service protection (defined in clause 11.3);
- a metadata fragment describing details of the FEC repair data stream;
- a metadata fragment providing a Media Presentation Description (defined in clause 11.2.1.2);
- a metadata fragment providing an Application Service Description (defined in clause 11.2.1.2);

- a metadata fragment providing Initialization Segments (defined in clause 11.2.1.2);
- a metadata fragment providing a Schedule information description (defined in clause 11.2A);
- a metadata fragment providing filtering data for an MBMS User Service within a service bundle at the level of individual sessions of a given user service, or individual file contents within a user service (defined in clause 11.2B).

Metadata management information consists of:

- a metadata envelope object(s) allowing the identification, versioning, update and temporal validity of metadata fragments (defined in clause 11.1).

A metadata envelope may have multiple metadata envelope items. The metadata envelope and metadata fragments are transported as file objects in the same download session either as separate referencing files or as a single embedding file – see clause 5.2.3.3. A single metadata envelope item shall describe a single metadata fragment, and thus instances of the two are paired. A service announcement sender shall make a metadata envelope item available for each metadata fragment instance. The creation and use of both an embedded envelope item and a referenced envelope item for a single fragment instance is not recommended.

The metadata envelope and metadata fragments may be compressed using the generic GZip algorithm specified in RFC 1952 [42] as content/transport encoding for transmission. Where used over an MBMS bearer, this shall be according to Download delivery content encoding using FLUTE – see clause 7.2.5.

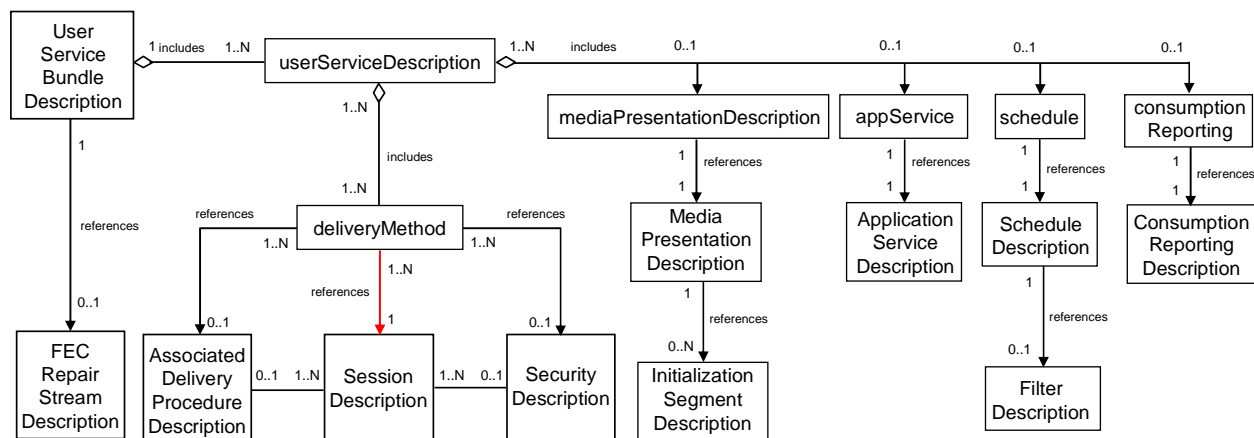


Figure 5: Simple Description Data Model

Figure 5 illustrates the simple data model relation between these description instances using UML [21] for a single User Service Bundle Description.

NOTE: "N" means any number in each instance.

One MBMS User Service Bundle Description shall contain one or more instances of the *userServiceDescription* element, each of which in turn represents a single MBMS User Service within the service bundle. The *bundleDescription* element may refer to a single instance of the FEC Repair Stream Description metadata fragment.

In the event a MBMS User Service carries DASH-formatted contents, the *userServiceDescription* element, representative of the User Service, shall contain a *mediaPresentationDescription* element and/or a *r12:appService* element. The *mediaPresentationDescription* element shall in turn contain a reference to the Media Presentation Description metadata fragment whose data structure is identical to the MPD (Media Presentation Description) as defined in TS 26.247 [98]. Furthermore, the Media Presentation Description fragment may refer to one or more Initialization Segment metadata fragments whose data structure is identical to the Initialization Segment as defined in [98].

With the introduction of the *r12:appService*, the type of the service is provided by the Internet media type of the service entry document by using the *contentType* attribute. The *r12:appService* element contains a reference to an Application Service Description metadata fragment.

If DASH is delivered through MBMS, the Application Service Description metadata fragment, shall be a Media Presentation Description fragment, similar to that referenced by the *mediaPresentationDescription* element. In this case, however, this MPD describes files and segments (commonly referred to as resources in the following) delivered both over MBMS bearer(s) and unicast bearer(s), and is referred to in this specification as a "unified" MPD. Furthermore, such *r12:appService* element identifies those broadcast and unicast resources conveyed by the unified MPD that are interchangeable for one another, and whether the interchangeable contents are identical, or represent alternative but replaceable versions. The details for DASH over MBMS are provided in clause 5.6.

Other services may be delivered through MBMS, in which case the Application Service Description corresponds to another type of application service entry document as long as it can be properly described by an Internet media type. Examples include dynamic web pages, other segment-based streaming applications or other object streams. In this case, the Application Service Description is expected to describe resources delivered both over MBMS bearer(s) and accessible through unicast bearer(s). Furthermore, such *r12:appService* element identifies those broadcast and unicast resources, conveyed by the Application Service Description, that are interchangeable for one another, and whether the interchangeable contents are identical. The details for a generic application service are provided in clause 5.7.

Also, when DASH-formatted contents are delivered by MBMS, at least one of the delivery methods shall be the download delivery method.

If a generic application service is delivered, at least one of the delivery methods shall be the download delivery method.

Each instance of the *userServiceDescription* element representing an MBMS User Service instance shall include at least one *deliveryMethod* element. The delivery Method element shall refer to one Session Description fragment.

Each delivery Method instance may contain a reference to a Security Description fragment and an Associated Delivery Procedure Description fragment that only includes File Repair and/or Reception Reporting Descriptions. Several delivery methods may reference the same Security Description fragment. A Session Description fragment may indicate at most one MBMS delivery session. An MBMS delivery session may carry one or more content components. The MBMS User Service instance may include multiple MBMS delivery sessions (i.e. multiple *deliveryMethod* elements), each carrying one or more content components belonging to that service.

A given Associated Delivery Procedure fragment referenced by an instance of *deliveryMethod* element under the *userServiceDescription* element may be referenced by other delivery methods of that service.

An instance of the *userServiceDescription* element allows the association of delivery methods to one or more access systems. The association is used to describe the use of separate access systems for the same MBMS User Service. One delivery method may be offered throughout one or more radio access systems. The use of separate MBMS bearer services for the same MBMS User Service is described in clause 5.1.5.2 of TS 23.246 [4].

One instance of the *userServiceDescription* element may include at most one *consumptionReporting* element instance, which references an Associated Delivery Procedure Description fragment containing only the Consumption Reporting Description.

One instance of the *userServiceDescription* element may include at most one schedule element instance. If included, the schedule instance shall refer to one Schedule Description fragment, and the UE can expect to receive MBMS User Service data during the time periods described in the Schedule Description fragment. In the case of a file download service, the Schedule Description fragment may include a file transmission schedule for file objects associated with the User Service. The UE may select which files to receive based on the file transmission schedule information in the Schedule Description fragment.

It is also possible for multiple *userServiceDescription* instances to reference the same Schedule Description fragment. In this case, the associated delivery schedule information shall include the file transmission schedule for files belonging to each of these User Services.

The Schedule Description may contain a reference to one Filter Description fragment, in which case the MBMS User Service is associated with filtering data which enables the UE to perform selective or targeted reception at either the session or the content file level of the User Service.

Multipart MIME as specified in RFC 2557 [37] may be used to concatenate the descriptions into one document for transport.

Metadata fragments may be updated in-band with an MBMS User Service session while an MBMS User Service session is active. The MBMS Client shall receive and process all in-band metadata fragments. In-band metadata fragments are uniquely identified by its URL within the MBMS Download session as used during user service

announcement. The MBMS Client associates the updated service announcement fragments through the URL with the MBMS User Service.

In-Band fragments may be referenced by or embedded in metadata envelopes as defined in clause 11.1.4. The same URL as used during user service announcement shall identify the metadata fragment in the metadata envelope. The metadata envelope file shall be identified by a unique file URL. When the metadata envelope for the updated metadata fragment uses the referenced method, the metadata fragment URL in the MBMS Download session (i.e. in the *Content-Location* element of the FDT Instance) shall be the same URL, as used in user service announcement. When a metadata fragment update is embedded in a metadata envelope, the same URL as used in user service announcement shall be used in the *metadataURI* element of the envelope.

5.2.2.2 Session Description

One or more session descriptions are contained in one session description object. The session description instance shall be formatted according to the Session Description Protocol (SDP) [14]. Each session description instance must describe either one Streaming session, one FLUTE Download session or one Transparent session. A session description for a Streaming session may include multiple media descriptions for RTP sessions. A session description of a transparent session may include one or multiple component sessions. The *sessionDescriptionURI* references the session description object. The session description is specified in clause 7.3 for the MBMS download delivery method, in clause 8.3 for the MBMS streaming delivery method and in clause 8B.3 for Transparent delivery method.

5.2.2.3 Associated Delivery Procedure Description

The description and configuration of associated delivery procedures is specified in clause 9. The *associatedProcedureDescriptionURI* references the associated delivery procedure instance.

An associated delivery procedure description may be delivered on a dedicated announcement channel and updated on a dedicated announcement channel as well as in-band with an MBMS download session.

If an associated delivery procedure description for File Repair operations is available, then the MBMS receiver may use the file repair service as specified in clause 9.3.

If an associated delivery procedure description for reception reporting is available, then the MBMS receiver shall provide reception reports as specified in clause 9.4.

The Associated Delivery Procedure Description instance referenced by the *associatedProcedureDescriptionURI* shall not include descriptions for consumption reporting. Instead, consumption reporting shall be described by a separate Associated Delivery Procedure Description instance referenced by the *consumptionReporting* element. This instance is called Consumption Reporting Description.

5.2.2.3A Consumption Reporting Description

The description and configuration of consumption reporting is specified in clause 9.4A. The *consumptionReportingURI* references an Associated Delivery Procedure Description that only includes the Consumption Reporting Description. The Consumption Reporting Description shall be formatted according to the Associated Delivery Procedure Description as defined in clause 9.5. Such Associated Delivery Procedure Description fragment shall only include the *r12:consumptionReport* element.

The ADPD fragment including only the *r12:consumptionReport* element may be delivered on a dedicated service announcement channel and updated on a dedicated announcement channel as well as in-band with an MBMS download session.

5.2.2.4 Security Description

The Security Description fragment contains the key identifiers and procedure descriptions for one delivery method. Multiple delivery methods, each via an instance of the *deliveryMethod* element, may reference the same Security Description fragment.

The Security Description fragment contains key identifiers and the server address to request the actual key material. To avoid overload situations, the same load balancing principles as in the associated delivery procedures are used. The key management server shall be selected as defined in clause 9.3.5. The back-off time shall be determined as defined in clause 9.3.4.

The XML schema for the Security Description fragment is defined in clause 11.3.

5.2.2.5 FEC Repair Stream Description

The streaming delivery method's FEC employs separate stream for the transport of repair data, which is described by the FEC Repair Stream Description. The FEC Repair Stream Description shall correspond to an SDP [14] file. This SDP file is referenced by the *bundleDescription* element in the User Service Bundle Description metadata fragment. The FEC Repair Stream described is common for all FEC protected packet flows within the MBMS User Service Bundle Description instance.

5.2.2.6 Media Presentation Description

The Media Presentation Description fragment shall be a Media Presentation Description as specified in [98], containing descriptive information on the media presentation. This information will be used by the DASH client to construct the associated media presentation as a streaming service to the end user.

Availability of this metadata fragment is indicated by the presence of the *mediaPresentationDescription* element in the MBMS User Service Description fragment. In that case, at least one of the delivery methods shall be a download delivery method. The actual URI to the Media Presentation Description fragment is provided by the element *mpdURI* in the *mediaPresentationDescription* element.

5.2.2.7 Schedule Description

The Schedule Description metadata fragment is specified in clause 11.2A.

The schedule description information describes the transmission schedule on the MBMS bearer and the availability of content via unicast delivery for an MBMS User Service in terms of

- start/stop lists,
- recurrence information,
- The service ID or service Class to which the schedule may apply,
- nominal monitoring interval and indication of delivery mode for a Datacasting service.

An MBMS User Service containing multiple content components may be carried on a single MBMS delivery session, or on multiple delivery sessions. The UE can expect to receive MBMS data during the described time period(s) when at least one of the sessions for the User Service is active.

The Schedule Description fragment may also include the schedule for when the files of a download delivery MBMS User Service are to be transmitted. The file schedule information is defined in terms of:

- The service ID or service Class to which the file schedule may apply,
- The list of file delivery schedule information consisting of:
 - A file URI to identify a given file being transmitted,
 - A list of broadcast delivery start and end times,

Note that such file schedule information would not be useful for download delivery services transporting DASH segments.

When including file delivery schedule, the schedule description fragment may capture the file transmission schedule for multiple User Services.

The schedule information contains a schedule update time, allowing the UE to know when to update its current schedule.

A Schedule Description fragment may be delivered as a metadata fragment on the service announcement channel and may be updated in-band with an MBMS download session. When describing the file delivery schedule for multiple user services, the Schedule Description fragment may be carried on an MBMS download session dedicated to the transport

of file schedule information. The mechanism UEs use to discover this file delivery schedule session is outside the scope of this specification.

The Schedule Description fragment may reference a Filter Description fragment, in which case the MBMS User Service is associated with filtering information which enables selective/targeted reception at one of the two mutually-exclusive levels:

- i) by individual sessions of the User Service, and
- ii) by individual content files of the User Service.

Detailed description of the alternative means to establish association between the Schedule Description and Filter Description fragments, and related filtering semantics, are provided in clauses 11.2A and 11.2B.

5.2.2.8 Filter Description

The Filter Description metadata fragment contains filter data to enable selective/targeted UE reception of MBMS User Services or contents. When present in the USD, as indicated by the reference from the Schedule Description, it supports mechanisms to filter services/contents for intended ("positive") reception, as previously described in clause 5.2.2.7. The intended usage of the filter data is defined by the way in which the Filter Description is referenced by the Schedule Description. As an example, each session of a DASH-encoded streaming service sent via the MBMS download delivery method may be associated with a unique filtering criterion, to enable targeted reception by specific UEs of data carried in that session. As another example, one or more content file items belonging to a download delivery service may be affiliated with a specific filter data instance which defines the rules for intended download of those files.

One or more *filterData* elements may be present in the Filter Description and is uniquely identified by its *id* attribute. A given instance of the filter data may be applicable to more than one MBMS User Service – for example, it may be intended for multiple User Services belonging to a User Service bundle to receive the same filtering treatment specified by that filter data instance.

5.2.2.9 Application Service Description

An MBMS User Service Description may contain one or more Application Service Description fragment. If present, the Application Service Description fragment corresponds to an application service entry point document, e.g. an MPD to a DASH Media Presentation, an HTML page, or a manifest for some other type of streaming formatted content. The entry point document itself typically references additional objects through URIs.

If the MBMS User Service Description contains an Application Service Description fragment, then it indicates that all resources that are directly or indirectly referenced in the application service entry point document are delivered through one of the following means:

- through at least one of the delivery methods defined under the *userServiceDescription* element,
- in the MBMS User Service Announcement as a metadata fragment,
- through unicast and accessible with HTTP protocol according to clause 7.6.

In figure 5, the MIME type of the Application Service Description metadata fragment enables the MBMS Client to determine, for example, whether the service content is formatted in DASH, or is an HTML5 presentation, and whether and how to process the associated Application Service Description document. In the case of a DASH-over-MBMS service with support for service continuity between broadcast and unicast, the Application Service Description is an MPD. The definition of any other application service and associated Application Service Description is outside the scope of this specification.

The definition of any application service which is not a DASH-over-MBMS service, any specialized handling for such application service delivery over MBMS, as well as the content format with the exception that it is an HTML5 document, and management and hosting of the associated Application Service Description are outside the scope of this specification.

5.2.3 User Service Announcement over an MBMS bearer

5.2.3.1 General

Both the metadata envelope and metadata fragments are transported as file objects in the same download session.

To receive a Service Announcement User Service the client shall obtain the session parameters for the related MBMS download session transport. This may be achieved by:

- a) pre-storing the related session parameters in the MBMS UE,
- b) pre-storing the session parameters in the MBMS application, to be provided to the MBMS Client,
- c) acquisition via delivery over OMA PUSH [79], or
- d) downloading the session parameters from an HTTP server resolved from the Service Announcement Fully Qualified Domain Name (FQDN).

The Service Announcement FQDN shall be "mbmsbs.mnc<MNC>.mcc<MCC>.pub.3gppnetwork.org" as specified in TS 23.003 [77]. The URL to obtain the session parameters shall be:

`http://mbmsbs.mnc<MNC>.mcc<MCC>.pub.3gppnetwork.org/bootstrap.multipart,`

for which 'bootstrap.multipart' references a multipart MIME file comprising the necessary metadata fragments pertaining to the Service Announcement User Service (i.e. the User Service Bundle Description and the Session Description, and may include optional metadata fragments such as Schedule Description, Associated Delivery Procedure Description).

NOTE 1: The user service announcements are not protected when sent over MBMS bearer. See TS 33.246 [20].

NOTE 2: Instead of the format defined above, the Service Announcement FQDN may also be privately defined by the MBMS operator, in which case it would represent another form of pre-stored information in the UE.

5.2.3.1.1 Service Announcement for Receive-Only Mode services

Receive-Only-Mode (ROM) services may be described by Service Announcement User Services whose TMGIs correspond to a reserved range of values as defined in TS 24.116 [131], and broadcast to UEs according to a defined schedule. Such Service Announcement service is named the ROM SACH (Service Announcement CHannel). One of those reserved TMGI values, along with pre-defined multicast IP address, destination port number, and TSI value of the MBMS download session carrying the ROM SACH, represent the session parameters for an instance of the ROM SACH. Although delivery of the ROM SACH employs source-specific multicast (SSM) destination addressing, a UE configured in Receive Only Mode shall promiscuously acquire this service without filtering on the source IP address in the associated FLUTE packets. Therefore, source IP address need not be pre-stored in, or provisioned to, such UE.

The aforementioned session parameters may be either pre-stored in – or provisioned to – UEs configured in Receive-Only Mode by the TV service configuration Management Object (MO) as defined in TS 24.117 [132]. In the case of pre-storage, all of the TMGI values in the reserved range for ROM SACHs shall be stored in the UE. The values of the multicast IP address, in IPv4 and IPv6 forms, are defined in clauses C.17 and C.18, respectively. The value of the UDP destination port number shall be set to '55555', a 3GPP-designated value for the ROM SACH and chosen from the "Dynamic Ports" range defined in RFC 6335 [152] and which are not assigned by IANA. The minimum set of Service Announcement information contained in the MO shall comprise:

- The USBD fragment containing exactly one instance of the *userServiceDescription* element, which in turn contains exactly one instance of the *deliveryMethod* element. The *deliveryMethod* element shall contain a reference to a Session Description fragment which provides the download delivery session parameters for acquisition of the Service Announcement User Service;
- The Session Description fragment containing at least the following parameters (whose values are indicated above) that describe the MBMS download session/FLUTE channel:
 - IP Multicast address (IPv4 or IPv6);
 - Destination UDP port;

- Transport Session Identifier (TSI);
- The Schedule Description fragment (referenced by the *userServiceDescription* element in the USBF fragment) that specifies the time periods during which the Service Announcement service will be broadcast, as given by the session schedule (via the *sessionSchedule* element).

It should be noted that a UE configured in Receive Only Mode may be able to acquire ROM services from an MBMS network which does not provide the ROM SACH. The TV service configuration Management Object as defined in TS 24.117 [132] may include the session parameters for FLUTE sessions that carry ROM services. Therefore, it is not strictly necessary for the UE to acquire the ROM SACH in order to discover and acquire ROM services. A UE configured in Receive Only Mode cannot access a SACH whose TMGI is not in the reserved range as defined in TS 24.116 [131].

5.2.3.1.2 Service Announcement for non-Receive-Only Mode services

Non-ROM services, or "regular" MBMS User Services shall be described by a Service Announcement User Service whose TMGI may be either associated with an operator-specific MCC+MNC value, or correspond to one of the reserved values as defined in TS 24.116 [131]. Acquisition of such Service Announcement service by MBMS UEs which are not configured in Receive Only Mode may be achieved by:

- a) pre-storing the related session parameters in the MBMS UE,
- b) pre-storing the session parameters in the MBMS application, to be provided to the MBMS Client,
- c) acquisition via delivery over OMA PUSH [79], or
- d) downloading the session parameters from an HTTP server resolved from the Service Announcement Fully Qualified Domain Name (FQDN).

The Service Announcement FQDN shall be "mbmsbs.mnc<MNC>.mcc<MCC>.pub.3gppnetwork.org" as specified in TS 23.003 [77]. The URL to obtain the session parameters shall be:

<http://mbmsbs.mnc<MNC>.mcc<MCC>.pub.3gppnetwork.org/bootstrap.multipart>,

for which 'bootstrap.multipart' references a multipart MIME file comprising the necessary metadata fragments pertaining to the Service Announcement User Service (i.e. the User Service Bundle Description and the Session Description, and may include optional metadata fragments such as Schedule Description, Associated Delivery Procedure Description).

NOTE 1: The user service announcements are not protected when sent over MBMS bearer. See 3GPP TS 33.246 [20]

NOTE 2: Instead of the format defined above, the Service Announcement FQDN may also be privately defined by the MBMS operator, in which case it would represent another form of pre-stored information in the UE.

5.2.3.2 Metadata Envelope transport

The metadata envelope object is transported as an object in the same MBMS service announcement download session as its metadata fragment object.

5.2.3.3 Metadata Envelope and metadata fragment association with FLUTE

The MBMS Download service announcement session FDT Instances provide URIs for each transported object. The metadata envelope item *metadataURI* field shall use the same URI for the metadata fragment as is used in the FDT Instances for that metadata fragment file. Thus, the fragment can be mapped to its associated envelope in-band of a single MBMS download session.

In the referencing case, each metadata envelope and corresponding metadata fragment shall be grouped together by the FDT using the grouping mechanism described in clause 7.2.6. This reduces the complexity of requesting both fragment and envelope for each pair, thus it is recommended that only the metadata fragment (*fileURI*) be requested from the download client (which will result in both fragment and envelope being received using the grouping mechanism).

5.2.4 User Service Announcement using Interactive Announcement Function

User Service descriptions may be transported to the UE using HTTP and other interactive transport methods. The HTTP URL used by UE to obtain USD information via unicast may be:

- a) pre-stored in the UE (for example as a BM-SC URL),
- b) pre-stored in the MBMS application, to be provided to the MBMS Client,
- c) acquired via delivery over OMA PUSH [79], or
- d) resolved from the Service Announcement FQDN. The Service Announcement FQDN shall be "mbmsbs.mnc<MNC>.mcc<MCC>.pub.3gppnetwork.org" as specified in TS 23.003 [77]. The URL to obtain the User Service descriptions for all MBMS User Services shall be:

`http://mbmsbs.mnc<MNC>.mcc<MCC>.pub.3gppnetwork.org/unicastUSD,`

for which 'unicastUSD' references a file that contains USD information for all MBMS User Services offered by the MBMS operator. Actual USD contents returned from the above URL shall be deployment-specific.

Aggregated MBMS service announcement documents as specified in clause 5.2.5 may be used with the interactive announcement functions. UEs shall support the disassembly of aggregated MBMS service announcement documents. UEs shall support Gzip decoding of MBMS service description objects for interactive transport (BM-SC use of Gzip is optional in accordance with clause 5.2.2).

The BM-SC may use Metadata Envelopes as described in clause 11.1, and UEs shall support their use with the Interactive Announcement Function. Where metadata envelopes are not used, only the latest delivery of a metadata fragment shall be used by the UE, and the BM-SC shall ensure timely, consistent, size-limited and secure delivery of metadata by means outside the scope of this document.

NOTE: Instead of the format defined above, the Service Announcement FQDN may also be privately defined by the MBMS operator, in which case it would represent another form of pre-stored information in the UE.

5.2.5 User Service Announcement over point-to-point push bearers

5.2.5.1 General

User service announcement over point-to-point push bearers has several characteristics that differ from user service announcement over a MBMS bearer. It is not essential that the metadata envelope made available by the service announcement sender is transmitted to the MBMS terminal. In the case that both the metadata envelope and metadata fragments are transported, it is a limitation of the solution that the metadata fragment must either be embedded within the metadata envelope, or that the metadata fragment must be referenced by the Metadata Envelope and they are both contained within a multipart MIME container per RFC 2557 [37]. In either configuration, both the metadata envelope and the metadata fragments are transported as file objects in the same download session.

This clause covers both metadata transport and metadata fragmentation aspects of Service Announcement. Service Announcement over point-to-point push bearers is specified.

NOTE: The user service announcements are not protected when sent over point-to-point push bearers. See TS 33.246 [20].

5.2.5.2 Supported metadata syntaxes

- The supported metadata syntaxes are as defined in clause 11.1 of the present document.

5.2.5.3 Consistency control and syntax independence

The consistency control and syntax independence is as defined in clause 11.1 of the present document.

5.2.5.4 Metadata Envelope definition

The metadata envelope definition is as defined in clause 11.1 of the present document.

5.2.5.5 Delivery of the Metadata Envelope

- An instance of metadata fragment shall either be embedded within the metadata envelope or be included in a multipart MIME container together with the envelope. The envelope and fragment are, by definition, transported together and in-band of the same transport session.

The Metadata Envelope includes a reference (*metadataURI*) to the associated metadata fragment using the same URI as the fragment file is identified by in the Service Announcement. Thus, Metadata Envelope can be mapped to its associated metadata fragment.

5.2.5.6 Void

5.2.5.7 User Service announcement over SMS bearers

User service announcements over SMS bearers are formatted according to the OMA Push OTA specification [79].

OTA-WSP shall be used over the SMS bearer. Application port addressing shall be used as specified in [79]. The application ID to be used is 0x9023 as allocated by OMNA [85].

Either confirmed or unconfirmed push may be used. In either case, the primitive shall contain the Push Headers parameter. Within this parameter, the *Content-Type* header shall be included, and the *Content-Encoding* header shall be included if GZip is used.

5.2.5.8 User service announcement over HTTP push bearers

User service announcements over HTTP push bearers are formatted according to the OMA Push OTA specification [79].

OTA-HTTP shall be used over the HTTP push bearer. Application port addressing shall be used as specified in [79]. The application ID to be used is 0x9023 as allocated by OMNA [85].

The Content-Encoding header shall be included if GZip is used.

5.2.6 Metadata fragment encapsulation to aggregate Service Announcement documents

The present document defines a number of metadata fragments to describe MBMS User Services. A metadata fragment is a single uniquely identifiable block of metadata. Generally, more than one metadata fragment is necessary to provide all necessary parameters to initiate an MBMS User Service. Typically, metadata fragments are provided in separate documents. Each metadata fragment is labelled with its MIME media type.

Multipart MIME may be used to encapsulate metadata fragments into an aggregate service announcement document. The aggregate document may contain metadata fragments of several MBMS User Services. It is recommended that any such aggregate service announcement document contains all the referenced metadata fragments of each MBMS user service description it contains (i.e. in the same multipart MIME structure).

An aggregate service announcement document shall encapsulate metadata fragments according to RFC 2557 [37]. The first encapsulated file of an aggregate service announcement document is the root resource. The root resource shall be either an MBMS user service description or a metadata envelope (as a referencing index). The service description metadata is described in clause 5.2.2 and defined in clause 11.2. The metadata envelope is defined in clause 11.1.

The type field of the multipart/related header shall be set to application/mbms-user-service-description-parameter in case the root resource is a user service description instance. The type field of the multipart/related header shall be set to application/mbms-envelope in case the root resource is a metadata envelope.

5.2.7 Registration and deregistration procedure for MBMS User Service consumption

The User Service Bundle Description fragment (see clause 11.2) may include a Registration Description. If the Registration Description is present in the User Service Bundle Description fragment, then the UE shall use the registration and deregistration procedures as defined in this clause.

A registration request is initiated by the MBMS UE in order to receive the complete User Service Description. The registration procedure is performed using an HTTP/1.1 POST message per RFC 2616 [18] towards the indicated Registration URL.

A successful registration response shall start with a 200 OK status line in the response header and shall contain in the body the metadata fragments that are referenced by the User Service Bundle Description fragment in a multipart MIME container.

The registration request shall be formatted according to the XML schema specified in listing 5.2.7-1 and using the *RegistrationRequest* element. The filename of the Registration schema is "TS26346_Registration.xsd".

Listing 5.2.7-1: Registration schema

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:3GPP:metadata:2008:MBMS:Registration"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  xmlns="urn:3GPP:metadata:2008:MBMS:Registration"
  elementFormDefault="qualified">
  <xs:annotation>
    <xs:documentation>MBMS Registration schema</xs:documentation>
    <xs:documentation>3GPP TS 26.346 clause 5.2.7</xs:documentation>
    <xs:documentation>Copyright © 2008, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI,
    TSDSI, TTA, TTC). All rights reserved.</xs:documentation>
  </xs:annotation>

  <xs:element name="RegistrationOperationRequest">
    <xs:complexType>
      <xs:choice>
        <xs:element name="RegistrationRequest" type="RegistrationOperationRequestType"/>
        <xs:element name="DeregistrationRequest" type="RegistrationOperationRequestType"/>
      </xs:choice>
    </xs:complexType>
  </xs:element>

  <xs:complexType name="RegistrationOperationRequestType">
    <xs:attribute name="IMEI" type="xs:string" use="optional"/>
    <xs:attribute name="MSISDN" type="xs:string" use="required"/>
    <xs:attribute name="ServiceID" type="xs:anyURI" use="required"/>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
  </xs:complexType>
</xs:schema>
```

A de-registration procedure is used by the UE to de-register at the end of the user service consumption, in case a registration procedure has been performed. The de-registration request shall be sent to a registration server (preferably the one with which the registration procedure has been performed). The de-registration procedure consists of sending an HTTP/1.1 POST request with an XML body formatted according to the XML schema above, using the *DeregistrationRequest* element.

The MIME media type of the message body of the registration and deregistration request shall be set to "text/xml".

The *IMEI* attribute contains, if present, the International Mobile Equipment Identifier as defined in TS 23.003 [77].

The *MSISDN* attribute contains the Mobile Subscriber ISDN Number as defined in TS 23.003 [77].

The *ServiceID* attribute contains the unique MBMS User Service Identifier as defined in clause 11.2.1.1.

5.3 User Service initiation/termination

5.3.1 Initiation of MBMS Bearer Service based User Services

MBMS User Service initiation refers to UE mechanisms to set-up the reception of MBMS User Service data. During the User Service Initiation procedure, a set of MBMS Bearers may be activated. The User Service initiation procedure takes place after the discovery of the MBMS User Service.

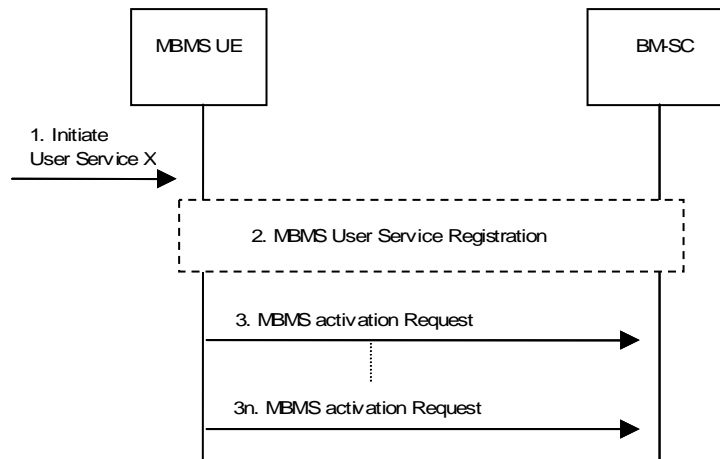


Figure 6: Initiation of an MBMS User Service

1. The User Service initiation procedure is triggered and takes a User Service Description as input that has been obtained e.g. by executing the MBMS User Service discovery and announcement functions.
2. The MBMS UE registers to the MBMS User Service, if registration is required for the MBMS User Service. If security functions are activated for the MBMS User Service, the MBMS UE requests MBMS service keys. The keys are sent to the UE, after the user is authorized to receive the MBMS service. The request shall be authenticated. Details on the MBMS User Service Registration procedure are described in TS 33.246 [20].
3. The MBMS UE uses the MBMS activation procedure to activate the MBMS Bearer Service. The MBMS activation procedure is the MBMS Multicast Service activation procedure, and the MBMS Broadcast activation procedure as defined in TS 23.246 [4]. In case the MBMS Broadcast Mode is activated, there is no activation message sent from the UE to the BM-SC. The activation is locally in the UE. Note that the MBMS Bearer Services may already be active and in use by another MBMS User Service.
- 3n. In case the MBMS User Service uses several MBMS Bearer Services, the User Service Description contains several description items. In that case, the MBMS receiver function repeats the activation procedure for each MBMS Bearer Service as described in 3.

5.3.2 Termination of MBMS Bearer Service based User Services

MBMS User Service termination refers to the UE mechanisms to terminate the reception of MBMS User Services. A set of MBMS Bearers may be deactivated during this procedure.

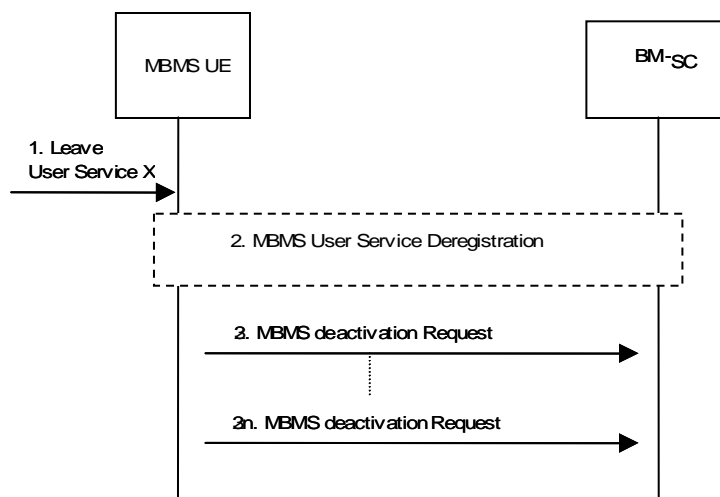


Figure 7: Termination of an MBMS user service

1. The User Service termination procedure is triggered. A reference to the User Service to terminate is provided as parameter.
2. The MBMS UE deregisters, when registration was required for the MBMS User Service. If security functions are activated for the MBMS User Service, the MBMS UE deregisters the security association for the MBMS User Services. Details on the MBMS User Service Deregistration procedure are described in 3GPP TS 33.246 [20].
3. If no other MBMS User Service uses the MBMS Bearer service, the MBMS UE uses the MBMS deactivation procedure to deactivate the MBMS Bearer Services. The MBMS deactivation procedure represents the MBMS Multicast service deactivation procedure and the MBMS Broadcast deactivation procedure as described in TS 23.246 [4]. In case the MBMS Broadcast Mode is deactivated, there is no message sent to the BM-SC. The deactivation is only locally in the UE.
- 3n. In case the MBMS User Service uses several Bearer Services, the UE repeats the deactivation procedure for each Bearer Service as described in 3.

5.3.3 Initiation of Unicast Bearer Service based User Services

Unicast Bearer Service based MBMS User Service initiation refers to the mechanisms to set-up the reception of MBMS User Service data via a UMTS/EPS Bearer Service with interactive and/or streaming traffic class.

In case of the initiation of a MBMS Streaming delivery method or a combined MBMS Streaming and MBMS Download delivery method, the Packet Switched Streaming Service (PSS) as defined in TS 26.234 [47] shall be used. The establishment of a PSS session is described in clause 5.1 of TS 26.234 [47].

In case of the initiation of a MBMS Download delivery method, the MBMS UE is registered in the BM-SC for OMA-PUSH based reception of the files with the BM-SC.

5.3.4 Termination of Unicast Bearer Service based Services

Unicast Bearer Service based MBMS User Service termination refers to the mechanisms to terminate the reception of MBMS user service data via a UMTS/EPS Bearer Service with interactive and/or streaming traffic class.

In case of the termination of a MBMS Streaming delivery method or a combined MBMS Streaming and MBMS Download delivery method, the Packet Switched Streaming Service (PSS) as defined in TS 26.234 [47] shall be used. The termination of a PSS session is described in clause 5.3 of TS 26.234 [47].

In case of the termination of a MBMS Download delivery method, the MBMS UE is deregistered in the BM-SC so that the OMA-PUSH based reception of the files with the BM-SC will be terminated.

5.3.5 Scalable service initiation and termination for MBMS Services

5.3.5.1 General

MBMS service initiation and termination as defined in clauses 5.3.1 to 5.3.4 may consist of network interactions such as sending an IGMP Join or Leave message to the network as described in clauses 8.2 and 8.7 of TS 23.246 [4]. Initiation and termination procedures may be triggered at the MBMS UE by the user or be scheduled to happen automatically. Upon (or after) receiving a user service announcement, the MBMS UE may render the information about the advertised services to the user to assist him in the service selection. The user may decide to receive a given service and hence trigger the service initiation procedure. Alternatively, the user may declare his interest in a specific service *a priori* and upon receiving the service announcement for that specific service, the MBMS UE may schedule the initiation procedure at or around the start time of the session. Similarly, the MBMS UE may schedule the termination procedure at or around the session end time.

As a consequence, MBMS UEs may be oriented to start their service initiation and termination procedures at the same time or during a relatively short period. This may cause network congestion, especially during the multicast of a popular service, as all MBMS UEs may be time synchronized.

5.3.5.2 Randomization of service initiation over time

The MBMS User Service description may contain parameters to uniformly randomize the User Service Initiation procedures of the MBMS UEs. Security functions may be part of the User Service Initiation procedure as defined in clause 5.3.1. If a user service initiation randomization is defined for a user service, then the overload prevention definition in the Security Description shall be ignored for the service initiation. For randomizing the time of the initiation procedure, the MBMS UE shall understand the following parameters, which may be signalled by the BM-SC in the MBMS User Service description as described in clause 11.2.1:

- 1) *initiationStartTime* parameter is used by the BM-SC to signal to the MBMS UE the start time for the User Service Initiation procedure randomization period. If the *initiationStartTime* parameter is not present, the MBMS UE uses the time of the Service Announcement reception as the start time.
- 2) *protectionPeriod* parameter is used by the BM-SC to signal to the MBMS UE the duration of the critical time periods, during which congestion shall be avoided. The MBMS UEs shall randomly spread the initiation procedure using the *randomTimePeriod* during this protection period.
- 3) *randomTimePeriod* parameter is used by the BM-SC to signal to the MBMS UE the duration of an interval over which initiation procedures shall be randomly deferred. The MBMS UE calculates a random time out of the *randomTimePeriod* interval to defer the execution of the initiation procedure.

The MBMS UE shall start its initiation procedure immediately if the procedure is triggered outside of protection periods.

5.3.5.3 Randomization of service termination over time

The MBMS User Service description may contain parameters to uniformly randomize the User Service Termination procedures of the MBMS UEs. For randomizing the time of the termination procedure, the MBMS UE shall understand the following parameters, which may be signalled by the BM-SC in the MBMS User Service Description as described in clause 11.2.1:

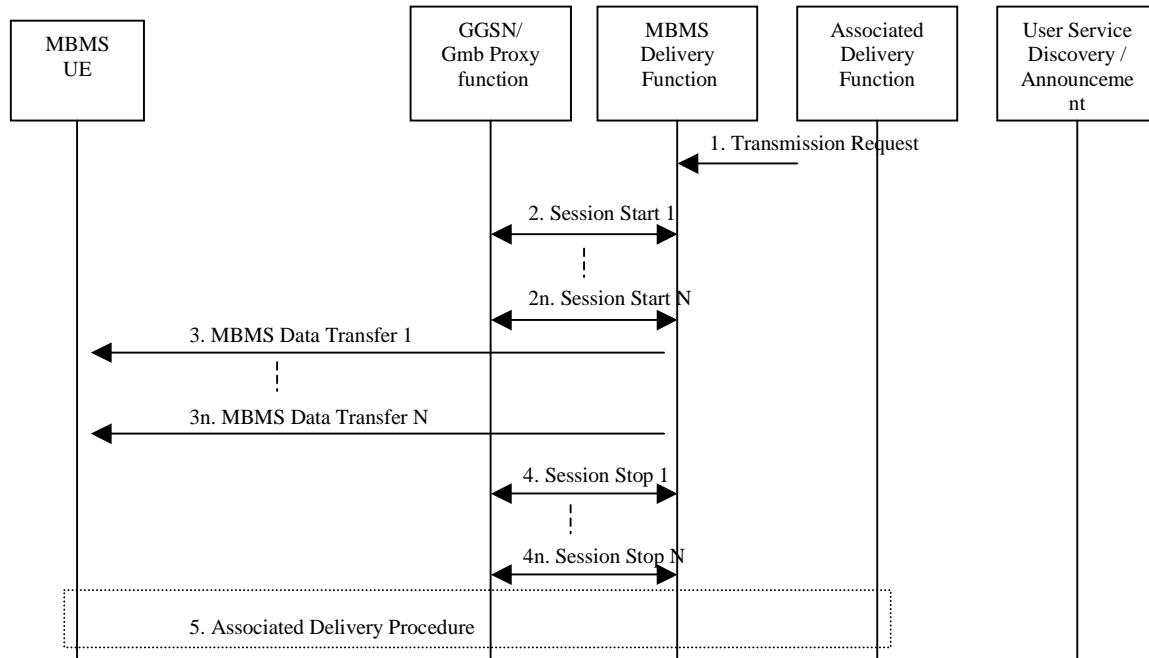
- 1) *protectionPeriod* parameter is used by the BM-SC to signal to the MBMS UE the duration of the critical time period, during which congestion needs to be avoided. The MBMS UEs shall randomly spread the termination procedure using the *randomTimePeriod* during this period and starting from the session end time.
- 2) *randomTimePeriod* parameter is used by the BM-SC to signal to the MBMS UE the duration of an interval over which termination procedures shall be randomly deferred. The termination procedure is only randomized during the *protectionPeriod*.

If the termination procedure is triggered before the session end time or after the protection period end time, the MBMS UE shall start its termination procedure immediately. If it is in a protection period, the MBMS UE shall defer its termination procedure to a random time spread over an interval of duration *randomTimePeriod*.

5.4 MBMS data transfer procedure

5.4.1 MBMS data transfer procedure using MBMS Bearer Services

MBMS data Transfer procedure using MBMS Bearer Services refers to the network (and UE) mechanism to transfer (and receive) data for one MBMS User Service on one or several MBMS Bearer Services.



NOTE: Security related interactions are not depicted in the sequence.

Figure 8: Procedure of MBMS data transfer

1. The MBMS Delivery Method for the MBMS User Service is triggered by the MBMS User Service Provider. Note, details of the trigger are beyond of the present document.
2. - 2n. The MBMS Delivery function uses the MBMS Session Start Procedure to the GGSN and/or MBMS-GW, possibly through the Gmb Proxy and/or the SGmb Proxy function to activate all MBMS Bearer Services, which belong to the MBMS User Service. The MBMS Bearer service to be activated is uniquely identified by the TMGI.

Note. MBMS Bearer services might be activated only to a subset of the available access systems (see TS 23.246 [4]). In case MBMS User Services or delivery methods are not available throughout all access systems, the BM-SC describes this transmission strategy in the MBMS User Service Description (see clause 5.2.2).

3. - 3n. The data of the MBMS User Service are transmitted to all listening MBMS UEs. Several MBMS Bearer services may be used to transmit the MBMS User Service data. MBMS User Service data may be integrity- and/or confidentiality-protected. In case MBMS User Service data are integrity and/or confidentiality protected, MBMS traffic keys are delivered simultaneously on the same or a different MBMS bearer. Optionally, synchronization information for MBSFN may be added to the MBMS User Data. The headers of MBMS User Data may optionally be compressed (see 3GPP TS 23.246 [4] and TS 25.346 [5]).
4. - 4n. The MBMS Delivery function uses the MBMS Session Stop procedure to trigger the GGSN and/or MBMS-GW, possibly through the Gmb and/or SGmb Proxy function to release all MBMS Bearer Service for this User Service. A unique identifier for the MBMS Bearer service to be deactivated (i.e. the TMGI) is passed on as a parameter.
5. In case associated delivery procedures are allowed or requested for an MBMS User Service, the MBMS UE sends an associated-delivery procedure request to the associated -delivery function. The BM-SC may

authenticate the user. See TS 33.246 [20]. The MBMS UE may need to wait a random time before it starts the associated delivery procedure according to clause 9.

5.4.2 MBMS data transfer procedure using other UMTS Bearer Services

MBMS data transfer procedure using other UMTS Bearer Services refers to the network (and UE) mechanism to transfer (and receive) data for one MBMS User Service on one or more Unicast Bearer Services.

In case the MBMS Data belong to a MBMS streaming session or a combined MBMS streaming and MBMS download session, the Packet Switched Streaming Service (PSS) as defined in TS 26.234 [47] shall be used.

In case the MBMS Data belong to a MBMS download session, the MBMS data is transferred using OMA-PUSH.

5.4A Procedures between Content Provider and BM-SC

The reference point between Content Provider and BM-SC is named xMB. This reference point is specified in TS 26.348 [143].

5.5 MBMS protocols

Figure 9 illustrates the protocol stack used by MBMS User services for Streaming and Download delivery. The grey-shaded protocols and functions are outside of the scope of the present document. MBMS security functions and the usage of HTTP-digest and SRTP are defined in TS 33.246 [20], and 3GP-DASH is defined in TS 26.247 [98].

NOTE: The asterisk (*) mark after the box labelled "HTTP(S)" in the left side of Figure 9 means that although the box is unshaded, the use of HTTP(S) for unicast delivery of Service Announcement & Metadata is outside the scope of this document, and is defined by the OMA Push OTA specification [79].

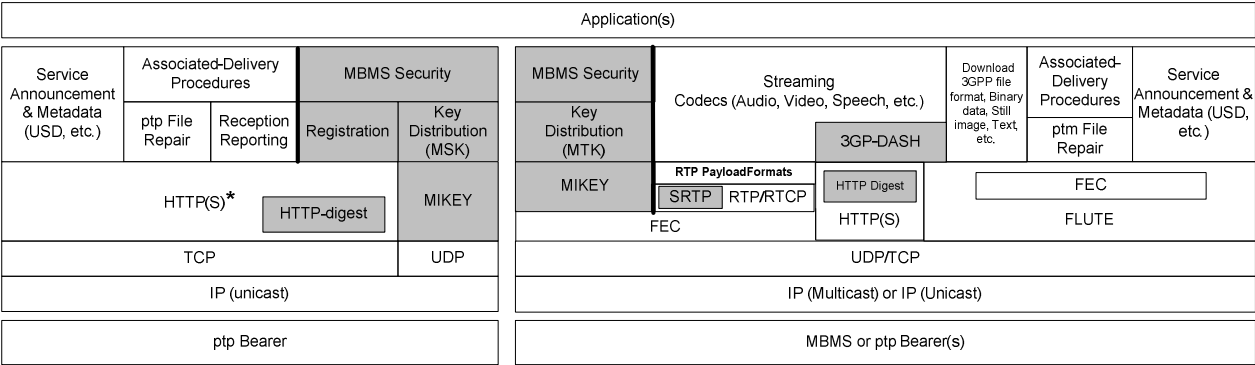


Figure 9: Protocol stack view of the MBMS User Services for Streaming and Download Delivery

5.6 DASH and MBMS

The 3GPP Dynamic Adaptive Streaming over HTTP (3GP-DASH) as defined in TS 26.247 [98] specifies formats and methods that enable the delivery of streaming service(s) from standard HTTP servers to 3GP-DASH client(s). It specifies the description of a collection of Media Segments and auxiliary metadata (all referenced by HTTP-URLs) through a Media Presentation Description (MPD). In addition, ISO/IEC 23009-1 [116] defines DASH services.

MBMS is designed to serve large receive groups with same content. The MBMS Download Delivery Method is designed to deliver an arbitrary number of objects via MBMS to a large receiver population. MBMS download delivery defines several methods to increase reliability such as FEC and file repair. The download delivery method allows the delivery of 3GP-DASH Segments, Media Presentation Descriptions, as well as other objects referenced in the MPD as defined in [98].

In order to support DASH Streaming in MBMS, the USBD metadata fragment for a service shall contain either or both a *r9:mediaPresentationDescription* element referencing an MPD, and a *r12:appService* referencing an MPD, which is also a metadata fragment describing the service. The referenced MPD corresponds to a metadata fragment as defined in [98]. If the USBD contains a reference to an MPD containing broadcast Representation(s), then

- 1) The User Service shall be a download delivery service, i.e. shall include at least one *deliveryMethod* element referencing an SDP that describes FLUTE transport.
- 2) If objects are not already provided during MBMS User Service Announcement, the MBMS download session shall deliver objects that are referenced by the MPD, all updates of the MPD and objects that are referenced by any update of the MPD, which are not already provided during MBMS User Service Announcement.
- 3) If a Segment is delivered as a FLUTE object then all of the following shall hold:
 - a) The MBMS download session shall deliver segments such that the last packet of the delivered object is available at the UE latest at its segment availability start time as announced in the MPD.
 - b) The Content-Location element in the FDT for the delivered object shall match the Segment URL in the MPD.
- 4) If an MPD update (with or without a metadata envelope) is delivered as a FLUTE object then all of the following shall hold:
 - c) The URL of the delivered object shall match the URI of the appropriate referenced MPD.
 - d) The MPD update shall be a valid update to a previously delivered MPD or an MPD delivered during MBMS User Service Announcement.
- 5) If an Initialization Segment (with or without a metadata envelope) is delivered as a FLUTE object then the URI of the delivered object shall match the appropriate reference in the MPD.
- 6) If any other resource in the MPD is delivered (e.g. xlink resource, metrics, etc.) then
 - e) The Content-Location element in the FDT Instance for the delivered object shall match the URL of the object in the MPD.
 - f) The MBMS download session shall deliver objects such that the last packet of the delivered object is available at the UE latest at the earliest time a DASH client operating on the delivered MPD sequence may ask for the resource.

In the case a real-time streaming service is provided as DASH streaming over MBMS, then the **MPD@type** (attribute 'type' of the MPD) shall be set to "dynamic", i.e. this indicates that the segments get available over time, latest at its announced segment availability start time. When **MPD@minimumUpdatePeriod** (attribute 'minimumUpdatePeriod' of the MPD) is present, then the UE should expect MPD updates to be sent in the FLUTE session with the media segments and treat these updates as defined in step 4 above.

The objects delivered with the MBMS download delivery method shall be formatted according to the announcement in the MPD. The MPD and the described Media Presentation should conform to a profile specified in [98].

Furthermore, the Media Presentation Description fragment may contain reference(s) to Initialization Segment Description fragment(s) whose content is an Initialization Segment as defined in [98].

If the DASH Media Presentation conforms to the DASH Profile for CMAF content as defined in ISO/IEC 23009-1 [116], then the DASH Media Presentation follows the constraints for the CMAF Segment formats and additional CMAF constraints. In this case, the *userServiceDescription* element should contain an *r12:appService* element with a MIME type containing "application/dash+xml profiles=' urn:mpeg:dash:profile:cmcf:2019'" indicating that the DASH Media Presentation conforms to DASH Profile for CMAF content as defined in [116]. The MBMS distributed CMAF content may be consumed by streaming clients that support playback of CMAF content. The announcement of CMAF content to such a CMAF capable streaming client is implementation-specific.

If a Hybrid DASH/HLS service is provided as DASH over MBMS, then the content should conform to DASH Profile for CMAF content as defined in ISO/IEC 23009-1 [116] and the announcement in the *userServiceDescription* element should be provided as documented above.

The *r9:mediaPresentationDescription* element refers to an MPD which describes only the Representation(s) available over the MBMS bearer(s), and shall be used by UEs complying to previous versions of this specification.

The *r12:appService* element may refer to a unified MPD which describes Representations available for both broadcast and unicast reception, and shall be used by UEs compliant to this specification. If *r12:appService* element is absent, and *r9:mediaPresentationDescription* element is present, then a UE complying with this release of the specification shall use the *r9:mediaPresentationDescription*. This case also applies to UE compliant to the current release of this specification, deployed in networks of a previous releases not having *r12:appService* element defined. In practical deployments, different subsets of the Representations described by the unified MPD and referenced by such *r12:appService* may be specified for

- broadcast only availability
- both unicast and broadcast availability,
- unicast only availability and the Representation is redundant in broadcast coverage, i.e. the usage of these resources does not provide an improved user experience. As an example, this may be a lower bitrate Representation of a media component for which a higher bitrate is available over broadcast, and
- unicast always availability and the Representation is supplementary in broadcast coverage, i.e. even in broadcast coverage these resources provide an improved user experience. As an example, this may be a secondary language that is only accessible over unicast.

For more details on consistent signalling for resources in hybrid service offerings, refer to clause 7.6.

Clause 4.4.3 of this specification enables integrity and/or confidentiality protection of MBMS user services data according to TS 33.246 [20]. In this case each DASH formatted file is protected using the Protection of Download Data as described in [20].

As this protection mechanism is performed in the underlying layer of the DASH client it is transparent to 3GP-DASH client and not reflected in the MPD associated to the DASH representation.

For HTTP streaming, QoE reporting on MBMS level can be activated as described in clause 8.3.2.1 or 8.3.2.2, and QoE reporting shall in such case be done as specified in clause 8.4. The Network Resource, Loss of Objects, and Distribution of Symbol Count Underrun for Failed Blocks QoE metrics are relevant to DASH over MBMS.

QoE reporting can also be activated on DASH level as specified in clause 10 or annex F of TS 26.247 [98], and reporting shall in such case be done according to [98].

NOTE: One way of supporting the delivery of a subset of the nominally requested content by the DASH client which indicates explicit willingness to accept such incomplete content, and based on a specific UE implementation architecture, is described in clause 7.2.3 of TR 26.946 [110].

Media decoders for DASH streaming as defined in this clause delivered over MBMS are specified in clause 10 of this specification.

DASH streaming may also be switched from MBMS to unicast. In the case of PSS-based delivery, the media decoders for DASH are specified in clause 7.3.6 of [98].

Service interactivity functionality may be supported in a DASH-over-MBMS service. If supported, such functionality shall be implemented in accordance with TS 26.247 [98] as follows:

- by the BM-SC: delivery of interactivity event signaling as described in [98], clause 15, and
- by the DASH client: processing of interactivity event signaling, and forwarding of event metadata to the subscribing service interactivity application, as described in [98], clause 15.

5.7 Generic Application Service

If the USD contains an Application Service Description fragment, then all resources that are directly or indirectly referenced in the application service entry point document instance of this metadata fragment, and are expected to be retrieved by HTTP GET, shall be delivered by at least one of the delivery methods associated with the *r12:appService* element. For more details on consistent signalling for resources in potentially hybrid service offerings, refer to clause 7.6.

In order to support generic application services in MBMS, the User Service Bundle Description metadata fragment shall contain an *r12:appService* element referencing an Application Service Description metadata fragment which describes

the service. That application service entry document shall be formatted according to the value of the *contentType* attribute. If the USD contains a reference to an application service entry document containing broadcast-delivered objects, then

- 1) The user service shall be a download delivery service, i.e. shall include at least one *deliveryMethod* element referencing an SDP that describes FLUTE transport.
- 2) The MBMS download session shall deliver objects that are directly or indirectly referenced by the service entry document.
- 3) If an object is delivered as a FLUTE object with an availability time defined by service is delivered then all of the following shall hold:
 - a) The MBMS download session shall deliver the objects such that the last packet of the delivered object is available at the UE latest at its availability time as announced in the application service document
 - b) The Content-Location element in the FDT for the delivered object shall match the URL in the application service document.
- 4) If an update to the application service document is delivered as a FLUTE object then the Content-Location element in the FDT for the delivered object shall match the URI of the appropriate referenced application service document by using the *r12:appService* element and the document referenced by this element

Clause 4.4.3 of the present document enables integrity and/or confidentiality protection of MBMS user services data according to TS 33.246 [20]. In this case each object is protected using the Protection of Download Data as described in [20].

QoE reporting on MBMS level can be activated as described in clauses 8.3.2.1 or 8.3.2.2, and QoE reporting shall in such case be done as specified in clause 8.4. The Network Resource, Loss of Objects, and Distribution of Symbol Count Underrun for Failed Blocks QoE metrics may be used to generic application services.

For any application service which is not a DASH-over-MBMS service, a) its service definition and any specialized handling for service delivery over MBMS, and b) the content format with the exception that it is an HTML5 document, management and hosting of the associated Application Service Description are outside the scope of this specification.

6 Introduction on delivery methods

Four delivery methods are defined in the present document - the download delivery method, the streaming delivery method, the transparent delivery method and the group communication delivery method. MBMS delivery methods make use of MBMS bearers for content delivery but may also use the associated procedures defined in clause 9.

Use of MBMS bearers by the download delivery method is described in clause 7. The File Repair Procedure and the Reception Reporting Procedure (described in clause 9) may be used by the download delivery method.

Use of MBMS bearers by the streaming delivery method is described in clause 8.

Use of MBMS bearers by the group communication delivery method is described in clause 8A.

Use of MBMS bearers by the transparent delivery method is described in clause 8B.

7 Download Delivery Method

7.1 Introduction

MBMS download delivery method uses the FLUTE protocol (RFC 3926 [9]) when delivering content over MBMS bearers. MBMS download delivery method may use OMA PUSH [79] when delivering content over other UMTS/EPS bearers. Usage of FLUTE protocol is described in clause 7.2. The usage of OMA Push is described in clause 7.4. The FLUTE session set-up with RTSP is defined in clause 7.5.

FLUTE is built on top of the Asynchronous Layered Coding (ALC) protocol instantiation (RFC 3450 [10]). ALC combines the Layered Coding Transport (LCT) building block [11], a congestion control building block and the Forward Error Correction (FEC) building block ([12]) to provide congestion controlled reliable asynchronous delivery of content to an unlimited number of concurrent receivers from a single sender. As mentioned in (RFC 3450 [10]), congestion control is not appropriate in the type of environment that MBMS download delivery is provided, and thus congestion control is not used for MBMS download delivery. See figure 10 for an illustration of FLUTE building block structure. FLUTE is carried over UDP/IP, and is independent of the IP version and the underlying link layers used.

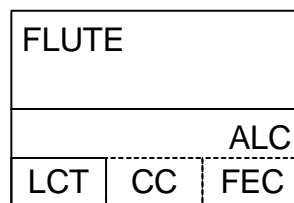


Figure 10: Building block structure of FLUTE

ALC uses the LCT building block to provide in-band session management functionality. The LCT building block has several specified and under-specified fields that are inherited and further specified by ALC. ALC uses the FEC building block to provide reliability. The FEC building block allows the choice of an appropriate FEC code to be used within ALC, including using the no-code FEC code that simply sends the original data using no FEC coding. ALC is under-specified and generally transports binary objects of finite or indeterminate length. FLUTE is a fully-specified protocol to transport files (any kind of discrete binary object), and uses special purpose objects - the File Description Table (FDT) Instances - to provide a running index of files and their essential reception parameters in-band of a FLUTE session.

NOTE: One way of supporting the delivery of a subset of the nominally requested content by the DASH client which indicates explicit willingness to accept such incomplete content, and based on a specific UE implementation architecture, is described in clause 7.2.3 in TR 26.946 [110].

7.2 FLUTE usage for MBMS download

7.2.0 General

The purpose of download is to deliver content in files. In the context of MBMS download, a file contains any type of MBMS data (e.g. 3GPP file (Audio/Video), binary data, still images, text, Service Announcement metadata).

In the present document the term "file" is used for all objects carried by FLUTE (with the exception of the FDT Instances).

UE applications for MBMS user services built upon the download delivery method have three general approaches to getting files from the FLUTE receiver for a joined session:

- **Promiscuous:** Instruct FLUTE to promiscuously receive all files available. Promiscuous reception can be suitable for single purpose sessions (generally with limited number and/or size of files) although uncertainty over the quality and content of files makes this approach generally undesirable.
- **One-copy:** Instruct FLUTE to receive a copy of one or more specific files (identified by the fileURI) - and potentially leaving the session following reception of one copy of all the specified files. Specifying the download

file ensures that the UE has an upper bound to the quantity of files downloaded. One-copy reception requires prior knowledge of the file identifiers (fileURIs).

- **Keep-updated:** Instruct FLUTE to receive one or more specific files and continue to receive any updates to those files. As with one-copy, the keep-updated approach bounds the quantity of files downloaded and requires prior knowledge of the file identifiers. In order to realise an efficient keep-updated service, where file updates are unpredictable and maybe far apart in time, a registration and notification service is defined in clause 7.7.

NOTE 1: The keep updated service is optional for the UE. In the absence of content filtering tools, the service is typically offered to a restricted set of applications.

NOTE 2: The present document does not prevent or endorse changing download reception approach, and any related file list, during the life of the download session. Discovery of session content lists (including file lists) out-of-band of the delivery method sessions is beyond the scope of the present document.

The interaction of these file download modes and the caching directives is defined in clause 7.2.13.

MBMS Clients and servers supporting MBMS download shall implement the FLUTE specification (RFC 3926 [9]), as well as ALC (RFC 3450 [10]) and LCT (RFC 3451 [11]) features that FLUTE inherits. In addition, several optional and extended aspects of FLUTE, as described in the following clauses, shall be supported.

One FDT instance is typically bound to one MBMS transmission session. It is therefore recommended, that each MBMS transmission session should contain one or more repetitions of the same FDT instance.

7.2.1 Fragmentation of files

Fragmentation of files shall be provided by a blocking algorithm (which calculates source blocks from source files) and a symbol encoding algorithm (which calculates encoding symbols from source blocks).

7.2.2 Symbol encoding algorithm

The "Compact No-Code FEC scheme" per RFC 3695 [13] (FEC Encoding ID 0, also known as "Null-FEC") shall be supported.

The Raptor FEC scheme is described in clause 7.2.12.

A UE that supports MBMS User Services shall support a decoder for the Raptor FEC scheme.

If a UE that supports MBMS User Services receives a mathematically sufficient set of encoding symbols generated according to the encoder specification in RFC 5053 [91] for reconstruction of a source block then the decoder shall recover the entire source block. Note that the example decoder described in [91] clause 5.5 fulfils this requirement.

7.2.3 Blocking algorithm

In the case of the Compact No-Code FEC scheme per RFC 3695 [13] (FEC Encoding ID 0), then the "Algorithm for Computing Source Block Structure" described within the FLUTE specification (RFC 3926 [9]) shall be used.

In the case of Raptor forward error correction, then the algorithm defined in RFC 5053 [91] shall be used.

The values of N , Z , T and A shall be set such that the sub-block size is less than 256 KB.

7.2.4 Congestion control

For simplicity of congestion control, FLUTE channelization shall be provided by a single FLUTE channel with single rate transport.

7.2.5 Content encoding of files for transport

Files may be content encoded for transport, as described in [9], in the Download delivery method using the generic GZip algorithm as specified in RFC 1952 [42]. UEs shall support GZip content decoding of FLUTE files (GZIP RFC 1952 [42], clause 9).

7.2.6 Transport file grouping

Files downloaded as part of a multiple-file delivery are generally related to one another. Examples include web pages, software packages, and the referencing metadata envelopes and their metadata fragments. FLUTE clients analyse the XML-encoded FDT Instances as they are received, identify each requested file, associate it with FLUTE packets (using the TOI) and discover the relevant in-band download configuration parameters of each file.

An additional "group" field in the FLUTE FDT instance and file elements enables logical grouping of related files. A FLUTE receiver should download all the files belonging to all groups where one or more of the files of those groups have been requested. However, a UE may instruct its FLUTE receiver to ignore grouping to deal with special circumstances, such as low storage availability.

The group names are allocated by the FLUTE sender, and each specific group name shall group the corresponding files together as one group, including files describes in the same and other FDT Instances, for a session.

Group field usage in FDT Instances is shown in the FDT XML schema (clause 7.2.10). Each file element of an FDT Instance may be labelled with zero, one or more group names. Each FDT Instance element may be labelled with zero, one or more group names which are inherited by all files described in that FDT Instance.

7.2.7 Signalling of parameters with Basic ALC/FLUTE headers

FLUTE and ALC mandatory header fields shall be as specified in [9, 10] with the following additional specializations:

- The length of the CCI (Congestion Control Identifier) field shall be 32 bits and it is assigned a value of zero (C=0).
- The Transmission Session Identifier (TSI) field shall be of length 16 bits (S=0, H=1, 16 bits).
- The Transport Object Identifier (TOI) field should be of length 16 bits (O=0, H=1).
- Only Transport Object Identifier (TOI) 0 (zero) shall be used for FDT Instances.
- The following features may be used for signalling the end of session and end of object transmission to the receiver:
 - The Close Session flag (A) for indicating the end of a session.
 - The Close Object flag (B) for indicating the end of an object.

In FLUTE the following applies:

- The Sender Current Time present flag (T) shall be set to zero.
- The Expected Residual Time present flag (R) shall be set to zero.
- The LCT header length (HDR_LEN) shall be set to the total length of the LCT header in units of 32-bit words.
- For "Compact No-Code FEC scheme", the FEC Payload ID shall be set according to RFC 3695 [13] such that a 16 bit SBN (Source Block Number) and then the 16 bit ESI (Encoding Symbol ID) are given.
- For "MBMS FEC scheme", the FEC Payload ID shall be set according to clause 7.2.12.1.
- For "EXT_TIME" LCT Header [119], the sender may include it in all or some of the LCT packets for a file transmission. If EXT_TIME is included, it shall contain the ERT time value set according to [119].

7.2.8 Signalling of parameters with FLUTE extension headers

The FLUTE sender shall use FLUTE extension header fields EXT_FDT, EXT_FTI, EXT_CENC [9] as follows:

- EXT_FTI shall be included in every FLUTE packet carrying symbols belonging to any FDT Instance.
- FLUTE packets carrying symbols of files (not FDT Instances) shall not include an EXT_FTI.
- FDT Instances shall not be content encoded and therefore EXT_CENC shall not be used.

According to FLUTE [9] the following rules apply for a FLUTE sender:

- EXT_FDT is in every FLUTE packet carrying symbols belonging to any FDT Instance.
- FLUTE packets carrying symbols of files (not FDT instances) do not include the EXT_FDT.

NOTE: As an MBMS Client conforms to a FLUTE receiver the receiver side treatment of LCT extension headers is covered by RFC 3451 [11] and RFC 3926 [9]. The actions when receiving *EXT_FDT* and *EXT_FTI* are defined in RFC 3926 [9]. The default action for unrecognized header extensions is to ignore them.

7.2.9 Signalling of parameters with FDT instances

The extended FLUTE FDT instance schema defined in clause 7.2.10.1 (based on the one in RFC 3926 [9]) shall be used. In addition, the following applies to both the session level information and all files of a FLUTE session.

The inclusion of these FDT Instance data elements is mandatory according to the FLUTE specification:

- *Content-Location* (URI of a file).
- *TOI* (Transport Object Identifier of a file instance).
- *Expires* (expiry data for the FDT Instance).

For MBMS operation, the UE shall not use a received FDT Instance to interpret packets received beyond the expiration time of the FDT Instance.

NOTE 1: This requirement is strengthened for MBMS compared to RFC 3926 [9], where it is mentioned that "the receiver SHOULD NOT use a received FDT Instance to interpret packets received beyond the expiration time of the FDT Instance."

NOTE 2: It is expected that a TOI value may be reused after the highest expiry time of the FDT instances containing that TOI value.

NOTE 3: Since the expiry time corresponds to the end of transmission, A UE can either clean up its memory in case not sufficient symbols are received, or perform file repair if enabled in the system, or make partial file delivery available to the application (e.g. see clause 7.2.3 in TR 26.946 [110]).

Additionally, the INCLUSION of these FDT Instance data elements is mandatory. Note the following elements are optional in the FDT schema to stay aligned with the IETF RFC defined schema:

- *Content-Length* (source file length in bytes).
- *Content-Type* (content MIME type).
- *FEC Encoding ID*.

Other FEC Object Transmission Information specified by the FEC scheme in use:

NOTE 4: The FEC Object Transmission Information elements used are dependent on the FEC scheme, as indicated by the FEC Encoding ID.

- *FEC-OTI-Maximum-Source-Block-Length*. When the FEC Encoding ID indicates the "Compact No-Code FEC scheme", the value of this data element shall not exceed 65535, consistent with the 16-bit constraint on the Encoding Symbol ID specified in section 3 of RFC 3695 [13] and in section 3.3 of RFC 3926 [9].
- *FEC-OTI-Encoding-Symbol-Length*.
- *FEC-OTI-Max-Number-of-Encoding-Symbols*.
- *FEC-OTI-Scheme-Specific-Info*.

NOTE 5: RFC 3926 [9] describes which part or parts of an FDT Instance may be used to provide these data elements.

These optional FDT Instance data elements may or may not be included for FLUTE in MBMS:

- *Complete* (the signalling that an FDT Instance provides a complete, and subsequently unmodifiable, set of file parameters for a FLUTE session may or may not be performed according to this method).
- *Content-Encoding*.
- *Content-MD5*: represents a digest of the transport object. The file server should indicate the MD5 hash value whenever multiple versions of the file are anticipated for the download session.
- *IndependentUnitPositions*: represents a list of byte position in the file, at which the handler assigned to the Content-Type for the file may access the file.
- *File-ETag*: represents the value of the entity tag as defined in RFC 9110 [155] which may also serve as the version identifier of the file object described by the FDT Instance.

NOTE 6: The values for each of the above data elements are calculated or discovered by the FLUTE sender.

The FEC-OTI-Scheme-Specific-Info FDT Instance data element contains information specific to the FEC scheme indicated by the FEC Encoding ID encoded using Base 64.

7.2.10 FDT schema

7.2.10.1 Extended FLUTE FDT syntax

The XML schema specified in listing 7.2.10-1 below shall be use for the FDT Instance. The filename of this schema is "TS26346_FLUTE-FDT.xsd". This schema extends the baseline IETF schema reproduced in clause 7.2.10.3 by importing the 3GPP extensions specified in clauses 7.2.10.2 and J.2.

In this version of the present document the network shall set the content of the *schemaVersion* element, defined as a child of the *FDT-Instance* element, to the value 4.

The schema *version* attribute (part of the schema instruction) shall be included in the UE schema and the network schema.

NOTE: The value of the *schemaVersion* element and *version* attribute is intended to be increased by 1 in every future release where new element(s) or attribute(s) are added.

When a UE receives an instantiation of an FDT compliant to this schema, it shall determine the schema version required to parse the instantiation as follows:

- If the UE supports one or more versions of the FDT schema with the schema *version* attribute, then the UE shall use the schema that has the highest schema *version* attribute value that is equal to or less than the value in the received *schemaVersion* element;

Listing 7.2.10-1: Extended FLUTE FDT schema

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:IETF:metadata:2005:FLUTE:FDT" version="4"
  xmlns="urn:IETF:metadata:2005:FLUTE:FDT"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  xmlns:mbms2005="urn:3GPP:metadata:2005:MBMS:FLUTE:FDT"
  xmlns:mbms2007="urn:3GPP:metadata:2007:MBMS:FLUTE:FDT"
  xmlns:mbms2008="urn:3GPP:metadata:2008:MBMS:FLUTE:FDT_ext"
  xmlns:mbms2009="urn:3GPP:metadata:2009:MBMS:FLUTE:FDT_ext"
  xmlns:mbms2012="urn:3GPP:metadata:2012:MBMS:FLUTE:FDT"
  xmlns:mbms2015="urn:3GPP:metadata:2015:MBMS:FLUTE:FDT"
  xmlns:sv="urn:3gpp:metadata:2009:MBMS:schemaVersion"
  elementFormDefault="qualified">
  <xs:annotation>
    <xs:documentation>Extended MBMS FLUTE File Delivery Table schema</xs:documentation>
    <xs:documentation>3GPP TS 26.346 clause 7.2.10.1</xs:documentation>
    <xs:documentation>Copyright © 2005, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI,
    TSDSI, TTA, TTC). All rights reserved.</xs:documentation>
  </xs:annotation>

  <xs:import namespace="urn:3GPP:metadata:2005:MBMS:FLUTE:FDT"
    schemaLocation="TS26346_FLUTE-FDT_Extensions_Rel-6.xsd"/>
```

```

<xs:import namespace="urn:3GPP:metadata:2007:MBMS:FLUTE:FDT"
  schemaLocation="TS26346_FLUTE-FDT_Extensions_Rel-7.xsd"/>
<xs:import namespace="urn:3GPP:metadata:2008:MBMS:FLUTE:FDT_ext"
  schemaLocation="TS26346_FLUTE-FDT_Extensions_Rel-8.xsd"/>
<xs:import namespace="urn:3GPP:metadata:2009:MBMS:FLUTE:FDT_ext"
  schemaLocation="TS26346_FLUTE-FDT_Extensions_Rel-9.xsd"/>
<xs:import namespace="urn:3GPP:metadata:2012:MBMS:FLUTE:FDT"
  schemaLocation="TS26346_FLUTE-FDT_Extensions_Rel-11.xsd"/>
<xs:import namespace="urn:3GPP:metadata:2015:MBMS:FLUTE:FDT"
  schemaLocation="TS26346_FLUTE-FDT_Extensions_Rel-13.xsd"/>
<xs:import namespace="urn:3gpp:metadata:2009:MBMS:schemaVersion"
  schemaLocation="TS26346_SchemaVersion.xsd"/>

<xs:element name="FDT-Instance" type="FDT-InstanceType"/>
<xs:complexType name="FDT-InstanceType">
  <xs:sequence>
    <xs:element name="File" type="FileType" maxOccurs="unbounded"/>
    <xs:element ref="sv:schemaVersion"/>
    <xs:element ref="mbms2012:Base-URL-1" minOccurs="0" maxOccurs="unbounded"/>
    <xs:element ref="mbms2012:Base-URL-2" minOccurs="0" maxOccurs="unbounded"/>
    <xs:element ref="sv:delimiter"/>
    <xs:element name="Group" type="mbms2005:groupIdType" minOccurs="0"
maxOccurs="unbounded"/>
    <xs:element name="MBMS-Session-Identity-Expiry" type="mbms2005:MBMS-Session-Identity-
Expiry-Type" minOccurs="0" maxOccurs="unbounded"/>
    <xs:any namespace="##other" processContents="skip" minOccurs="0"
maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:attribute name="Expires" type="xs:string" use="required"/>
  <xs:attribute name="Complete" type="xs:boolean" use="optional"/>
  <xs:attribute name="Content-Type" type="xs:string" use="optional"/>
  <xs:attribute name="Content-Encoding" type="xs:string" use="optional"/>
  <xs:attribute name="FEC-OTI-FEC-Encoding-ID" type="xs:unsignedLong" use="optional"/>
  <xs:attribute name="FEC-OTI-FEC-Instance-ID" type="xs:unsignedLong" use="optional"/>
  <xs:attribute name="FEC-OTI-Maximum-Source-Block-Length" type="xs:unsignedLong"
use="optional"/>
  <xs:attribute name="FEC-OTI-Encoding-Symbol-Length" type="xs:unsignedLong"
use="optional"/>
  <xs:attribute name="FEC-OTI-Max-Number-of-Encoding-Symbols" type="xs:unsignedLong"
use="optional"/>
  <xs:attribute name="FEC-OTI-Scheme-Specific-Info" type="xs:base64Binary" use="optional"/>
  <xs:attribute ref="mbms2008:FullFDT" use="optional" default="false"/>
  <xs:anyAttribute processContents="skip"/>
</xs:complexType>

<xs:complexType name="FileType">
  <xs:sequence>
    <xs:element ref="mbms2007:Cache-Control" minOccurs="0"/>
    <xs:element ref="sv:delimiter"/>
    <xs:element ref="mbms2012:Alternate-Content-Location-1" minOccurs="0"
maxOccurs="unbounded"/>
    <xs:element ref="mbms2012:Alternate-Content-Location-2" minOccurs="0"
maxOccurs="unbounded"/>
    <xs:element ref="sv:delimiter"/>
    <xs:element name="Group" type="mbms2005:groupIdType" minOccurs="0"
maxOccurs="unbounded"/>
    <xs:element name="MBMS-Session-Identity" type="mbms2005:MBMS-Session-Identity-Type"
minOccurs="0" maxOccurs="unbounded"/>
    <xs:any namespace="##other" processContents="skip" minOccurs="0"
maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:attribute name="Content-Location" type="xs:anyURI" use="required"/>
  <xs:attribute name="TOI" type="xs:positiveInteger" use="required"/>
  <xs:attribute name="Content-Length" type="xs:unsignedLong" use="optional"/>
  <xs:attribute name="Transfer-Length" type="xs:unsignedLong" use="optional"/>
  <xs:attribute name="Content-Type" type="xs:string" use="optional"/>
  <xs:attribute name="Content-Encoding" type="xs:string" use="optional"/>
  <xs:attribute name="Content-MD5" type="xs:base64Binary" use="optional"/>
  <xs:attribute name="FEC-OTI-FEC-Encoding-ID" type="xs:unsignedLong" use="optional"/>
  <xs:attribute name="FEC-OTI-FEC-Instance-ID" type="xs:unsignedLong" use="optional"/>
  <xs:attribute name="FEC-OTI-Maximum-Source-Block-Length" type="xs:unsignedLong"
use="optional"/>
  <xs:attribute name="FEC-OTI-Encoding-Symbol-Length" type="xs:unsignedLong"
use="optional"/>
  <xs:attribute name="FEC-OTI-Max-Number-of-Encoding-Symbols" type="xs:unsignedLong"
use="optional"/>
  <xs:attribute name="FEC-OTI-Scheme-Specific-Info" type="xs:base64Binary" use="optional"/>
  <xs:attribute ref="mbms2009:Decryption-KEY-URI" use="optional"/>

```



```

<xs:attribute ref="mbms2012:FEC-Redundancy-Level" use="optional"/>
<xs:attribute ref="mbms2012:File-ETag" use="optional"/>
<xs:attribute ref="mbms2015:IndependentUnitPositions" use="optional"/>
<xs:anyAttribute processContents="skip"/>
</xs:complexType>
</xs:schema>

```

7.2.10.2 3GPP FLUTE FDT schema extensions

The Release 6 extensions to the 3GPP FLUTE FDT schema are specified in listing 7.2.10.2-1 below. The filename of this schema is "TS26346_FLUTE-FDT_Extensions_Rel-6.xsd".

Listing 7.2.10.2-1: 3GPP FLUTE FDT schema extensions (Release 6)

```

<?xml version="1.0" encoding="UTF-8"?>
<xs:schema
targetNamespace="urn:3GPP:metadata:2005:MBMS:FLUTE:FDT" xmlns="urn:3GPP:metadata:2005:MBMS:FLUTE:FDT"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  elementFormDefault="qualified">
  <xs:annotation>
    <xs:documentation>MBMS FLUTE FDT schema extensions (Release 6)</xs:documentation>
    <xs:documentation>3GPP TS 26.346 clause 7.2.10.2</xs:documentation>
    <xs:documentation>Copyright © 2005, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI,
TSDSI, TTA, TTC). All rights reserved.</xs:documentation>
  </xs:annotation>

  <xs:complexType name="MBMS-Session-Identity-Expiry-Type">
    <xs:simpleContent>
      <xs:extension base="MBMS-Session-Identity-Type">
        <xs:attribute name="value" type="xs:unsignedInt" use="required"/>
      </xs:extension>
    </xs:simpleContent>
  </xs:complexType>

  <xs:simpleType name="MBMS-Session-Identity-Type">
    <xs:restriction base="xs:unsignedByte"/>
  </xs:simpleType>

  <xs:simpleType name="groupIdType">
    <xs:restriction base="xs:string"/>
  </xs:simpleType>
</xs:schema>

```

The Release 7 extensions to the 3GPP FLUTE FDT schema are specified in listing 7.2.10.2-2 below. The filename of this schema is "TS26346_FLUTE-FDT_Extensions_Rel-7.xsd".

Listing 7.2.10.2-2: 3GPP FLUTE FDT schema extensions (Release 7)

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:3GPP:metadata:2007:MBMS:FLUTE:FDT"
  xmlns="urn:3GPP:metadata:2007:MBMS:FLUTE:FDT"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  elementFormDefault="qualified">
  <xs:annotation>
    <xs:documentation>MBMS FLUTE FDT schema extensions (Release 7)</xs:documentation>
    <xs:documentation>3GPP TS 26.346 clause 7.2.10.2</xs:documentation>
    <xs:documentation>Copyright © 2007, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI,
TSDSI, TTA, TTC). All rights reserved.</xs:documentation>
  </xs:annotation>

  <xs:element name="Cache-Control">
    <xs:complexType>
      <xs:choice>
        <xs:element name="no-cache" type="xs:boolean" fixed="true"/>
        <xs:element name="max-stale" type="xs:boolean" fixed="true"/>
        <xs:element name="Expires" type="xs:unsignedInt"/>
      </xs:choice>
      <xs:anyAttribute processContents="skip"/>
    </xs:complexType>
  </xs:element>
</xs:schema>
```

The Release 8 extensions to the 3GPP FLUTE FDT schema are specified in listing 7.2.10.2-3 below. The filename of this schema is "TS26346_FLUTE-FDT_Extensions_Rel-8.xsd".

Listing 7.2.10.2-3: 3GPP FLUTE FDT schema extensions (Release 8)

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:3GPP:metadata:2008:MBMS:FLUTE:FDT_ext"
  xmlns="urn:3GPP:metadata:2008:MBMS:FLUTE:FDT_ext"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  elementFormDefault="qualified">
  <xs:annotation>
    <xs:documentation>MBMS FLUTE FDT schema extensions (Release 8)</xs:documentation>
    <xs:documentation>3GPP TS 26.346 clause 7.2.14</xs:documentation>
    <xs:documentation>Copyright © 2008, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI,
TSDSI, TTA, TTC). All rights reserved.</xs:documentation>
  </xs:annotation>

  <xs:attribute name="FullFDT" type="xs:boolean"/>
</xs:schema>
```

The Release 9 extensions to the 3GPP FLUTE FDT schema are specified in listing 7.2.10.2-4 below. The filename of this XML schema is "TS26346_FLUTE-FDT_Extensions_Rel-9.xsd".

Listing 7.2.10.2-4: 3GPP FLUTE FDT schema extensions (Release 9)

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:3GPP:metadata:2009:MBMS:FLUTE:FDT_ext"
  xmlns="urn:3GPP:metadata:2009:MBMS:FLUTE:FDT_ext"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  elementFormDefault="qualified">
  <xs:annotation>
    <xs:documentation>MBMS FLUTE FDT schema extensions (Release 9)</xs:documentation>
    <xs:documentation>3GPP TS 26.346 clause 7.2.15</xs:documentation>
    <xs:documentation>Copyright © 2009, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI,
TSDSI, TTA, TTC). All rights reserved.</xs:documentation>
  </xs:annotation>

  <xs:attribute name="Decryption-KEY-URI" type="xs:anyURI"/>
</xs:schema>
```

The Release 11 extensions to the 3GPP FLUTE FDT schema are specified in listing 7.2.10.2-5 below. The filename of this schema is "TS26346_FLUTE-FDT_Extensions_Rel-11.xsd".

Listing 7.2.10.2-5: 3GPP FLUTE FDT schema extensions (Release 11)

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:3GPP:metadata:2012:MBMS:FLUTE:FDT"
  xmlns="urn:3GPP:metadata:2012:MBMS:FLUTE:FDT"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  elementFormDefault="qualified">
  <xs:annotation>
    <xs:documentation>MBMS FLUTE FDT schema extensions (Release 11)</xs:documentation>
    <xs:documentation>3GPP TS 26.346 clause 7.2.10.2</xs:documentation>
    <xs:documentation>Copyright © 2012, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI,
TSDSI, TTA, TTC). All rights reserved.</xs:documentation>
  </xs:annotation>

  <xs:element name="Alternate-Content-Location-1" type="Alternative-Content-LocationType"/>
  <xs:element name="Alternate-Content-Location-2" type="Alternative-Content-LocationType"/>
  <xs:complexType name="Alternative-Content-LocationType">
    <xs:sequence>
      <xs:element name="Alternate-Content-Location" type="xs:anyURI" minOccurs="0"
maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:attribute name="Availability-Time" type="xs:dateTime"/>
  </xs:complexType>

  <xs:element name="Base-URL-1" type="xs:anyURI"/>
  <xs:element name="Base-URL-2" type="xs:anyURI"/>
  <xs:attribute name="FEC-Redundancy-Level" type="xs:unsignedInt"/>
  <xs:attribute name="File-ETag" type="xs:string"/>
</xs:schema>
```

The Release 13 extensions to the 3GPP FLUTE FDT schema are specified in listing 7.2.10.2-6 below. The filename of this schema is "TS26346_FLUTE-FDT_Extensions_Rel-13.xsd".

Listing 7.2.10.2-6: 3GPP FLUTE FDT schema extensions (Release 13)

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:3GPP:metadata:2015:MBMS:FLUTE:FDT"
  xmlns="urn:3GPP:metadata:2015:MBMS:FLUTE:FDT"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  elementFormDefault="qualified">
  <xs:annotation>
    <xs:documentation>MBMS FLUTE FDT schema extensions (Release 13)</xs:documentation>
    <xs:documentation>3GPP TS 26.346 clause 7.2.10.2</xs:documentation>
    <xs:documentation>Copyright © 2015, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI,
TSDSI, TTA, TTC). All rights reserved.</xs:documentation>
  </xs:annotation>

  <xs:attribute name="IndependentUnitPositions" type="IndependentUnitPositionsType"/>
  <xs:simpleType name="IndependentUnitPositionsType">
    <xs:list itemType="xs:unsignedLong"/>
  </xs:simpleType>
</xs:schema>
```

7.2.10.3 Baseline IETF FLUTE FDT schema (informative)

The baseline FDT XML schema specified by the IETF in RFC 3926 [9] is reproduced in listing 7.2.10-1 below. This schema is not included as an attachment to the present document.

NOTE 1: Because the schema in RFC 3926 [9] is not valid there exist no stable reference, this schema is included in the present document until IETF publishes an updated version.

NOTE 2: The schema presented in listing 7.2.10-1 is provided for information only, since the extended schema specified in clause 7.2.10.1 duplicates its definitions and adds 3GPP specific extensions to it.

Listing 7.2.10.2-1: Baseline IETF FLUTE FDT schema

```

<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:IETF:metadata:2005:FLUTE:FDT"
  xmlns="urn:IETF:metadata:2005:FLUTE:FDT"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  elementFormDefault="qualified">

  <xs:element name="FDT-Instance" type="FDT-InstanceType"/>
  <xs:complexType name="FDT-InstanceType">
    <xs:sequence>
      <xs:element name="File" type="FileType" maxOccurs="unbounded"/>
      <xs:any namespace="##other" processContents="skip" minOccurs="0"
maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:attribute name="Expires" type="xs:string" use="required"/>
    <xs:attribute name="Complete" type="xs:boolean" use="optional"/>
    <xs:attribute name="Content-Type" type="xs:string" use="optional"/>
    <xs:attribute name="Content-Encoding" type="xs:string" use="optional"/>
    <xs:attribute name="FEC-OTI-FEC-Encoding-ID" type="xs:unsignedLong" use="optional"/>
    <xs:attribute name="FEC-OTI-FEC-Instance-ID" type="xs:unsignedLong" use="optional"/>
    <xs:attribute name="FEC-OTI-Maximum-Source-Block-Length" type="xs:unsignedLong"
use="optional"/>
    <xs:attribute name="FEC-OTI-Encoding-Symbol-Length" type="xs:unsignedLong"
use="optional"/>
    <xs:attribute name="FEC-OTI-Max-Number-of-Encoding-Symbols" type="xs:unsignedLong"
use="optional"/>
    <xs:attribute name="FEC-OTI-Scheme-Specific-Info" type="xs:base64Binary" use="optional"/>
    <xs:anyAttribute processContents="skip"/>
  </xs:complexType>

  <xs:complexType name="FileType">
    <xs:sequence>
      <xs:any namespace="##other" processContents="skip" minOccurs="0"
maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:attribute name="Content-Location" type="xs:anyURI" use="required"/>
    <xs:attribute name="TOI" type="xs:positiveInteger" use="required"/>
    <xs:attribute name="Content-Length" type="xs:unsignedLong" use="optional"/>
    <xs:attribute name="Transfer-Length" type="xs:unsignedLong" use="optional"/>
    <xs:attribute name="Content-Type" type="xs:string" use="optional"/>
    <xs:attribute name="Content-Encoding" type="xs:string" use="optional"/>
    <xs:attribute name="Content-MD5" type="xs:base64Binary" use="optional"/>
    <xs:attribute name="FEC-OTI-FEC-Encoding-ID" type="xs:unsignedLong" use="optional"/>
    <xs:attribute name="FEC-OTI-FEC-Instance-ID" type="xs:unsignedLong" use="optional"/>
    <xs:attribute name="FEC-OTI-Maximum-Source-Block-Length" type="xs:unsignedLong"
use="optional"/>
    <xs:attribute name="FEC-OTI-Encoding-Symbol-Length" type="xs:unsignedLong"
use="optional"/>
    <xs:attribute name="FEC-OTI-Max-Number-of-Encoding-Symbols" type="xs:unsignedLong"
use="optional"/>
    <xs:attribute name="FEC-OTI-Scheme-Specific-Info" type="xs:base64Binary" use="optional"/>
    <xs:anyAttribute processContents="skip"/>
  </xs:complexType>
</xs:schema>

```

7.2.10.4 Example 3GPP FLUTE FDT

Listing 7.2.10.4-1: Example 3GPP FLUTE FDT

```
<?xml version="1.0" encoding="UTF-8"?>
<FDT-Instance xmlns="urn:IETF:metadata:2005:FLUTE:FDT"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:r7="urn:3GPP:metadata:2007:MBMS:FLUTE:FDT"
  xmlns:r8="urn:3GPP:metadata:2008:MBMS:FLUTE:FDT_ext"
  xmlns:r9="urn:3GPP:metadata:2009:MBMS:FLUTE:FDT_ext"
  xmlns:sv="urn:3gpp:metadata:2009:MBMS:schemaVersion"
  xsi:schemaLocation="urn:IETF:metadata:2005:FLUTE:FDT TS26346_FLUTE-FDT.xsd"
  FEC-OTI-FEC-Encoding-ID="1"
  Complete="true"
  Content-Encoding="gzip"
  FEC-OTI-Encoding-Symbol-Length="512"
  Expires="331129600"
  r8:FullFDT="true">

  <File TOI="2"
    Content-Type="application/sdp"
    Content-Length="7543"
    Transfer-Length="4294"
    FEC-OTI-Encoding-Symbol-Length="16"
    FEC-OTI-Scheme-Specific-Info="AAEBBA=="
    Content-Location="http://www.example.com/fancy-session/main.sdp"
    r9:Decryption-KEY-URI="http://www.example.com/key-uri">
    <r7:Cache-Control>
      <r7:Expires>331129630</r7:Expires>
    </r7:Cache-Control>

    <sv:delimiter>0</sv:delimiter>
    <sv:delimiter>0</sv:delimiter>
    <MBMS-Session-Identity>93</MBMS-Session-Identity>
  </File>

  <File TOI="3"
    Content-Type="String"
    Content-Length="161934"
    Transfer-Length="157821"
    FEC-OTI-Encoding-Symbol-Length="512"
    Content-Location="http://www.example.com/fancy-session/trailer.3gp">

    <sv:delimiter>0</sv:delimiter>
    <sv:delimiter>0</sv:delimiter>
    <MBMS-Session-Identity>93</MBMS-Session-Identity>
  </File>

  <sv:schemaVersion>4</sv:schemaVersion>
  <sv:delimiter>0</sv:delimiter>
  <MBMS-Session-Identity-Expiry value="3311288760">93</MBMS-Session-Identity-Expiry>
</FDT-Instance>
```

7.2.10.5 Caching directives extension

See clause 7.2.13.

7.2.10.6 FEC redundancy level extension

See clause 7.2.16.

7.2.11 MBMS Session identity

The *MBMS-Session-Identity* element associates the file to the identity of the MBMS session. If the file will be part of several MBMS transmission sessions, then a list of MBMS session identities is defined.

The *MBMS-Session-Identity-Expiry* element associates an expiration time with a MBMS session identity value. Similar to the FLUTE FDT expiration time, the MBMS session identity expiration time (*value* attribute) is expressed within the FDT Instance payload as a 32-bit data field. The value of the data field represents the 32 most significant bits of a 64-bit Network Time Protocol (NTP) time value as specified in RFC 5905 [78]. These 32 bits provide an unsigned integer representing the time in seconds relative to 0 hours 1 January 1900.

7.2.12 FEC Scheme definition

7.2.12.1 General

This clause defines an FEC encoding scheme for the MBMS forward error correction code defined in RFC 5053 [91] for the download delivery method. This scheme is identified by FEC Encoding ID 1. The FEC Payload ID format and FEC Object Transmission Information format are as defined in [91], clauses 3.1 and 3.2 respectively.

7.2.13 Caching directives signalling

A file download service may indicate the caching recommendations for a specific file or set of files that are delivered using FLUTE. The caching directives are to be used with the file download modes as follows:

- *Promiscuous mode*: it is recommended to use the caching directives with the promiscuous mode as it enables improved management of the storage at the UE. Applications make use of available copies of files as long as their respective caching time is still valid. In case one or several files have expired, and the download session is still available, the UE should join the FLUTE session and download the expired files. Alternatively, the UE may attempt to retrieve the file using HTTP and the file URL.
- *One-Copy mode*: Caching directives may be used with the one-copy mode to indicate the validity of a certain file. Applications requesting the file will receive the cached file as long as it is still valid. A file that is not expected to be static may indicate a long expiry time or permanent validity.
- *Keep-Updated mode*: it is recommended to use the caching directives with the keep-updated mode to indicate the validity of a certain file. Applications requesting the file will receive the cached file as long as it is still valid.

The caching functionality defines three different caching directives:

- *no-cache*: this directive is used to indicate to the receiver not to cache a specific file (or set of files). This is probably useful in the case where the file is expected to be highly dynamic (changes to the file occur quite often) or if the file will be used only once by the receiver application.
- *max-stale*: this directive indicates to the FLUTE receiver that a specific file (or set of files) should be cached for an indefinite period of time, if possible. The file has no expiry date.
- *Expires*: this directive is used by the server to indicate the expected expiry time of a specific file (or set of files). It indicates a date and time value expressed as the 32 most significant bits of the NTP [78] 64-bit timestamp format. These 32 bits provide an unsigned integer representing the time in seconds relative to 0 hours 1 January 1900.

The syntax of the caching directives is specified in listing 7.2.10.2-2, and the "Cache-Control" element is further referred to by the main FDT schema of clause 7.2.10.1.

7.2.14 Indicating a full FDT snapshot

If the server wants to inform the MBMS Client about the current FDT snapshot, the server shall set the "FullFDT" attribute in the FLUTE FDT instance file. If the "FullFDT" attribute is set, the FDT instance shall be equivalent to the full File Delivery Table. Note FDT instances with a higher FDT instance ID may again extend the File Delivery Table.

A new attribute "FullFDT" is created within the element "FDT-Instance" of the FDT to indicate to the receivers that the FDT Instance contains the exact set of Transport Objects that are currently scheduled for transmission by the sender, in the actual FLUTE session.

The XML syntax of the "FullFDT" attribute within the FLUTE FDT is specified in listing 7.2.10.2-3, and the attribute is further referred to by the main FDT schema of clause 7.2.10.1.

This attribute differs from the existing "Complete" attribute in that the "Complete" attribute indicates that no new objects description will be provided in future FDT Instances within this session.

No assumption shall be made about the fact that a given FDT instance for which the attribute "FullFDT" is absent or set to FALSE, contains the exact set of Transport Objects that are currently scheduled for transmission by the sender, in the actual FLUTE session.

When two FDT instances with attribute "FullFDT" is equal to TRUE are received by a receiver and valid in a given time (that is to say they have not expired), the FDT instance with the highest FDT Instance ID shall be used by the terminal.

7.2.15 Decryption key indicating of protected download data

An MBMS download service may indicate relevant decryption key file for a protected download file listed in a FLUTE FDT instance. A new attribute "Decryption-KEY-URI" is created within element "file" of the FDT to indicate the association between the protected download file and the corresponding decryption key file. The value of the "Decryption-KEY-URI" attribute in the "file" element shall be equal to the content-location of the MIKEY file that contains the decryption key file.

When the BM-SC delivers a protected download file, it should populate the "Decryption-KEY-URI" attribute in the corresponding "File" element in the FLUTE FDT instance.

When a UE receives a protected file, the UE may instruct its FLUTE receiver to download the relevant decryption key file according to "Decryption-KEY-URI" field present in the "File" element of the FDT instance.

The XML syntax of the "Decryption-KEY-URI" attribute within the FLUTE FDT is specified in listing 7.2.10.2-4, and the attribute is further referred to by the main FDT schema of clause 7.2.10.1.

7.2.16 FEC redundancy level signalling

An MBMS download service may indicate FEC redundancy level for individual FLUTE Transport Objects in a FLUTE FDT Instance. The attribute "FEC-Redundancy-Level" is included within the "File" element of the FDT Instance to indicate the FEC redundancy level for the file. For example, if the FEC-Redundancy-Level is set to 20, it means BM-SC will add 20% extra redundancy for this file during MBMS delivery.

The FEC redundancy level information may be used by the MBMS Client to e.g. stop decoding a particular DASH segment when MBMS Client detects that the packet loss rate already exceeds the FEC redundancy level for that segment.

The XML syntax of the "FEC-Redundancy-Level" attribute within the FLUTE FDT is specified in listing 7.2.10.2-5, and the attribute is further referred to by the main FDT schema of clause 7.2.10.1.

7.3 SDP for Download Delivery Method

7.3.1 Introduction

RFC 3926 [9] describes required and optional parameters for FLUTE session and media descriptors. This clause specifies SDP for FLUTE session that is used for the MBMS download and service announcement sessions. The formal specification of the parameters is given in ABNF [23].

7.3.2 SDP parameters for MBMS download session

7.3.2.0 General

The semantics of a Session Description of an MBMS download session includes the following parameters:

- The sender IP address.
- The number of channels in the session.
- The destination IP address and port number for each channel in the session per media.
- The Transport Session Identifier (TSI) of the session.
- The start time and end time of the session.
- The protocol ID (i.e. FLUTE/UDP).

- Media type(s) and fmt-list.
- Data rate using existing SDP bandwidth modifiers.
- Mode of MBMS bearer per media.
- FEC capabilities and related parameters.
- Service-language(s) per media.
- QoE Metrics (as defined in clauses 8.3.2.1 and 8.4).
- Alternative TMGI

This list includes the parameters required by FLUTE in RFC 3926 [9]

These shall be expressed in SDP ([14] and [15]) syntax according to the following clauses.

7.3.2.1 Sender IP address

There shall be exactly one IP sender address per MBMS download session, and thus there shall be exactly one IP source address per complete MBMS download session SDP description. The IP source address shall be defined according to the source-filter attribute ("a=source-filter:") ([14] and [15]) for both IPv4 and IPv6 sources, with the following exceptions:

1. Exactly one source address may be specified by this attribute such that exclusive-mode shall not be used and inclusive-mode shall use exactly one source address in the <src-list>.
2. There shall be exactly one source-filter attribute per complete MBMS download session SDP description, and this shall be in the session part of the session description (i.e. not per media).
3. The * value shall be used for the <dest-address> subfield, even when the MBMS download session employs only a single LCT (multicast) channel.

7.3.2.2 Number of channels

Only one FLUTE channel is allowed per FLUTE session in the present document and thus there is no further need for a descriptor of the number of channels.

7.3.2.3 Destination IP address and port number for channels

The FLUTE channel shall be described by the media-level channel descriptor. These channel parameters shall be per channel:

- IP destination address.
- Destination port number.

The IP destination address shall be defined according to the "connection data" field ("c=") of SDP [14]. The destination port number shall be defined according to the <port> sub-field of the media announcement field ("m=") of SDP [14].

The presence of a FLUTE session on a certain channel shall be indicated by using the "*m*-line" in the SDP description as shown in the following example:

- m=application 12345 FLUTE/UDP 0
- c=IN IP6 FF1E:03AD::7F2E:172A:1E24/1

In the above SDP attributes, the *m*-line indicates the media used and the *c*-line indicates the corresponding channel. Thus, in the above example, the *m*-line indicates that the media is transported on a channel that uses FLUTE over UDP. Further, the *c*-line indicates the channel address, which, in this case, is an IPv6 address.

7.3.2.4 Transport Session Identifier (TSI) of the session

The combination of the TSI and the IP source address identifies the FLUTE session. Each TSI shall uniquely identify a FLUTE session for a given IP source address during the time that the session is active, and also for a large time before and after the active session time (this is also an LCT requirement – see RFC 3451 [11]).

The TSI shall be defined according the SDP descriptor given below. There shall be exactly one occurrence of this descriptor in a complete FLUTE SDP session description and it shall appear at session level.

The syntax in ABNF is given below:

- flute-tsi-line = "a=flute-tsi:" tsi CRLF
- tsi = 1*15DIGIT

7.3.2.5 Multiple objects transport indication

RFC 3626 [9] requires the use of the Transport Object Identifier (TOI) header field (with one exception for packets with no payload when the A flag is used). The transport of a single FLUTE file requires that multiple TOIs are used (TOI 0 for FDT Instances). Thus, there is no further need to indicate to receivers that the session carries packets for more than one object and no SDP attribute (or other FLUTE out of band information) is needed for this.

7.3.2.6 Session timing parameters

A MBMS download session start and end times shall be defined according to the SDP timing field ("t=") [14].

7.3.2.7 Mode of MBMS bearer per media

A new MBMS bearer mode declaration attribute is defined which results in, e.g.:

- a=mbms-mode:broadcast 123869108302929 1
- OR
- a=mbms-mode:broadcast-mbsfn 123869108302929

The MBMS bearer mode declaration attribute shall be used in session descriptions using one or more MBMS broadcast mode media or broadcast-mbsfn mode media. If all media declarations use MBMS broadcast mode or broadcast-mbsfn mode, then the SDP attribute may be declared at session level. In that case the session level attribute applies to all media without a media level occurrence of the "mbms-mode" attribute. If one or more media using MBMS multicast mode is present in the same declaration as media using MBMS broadcast mode, then only media using the MBMS broadcast mode or broadcast-mbsfn mode will contain the "mbms-mode" attribute.

- mbms-bearer-mode-declaration-line = "a=mbms-mode:" ("broadcast" SP tmgi SP mbms-counting-information) / ("broadcast-mbsfn" SP tmgi) CRLF
- tmgi = 1*15DIGIT
- mbms-counting-information = 1 * DIGIT

Please find below an example of the building of the TMGI:

UK MCC = 234 (MCC Digit 1 = 2; MCC Digit 2 = 3 and MCC Digit 3 = 4)

Vodafone UK MNC = 15

Therefore, with padding, Vodafone UK MNC = 15F (MNC Digit 1 = 1; MNC Digit 2 = 5 and MNC Digit 3 = F)

MBMS Service ID = 70A886

Therefore, TMGI = 70A886 32F451 (Hex)

Therefore, TMGI = 123869108302929 (Decimal)

The Temporary Mobile Group Identity (tmgi) information element is defined in TS 24.008 [40] including the coding of the fields. Octets 3 to 8 (MBMS Service ID, MCC and MNC) shall be placed in the tmgi attribute of the MBMS bearer mode declaration line, and are encoded as a decimal number. Octet 3 is the most significant octet. As this is encoded as a decimal number, leading zeros of the MBMS Service ID field may be omitted.

The MBMS Counting Information (mbms-counting-information) information element is defined in TS 25.413 [87] and indicates whether the RAN level counting procedures are applicable or not for the MBMS broadcast mode. The value 0 corresponds to the information element value of "not counting" and the value 1 corresponds to the information element value "counting".

If the MBMS bearer mode declaration attribute is applied at the session level, there shall be exactly one instance of MBMS bearer mode declaration attribute in the Session Description.

7.3.2.8 FEC capabilities and related parameters

A new FEC-declaration attribute is defined which results in, e.g.:

- a=FEC-declaration:0 encoding-id=1

This attribute may be used on both session-level and media-level. Multiple instances are allowed to specify several different FEC declarations. The attribute is used on session level to define FEC declarations used by multiple media components. On media level it is used to define FEC declarations which are only valid for a single media component. If FEC declarations on both session and media level use the same reference number (fec-ref) then the media level declaration takes precedence for that media component. Each media component references one FEC declaration using the "a=FEC" attribute.

This attribute is optional to use for the download delivery method as the information will be available elsewhere (e.g. FLUTE FDT Instances). If this attribute is not used, and no other FEC-OTI information is signalled to the UE by other means, the UE may assume that support for FEC id 0 is sufficient capability to enter the session.

A new FEC-declaration reference attribute is defined which results in, e.g.:

- a=FEC:0

This is a media-level only attribute, used as a short hand to reference one of one or more FEC-declarations.

The syntax for the attributes in ABNF [23] is:

- fec-declaration-line = "a=FEC-declaration:" fec-ref SP fec-enc-id ["," SP fec-inst-id] CRLF
- fec-ref = 1*3DIGIT ; value is the SDP-internal identifier for FEC-declaration.
- fec-enc-id = "encoding-id=" enc-id
- enc-id = 1*DIGIT ; value is the FEC encoding ID used
- fec-inst-id = "instance-id=" inst-id
- inst-id = 1*DIGIT ; value is the FEC Instance ID used.
- fec-line = "a=FEC:" fec-ref CRLF

7.3.2.9 Service-language(s) per media

The existing SDP attribute "a=lang" is used to label the language of any language-specific media. The values are taken from [73] which in turn takes language and (optionally) country tags from ISO 639 [74] and ISO 3166 [75] (e.g. "a=lang:EN-US"). These are the same tags used in the User Service Description XML.

7.3.2.10 Bandwidth specification

The maximum bit rate required by this FLUTE session shall be specified using the "AS" bandwidth modifier [14] on media level. The Application Specific (AS) bandwidth for a FLUTE session shall be the largest sum of the sizes of all packets transmitted during any one second long period of the session, expressed as kilobits. The size of the packet shall be the complete packet, i.e. IP, UDP and FLUTE headers, and the data payload.

7.3.2.11 FEC redundancy level

The "FEC-redundancy-level" declaration attribute is defined in the form:

- a=FEC-redundancy-level:<fec-ref> <fec-redun-lev>,

This attribute is associated with the FEC-declaration attribute defined in clause 7.3.2.8, with the same <fec-ref> field value. It may be used at the session or media level, and declares the redundant level of FEC protection, as a percentage, applied to the media component(s) carried on the associated MBMS download session. For example, a FEC redundancy level of 40% means that for an FEC-encoded block of K symbols, $1.4 \cdot K$ symbols are broadcast over the air. The applicability of the FEC redundancy level parameter, at the session or media level, mirrors the session- or media-level use of the corresponding FEC-declaration attribute with the same <fec-ref> value. The FEC-redundancy-level attribute is optional to use as a FEC declaration.

The syntax for this attribute, expressed in ABNF per RFC 5234 [23], is as follows:

- <fec-ref> is as defined in clause 7.3.2.8,
- <fec-redun-lev> = "redundancy level=" <redun-lev>, and
- <redun-lev> = 1*3DIGIT; represents the redundant amount of FEC protection applied to the file object, expressed as an integer percentage value.

In the event that both the FDT extension attribute "FEC-Redundancy-Level" as defined in clause 7.2.16, and the SDP FEC redundancy level indication are present, the declaration in the FDT shall take precedence from the UE processing perspective.

7.3.2.12 Alternative TMGI

An alternative TMGI declaration attribute is defined at the session level with the following ABNF [23] syntax:

- "a=alternative-tmgi:" tmgi-list CRLF
- tmgi-list = tmgi *("," tmgi)
- tmgi = 1*15DIGIT

The content(s) of an MBMS User Service may be delivered simultaneously in multiple PLMN areas, over different MBMS bearer service instances (each identified by a unique TMGI). In this case, the *alternative-tmgi* attribute shall be present at the session level and lists all alternative values to the TMGI contained in the session-level MBMS bearer mode declaration attribute, used for the broadcast of the FLUTE session data.

When this attribute is present, the UE shall determine that the service is available at its current location, upon detecting a match between the TMGI derived from the PLMN-ID representing its current location, with one of the TMGIs from the following list:

- The set of TMGI values comprising the default TMGI in the MBMS bearer mode declaration attribute and
- the TMGIs contained in the *alternative-tmgi* attribute.

Absence of a match shall be an indication to the UE that the service not available at its current location.

The *alternative-tmgi* declaration attribute is optional. It is not a replacement for the MBMS mode declaration attribute as defined in clause 7.3.2.7. In addition to the MBMS mode declaration attribute (which is the default TMGI), at most a single instance of the *alternative-tmgi* declaration attribute shall be present in the Session Description. The same definition of the Temporary Mobile Group Identity (*tmgi*) as used in clause 7.3.2.7 shall be applied.

7.3.2.13 Transport protocol identification

For the MBMS download delivery method, the <proto> field of the media descriptions ("m=") line of the SDP shall be set to 'FLUTE/UDP'.

7.3.2.14 Media type and fmt-list

For the MBMS download delivery method, the media type and format list information shall be set in the "m=" line of the SDP as follows. The <media> field shall be set to 'application' and the <fmt> field shall be set to '0'.

7.3.3 SDP examples for FLUTE Session

Here is a full example of SDP description describing a FLUTE session:

```
v=0
o=user123 2890844526 2890842807 IN IP6 2201:056D::112E:144A:1E24
s=File delivery session example
i=More information
t=2873397496 2873404696
a=mbms-mode:broadcast 123869108302929 1
a=FEC-declaration:0 encoding-id=1
a=source-filter: incl IN IP6 * 2001:210:1:2:240:96FF:FE25:8EC9
a=flute-tsi:3
m=application 12345 FLUTE/UDP 0
c=IN IP6 FF1E:03AD::7F2E:172A:1E24/1
b=64
a=lang:EN
a=FEC:0
```

Below is a second example of an SDP description describing a FLUTE session and which indicates that 25% redundant FEC protection is applied to the FEC encoding of the video Segments of the associated DASH-formatted content:

```
v=0
o=user123 2890844526 2890842807 IN IP6 2201:056D::112E:144A:1E24
s=Download session carrying 2-hour DASH-encoded program
i=More information
t=3615124600 3615131800
a=mbms-mode:broadcast 123869108302929 1
a=FEC-declaration:0 encoding-id=1
a=FEC-redundancy-level:0 redundancy-level=25
a=source-filter: incl IN IP6 * 2001:210:1:2:240:96FF:FE25:8EC9
a=flute-tsi:5
m=video 10111 FLUTE/UDP 0
c=IN IP6 FF1E:03AD::7F2E:172A:1E24/1
b=512
a=lang:EN
```

Below is a third example of an SDP description describing a FLUTE session with three TMGIs: one associated with the MBMS bearer mode declaration attribute, and two others that are carried in the "*alternative-tmgi*" attribute:

```
v=0
o=user123 2890844526 2890842807 IN IP6 2201:056D::112E:144A:1E24
s=Download session carrying 2-hour DASH-encoded program
i=More information
t=3615124600 3615131800
a=mbms-mode:broadcast-mbsfn 123869108302929
a=FEC-declaration:0 encoding-id=1
a=FEC-redundancy-level:0 redundancy-level=25
a=source-filter: incl IN IP6 * 2001:210:1:2:240:96FF:FE25:8EC9
a=flute-tsi:5
a=alternative-tmgi:123869108302899,123869108302915
m=video 10111 FLUTE/UDP 0
c=IN IP6 FF1E:03AD::7F2E:172A:1E24/1
b=512
a=lang:EN
```

7.4 OMA Push usage for MBMS Download

7.4.1 Introduction

OMA Push may be used for MBMS download reception when MBMS Bearers are not available. The MBMS UE registers its MSISDN with the BM-SC to receive the Download Sessions using OMA Push. The BM-SC distributes FLUTE FDT instance which allows the MBMS UE to fetch files of interest.

If the MBMS UE is out of its home network and if at least one *unicastAccessURI* element is available in the deliver method description, the MBMS UE should register its MBMS Download Services with the BM-SC.

7.4.2 HTTP registration and deregistration procedure

The MBMS UE may register and deregister for unicast service delivery, if the User Service Description for this service includes at least one *unicastAccessURI* element in the *deliveryMethod* element.

The HTTP GET method as specified in RFC 9112 [18] is used for this purpose. If more than one *unicastAccessURI* is provided in the *deliveryMethod* element, the UE shall randomly select one.

The syntax of the above request method is expressed in ABNF according to RFC 5234 [23] as follows:

- `unicast_access_request_http_URL` = `unicast_access_URI` "?" query
- `unicast_access_URI` = <*unicastAccessURI* from the User Service Description; URI-reference is as defined in [19].>
- `query` = `action` "&" `serviceId` "&" `msisdn`
- `action` = "action=" ("register" / "Register" / "deregister" / "Deregister")
- `serviceId` = "serviceId=" <value of the *serviceId* attribute of the User Service Description>
- `msisdn` = "msisdn=" 1*DIGIT <format as defined in [77]>

The BM-SC responds with an "200 OK" status code in case of successful registration or deregistration. With the response to a successful registration request, an Associated Delivery Procedure fragment as defined in clause 9.5 shall be delivered to the MBMS UE. The MBMS UE uses the File Repair procedure as described in the received associated delivery procedure description fragment. The file repair procedure is defined in clause 9.3.

NOTE: The file repair procedure allows also to fetch complete files.

An HTTP GET request with "action" value set to "register" or "Register" shall be sent to register the MBMS UE for unicast file delivery service. The request shall also include the *serviceId* and the MSISDN of the MBMS UE. The format for the MSISDN is defined in [77]. The following is an example for a registration request:

```
GET /unicastDelivery?action=Register&serviceId=urn:3gpp:0010120123hotdog&MSISDN=436642012345 HTTP/1.1
Host: bmsc.example.com
```

An HTTP GET request with "action" value set to "deregister" or "Deregister" shall be sent to deregister the MBMS UE from the unicast file delivery service. The request also includes the service ID and the MSISDN number of the MBMS UE as shown in the following example:

```
GET /unicastDelivery?action=Deregister&serviceId=urn:3gpp:0010120123hotdog&MSISDN=436642012345
HTTP/1.1
Host: bmsc.example.com
```

7.4.3 MBMS Download Delivery Method over OMA push bearers

MBMS Download over OMA Push bearers are formatted according to the OMA Push OTA specification [79].

OTA-WSP shall be used over unicast bearers. Application port addressing shall be used as specified in [79]. The application ID to be used is 0x9045 as allocated by OMNA [85].

OTA-HTTP may be used over the HTTP push bearer. Application port addressing shall be used as specified in [79]. The application ID to be used is 0x9045 as allocated by OMNA [85].

The Content-Encoding header shall be included if GZip is used.

The MBMS UE receives the FLUTE FDT instance and the Download Header instance via OMA Push OTA protocol [79]. Both documents are encapsulated in a multipart MIME document. Optionally, an associated delivery description fragment as specified in clause 9.5 is part of the pushed document. The FLUTE FDT instance is identified by the MIME media type "application/fdt+xml" and the associated delivery description fragment by the MIME media type specified in clause C.7. The Download Header instance should use a default MIME media type "application/xml".

The XML schema for the Download Header fragment is specified in listing 7.4.3-1 below. The *serviceld* element contains the unique identifier of the MBMS service. The MBMS UE uses the Service Id to select the target application and has received the *serviceld* with the User Service Announcement fragment. The format of the *serviceld* element is defined in clause 11.2.1.1.

The *fdtInstanceId* element of the Download Header instance shall contain the FDT instance Identifier for the sent FDT instance.

NOTE: The FDT instance identifier is transferred using the FDT Instance Header as specified in section 3.4.1 of RFC 3926 [9].

Listing 7.4.3-1: Download Header schema

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:3GPP:metadata:2007:MBMS:downloadHeader"
  xmlns="urn:3GPP:metadata:2007:MBMS:downloadHeader"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  elementFormDefault="qualified"
  attributeFormDefault="unqualified">
  <xs:annotation>
    <xs:documentation>MBMS Download Header schema</xs:documentation>
    <xs:documentation>3GPP TS 26.346 clause 7.4.3</xs:documentation>
    <xs:documentation>Copyright © 2007, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI,
TSDSI, TTA, TTC). All rights reserved.</xs:documentation>
  </xs:annotation>

  <xs:element name="mbmsDownloadHeader">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="serviceId" type="xs:anyURI"/>
        <xs:element name="fdtInstanceId" type="xs:unsignedInt"/>
        <xs:any namespace="##other" processContents="lax" minOccurs="0"/>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
</xs:schema>
```

The UE will then have necessary information about all Transport Objects in the FLUTE session, including their fileURIs, content encodings, content lengths etc.

7.5 FLUTE session setup and control with RTSP

7.5.1 Introduction

In case the MBMS User Service contains MBMS streaming and MBMS download sessions, it may be beneficial to control all flows with RTSP. The prime use case of FLUTE session set-up and control with RTSP is for sending MBMS streaming associated presentation data.

7.5.2 SDP handling

The FLUTE specific SDP extensions are defined in clause 7. For the FLUTE session establishment using RTSP, a control URI as defined in [88] shall be present for the FLUTE media description. Note, a control URI is defined by the "a=control:" SDP field according to [88].

7.5.3 RTSP SETUP method

The control URI as defined in [88] shall be present for each FLUTE media description in the SDP. The control URI is used within the RTSP SETUP method to establish the described FLUTE sessions.

The RTSP transport protocol specifier for FLUTE as defined in [88] shall be "FLUTE/UDP". One and only one UDP port is allocated for each FLUTE channel.

The following RTP specific parameters shall be used in the transport request and responds header for FLUTE sessions:

- client_port: This parameter provides the unicast FLUTE port(s) on which the client has chosen to receive FLUTE data.
- server_port: This parameter provides the unicast FLUTE port(s) on which the server has chosen to send data.

7.5.4 RTSP PLAY method

The PLAY method tells the server to start sending data including FLUTE session data as defined in [88]. The RTSP server forwards the FLUTE packets as according by the RTSP range header in the RTSP PLAY.

Only ntp and clock range units may be used with the "Range" headers. Normal Play Time (NPT) indicates the stream absolute position relative to the beginning of the presentation. The NPT consists of a decimal fraction. The clock range header describe the absolute time expressed as ISO 8601 timestamps, using UTC (GMT).

7.5.5 RTSP PAUSE method

The PAUSE request causes the stream delivery including all FLUTE sessions to be interrupted (halted) as defined in [88].

7.5.6 RTSP TEARDOWN method

The TEARDOWN client to server request stops the stream delivery including all FLUTE data delivery for the given URI, freeing the resources associated with it. Details for the TEARDOWN method are defined in [88].

7.6 Hybrid service offerings for DASH-over-MBMS User Service and Generic Application Service

7.6.1 Introduction

As conveyed by the application service document (e.g. a unified MPD in case of DASH), an Application Service belonging to a MBMS User Service and carried by the MBMS download delivery method may be made available such that the resources are partly available on broadcast and are partly available in unicast.

This clause uses the generic term "resources". However, in case of DASH-over-MBMS, the term "resources" is expected to refer to Segments associated to Representations.

Two main use cases are considered in this context:

- 1) unicast fallback reception should the UE move outside the MBMS coverage area of the corresponding User Service. Subsequently, should the UE move back into MBMS coverage, it may be required by network operator policy that only broadcast reception of the Service is permitted (network policy and the means for its delivery and execution is outside the scope of this specification). It may also be desired by the MBMS service provider that reception of individual broadcast resources are restricted by MBMS service areas.
- 2) unicast-supplemented service offerings, for which certain resources are only available on unicast and these resources provide an additional user experience and therefore should be accessible by the application, regardless whether the MBMS Client is in the coverage for broadcast reception or not.

In this specification, the MBMS User Service Bundle Description fragment is extended to support these capabilities. The extensions comprise two parts:

- 1) Parameters are added to the *deliveryMethod* child element of the *userServiceDescription* element, which identify whether content requested by the client application of the MBMS Client, e.g., a DASH client, is carried over unicast or broadcast transport (or both), and if the information is redundant or supplementary to the user experience. In addition, for application service content delivered via broadcast, the MBMS service areas in which it is restricted for reception can be specified.
- 2) A new child element is added to the *userServiceDescription* element for providing the identities of identical and alternative versions of an application service content item which can be substituted for one another, in accordance to coverage conditions (i.e., inside or outside of MBMS coverage), or policy requirements (e.g., "only broadcast reception of content is allowed when the UE is within MBMS coverage"). In addition, a reference is provided to an Application Service Description document, that describes both broadcast and unicast resources, to enable the MBMS Client to acquire this metadata fragment and subsequently passing it to the corresponding application. In the case that the application service is DASH content delivered over MBMS, the unified MPD is passed to the DASH client. For details on a proper communication between the DASH client and the MBMS Client, refer to TS 26.347 [136], clause 7.

NOTE: For DASH-over-MBMS, the MPD can contain resources (not only Segments of Representations) for which the availability on unicast is not signalled in the *userServiceDescription* element. In this case the service provider need to be aware that the MBMS Client does not have any control over requests associated to these resources and this can for example result in unwanted unicast traffic even if the UE is the coverage for broadcast reception.

7.6.2 Extension of the *deliveryMethod* element

7.6.2.1 Broadcast resource-specific metadata

As a child element of *deliveryMethod*, each instance of *r12:broadcastAppService* denotes all resources that are available over broadcast, i.e. the resources are carried over the MBMS bearer. Each entry of *basePattern* under all *r12:broadcastAppService* element(s) is for use by the MBMS Client to match against a portion of the entire resource URL used by the application to request files. A match implies that the corresponding requested resource is carried over an MBMS bearer. For example in DASH over MBMS, should the URL associated with a Segment request contain the BaseURL "http://example.com/per-3/rep-512", and the same BaseURL value were to appear in an instance of *r12:broadcastAppService.basePattern*, it means that the Representation with **Representation**@id = '512' is available over broadcast. The *basePattern* value may, but is not required to, be identical to that of the **Representation.BaseURL** if present in the MPD.

In addition, each *r12:broadcastAppService* element may contain one or more *serviceArea* child elements which specify the service area(s) in which the associated broadcast resources (as identified by *basePattern*) is delivered/accessible. The semantics of *serviceArea* complies to the *MBMS Service Area Identity* as defined in [77] and [104]. A given broadcast resource may be available in a set of service area(s) in common with, or different from, the service area(s) of any other broadcast resources. Absence of the *serviceArea* element implies that the availability of the broadcast resources is not restricted by service area. The *serviceArea* element(s) that may be present in one instance of *r12:broadcastAppService* element must be a subset of the MBMS Service Area Identities included in the *userServiceDescription.availabilityInfo.infoBinding.serviceArea* elements for the same *serviceId*. When one or more *serviceArea* element(s) are included under one or more *r12:broadcastAppService*, the union of all the MBMS Service Area Identities identified by the *serviceArea* elements under all the *r12:broadcastAppService* must match the list of MBMS Service Area Identities included in the *userServiceDescription.availabilityInfo.infoBinding.serviceArea* elements for the same *serviceId*.

7.6.2.2 Redundant unicast resource-specific metadata

The *deliveryMethod* element may also include one instance of the *r12:unicastAppService* element that denotes unicast resources that are redundant to resources available as broadcast resources. Similar to *r12:broadcastAppService*, each entry of *basePattern* element under the *r12:unicastAppService* element is for use by the MBMS Client to match against a portion of the entire file URL used by the application to request files provided in the application service document. A match implies that the associated file is available over unicast delivery, but if broadcast resources are available to the application service, then these resources are of no additional benefit for the user experience. Typically, such resources are particularly relevant in case broadcast resources are not available and the MBMS Client may provide these resources for unicast fallback and service continuity.

NOTE: In the absence of externally defined policies, the MBMS Client can offer such resources to the application also in other circumstances. For example when the service is initially accessed, such resources may be offered to the application to support faster service access.

For example for DASH over MBMS, should the URL associated with a Segment request contain the BaseURL "http://example.com/per-3/rep-256", and the same BaseURL value were to appear in an instance of *r12:unicastAppService.basePattern*, it means that the Representation with **Representation**@id = '256' is available over unicast. The *basePattern* value may, but is not required to, be identical to that of the **Representation.BaseURL** if present in the MPD.

7.6.2.2A Supplementary unicast resource-specific metadata

The *deliveryMethod* element may also include one or more instances of the *r15:supplementaryUnicastAppService* element to denote one or more available unicast resources which are supplemental to resources provided on broadcast, i.e. they provide an additional user experience. Similar to *r12:unicastAppService*, each entry of the *basePattern* element child of the *r15:supplementaryUnicastAppService* element typically represents a media component delivered over unicast, but with the difference that the information is not redundant and therefore is expected to also be of benefit for the application service when in broadcast coverage.

7.6.2.3 Additional points

A given resource may be delivered/available over one or both transport modes. The broadcast version might be deemed as preferable or even required for reception, for example, in accordance with service provider policy pertaining to location of the UE with respect to MBMS coverage. Based on user preference, and when the UE is in broadcast coverage, the UE may receive media resources delivered over broadcast, as well as additional resources delivered over unicast under *r15:supplementaryUnicastAppService*.

The presence of the *r12:broadcastAppService* and/or *r12:unicastAppService* element under *deliveryMethod* signifies that the parent MBMS User Service is an application service which contains resources delivered via broadcast and/or unicast modes. One or both of these child elements of *deliveryMethod* must be present when its parent *userServiceDescription* element contains the *r12:appService* element (see clause 7.6.3).

7.6.3 Extension of the *userServiceDescription* element

7.6.3.0 General

Presence of the *r12:appService* child element of *userServiceDescription* indicates that the associated MBMS User Service is an application service explicitly linked to the *r12:broadcastAppService* and *r12:unicastAppService* elements under *deliveryMethod*. The *r12:appService* element may contain either or both the child elements *identicalContent* and *alternativeContent*. *r12:appService* also has the attributes *appServiceDescriptionURI* and *contentType*.

7.6.3.1 Identical content

Each *identicalContent* element under *userServiceDescription* contains two or more interchangeable URLs, as indicated by the *basePattern* values, for the same resources. The implication is that the resource could be interchanged in accordance to coverage condition, policy requirements, etc.

7.6.3.2 Alternative content

Each *alternativeContent* element under *userServiceDescription* contains two or more interchangeable URLs, as indicated by the *basePattern* values, corresponding to different resources available over broadcast and unicast transport but which could be substituted for one another in accordance to coverage condition, policy requirements, etc. In practical deployment of a DASH-over-MBMS service, eligibility for such switching may additionally require the following conditions to be met:

- the employed media codecs and configuration information must be identical between the requested and substituted Representations,
- the request does not contain a byte range, and
- Segments of the alternative Representations must be time-aligned.

The UE may support the processing of the *alternativeContent* element.

identicalContent and/or *alternativeContent* may be present under the *r12:appService* element because Representations listed in the MPD may be encoded differently, or associated with different configurations for a given encoding scheme, as defined by their Initialization Segments (represented by Initialization Segment Description fragments). Therefore, the mere presence of *basePattern* entries under *r12:broadcastAppService* and *r12:unicastAppService* does not imply that the associated Representations are automatically eligible for interchange between broadcast and unicast reception.

The *alternativeContent* element shall not be present if the application service is not DASH-over-MBMS.

7.6.3.3 Reference to Unified MPD and other Application Service Documents

The attribute *appServiceDescriptionURI* of *r12:appService* references an Application Service Description which may be a Media Presentation Description fragment corresponding to a unified MPD. In this case, the attribute *contentType* of *r12:appService* specifies the MIME type of the MPD, which may include the optional 'profiles' parameter. The latter parameter declares the interoperability and signals the use of features associated with the DASH Media Presentation described by this MPD. An example value of *contentType* is the string "application/dash+xml;profiles=urn:3GPP:PSS:profile:DASH10", which denotes an MPD conforming to the 3GP-DASH Release-10 profile.

Other types of Application Service Description fragments may be supported.

A UE compliant with this specification shall ignore the *r12:appService* element whose *contentType* attribute value is not supported by the UE.

7.7 Keep Updated service

7.7.1 Registration procedure

The MBMS UE may register and deregister for the keep-updated service, if the User Service Description for this eMBMS service includes one *KeepUpdatedService* element.

The HTTP POST method as specified in RFC 9112 [18] is used for this purpose. A Keep Updated Registration XML fragment is sent to the BM-SC as the body of the POST request. This fragment shall conform to the XML schema in listing 7.7.1-1 with the filename "TS26346_KeepUpdatedRegistration.xsd".

Listing 7.7.1-1: Keep Updated Registration schema

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:3GPP:metadata:2007:MBMS:downloadHeader"
  xmlns="urn:3GPP:metadata:2007:MBMS:downloadHeader"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  elementFormDefault="qualified" attributeFormDefault="unqualified">
  <xs:annotation>
    <xs:documentation>MBMS Keep Updated Registration schema</xs:documentation>
    <xs:documentation>3GPP TS 26.346 clause 7.7.1</xs:documentation>
    <xs:documentation>Copyright © 2007, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI,
    TSDSI, TTA, TTC). All rights reserved.</xs:documentation>
  </xs:annotation>

  <xs:element name="KeepUpdated" type="KeepUpdatedType"/>
  <xs:complexType name="KeepUpdatedType">
    <xs:sequence>
      <xs:element name="fileURL" type="xs:anyURI" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:attribute name="request" type="RequestType" use="optional" default="Register"/>
    <xs:attribute name="MSISDN" type="xs:string" use="optional"/>
  </xs:complexType>

  <xs:simpleType name="RequestType">
    <xs:restriction base="xs:string">
      <xs:enumeration value="Register"/>
      <xs:enumeration value="Deregister"/>
    </xs:restriction>
  </xs:simpleType>
</xs:schema>
```

The keep-updated XML fragment shall have the following MIME media type: "application/vnd.3gpp.keep-updated+xml".

An MBMS UE shall de-register when it no longer requires to receive the service. The HTTP POST method is used for de-registration. The set of files that the receiver wishes to de-register may be provided in the de-registration message as the body of the HTTP request. The MBMS UE may de-register all files that it has earlier registered for by sending an empty list.

As part of the request for registration or de-registration, the MBMS UE shall provide its MSISDN number, that may be used by the BM-SC to identify the MBMS Client.

The BM-SC shall respond with an "200 OK" status code in case of a successful registration or deregistration. The body of the reply shall contain a Keep Updated XML fragment that contains all files for which the BM-SC is willing to provide update notifications.

In case the BM-SC is not able to provide the service or if the request fails for any other reason, the BM-SC shall reply with an HTTP 4xx or a 5xx error response code.

7.7.2 Client notification about updates

When the BM-SC detects an update on a file or set of files that at least one user has registered for, it shall determine if delivery over MBMS is beneficial or not. The BM-SC should inform all MBMS UEs that have registered for that particular file about the existing file update(s).

The BM-SC informs the UEs about the forthcoming delivery of the file updates using eMBMS by sending an update of the Schedule Description metadata fragment of the keep-updated service USD using the MBMS service announcement procedures over unicast as defined in 5.2.5. For updated files that the BM-SC does not intend to broadcast, the file should be marked as unicast only using the *r12:unicastOnly* attribute in the Schedule Description metadata fragment. The file shall then be accessible using the same URI as provided by the *fileURI* element.

7.8 Location-specific *deliveryMethod*

An MBMS User Service may be distributed using different delivery methods (i.e., multiple instances of the *deliveryMethod* child element of the *userServiceDescription* element), each of which is available only in certain areas. These delivery methods may be carrying exactly the same content but over different MBMS bearers (e.g. over different PLMNs).

For the case that the FLUTE session parameters are exactly the same but are distributed over different MBMS bearers with different TMGIs, the *alternative-tmgi* attribute as defined in clause 7.3.2.12 shall be used.

For the case that the FLUTE session parameters are different (e.g. different destination IP address, port number, or TSI), the *userServiceDescription* element shall signal one of the following options:

- One or more *deliveryMethod* elements each of which declares the geographical area where the *deliveryMethod* instance is applicable, and an indication that this *deliveryMethod* belongs to a group of alternative *deliveryMethod* elements. The UE shall only use the *deliveryMethod* whose applicable area matches the current UE location
- Deliver the session description file (SDP) over unicast, where the UE will receive the SDP file applicable to the UE's location

7.9 Partial file handling

7.9.1 General

Files may be lost entirely or partially during the transmission and the MBMS Client may not be able to recover the lost files. This clause provides recommended procedures for handling partial files in the MBMS Client.

A partial file is defined as follows:

- an FDT Instance is received that contains a *File* entry with a specific TOI.

- the object associated to the TOI was not recovered by any recovery procedure (FEC, file repair, etc.). The MBMS Client determines that a file will not be recovered. A file is not recovered if the starting time of the ADPD as defined in 9.3.2 is reached for that file and if present, the file repair for that file has not succeeded,

The partial file is the collection of all FDT Instance data that is assigned to the file, i.e.

- Content-Location (URI of a file).
- Content-Length (source file length in bytes)
- Content-Type (content MIME type)

as well as all received bytes including their position in the original file. In addition, the *mbms2015:IndependentUnitPositions* attribute may be present.

If the application supports the handling of partial files, then the MBMS Client should provide the partial file to the application including the position of all received bytes. The partial file handling capability information from the application to the MBMS Client as well as the handing of the partial file data is generally out of scope of this specification.

However, if the application communicates with the MBMS Client using HTTP methods then

- the MBMS Client may signal the availability of a partial file to a request according to the Response format as defined in clause 7.9.2.2.
- The application may signal the capability to handle partial files for using a partial-file-accept request as defined in clause 7.9.2.1. If a partial-file-accept request is sent,
- the MBMS Client should respond. If it responds it shall use the HTTP Response format as defined in clause 7.9.2.2 and shall include all received bytes in the response.
- Appropriate examples in the context of DASH over MBMS is provided in clause 7.9.2.3.

Independent units are defined in clause 7.9.3. The MBMS Client may also support handling of independent units. If an MBMS Client supports handling of independent units, it shall also support partial file handling.

7.9.2 Partial file handling with HTTP GET method

7.9.2.1 Partial-File-Accept request

An application using HTTP GET requests to retrieve files may include in the GET request, the 'Accept' request header as defined in RFC 7231 [4], along with a new 3GPP-defined media type 'application/3gpp-partial'.

By providing this header and issuing such a partial-file-accept request, the application signals that is capable to receive partial file responses as defined in clause 7.9.2.2.

An example of the use of such Accept header is:

Accept: */*, application/3gpp-partial

In this example, the application indicates that it will accept all media types in the response, as well as the specific "incomplete" type designated by application/3gpp-partial.

7.9.2.2 HTTP response format for partial files

If the MBMS Client receives a regular HTTP GET request that includes the 'Accept' header but which does not contain media type 'application/3gpp-partial', and the MBMS Client has received a partial file with *at least one byte*, it should respond with HTTP/1.1 404 Not Found, and include in the response the 'Content-Type' header set to 'application/3gpp-partial'.

- The response code shall be set to 200 OK
- The Content-Type header shall be set to application/3gpp-partial.

- The message body is a multipart message body shall be exactly the same format as the multipart/byteranges media type as described in RFC 7233 [5], appendix A. The multipart/byteranges media type includes one or more body parts, each with its own Content-Type and Content-Range fields as the means to convey the byte range(s) of the partial file being returned. Each Content-Type header shall be set to the value of the Content-Type provided in the FDT Instance for this file. An extension header may be added 3gpp-access-position providing a byte position at which the handler of assigned to the Content-Type of the file may access the file. The value may be created from the *mbms2015: IndependentUnitPositions*, if present.
- A cache directive should be included in the response to prevent any intermediate proxies from storing an incomplete file and serving it to another application. Example for such cache directive are "Cache-Control: max-age=0" or "Cache-Control: no-cache"

If the MBMS Client receives a partial-file-accept request, and the MBMS Client has received a partial file *with no bytes* (i.e. only the FDT Instance describing the file metadata is received), then the MBMS Client may respond with a partial file response defined as follows:

- The response code shall be set to 416 Requested Range Not Satisfiable
- The Content-Type header shall be set to the value of the Content-Type provided in the FDT Instance for this file.
- The Content-Range shall be set to bytes */Content-Length with Content-Length the value of the attribute Content-Length provided in the FDT Instance for this file.

7.9.2.3 Example client and server implementation for DASH-over-MBMS

As an example, assume the Media Segment of interest is identified by the URL: "http://www.example.com/Period-2012-08-04T08-45-00/rep-xyz12345/seg-777.3gp". In addition, the client is willing to receive the incomplete portion of the Segment (777) available at the Server when the request is received. The DASH client sends the partial-accept request as follows:

```
GET /Period-2015-08-04T08-45-00/rep-xyz12345/seg-777.3gp HTTP/1.1
Host: www.example.com
...
Accept: */*, application/3gpp-partial
```

Assume that the server receives the above GET request for Segment 777, and it has the following sets of byte ranges of the requested Segment of size 256000 bytes at the time it receives the request: 0-19999, 50000-85000, 105500-199888, and 201515-229566. Due to the presence of the specific Accept header in the request, the server will return the partial Segment via the 200 response, by indicating the same content type for the message body as indicated in the request (i.e., application/3gpp-partial), but whereby the message body is constructed identically to the multipart/byteranges format. In addition, the response header Cache-Control: no-cache may be included in the response to prevent downstream caching of the message. The server's response in this case is shown below:

```
HTTP/1.1 200 OK
Date: Tue, 04 Aug 2015 08:45:05 GMT
...
Content-Length: 172441
Content-Type: application/3gpp-partial; boundary=SEPARATION_STRING
Cache-Control: no-cache

--SEPARATION_STRING
Content-Type: video.3gpp; codecs=avc1.64001E, mp4a.40.2
Content-Range: bytes 0-19999

...<the first range>...
-- SEPARATION_STRING
Content-type: video.3gpp; codecs=avc1.64001E, mp4a.40.2
Content-range: bytes 50000-79999

...<the second range>...
-- SEPARATION_STRING
Content-type: video.3gpp; codecs=avc1.64001E, mp4a.40.2
Content-range: bytes 105500-199888

...<the third range>...
-- SEPARATION_STRING
Content-type: video.3gpp; codecs=avc1.64001E, mp4a.40.2
Content-range: bytes 201515-229566

...<the fourth range>...
```

-- SEPARATION_STRING

As an extension to the example, assume that the first byte range is lost as well and FDT Instance contains an *mbms2015:IndependentUnitPositions* attribute with value "0 60000 80000 110000":

The server's response in this case is shown below:

```
HTTP/1.1 200 OK
Date: Tue, 04 Aug 2015 08:45:05 GMT
...
Content-Length: 172441
Content-Type: application/3gpp-partial; boundary=SEPARATION_STRING
Cache-Control: no-cache

-- SEPARATION_STRING
Content-type: video.3gpp; codecs=avcl.64001E, mp4a.40.2
Content-range: bytes 55000-79999
3gpp-access-position: 60000

...<the second range>...
-- SEPARATION_STRING
Content-type: video.3gpp; codecs=avcl.64001E, mp4a.40.2
Content-range: bytes 105500-199888
3gpp-access-position: 110000

...<the third range>...
-- SEPARATION_STRING
Content-type: video.3gpp; codecs=avcl.64001E, mp4a.40.2
Content-range: bytes 201515-229566

...<the fourth range>...
-- SEPARATION_STRING
```

7.9.3 Signalling Independent Units

7.9.3.1 Introduction

Independent Units may be signalled in the File entry of an FDT Instance using the attribute *mbms2015:IndependentUnitPositions*. The FDT Instance signaling is defined in clause 7.9.3.2.

MBMS Clients that support partial file handling may also support the handling of independent units. The details of handling independent units are provided in clause 7.9.2.

7.9.3.2 FDT Instance signalling

Independent Units represent a non-empty list of byte locations, each of which is the location of the first byte of an Independent Unit.

An Independent Unit is the chunk of bytes between two consecutive entries in the *IndependentUnitPositions* list, except for the last Independent Unit which ranges from the last entry in the list to the end of the file.

The position of an Independent Unit is the byte position in the file, at which the handler assigned to the Content-Type for the file may access the file.

If Independent Units are signalled in the FDT Instance, the following restrictions apply:

- The attribute *mbms2015:IndependentUnitPositions* shall not be used in combination with the use of the Content-Encoding.
- The generation of the *IndependentUnitPositions* values is beyond the scope of the present document.

The XML syntax of the *IndependentUnitPositions* attribute within the FLUTE FDT is specified in listing 7.2.10.2-6, and the attribute is further referred to by the main FDT schema of clause 7.2.10.1.

7.10 File Delivery Manifest

The File Delivery Manifest that is used within the xMB interface is defined in the xMB reference point specification TS 26.348 [143].

8 Streaming delivery method

8.1 Introduction

The purpose of the MBMS streaming delivery method is to deliver continuous multimedia data (i.e. speech, audio and video) over an MBMS bearer. Using MBMS Streaming delivery on unicast is defined in clause 8.5. This delivery method complements the download delivery method which consists of the delivery of files. The streaming delivery method is particularly useful for multicast and broadcast of scheduled streaming content.

8.2 Transport protocol

RTP is the transport protocol for MBMS streaming delivery. RTP provides means for sending real-time or streaming data over UDP and is already used for the transport of PSS in 3GPP. RTP provides RTCP for feedback about the transmission quality. The transmission of RTCP packets in the downlink (sender reports) is allowed. In this version of the specification, RTCP RR shall be turned off by SDP RR bandwidth modifiers. Note that in the context of MBMS detection of link aliveness is not necessary.

8.2.1 RTP payload formats for media

The RTP payload formats and corresponding MIME types are closely aligned with those defined in PSS [47]. For RTP/UDP/IP transport of continuous media the following RTP payload formats shall be used:

- AMR narrow-band speech codec (see clause 10.2) RTP payload format according to RFC 4867 [33]. A MBMS Client is not required to support multi-channel sessions.
- AMR wideband speech codec (see clause 10.2) RTP payload format according to RFC 4867 [33]. A MBMS Client is not required to support multi-channel sessions.
- Extended AMR-WB codec (see clause 10.3) RTP payload format according to RFC 4352 [34].
- Enhanced aacPlus codec (see clause 10.3) RTP payload format and MIME types according to RFC 3640 [41], namely the Low Bit-Rate AAC or the High Bit-Rate AAC modes.
- H.264 (AVC) video codec (see clause 10.5) RTP payload format according to RFC 6184 [35]. An MBMS Client supporting H.264 (AVC) is required to support all three packetization modes: single NAL unit mode, non-interleaved mode and interleaved mode. For the interleaved packetization mode, an MBMS client shall support streams for which the value of the "sprop-deint-buf-req" MIME parameter is less than or equal to $MaxCPB \times 1000 / 8$, inclusive, in which "MaxCPB" is the value for Video Coding Layer (VCL) parameters of the H.264 (AVC) profile and level in use, as specified in [43].
- H.265 (HEVC) [112] video codec (see clause 10.5) RTP payload format according to RFC 7798 [113].
- Timed Text (see clause 10.10) RTP payload format according to RFC 4396 [93].

8.2.2 FEC mechanism for RTP

8.2.2.0 General

The "MBMS FEC scheme" is the fully-specified FEC scheme defined in RFC 6681 [106], section 6 with ID 1.

The source flows for the MBMS FEC scheme are UDP flows including RTP, RTCP, SRTP and MIKEY packets. The payload of such UDP packets constitute an Application Data Unit (ADU) as defined in RFC 6363 [107]. The source data flow with which the ADUs are associated is the UDP flow identity of the corresponding UDP flow.

A UE that supports MBMS User Services shall support a decoder for the "MBMS FEC scheme". The use of MBMS FEC by the sender is recommended, but it is permitted not to use it. In the case where the FEC is not used by the sender, the FEC Layer should not be used (i.e. RTP is mapped onto UDP directly).

The mechanism does not place any restrictions on the source data which can be protected together, except that the source data is carried over UDP. The data may be from several different UDP flows that are protected jointly.

A UE supporting the streaming delivery method shall support the packet format for FEC packets.

If any FEC source packets have been lost, but sufficient FEC source and FEC repair packets have been received, FEC decoding can be performed to recover the FEC source block. The original packets UDP payload and UDP flow identity can then be extracted from the source block and provided to the upper layer. If not enough FEC source and repair packets were received, only the original packets that were received as FEC source packets will be available. The rest of the original packets are lost.

If a UE that supports MBMS User Services receives a mathematically sufficient set of encoding symbols generated according to the encoder specification in RFC 5053 [91], section 5.3, for reconstruction of a source block, then the decoder shall recover the entire source block. Note that the example decoder described in [91] section 5.5 fulfils this requirement.

Note that the receiver must be able to buffer all the original packets and allow time for the FEC repair packets to arrive and FEC decoding to be performed before media playback begins. The min-buffer-time parameter specified in clause 8.3.1.8 helps the receiver to determine a sufficient duration for initial start-up delay.

The protocol architecture is illustrated in figure 11.

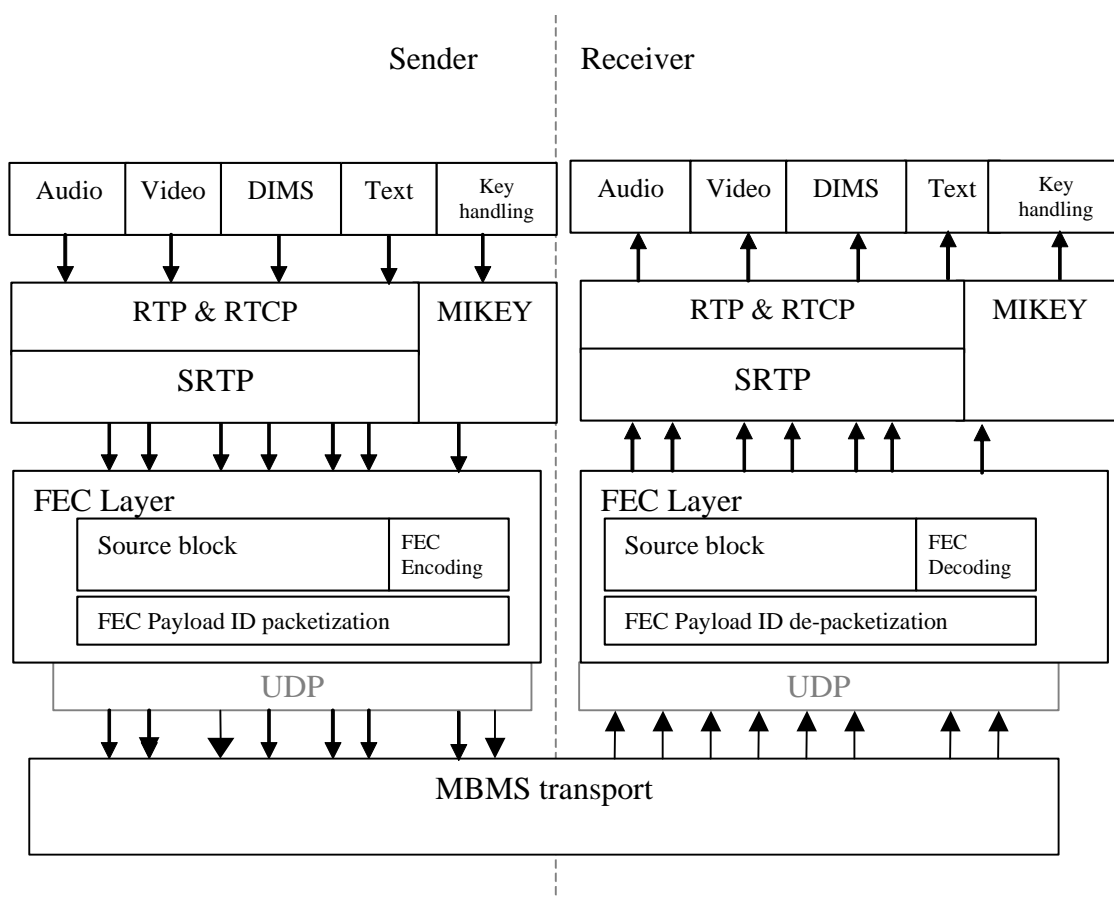


Figure 11: FEC mechanism for the streaming delivery method interaction diagram

Figure 11 depicts how one or more out of several possible packet flows of different types (Audio, video, text RTP and RTCP flows, MIKEY flow) are sent to the FEC layer for protection. The source packets are modified to carry the FEC payload ID and a new flow with repair data is generated. The receiver takes the source and repair packets and buffers them to perform, if necessary, the FEC decoding. After appropriate buffering received and recovered source packets are forwarded to the higher layers. The arrows in the figure indicate distinct data flows.

8.2.2.1 Sending terminal operation (Informative)

It is assumed that the sender has constructed or received original data packets for the session. These may be RTP, RTCP, MIKEY or other UDP packets. The following procedures are based on the UDP payload and the identity of the UDP flow. The UDP payload constitutes an ADU according to RFC 6363 [107] and the identity of the UDP flow is the integer identifier associated with the identifier of the ADU flow.

In order to FEC protect a sequence of original data packets, the sender constructs a source block as specified in RFC 6681 [106], section 5 to which the FEC algorithm is to be applied, and includes the original source packet data within FEC source packets. The following operations describe a possible way to generate compliant FEC source packet and FEC repair packet streams:

1. Each original packet is placed in the source block. In doing so, the Source FEC Payload ID information to be included in the FEC payload ID of the FEC source packet can be determined. In the source block the identity of the packet's flow is marked using the Flow ID. See RFC 6681 [106], section 5 for details.
2. The FEC source packet is constructed according to clause 8.2.2.4. The identity of the original flow is maintained by the source packet through the use of the destination UDP port number and destination IP address, which has been advertised (for example using SDP), as carrying FEC source packets generated from an original stream of a particular protocol (e.g. RTP, RTCP, SRTP, MIKEY etc.). See clause 8.2.2.13.
3. The generated FEC source packet is sent using UDP.

When a source block is complete, the FEC encoder generates encoding symbols and places these symbols into FEC repair packets, to be conveyed to the receivers. These repair packets are sent using normal UDP procedures to a unique destination port to separate it from any of the source packet flows.

In particular cases it may be advantageous not to use FEC for some source blocks and to signal this to the receiver. In this case the sender may send one or more empty repair packets consisting exclusively of the Repair FEC Payload ID. This will be helpful in particular for selective FEC where some of the source blocks (e.g. consisting of reference video frames) are FEC protected while others (e.g. consisting exclusively of non-reference frames) will not be protected.

8.2.2.2 Receiving terminal operation (Informative)

The following describes a possible receiver algorithm, when receiving an FEC source or repair packet:

1. If a FEC source packet is received (as indicated by the UDP port on which it was received):
 - a. The original source packet is reconstructed by removing the Source FEC Payload ID. The resulting packet is buffered to allow time for the FEC repair.
 - b. The resulting packet is placed into the source block according to the information in the Source FEC Payload ID and the source block format described in RFC 6681 [106], section 5. The UDP port the packet was received on is used to determine the Flow ID written into the source block.
2. If an FEC repair packet is received (as indicated by the UDP port), the contained encoding symbols are placed into an FEC encoding block according to the Repair FEC Payload ID. In case the received FEC repair packet is empty, there are no repair symbols to be placed in the FEC encoding block.
3. If at least one source packet is missing, then FEC decoding may be desirable. The FEC decoder determines if the encoding block constructed in steps 1 and 2 contains enough symbols from the source and repair packets for decoding and, if so, performs the decoding operation. If only empty FEC repair packets are received, the receiver may start immediately some procedures to conceal the effect of missing media data.
4. Any missing source packets that were reconstructed during the decoding operation are then buffered as normal received packets (see step 1a above).

Note that the above procedure may result in that not all original packets are recovered, and they must simply be marked as being lost.

Obviously, buffering and packet re-ordering are required to insert any reconstructed packets in the appropriate place in the packet sequence if that is necessary according to the used higher layer protocol (RTP, RTCP or MIKEY). To allow receivers to determine the minimal start-up buffering requirement for FEC decoding, the min-buffer-time parameter

indicates a minimum initial buffering time that is sufficient regardless of the position of the stream in which the reception starts.

8.2.2.3 (Void)

8.2.2.4 Packet format for FEC source packets

The packet format for FEC source packets as defined in RFC 6363 [107], section 5.3, shall be used to encapsulate an original UDP packet.

The destination IP address and UDP port shall be set as indicated in the session control signalling. This ensures that the receiver can determine which protocols and FEC Payload ID formats are used for this flow. The remaining fields in the IP and UDP headers shall be set according to their specifications.

The Source FEC Payload ID shall be constructed according to RFC 6681 [106], section 6.2.2.

The FEC Source packets over IP and UDP are indicated to be used for a flow by using one of the SDP protocol identifiers "UDP/MBMS-FEC/RTP/AVP", "UDP/MBMS-FEC/RTP/SAVP" depending on the upper layer protocol RTP/AVP or RTP/SAVP respectively. If MIKEY is FEC protected and encapsulated in source packets, then it is indicated in the security description using the *fecProtection* element and the destination IP address.

8.2.2.5 Packet format for FEC repair packets

The packet format for FEC repair packets as defined in RFC 6363 [107], section 5.4 shall be used for repair packets.

The UDP payload consists of the Repair FEC Payload ID, and zero, one or more repair symbols. The format of the Repair FEC payload ID is defined in RFC 6681 [106], section 6.2.3.

The repair packet sent over IP and UDP is indicated in the SDP using the protocol identifier "UDP/MBMS-REPAIR".

8.2.2.6 Void

8.2.2.7 FEC block Construction algorithm and example (informative)

This section provides an example how to use the methods in RFC 6363 [107] and RFC 6681 [106] to generate a source block.

When the original UDP packet is placed into the source block, the value of the UDP flow identifier, *F*, followed by the value of the UDP payload length, *L*, are first written as a single byte and two-byte value in network byte order (i.e. with high order byte first) respectively into the first available bytes in the source block, followed by the UDP packet payload itself (i.e. not including the IP/UDP headers). Following this, if the next available byte is not the first byte of a new symbol, then padding bytes up to the next symbol boundary shall be included using the value 0 in each byte. As long as any source UDP packets remain to be placed, the procedure is repeated starting each UDP flow identifier at the start of the next encoding symbol.

An example of forming a source block is given in figure 14 below. In this example, three UDP packets of lengths 26, 52 and 103 bytes have been placed into a source block with symbol size $T = 16$ bytes. The first two packets are from UDP flow 0 and the third from UDP flow 1. Each entry in figure 14 is a byte and the rows correspond to the source symbols and are numbered from 0 to 12. $B_{i,j}$ denotes the $(j+1)$ th byte of the $(i+1)$ th UDP packet.

0	26			B0,0	B0,1	B0,2	B0,3	B0,4	B0,5	B0,6	B0,7	B0,8	B0,9	B0,10	B0,11	B0,12
B0,13	B0,14	B0,15	B0,16	B0,17	B0,18	B0,19	B0,20	B0,21	B0,22	B0,23	B0,24	B0,25	0	0	0	0
0	52			B1,0	B1,1	B1,2	B1,3	B1,4	B1,5	B1,6	B1,7	B1,8	B1,9	B1,10	B1,11	B1,12
B1,13	B1,14	B1,15	B1,16	B1,17	B1,18	B1,19	B1,20	B1,21	B1,22	B1,23	B1,24	B1,25	B1,26	B1,27	B1,28	B1,29
B1,29	B1,30	B1,31	B1,32	B1,33	B1,34	B1,35	B1,36	B1,37	B1,38	B1,39	B1,40	B1,41	B1,42	B1,43	B1,44	B1,45
B1,45	B1,46	B1,47	B1,48	B1,49	B1,50	B1,51	0	0	0	0	0	0	0	0	0	0
1	103			B2,0	B2,1	B2,2	B2,3	B2,4	B2,5	B2,6	B2,7	B2,8	B2,9	B2,10	B2,11	B2,12
B2,13	B2,14	B2,15	B2,16	B2,17	B2,18	B2,19	B2,20	B2,21	B2,22	B2,23	B2,24	B2,25	B2,26	B2,27	B2,28	B2,29
B2,29	B2,30	B2,31	B2,32	B2,33	B2,34	B2,35	B2,36	B2,37	B2,38	B2,39	B2,40	B2,41	B2,42	B2,43	B2,44	B2,45
B2,45	B2,46	B2,47	B2,48	B2,49	B2,50	B2,51	B2,52	B2,53	B2,54	B2,55	B2,56	B2,57	B2,58	B2,59	B2,60	B2,61
B2,61	B2,62	B2,63	B2,64	B2,65	B2,66	B2,67	B2,68	B2,69	B2,70	B2,71	B2,72	B2,73	B2,74	B2,75	B2,76	B2,77
B2,77	B2,78	B2,79	B2,80	B2,81	B2,82	B2,83	B2,84	B2,85	B2,86	B2,87	B2,88	B2,89	B2,90	B2,91	B2,92	B2,93
B2,93	B2,94	B2,95	B2,96	B2,97	B2,98	B2,99	B2,100	B2,101	B2,102	0	0	0	0	0	0	0

Figure 14: Source block consisting of 3 source UDP packets of lengths 26, 52 and 103 bytes.

8.2.2.8 Void

8.2.2.9 Source FEC Payload ID

The Source FEC payload ID shall be the Source FEC Payload ID format A in section 6.2.2 of RFC 6681 [106].

8.2.2.10 Repair FEC payload ID

The Repair FEC Payload ID shall be the Repair FEC Payload ID format A in section 6.2.3 of RFC 6681 [106].

8.2.2.10a FEC Object Transmission information

The FEC Object Transmission information consists of:

- the maximum source block length, in symbols
- the symbol size, in bytes

The FEC Object Transmission information shall be the first four octets of the FEC Scheme Specific Information in section 6.2.1.2 of RFC 6681 [106].

NOTE: This corresponds to Payload ID Format A in RFC 6681 [106] as the last octet of FEC Scheme Specific Information is omitted.

The Source Block Length signalled within the Repair FEC Payload ID of any packet of a stream shall not exceed the Maximum Source Block Length signalled within the FEC Object Transmission Information for the stream.

The FEC Object Transmission Information shall be communicated as described in clause 8.2.2.14.

NOTE: The FEC Object Transmission Information is only communicated in SDP.

8.2.2.11 Hypothetical FEC Decoder

This clause specifies the hypothetical FEC decoder and its use to check packet stream and MBMS receiver conformance.

The hypothetical FEC decoder uses the packet stream, the transmission time of each packet, the initial buffering delay, and the SDP for the stream as inputs. The packet stream from the beginning of the FEC source block until the end of the stream shall comply with the hypothetical reference decoder as specified below when the initial buffer delay equals to the value of the min-buffer-time parameter.

The maximum hypothetical FEC decoding buffer size for MBMS streaming is 1 Mbytes. The default hypothetical FEC decoding buffer size is equal to 1 MByte.

For the packet stream, the buffer occupancy level of the hypothetical FEC decoding buffer shall not exceed the value of the *buf-size* parameter, when it is present in the SDP, or the default FEC decoding buffer size, when the *buf-size*

parameter is not present in the SDP. The output of the hypothetical FEC decoder shall comply with the RTP payload and decoding specifications of the media format.

The hypothetical FEC decoder operates as follows:

- 1) The hypothetical FEC decoding buffer is initially empty.
- 2) Each FEC source packet and FEC repair packet, starting from the first packet in transmission order, is inserted into a FEC source block at its transmission time. The FEC source block generation is done as specified in RFC 6681 [106], section 6.2.3. The FEC source block resides in the hypothetical FEC decoding buffer.
- 3) When both the last FEC source packet and the last FEC repair packet of an FEC source block are transmitted, any elements of the FEC source block that are not original UDP packets (e.g. FEC repair packets and potential padding bytes) are removed from the hypothetical FEC decoding buffer.
- 4) Original UDP packets are not removed from the hypothetical FEC decoding buffer before the signalled initial buffering delay has expired. Then, the first original UDP packet in sequence number order is output and removed from the hypothetical FEC decoding buffer immediately. Each succeeding original UDP packet is output and removed when the following conditions are true:
 - i. The following time (in seconds) since the removal of the previous packet has elapsed:

$$8 \times (\text{size of the previous original UDP packet including UDP/IP header in bytes}) / (1\,000 \times (\text{value of "b=AS" SDP attribute for the stream}))$$
 - ii. All the packets in the same FEC source block as the original UDP packet have been transmitted.

An MBMS Client shall be capable of receiving a packet stream that complies with the hypothetical FEC decoder. Furthermore, in the case of RTP packets, when an MBMS Client complies with the requirements for the media decoding of the packet stream, it shall be able to de-packetize and decode the packet stream and output decoded data at the correct rate specified by the RTP timestamps of the received packet stream.

8.2.2.12 Void

8.2.2.13 Signalling

The signalling for streaming FEC consists of several components:

- If several user services are bundled together they are indicated as a sequence of services in the User Service Bundle Description. See clause 11.2.
- A separate SDP describing the FEC repair stream and all the flow IDs referenced from the User Service Bundle Description. See clauses 11.2 and 8.2.2.14.
- SDP protocol identifiers and attributes to indicate the usage of the source packet format, how the FEC payload ID is configured and other FEC parameters such as minimal buffering delay, for the RTP/RTCP streams. See clause 8.2.2.13a.
- Security description extensions to indicate usage of FEC source packet format, and the FEC parameters. See clauses 11.3 and 8.2.2.13a.

The User Service Description contains either a single service or several bundled services. All of the streaming delivery methods and security descriptions that are present within the *bundleDescription* element must be considered when configuring the FEC operations. This includes RTP, RTCP and MIKEY flows. A receiver intending to perform FEC decoding to cover for packet losses shall receive all the flows that are indicated to be sent as FEC source packets, even if the flows are in a service currently not played out. A receiver intending to use FEC shall also receive the FEC repair stream as described by the FEC Repair Stream Description. The delivery method's session description, and the security description both carry the FEC source packet configuration information: FEC encoding ID, FEC instance ID, and FEC OTI information. The FEC repair packet stream is configured using the similar methods as for the source packets, with the addition of the Flow ID information and buffer delay parameter.

8.2.2.13a SDP for FEC source packet streams

To indicate the presence of the FEC layer between IP/UDP and, RTP or SRTP an SDP protocol identifier is used. Instead of the normal RTP/AVP and RTP/SAVP protocol identifiers, 'UDP/MBMS-FEC/RTP/AVP' and 'UDP/MBMS-FEC/RTP/SAVP' are defined respectively. Both these protocol identifiers shall use the FMT space rules that are used for RTP/AVP and RTP/SAVP respectively, i.e. payload types used in the RTP session is listed. The protocol identifiers are defined in clause C.1.

The FEC parameters, FEC encoding ID, FEC instance ID and FEC-OTI-Extension information are signalled using the mechanism defined in clause 8.3.1.8. The "a=FEC" SDP attribute shall be used to indicate the single definition that is used for each media component.

For MIKEY messages the Security Description is used to indicate when FEC source packet shall be used, see clause 11.3. The FEC parameter used is also defined in the Security Description. As all MIKEY packets from all user services arrive on the same port, the receiver must use the destination address to separate FEC protected packets from not FEC protected packets. This requires that all MIKEY packets sent to a specific destination address are either FEC protected or not. Note that it is not possible to mix protected and non-protected packets within a single stream as there is no mechanism to determine whether they are protected or not.

8.2.2.14 SDP for FEC repair packet streams

The repair packet stream is indicated in SDP using a media block with the protocol identifier "UDP/MBMS-REPAIR". The media type shall be "application". The FEC parameters, FEC encoding ID, FEC instance ID, FEC-OTI-Extension information and repair parameters (min-buffer-time) are signalled using the mechanisms defined in clause 8.3.1.9. Each media component shall reference only one FEC declaration.

The mapping of the FEC source block flow ID to the destination IP address and UDP port are done using the SDP attribute "a=mbms-flowid" defined in clause 8.3.1.9.

Interleaving may be signalled using the "X-3gpp-FEC-Interleaving" attribute, which also gives the arrangement of the flows in the source block and by consequence their transmission order. The "X-3gpp-FEC-Interleaving" attribute is defined in clause 8.3.1.11.

8.2.2.15 Signalling example for FEC

This clause contains a complete signalling example for an MBMS multicast mode session using FEC with a Service description, an SDP for the streaming delivery method, an SDP for the FEC repair stream, and a security description.

The following is an example *bundleDescription*.

```
<?xml version="1.0" encoding="UTF-8"?>
<bundleDescription
  xmlns="urn:3GPP:metadata:2005:MBMS:userServiceDescription"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:sv="urn:3gpp:metadata:2009:MBMS:schemaVersion"
  xsi:schemaLocation="urn:3GPP:metadata:2005:MBMS:userServiceDescription USD-schema-main.xsd"
  fecDescriptionURI="http://www.example.com/3gpp/mbms/session1-fec.sdp">
  <userServiceDescription
    serviceId="urn:3gpp:0010120123hotdog">
    <deliveryMethod
      sessionDescriptionURI="http://www.example.com/3gpp/mbms/session1.sdp"
      protectionDescriptionURI="http://www.example.com/3gpp/mbms/sec-descript">
      <sv:delimiter>0</sv:delimiter>
    </deliveryMethod>
    <sv:delimiter>0</sv:delimiter>
  </userServiceDescription>
  <sv:schemaVersion>1</sv:schemaVersion>
</bundleDescription>
```

The security description has the URI: <http://www.example.com/3gpp/mbms/sec-descript>

```
<?xml version="1.0" encoding="UTF-8"?>
<securityDescription
  xmlns="urn:3GPP:metadata:2005:MBMS:securityDescription"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="urn:3GPP:metadata:2005:MBMS:securityDescription security.xsd">
  <keyManagement
```

```

offsetTime="5"
randomTimePeriod="10">
<serverURI>http://register.example.com/</serverURI>
<serverURI>http://register2.example.com/</serverURI>
</keyManagement>
<keyId>
<mediaFlow flowID="FF1E:03AD::7F2E:172A:1E24/4002">
  <MSK>
    <keyDomainID>aMoM</keyDomainID>
    <MSKID>aMoAAA==</MSKID>
  </MSK>
</mediaFlow>
<mediaFlow flowID="FF1E:03AD::7F2E:172A:1E24/4004">
  <MSK>
    <keyDomainID>GM8M</keyDomainID>
    <MSKID>aMkAAA==</MSKID>
  </MSK>
</mediaFlow>
</keyId>
<fecProtection fecEncodingId="1" fecOtiExtension="ACAEAA==" />
</securityDescription>

```

An example of how the SDP <http://www.example.com/3gpp/mbms/session1.sdp> could look for a session containing two media streams that are FEC protected. In this example we have assumed an audiovisual stream, using 56 kbps for video and 12 kbps for audio. In addition another 300 bit/second of RTCP packets from the source is used for the each of the sessions. Hence, the total media session bandwidth is $56+12+0.3+0.3 = 68.6$ kbps.

```

v=0
o=ghost 2890844526 2890842807 IN IP6 2001:210:1:2:240:96FF:FE25:8EC9
s=3GPP MBMS Streaming SDP Example
i=Example of MBMS streaming SDP file
u=http://www.infoserver.example.com/ae600
e=ghost@mailserver.example.com
c=IN IP6 FF1E:03AD::7F2E:172A:1E24
t=3034423619 3042462419
b=AS:62
b=TIAS: 60500
a=maxprate: 25
a=source-filter: incl IN IP6 * 2001:210:1:2:240:96FF:FE25:8EC9
a=FEC-declaration:0 encoding-id=1
m=video 4002 UDP/MBMS-FEC/RTP/AVP 96
b=TIAS:55000
b=RR:0
b=RS:300
a=rtpmap:96 H263-2000/90000
a=fmtp:96 profile=3;level=10
a=framesize:96 176-144
a=FEC:0
a=maxprate:15
m=audio 4004 UDP/MBMS-FEC/RTP/AVP 98
b=TIAS: 11500
b=RR:0
b=RS:300
a=rtpmap:98 AMR/8000
a=fmtp:98 octet-align=1
a=FEC:0
a=maxprate:10

```

The FEC stream used to protect the above RTP sessions and a MIKEY key stream has the below SDP (<http://www.example.com/3gpp/mbms/session1-fec.sdp>):

```

v=0
o=ghost 2890844526 2890842807 IN IP6 2001:210:1:2:240:96FF:FE25:8EC9
s=3GPP MBMS Streaming FEC SDP Example
i=Example of MBMS streaming SDP file
u=http://www.infoserver.example.com/ae600
e=ghost@mailserver.example.com
c=IN IP6 FF1E:03AD::7F2E:172A:1E24
t=3034423619 3042462419
b=AS:15
a=FEC-declaration:0 encoding-id=1
a=FEC-OTI-extension:0 ACAEAA==
a=mbms-repair: 0 min-buffer-time=2600
a=source-filter: incl IN IP6 * 2001:210:1:2:240:96FF:FE25:8EC9
m=application 4006 UDP/MBMS-REPAIR *
b=AS:15

```

```

a=FEC:0
a=mbms-flowid: 1=FF1E:03AD::7F2E:172A:1E24/4002, 2=FF1E:03AD::7F2E:172A:1E24/4003,
3=FF1E:03AD::7F2E:172A:1E24/4004, 4=FF1E:03AD::7F2E:172A:1E24/4005, 5=FF1E:03AD::7F2E:172A:1E24/2269
a=X-3gpp-FEC-Interleaving: 1="reverse", 2="ordered"

```

A more traditional FEC configuration is shown below. The audio and video media components use different FEC repair flows. The same principle can also be applied when bundling several user services together.

```

<?xml version="1.0" encoding="UTF-8"?>
<bundleDescription
  xmlns="urn:3GPP:metadata:2005:MBMS:userServiceDescription"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:sv="urn:3gpp:metadata:2009:MBMS:schemaVersion"
  xsi:schemaLocation="urn:3GPP:metadata:2005:MBMS:userServiceDescription USD-schema-main.xsd"
  fecDescriptionURI="http://www.example.com/3gpp/mbms/session2-fec.sdp">
  <userServiceDescription
    serviceId="urn:3gpp:0010120123hotdog">
    <deliveryMethod
      sessionDescriptionURI="http://www.example.com/3gpp/mbms/session2.sdp">
      <sv:delimiter>0</sv:delimiter>
    </deliveryMethod>
    <sv:delimiter>0</sv:delimiter>
  </userServiceDescription>
</sv:schemaVersion>1</sv:schemaVersion>
</bundleDescription>

```

The SDP file from above is modified to use two different FEC flows.

```

v=0
o=ghost 2890844526 2890842807 IN IP6 2001:210:1:2:240:96FF:FE25:8EC9
s=3GPP MBMS Streaming SDP Example
i=Example of MBMS streaming SDP file
u=http://www.infoserver.example.com/ae600
e=ghost@mailserver.example.com
c=IN IP6 FF1E:03AD::7F2E:172A:1E24
t=3034423619 3042462419
b=AS:62
b=TIAS: 60500
a=maxprate: 25
a=source-filter: incl IN IP6 * 2001:210:1:2:240:96FF:FE25:8EC9
m=video 4002 UDP/MBMS-FEC/RTP/AVP 96
b=TIAS:55000
b=RR:0
b=RS:300
a=FEC-declaration:0 encoding-id=1
a=rtpmap:96 H263-2000/90000
a=fmtp:96 profile=3;level=10
a=framesize:96 176-144
a=FEC:0
a=maxprate:15
m=audio 4004 UDP/MBMS-FEC/RTP/AVP 98
b=TIAS: 11500
b=RR:0
b=RS:300
a=FEC-declaration:1 encoding-id=1
a=rtpmap:98 AMR/8000
a=fmtp:98 octet-align=1
a=FEC:1
a=maxprate:10

```

The SDP file for the two FEC streams

```

v=0
o=ghost 2890844526 2890842807 IN IP6 2001:210:1:2:240:96FF:FE25:8EC9
s=3GPP MBMS Streaming FEC SDP Example
i=Example of MBMS streaming SDP file
u=http://www.infoserver.example.com/ae600
e=ghost@mailserver.example.com
t=3034423619 3042462419
b=AS:15
a=source-filter: incl IN IP6 * 2001:210:1:2:240:96FF:FE25:8EC9
m=application 4006 UDP/MBMS-REPAIR *
c=IN IP6 FF1E:03AD::7F2E:172A:1E24
b=AS:15
a=FEC-declaration:0 encoding-id=1
a=FEC-OTI-extension:0 ACAEAA==
a=mbms-repair: 0 min-buffer-time=2600

```

```

a=FEC:0
a=mbms-flowid: 1=FF1E:03AD::7F2E:172A:1E24/4002, 2=FF1E:03AD::7F2E:172A:1E24/4003
m=application 4008 UDP/MBMS-REPAIR *
c=IN IP6 FF1E:03AD::7F2E:172A:1E24
b=AS:15
a=FEC-declaration:1 encoding-id=1
a=FEC-OTI-extension:1 ACAEAA==
a=mbms-repair: 1 min-buffer-time=2600
a=FEC:1
a=mbms-flowid: 3=FF1E:03AD::7F2E:172A:1E24/4004, 4=FF1E:03AD::7F2E:172A:1E24/4005

```

8.2.3 General RTP header extension mechanism

8.2.3.1 Introduction

The general RTP header extension mechanism specified in RFC 5285 [92] is a general mechanism to use the header extension feature of RTP (the Real-Time Transport Protocol). The general RTP header extension mechanism should be supported.

8.2.3.2 Timestamp offset

Timestamp offsets for RTP may be transmitted using the general RTP header extension mechanism.

The variable timestamp extension element is 32 bits long. The first byte is the extension element header, i.e. the *ID* and *len* fields, as defined in RFC 5285 [92]. The remaining 3 bytes are the *timestamp-offset* measured in the same frequency as the RTP timestamp.

Timestamp-offset: A 24-bit unsigned integer signalling the offset of the received packets of the same media in the tune-in FEC block. The timestamp offset indicates at most the difference between the RTP timestamp of the current packet and the highest RTP timestamp of packets of the same media stream that are transmitted in the current FEC source block.

Timestamp offset shall not be used if FEC protection and Interleaving are not being used.

The following example is a general RTP header extension block containing a single variable timestamp extension element.

0								1								2								3							
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
0xBEDE								length=1																							
ID		len=2		timestamp-offset																											

The presence of variable timestamps is signalled in the SDP file using the header extension specification and the URI "http://www.3gpp.org/2008/TimeStampOffset". The URI signals the possible presence of timestamp offsets with the given ID.

8.3 Session description

SDP is provided to the MBMS Client via a discovery/announcement procedure to describe the MBMS streaming session. The SDP describes one or more RTP sessions part of the MBMS streaming session. The SDP shall be a correctly formed SDP according to RFC 4566 [14].

8.3.1 SDP Parameters for MBMS streaming session

The semantics of a Session Description of an MBMS streaming session shall include the parameters:

- The sender IP address.
- The number of media in the session.

- The destination IP address and port number for each and all of the RTP sessions in the MBMS streaming session.
- The start time and end time of the session.
- The protocol ID (i.e. RTP/AVP).
- Media type(s) and fmt-list.
- Data rate using existing SDP bandwidth modifiers.
- Mode of MBMS bearer per media.
- FEC configuration and related parameters.
- Service-language(s) per media.
- QoE Metrics (defined in clauses 8.3.2.1 and 8.4).

8.3.1.1 Sender IP address

There shall be exactly one IP source address per media description within the SDP. The IP source address shall be defined according to the *source-filter* attribute ("a=source-filter:") specified in RFC 4570 [15] for both IPv4 and IPv6 sources, with the following exceptions:

1. Exactly one source address may be specified by this attribute such that exclusive-mode shall not be used and inclusive-mode shall use exactly one source address in the <src-list>.
2. There shall be exactly one source-filter attribute per complete MBMS streaming session SDP description, and this shall be in the session part of the session description (i.e. not per media).
3. The * value shall be used for the <dest-address> subfield.

8.3.1.2 Destination IP address and port number for channels

Each RTP session part of a MBMS streaming session is defined by two parameters:

- IP destination address.
- Destination port number(s).

The IP destination address shall be defined according to the "connection data" field ("c=") of RFC 4566 [14]. The destination port number shall be defined according to the <port> sub-field of the media announcement field ("m=") of [14]. Multiple ports using "/" notation shall not be used. The RTCP port, if used, shall be RTP port +1.

8.3.1.3 Media description

The media description line shall be used as defined in RFC 4566 [14] for RTP. The <media> part indicates the type of media, audio, video, or text. The usage of RTP and any applicable RTP profile shall be indicated by using the <proto> field of the 'm-line'. The one or more payload types that are being used in this RTP session are enumerated in the <fmt> part. Each payload type is declared using the "a=rtpmap" attribute according to [14] and use the "a=fmtp" line when required to describe the payload format parameters.

8.3.1.4 Session timing parameters

A MBMS streaming session start and end times shall be defined according to the SDP timing field ("t=") specified in RFC 4566 [14].

8.3.1.5 Mode of MBMS bearer per media

The MBMS bearer mode declaration attribute shall be used for MBMS streaming sessions, as defined in clause 7.3.2.7.

8.3.1.6 Service language(s) per media

The existing SDP attribute "a=lang" is used to label the language of any language-specific media. The values are taken from RFC 4646 [73] which in turn takes language and (optionally) country tags from ISO 639 [74] and ISO 3166 [75] (e.g. "a=lang:EN-US"). These are the same tags used in the User Service Description XML.

8.3.1.7 Bandwidth specification

The bit-rate required by the MBMS streaming session and its media components shall be specified using both the "AS" bandwidth modifier and the "TIAS" bandwidth modifier combined with "a=maxprate" [38] on media level in the SDP. On session level the "TIAS" bandwidth modifier combined with "a=maxprate" may be used, where the session level expresses the aggregated peak bit-rate, which may be lower than the sum of the individual media streams.

The bandwidth required for RTCP is specified by the "RR" and "RS" bandwidth modifiers (TS 26.244 [32]) on media level for each RTP session. The "RR" modifier shall be included and set to 0 to specify that RTCP receiver reports are not used. The bandwidth used for RTCP sender reports shall be specified using the "RS" bandwidth modifier.

8.3.1.8 FEC parameters

The FEC encoding ID and instance ID are provided using the "a=FEC-declaration" attribute defined in clause 7.3.2.8. Any OTI information for that FEC encoding ID and instance ID is provided with below defined FEC OTI attribute.

The FEC OTI attribute must be immediately preceded by the "a=FEC-declaration" attribute (and so can be session-level and media-level). The *fec-ref* maps the *oti-extension* to the FEC-declaration OTI it extends. The purpose of the *oti-extension* is to define FEC code specific OTI required for RTP receiver FEC payload configuration; exact contents are FEC code specific and need to be specified by each FEC code using this attribute. The OTI for the MBMS FEC Scheme is defined in clause 8.2.2.10a.

The syntax for the attributes in ABNF [23] is:

- sdp-fec-oti-extension-line = "a=FEC-OTI-extension:" fec-ref SP oti-extension CRLF
- fec-ref = 1*3DIGIT (the SDP-internal identifier for the associated FEC-declaration).
- oti-extension = base64
- base64= *base64-unit [base64-pad]
- base64-unit = 4base64-char
- base64-pad = 2base64-char "==" / 3base64-char "="
- base64-char = ALPHA / DIGIT / "+" / "/"

To provide the FEC repair packets with additional, non FEC specific parameters, a session and media level SDP attribute is defined.

- sdp-fec-parameter-line = "a=mbms-repair: 0*1SP fec-ref SP parameter-list CRLF
- parameter-list = parameter-spec *(1*SP parameter-spec)
- parameter-spec = name "=" value;
- name = 1*(ALPHA / DIGIT / "-")
- value = 1*(safe) ; safe defined in RFC 4566 [14]

Currently one FEC non code-specific parameter is defined:

min-buffer-time: This FEC buffering parameter specifies the minimum receiver buffer time (delay) needed to ensure that FEC repair has time to happen regardless of the FEC source block of the stream from which the reception starts. The value is in milliseconds and represents the wallclock time between the reception of the first FEC source or repair packet of a FEC source block, whichever is earlier in transmission order, and the wallclock time when media decoding can safely start.

The parameters name and value is defined in ABNF as follows:

Min-buffer-time-parameter-name = "min-buffer-time"

Min-buffer-time-parameter-value = 1*8DIGIT ;Wallclock time in milliseconds.

The FEC declaration and FEC OTI information utilized in a specific source or repair packet is indicated using the FEC-ref number in the a=fec lines as described in clauses 8.2.2.12 and 8.2.2.13.

8.3.1.9 FEC Flow ID attribute

To indicate the mapping between destination IP address and UDP port number and FEC source block flow IDs, the "a=mbms-flowid" SDP attribute is defined. Each flowID that is used to construct a source block within the bundled sessions shall be included. It is a media level attribute that shall be present in any SDP media block using the "UDP/MBMS-REPAIR" protocol identifier.

The syntax for the attributes in ABNF [23] is:

Sdp-mbms-flowid-attr = "a=mbms-flowid:" *WSP flow-id-spec *(", " *WSP flow-id-spec) CRLF

flow-id-spec = flowID "=" address-spec "/" port-spec

address-spec = IP4-multicast / IP6-multicast

IP4-multicast = m1 3*("." decimal-uchar)

m1 = ("22" ("4"/"5"/"6"/"7"/"8"/"9")) / ("23" DIGIT)

IP6-multicast = hexpart

hexpart = hexseq / hexseq "::" [hexseq] / "::" [hexseq]

hexseq = hex4 *(":" hex4)

hex4 = 1*4HEXDIG

port-spec = 1*5DIGIT

8.3.1.10 Buffer requirement signaling

Due to the variable bitrate nature of some media streams (especially video streams), initial buffering at the receiver becomes necessary to smooth out those variations. The initial buffering delay should be signaled to the receiver in the SDP using the following media level attribute:

- "a=X-initpredecbufperiod:<initial pre-decoder buffering period>"

For H.264 video streams, the *X-initpredecbufperiod* (see TS 26.234 [47]) indicates the nominal removal time of the first access unit from the coded picture buffer (CPB).

For H.265 (HEVC) video streams, the *X-initpredecbufperiod* (see [47]) indicates the nominal removal time of the first decoding unit from the coded picture buffer (CPB).

Note that *X-initpredecbufperiod* is expressed as clock ticks of a 90-kHz clock. Hence, conversion may be required if the RTP timestamp clock frequency is not 90 kHz.

8.3.1.11 Interleaving signaling

When interleaving is used in combination with FEC protection of an MBMS service, the BM-SC may indicate to receivers the order of transmission of the media units of a source block using the *X-3gpp-FEC-Interleaving* attribute. It also indicates whether intra-stream interleaving (described in section G.1) has been performed or not for each of the flows in the FEC source block.

The "*X-3gpp-FEC-Interleaving*" attribute is defined as follows:

- Interleaving="X-3gpp-FEC-Interleaving:" SP flow_interleaving *(", " flow_interleaving) CRLF

- flow_interleaving=flowID "=" ["ordered" / "mixed" / "reverse"]

flowID is the identification of the flow as described in clause 8.3.1.9. The intra-stream interleaving modes may result in un-changed transmission order ("Ordered"), a mixed transmission order ("Mixed"), or a reversed transmission order ("Reverse"). For a flow that is not listed in the *X-3gpp-FEC-Interleaving* attribute, the receiver should assume that no particular intra- or inter-stream interleaving has been performed. The transmission order does not preclude that some media units of a lower priority stream are interleaved with the media units of higher priority stream.

8.3.2 SDP example for streaming session

Here is a full example of SDP description describing the media streams part of a MBMS streaming session:

```
v=0
o=ghost 2890844526 2890842807 IN IP4 192.168.10.10
s=3GPP MBMS Streaming SDP Example
i=Example of MBMS streaming SDP file
u=http://www.infoserver.example.com/ae600
e=ghost@mailserver.example.com
c=IN IP6 FF1E:03AD::7F2E:172A:1E24
t=3034423619 3042462419
b=AS:77
a=mbms-mode:broadcast 123869108302929 1
a=source-filter: incl IN IP6 * 2001:210:1:2:240:96FF:FE25:8EC9
m=video 4002 RTP/AVP 96
b=TIAS:62000
b=RR:0
b=RS:600
a=maxprate:17
a=rtpmap:96 H264/90000
a=fmtp:96 profile-level-id=42A01E; packetization-mode=1; sprop-parameter-sets=Z0IACpZTBmI,aM1jiA==
m=audio 4004 RTP/AVP 98
b=TIAS:15120
b=RR:0
b=RS:600
a=maxprate:10
a=rtpmap:98 AMR/8000
a=fmtp:98 octet-align=1
```

FEC is not used in that example. See clause 8.2.2.15 for an example with FEC.

8.3.2.1 SDP description for QoE metrics

Similar to TS 26.234 [47], an SDP attribute for QoE, which can be used either at session or media level, is defined below in ABNF [23] based on RFC 4566 [14]:

- QoE-Metrics-line = "a" "=" "3GPP-QoE-Metrics:" att-measure-spec *("," att-measure-spec) CRLF
- att-measure-spec = Metrics ";" Sending-rate [";" Measure-Range
[";" Measure-Resolution] *("," Parameter-Ext)]
- Metrics = "metrics" "=" "{" Metrics-Name *("," Metrics-Name) "}"
- Metrics-Name = 1*((0x21..0x2b) / (0x2d..0x3a) / (0x3c..0x7a) / 0x7e) ; VCHAR except ";", ",", "{", "}"
- Sending-Rate = "rate" "=" 1 * DIGIT / "End" / "Periodic"
- Measure-Resolution = "resolution" "=" 1 * DIGIT ; in seconds
- Measure-Range = "range" ":" Ranges-Specifier
- Parameter-Ext = (1 * DIGIT ["." 1 * DIGIT]) / (1*((0x21..0x2b) / (0x2d..0x3a) / (0x3c..0x7a) / 0x7c / 0x7e))
- Ranges-Specifier = as defined in RFC 2326 [88].

An MBMS server uses this attribute to indicate that QoE metrics are supported and shall be used if also supported by the MBMS Client. When present at session level, it shall only contain metrics that apply to the complete session. When present at media level, it shall only contain metrics that are applicable to individual media.

The "Metrics" field contains the list of names that describes the metrics/measurements that are required to be reported in a MBMS session (see clause 8.4). The names that are not included in the "Metrics" field shall not be reported during the session. If a name included in any instances of "Metrics-Name" field is not recognized by the UE as a valid metric name as specified in table 8.4.2, the UE shall ignore this QoE metric reporting, but still report QoE metrics corresponding to recognized metric names in the other "Metrics-Name" instances. A UE of the current release may receive an SDP containing unrecognized QoE metric names, if a network supporting a future release of the specification includes one or more new QoE metrics names in the SDP.

In this version of the specification, the "Sending-Rate" shall be set to the value "End", which indicates that only one report is sent at the end of the MBMS session, or to the value "Periodic", which indicates that reports are sent at periodic time interval, as defined in clause 9.4.3. When there are multiple QoE-Metrics lines at the session and media levels, a single value shall be specified for 'Sending-Rate' across all those lines in the SDP. In other words, all QoE-Metrics lines will be set to either 'End' or 'Periodic'.

The optional "Measure-Resolution" field, if used, shall define a time over which each metrics value is calculated. The "Measure-Resolution" field splits the session duration into a number of equally sized periods where each period is of the length specified by the "Measure-Resolution" field. The "Measure-Resolution" field is thus defining the time before the calculation of a QoE parameter starts over. If the "Measure-Resolution" field is not present the metrics resolution shall cover the period specified by the "Measure-Range" field. If the "Measure-Range" field is not present the metrics resolution shall be the whole session duration.

The "Measure-Resolution" field shall take only one value for all session level metrics and only one value for all metrics associated to one media. Note that "Measure-Resolution" shall be evaluated according to a real-time clock. This implies that the real-time interval between consecutive measurements is not affected by changes in playback rate, for instance due to buffering.

The optional "Measure-Range" field, if used, shall define the time range in the stream for which the QoE metrics will be reported. There shall be only one range per measurement specification. The range format shall be any of the formats allowed by the media. If the "Measure-Range" field is not present, the corresponding (media or session level) range attribute in SDP shall be used. If SDP information is not present, the metrics range shall be the whole session duration.

8.3.2.2 OMA-DM configuration of QoE metrics

8.3.2.2.1 General

As a supplement to QoE provisioning per session (as specified in clause 8.3.2.1), OMA-DM can be used to specify QoE configuration. If such QoE configuration has been specified, it should be used by the terminal for all subsequent MBMS streaming or download sessions.

NOTE: The use of OMA-DM for configuring QoE reporting is applicable to either MBMS streaming or download sessions over which streaming services are delivered.

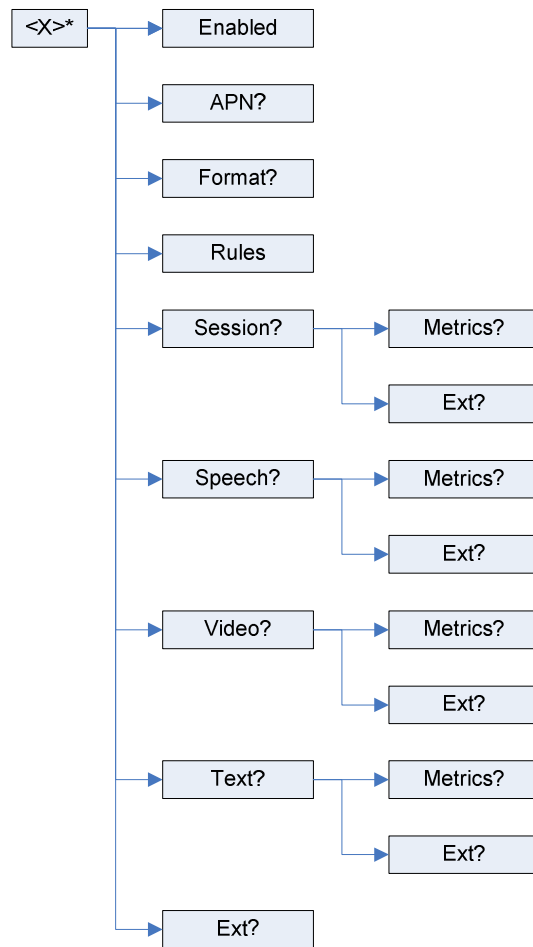
From the QoE reporting perspective, session-specific and OMA-DM provisioned QoE configuration shall be considered separate and independent processes. A UE shall consider both these types of reception reporting to be valid, if it receives QoE configuration parameters for both of them.

For OMA-DM QoE configuration the parameters are specified according to the following Managed Object (MO). Version numbering is included for possible extension of the MO.

The Management Object Identifier shall be: *urn:oma:mo:ext-3gpp-mbmsqoe:1.0*.

Protocol compatibility: The MO is compatible with OMA Device Management protocol specifications, version 1.2 and upwards, and is defined using the OMA DM Device Description Framework as described in the Enabler Release Definition OMA-ERELD-DM-V1_2 [94].

The following nodes and leaf objects shall be contained under the *3GPP_MBMSQOE* node if an MBMS Client supports the feature described in this clause (information of DDF for this MO is given in annex H):



8.3.2.2.2 Node: /<X>

This interior node specifies the unique object id of a MBMS QoE metrics management object. The purpose of this interior node is to group together the parameters of a single object.

- Occurrence: ZeroOrOne
- Format: node
- Minimum Access Types: Get

The following interior nodes shall be contained if the MBMS Client supports the "MBMS QoE metrics Management Object".

8.3.2.2.3 /<X>/Enabled

This leaf indicates if QoE reporting is requested by the provider.

- Occurrence: One
- Format: bool
- Minimum Access Types: Get

8.3.2.2.4 /<X>/APN

This leaf contains the Access Point Name that should be used for establishing the PDP context on which the QoE metric reports will be transmitted. This may be used to ensure that no costs are charged for QoE metrics reporting. If this leaf is not defined then any QoE reporting is done over the access point according to clause 11.2.1.1.

- Occurrence: ZeroOrOne
- Format: chr
- Minimum Access Types: Get
- Values: the Access Point Name

8.3.2.2.5 /<X>/Format

This leaf specifies the format of the report and if compression (Gzip XML) is used.

- Occurrence: ZeroOrOne
- Format: chr
- Minimum Access Types: Get
- Values: "XML", "GZIPXML".

8.3.2.2.6 /<X>/Rules

This leaf provides in XML format the rules used to decide if and how the reports are sent to the QoE metrics report server. The leaf also provides the URIs of one or more servers which shall be the receiver of the QoE metrics report. In case of multiple servers, the MBMS Client randomly selects one of the servers from the list, with uniform distribution.

The XML scheme is described in clause 9.5.1 and an example XML code is shown in clause 9.5.2. Only the *postReceptionReport* part needs to be specified. The use of OMA-DM based configuration of QoE reception reporting shall be independent of any such configuration specified by session-specific mechanisms such as SDP description or Associated Delivery Procedure Description. In other words, QoE reception reporting procedure by the UE as determined by parameters set by OMA-DM configuration shall occur independently and separately from its reporting procedure as determined by parameters set in the Associated Delivery Procedures Description or the SDP description, and vice versa.

- Occurrence: One
- Format: chr
- Minimum Access Types: Get
- Values: See clause annex H.

8.3.2.2.7 /<X>/Ext

The Ext node is an interior node where the vendor specific information can be placed (vendor includes application vendor, device vendor etc.). Usually the vendor extension is identified by vendor-specific name under the Ext node. The tree structure under the vendor identified is not defined and can therefore include one or more un-standardized sub-trees.

- Occurrence: ZeroOrOne
- Format: node
- Minimum Access Types: Get

8.3.2.2.8 /<X>/Session

The Session node is the starting point of the session level QoE metrics definitions.

- Occurrence: ZeroOrOne
- Format: node
- Minimum Access Types: Get

8.3.2.2.9 /<X>/Session/Metrics

This leaf provides in textual format the QoE metrics that need to be reported, the measurement frequency, the reporting interval and the reporting range. The syntax and semantics of this leaf are defined in clause 8.3.2.1.

- Occurrence: ZeroOrOne
- Format: chr
- Minimum Access Types: Get
- Values: see clause 8.3.2.1.

8.3.2.2.10 /<X>/Session/Ext

The Ext node is an interior node where the vendor specific information can be placed (vendor meaning application vendor, device vendor etc.). Usually the vendor extension is identified by vendor specific name under the ext node. The tree structure under the vendor identified is not defined and can therefore include one or more un-standardized sub-trees.

- Occurrence: ZeroOrOne
- Format: node
- Minimum Access Types: Get

8.3.2.2.11 /<X>/Speech

The Speech node is the starting point of the speech/audio media level QoE metrics definitions.

- Occurrence: ZeroOrOne
- Format: node
- Minimum Access Types: Get

8.3.2.2.12 /<X>/Speech/Metrics

This leaf provides in textual format the QoE metrics that need to be reported, the measurement frequency, the reporting interval and the reporting range. The syntax and semantics of this leaf are defined in clause 8.3.2.1.

- Occurrence: ZeroOrOne
- Format: chr
- Minimum Access Types: Get
- Values: see clause 8.3.2.1.

8.3.2.2.13 /<X>/Speech/Ext

The Ext node is an interior node where the vendor specific information can be placed (vendor meaning application vendor, device vendor etc.). Usually the vendor extension is identified by vendor specific name under the ext node. The tree structure under the vendor identified is not defined and can therefore include one or more un-standardized sub-trees.

- Occurrence: ZeroOrOne
- Format: node
- Minimum Access Types: Get

8.3.2.2.14 /<X>/Video

The Video node is the starting point of the video media level QoE metrics definitions.

- Occurrence: ZeroOrOne
- Format: node
- Minimum Access Types: Get

8.3.2.2.15 /<X>/Video/Metrics

This leaf provides in textual format the QoE metrics that need to be reported, the measurement frequency, the reporting interval and the reporting range. The syntax and semantics of this leaf are defined in clause 8.3.2.1.

- Occurrence: ZeroOrOne
- Format: chr
- Access Types: Get
- Values: see clause 8.3.2.1.

8.3.2.2.16 /<X>/Video/Ext

The Ext is an interior node where the vendor specific information can be placed (vendor meaning application vendor, device vendor etc.). Usually the vendor extension is identified by vendor specific name under the Ext node. The tree structure under the vendor identified is not defined and can therefore include one or more un-standardized sub-trees.

- Occurrence: ZeroOrOne
- Format: node
- Minimum Access Types: Get

8.3.2.2.17 /<X>/Text

The Text node is the starting point of the timed-text media level QoE metrics definitions.

- Occurrence: ZeroOrOne
- Format: node
- Minimum Access Types: Get
- Values: see clause 8.3.2.1.

8.3.2.2.18 /<X>/Text/Metrics

This leaf provides in textual format the QoE metrics that need to be reported, the measurement frequency, the reporting interval and the reporting range. The syntax and semantics of this leaf are defined in clause 8.3.2.1.

- Occurrence: ZeroOrOne
- Format: chr
- Minimum Access Types: Get
- Values: see clause 8.3.2.1.

8.3.2.2.19 /<X>/Text/Ext

The Ext is an interior node where the vendor specific information can be placed (vendor meaning application vendor, device vendor etc.). Usually the vendor extension is identified by vendor specific name under the ext node. The tree structure under the vendor identified is not defined and can therefore include one or more un-standardized sub-trees.

- Occurrence: ZeroOrOne
- Format: node
- Minimum Access Types: Get

8.3.3 SDP examples for MBMS transparent session

The following is a full example of SDP description an MBMS transparent session carrying two MPEG-2 Transport Streams:

```
v=0
o=ghost 2890844526 2890842807 IN IP4 192.168.10.10
s=3GPP MBMS Transport-only SDP Example
i=Example of MBMS transport-only SDP file
u=http://www.infoserver.example.com/ae600
e=ghost@mailserver.example.com
c=IN IP6 FF1E:03AD::7F2E:172A:1E24
t=3034423619 3042462419
b=AS:8000000
a=mbms-mode:broadcast 123869108302929 1

a=source-filter: incl IN IP6 * 2001:210:1:2:240:96FF:FE25:8EC9
m=video 4002 UDP/RTP/AVP 96
b=TIAS:4000000
a=mbms-framing-header:0 2
a=rtpmap:100 MP2T/90000
m=video 4002 RTP/AVP 98
b=TIAS:4000000
a=rtpmap:100 MP2T/90000
a=mbms-framing-trailer:0 2
```

8.4 Quality of Experience

8.4.1 General

The MBMS Quality of Experience (QoE) metrics feature is optional for both MBMS streaming server and MBMS Client, and shall not disturb the MBMS service. An MBMS Server that supports the QoE metrics feature shall activate the gathering of client QoE metrics with SDP as described in clauses 8.3.2.1 and 8.4.2 and via the reception reporting procedure as described in clause 9.4. Alternatively, QoE activation can be done with OMA-DM as described in clause 8.3.2.2. An MBMS Client supporting the feature shall perform the quality measurements in accordance to the measurement definitions, aggregate them into client QoE metrics and report the metrics to the specified server using the content reception reporting procedure. The way the QoE metrics are processed and made available is out of the scope of the present document.

8.4.2 QoE metrics

An MBMS Client should measure the metrics at the transport layer after FEC decoding (if FEC is used), but may also do it at the application layer for better accuracy.

The measurement period for the metrics is the whole streaming duration and the measurement resolution of each reported metrics value is defined by the "Measure-Resolution" field. The measurement period may be less than the session duration, because of late joiners or early leavers. The measurement period shall not include any voluntary event that impacts the actual play, such as pause, or any buffering or freezes/gaps caused by them.

The following metrics in table 8.4.2 shall be derived by the MBMS Client implementing QoE:

Table 8.4.2: QoE metrics

QoE metric	Streaming delivery method	Download delivery method	Metric type
Corruption duration metric	✓		Media
Rebuffering duration metric	✓		Session
Initial buffering duration metric	✓		Session
Successive loss of RTP packets	✓		Media
Frame rate deviation	✓		Media
Jitter duration	✓		Media
Content Access/Switch Time	✓		Session
Network Resource	✓	✓	Session
Average codec bit rate	✓		Media
Codec information	✓		Media
Loss of Objects (see NOTE)		✓	Session
Distribution of Symbol Count Underrun for Failed Blocks (see NOTE)		✓	Session
NOTE: Metric of interest mainly for sessions with a large number of object deliveries such as HTTP streaming sessions (see TS 26.247 [98]).			

All media metrics are only applicable to at least one of audio, video, speech and timed text media types, and are not applicable to other media types such as synthetic audio, still images, bitmap graphics, vector graphics, and text.

8.4.2.1 Corruption duration metric

Corruption duration, M , is the time period from the NPT time of the last good frame before the corruption, (since the NPT time for the first corrupted frame cannot always be determined) or the start of the measurement period (whichever is later) to the NPT time of the first subsequent good frame or the end of the measurement period (whichever is sooner). A corrupted frame may either be an entirely lost frame, or a media frame that has quality degradation and the decoded frame is not the same as in error-free decoding. A good frame is a "completely received" frame X that, either:

- it is a refresh frame (does not reference any previously decoded frames AND where none of the subsequently decoded frames reference any frames decoded prior to X); or
- does not reference any previously decoded frames; or
- only references previously decoded "good frames".

"Completely received" means that all the bits are received and no bit error has occurred.

Corruption duration, M , in milliseconds can be calculated according to the derivation of good frames as below:

- a) A good frame can be derived by the client using the codec layer, in which case the codec layer signals the decoding of a good frame to the client. A good frame could also be derived by error tracking methods, but decoding quality evaluation methods shall not be used. An error tracking method may derive that a frame is a good frame even when it references previously decoded corrupted frames, as long as all the referenced pixels for generating the prediction signal were correctly reconstructed when decoding the reference frames. A decoding quality evaluation method may derive that a frame is a good frame even one or more pixels of the frame have not been correctly reconstructed, as long as the decoding quality is considered by the method as acceptable. Such a frame is not a good frame according to the definition above, which shall be strictly followed.

b) In the absence of information from the codec layer, a good frame should be derived according to N , where N is optionally signalled from MBMS streaming server (via SDP) to the MBMS Client and represents the maximum duration, in presentation time, between two subsequent refresh frames in milliseconds. After a corrupted frame, if all subsequent frames within N milliseconds in presentation time have been completely received, then the next frame is a good frame.

c) N is not signalled, then it defaults to ∞ (for video) or to one frame duration (for audio).

The optional parameter D is defined to indicate which of options a) and b) is in use. D is signalled from the client to the server. When D is equal to "a", option a) shall be in use, and the optional parameter T shall be present. When D is equal to "b", option b) shall be in use and the optional parameter T shall not be present.

The optional parameter N as defined in point b) is used with the "Corruption_Duration" parameter. The optional parameter T is defined to indicate whether the client uses error tracking (when T is equal to "On") or not (when T is equal to "Off"). T is signalled from the client to the server.

The syntax for D , N to be included in the "att-measure-spec" (clause 8.3.2.1) is as follows:

- $D = "D" "=" "a" / "b"$
- $N = "N" "=" 1 * \text{DIGIT}$

In MBMS reception reporting will be done only once at the end of streaming, hence all the occurred corruption durations are summed up over each resolution period of the stream and stored in the vector *TotalCorruptionDuration*. The unit of this metrics is expressed in milliseconds. For each resolution duration the number of individual corruption events are summed up and stored in the vector *NumberOfCorruptionEvents*. These two vectors are reported by the MBMS Client as part of the reception report (clauses 9.4.6 and 9.5.3).

8.4.2.2 Rebuffering duration metric

Rebuffering is defined as any stall in playback time due to any involuntary event at the client side.

The syntax for the metric "Rebuffering_Duration" for the QoE-Feedback header is as defined in clause 8.3.2.1.

Rebuffering starts at the NPT time of the last played frame before the occurrence of the rebuffering.

In MBMS reception reporting will be done only once at the end of streaming, hence all the occurred rebuffering durations are summed up over each resolution period of the stream and stored in the vector *TotalRebufferingDuration*. The unit of this metrics is expressed in seconds, and can be a fractional value. The number of individual rebuffering events for each resolution duration are summed up and stored in the vector *NumberOfRebufferingEvents*. These two vectors are reported by the MBMS Client as part of the reception report (clauses 9.4.6 and 9.5.3).

8.4.2.3 Initial buffering duration metric

Initial buffering duration is the time from receiving the first RTP packet until playing starts.

The syntax for the "Initial_Buffering_Duration" is as defined in clause 8.3.2.1.

The metric value indicates the initial buffering duration where the unit of this metrics is expressed in seconds, and can be a fractional value. There can be only one measure and it can only take one value. "Initial_Buffering_Duration" is a session level parameter. This value is reported by the MBMS Client as part of the reception report (clauses 9.4.6 and 9.5.3).

8.4.2.4 Successive loss of RTP packets

The metric "Successive_Loss" indicates the number of RTP packets lost in succession (excluding FEC packets) per media channel.

The syntax for the metrics "Successive_Loss" is as defined in clause 8.3.2.1.

In MBMS reception reporting will be done only once at the end of streaming, hence all the number of successively lost RTP packets are summed up over each resolution period of the stream and stored in the vector *TotalNumberOfSuccessivePacketLoss*. The unit of this metric is expressed as an integer equal to or larger than 0. The number of individual successive packet loss events over each resolution duration are summed up and stored in the vector *Number*

OfSuccessiveLossEvents. The number of received packets is also summed up over each resolution duration and stored in the vector *NumberOfReceivedPackets*. These three vectors are reported by the MBMS Client as part of the reception report (clauses 9.4.6 and 9.5.3).

8.4.2.5 Frame rate deviation

Frame rate and frame rate deviation indicates the playback frame rate information. Frame rate deviation happens when the actual playback frame rate during a measurement period is deviated from a pre-defined value.

The actual playback frame rate is equal to the number of frames played during the resolution period divided by the time duration, in seconds, of the actual measurement. For the last measurement period in the session this time duration might be shorter than the configured measurement resolution (see clause 8.3.2.1 for the definition of the measurement resolution).

The parameter FR that denotes the pre-defined frame rate value is used with the "Framerate_Deviation" parameter in the "3GPP-QoE-Metrics" attribute. The value of FR shall be set by the server. The syntax for FR to be included in the "att-measure-spec" (clause 8.3.2.1) is as follows:

- FR = "FR" "=" 1*DIGIT "." 1*DIGIT

The syntax for the metrics "Framerate" and "Framerate_Deviation" is defined in clause 8.3.2.1

The metric "Framerate" indicates the actual playback frame rate. It is expressed in frames per second, and can be a fractional value..

For the Metrics-Name "Framerate_Deviation", the value field indicates the frame rate deviation value that is equal to the pre-defined frame rate minus the actual playback frame rate. This metric is expressed in frames per second, and can be a fractional value, and can be negative.

The frame rate and the frame rate deviations for each resolution period are stored in the vectors *Framerate* and *FramerateDeviation* and the vectors are reported by the MBMS Client as part of the reception report (clauses 9.4.6 and 9.5.3).

8.4.2.6 Jitter duration

Jitter happens when the absolute difference between the actual playback time and the expected playback time is larger than a pre-defined value, which is 100 milliseconds. The expected time of a frame is equal to the actual playback time of the last played frame plus the difference between the NPT time of the frame and the NPT time of the last played frame.

The syntax for the metric "Jitter_Duration" is defined in clause 8.3.2.1.

In MBMS reception reporting will be done only once at the end of streaming, hence all the Jitter_Durations are summed up over each resolution duration and stored in the vector *TotalJitterDuration*. The unit of this metrics is expressed in seconds, and can be a fractional value. The number of individual events over the resolution duration are summed up and stored in the vector *NumberOfJitterEvents*. These two vectors are reported by the MBMS Client as part of the reception report (clauses 9.4.6 and 9.5.3).

8.4.2.7 Content access/switch time

Content access/switch time is the time that elapses between the initiation of a content request/switch by the user and up to the time when the first packet of the content or media stream is received.

The syntax for the metric "Content_Access_Time" is defined in clause 8.3.2.1.

The metric value indicates the content access/switch time and the unit of this metrics is expressed in seconds, and can be a fractional value. There can be only one measure and it can only take one value. "Content_Access_Time" is a session level parameter. This value is reported by the MBMS Client as part of the reception report (clauses 9.4.6 and 9.5.3).

8.4.2.8 Network resource

The *Network_Resource* identifies the cell which has been used during each measurement resolution duration. There may be many measurement resolution durations in a reception report for a session, each of which identified with a cell identity in which the measurement was performed.

The syntax for the metric "*Network_Resource*" is as defined in clause 8.3.2.1.

In GERAN and UTRAN, the cell is identified by the Cell Global Identity (as described in 3GPP TS 23.003 [77]), which is a concatenation of MCC, MNC, LAC and CI. It shall be coded as a text string as follows: Starting with the most significant bit, MCC (3 digits), MNC (2 or 3 digits depending on MCC value), LAC (4 hexadecimal digits) and CI (4 hexadecimal digits).

In E-UTRAN, the cell is identified by the E-UTRAN Cell Global Identification (ECGI) (as described in 3GPP TS 36.331 [97]) which is a concatenation of the PLMN Identifier (PLMN-Id) and the E-UTRAN Cell Identity (ECI). The PLMN identifier consists of MCC and MNC. It shall be coded as a text string as follows: starting with the most significant bit, MCC (3 digits), MNC (2 or 3 digits depending on MCC value) and ECI (7 hexadecimal digits). The reported ECGI shall be the identity of the MBMS cell (see TS 36.300 [96]), which could be the Primary Cell (PCell), the Secondary Cell (SCell), or the configurable SCell, if Carrier Aggregation [96] is employed in the E-UTRAN.

Only one cell shall be reported per measurement resolution duration, even if more than one cell has been used during a measurement resolution duration or if reception is done simultaneously from several cells.

The cells used for all the corresponding measurement durations are stored in the vector *networkResourceCellId*. If the cell identifier value in the vector for a resolution period is unchanged from the previous value, it is allowed to put the value "=" in the vector to indicate this. The vector is reported by the MBMS Client as part of the reception report (clauses 9.4.6 and 9.5.3).

8.4.2.9 Average codec bit rate

The average codec bit rate is the bit rate used for coding "active" media information during the measurement resolution period.

For audio media "active" information is defined by frames containing audio. If the audio codec uses silence frames (SID-frames), these frames are not counted as "active", and the SID-frames and the corresponding DTX time periods are excluded from the calculation. Thus for audio media the average codec bit rate can be calculated as the number of audio bits received for "active" frames, divided by the total time, in seconds, covered by these frames. The total time covered is calculated as the number of "active" frames times the length of each audio frame.

For non-audio media the average codec bit rate is the total number of media bits played out during the measurement resolution period, divided by the length of the playout period. The playout period length is normally equal to the length of the measurement resolution period, but if rebuffering occurs the playout period will be shorter (i.e. any rebuffering time shall be ignored when calculating the codec bit rate).

The syntax for the metric "*Average_Codec_Bitrate*" is defined in clause 8.3.2.1.

The average codec bit rate value for each measurement resolution period shall be stored in the vector *AverageCodecBitrate*. The unit of this metrics is expressed in kbit/s and can be a fractional value. The vector is reported by the client as part of the reception report (clauses 9.4.6 and 9.5.3).

8.4.2.10 Codec information

The codec information metrics contain details of the media codec used during the measurement resolution period. If the codec information is changed during the measurement resolution period, the codec information valid when each measurement resolution period ends shall be reported. The unit of this metric is a string value. No "white space" characters are allowed in the string values, and shall be removed if necessary.

For audio media the codec information contains the audio codec type, represented as in an SDP offer, for instance "AMR-WB/16000/1".

For video media, the codec information contains the video codec type, represented as in an SDP offer, for instance "H263-2000/90000". Furthermore, the video profile and level used, as well as the image size used shall be reported. For instance "profile=0;level=45" for the profile and level information and "176x144" for the image size. In some cases the

profile and level is reported together, for instance "profile-level-id=42e00a". Note that the image size reported for each measurement resolution period shall be the one actually used, not the maximum size allowed by the SDP negotiation.

For timed text media, the codec information contains the text encoding, represented as in an SDP offer, for instance "3gpp-tt/1000".

The syntax for the metric "Codec_Info", "Codec_ProfileLevel" and "Codec_ImageSize" are defined in clause 8.3.2.1.

The codec info, profile/level and codec image size value for each measurement resolution period shall be stored in the vectors *CodecInfo*, *CodecProfileLevel* and *CodecImageSize* respectively. If the metric values in these vectors for a measurement resolution period are unchanged from the previous values in the respective vector, it is allowed to put the value "=" in the vector to indicate this. The *CodecInfo*, *CodecProfileLevel* and *CodecImageSize* vectors are reported by the client as part of the reception report (clauses 9.4.6 and 9.5.3).

8.4.2.11 Loss of objects

The metric "Object_Loss" indicates the number of objects lost in a FLUTE session during a resolution period.

The syntax for the metric "Object_Loss" is as defined in clause 8.3.2.1.

The number of lost objects are summed up over each resolution period of the session and stored in the vector *numberOfLostObjects*. The unit of this metric is expressed as an integer equal to or larger than 0. The number of received objects is also summed up over each resolution duration and stored in the vector *NumberOfReceivedObjects*. These two vectors are reported by the MBMS Client as part of the reception report (clauses 9.4.6 and 9.5.3).

8.4.2.12 Distribution of symbol count underrun for failed blocks

The elements of the distribution of the metric "Distribution_of_Symbol_Count_Underrun" are calculated by subtracting the total number of source symbols, from the number of received symbols for a failed block in a failed object. The range of values of the distribution are limited to the range of interest through top and bottom range parameters. Values greater than the top of the range are reported as the maximum value. Values lower than the bottom of the range are reported as the minimum value.

Reported values may also be grouped in bins. The size of the bins used for collecting statistics are specified through a bin size parameter. The first bin starts at the bottom of the range. The last bin must include the top of the range. Collection bins are adjacent.

The range of file sizes considered for calculating the metric can also be restricted through optional minimum, and maximum file size parameters.

The distribution is reported per measurement duration as a string list of (bin lower bound, number of occurrences) pairs, with each pair corresponding to a single entry. The bin lower bound uniquely identifies a bin by providing the lowest value of the range of each bin. The bin lower bound, and number of occurrences are both integer values. When reporting the bin lower bound and number of occurrences pairs, the following string format shall be used: "(bin lower bound, number of occurrences)", where the parentheses represent the delimiter and the comma separates the bin lower bound (integer range of values) and number of occurrences (positive integer range of values).

When it contains entries for a single measurement duration, the vector *SymbolCountUnderrun* is a string vector where the entries are listed sequentially, without a space character between adjacent entries of the overall set. The set of entries is delimited by curly brackets: "{" at the beginning and "}" at the end. Bins with zero occurrences are omitted from the list. Values greater than the top of the range are reported within the bin containing the top of the range. Values lower than the bottom of the range are reported within the first bin containing the bottom of the range.

When *SymbolCountUnderrun* contains information for multiple measurement durations, it shall comprise a sequence of curly bracket delimited entries, with adjacent members of the sequence separated by one or more space characters. If the number of occurrences for all bins equals zero for a particular measurement duration within the *SymbolCountUnderrun*, the string "{}" shall be used to signal that event.

The following example shows a scenario whereby the reported distribution of the symbol count underrun comprises the entries of a single measurement duration, and for which bins -9, -4 and 0 have occurrences 2, 6 and 4, respectively. The vector *SymbolCountUnderrun* is given as:

```
SymbolCountUnderrun = "{(-9,2)(-4,6)(0,4)}"
```

The next example shows a scenario whereby the reported distribution comprises entries of multiple measurement durations. In the first measurement duration, bins -3, -2 and -1 have occurrences 1, 3 and 5, respectively, and there are no occurrences in the next two measurement durations. In this case, the vector *SymbolCountUnderrun* is given as:

```
SymbolCountUnderrun = "{(-3,1)(-2,3)(-1,5)} {} {}"
```

The top, bottom, and bin size of the distribution range are provided through the optional parameters T, B, and S respectively. The syntax for T, B, and S to be included in the "att-measure-spec" (see clause 8.3.2.1) is as follows:

- T = "T" "=" {+/-} 1*DIGIT
- B = "B" "=" {+/-} 1*DIGIT
- S = "S" "=" 1*DIGIT

The default value of the top of the range, in case the T parameter is omitted, is 0. The default value of the bottom of the range, in case the B parameter is omitted, is -10. The default value of the bin size is 1.

The minimum and maximum file sizes considered for calculating the metric are provided through the optional parameters Y and Z, respectively. The syntax for Y and Z to be included in the "att-measure-spec" (see clause 8.3.2.1) is as follows:

- Y = "Y" "=" 1*DIGIT
- Z = "Z" "=" 1*DIGIT

The default value of the minimum file size is 0, and the default value of the maximum file size is infinity.

8.4.3 Example metrics initiation with SDP

This following example shows the syntax of the SDP attribute for QoE metrics. The session level QoE metrics description (Initial buffering duration, rebufferings and network resource) are to be monitored with a measurement resolution of 20 seconds and reported at the end of the session. Also video specific description of metrics (corruptions) are to be monitored and reported at the end from the beginning of the stream until the time 40s. Finally, audio specific description of metrics (corruptions) is to be monitored with a measurement resolution of 10s and reported at the end of the stream.

SDP example:

```
v=0
o=- 3268077682 433392265 IN IP4 63.108.142.6
s=QoE Enabled Session Description Example
e=support@foo.com
c=IN IP4 0.0.0.0
t=0 0
a=range:npt=0-83.660000
a=3GPP-QoE-Metrics:metrics={Initial_Buffering_Duration|Rebuffering_Duration|
  Network_Resource };rate=End;resolution=20
a=control:*
m=video 0 RTP/AVP 96
b=AS:28
a=3GPP-QoE-Metrics:metrics={Corruption_Duration };rate=End;range:npt=0-40
a=control:trackID=3
a=rtpmap:96 MP4V-ES/1000
a=range:npt=0-83.666000
a=fmtp:96profile-level-id=8;config=000001b008000001b50900012000
m=audio 0 RTP/AVP 98
b=AS:13
a=3GPP-QoE-Metrics:metrics={Corruption_Duration };rate=End;resolution=10
a=control:trackID=5
a=rtpmap:98 AMR/8000
a=range:npt=0-83.660000
a=fmtp:98 octet-align=1
a=maxptime:200
```


8.5 Using MBMS Streaming delivery on unicast

If the MBMS UE supports MBMS streaming delivery on unicast, then MBMS Streaming shall perform the functions of a PSS client per TS 26.234 [47] to deliver content when MBMS Bearers are not usable or available and if an *alternativeAccessDelivery* element is available for the delivery method in the MBMS User Service Description. Note, if an *alternativeAccessDelivery* element is available, it is presumed that the same content is offered over both PSS and MBMS. If more than one *unicastAccessURI* element is available in the *alternativeAccessDelivery* element, then the UE shall randomly choose one URI to be used for unicast access to the service.

If the MBMS UE is receiving an MBMS Streaming User Service using MBMS delivery on Unicast in E-UTRAN, while not being in time-shifting mode, but is interested to receive the corresponding service via an MBMS Bearer instead, it shall handle counting requests as defined in TS 36.300 [96] and TS 36.331 [97].

MBMS and PSS define Quality of Experience (QoE) metrics features. The UE shall not mix MBMS and PSS QoE metrics gatherings and/or reports. QoE is negotiated, gathered and reported separately for PSS and MBMS.

The UE may compare the SSRC values of PSS and MBMS flows. If the UE detects that the same SSRC value is used for PSS and MBMS flows, then the UE should assume that the same wallclock time and same random RTP timestamp offset is used for the flows with the same SSRC value. This gives the UE an advantage for the synchronization onto the flows. The UE does not need to wait for new, flow specific RTCP packets.

The BM-SC and the PSS servers which provide for unicast access to the MBMS service shall be time synchronized. The PSS server and the UE should support UTC clock time format in the "Range" header field as defined in RFC 2326 [88].

The UE may request a specific start time of the PSS session by indicating a UTC clock time in the *Range* header field of the PLAY request. The UTC clock time represents the requested streaming start point according to the timeline of the BM-SC. This time may be calculated using the NTP timestamp of the last received RTCP sender reports. Otherwise, the UE may either specify an NPT range using the "now" value as a start point of the PSS session or it may completely omit the *Range* header field.

If the PSS server does not support time shifting and the request contains a range indication (other than "now") then the PSS server shall reply with the actual range that will be played back. Examples of this are an NPT range header field using "now" or the selected start time in UTC clock time.

A *unicastAccessURI* element of an *alternativeAccessDelivery* element in the *deliveryMethod* element of the User Service Description may contain an RTSP URI or a reference to an PSS SDP file.

8A Group Communication delivery method

8A.1 Overview

The MBMS Group Communication delivery method delivers a UDP/IP packet flow to the UE. The BM-SC provides Group Communication delivery by receiving UDP/IP packets and forwarding them over the MBMS path provided by the MBMS Bearer Service. Both IPv4 and IPv6 may be used by the Group Communication delivery method.

Figure 8A.1 depicts a reference model of the GCSE architecture with a MCPTT Server as the GCS AS, and shows how GCS application data is ingested by the BM-SC via the MB2 interface.

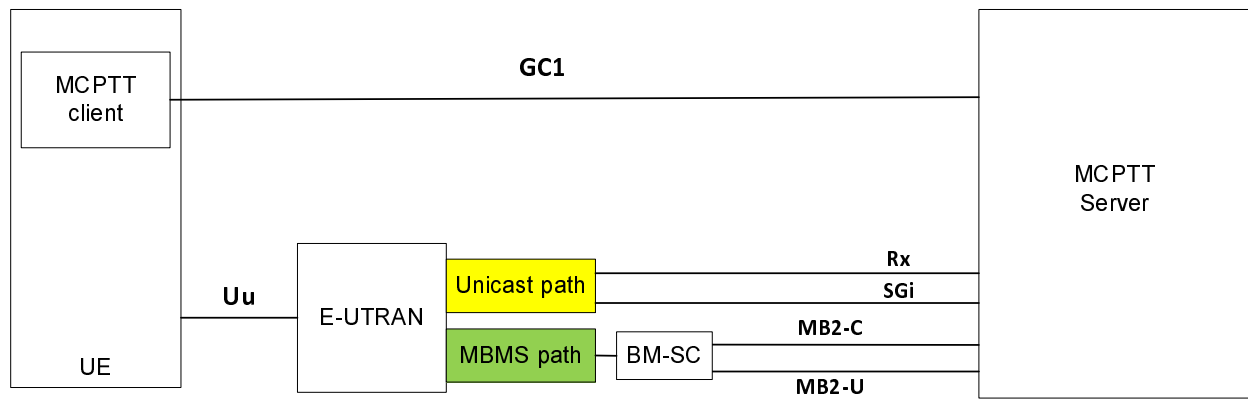


Figure 8A.1: Reference Model of GCS Architecture for MCPTT service delivery over eMBMS via BM-SC group communication delivery method

8A.2 Transport method

The application transport protocol on top of the MB2 UDP/IP is transparent to the BM-SC and is not defined in this specification.

Upon reception of GCS AS UDP/IP packets, the BM-SC removes the UDP/IP header and performs UDP/ IP encapsulation of the user plane IP data that was received over the MB2-U interface.

NOTE: The present document does not define any FEC for the Group Communication delivery method.

If requested by the GCS-AS over the MB2 interface, the BM-SC shall perform ROHC header compression over the broadcast link (between BM-SC and UE). The header compression shall be applied on the encapsulated UDP/IP packets according to the limitations in clause 8A.4.

If FEC protection is requested by the GCS AS, the BM-SC shall use the MBMS FEC scheme as specified in clause 8.2.2.

8A.3 Signalling of GCS application service content

8A.3.1 General

The GCS AS signals the GCS application service content to the UE over the GC1 interface.

The GCS application client in the UE will use the signalled information provided by the GCS AS to enable reception of GCS application data over the appropriate MBMS Bearer(s). This signalling shall include TMGI associated to this MBMS bearer, multicast IP address, UDP port and source IP address. The MCPTT server signals group calls over MBMS by combining the announcement of the MBMS bearer (see TS 23.280 [141]), which provides the TMGI and session description parameters, and signalling messages, which indicates the delivery start over MBMS of a group call and provides additional media parameters (see TS 23.379 [142]).

8A.3.2 Void

8A.4 ROHC for Group Communication delivery method

8A.4.1 General

If ROHC is enabled for the GC delivery session at reference point MB2, then the following conditions shall apply:

- Only the U-mode shall be used throughout the lifetime of the session. Other modes shall not be used.
- A single ROHC channel per GC delivery session shall be used.
- Exactly one of the following alternatives as specified in [138] shall be used:
 - the RTP/UDP/IP profile with identifier 0x0001,
 - the UDP/IP profile with identifier 0x0002, or
 - the uncompressed IP profile with identifier 0x0000.
- UDP flow encoded with profile 0x0001 or profile 0x0002 shall use different context IDs.
- A common context ID may be used for all flows encoded with profile 0x0000.
- The LARGE_CIDS flag may be set to true. LARGE_CIDS value can be derived from the value from the MAX_CID flag.
- ROHC segmentation shall not be used and the MRRU value shall be set to 0

If indicated by the MB2, FEC protection shall also be applied according to the FEC scheme defined in clause 8.2.2.

8A.5 SDP exchange for FEC support with the Group Communication delivery method

The GCS AS can request the BM-SC to apply FEC to protect the flow delivered with the group communication delivery method, as specified in TS 23.468 [120] and TS 29.468 [121], by including the FEC-Request AVP in the MBMS-Bearer-Request AVP. The FEC-Request AVP contains an SDP describing the FEC framework configuration information (see clause 5.5 of RFC 6363 [31]), which includes identification of the set of source flows, repair flows, and other FEC parameters.

To describe the FEC framework configuration information,

- the exchanged SDP shall include the sender IP address, using the source-filter attribute ("a=source-filter:") as specified in clause 8.3.3.1,
- the exchanged SDP shall include the destination IP address using the "connection data" field ("c="), as specified in clause 8.3.3.2,
- the exchanged SDP shall include, at session level, a FEC declaration attribute ("a=FEC-declaration") as specified in clause 7.3.2.8, a "a=FEC-OTI-extension" attribute specified in 8.3.1.8 and a "a=mbms-repair" attribute, as specified in clause 8.3.1.8,
- for each RTP/UDP source flow to be protected by FEC, the exchanged SDP shall include a media block
 - where the media ('m-line') provides the destination port, as specified in 8.3.3.2, and uses 'UDP/MBMS-FEC/RTP/AVP' or 'UDP/MBMS-FEC/RTP/SAVP' as protocol identifier (see clause 8.2.2.13a),
 - with the "a=FEC" attribute, specified in clause 7.3.2.8.
- for each repair flow, the exchanged SDP shall include a media block
 - where the media ('m-line') provides the destination port, as specified in clause 8.3.3.2, and uses 'UDP/MBMS-REPAIR' as protocol identifier (see clause 8.2.2.13a),
 - with the "a=mbms-flowid" attribute, as specified in clause 8.3.1.9.

The exchanged SDP may also include bandwidth information, as specified in clause 8.3.1.7. The BM-SC identifies the input RTP source flows to be FEC encoded, based on the source address, destination address and destination port listed in the media blocks using 'UDP/MBMS-FEC/RTP/AVP' or 'UDP/MBMS-FEC/RTP/SAVP' as protocol identifier. Encoded source flows are outputted by the BM-SC on the same destination address and port.

Source flows that are not described in the exchanged SDP are directly delivered without FEC encoding.

8B Transparent delivery method

8B.1 Introduction

The MBMS transparent delivery method shall be used by the BM-SC to transmit downstream service content received over xMB-U ([143]) from the Content Provider when the *Session Type* property, as described in table 5-2 of TS 26.348 [143], is set to **Transport-Mode**. The transparent delivery method delivers application data units as part of UDP or IP flows over an MBMS bearer to the UE. This delivery method complements the download delivery method and streaming delivery method and is particularly useful for multicast and broadcast of IP-based services for which the media codecs and application protocols are defined outside of this specification.

The BM-SC receives Application Data Units (ADUs) from the content provider, typically provided as UDP/IP packets and forwards them to the destination multicast IP address and port number. Both IPv4 and IPv6 may be used by the transparent delivery method.

Transparent delivery methods may be used within MBMS User Services, where the session description is delivered as a fragment of a User Service Description, or they may be used independently, where the content provider will announce the session via external means.

An MBMS transparent delivery session may be operated in a forward-only or in a proxy mode, as indicated in table 5-3 of TS 26.348 [143]. In the forward-only mode, the transport protocol on top of IP is opaque to the MBMS system and the session announcement may be handled by the content provider itself. In the proxy mode, the UDP packet payload of the UDP streams is opaque to the MBMS session and an MBMS Client is expected to make the UDP Payloads available to an application, without further knowledge on the content.

In the proxy mode is used, the transport protocol and session description are described in clauses 8B.2 and 8B.3.

If requested by the content provider, the BM-SC shall apply ROHC per RFC 5795 [137] to compress the UDP/IP headers of the encapsulated source datagrams. Note that the MBMS Gateway might also apply ROHC on the resulting UDP flow, but that does not include the encapsulated UDP datagrams. ROHC is described in clause 8B.4.

The content provider may also request the application of FEC over broadcast. FEC is described in clause 8B.5.

8B.2 Transport protocol

8B.2.1 General

When the proxy mode is used, the transport protocol shall be UDP/IP.

The application layer protocol on top of UDP/IP is out of scope of this specification. However, examples for application layer protocols are RTP, packetized MPEG-2 TS or other UDP-based streams. Generally, a sequence of Application Data Units (ADUs), i.e. unit of source data provided as payload to the transport layer, can be delivered by this transport protocol. As an example, this framework can be applied to RTP flows as well.

ADUs may be encapsulated into frames by a transport framing protocol prior to transmission using the UDP protocol, in order to provide additional transport functionality.

A UE that does not understand the transport framing protocol shall discard the transport framing header or trailer, and recalculate the UDP checksum prior to forwarding ADU to the receiver. The usage of the transport framing protocol is signalled by the presence of the "mbms-framing" attribute in a media session of the SDP. If used, all datagrams of the UDP flow shall be framed using the same transport framing protocol.

If transport framing is used, the BM-SC shall encapsulate exactly one ADU in an IP/UDP multicast packet where the ADU carried as a UDP payload is appended or prepended by the transport framing trailer/header as shown in figure 8B-3.

NOTE: The content provider shall be aware of the path MTU and shall not generate ADUs that do not fit into a single IP/UDP datagram.

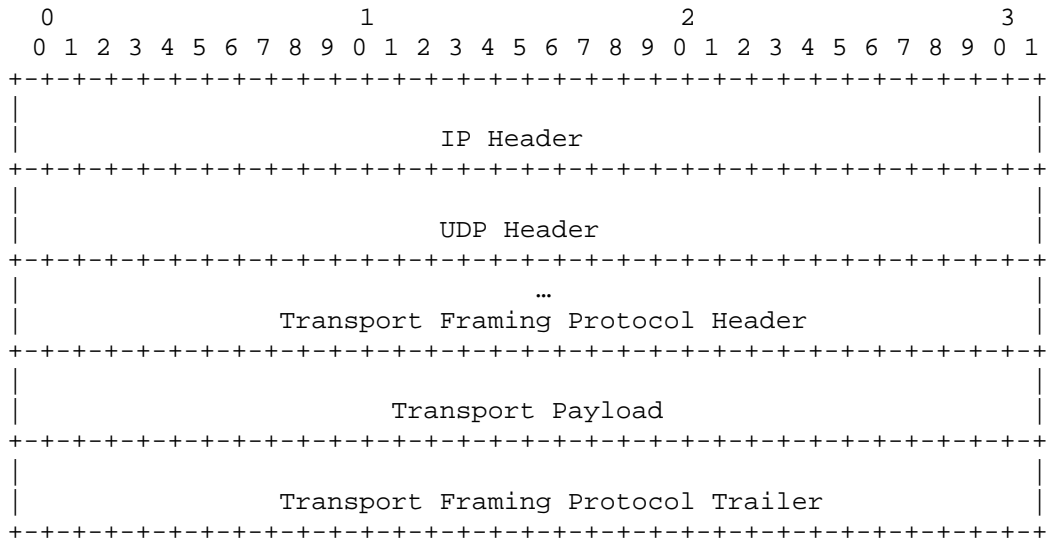


Figure 8B-3 Transport framing protocol header/trailer

The transport framing protocol trailer/header shall be of constant length for all packets of the same UDP flow. The length of the transport framing protocol trailer/header shall be signalled to the UE as part of the "mbms-framing" attribute of the session description of the transparent session.

NOTE: The present document does not define a transport framing protocol. Instead, it defines the framework for this protocol to ensure backwards compatibility by future versions of the protocol.

If the transport framing protocol is used and the receiver does not recognize the version of the transport protocol, it shall discard the trailer/header. The sender shall ensure that simple discarding by a receiver that does not support the indicated version of the transport framing protocol does not impact the integrity and consistency of the payload.

The UDP checksum shall be recalculated after any transport framing is performed and also after that transport framing is terminated.

8B.3 Session description

8B.3.1 Introduction

When the proxy mode of the transparent delivery method is used, the BM-SC shall act as the source for the multicast traffic. The SDP for the transparent delivery method shall be created by the BM-SC and may be shared as a fragment of the service announcement or sent to the content provider, if the latter selects to perform service announcement by itself.

8B.3.2 SDP parameters

8B.3.2.1 General

The session description of an MBMS Transparent session includes the following parameters:

- The sender IP address
- Session timing information
- Mode of the MBMS bearer

- The TMGI of the MBMS Bearer
- The bit rate of the session
- For each UDP flow:
 - The destination IP address and port number for each media line
 - An indication of the usage of a transport framing protocol or not
 - The protocol ID for each media session
 - Any other parameters of the transported flow for each media

8B.3.2.2 Sender IP address

There shall be exactly one source IP address per media description within the SDP. The source IP address shall be defined according to the source-filter attribute ("a=source-filter:") [15] for both IPv4 and IPv6 sources, with the following exceptions:

1. exactly one source address may be specified by this attribute such that exclusive-mode shall not be used and inclusive-mode shall use exactly one source address in the <src-list>.
2. there shall be exactly one source-filter attribute per complete MBMS transparent session SDP description, and this shall be in the session part of the session description (i.e. not per media).
3. The * value shall be used for the <dest-address> subfield.

8B.3.2.3 Destination IP address and port number

The destination IP address shall be defined using the "connection data" field ("c=") specified in RFC 4566 [14]. The destination port number shall be defined according to the <port> sub-field of the media announcement field ("m=") of [14].

In case multiple media sessions are present, all of them shall share the same destination multicast IP address. The "c=" parameter shall be a session level attribute.

8B.3.2.4 Session timing parameters

An MBMS transparent session start and end times shall be provided according to the SDP timing field ("t=") specified in RFC 4566 [14].

8B.3.2.5 Mode of MBMS bearer per media

The MBMS bearer mode declaration attribute shall be used for MBMS transparent sessions, as defined in clause 7.3.2.7.

8B.3.2.6 MBMS Bearer information

The SDP shall contain exactly one MBMS bearer mode attribute (defined in clause 7.3.2.7) at session level. It may contain an alternative TMGI attribute as defined in clause 7.3.2.12.

8B.3.2.7 Bandwidth specification

The maximum bit rate required by a UDP flow may be specified using the "AS" bandwidth modifier specified in RFC 4566 [14] on media level. The Application Specific (AS) bandwidth for a transparent session shall be the largest sum of the sizes of all packets transmitted during any one-second period of the session, expressed as kilobits. The size of a packet shall include the complete packet, i.e. IP, UDP and FLUTE headers, and the data payload.

8B.3.2.8 Transport framing protocol

The "mbms-framing-header" or "mbm-framing-trailer" attributes, if present at the media level, indicate that MBMS transport framing protocol is used and provides a version number and length field for the transport framing header or trailer, respectively.

The ABNF syntax for the "mbms-framing-header" and the "mbms-framing-trailer" attributes is as follows:

```
mbms-framing=("a=mbms-framing-header" / "a=mbms-framing-trailer") ":" SP version SP length SP
parameters
  version = 1*2DIGIT
  length = 1*2DIGIT
  parameters = *(parameter [";"])
  parameter = name "=" value
  name = *(ALPHA / DIGIT / "|" / "-" / "_")
  value = *(ALPHA / DIGIT / "|" / "-" / "_")
```

8B.4 ROHC for transparent delivery method

8B.4.1 General

If ROHC is used in a transparent delivery session, then the following conditions shall apply:

- Only the U-mode shall be used throughout the lifetime of the session. Other modes shall not be used.
- A single ROHC channel per Transparent delivery session shall be used.
- Exactly one of the following alternatives as specified in RFC 3095 [138] shall be used:
 - the RTP/UDP/IP profile with identifier 0x0001,
 - the UDP/IP profile with identifier 0x0002, or
 - the uncompressed IP profile with identifier 0x0000.
- UDP flow encoded with profile 0x0001 or profile 0x0002 shall use different context IDs.
- A common context ID may be used for all flows encoded with profile 0x0000.
- The LARGE_CIDS flag may be set to true. LARGE_CIDS value can be derived from the value from the MAX_CID flag.
- ROHC segmentation shall not be used and the MRRU value shall be set to 0

8B.4.2 ROHC negotiation

ROHC usage shall be indicated by the "**a=3gpp-rohc:1**" attribute in the session description.

8B.4.3 ROHC operation

The BM-SC shall send IR type packets periodically.

8B.5 FEC

8B.5.1 General

If FEC protection is requested by the content provider, the BM-SC shall use the MBMS FEC scheme as specified in clause 8.2.2. The FEC protection covers UDP payload and can be applied in both the forward only and the proxy modes of the Transparent delivery method.

9 Associated delivery procedures

9.1 Introduction

Associated delivery procedures describe general procedures, which start before, during or after the MBMS data transmission phase. They provide auxiliary features to MBMS user services in addition, and in association with, MBMS delivery methods and their sessions. Those procedures that shall only be permitted after the MBMS Data transmission phase may also be described as post-delivery procedures.

To enable future backwards compatibility, clause 9 specifies generic and extensible techniques for a potentially wide range of associated delivery procedures.

Clauses 9.3 and 9.4 specify the associated delivery procedures that are initiated only after an MBMS data transmission phase.

The present document describes the following associated delivery procedures:

- File repair, for post-delivery repair of files initially delivered as part of an MBMS download session.
- Content reception reporting of download files and/or media streams of an MBMS User Service delivered to an MBMS UE, which may include the reporting of DASH QoE metrics for a DASH-over-MBMS service.
- Consumption reporting of MBMS User Service.

These procedures are enabled by establishing a point-to-point connection; and using the MBMS session parameters, received during User Service Discovery/Announcement, to communicate the context (e.g. file and session in question) to the network and the MBMS sender infrastructure. To avoid network congestion in the uplink and downlink directions, and also to protect servers against overload situations, the associated delivery procedures from different MBMS UEs shall be distributed over time and resources (network elements).

One or more *serviceURI* elements in the Associated Delivery Procedure Description are used to specify the network server(s) associated with one or more of the following Associated Delivery Procedure functionality: symbol-based file repair, reception reporting, and consumption reporting. In MBMS download delivery, the use of the *Alternate-Content-Location-1* or *Alternate-Content-Location-2* elements alone, or in combination with the *Base-URL-1* or *Base-URL-2* elements in the FDT specify standard HTTP/1.1 servers in support of byte-range-based file repair. The network can selectively enable or disable the use of confidentiality protection of Reception Reporting, Consumption Reporting, and/or File Repair, based on indicating in the server identities the use of the 'HTTPS' or 'HTTP' scheme as specified in TS 33.246 [10] clause 6.7.

NOTE: The use of the HTTPS scheme for Reception Reporting, Consumption Reporting, or File Repair Associated Delivery Procedures is restricted to servers for which a trusted root certificate is present in the list described in TS 33.246 [10], clause 6.7.3.

An instance of an "associated procedure description" is an XML file that describes the configuration parameters of one or more associated delivery procedures.

MBMS Download receivers shall support the file repair procedure as defined in clause 9.3.

MBMS Download receivers shall support the reception reporting procedure as defined in clause 9.4.

MBMS Download receivers shall support the consumption reporting procedures as defined in clause 9.4A.

MBMS Streaming receivers shall support reception reporting procedures (StaR and StaR-all report types) as defined in clause 9.4.

MBMS Transparent Delivery receivers are not expected to support any associated delivery procedures.

9.2 Associated procedure description

An associated procedure description instance (configuration file) for the associated delivery procedures may be delivered to the MBMS Clients:

- during a User Service Discovery/Announcement prior to the MBMS download session along with the session description (out-of-band of that session); or
- in-band within a MBMS download session.

The most recently delivered configuration file (i.e. the one with the highest version number - as given from the envelope, see clause 11.1.3) shall take priority, such that configuration parameters received prior to, and out-of-band of, the download session they apply to are regarded as "initial defaults", and configuration parameters received during, and in-band with the download session, overwrite the earlier received parameters. Thus, a method to update parameters dynamically on a short timescale is provided but, as would be desirable where dynamics are minimal, is not mandatory.

During the User Service Discovery/Announcement Procedure, the associated procedure description instance is clearly identified using a URI, to enable UE cross-referencing of in and out-of-band configuration files.

The MIME application type "application/mbms-associated-procedure-description+xml" as defined in clause C.7 identifies associated delivery procedure description instances (configuration files).

In XML, each associated delivery procedure entry shall be configured using an "associatedProcedureDescription" element. All configuration parameters of one associated delivery procedure are contained as attributes of an "associatedProcedureDescription" element. The elements (e.g. "postFileRepair" and "postReceptionReport") of an "associatedProcedureDescription" element identify which associated procedure(s) to configure. The Associated Delivery Procedure Description is specified formally as an XML schema in clause 9.5.1.

9.3 File repair procedure

9.3.1 Introduction

The purpose of the File Repair Procedure is to repair lost or corrupted file fragments from the MBMS download data transmission. When in multicast/broadcast environment, scalability becomes an important issue as the number of MBMS Clients grows. Three problems must generally be avoided:

- Feedback implosion due to a large number of MBMS Clients requesting simultaneous file repairs. This would congest the uplink network channel.
- Downlink network channel congestion to transport the repair data, as a consequence of the simultaneous client requests.
- File repair server overload, caused again by the incoming and outgoing traffic due to the clients' requests arriving at the server, and the server responses to serve these repair requests.

The three problems are interrelated and must be addressed at the same time, in order to guarantee a scalable and efficient solution for MBMS file repair.

The principle to protect network resources is to spread the file repair request load in time and across multiple servers.

The MBMS Client:

1. Identifies the end of transmission of files or sessions.
2. Identifies the missing data from an MBMS download.
3. Calculates a random *back-off time* and selects a file repair server randomly out of a list.
4. Sends a *repair request* message to the selected file repair server at the calculated time.

When a MBMS download session of repair data is configured in the associated delivery descriptions, a MBMS Client should wait for repair data in the defined MBMS download session on its MBMS bearer - except where the UE is prevented from doing so due to limited simultaneous context activation capability.

Then the file repair server:

1. Responds with a *repair response* message either containing the requested data, redirecting the client to an MBMS download session, redirecting the client to another server, or alternatively, describing an error case.

The BM-SC may also send the repair data on a MBMS bearer (possibly the same MBMS bearer as the original download) as a function of the repair process.

The random distribution, in time, of *repair request* messages enhances system scalability to the total number of such messages the system can handle without failure.

9.3.2 Starting time of the Associated Delivery Procedure for MBMS Download Delivery

FLUTE File Delivery Table (FDT) Instances include an "expires" attribute, which defines the expiration time of the FDT Instance. The sender must use an expiry time relative to the current time at the BM-SC. According to clause 7.2.9, the UE shall not use a received FDT Instance to interpret packets received beyond the expiration time of the FDT Instance".

The starting time of Associated Delivery Procedure for the MBMS download is the expiration time of the FDT instance at the latest.

The starting time of the *postFileRepair* timer (see clause 9.4.4) corresponds to the starting time of the Associated Delivery Procedure. The *postFileRepair* timer value corresponds to the back-off time determined from clause 9.3.4, using the file repair associated parameters in the ADP.

The starting time for the *postReceptionReport* timer (see clause 9.4.4) for RACK reports corresponds to the time at which the UE determines that there has been a complete file reception for MBMS download, as specified in clause 9.4.1.

The starting time for the *postReceptionReport* timer (see clause 9.4.4) for StaR/StaR-only/StaR-all reports corresponds to the expiration of a periodic 'report interval' timer whose value is defined by the *r14:reportInterval* attribute of the *postReceptionReport* element if present, or, to the time at which the UE has identified a complete MBMS delivery session reception, as specified in clause 9.4.2.

The *postReceptionReport* timer value for RACK and StaR/StaR-only/StaR-all reports is set to the same value and corresponds to the back-off time, as determined from clause 9.3.4, using the reception reporting associated parameters in the ADP.

The MBMS UE may also choose to start the Associated Delivery Procedure when any of the following occurs:

- The MBMS UE has received an end-of-object (B-flag) for an object;
- An end-of-session (A-flag) is received before the FDT instance expires. Note, the end-of session (A-flag) indicates, that neither more objects nor FDT instances will be transmitted by the BM-SC;
- The end of the file transmission time (*end* attribute in the *fileSchedule* element) per the Schedule Description fragment is reached even when the FDT Instance is not received;
- The end of the session occurrence transmission time (given by the *stop* element in the *sessionSchedule* element adjusted to the specific session occurrence, to account for any session reoccurrences) per the Schedule Description fragment is reached even when the FDT Instance is not received.

If the MBMS UE is not capable of receiving an MBMS transmission while using an interactive bearer, the MBMS UE shall ignore the end-of-object flags (B-flag).

When a particular file (URI) is present in several FDT Instances with different TOI values, then the FDT Instance with the highest FDT Instance ID defines the TOI for the most recent instance of the file and determines the end of transmission time for that file. A UE shall only determine transmission completeness for a file for the most recent instance of the file - and shall not use FDT Instance expiry time to determine transmission completeness for any other (TOI) instances of a file (fileURI).

NOTE 1: The intention of this clause is to just start the Associated Delivery Procedure back-off timer for the more recent instance version of a file with respect to the FLUTE transmission session.

When a particular file (URI) is present in more than one FDT Instance with the same TOI value, then the end of transmission time is defined by the expiration time of the latest FDT Instance to expire.

If an FDT Instance is received describing the file after this time (giving an FDT Instance expiry time in the future and a different TOI value) the UE shall determine that the transmission of the file is incomplete - i.e. that more packets may arrive within the MBMS download session for that file, 'forgetting' its previous file transmission complete determination.

NOTE 2: This effectively resets and stops any running timers already initiated for an associated delivery procedure for that file.

If the MBMS UE receives an end-of-object packet (with FLUTE header B flag set true) the MBMS UE shall determine that the transmission of that object is complete, and shall interpret that as file transmission complete if no, more recent, TOIs are described for the same file (URI) in any received and unexpired FDT Instance(s).

If the MBMS UE determines that the download session is complete (as specified in clause 9.4.2) then it shall interpret this also that all the transmissions of all files (and TOIs) described by all FDT Instances, received from that session, are complete.

9.3.3 Identification of missing data from an MBMS Download

The session description and the MBMS download delivery protocol, FLUTE, provide the client with sufficient information to determine the source block and encoding symbol structure of each file. From this a client is able to determine which source symbols should have been transmitted but have not been received. The client is also able to determine the number of symbols it has received for each source block of each file, and thus the number of further symbols required to decode the block.

Thus, an MBMS Client is able to identify any source symbols lost in transmission, and the number (and ESI values where appropriate) of required source and/or repair symbols that would complete the reconstruction of a source block (of a file).

When the MBMS FEC scheme is used, the MBMS Client shall consider already received repair symbols when making the determination of the further symbols required. In this case, the client should either:

- identify a minimal set of specific symbols that, combined with the already received symbols, allows the MBMS FEC decoder to recover the file, or
- identify a number, r , of symbols such that reception of r previously unreceived symbols will allow the MBMS FEC decoder to recover the file.

9.3.4 Back-off timing the procedure initiation messaging for scalability

This clause describes a *back-off mode* for MBMS download to provide information on when a receiver that did not correctly receive some data from the MBMS sender during a transmission session can start a request for a repair session. In the following it is specified how the information and method a MBMS Client uses to calculate a time (*back-off time*), instance of the back-off mode, to send a file repair message to the MBMS server.

The back-off mode is represented by a *back-off unit*, a *back-off value*, and a *back-off window*. The two latter parameters describe the back-off time used by the MBMS Client.

The *back-off unit* (in the time dimension) defaults to *seconds* and it is not signalled.

The *back-off time* shall be given by an *offset time* (describing the back-off value) and a *random time period* (describing the back-off window) as described in the following clauses.

An MBMS Client shall generate random or pseudo-random time dispersion of *repair requests* to be sent from the receiver (MBMS Client) to the sender (MBMS server). In this way, the repair request is delayed by a pre-determined (random) amount of time.

The back-off timing of *repair request* messages (i.e. delaying the sending of *repair requests* at the receiver) enhances system scalability to the total number of such messages the system can handle without failure.

9.3.4.1 Offset time

The *OffsetTime* refers to the repair request suppression time to wait before requesting repair, or in other words, it is the time that a MBMS Client shall wait after the end of the MBMS data transmission to start the file repair procedure. An associated procedure description instance shall specify the wait time (expressed in *back-off unit*) using the "offset-time" attribute.

9.3.4.2 Random time period

The *random time period* refers to the time window length over which a MBMS Client shall calculate a *random time* for the initiation of the file repair procedure. The method provides for statistically uniform distribution over a relevant period of time. An associated procedure description instance shall specify the wait time (expressed in *back-off unit*) using the "random-time-period" attribute.

The MBMS Client shall calculate a uniformly distributed *random time* out of the interval between 0 and *random time period*.

9.3.4.3 Back-off time

The sending of the file *repair request* message shall start at $\text{back-off time} = \text{offset-time} + \text{random time}$, and this calculated time shall be a relative time after the MBMS data transmission. The MBMS Client shall not start sending the repair request message before this calculated time has elapsed after the initial transmission ends.

9.3.4.4 Reset of the back-off timer

The reception of an updated (higher version number) *associatedDeliveryProcedureDescription* and/or an updated *sessionDescription* shall overwrite the timer parameters used in the back-off algorithm. Except in the case that the offset-time, random-time-period and session end time parameters are identical to the earlier version; the back-off time shall be recalculated. For currently running timers this requires a reset.

9.3.5 File repair server selection

9.3.5.1 List of server URIs

A list of symbol-based file repair service URIs is provided as elements of the Associated Delivery procedure fragment's *postFileRepair* element. A list of byte-range based repair servers may be additionally provided as elements of the FDT. Service URIs host identity may also be given as IP addresses, which may be used to avoid a requirement for DNS messaging. The file repair service URIs of a single associated delivery procedure description shall be of the same type, e.g. all IP addresses of the same version, or all domain names. The number of symbol-based file repair service URIs is determined by the number of *serviceURI* elements, each of which shall be a child-element of the *procedure* element. The *serviceURI* element provides the references to the file repair server's resource via the *xs:anyURI* value. At least one *serviceURI* element shall be present. The number of byte-range based file repair service URIs is determined by the number of *Alternate-Content-Location-1* and *Alternate-Content-Location-2* elements in the FDT. The *Alternate-Content-Location-1* and *Alternate-Content-Location-2* elements provide the references to the file repair server's resource via the *xs:anyURI* value. At least one *Alternate-Content-Location-1* element shall be present in the FDT if byte-range based file repair is to be supported by the network.

When present, the *Base-URL-1* and *Base-URL-2* elements provide base URLs against which to resolve a relative reference included in any *Alternate-Content-Location-1* or *Alternate-Content-Location-2* element, respectively.

When present, the *Availability-Time* attribute provides a method to inform the UE of an absolute time according to the UTC time standard until which the UE can expect that, if reachable and functioning, the file repair server will return the requested repair data.

9.3.5.2 Selection from the server URI list

There may be one or more file repair URIs of one or more types present in the Associated Delivery Procedure fragment and the FDT. Within a list, the UE randomly selects one of the service URIs from the list, with uniform distribution.

The MBMS Client shall exhaust (according to section 9.3.7.1) the list of highest priority URIs before moving to the list of next highest priority, etc.

The priority of file repair URI lists is:

- byte-range based repair servers included as *Alternate-Content-Location-1*
- byte-range based repair servers included as *Alternate-Content-Location-2*
- symbol-based repair servers

9.3.6 File Repair Request messages

9.3.6.0 General

Once missing file data is identified, the MBMS Client sends one or more messages to a file repair server requesting transmission of data that allows recovery of missing file data. All file repair requests and repair responses for a particular MBMS transmission shall take place in a single TCP session using the HTTP/1.1 protocol specified in RFC 9112 [18]). The repair request is routed to the file repair server IP address resolved from the selected file repair server URI.

The timing of the opening of the TCP connection to the server, and the first repair request, of a particular MBMS Client is randomized over a time window as described in clause 9.3.2. If there is more than one repair request to be made these are sent immediately after the first.

When a MBMS UE identifies symbols or the byte range of symbols in repair requests these symbols shall be source symbols, and should include all the missing source symbols of the relevant source block.

NOTE: These represent information for the file repair server and the BM-SC may use these source symbols and/or redundant symbols in providing the necessary repair data.

After the MBMS download session, the receiver identifies a set of encoding symbols that allow recovery of the missing file data and requests for their transmission in a file repair session.

There are two formats for the MBMS UE to request repair data: the Symbol-Based File Repair Request Message and the Byte-Range-based Request Message.

9.3.6.1 Symbol-based File Repair Request message format

In this message format, the MBMS UE requests specific encoding symbols and uniquely identifies these by the combination (URI, SBN, ESI). This message format shall be used if the MBMS UE is requesting symbols from a file repair server that only supports symbol-based file repair request messages, i.e., the server is listed in a "serviceURI" element of the Associated Delivery procedure. The file repair request shall either include the URI of the file for which it is requesting the repair data or an identifier of a set of files. The URI uniquely identifies the file (resource) and is found from the FLUTE FDT Instances. Additionally, the repair request for single files shall contain the MD5 hash value of the transport object, if present in the FDT instance declaring the file from which data is being requested. The MD5 hash value is used to identify a specific transport object and version of the file.

For completely missed files, a Repair Request may give only the URI of the file and optionally the MD5 hash value of the transport object of the file. If the MD5 hash value is not present, the server shall respond with the latest version of the file.

A set of files may be fetched using the File Repair server. A client may request all files from a specific FDT instance or a specific logical group of a particular MBMS User Services.

The client makes a file repair request using the HTTP request method GET as specified in RFC 9112 [18]. Further arguments are encoded into the URI query part (RFC 3986 [19]) as defined below and included in the HTTP GET request. If a number of previously unreceived symbols are requested for a specific Source Block, then the SBN is

provided along with the ESI of the symbol, which is subsequent in the symbol sequence to the latest received symbol for that source block and the number of symbols requested. If a number of previously unreceived source blocks are requested for a specific file, the URI should be provided along with an SBN range starting from the first missing source block and ending with the SBN of the last missing source block of the contiguous set of source block. Examples for requesting contiguous and non-contiguous ranges of symbols and source blocks or even entire files or group of files are given below.

For example, assume that in a MBMS download session a 3gp file with URI = `www.example.com/news/latest.3gp` was delivered to an MBMS Client. After the MBMS download session, the MBMS Client recognized that it did not receive two packets with SBN = 5, ESI = 12 and SBN=20, ESI = 27. If the selected repair service URI (from the associated delivery procedure meta data fragment) is `http://mbmsrepair1.example.com/path/repair_script`, only supports symbol-based file repair requests, and the MD5 value of that file is "ODZiYTU1OTFkZGY2NWY5ODh==", then the HTTP GET request is as follows:

```
GET /path/repair_script?fileURI=www.example.com/news/latest.3gp&Content-MD5=
ODZiYTU1OTFkZGY2NWY5ODh== &SBN=5;ESI=12&SBN=20;ESI=27 HTTP/1.1
Host: mbmsrepair1.example.com
```

A file repair session shall be used to recover the missing file data from a single MBMS download session only. If more than one file were downloaded in a particular MBMS download session, and, if the MBMS Client needs repair data for more than one file received in that session, the MBMS Client shall send separate HTTP GET requests for each file.

An HTTP client implementation might limit the length of the URL to a finite value, for example 256 bytes. In the case that the length of the URL-encoded (SBN, ESI) data exceeds this limit, the MBMS Client shall distribute the URL-encoded data into multiple HTTP GET requests.

In any case, all the HTTP GETs of a single file repair session shall be performed within a single TCP session and they shall be performed immediately one after the other.

In the following, we give the details of the syntax used for the above request method in ABNF.

In this case an HTTP GET with a normal query shall be used to request the missing data, according to RFC 9112 [18]]

- repair_request_http_URL = repair_service_URI "?" query
- repair_service_URI = <selected serviceURI from the Associated Delivery Procedure Description>

Where, for MBMS file repair request:

- query = std_query / alt_query
- std_query = file_uri ["&" content_md5] *("&" sbn_info)
- file_uri = "fileURI=" URI-reference; URI-reference is as defined in [19].
- content_md5 = "Content-MD5=" 1*(ALPHA / DIGIT / "+" / "/" / "=")
- sbn_info = "SBN=" sbn_range
- sbn_range = (sbnA ["-" sbnZ]) / (sbnA [";" esi_info])
- esi_info = "ESI=" ((esi_range *(";" esi_range))) / (esiA "+" number_symbols)
- esi_range = esiA ["-" esiZ]
- sbnA = 1*DIGIT; the SBN, or the first of a range of SBNs
- sbnZ = 1*DIGIT; the last SBN of a range of SBNs
- esiA = 1*DIGIT; the ESI, or the first of a range of ESIs
- esiZ = 1*DIGIT; the last ESI of a range of ESIs
- number_symbols = 1*DIGIT; the number of additional symbols required
- alt_query = service_id "&" (fdt_inst_id / fdt_group_id)
- service_id = "serviceId=" <value of the *serviceId* attribute of the User Service Description>

- `fdt_inst_id = "fdtInstanceId="` <as defined in clause 3.4.1 of [9] or in clause 7.4>
- `fdt_group_id = "fdtGroupId="` <value of the *Group* element as defined in clause 7.2.10.1>

Thus, the following symbols adopt a special meaning for MBMS download URI: ? - + , ; & =

One example of a query on encoding symbol 34 of source block 12 of a music file "www.example.com/greatmusic/number1.aac" using the provided repair service URI "http://mbmsrepair1.example.com/path/repair_script" is:

- `http://mbmsrepair1.example.com/path/repair_script?fileURI=www.example.com/greatmusic/number1.aac&SBN=12;ESI=34`

An example of requesting an entire file is

- `http://mbmsrepair1.example.com/path/repair_script?fileURI=www.example.com/greatmusic/number1.aac`

An example of requesting a specific source block from a specific file version is

- `http://mbmsrepair1.example.com/path/repair_script?fileURI=www.example.com/greatmusic/number1.aac&Content-MD5=ODZiYTU1OTFkZGY2NWY5ODh==`

For messaging efficiency, the formal definition enables several contiguous and non-contiguous ranges to be expressed, as well as a number of symbols with ESIs of a given value or above in a single query:

- An entire file (like in the above example).
- A symbol of a source block (e.g. `...&SBN=12;ESI=23`).
- A range of symbols for a certain source block (e.g. `...&SBN=12;ESI=23-28`).
- A number of symbols with ESIs of a given value or above (e.g. `...&SBN=12;ESI=120+10`).
- A list of symbols for a certain source block (e.g. `...&SBN=12;ESI=23,26,28`).
- All symbols of a source block (e.g. `...&SBN=12`).
- All symbols of a range of source blocks (e.g. `...&SBN=12-19`).
- non-contiguous ranges (e.g. 1. `...&SBN=12;ESI=34&SBN=20;ESI=23` also, * e.g. 2. `...&SBN=12 19&SBN=28;ESI=23-59&SBN=30;ESI=101`).

An example to request all file of a particular FDT instance is given below:

- `http://mbmsrepair1.example.com/path/repair_script?serviceId=urn:3gpp:0010120123hotdog&fdtInstanceId=12`

9.3.6.2 Byte-Range-based File Repair Request message format

In this message format, the MBMS UE uses the conventional HTTP/1.1 GET or partial GET requests as specified in RFC 9112[18] to request all or a subset of source symbols of the referenced resource, respectively. The UE shall support these message requests formats to allow the file repair requests to be serviced by a standard HTTP/1.1 server. These message formats shall be used if the MBMS UE is requesting symbols from a file repair server that supports byte range requests, i.e., the server is listed in the *Alternate-Content-Location-1* or *Alternate-Content-Location-2* elements in the FDT.

The MBMS UE uses the HTTP GET request when it requires all the source symbols of the resource to be transmitted.

If the MBMS UE only requests transmission of a subset of the source symbols or sub-symbols the UE uses the HTTP partial GET request with the Range request header as specified in section 14.2 of RFC 9110 [155]. The MBMS UE shall indicate the specific source symbols or sub-symbols as a *bytes range specifier* as specified in section 14.1.2 of RFC 9110 [155].

For messaging efficiency, the HTTP GET method allows the UE to include multiple byte range requests within a single partial GET request. If the UE includes multiple byte ranges in a single request the HTTP GET request should not exceed 2048 bytes in length to avoid truncation by the HTTP server.

If the MBMS UE determines that it can select among multiple subsets of the source symbols or sub-symbols, the MBMS UE should request the subset with the lowest ESI values, i.e., choose the missing source symbols or sub-symbols from the beginning of the source block or source sub-block, respectively. This improves the caching efficiency of the HTTP file repair servers.

If more than one file were downloaded in a particular MBMS download session, and, if the MBMS Client needs repair data for more than one file received in that session, the MBMS Client shall send separate HTTP GET requests for each file.

If *File-ETag* is present in the FDT Instance, its value shall be used as the entity-tag in the *If-Match* or *If-Range* header of a conditional byte-range file request, as specified in sections 13.1.1 and 13.1.5 respectively of RFC 9110 [155].

If *File-ETag* is not present in the FDT Instance, but *Content-MD5* is, the latter may be used as the entity tag in the *If-Match* or *If-Range* header of a conditional byte-range file request, or the UE may choose to send an HTTP GET request containing the *Range* header for the requested byte range(s), without the *If-Match* or *If-Range* header.

For the UE, the nominal objective of using the *If-Match* header is to receive the requested range(s) of the file associated with the entity tag, or no repair data if the request cannot be satisfied by the repair server. The nominal objective of using the *If-Range* header is to receive the latest version of the entire file in case the version associated with the entity tag is no longer available on the repair server. To reduce the impact to capacity, the UE should not use the *If-Range* header if it can request the range(s) from other repair servers.

If the *Content-Encoding* element is included in the FDT Instance for the file and is set to "gzip", then the MBMS UE shall make the request to a modified URL, that is, the original file URL with the ".gz" extension added to the full path name but prior to the query part of the URL, if any. The MBMS UE shall only use this request if a) the *File-ETag* attribute is present in the FDT Instance of that file, for use as the entity-tag in the request, or b) the *Content-MD5* attribute is present in the FDT Instance for that file, for use as the entity-tag in the request. Otherwise, the MBMS UE should rather request the complete file instead of using byte range requests.

As an example, a FLUTE receiver partially receives the transport object with URL "http://www.example.com/service1/document.pdf", *Content-Encoding* set to "gzip", and with the *Content-MD5* set to "B2B359591E961C6B0F468FE536BCD920=" while the *File-ETag* attribute is absent in the FDT Instance. It issues a repair request to the host server to fetch the missing bytes. The request is as follows:

```
GET /service1/document.pdf.gz HTTP/1.1
If-Match: "B2B359591E961C6B0F468FE536BCD920="
Range: bytes=5018640-5042399
Host: www.example.com
```

The conditional request is used by the repair server to ensure that the byte range it will serve to the client is from the exact same compressed file. The conditional repair procedure is described earlier in this section.

As a second example, assume that the *Alternate-Content-Location-1* element in the FDT Instance of the file indicates that byte range repair requests are supported by the HTTP server at URI "http://www.example.com/service1/news_service/latest_news.mp4". The UE determines that it requires the byte ranges 5018640-5042399 and 19037040-19050239. The *Content-MD5* attribute provided in the FDT Instance of the file is Base64 encoded as B2B359591E961C6B0F468FE536BCD920, and the *File-ETag* attribute is absent in the FDT Instance. The HTTP GET request may look as follows:

```
GET /service1/news_service/latest_news.mp4 HTTP/1.1
If-Match: "B2B359591E961C6B0F468FE536BCD920="
Range: bytes=5018640-5042399,19037040-19050239
Host: www.example.com
```

In case the version identifier, indicated by the *Content-MD5* value as the entity-tag in the *If-Match* header cannot be matched, the server replies with a 412 "Precondition Failed" reply. Otherwise, the server satisfies the request and replies with a 206 "Partial Content" if the request would be successful without the 'If-Match' header.

The following is an example of a response from the repair server:

```
HTTP/1.1 412 Precondition Failed
Content-Range: bytes=5018640-5042399,19037040-19050239
ETag: "B2B359591E961C6B0F468FE536BCD920="
Content-Length: 0
```

As a third example, assume that the *Alternate-Content-Location-1* element in the FDT Instance of the file indicates that byte range repair requests are supported by the HTTP server at URI http://www.example.com/service2/

magazine_service/article_xyz.pdf. The UE determines that it requires the byte ranges 5000-7999 and 25500-40500. The *File-ETag* attribute is present in the FDT Instance and its value is "10690a1-4f2-40d45ae1". The HTTP GET request may look as follows:

```
GET /service2/magazine_service /article_xyz.pdf HTTP/1.1
If-Match: "10690a1-4f2-40d45ae1"
Range: bytes=5000-7999, 25500-40500
Host: www.example.com
```

In this example, the version identifier of the file, represented by the value of the FDT Instance's *File-ETag* and used as the entity-tag in the *If-Match* header, matches the file version at the byte-range repair server. The server will send a 206 "Partial Content" response, providing the requested byte ranges in the payload:

```
HTTP/1.1 206 Partial Content
Date: Wed, 15 Nov 2015 06:25:24 GMT
ETag: "10690a1-4f2-40d45ae1"
Content-Length: 18001
Content-Type: multipart/byteranges; boundary=SEPARATION_STRING
--SEPARATION_STRING
Content-Type: application/pdf
Content-Range: bytes 5000-7999
...<the first range>...
-- SEPARATION_STRING
Content-type: application/pdf
Content-range: bytes 25500-40500
...<the second range>...
-- SEPARATION_STRING
```

9.3.7 File Repair Response message

9.3.7.0 General

Once the MBMS file repair server has assembled a set of encoding symbols that contain sufficient data to allow the UE to reconstruct the file data from a particular file repair request, the MBMS file repair server sends one message to the UE. Each file repair response occurs in the same TCP and HTTP session as the repair request that initiated it.

An MBMS Client shall be prepared for any of these five response scenarios:

- The server returns a repair response message where a set of encoding symbols forms an HTTP payload as specified below (see clause 9.3.7.2 for details).
- The server returns a repair response message where a byte range or set of byte ranges forms an HTTP payload as specified below (see clause 9.3.7.2a for details).
- The server returns the requested file or file groups (see clause 9.3.7.5 for details).
- The server redirects the client to a broadcast/multicast delivery (an MBMS download session).
- The server redirects the client to another file repair server (if a server is functioning correctly but is temporarily overloaded).
- An HTTP error code is returned (note that clause 9.3.8 describes the case of no server response).

For (reasonably) uniformly distributed random data losses, immediate point-to-point HTTP delivery of the repair data will generally be suitable for all clients. However, broadcast/multicast delivery of the requested data may be desirable in some cases:

- A repeat MBMS download (all or part of the files from a download session) is already scheduled and the BM-SC prefers to handle repairs after that repeat MBMS download.
- Many UEs request download data (over a short period of time) indicating that broadcast/multicast delivery of the repaired data would be desirable.

In this case a redirect to the broadcast/multicast repair session for UEs that have made a repair request would be advantageous.

9.3.7.1 Symbol-based File Repair Response message codes

The response codes of HTTP servers to the byte-range-based repair request message in clause 9.3.6.2 are specified in section 15 of RFC 9110[155]. The response codes of symbol-based file repair servers to the symbol-based repair request message in clause 9.3.6.1 are specified as follows.

In the case that the file repair server receives a correctly formatted repair request which it is able to understand and properly respond to with the appropriate repair data, the file repair server shall attempt to serve that request without an error case.

For a direct point-to-point HTTP response with the requested data, the file response message shall report a 200 OK status code, and the file repair response message shall consist of HTTP header and file repair response payload (HTTP payload), as defined in clause 9.3.7.2. If the client receives a 200 OK response with fewer than all the quantity of requested symbols it shall assume that the file repair server wishes the missing symbols to be requested again (due to its choice or inability to deliver those symbols with this HTTP response).

For a redirect case the file repair server uses the HTTP response status code 302 (Found - Redirection) to indicate to the UE that the resource (file repair data) is temporarily available via a different URI. The temporary URI is given by the Location field in the HTTP response. In the case of a redirect to another file repair server, this temporary URI shall be the URL of that repair server.

In the case of a redirect to a broadcast/multicast delivery, the temporary URI shall be the URI of the Session Description (SDP file) of the broadcast/multicast (repair) session as described in clause 9.3.7.3. Other HTTP status codes specified in section 15 of RFC 9110 [155]) shall be used to support other cases. Other cases may include server errors, client errors (in the file repair request message) and server overload.

In case the file repair server does not find the requested file (file with given fileURI is found), the server shall respond with "400 Bad Request" and optionally with "0001 File not found" in the response body. As a result, the MBMS UE may choose another file repair server as defined in clause 9.3.5.

In case the file repair server does not find the requested version of the requested file (file with given fileURI is found but Content-MD5 is not found), the server shall respond with "400 Bad Request" and optionally with "0002 Content-MD5 not valid" in the response body. As a result, the MBMS UE may choose another file repair server as defined in clause 9.3.5. Or the MBMS UE may request the latest version of the file and discard the previously received chunks of the file. Note, the MBMS UE can request the latest version of a file by using only the fileURI argument in the file repair request.

NOTE: In the case of repetitive server errors, the client is not expected to go through the complete list of available file repair servers, and may abandon after a limited number of attempts.

If the file repair server does not find any of the requested SBN or ESI values, it shall respond with the "400 Bad Request" and optionally with "0003 SBN or ESI out of range" in the response body. As a result, the UE should discard all received chunks of the file and request the entire file from the file repair server.

If the file repair server receives unknown query line arguments, it shall respond with "501 Not Implemented". The server should add the HTTP/1.1 "Server" header with the value "MBMS/6". As a result, the client should try to fetch the entire file from the file repair server. Note, this behaviour is intended to make the file repair service forward compatible and allow addition of new function in later releases.

If the file repair server does not find the requested serviceId value, it shall respond with the "400 Bad Request" and optionally with "0004 ServiceId not found" in the response body. As a result, the UE should request the needed file separately using the fileURI query line argument.

In case the file repair server does not find the requested fdtInstanceId value, it shall respond with the "400 Bad Request" and optionally with "0005 fdtInstanceId not found" in the response body. As a result, the UE should request the needed file separately using the fileURI query line argument.

If the file repair server does not find the requested fdtGroupId value, it shall respond with the "400 Bad Request" and optionally with "0006 fdtGroupId not found" in the response body. As a result, the UE should request the needed file separately using the fileURI query line argument.

If the file repair server is, or is about to, experiencing an overload condition, it should respond with the "503 Service Unavailable" that can include a *Retry-After* header. As a result, the UE should stop the file repair procedure to that file repair server. The UE shall consider this server unavailable for this file repair session, or, if supported by the UE, for the

period of time indicated in the *Retry-After* header, The UE may immediately try an alternative available file repair server. The UE may re-try the current file repair server after the *Retry-After* time has elapsed. In the case that all known file repair servers have been exhausted in this manner, the UE shall cease the file repair procedure. When the time in *Retry-After* header is expressed as an integer number of seconds then it is relative to the reception time of the "503 Service Unavailable".

HTTP response error messages may contain a message body, which gives a more detailed error message. The MIME type of such message body shall be in text/plain. The syntax of the HTTP error message body is defined in ABNF per RFC 5234 [23] as follows:

http-error-body = error-code (SP / HTAB) error-description CRLF

error-code = 4DIGIT

error-description = 1*(SP / VCHAR)

Note that the following error messages MAY be used in the message body of the HTTP response error messages.

0001 File not found

0002 Content-MD5 not valid

0003 SBN or ESI out of range

0004 ServiceId not found

0005 fdtInstanceId not found

0006 fdtGroupId not found

9.3.7.2 Symbol-based File Repair Response message format for HTTP carriage of repair data

The format of the response message to the symbol-based repair request message in clause 9.3.6.1 is specified here.

The file repair response message consists of HTTP header and file repair response payload (HTTP payload).

The HTTP header shall provide:

- HTTP status code, set to 200 OK for the case of a successful request.
- Content type of the HTTP payload (see below).

NOTE: Other HTTP response headers specified in RFC 9110 [155] may also be used but are not mandated by this mechanism.

The Content-Type response header shall be set to "application/simpleSymbolContainer", which denotes that the message body is a simple container of encoding symbols as described below.

This header is as follows:

- HTTP/1.1 200 OK
- Content-Type: application/simpleSymbolContainer

NOTE: Other HTTP headers specified in RFC 9110 [155] may also be used but are not mandated by this mechanism.

Encoding symbols are included in the response in groups. Each group is preceded by an indication of the number of symbols within the group and an FEC Payload ID coded according to the FEC scheme used for the original file delivery session. The FEC Payload ID identifies all the symbols in the group in the same way that the FEC Payload ID of an FEC source or repair packet identifies all the symbols in the packet. The file repair response payload is constructed by including each FEC Payload ID and Encoding Symbol group one after another (these are already byte aligned). The order of these pairs in the repair response payload may be in order of increasing SBN, and then increasing ESI, value; however no particular order is mandated.

A single HTTP repair response message shall contain, at the most, the same number of symbols as requested by the respective HTTP repair request message.

The UE and file repair server already have sufficient information to calculate the length of each encoding symbol and each FEC Payload ID. All encoding symbols are of the same length with the possible exception of the last source encoding symbol in the repair response. All FEC Payload IDs are the same length for one file repair request-response as a single FEC Scheme is used for a single file.

Figure 17: Void

Figure 9.3.7-1 illustrates the complete file repair response message format (box sizes are not indicative of the relative lengths of the labelled entities).

HTTP Header		
Length Indicator	FEC Payload ID	Encoding Symbols
Length Indicator	FEC Payload ID	Encoding Symbols
Length Indicator	FEC Payload ID	Encoding Symbols

Length Indicator (2 bytes): indicates the number of encoding symbols in the group (in network byte order, i.e. high order byte first)

FEC Payload ID: indicates which encoding symbols are included in the group. The format and interpretation of the FEC Payload ID are dependent on the FEC Scheme in use.

Encoding Symbols: contain the encoding symbols. All the symbols shall be the same length.

Figure9.3.7-1: File Repair Response Message Format

9.3.7.2a Byte-Range-based File Repair Response message format for HTTP carriage of repair data

The response message to the byte-range-based repair request message in clause 9.3.6.2 follows the format and procedures specified in section 14.4 of RFC 9110 [155] for responding to byte range requests.

When the HTTP message includes the content of a single byte range the repair server can provide the HTTP response with a "206 Partial content" status, include the Content-Range header, and use the range-resp to indicate the byte range of the repair data as specified in 14.4 of RFC 9110 [155].

When the repair server receives a request for multiple byte ranges it should attempt to transmit all the requested ranges in a single HTTP response. When an HTTP message includes multiple byte ranges, these are transmitted as a multipart message using the "multipart/byteranges" media type as defined in section 14.6 of RFC 9110 [155].

9.3.7.3 File Repair response for broadcast/multicast of repair data

Details of how a file repair server decides, or is instructed, to use broadcast/multicast repair instead of point-to-point over HTTP are implementation specific and beyond the scope of the present document.

Prior to the decision to use broadcast/multicast repair, each repair response shall be provided by HTTP according to clause 9.3.7.2 or clause 9.3.7.2a.

The file repair server uses the HTTP response status code 302 (Found - Redirection) to indicate to the UE that the resource (file repair data) is temporarily available via a different URI. The temporary URI is given by the Location field in the HTTP response and is the URI of the Session Description (SDP file) of the broadcast/multicast repair session.

Where feasible, it is recommended that the same download session that delivered the original data be used for the broadcast/multicast repair. If this conflicts with the session end time limit of the Session Description then a new version of the Session Description shall be sent with an updated (extended) session end time. This shall be sent in-band of that download session.

In some cases this may not be feasible and a different (possibly new) download session may be defined for the repair.

The SDP file for broadcast/multicast repair session may be carried as payload (entity-body) in the HTTP response - which is especially useful if the broadcast/multicast repair session is a new (or recently end time modified) FLUTE download session and other means of service announcement prior to this were not feasible.

The delivery method's Associated Delivery Procedures Description (see clause 9.5) may be updated and the new version transmitted in-band with the download session so that currently active client back-off timers are reset, thus minimizing additional client requests until after the broadcast/multicast repair session. The server shall be prepared for additional requests in any case as successful reception of the updated Associated Delivery Procedures Description cannot be assured in all cases.

The existence of a broadcast/multicast file repair session is signalled by the inclusion of the optional *bmFileRepair* procedure in the updated Associated Delivery procedure description. This is signalled by the *bmFileRepair* element with a single *sessionDescriptionURI* attribute of type *xs:anyURI* which specifies the URI of the broadcast/multicast file repair session's session description.

In the cases where the same IP addressing is used for the broadcast/multicast repair session as the original download session, the UE simply shall not leave the group. Otherwise, the UE shall join to the MBMS bearer for the repair session as it would for any MBMS session.

A broadcast/multicast file repair session behaves just as an MBMS download session, and the determination of end of files and session, and use of further associated delivery procedures uses the same techniques as specified for the MBMS download delivery method.

9.3.7.4 File Repair Response Message Format for HTTP carriage of complete files

The file repair response message consists of HTTP header and one or more complete files.

The HTTP header shall provide:

- HTTP status code, set to 200 OK for the case of a successful response.
- Content type shall be set to multipart/related

NOTE: Other HTTP headers specified in RFC 9110 [155]) may also be used but are not mandated by this mechanism.

The server shall encapsulate the requested files into a multipart MIME container. Each part of the multipart MIME container shall contain at least the *Content-Location* of the embedded files.

9.3.8 Server not responding error case

In the error case where a UE determines that its selected file repair server is not responding it shall return to the *serverURI* list of repair servers and uniformly randomly select another server from the list, excluding any servers it has determined are not responding. All the repair requests message(s) from that UE shall then be immediately sent to the newly selected file repair server.

If all of the repair servers from the *serverURI* list are determined to be not responding, the UE may attempt an HTTP GET to retrieve a, potentially new, instance of the session's Associated Procedure Description; otherwise, UE behaviour in this case is unspecified.

A UE determines that a file repair server is not responding if any of these conditions apply:

1. The UE is unable to establish a TCP connection to the server.
2. The server does not respond to any of the HTTP repair requests that have been sent by the UE (it is possible that second and subsequent repair requests are sent before the first repair request is determined to be not-responded-to).
3. The server returns an unrecognized message (not a recognizable HTTP response).
4. The server returns an HTTP server error status code (in the range 500 to 505).

9.3.9 Full file repair without the FDT

9.3.9.1 Introduction

When an MBMS UE is unable to receive a file of interest and its associated FDT Instance over MBMS bearers (e.g., UE is outside of MBMS coverage or tunes in between session occurrences of a Datacasting service), the UE may use the following procedures to retrieve the file.

9.3.9.2 File Repair Using the *FileSchedule*

When the *fileSchedule* element is provided in the Schedule Description metadata fragment, the MBMS UE may use the *fileURI* element in the *fileSchedule* to request the file of interest in accordance with the file repair procedures specified in clause 9.3, i.e., the back-off timing procedures (clause 9.3.4), symbol-based repair server selection (clause 9.3.5) and Repair Request Message format (clause 9.3.6.1).

9.3.9.3 File Repair Using the *FDTInstanceURI* in the Session Schedule

When the *FDTInstanceURI* element is provided in the *sessionSchedule* of the Schedule Description metadata fragment, the MBMS UE may use this to retrieve the FDT Instance for the file(s) of interest. The UE determines the URI of the FDT Instance based on the *FDTInstanceURI* and when applicable, the session *index* value for the session occurrence as specified in clause 11.2A.1.2.

From the time that the transmission of files for a session occurrence is considered complete (see clause 9.3.2), the MBMS UE shall wait for the *Back-off Time* as specified in clause 9.3.4.3 to elapse before requesting the FDT Instance for the file(s) of interest via the HTTP GET method as specified in RFC 9112 [18]. The FDT Instance is identified in the response by the MIME media type "application/fdt+xml" and should fully describe (i.e., contains all necessary FDT file description entries) all of the files delivered in the session occurrence. After receiving the FDT Instance, the MBMS Client shall request any file(s) of interest described by that FDT Instance using the server selection procedures specified in clause 9.3.5 and the symbol-based or byte-range-based Request Message formats specified in clauses 9.3.6.1 and 9.3.6.2, respectively.

9.4 Reception reporting procedure

9.4.0 Generic reception reporting procedure description

Following successful reception of content whether through point-to-multipoint MBMS bearers only, unicast bearers only, or using both point-to-multipoint and point-to-point bearers, a reception reporting procedure can be initiated by the MBMS Receiver (UE) to the BM-SC. For a DASH-over-MBMS service, the nominal reception reporting procedure may also include DASH QoE measurements as defined in TS 26.247 [98], provided to the MBMS Client by the DASH client. The additional procedure for such optional inclusion of DASH QoE metrics reporting is described in clause 9.4.8.

For MBMS Download Delivery method, and depending on the content of the MBMS User Service, the reception reporting procedure is used to report a) the complete reception of one or more files, or b) transport level statistics on the stream, or c) both report types a and b. In particular, for a DASH-over-MBMS service, application-level statistics on the media stream, in the form of DASH quality metrics, may be aggregated with the report of transport level statistics. For MBMS Streaming Delivery method, the reception reporting procedure is used to report statistics on the stream.

If the BM-SC provided parameters requiring reception reporting confirmation then the MBMS Receiver shall confirm the content reception.

If reception reporting is requested for statistical purposes the BM-SC may specify the percentage subset of MBMS receivers it would like to perform reception reporting. A different sample percentage value may be defined for DASH QoE reports relative to the sample percentage value defined for a nominal MBMS reception report, in deriving the probability of the DASH QoE reporting event given the occurrence of the MBMS reception report.

Transport errors can prevent an MBMS Receiver from deterministically discovering whether the reception reporting associated delivery procedure is described for a session, and even if this is successful whether a sample percentage is described. An MBMS Receiver shall behave according to the information it has even when it is aware that this may be incomplete.

The MBMS Receiver:

1. Identifies the completion of the reception of an MBMS session and its content items (e.g. a file, or a set of files within an MBMS download session). See clauses 9.4.1 and 9.4.2.
2. Determines the need to report reception. See clause 9.4.3.
3. Determines the ability to aggregate reception reports. See clause 9.4.4.
4. Selects a time (Request time) at which a reception report request will be sent and selects a server from a list - both randomly and uniformly distributed. See clauses 9.4.4 and 9.4.5.
5. Sends a *reception report request* message to the selected server at the selected time. In the event that the content components of an MBMS User Service instance are carried on multiple MBMS delivery sessions, each reception report request message shall identify the delivery session to which the report pertains. See clause 9.4.6.

Regarding the above rules for determining the need for, and subsequent occurrences of reception reports, each of these reception reports may also include one or more DASH QoE metrics reports, the rules on the generation of which are defined in clause 9.4.8.

Then the server:

1. Responds with a *reception report response* message either describing a success or an error case. See clause 9.4.7.

9.4.1 Identifying complete file reception from MBMS Download and determining download status

A file is determined to be completely downloaded when it is fully received and reconstructed by MBMS reception with FEC decoding (if FEC is actually used) and/or a subsequent File Repair Procedure (clause 9.3).

When compiling RACK reception reports for an MBMS download session, the failure or success of a file is determined after FEC decoding and any subsequent File Repair Procedure.

When compiling StaR, StaR-all, or StaR-only reception reports for an MBMS download session, the failure or success of a file is determined after FEC decoding and before any subsequent File Repair Procedure.

9.4.2 Identifying complete MBMS Delivery Session reception

If a schedule description fragment is received for a service, MBMS download sessions are considered complete when the *stop* time in the *sessionSchedule* adjusted to the specific session occurrence to account for any session reoccurrence when applicable, is reached.

If a Schedule Description fragment is not received for a service, the sessions (MBMS download and MBMS streaming) are considered complete when the "time to" value of the session description (from "t=" in SDP) is reached. Where the end time is unbounded (time to = 0) then this parameter is not used for identifying completed sessions.

MBMS download and MBMS streaming sessions are also considered complete when the UE decides to exit the session - where no further data from that session will be received. In this case the UE may or may not deactivate the MBMS bearer(s).

For MBMS download sessions, FLUTE provides a "Close session flag" (see clause 7.2.7) which, when used, indicates to the UE that the session is complete.

9.4.3 Determining whether a Reception Report is required

Upon full reception of a content item, or at the expiration of the periodic 'report interval' timer if present, or when a session is complete, the MBMS Receiver must determine whether a reception report is required. The reception report may additionally include the reporting of DASH QoE metrics, in the event of a DASH-over-MBMS service, as described in clause 9.4.8. An Associated Delivery Procedure Description indicates the parameters of a reception reporting procedure (which is transported using the same methods as the ones that describe File Repair).

A delivery method may associate zero or one associated delivery procedure descriptions with an MBMS delivery session. Where an associated delivery procedure description is associated with a session, and the description includes a

postReceptionReport element, the UE shall initiate a reception reporting procedure. Reception reporting behaviour depends on the parameters given in the description as explained below.

The Reception Reporting Procedure is initiated if:

- a. A *postReceptionReport* element is present in the associated procedure description instance, and/or if the QoE reporting according to clause 8.3.2.2 is activated.

For report types StaR, StaR-all, and StaR-only, if the *r14:reportInterval* attribute is present under *postReceptionReport*, then whenever the UE starts consumption of the MBMS User Service of concern, it is expected to reset its corresponding 'report interval' timer to the value of that attribute and begin count down of the timer. Whenever the UE stops the consumption of the same service, it is expected to disable its corresponding 'report interval' timer and transmit the last report, if required and in accordance to the rules defined in clause 9.4.0.

If *r14:reportInterval* is present and the "Sending-Rate" parameter of the SDP is set to "Periodic", QoE metrics completely gathered during the ending *reportInterval* period shall be inserted into the reception report request message. If the "Sending-Rate" parameter of the SDP is set to "End", then the QoE metrics shall be sent at the end of the session.

NOTE: In case of "Periodic" sending-rate, the UE shall report all metrics that have been completely gathered (linked to "Measure-Resolution" or "Measure-Range" if present). If QoE metrics are currently being calculated but gathering is not finished, the UE shall not send such metrics and wait for the next *reportInterval* time to send this currently accumulating data. Similar rule shall apply to the reporting of successful and/or failed file reception and associated reception details, i.e. if such file reception information is currently being calculated but its collection is not yet finished, the UE shall defer the reporting of this information and wait until the occurrence of the next *reportInterval* time to do so.

In the event that the UE determines a selection for reporting to both active reporting procedures, it should comply with both reporting configurations. Should such separate reporting not be desirable due to, for example, report compilation complexity, reception reporting in accordance to OMA-DM should take precedence over reporting in accordance with the Associated Delivery Procedure.

One of the following will determine the UE behaviour:

- b. *reportType* is set to RAck (Reception Acknowledgement). Only successful file reception is reported without reception details.
- c. *reportType* is set to StaR (Statistical Reporting for successful reception). Successful file reception is reported (as with RAck) with reception details for statistical analysis in the network.
- d. *reportType* is set to StaR-all (Statistical Reporting for all content reception). The same as StaR with the addition that failed reception is also reported. StaR-all is relevant to both streaming and download delivery.
- e. *reportType* is set to StaR-only (Statistical Reporting without Reception Acknowledgement). The same as StaR-all with the exception that individual files are not acknowledged. Only reception details are reported for the session for both streaming and download delivery. StaR-only is equivalent to StaR-all for streaming delivery. StaR-all is relevant to download delivery where session performance is obtained through QoE metrics.

The *reportType* attribute is optional and behaviour shall default to RAck when it is not present.

If a *reportType* attribute is included, and set to an unknown value, then it shall be ignored by the receiver (i.e. the UE).

The *samplePercentage* attribute can be used to set a percentage sample of receivers which should report reception. This can be useful for statistical data analysis of large populations while increasing scalability due to reduced total uplink signalling. The *samplePercentage* takes on a value between 0 and 100, including the use of decimals. It is recommended that no more than 3 digits follow a decimal point (e.g. 67.323 is sufficient precision).

The *samplePercentage* attribute is optional and behaviour shall default to 100 (%) when it is not present. The *samplePercentage* attribute may be used with StaR, StaR-only and StaR-all, but shall not be used with RAck.

When the *samplePercentage* is not present or its value is 100 each UE which entered the associated session shall send a reception report. If the *samplePercentage* were provided for reportType StaR, StaR-only and StaR-all and the value is less than 100, the UE generates a random number which is uniformly distributed in the range of 0 to 100. The UE sends the reception report when the generated random number is of a lower value than the *samplePercentage* value.

In the case of a DASH-over-MBMS service, the determination of whether a DASH QoE metrics report shall be attached to the nominal reception report parameters, assuming the presence of the *r13:DASHQoEProcedure* child element of the *associatedProcedureDescription* element, is specified by an additional target probability, as given by the *DASHQoESamplePercentage* element. The details are specified in clause 9.4.8.

9.4.4 Request time selection

The MBMS receiver selects a time at which it is to issue a delivery confirmation request. The default start time for the reception reporting procedure is defined in clause 9.3.2.

Back-off timing is used to spread the load of delivery confirmation requests and responses over time.

Back-off timing is performed according to the procedure described in clause 9.3.4. The *offsetTime* and *randomTimePeriod* used for delivery confirmation may have different values from those used for file-repair and are signalled separately in the reception reporting description of the associated delivery procedure description instance.

In general, reception reporting procedures may be less time critical than file repair procedures. Thus, if a *postFileRepair* timer may expire earlier than a *postReceptionReport*, radio and signalling resources may be saved by using the file repair point-to-point PDP context (and radio bearer) activate period also for reception reporting (to remove the delay and signalling of multiple activations and deactivations over time).

The default behaviour is that a UE shall stop its *postReceptionReport* timers which are active when a *postFileRepair* timer expires, and the UE shall send the corresponding reception report(s) immediately following the file repair procedure on the point-to-point communication setup for file repair.

In some circumstances, the system bottleneck may be in the server handling of reception reporting. In this case the *forceTimeIndependence* attribute may be used and set to true. (false is the default case and would be a redundant use of this optional attribute). When *forceTimeIndependence* is true the UE shall not use file repair point-to-point connections to send reception reporting messages. Instead, it will allow the timers to expire and initiate point-to-point connections dedicated to reception report messaging.

A UE may aggregate multiple reception reports together to be more efficient. When a UE has determined that a reception report is required, the UE may determine that if a currently pending reception report exists, these reception reports may be aggregated and sent together.

In the case that a UE decides to aggregate more than one reception reports together from across different user services, the UE shall collect the new reception report and the *postReceptionReport* timer for this aggregated bundle shall be set to the lowest remaining *postReceptionReport* timer of the individual reception reports in the aggregated bundle.

In the case that a UE decides to aggregate more than one reception reports together within a user service, the UE shall collect the new reception report and the *postReceptionReport* timer for this aggregated bundle shall be set according to the first reception report and remain unchanged during any further aggregation (i.e., equal to the sum of the *offsetTime* and the generated *randomTimePeriod* of the first reception report in the aggregated bundle).

In the case of aggregating reception reports from within a user service, if a UE has generated a random number to compare against *samplePercentage* (in the case that *samplePercentage* is used), this number shall persist until the aggregated reception report bundle is sent. This means that an original decision to report or not persists until the end of a session. In the case of aggregating across services, the various generated random numbers to compare against *samplePercentage* remain independent from other services.

These reception reports are then aggregated as in clause 9.4.6 and the aggregated bundle shall be sent at the expiration of the *postReceptionReport* timer, assuming no further aggregation.

For StaR, StaR-only and StaR-all, session completeness – according to clause 9.4.2 – shall determine the back-off timer initialization time.

For Rack, the complete download session – according to clause 9.4.2 – as well as completing any associated file repair delivery procedure shall determine the back-off timer initialization time. RACKs shall be only sent for completely received files.

9.4.5 Reception Report server selection

Reception report server selection is performed according to the procedure described in clause 9.3.5.2.

In the case of an aggregated reception report, the server URI list shall be the subset of server URIs common to all reports.

9.4.6 Reception Report request message

Once the need for reception reporting has been established, the MBMS Client sends one or more Reception Report messages to the reception report server URI. The report message shall include the parameters associated with the nominal MBMS reception report type (i.e. one of the following categories: RACK, StaR, StaR-all and StaR-any). It may optionally include the report by the DASH client of DASH quality metrics as defined in [98], and in accordance to the parameters and procedure specified in clause 9.4.8. A reception report message shall not be used to only carry DASH QoE metrics of a DASH-over-MBMS service. All Reception Report requests and responses for a particular MBMS transmission should take place in a single TCP session using the HTTP/1.1 protocol as specified in RFC 9112 [18].

The Reception Report request shall include the URI of the file for which delivery is being confirmed. URI is required to uniquely identify the file (resource).

The client shall make a Reception Report request using the HTTP POST request as specified in RFC 9112 [18] carrying XML formatted metadata for each reported received content (file). An HTTP session shall be used to confirm the successful delivery of a single file. If more than one file were downloaded in a particular MBMS download multiple reception reports shall be added in a single POST request.

Each Reception Report is formatted in XML according to the XML schema specified in clause 9.5.3. An informative example of a single reception report XML object is given in clause 9.5.3.2.

Multipart MIME (multipart/mixed) may be used to aggregate one or more small XML files of individual reports to a larger object. The aggregated multipart MIME file may contain only nominal MBMS reception reports, or any combination of one or more MBMS reception reports along with one or more DASH QoE metrics reports. For Reception Acknowledgement (RACK) a *receptionAcknowledgement* element shall provide the relevant data. In the event that the content components of an MBMS User Service instance are delivered on multiple MBMS delivery sessions, each Reception Report request shall identify the corresponding session as given by the attribute *sessionId* of the *receptionAcknowledgement* element.

For Statistical Reporting (StaR) one or more *statisticalReport* elements shall provide the relevant data. In the event that the content components of an MBMS User Service instance are delivered on multiple MBMS delivery sessions, the *sessionId* attribute for any given StaR type of reception report (StaR, StaR-all or StaR-only), i.e., *receptionReport.statisticalReport.qoeMetrics.mediaLevel_qoeMetrics@sessionId*, shall provide the identity of the session for that StaR reception report.

Multiple reception reports, along with zero or more DASH QoE metrics reports, may be aggregated together in order to reduce radio resources and HTTP transactions. In the case that sessions are close together as defined in clause 9.4.4, two or more reception reports should be aggregated together at the client.

NOTE 1: The following text in the present clause on RACK and/or StaR-related types of reception reports addresses aggregation only for nominal MBMS reception reports. Inclusion of DASH QoE reports in the aggregated report file is not precluded.

There are two possible mechanisms for aggregating reception reports. In the case of StaR (StaR, StaR-all, StaR-only):

- a single reception report should contain multiple *statisticalReport* elements, each relating to a different *serviceId*.
- alternatively, multipart MIME (multipart/mixed) may be used to aggregate several reception report XML files.

In the case of RACK reporting:

- multipart MIME (multipart/mixed) may be used to aggregate several reception report XML files.

For both RACK and StaR/StaR-all (mandatory):

- For download, one or more *fileURI* elements shall specify the list of files which are reported. If the Content-MD5 value of the file is present in the FDT, it shall be provided in the Content-MD5 attribute in the reception report.

NOTE 2: This allows unambiguous identification of the files.

For RACK reporting, the following attributes may be included:

- A *clientId* and a *deviceId* attribute, whose format is the same as that defined below for *clientId* and *deviceId* under StaR/StaR-all/StaR-only. If present, they shall be included in at least the first instance of the *fileURI* elements to allow identification of the client and the device that has received the file(s) identified by all instances of the *fileURI* element in the RACK report.
- A *sessionId* attribute, whose format is the same as that defined below for *sessionId* under StaR/StaR-all/StaR-only. If present, it shall be included in at least the first instance of the *fileURI* elements.
- For the StaR-all mode only, a list of the number of received symbols and a list of the total number of source symbols shall be provided for failed blocks of the file, if any. Both lists are tabulated before any unicast file repair procedures. Thus, the lists are provided for failed files, and for successfully received files that required unicast file repair procedures.

For only StaR/StaR-all/StaR-only (all optional):

- Each *fileURI* element has an optional *receptionSuccess* status code attribute which defaults to "true" ("1") when not used. This attribute shall be used for StaR-all reports. This attribute shall not be used for StaR reports. This attribute is not relevant for StaR-only reports.
- Each QoE Metrics element has a set of attributes and any number of media level QoE Metrics elements. All attributes are defined in clause 9.5.3 and correspond to the QoE metrics listed in clause 8.4.2. Individual metrics, both at session and at media level can be selected via SDP as described in clause 8.3.2.1.

NOTE 3: The *medialevel_qoeMetrics* element is nominally used to declare QoE metrics associated with RTP streaming content. For a StaR-type reception report pertaining to media components of a DASH-over-MBMS service, only the *sessionId* attribute (i.e., none of the other attributes of this element) should be present under *medialevel_qoeMetrics*.

- The *sessionId* attribute identifies the delivery session. If the *sessionType* is "download", *sessionId* is of the format *source_IP_address* + ":" + *flute-tsi*. If the *sessionType* is "streaming", *sessionId* is of the format *source_IP_address* + ":" + *RTP_destination_port*.
- The *sessionStartTime* and *sessionStopTime* attributes identifies the time when the session was started and stopped, respectively. The values of each attribute corresponds to the 32 most significant bits of a 64-bit Network Time Protocol (NTP) time value as specified in RFC 5905 (i.e. the seconds part of the NTP timestamp format). These 32 bits provide an unsigned integer representing the time in seconds relative to 0 hours 1 January 1900. Handling of wraparound of the 32-bit time is outside the scope of NTP and FLUTE.
- The *sessionType* attribute defines the basic delivery method session type used = "download" || "streaming".
- The *serviceId* attribute is value and format is taken from the respective *userServiceDescription* *serviceId* definition.
- The *clientId* attribute is unique identifier for the receiver, e.g. an MSISDN of the UE as defined in TS 23.003 [77].
- The *deviceId* attribute is a unique identifier for the receiver device, e.g. an IMEI of the UE as defined in TS 23.003 [77].
- The *serviceURI* attribute value and format is taken from the respective Associated Delivery Procedures Description *serviceURI*, which was selected by the UE for the current report. This attribute expresses the reception report server to which the reception report is addressed.

9.4.7 Reception Report response message

An HTTP response is used as the Reception Report response message.

The HTTP header shall use a status code of 200 OK to signal successful processing of a Reception Report. Other status codes specified in sections 15.5 and 15.6 of RFC 9110 [155] may be used in error cases.

9.4.8 Combining DASH Quality Measurements with Reception Reporting

9.4.8.1 Introduction

A new element is added to the Associated Delivery Procedure Description (ADPD) fragment to support, in the case of DASH-over-MBMS services, DASH QoE metrics reports produced by the DASH client to be acquired and subsequently sent by the MBMS Client as part of reception reporting. The *r13:DASHQoEProcedure* element may be present as a child of the *associatedProcedureDescription* element, containing signalling on the eligibility, actual presence and characteristics of DASH QoE metrics measurements, attached to the nominal reception report. The details of DASH QoE metrics are described in TS 26.247 [98]. The aggregation of the XML documents representing MBMS reception report(s) and DASH QoE metrics report(s) shall be implemented as a MIME multipart structure of the multipart/mixed subtype, as defined in RFC 2557 [37].

9.4.8.2 Whether and what DASH QoE metrics to include in Reception Report

Presence of the *r13:DASHQoEProcedure* element in the ADPD is an indication that the MBMS Client shall collect the DASH QoE metrics reported by the DASH client in order for this information to become eligible for inclusion in Reception Report request messages. The DASH QoE metrics are reported in conjunction with the nominal reception reports as described in clause 9.4.8.3. If *r13:DASHQoEProcedure* is present, then the target probability for DASH quality metrics measurements to be included in the Reception Report request message shall be specified by the *DASHQoESamplePercentage* child element of *r13:DASHQoEProcedure*. The semantics of *DASHQoESamplePercentage*, including its default value when this element is absent, is identical to the *samplePercentage* attribute of the *postReceptionReport* element as defined in clause 9.4.3. In particular, the following rules shall apply when the *r13:DASHQoEProcedure* element is present:

- If the reception reporting procedure is active (i.e. the *postReceptionReport* element is present in the ADPD fragment, and its attribute *samplePercentage* value is non-zero), and the *DASHQoESamplePercentage* is absent, then a DASH QoE metrics report shall be sent every time a MBMS reception report is sent. Whenever a Reception Report is sent, it shall include the one or more DASH QoE metrics reports collected by the MBMS Client for the same time period over which the Reception Report was collected.
- If the reception reporting procedure is active, and *DASHQoESamplePercentage* is present, then the probability of DASH QoE metrics measurements being present in a given reception report shall be given by the value of $\{r13:DASHQoEProcedure.DASHQoESamplePercentage\}$. The DASH QoE metrics measurements to be attached in the reception report shall be specified by the *DASHMetrics* child of the *r13:DASHQoEProcedure* element, as a string of comma-separated variables.
- If the reception reporting procedure is inactive (i.e., the *postReceptionReport* element is either absent in the ADPD, or if present, the random number generated by the UE is above the *samplePercentage* value), then regardless of the value of *DASHQoESamplePercentage*, no DASH QoE metrics report will be sent.

NOTE: It is expected that these parameters will correspond exactly to the QoE metrics sent by the DASH client in its QoE report to the MBMS Client, and may represent the entirety or a subset of the quality metrics defined in clause 10.2 of TS 26.247 [98] and specified by the **MPD.Metrics@metrics** attribute in TS 26.247 [98].

9.4.8.3 Multipart MIME aggregation of Reception Report and DASH QoE Metrics Report

As described in clause 9.4.6, MBMS reception reports and DASH QoE measurement reports shall be combined into a single aggregate document by making use of the MIME multipart/mixed file format [37]. Two options are possible:

- Option 1: The MIME media type (*Content-Type* header) is used to differentiate between the two types of reports, i.e., "application/mbms-reception-report+xml" for nominal reception reports, and "application/3gpdash-qoe-report+xml" for DASH QoE metrics reports.
- Option 2: The same text/xml media type may be used for both. The server can differentiate the report types by the XML header portion of the report.

An example of Option 1 is shown below. Here, the MIME multipart message which contains as separate body parts the Reception Report and the DASH QoE Report delineates the two parts by a boundary, named "separator" in the "Content-Type: " header. This boundary is placed between the parts at the beginning and end of the body of the message, as follows:

```
POST http://www.exampleserver.com/rr HTTP/1.1
Host: 192.68.1.1
User-Agent: Mozilla/5.0(Linux; U; Android 4.0.3 ...)
Content-Length: 12345
Content-Type: multipart/mixed; boundary=separator
Connection: Keep-Alive
<...other HTTP headers>

--separator
Content-Type: application/mbms-reception-report+xml

<XML document of the MBMS Reception Report>
--separator
Content-Type: application/3gpdash-qoe-report+xml

<XML document of the DASH QoE Metrics Report>
--separator--
```

Option 1 is recommended as the aggregate report format since it avoids the report server having to look into the header portion of each component XML file to determine the composition of the aggregated report.

9.4A MBMS User Service Consumption Reporting

9.4A.1 Introduction

Towards attaining more accurate knowledge of ongoing consumption of an MBMS User Service, consumption reporting procedures are defined in this clause. This functionality better enables the MBMS service operator to decide, based on real time demand of an MBMS User Service, to either

- establish service delivery over an MBMS bearer;
- tear down service delivery over an already established MBMS bearer to only leave service delivery over unicast

and doing so in a dynamic manner, to best utilize overall network capacity resources in supporting unicast and/or MBMS services delivery. The MBMS service consumption reporting procedure is initiated by the MBMS receiver (UE) to the BM-SC, in accordance to parameters in the Associated Delivery Procedure description. Consumption of an MBMS User Service over an MBMS bearer by a UE is defined as the reception of service content on any of the transport session(s) referenced by the *deliveryMethod* element(s) under the *userServiceDescription* element of that service. Consumption of an MBMS User Service delivered over unicast by the UE, in the event that the MBMS bearer for such service is not provisioned where the UE is located, is represented by the reception of service content associated with either (but not both) the *r12:unicastAppService* child element or the *r8:alternativeAccessDelivery* child element under the *deliveryMethod* element.

9.4A.2 Whether and how Consumption Reporting is to be performed

The MBMS Receiver shall determine whether a consumption report is required for an associated MBMS User Service. An Associated Delivery Procedure Description indicates the parameters of a consumption reporting procedure (transported using the HTTP request mechanism procedure similarly used for File Repair and Reception Reporting).

An MBMS User Service may associate zero or one Consumption Reporting Description instances with the MBMS User Service. When the *r12:consumptionReporting* element is present in the *userServiceDescription* element of the MBMS User Service Bundle Description Fragment, the UE shall initiate a consumption reporting procedure when any of the conditions below become valid:

- Start of UE consumption of the MBMS User Service on the MBMS bearer;
- Stop of UE consumption of the MBMS User Service on the MBMS bearer;
- Start of UE consumption of the MBMS User Service on unicast;
- Stop of UE consumption of the MBMS User Service on unicast;
- Transition of UE consumption of the service from unicast to MBMS bearer, which may occur in one of the following ways:
 - a) The UE stops consuming the Mood eligible MBMS User Service on unicast, and starts consumption of the service on an MBMS bearer;
 - b) The UE stops consuming the Mood eligible non-MBMS service on unicast, and starts consumption of the corresponding MBMS User Service on an MBMS bearer
- Transition of UE consumption of the MBMS User Service from MBMS bearer to unicast, which occurs in the following way:
 - The UE stops consuming the MBMS User Service on a MBMS bearer, and starts consumption of the MBMS User Service on unicast;
- Upon determining the need to report ongoing UE consumption of the MBMS User Service
 - The "ongoing" report is performed at periodic intervals as set by the *reportInterval* attribute of the *r12:consumptionReport* element.

NOTE 1: If the *reportInterval* attribute is present under *r12:consumptionReport*, then whenever the UE starts consumption of the MBMS User Service of concern, it is expected to reset its corresponding 'report interval' timer to the value of that attribute and begin count down of the timer. Whenever the UE stops the consumption of the same service, it is expected to disable its corresponding 'report interval' timer.

- Upon determining a location change. If the *location* element in *r12:consumptionReport* is included, and upon detecting a change of location while consuming an MBMS User Service. Depending on the value of the *location* child element in the *r12:consumptionReport* element, the UE detects a location change as either
 - an MBMS SAI change, if the location element indicates to report MBMS SAI. An MBMS SAI location change shall be detected by the UE if there are one or more SAI values that have changed in its non-empty SAI list(s) prepared for inclusion in the Consumption Report Request message as specified in clause 9.5A.5, and any of the SAIs in the list match any of the SAI in *availabilityInfo.infoBinding.serviceArea* elements in the USD.
 - a CGI change, if the location element indicates to report CGI
 - an ECGI change, if the location element indicates to report ECGI

NOTE 2: If the *reportInterval* attribute is present under *r12:consumptionReport*, then whenever the UE detects a location change while consuming an MBMS User Service, it is expected to reset its corresponding 'report interval' timer to the value of that attribute and begin count down of the timer.

Consumption Reporting shall not be performed by the UE if any of the following conditions are met:

- If the Consumption Reporting Description is absent under the *userServiceDescription* element;

- If the Consumption Reporting Description is present, and the location type requested to be reported is MBMS SAI and
 - there is no match between any of the SAI in *availabilityInfo.infoBinding.serviceArea* elements in the USD with the entries in the MBMS SAI list prepared for inclusion in the Consumption Report request message (see 9.5A.5), or
 - SIB 15 is not present.
- If the *r12:moodConfiguration* element in the *userServiceDescription* element is present, and the UE is consuming the service on unicast. More specifically, the UE shall not generate Consumption Report signalling unicast consumption to indicate:
 - Start of UE consumption of the MBMS User Service on unicast;
 - Stop of UE consumption of the MBMS User Service on unicast;
 - Transition of UE consumption of the service from unicast to MBMS bearer. The UE shall instead report Start of UE consumption of the MBMS User Service on the MBMS bearer if Consumption Report is enabled for MBMS User Service consumed on the MBMS bearer;
 - Transition of UE consumption of the MBMS User Service from MBMS bearer to unicast. The UE shall instead report Stop of UE consumption of the MBMS User Service on the MBMS bearer if Consumption Report is enabled for MBMS User Service consumed on the MBMS bearer;
 - Ongoing consumption of the MBMS User Service on unicast, upon the expiration of the "report interval" timer;
 - Location change while consuming the MBMS User Service on unicast.

The BM-SC can specify the percentage subset of MBMS receivers that the BM-SC would like to perform consumption reporting via the *samplePercentage* attribute. The *samplePercentage* takes on a value between 0 and 100, including the use of decimals. It is recommended that no more than 3 digits follow a decimal point (e.g. 67.323 is sufficient precision). The *samplePercentage* attribute is optional and the default UE behaviour when it is absent is to always perform consumption reporting in accordance to the rules and criteria stated in this clause 9.4A.2, as well as clauses 9.4A.3, 9.4A.4 and 9.4A.5.

The BM-SC can specify the nominal periodicity by which the UE, when it is continuously consuming the service of concern, shall perform consumption reporting. This periodicity, defined as a time duration between consecutive reports, is specified by the *reportInterval* attribute. Periodic consumption reporting uses the 'report interval' timer, which is preset to the *reportInterval* value whenever the UE starts consumption of the associated MBMS User Service, or when the timer has expired from the previous countdown cycle, and begins a subsequent countdown cycle. The *reportInterval* attribute is optional and the default UE behavior when it is absent is not to perform ongoing consumption reporting.

The BM-SC can specify whether the UE shall include its current location by serving cell-ID or MBMS SAI when it performs consumption reporting, via the *location* child element of *r12:consumptionReport*. The cell-ID(s) to be reported depends on whether the MBMS service is delivered on unicast bearer(s) or MBMS bearer(s), if Carrier Aggregation [96] is employed in the E-UTRAN. If the MBMS service is delivered via unicast bearer(s), the reported ECGI(s) should include the identity (identities) of all serving cell(s), i.e., that of the PCell and zero or more SCells. If the MBMS service is provided on MBMS bearer(s), the reported cell-ID shall be that of the MBMS cell, which could be either the PCell, the SCell, or a configurable SCell. The UE shall report its location according to the enumerated value of the *location* element, i.e., "MBMS SAI", "CGI" or ECGI". The *location* element is optional and the default UE behaviour when it is absent, or if its content is set to an unknown value, is not to include the UE's location in the consumption report.

NOTE 3: The means of reporting cell-ID as defined in this clause shall apply to the described mechanism in clause 9.4A5 on reporting of the *location* attribute for ECGI.

The BM-SC can specify whether the UE shall include, in the consumption report message, the *clientId* attribute which represents the unique identifier for the receiver, e.g. an MSISDN of the UE as defined in [77]. This is specified by the *reportClientId* attribute of *r12:consumptionReport*, which when set to "1" or "true" indicates that the UE shall include *clientId* in the consumption report message, and when set to "0" or "false" indicates that the UE shall not include *clientId* in the consumption report message. The *reportClientId* attribute is optional and the default UE behaviour when it is absent is not to include the client identifier in the consumption report.

9.4A.3 Consumption Report server selection

One or more consumption report servers are implemented in the BM-SC, and the selection of which consumption report to use by the UE is performed similar to the procedure described for file repair server selection in clause 9.1. If more than one *serviceURI* elements are present under *consumptionReporting*, the UE shall randomly select one of them, with uniform distribution as the destination of the consumption report message. Use of the selected consumption report server by the UE shall be maintained for the entire duration span of UE submissions of the "start", "ongoing" (one or more), and "stop" consumption reports, unless the consumption report server redirects the UE to another consumption report server using an HTTP 3xx status code in the response message.

When a UE obtains an updated APD fragment for the MBMS User Service of interest, and the *serviceURI* under the *consumptionReporting* element that the UE had selected is no longer listed in the updated APD, the UE shall randomly select a new *serviceURI* element currently present under *consumptionReporting*, with uniform distribution as the destination of the consumption report request message. The UE shall send consumption reports to the newly selected destination at the next scheduled "ongoing" consumption report opportunity, as well as for consumption report submission resulting from a "location change", a "stop", or a "start" condition.

9.4A.4 Back-off timing in Consumption Reporting

Back-off timing is used to spread the load of consumption report requests uniformly over time. Back-off timing is performed according to the procedure described in clause 9.3.4. The offset time and random time period used for consumption reporting may differ in values from those used in file-repair and/or reception reporting, and are signalled separately by the *offsetTime* and *randomTimePeriod* attributes of the *consumptionReport* child element of the Associated Delivery Procedure Description instance. For example, UEs might be required to submit consumption reports within a tighter time window and with a smaller offset delay to enable more timely reception of consumption reports by the BM-SC in order to affect dynamic decision on whether to maintain or disable the associated MBMS service. The *offsetTime* attribute is optional. The default UE behavior when this attribute is absent or set to '0' is not to employ a wait time before computing a random time within the time window given by *randomTimePeriod* in initiating the consumption report procedure.

9.4A.5 Consumption Report request message

Once the need for consumption reporting has been established, the MBMS Client sends one or more Consumption Report request messages to the consumption report server identified by the *serviceURI*. Consumption Report requests and responses pertaining to a single complete sequence of the "start", one or more "ongoing", and the "stop" consumption reports to/from the same consumption report server shall take place in one or more TCP sessions using the HTTP/1.1 protocol as specified in RFC 9112 [18]), i.e., via the use of either persistent or non-persistent TCP connections for carrying the HTTP consumption reporting traffic.

NOTE: Should the BM-SC wish to correlate the start and stop consumption reports from individual UEs, the *reportClientId* attribute of the *r12:consumptionReport* element in the ADPD fragment should be set to "1" or "true".

The MBMS Client shall make a Consumption Report request using the HTTP POST request as specified in RFC 9112 [18] carrying XML formatted metadata for each report. The MIME media type for the document in the request shall be as defined in clause C.16.

Each consumption report is formatted in XML according to the XML schema shown in clause 9.5.4. An informative example of a single consumption report XML object is given in clause 9.5.4.1).

The Consumption Report request message contains the following mandatory and optional parameters:

Mandatory:

- The *serviceId* attribute that represents the MBMS User Service to which each consumption report pertains, and whose value and format are identical to that specified by the associated *userServiceDescription* element of the USD.
- The *consumptionType* attribute which declares the consumption report as belonging to one of the following types, and are mapped to the conditions for consumption reporting as indicated in clause 9.4A.2:

- 1) – start of consumption of the MBMS User Service on the MBMS bearer;

- 2) – transition of UE consumption of the service from unicast to MBMS bearer;
- 3) – stop of consumption of the MBMS User Service on the MBMS bearer;
- 4) – transition of UE consumption of the MBMS User Service from MBMS bearer to unicast;
- 5) – ongoing consumption of the MBMS User Service on the MBMS bearer upon the expiration of the 'report interval' timer;
- 6) – location change while consuming the MBMS User Service on the MBMS bearer;
- 7) – start of consumption of the MBMS User Service on unicast;
- 8) – stop of consumption of the MBMS User Service on unicast;
- 9) – ongoing consumption of the MBMS User Service on unicast, upon the expiration of the 'report interval' timer
- 10) – location change while consuming the MBMS User Service on unicast.

Optional:

- The *clientId* attribute which identifies the reporting UE, if the attribute *reportClientId* was present under the *consumptionReport* element in the Associated Delivery Procedure Description instance.
- The *reportTime* attribute which identifies the time when the report is generated by the UE.
- The *location* attribute which represents the UE's location by CGI or ECGI or the list(s) of MBMS SAI(s) from SIB15 specified in TS 36.331 [97] as defined by the *MobD* configuration parameter *<X>/LocationType* in clause 12.2.2. For the case of MBMS SAI, the UE shall build the list of MBMS SAIs to include in its Consumption Report Request message as follows:
 - Include all the SAIs from the SIB 15 intra-frequency list if present (see *mbms-SAI-IntraFreq-r11* in SIB 15 [97]), in *intraFreq-SAI* element in the Consumption report request message;
 - Include all the SAIs from every inter-frequency lists if present in SIB 15 (see *mbms-SAI-InterFreqList-r11* in SIB 15 [97]) in *interFreq-SAI* element in the Consumption report request message;
 - Include a list of SAIs corresponding to the intersection between the SAIs from SIB 15 [97] and the list of MBMS Service Area Identities included in the *userServiceDescription.availabilityInfo.infoBinding.serviceArea* elements for the same *serviceId*, in the *intersected-SAI* element in the Consumption report request message. Before the intersection is created, all SAIs from intra-frequency neighbour cells shall be removed from the SIB15 SAI list (see TS 26.331 [97] for details of SAIs from intra-frequency neighbour cells).

9.4A.6 Consumption Report response message

An HTTP response is used as the Consumption Report response message.

The HTTP header shall use a status code of 200 OK to signal successful processing of a Consumption Report request message. Other status codes specified in sections 15.5 and 15.6 of RFC 9110 [155] may be used in error cases.

9.5 XML-Schema for Associated Delivery Procedures

9.5.1 Associated Delivery Procedures Description syntax

Below is the formal XML syntax of Associated Delivery Procedures Description instances. Documents following this schema can be identified with the MIME media type "application/mbms-associated-procedure-description+xml" specified in clause C.7. The schema filename of delivery procedure description is "TS26346_AssociatedDeliveryProceduresDescription.xsd".

In this version of the present document, the network shall set the content of the *schemaVersion* element, defined as a child of the *associatedProcedureDescription* element, to the value 2.

The schema *version* attribute (part of the schema instruction) shall be included in the UE schema and the network schema.

NOTE: The value of the *schemaVersion* element and *version* attribute is intended to be increased by 1 in every future release where new element(s) or attribute(s) are added.

When a UE receives an instantiation of an Associated Delivery Procedures Description instance compliant to this schema, it shall determine the Associated Delivery Procedures Description schema version required to parse the instantiation as follows:

- If the UE supports one or more versions of the Associated Delivery Procedures Description schema with the *schema version* attribute, then the UE shall use the schema that has the highest *schema version* attribute value that is equal to or less than the value in the received *schemaVersion* element;
- Otherwise, if the UE supports an Associated Delivery Procedures Description schema without a *schema version* attribute, or if all of its Associated Delivery Procedures Description schemas with the *schema version* attribute have a value greater than the value received in the *schemaVersion* element, then the UE shall use its schema without a *version* attribute.

Listing 9.5.1-1: Associated Delivery Procedures Description schema

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:3gpp:metadata:2005:MBMS:associatedProcedure" version="2"
  xmlns="urn:3gpp:metadata:2005:MBMS:associatedProcedure"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  xmlns:r12="urn:3gpp:metadata:2005:MBMS:associatedProcedure-rel-12-extension"
  xmlns:r13="urn:3gpp:metadata:2005:MBMS:associatedProcedure-rel-13-extension"
  xmlns:r14="urn:3gpp:metadata:2005:MBMS:associatedProcedure-rel-14-extension"
  xmlns:sv="urn:3gpp:metadata:2009:MBMS:schemaVersion"
  elementFormDefault="qualified">
  <xs:annotation>
    <xs:documentation>MBMS Associated Delivery Procedures Description
schema</xs:documentation>
    <xs:documentation>3GPP TS 26.346 clause 9.5.1</xs:documentation>
    <xs:documentation>Copyright © 2005, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI,
TSDSI, TTA, TTC). All rights reserved.</xs:documentation>
  </xs:annotation>

  <xs:import namespace="urn:3gpp:metadata:2009:MBMS:schemaVersion"
schemaLocation="TS26346_SchemaVersion.xsd"/>
  <xs:import namespace="urn:3gpp:metadata:2005:MBMS:associatedProcedure-rel-12-extension"
schemaLocation="TS26346_AssociatedDeliveryProceduresDescription_Extensions_Rel-12.xsd"/>
  <xs:import namespace="urn:3gpp:metadata:2005:MBMS:associatedProcedure-rel-13-extension"
schemaLocation="TS26346_AssociatedDeliveryProceduresDescription_Extensions_Rel-13.xsd"/>
  <xs:import namespace="urn:3gpp:metadata:2005:MBMS:associatedProcedure-rel-14-extension"
schemaLocation="TS26346_AssociatedDeliveryProceduresDescription_Extensions_Rel-14.xsd"/>

  <xs:element name="associatedProcedureDescription" type="associatedProcedureType"/>
  <xs:complexType name="associatedProcedureType">
    <xs:sequence>
      <xs:element name="postFileRepair" type="basicProcedureType" minOccurs="0"/>
      <xs:element name="bmFileRepair" type="bmFileRepairType" minOccurs="0"/>
      <xs:element name="postReceptionReport" type="reportProcedureType" minOccurs="0"/>
      <xs:element ref="r12:consumptionReport" minOccurs="0"/>
      <xs:element ref="sv:schemaVersion"/>
      <xs:element ref="r13:DASHQoEProcedure" minOccurs="0"/>
      <xs:element ref="sv:delimiter"/>
      <xs:any namespace="##other" processContents="skip" minOccurs="0"
maxOccurs="unbounded"/>
    </xs:sequence>
  </xs:complexType>

  <xs:complexType name="basicProcedureType">
    <xs:sequence>
      <xs:element name="serviceURI" type="xs:anyURI" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:attribute name="offsetTime" type="xs:unsignedLong" use="optional"/>
    <xs:attribute name="randomTimePeriod" type="xs:unsignedLong" use="required"/>
  </xs:complexType>

  <xs:complexType name="bmFileRepairType">
    <xs:attribute name="sessionDescriptionURI" type="xs:anyURI" use="required"/>
  </xs:complexType>
```

```

<xs:complexType name="reportProcedureType">
  <xs:complexContent>
    <xs:extension base="basicProcedureType">
      <xs:attribute name="samplePercentage" type="xs:decimal" use="optional"
default="100"/>
      <xs:attribute name="forceTimeIndependence" type="xs:boolean" use="optional"
default="false"/>
      <xs:attribute name="reportType" use="optional" default="RAck">
        <xs:simpleType>
          <xs:union memberTypes="knownReportType xs:string"/>
        </xs:simpleType>
      </xs:attribute>
      <xs:attribute ref="r14:reportInterval" use="optional"/>
    </xs:extension>
  </xs:complexContent>
</xs:complexType>

<xs:simpleType name="knownReportType">
  <xs:restriction base="xs:string">
    <xs:enumeration value="RAck"/>
    <xs:enumeration value="StaR"/>
    <xs:enumeration value="StaR-all"/>
    <xs:enumeration value="StaR-only"/>
  </xs:restriction>
</xs:simpleType>
</xs:schema>

```

The Release 12 extensions to the Associated Delivery Procedures Description schema are specified in listing 9.5.1-2. The schema filename is "TS26346_AssociatedDeliveryProceduresDescription_Extensions_Rel-12.xsd".

Listing 9.5.1-2: Associated Delivery Procedures Description schema extensions (Release 12)

```

<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:3gpp:metadata:2005:MBMS:associatedProcedure-rel-12-extension"
  xmlns="urn:3gpp:metadata:2005:MBMS:associatedProcedure-rel-12-extension"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  elementFormDefault="qualified">
  <xs:annotation>
    <xs:documentation>MBMS Associated Delivery Procedures Description schema extensions
(Release 12)</xs:documentation>
    <xs:documentation>3GPP TS 26.346 clause 9.5.1</xs:documentation>
    <xs:documentation>Copyright © 2014, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI,
TSDSI, TTA, TTC). All rights reserved.</xs:documentation>
  </xs:annotation>

  <xs:element name="consumptionReport" type="consumptionReportType"/>
  <xs:complexType name="consumptionReportType">
    <xs:sequence>
      <xs:element name="serviceURI" type="xs:anyURI" maxOccurs="unbounded"/>
      <xs:element name="location" type="uELocationType" minOccurs="0"/>
      <xs:any namespace="##other" processContents="skip" minOccurs="0"
maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:attribute name="samplePercentage" type="xs:decimal" default="100"/>
    <xs:attribute name="reportInterval" type="xs:duration"/>
    <xs:attribute name="offsetTime" type="xs:unsignedLong"/>
    <xs:attribute name="randomTimePeriod" type="xs:unsignedLong" use="required"/>
    <xs:attribute name="reportClientId" type="xs:boolean" default="0"/>
    <xs:anyAttribute processContents="skip"/>
  </xs:complexType>

  <xs:simpleType name="uELocationType">
    <xs:union memberTypes="knownUELocationType xs:string"/>
  </xs:simpleType>

  <xs:simpleType name="knownUELocationType">
    <xs:restriction base="xs:string">
      <xs:enumeration value="CGI"/>
      <xs:enumeration value="ECGI"/>
      <xs:enumeration value="MBMS SAI"/>
    </xs:restriction>
  </xs:simpleType>
</xs:schema>

```

The Release 13 extensions to the Associated Delivery Procedures Description schema are specified in listing 9.5.1-3. The schema filename is "TS26346_AssociatedDeliveryProceduresDescription_Extensions_Rel-13.xsd".

Listing 9.5.1-3: Associated Delivery Procedures Description schema extensions (Release 13)

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:3gpp:metadata:2005:MBMS:associatedProcedure-rel-13-extension"
  xmlns="urn:3gpp:metadata:2005:MBMS:associatedProcedure-rel-13-extension"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  elementFormDefault="qualified">
  <xs:annotation>
    <xs:documentation>MBMS Associated Delivery Procedures Description schema extensions
    (Release 13)</xs:documentation>
    <xs:documentation>3GPP TS 26.346 clause 9.5.1</xs:documentation>
    <xs:documentation>Copyright © 2015, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI,
    TSDSI, TTA, TTC). All rights reserved.</xs:documentation>
  </xs:annotation>

  <xs:element name="DASHQoEProcedure" type="DASHQoEProcedureType"/>
  <xs:complexType name="DASHQoEProcedureType">
    <xs:sequence>
      <xs:element name="DASHQoEMetrics" type="xs:string"/>
      <xs:element name="DASHQoESamplePercentage" type="xs:decimal" default="100"
minOccurs="0"/>
      <xs:any namespace="##other" processContents="skip" minOccurs="0"
maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:anyAttribute processContents="skip"/>
  </xs:complexType>
</xs:schema>
```

The Release 14 extensions to the Associated Delivery Procedures Description schema are specified in listing 9.5.1-3. The schema filename is "TS26346_AssociatedDeliveryProceduresDescription_Extensions_Rel-14.xsd".

Listing 9.5.1-3: Associated Delivery Procedures Description schema extensions (Release 14)

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:3gpp:metadata:2005:MBMS:associatedProcedure-rel-14-extension"
  xmlns="urn:3gpp:metadata:2005:MBMS:associatedProcedure-rel-14-extension"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  elementFormDefault="qualified">
  <xs:annotation>
    <xs:documentation>MBMS Associated Delivery Procedures Description schema extensions
    (Release 14)</xs:documentation>
    <xs:documentation>3GPP TS 26.346 clause 9.5.1</xs:documentation>
    <xs:documentation>Copyright © 2016, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI,
    TSDSI, TTA, TTC). All rights reserved.</xs:documentation>
  </xs:annotation>

  <xs:attribute name="reportInterval" type="xs:duration"/>
</xs:schema>
```

9.5.2 Example Associated Delivery Procedures Description instance

Below is an example of an Associated Delivery Procedure Description instance for post-reception reporting.

Listing 9.5.2-1: Associated Delivery Procedures instance example

```
<?xml version="1.0" encoding="UTF-8"?>
<associatedProcedureDescription xmlns="urn:3gpp:metadata:2005:MBMS:associatedProcedure"
  xmlns:sv="urn:3gpp:metadata:2009:MBMS:schemaVersion"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="urn:3gpp:metadata:2005:MBMS:associatedProcedure
TS26346_AssociatedDeliveryProceduresDescription.xsd">

  <postFileRepair
    offsetTime="5"
    randomTimePeriod="10">
    <serviceURI>http://mbmsrepair0.example.com/path/repair_script</serviceURI>
    <serviceURI>http://mbmsrepair1.example.com/path1/repair_script</serviceURI>
    <serviceURI>http://mbmsrepair2.example.com/path2/repair_script</serviceURI>
  </postFileRepair>

  <bmFileRepair sessionDescriptionURI="http://www.example.com/3gpp/mbms/session1.sdp" />

  <postReceptionReport
    offsetTime="5"
    randomTimePeriod="10"
    reportType="StaR-all"
    samplePercentage="100"
    forceTimeIndependence="0">
    <serviceURI>http://mbmsreport.example.com/path/report_script</serviceURI>
  </postReceptionReport>

  <sv:schemaVersion>3</sv:schemaVersion>
  <sv:delimiter>1</sv:delimiter>
</associatedProcedureDescription>
```

9.5.3 Reception Reporting

9.5.3.0 Reception Reporting request syntax

The formal XML syntax of Reception Report request instances is specified in listing 9.5.3.0-1 below. The schema filename is "TS26346_ReceptionReport.xsd".

Listing 9.5.3.0-1: Reception Report schema

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:3gpp:metadata:2008:MBMS:receptionreport"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  xmlns="urn:3gpp:metadata:2008:MBMS:receptionreport"
  elementFormDefault="qualified">
  <xs:annotation>
    <xs:documentation>MBMS Reception Report schema</xs:documentation>
    <xs:documentation>3GPP TS 26.346 clause 9.5.3.0</xs:documentation>
    <xs:documentation>Copyright © 2008, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI,
TSDSI, TTA, TTC). All rights reserved.</xs:documentation>
  </xs:annotation>

  <xs:element name="receptionReport" type="receptionReportType"/>
  <xs:complexType name="receptionReportType">
    <xs:choice>
      <xs:element name="receptionAcknowledgement" type="rackType"/>
      <xs:element name="statisticalReport" type="starType" minOccurs="0"
maxOccurs="unbounded"/>
      <xs:any namespace="##other" processContents="skip" minOccurs="0"
maxOccurs="unbounded"/>
    </xs:choice>
  </xs:complexType>

  <xs:complexType name="rackType">
    <xs:sequence>
      <xs:element name="fileURI" minOccurs="0" maxOccurs="unbounded">
```

```

        <xs:complexType>
          <xs:simpleContent>
            <xs:extension base="fileUriType">
              <xs:attribute name="clientId" type="xs:string" use="optional"/>
              <xs:attribute name="sessionId" type="xs:string" use="optional"/>
              <xs:attribute name="deviceId" type="xs:string" use="optional"/>
            </xs:extension>
          </xs:simpleContent>
        </xs:complexType>
      </xs:element>
    </xs:sequence>
  </xs:complexType>

  <xs:complexType name="starType">
    <xs:sequence>
      <xs:element name="fileURI" type="fileUriType" minOccurs="0" maxOccurs="unbounded"/>
      <xs:element name="qoeMetrics" type="qoeMetricsType" minOccurs="0" maxOccurs="1"/>
      <xs:any namespace="##other" processContents="skip" minOccurs="0"
maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:attribute name="sessionType" type="sessionTypeType" use="optional"/>
    <xs:attribute name="serviceId" type="xs:string" use="optional"/>
    <xs:attribute name="clientId" type="xs:string" use="optional"/>
    <xs:attribute name="deviceId" type="xs:string" use="optional"/>
    <xs:attribute name="serviceURI" type="xs:anyURI" use="optional"/>
    <xs:anyAttribute processContents="skip"/>
  </xs:complexType>

  <xs:simpleType name="sessionTypeType">
    <xs:restriction base="xs:string">
      <xs:enumeration value="download"/>
      <xs:enumeration value="streaming"/>
    </xs:restriction>
  </xs:simpleType>

  <xs:complexType name="fileUriType">
    <xs:simpleContent>
      <xs:extension base="xs:anyURI">
        <xs:attribute name="receptionSuccess" type="xs:boolean" use="optional"
default="true"/>
        <xs:attribute name="Content-MD5" type="xs:base64Binary" use="optional"/>
        <xs:attribute name="receivedSymbolsForFailedBlocks" type="unsignedLongVectorType"
use="optional"/>
        <xs:attribute name="totalSymbolsForFailedBlocks" type="unsignedLongVectorType"
use="optional"/>
        <xs:anyAttribute processContents="skip"/>
      </xs:extension>
    </xs:simpleContent>
  </xs:complexType>

  <xs:complexType name="qoeMetricsType">
    <xs:sequence>
      <xs:element name="medialevel_qoeMetrics" type="medialevel_qoeMetricsType"
minOccurs="0" maxOccurs="unbounded"/>
      <xs:any namespace="##other" processContents="skip" minOccurs="0"
maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:attribute name="totalRebufferingDuration" type="doubleVectorType" use="optional"/>
    <xs:attribute name="numberOfRebufferingEvents" type="unsignedLongVectorType"
use="optional"/>
    <xs:attribute name="initialBufferingDuration" type="xs:double" use="optional"/>
    <xs:attribute name="contentAccessTime" type="xs:double" use="optional"/>
    <xs:attribute name="sessionStartTime" type="xs:unsignedLong"/>
    <xs:attribute name="sessionStopTime" type="xs:unsignedLong"/>
    <xs:attribute name="networkResourceCellId" type="stringVectorType" use="optional"/>
    <xs:attribute name="numberOfLostObjects" type="unsignedLongVectorType" use="optional"/>
    <xs:attribute name="symbolCountUnderrun" type="stringVectorType" use="optional"/>
    <xs:attribute name="numberOfReceivedObjects" type="unsignedLongVectorType"
use="optional"/>
    <xs:anyAttribute processContents="skip"/>
  </xs:complexType>

  <xs:complexType name="medialevel_qoeMetricsType">
    <xs:attribute name="sessionId" type="xs:string"/>
    <xs:attribute name="totalCorruptionDuration" type="unsignedLongVectorType"
use="optional"/>
    <xs:attribute name="numberOfCorruptionEvents" type="unsignedLongVectorType"
use="optional"/>

```

```

        <xs:attribute name="t" type="xs:boolean" use="optional"/>
        <xs:attribute name="totalNumberOfSuccessivePacketLoss" type="unsignedLongVectorType"
use="optional"/>
        <xs:attribute name="numberOfSuccessiveLossEvents" type="unsignedLongVectorType"
use="optional"/>
        <xs:attribute name="numberOfReceivedPackets" type="unsignedLongVectorType"
use="optional"/>
        <xs:attribute name="framerateDeviation" type="doubleVectorType" use="optional"/>
        <xs:attribute name="totalJitterDuration" type="doubleVectorType" use="optional"/>
        <xs:attribute name="numberOfJitterEvents" type="unsignedLongVectorType" use="optional"/>
        <xs:attribute name="framerate" type="doubleVectorType" use="optional"/>
        <xs:attribute name="codecInfo" type="stringVectorType" use="optional"/>
        <xs:attribute name="codecProfileLevel" type="stringVectorType" use="optional"/>
        <xs:attribute name="codecImageSize" type="stringVectorType" use="optional"/>
        <xs:attribute name="averageCodecBitrate" type="doubleVectorType" use="optional"/>
        <xs:anyAttribute processContents="skip"/>
    </xs:complexType>

    <xs:simpleType name="doubleVectorType">
        <xs:list itemType="xs:double"/>
    </xs:simpleType>

    <xs:simpleType name="unsignedLongVectorType">
        <xs:list itemType="xs:unsignedLong"/>
    </xs:simpleType>

    <xs:simpleType name="stringVectorType">
        <xs:list itemType="xs:string"/>
    </xs:simpleType>
</xs:schema>

```

9.5.3.1 Use of specific values

Void.

9.5.3.2 Example Reception Reporting requests

Listing 9.5.3.2-1: Reception acknowledgement example

```

<?xml version="1.0" encoding="UTF-8"?>
<receptionReport xmlns="urn:3gpp:metadata:2008:MBMS:receptionreport"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="urn:3gpp:metadata:2008:MBMS:receptionreport TS26346_ReceptionReport.xsd">

  <receptionAcknowledgement>
    <fileURI>http://www.example.com/mbms-files/file1.3gp</fileURI>
    <fileURI>http://www.example.com/mbms-files/file2.3gp</fileURI>
    <fileURI>http://www.example.com/mbms-files/file4.3gp</fileURI>
  </receptionAcknowledgement>
</receptionReport>

```

A second example in listing 9.5.3.2-2 shows a statistical report for a streaming session.

Listing 9.5.3.2-2: Statistical report example

```

<?xml version="1.0" encoding="UTF-8"?>
<receptionReport xmlns="urn:3gpp:metadata:2008:MBMS:receptionreport"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="urn:3gpp:metadata:2008:MBMS:receptionreport TS26346_ReceptionReport.xsd">

  <statisticalReport
    clientId="clientID"
    sessionType="streaming"
    serviceURI="bmsc.example.com"
    serviceId="serviceID">
    <qoeMetrics
      numberOfRebufferingEvents="0 1 0"
      initialBufferingDuration="3.213"
      totalRebufferingDuration="0 1.23 0"
      contentAccessTime="2.621"
      sessionStartTime="3428397714"
    </qoeMetrics>
  </statisticalReport>
</receptionReport>

```

```

    sessionStopTime="3428397741"
    networkResourceCellId="240012AF134EA = 240012AF1325E">
    <medialevel_goeMetrics
      sessionId="10.50.65.30:5050"
      framerateDeviation="0.345 0.250 0.123"
      t="false"
      numberOfSuccessiveLossEvents="5 0 3"
      numberOfCorruptionEvents="6 5 2"
      numberOfJitterEvents="0 1 0"
      totalCorruptionDuration="152 234 147"
      totalNumberOfSuccessivePacketLoss="25 0 6"
      numberOfReceivedPackets="456 500 478"
      codecInfo="H263-2000/90000 = ="
      codecProfileLevel="profile=0;level=45 = ="
      codecImageSize="176x144 = ="
      averageCodecBitRate="124.5 128.0 115.1"
      totalJitterDuration="0 0.346 0"/>
    </goeMetrics>
  </statisticalReport>
</receptionReport>

```

NOTE: The cell used during the second measurement period is the same cell as was used during the first period (indicated by the "=" sign).

9.5.4 Consumption Reporting

9.5.4.0 Consumption Reporting request syntax

The formal XML syntax of the Consumption Reporting request message is specified in listing 9.5.4.0-1 below. The schema filename is "TS26346_ConsumptionReport.xsd".

In this version of the present document, the UE shall set the content of the *schemaVersion* element, defined as a child of the *r12:consumptionReport* element, to the value 1.

The schema *version* attribute (part of the schema instruction) shall be included in the UE schema.

NOTE: The value of the *schemaVersion* element and *version* attribute is intended to be increased by 1 in every future release where new element(s) or attribute(s) are added.

When the network receives an instantiation of a consumption report request message compliant to this schema, it shall determine the schema version required to parse the instantiation as follows:

- If the network supports one or more versions of the consumption report request message schema with the *schema version* attribute, then it shall use the schema that has the highest *schema version* attribute value that is equal to or less than the value in the received *schemaVersion* element.

The XML schema "TS26346_SchemaVersion.xsd" is specified in clause J.2.

Listing 9.5.4.0-1: Consumption Report schema

```

<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:3gpp:metadata:2014:MBMS:consumptionreport"
  xmlns="urn:3gpp:metadata:2014:MBMS:consumptionreport"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  xmlns:sv="urn:3gpp:metadata:2009:MBMS:schemaVersion"

  elementFormDefault="qualified" attributeFormDefault="unqualified" version="1">
  <xs:annotation>
    <xs:documentation>MBMS Consumption Report schema</xs:documentation>
    <xs:documentation>3GPP TS 26.346 clause 9.5.4.0</xs:documentation>
    <xs:documentation>Copyright © 2014, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI,
TSDSI, TTA, TTC). All rights reserved.</xs:documentation>
  </xs:annotation>

  <xs:import namespace="urn:3gpp:metadata:2009:MBMS:schemaVersion"
    schemaLocation="TS26346_SchemaVersion.xsd"/>

  <xs:element name="consumptionReport" type="consumptionReportType"/>
  <xs:complexType name="consumptionReportType">
    <xs:sequence>
      <xs:choice>

```



```

        <xs:element name="locationCGI" type="xs:string"/>
        <xs:element name="locationECGI" type="xs:string"/>
        <xs:element name="locationSAI" type="locationSAIType"/>
    </xs:choice>
    <xs:element ref="sv:schemaVersion"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0"
maxOccurs="unbounded"/>
</xs:sequence>
<xs:attribute name="serviceId" type="xs:string" use="required"/>
<xs:attribute name="consumptionType" type="xs:unsignedByte" use="required">
    <xs:annotation>
        <xs:documentation>
1 - start of consumption of the MBMS User Service on the MBMS bearer;
2 - transition of UE consumption of the Service from unicast to MBMS bearer;
3 - stop of consumption of the MBMS User Service on the MBMS bearer;
4 - transition of UE consumption of the MBMS User Service from MBMS bearer to unicast;
5 - ongoing consumption of the MBMS User Service on the MBMS bearer upon the expiration of the
'report interval' timer;
6 - location change while consuming the MBMS User Service on the MBMS bearer;
7 - start of consumption of the MBMS User Service on the unicast;
8 - stop of consumption of the MBMS User Service on the unicast;
9 - ongoing consumption of the MBMS User Service on the unicast, upon the expiration of the
'report interval' timer;
10 - location change while consuming the MBMS User Service on the unicast
        </xs:documentation>
    </xs:annotation>
</xs:attribute>
<xs:attribute name="reportTime" type="xs:dateTime"/>
<xs:attribute name="clientId" type="xs:string">
    <xs:annotation>
        <xs:documentation>Presence depends on the value of the 'reportClientId' attribute
of the 'rl2:consumptionReport' element in Associated Delivery Procedures
    </xs:documentation>
    </xs:annotation>
</xs:attribute>
<xs:anyAttribute processContents="skip"/>
</xs:complexType>

<xs:complexType name="locationSAIType">
    <xs:sequence>
        <xs:element name="intraFreq-SAI" type="MBMS-SAI-List" minOccurs="0"/>
        <xs:element name="interFreq-SAI" type="MBMS-SAI-List" minOccurs="0"
maxOccurs="unbounded"/>
        <xs:element name="intersection-SAI" type="MBMS-SAI-List" minOccurs="0"/>
        <xs:any namespace="##other" processContents="lax" minOccurs="0"
maxOccurs="unbounded"/>
    </xs:sequence>
</xs:complexType>

<xs:complexType name="MBMS-SAI-List">
    <xs:sequence>
        <xs:element name="MBMS-SAI" type="xs:unsignedInt" maxOccurs="64"/>
    </xs:sequence>
</xs:complexType>
</xs:schema>

```

9.5.4.1 Example Consumption Reporting request

Listing 9.5.4.1-1: Consumption Reporting request example

```

<?xml version="1.0" encoding="UTF-8"?>
<consumptionReport xmlns="urn:3gpp:metadata:2014:MBMS:consumptionreport"
    xsi:schemaLocation="urn:3gpp:metadata:2014:MBMS:consumptionreport
TS26346_ConsumptionReport.xsd"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns:sv="urn:3gpp:metadata:2009:MBMS:schemaVersion"
    serviceId="urn:examplecom:1234567890hotdog"
    consumptionType="1"
    reportTime="2014-08-04T09:30:47Z"
    clientId="9410788021">

    <locationCGI>12345</locationCGI>

    <sv:schemaVersion>1</sv:schemaVersion>
</consumptionReport>

```

10 Media codecs and formats

10.1 General

The set of media decoders that are supported by the MBMS Client to support a particular media type are defined below. Speech, Audio, Video, Timed Text and Scene description media decoders are relevant for both MBMS Download and Streaming delivery. Other media decoders are only relevant for MBMS Download delivery.

10.2 Speech

If speech is supported, the AMR decoder, as specified in TS 26.071 [48], TS 26.090 [49], TS 26.073 [50] and TS 26.107 [51], shall be supported for narrow-band speech. The AMR wideband speech decoder, TS 26.171 [52], TS 26.190 [53], TS 26.173 [54] and TS 26.204 [55], shall be supported when wideband speech working at 16 kHz sampling frequency is supported.

10.3 Audio

If audio is supported, then the following two audio decoders should be supported:

- Enhanced aacPlus, as specified in TS 26.401 [28], TS 26.410 [29] and TS 26.411 [30].
- Extended AMR-WB, as specified in TS 26.290 [24], TS 26.304 [25] and TS 26.273 [26].

Specifically, based on the audio codec selection test results, Extended AMR-WB is strong for the scenarios marked with blue, Enhanced aacPlus is strong for the scenarios marked with orange, and both are strong for the scenarios marked with green colour in table 10.3-1.

Table 10.3-1

Content type Bit rate	Music	Speech over Music	Speech between Music	Speech
14 kbps mono				
18 kbps stereo				
24 kbps stereo				
24 kbps mono				
32 kbps stereo				
48 kbps stereo				

More recent information on the performance of the codecs based on more recent versions of the codecs can be found in TR 26.936 [86].

10.4 Synthetic audio

If synthetic audio is supported, the Scalable Polyphony MIDI (SP-MIDI) content format defined in Scalable Polyphony MIDI Specification [56] and the device requirements defined in Scalable Polyphony MIDI Device 5-to-24 Note Profile for 3GPP [57] should be supported.

SP-MIDI content is delivered in the structure specified in Standard MIDI Files 1.0 [58], either in format 0 or format 1.

In addition, the Mobile DLS instrument format defined in [59] and the Mobile XMF content format defined in [60] should be supported.

An MBMS Client supporting Mobile DLS shall meet the minimum device requirements defined in section 1.3 of [59] and the requirements for the common part of the synthesizer voice as defined in clause 1.2.1.2 of ISO/IEC 10646-1 [70]. If Mobile DLS is supported, wavetables encoded with the G.711 A-law codec (wFormatTag value 0x0006, as defined in [59]) shall also be supported. The optional group of processing blocks as defined in [59] may be supported. Mobile DLS resources are delivered either in the file format defined in ISO/IEC 10646-1 [70], or

within Mobile XMF as defined in [60]. For Mobile DLS files delivered outside of Mobile XMF, the loading application should unload Mobile DLS instruments so that the sound bank required by the SP-MIDI profile [57] is not persistently altered by temporary loadings of Mobile DLS files.

Content that pairs Mobile DLS and SP-MIDI resources is delivered in the structure specified in Mobile XMF [60]. As defined in [60], a Mobile XMF file shall contain one SP-MIDI SMF file and no more than one Mobile DLS file. MBMS Clients supporting Mobile XMF must not support any other resource types in the Mobile XMF file. Media handling behaviours for the SP-MIDI SMF and Mobile DLS resources contained within Mobile XMF are defined in [60].

10.5 Video

10.5.1 General video decoder requirements

If video is supported, the following applies:

- H.264 (AVC) Progressive High Profile Level 3.1 decoder [43] shall be supported wherein the maximum VCL Bit Rate is constrained to be 14Mbps with *cpbBrVclFactor* and *cpbBrNalFactor* being fixed to be 1000 and 1200, respectively.
- H.265 (HEVC) Main Profile, Main Tier, Level 3.1 decoder [112] should be supported.

When H.265 (HEVC) Main Profile decoder is supported, the MBMS Client is only required to process H.265 (HEVC) Main Profile bitstreams that have *general_progressive_source_flag* equal to 1, *general_interlaced_source_flag* equal to 0, *general_non_packed_constraint_flag* equal to 1, and *general_frame_only_constraint_flag* equal to 1.

NOTE: An H.264 (AVC) High Profile decoder is able to decode an H.264 (AVC) Main Profile stream that is progressively encoded.

10.5.2 Stereoscopic 3D video

If a MBMS Client supports stereoscopic 3D video, it should support frame-packed stereoscopic 3D video with the following characteristics:

- The bitstream conforms to H.264 (AVC) Constrained Baseline Profile Level 1.3 decoder [43], or conforms to H.264 (AVC) Progressive High Profile Level 3.1 decoder [43]. The Maximum VCL Bit Rate shall be constrained to be 14Mbps with *cpbBrVclFactor* and *cpbBrNalFactor* being fixed to be 1000 and 1200, respectively.
- Frame packing type is indicated by the frame packing arrangement SEI messages of H.264 (AVC) [43] as follows:
 - The syntax element *frame_packing_arrangement_type* has one of the defined values: 3 for Side-by-Side, 4 for Top-and-Bottom.
 - The syntax element *quincunx_sampling_flag* is equal to 0;
 - The syntax element *content_interpretation_type* is equal to 1;
 - The syntax elements *spatial_flipping_flag* is equal to 0;
 - The syntax element *field_views_flag* is equal to 0;
 - The syntax element *current_frame_is_frame0_flag* is equal to 0;
- When an access unit contains a frame packing arrangement SEI message A and the access unit is neither an IDR access unit nor an access unit containing a recovery point SEI message, the following two constraints apply:
 - There shall be another access unit that precedes the access unit in both decoding order and output order and that contains a frame packing arrangement SEI message B.
 - The two frame packing arrangement SEI messages A and B shall have the same value for the syntax element *frame_packing_arrangement_type*.

If a MBMS Client supports frame-packed stereoscopic 3D video, it shall support parsing of frame packing arrangement SEI messages as specified in H.264 (AVC) [43].

10.5.3 Decoder parameter sets

NOTE: MBMS does not offer dynamic negotiation of media codecs.

When H.264 (AVC) is in use in the MBMS streaming delivery method, it is recommended to transmit H.264 (AVC) parameter sets within the SDP description of a stream (using *sprop-parameter-sets* MIME/SDP parameter [35]), and it is not recommended to transmit parameter sets within the RTP stream. Moreover, it is not recommended to reuse any parameter set identifier value that appeared previously in the SDP description or in the RTP stream. However, if a sequence parameter set is taken into use or updated within the RTP stream, it shall be contained at least in each IDR access unit and each access unit including a recovery point SEI message in which the sequence parameter set is used in the decoding process. If a picture parameter set is taken into use or updated within the RTP stream, it shall be contained at the latest in the first such access unit in each entry sequence that uses the picture parameter set in the decoding process, in which an entry sequence is defined as the access units between an IDR access unit or an access unit containing a recovery point SEI message, inclusive, and the next access unit, exclusive, in decoding order, which is either an IDR access unit or contains a recovery point SEI message.

When H.265 (HEVC) is in use in the MBMS streaming delivery method, it is recommended to transmit H.265 (HEVC) parameter sets within the SDP description of a stream (using the *sprop-vps*, *sprop-sps*, and *sprop-pps* MIME/SDP parameters [113]), and it is not recommended to transmit parameter sets within the RTP stream. Moreover, it is recommended not to reuse any parameter set identifier value that appeared previously in the SDP description or in the RTP stream, i.e., it is recommended that *no_parameter_set_update_flag*, if present, for each CVS in the stream is equal to 1. Also, it is required that *self_contained_cvs_flag*, if present, for each CVS in the stream is equal to 1, i.e., each parameter set that is (directly or indirectly) referenced by any VCL NAL unit of a CVS that is not a VCL NAL unit of a RASL picture is present within the CVS at a position that precedes, in decoding order, any NAL unit that (directly or indirectly) references the parameter set.

10.5.4 Decoder timing

There are no requirements on output timing conformance (annex C of ITU-T Recommendation H.264 [43] or for H.265 (HEVC) decoding (annex C of [112])) for MBMS Clients.

The H.264 (AVC) decoder in an MBMS Client shall start decoding immediately when it receives data (even if the stream does not start with an IDR access unit) or alternatively no later than it receives the next IDR access unit or the next recovery point SEI message, whichever is earlier in decoding order. Note that when the interleaved packetization mode of H.264 (AVC) is in use, de-interleaving is normally done before starting the decoding process. The decoding process for a stream not starting with an IDR access unit shall be the same as for a valid H.264 (AVC) bitstream. However, the client shall be aware that such a stream may contain references to pictures not available in the decoded picture buffer.

10.5.5 Television services

If the 3GPP MBMS Client supports Television (TV) over 3GPP Services, it shall comply with

- the *H.264/AVC 720p HD* Operation Point Receiver requirements as specified in TS 26.116 [125], clause 4.4.2.6.

If the 3GPP MBMS Client supports Television (TV) over 3GPP Services, it should comply with

- *H.264/AVC Full HD* Operation Point Receiver requirements as specified in TS 26.116 [125], clause 4.4.3.6,
- *H.265/HEVC 720p HD* Operation Point Receiver requirements as specified in TS 26.116 [125], clause 4.5.2.7,
- *H.265/HEVC Full HD* Operation Point Receiver requirements as specified in TS 26.116 [125], clause 4.5.3.7,
- *H.265/HEVC UHD* Operation Point Receiver requirements as specified in TS 26.116 [125], clause 4.5.4.7,
- *H.265/HEVC Full HD HDR* Operation Point Receiver requirements as specified in TS 26.116 [125], clause 4.5.5.8, and
- *H.265/HEVC UHD HDR* Operation Point Receiver requirements as specified in TS 26.116 [125], clause 4.5.6.8.

10.6 Still images

If still images are supported, ISO/IEC JPEG [61] together with JFIF [62] decoders shall be supported. The support for ISO/IEC JPEG only applies to the following two modes:

- baseline DCT, non-differential, Huffman coding, as defined in table B.1, symbol 'SOF0' in TS 26.273 [26];
- progressive DCT, non-differential, Huffman coding, as defined in table B.1, symbol 'SOF2' TS 26.273 [26].

10.7 Bitmap graphics

If bitmap graphics is supported, the following bitmap graphics decoders should be supported:

- GIF87a, [63];
- GIF89a, [64];
- PNG, [65].

10.8 Vector graphics

If vector graphics is supported, SVG Tiny 1.2 [66], [67] and ECMAScript [68] shall be supported.

NOTE 1: The compression format for SVG content is GZIP [42], in accordance with the SVG specification [66].

NOTE 2 Content creators of SVG Tiny 1.2 are strongly recommended to follow the content creation guidelines provided in annex L of TS 26.234 [47].

10.9 Text

Text is supported as part of the HTML5 support [124].

The following character coding formats shall be supported:

- UTF-8, [71];
- UCS-2, [70].

10.10 Timed text

If timed text is supported, MBMS Clients shall support TS 26.245 [72]. Timed text may be transported over RTP or downloaded contained in 3GP files using Basic profile.

NOTE: When a MBMS Client supports timed text, it needs to be able to receive and parse 3GP files containing the text streams. This does not imply a requirement on MBMS Clients to be able to render other continuous media types contained in 3GP files, e.g. AMR, if such media types are included in a presentation together with timed text. Audio and video are instead streamed to the client using RTP.

10.11 3GPP file format

An MBMS Client shall support the Basic profile and the Extended presentation profile of the 3GPP file format TS 26.244 [32].

For delivery of 3GP-DASH formatted segments over MBMS download (see clause 5.6), the MBMS Client shall support the 3GPP file format and segments for Dynamic Adaptive Streaming over HTTP as specified in TS 26.247 [98] and in TS 26.244 [32].

10.12 Scene description

If scene description is supported, MBMS Clients shall support the 3GPP HTML5 profile [124] as the scene description format.

The HTML5 presentation shall be identified by the presence of an *appService* element in the USD with the attribute *appServiceDescriptionURI* set to point to the HTML5 document with the MIME type "text/html". The resources referenced from the HTML5 document should be delivered on the same FLUTE session as the HTML5 document itself. Alternatively, the HTML5 document and related static resources may be delivered as part of the USD as metadata fragments.

The HTML5 document may reference an MPD [98] or a progressive download file [98] as a source location for media playback using an HTML5 media element.

Scene updates are possible through the delivery of a scene update file that is referenced through a Javascript that periodically checks for these updates. The Javascript should detect new versions of the scene update file by checking the file version (provided e.g. as the Content-MD5 over FLUTE).

10.13 Timed graphics

If timed graphics is supported, MBMS Clients shall support TS 26.430 [95].

10.14 360 video and 3D audio for VR (Virtual Reality)

10.14.1 Video

10.14.1.1 Operation points

If the MBMS Client supports 360 VR video, it shall include a receiver that complies with

- the *H.264/AVC* Basic Operation Point Receiver requirements as specified in TS 26.118 [121], clause 5.1.4.

If the MBMS Client supports 360 VR video, it should include a receiver that complies with

- the *Main H.265/HEVC* Operation Point Receiver requirements as specified in TS 26.118 [121], clause 5.1.5.

10.14.1.2 DASH-over-MBMS

Only a single Adaptation Set for each media type should be offered in an MPD for DASH-over-MBMS.

If the MBMS Client supports 360 VR video for DASH-over-MBMS services, it shall include a receiver that complies with

- the *Basic Video Media Profile* Receiver requirements for DASH as specified in TS 26.118 [121], clause 5.2.2.

If the MBMS Client supports 360 VR video for DASH-over-MBMS services, it should include a receiver that complies with

- the *Main Video Media Profile* Receiver requirements for DASH as specified in TS 26.118 [121], clause 5.2.3.

NOTE: The receiver is not expected to handle Media Adaptation Set Ensembles for Viewport-Optimized offerings as defined in clause 5.2.3.3.4 of TS 26.118 [121].

10.14.2 Audio

10.14.2.1 Operation points

If the MBMS Client supports 3D/VR audio, it should include a receiver that complies with

- the *3GPP MPEG-H Audio* Operation Point Receiver requirements as specified in TS 26.118 [121], clause 6.1.4.

10.14.2.2 DASH-over-MBMS

If the MBMS Client supports 3D/VR audio for DASH-over-MBMS services, it should include a receiver that complies with

- the *OMAF 3D Audio Baseline* Media Profile Receiver requirements for DASH as specified in TS 26.118 [121], clause 6.2.2.3.

11 MBMS metadata

11.1 MBMS Metadata Envelope

11.1.1 Supported metadata syntaxes

The MBMS metadata syntax supports the following set of features:

- Support of carriage of SDP descriptions, and SDP is expected to sufficiently describe at least: MBMS Streaming sessions and, MBMS download sessions.
- Support for multiple metadata syntaxes, such that the delivery and use of more than one metadata syntax is possible.
- Consistency control of metadata versions, between senders and receivers, independent of the transport and bearer use for delivery.
- Metadata fragments are identified, versioned and time-limited (expiry described) in a metadata fragment syntax-independent manner (which is a consequence of the previous two features).

11.1.2 Consistency control and syntax-independence

The *Metadata Envelope* provides information to identify, version and expire each of its metadata fragments. This is specified to be independent of metadata fragments syntax and of transport method (thus enabling the use of more than one syntax and enabling delivery over more than a single transport and bearer).

A Metadata Envelope (as identified by the *metadataEnvelope* element in the schema in clause 11.1.3) consists of one or more Metadata Envelope items (as identified by the *item* element in the schema in clause 11.1.3). A Metadata Envelope item is associated to exactly one metadata fragment. A Metadata Envelope item may update the time validity of its metadata fragment without changing version of that metadata fragment if the metadata fragment has not changed. A newer version (higher version number) of a Metadata Envelope item shall automatically expire the earlier version. If the content type (metadata fragment syntax) is recognized and valid, the UE shall use the new metadata fragment description. However, if the content type is not recognized or valid, the UE may maintain the expired version data until the newer version is correctly received.

Service announcement senders shall increment the version by one for each subsequent transported version of a metadata fragment. However, a UE shall also accept versions with an increment greater than one (so that they do not fail in the case that an intermediate version was not successfully transported).

11.1.3 Metadata Envelope syntax

The attributes for a Metadata Envelope item and their description are as follows. These attributes shall be supported:

- *metadataURI*: A URI providing a unique identifier for the metadata fragment. The *metadataURI* attribute shall be present.
- *version*: The version number of the associated instance of the metadata fragment. The version number should be initialized to one. The version number shall be increased by one whenever the metadata fragment is updated. The *version* attribute shall be present.
- *validFrom*: The date and time from which the metadata fragment file is valid. The *validFrom* attribute may or not be present. If not present, the UE should assume the metadata fragment version is valid immediately.
- *validUntil*: The date and time when the metadata fragment file expires. The *validUntil* attribute may or not be present. If not present the UE should assume the associated metadata fragment is valid for all time, or until it receives a newer metadata envelope for the same metadata fragment describing a validUntil value.
- *contentType*: The MIME media type of the metadata fragment which shall be used as defined for the "Content-Type" header field in RFC 9110 [155]. The *contentType* attribute shall be present for embedding metadata envelopes. The *contentType* attribute may be present for referencing metadata envelopes.

The metadata envelope is instantiated using an XML structure. This XML contains a URI referencing the associated metadata fragment. The formal XML schema for the metadata envelope is specified in listing 11.1.3-1 below.

Listing 11.1.3-1: Metadata Envelope schema

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:3gpp:metadata:2005:MBMS:envelope"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  xmlns="urn:3gpp:metadata:2005:MBMS:envelope"
  elementFormDefault="qualified" attributeFormDefault="unqualified">
  <xs:annotation>
    <xs:documentation>MBMS Metadata Envelope schema</xs:documentation>
    <xs:documentation>3GPP TS 26.346 clause 11.1.3</xs:documentation>
    <xs:documentation>Copyright © 2005, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI,
TSDSI, TTA, TTC). All rights reserved.</xs:documentation>
  </xs:annotation>

  <xs:element name="metadataEnvelope" type="metadataEnvelopeType"/>
  <xs:complexType name="metadataEnvelopeType">
    <xs:sequence>
      <xs:element name="item" type="metadataEnvelopeItemType" maxOccurs="unbounded"
minOccurs="1"/>
    </xs:sequence>
  </xs:complexType>

  <xs:complexType name="metadataEnvelopeItemType">
    <xs:sequence>
      <xs:element name="metadataFragment" type="xs:string" minOccurs="0" maxOccurs="1"/>
      <xs:any namespace="##other" minOccurs="0" maxOccurs="unbounded"
processContents="lax"/>
    </xs:sequence>
    <xs:attribute name="metadataURI" type="xs:anyURI" use="required"/>
    <xs:attribute name="version" type="xs:positiveInteger" use="required"/>
    <xs:attribute name="validFrom" type="xs:dateTime" use="optional"/>
    <xs:attribute name="validUntil" type="xs:dateTime" use="optional"/>
    <xs:attribute name="contentType" type="xs:string" use="optional"/>
    <xs:anyAttribute processContents="skip"/>
  </xs:complexType>
</xs:schema>
```

The *metadataFragment* element shall be encapsulated in the Metadata Envelope for embedded metadata fragments, and shall not be encapsulated where the metadata fragment is not embedded. In the embedded case, the *metadataFragment* element shall contain exactly one embedded metadata fragment as specified by the Metadata Envelope syntax and only one instance of the envelope element shall be used for encapsulating envelopes.

An embedded metadata fragment (in the *metadataFragment* element) shall be escaped. Generally, an embedded metadata fragment should be escaped by placing inside a CDATA section [31]. Everything starting after "<![CDATA[" string and ending at the "]]>" string would be ignored by the XML envelope parser (quotes not included). Thus, the embedded parts would appear as "<![CDATA[" + metadata_fragment + "]]>". In this case, the complete Metadata Envelope with embedded metadata fragment shall not violate the rules of CDATA section usage [31].

In case the embedded metadata fragment is an XML document and include a CDATA section, the embedded metadata fragment may be escaped by replacing illegal characters with their ampersand-escaped equivalents [31] (instead of encapsulating the whole fragment in a CDATA section). For instance, "<" is an illegal character that would be replaced by "<". This method is useful to avoid nesting CDATA sections (which is not allowed).

A metadata fragment which does not adhere to either of these two methods shall not be embedded in a Metadata Envelope. Thus, it may only be referenced from a referencing metadata envelope.

Embedded fragments are not expected to be parsed by the Metadata Envelope XML parser, but decapsulated and passed to the relevant metadata management operation that is implementation-specific (e.g. for immediate parsing, storage, etc.).

11.1.4 Delivery of Metadata Envelope

An item of Metadata Envelope shall be associated with an instance of a metadata fragment by one of two methods:

- Embedded: The metadata fragment is embedded within the Metadata Envelope.
- Referenced: The metadata fragment is referenced from the Metadata Envelope.

The MBMS UE must know the MIME media type of each metadata fragment.

In the embedded case, the envelope and fragment are, by definition, transported together and in-band of one another. In the referenced case, the envelope and fragment shall be transported together in-band of the same transport session.

MBMS Service Announcement transports shall support delivery of the Metadata Envelope as a discrete object (XML document) for the referenced case. In the referenced case, the MIME media type of the metadata fragment should be provided by the transport protocol (e.g. as a Content-Type text string). In both cases, the MIME media type of the Metadata Envelope should be provided by the transport protocol.

The Metadata Envelope item includes a reference (*metadataURI*) to the associated metadata fragment using the same URI as the fragment file is identified by in the Service Announcement. Thus, the Metadata Envelope can be mapped to its associated metadata fragment.

11.2 User Service Bundle Description metadata fragment

11.2.1 User Service Bundle Description syntax

11.2.1.1 Baseline syntax

This clause specifies the syntax of the User Service Bundle Description in Release 6. Extensions to the baseline User Service Bundle Description schema are specified in clause 11.2.1.1.

The root element of the User Service Bundle Description is the *bundleDescription* element. The element is of the *bundleDescriptionType*. The *bundleDescription* contains one or several *userServiceDescription* elements and optionally a reference to the FEC repair stream description.

Each *userServiceDescription* element shall have a unique identifier. The unique identifier shall be offered as *serviceId* attribute within the *userServiceDescription* element and shall be of URI format.

The *userServiceDescription* element may contain one or more *name* elements. The intention of a *name* element is to offer a title of the user service. For each name elements, the language shall be specified according to XML datatypes (XML Schema Part 2 [22]).

The *userServiceDescription* element may contain one or more *serviceLanguage* elements. Each *serviceLanguage* element represents the available languages of the user services. The language shall be specified according to XML datatypes (XML Schema Part 2 [22]).

The *deliveryMethod* element may contain an *accessPointName* attribute. The *accessPointName* attribute is optional and gives an Access Point Name (APN) as defined in TS 23.003 [77]. When this attribute is present, the MBMS UE shall use the given APN for MBMS UE to network interactions like File Repair and/or security registration. If this attribute is not present, the MBMS UE shall use a default PDP context/default EPS bearer for network interactions.

Each *userServiceDescription* element shall contain at least one *deliveryMethod* element. The *deliveryMethod* element contains the description of one delivery method. The element shall contain one reference to a Session Description and may contain references to one Associated Delivery Procedure Description and/or one Security Description. The Session Description is further specified in clause 5.2.2.2.

A *requiredCapabilities* element gives a list of features, which are required for the consumption of the related MBMS user service. The list of features that are currently defined is included in section 11.9. The value of the *feature* element indicates the required feature.

NOTE: The BM-SC can also determine the terminal capabilities from the terminal identification during the security registration. If the registering terminal does not have the required capabilities, the BM-SC can reject the security registration.

The *deliveryMethod* element may contain a reference to an Associated Delivery Procedures Description via the attribute *associatedProcedureDescriptionURI*. The description and configuration of associated delivery procedures is specified in clause 5.2.2.3.

The *deliveryMethod* element may contain a reference to a Security Description via the attribute *protectionDescriptionURI*. The Security Description is specified in clause 5.2.2.4.

A *userServiceDescription* element contains zero or more *accessGroup* elements. An *accessGroup* element defines a list of access networks and is uniquely identified by its id attribute. An *accessGroup* element describes whether separate access systems for the same MBMS user service are used (see clause 5.1.5.2 of TS 23.246 [4]) by including one or more *accessBearer* elements, each describing one of those access systems and no two describing the same. Possible *accessBearer* values are "3GPP.R6.UTRAN", "3GPP.R6.GERAN", "3GPP.R7.MBSFN-FDD", "3GPP.R7.MBSFN-TDD" and "3GPP.R8.MBSFN-IMB" which indicate transport by 3GPP MBMS bearers according to the specification in TS 23.246 [4] and TS 25.346 [5]. The *accessBearer* value for evolved UTRAN is "3GPP.R9.E-UTRAN".

For forward compatibility, other *accessBearer* values are allowed but their definition and use are out of scope of this specification and an MBMS UE may silently ignore other values.

Each *deliveryMethod* element contains at most one *accessGroupId* attribute. One specific *accessGroupId* value maps to one specific *accessGroup* element id value. For each unique *accessGroupId* attribute value presented in a *deliveryMethod* element of a *userServiceDescription* instance, exactly one associated *accessGroup* element shall be present and the id attribute of the *accessGroup* element and the *accessGroupId* attribute shall have the same value. For each *deliveryMethod* element without an *accessGroupId* attribute, the UE should assume that the delivery method is offered through all available MBMS access systems.

The XML schema for the baseline Release 6 User Service Bundle Description is specified in listing 11.2.1.1-1 below. This schema is not distributed as an attachment to the present document; clause J.1 contains the normative User Service Bundle Description schema, including all extensions specified in clause 11.2.1.2.

Listing 11.2.1.1-1: User Service Bundle Description schema (Release 6)

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:3GPP:metadata:2005:MBMS:userServiceDescription"
  xmlns="urn:3GPP:metadata:2005:MBMS:userServiceDescription"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  elementFormDefault="qualified">
  <xs:annotation>
    <xs:documentation>MBMS User Service Bundle Description schema</xs:documentation>
    <xs:documentation>3GPP TS 26.346 clause 11.2.1.1</xs:documentation>
    <xs:documentation>Copyright © 2005, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI,
    TSDSI, TTA, TTC). All rights reserved.</xs:documentation>
  </xs:annotation>

  <xs:element name="bundleDescription" type="bundleDescriptionType"/>
  <xs:complexType name="bundleDescriptionType">
```

```

    <xs:sequence>
      <xs:element name="userServiceDescription" type="userServiceDescriptionType"
maxOccurs="unbounded"/>
      <xs:any namespace="##other" minOccurs="0" maxOccurs="unbounded"
processContents="lax"/>
    </xs:sequence>
    <xs:attribute name="fecDescriptionURI" type="xs:anyURI" use="optional"/>
    <xs:anyAttribute processContents="skip"/>
  </xs:complexType>

  <xs:complexType name="userServiceDescriptionType">
    <xs:sequence>
      <xs:element name="name" type="nameType" minOccurs="0" maxOccurs="unbounded"/>
      <xs:element name="serviceLanguage" type="xs:language" minOccurs="0"
maxOccurs="unbounded"/>
      <xs:element name="requiredCapabilities" type="requirementsType" minOccurs="0"
maxOccurs="1"/>
      <xs:element name="deliveryMethod" type="deliveryMethodType" maxOccurs="unbounded"/>
      <xs:element name="accessGroup" type="accessGroupType" minOccurs="0"
maxOccurs="unbounded"/>
      <xs:any namespace="##other" minOccurs="0" maxOccurs="unbounded"
processContents="lax"/>
    </xs:sequence>
    <xs:attribute name="serviceId" type="xs:anyURI" use="required"/>
    <xs:anyAttribute processContents="skip"/>
  </xs:complexType>

  <xs:complexType name="accessGroupType">
    <xs:sequence>
      <xs:element name="accessBearer" type="xs:string" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:attribute name="id" type="accessGroupIdType" use="required"/>
  </xs:complexType>

  <xs:complexType name="deliveryMethodType">
    <xs:sequence>
      <xs:any namespace="##other" minOccurs="0" maxOccurs="unbounded"
processContents="lax"/>
    </xs:sequence>
    <xs:attribute name="accessGroupId" type="accessGroupIdType" use="optional"/>
    <xs:attribute name="associatedProcedureDescriptionURI" type="xs:anyURI" use="optional"/>
    <xs:attribute name="protectionDescriptionURI" type="xs:anyURI" use="optional"/>
    <xs:attribute name="sessionDescriptionURI" type="xs:anyURI" use="required"/>
    <xs:attribute name="accessPointName" type="xs:anyURI" use="optional"/>
    <xs:anyAttribute processContents="skip"/>
  </xs:complexType>

  <xs:complexType name="nameType">
    <xs:simpleContent>
      <xs:extension base="xs:string">
        <xs:attribute name="lang" type="xs:language" use="optional"/>
      </xs:extension>
    </xs:simpleContent>
  </xs:complexType>

  <xs:simpleType name="accessGroupIdType">
    <xs:restriction base="xs:nonNegativeInteger"/>
  </xs:simpleType>

  <xs:complexType name="requirementsType">
    <xs:sequence>
      <xs:element name="feature" type="xs:unsignedInt" minOccurs="1" maxOccurs="unbounded"/>
    </xs:sequence>
  </xs:complexType>
</xs:schema>

```

11.2.1.2 Extensions to the User Service Bundle Description syntax

The schemas specified in this clause extend the Release 6 User Service Bundle Description schema specified in clause 11.2.1.1. An MBMS User Service Bundle Description schema of the current release shall comply with the User Service Bundle Description schema specified in listing 11.2.1.1-1 and the extension schemas specified in all subsequent releases up to and including the current release.

Clause J.1 specifies the normative Extended User Service Bundle Description schema referencing all of the extension schemas.

An *initiationRandomization* element and *terminationRandomization* element carries the parameters to be used by the MBMS UE to randomize their initiation and/or termination operations over time. If the *initiationRandomization* element is present, all MBMS UEs shall randomize the initiation time as defined by the attributes of the elements. If the *terminationRandomization* element is present, all MBMS UEs shall randomize the termination time as defined by the attributes of the elements.

The *initiationRandomization* and/or *terminationRandomization* element may be part of:

- a *bundleDescription*, where it applies to all services in the service bundle.
- a *userServiceDescription*, where it applies to all MBMS bearer services of a single service. If present, this overrides the element in *bundleDescription*.

If the *initiationRandomization* element is not present, the MBMS UE does not randomize the User Service Initiation procedure over time. The MBMS UE should then perform the operation immediately when it is triggered.

If the *terminationRandomization* element is not present, the MBMS UE does not randomize the User Service Termination procedure over time. The MBMS UE should then perform the operation immediately when it is triggered.

An *initiationRandomization* element may contain the *initiationStartTime* attribute, which defines the start time for the initiation procedure randomization period. The value of the data field represents the 32 most significant bits of a 64-bit Network Time Protocol (NTP) [78] time value. If the *initiationStartTime* attribute is not present, the MBMS UE shall use the reception time of the User Service Discovery/Announcement information as *initiationStartTime*.

The *initiationRandomization* element shall contain the *protectionPeriod* attribute. The *protectionPeriod* attribute expresses the length of the protection period in seconds. The initiation procedure shall be randomly deferred during protection period.

The *initiationRandomization* element shall contain the *randomTimePeriod* attribute. The *randomTimePeriod* attribute expresses the length of a time interval (in seconds) over which requests are deferred. The MBMS UE shall calculate a random time for the execution of the initiation procedure. The method provides for statistically uniform distribution over a relevant period of time.

The *terminationRandomization* element shall contain the *protectionPeriod* attribute. The *protectionPeriod* attribute expresses the length of the protection period in seconds. The termination procedure execution shall be randomly deferred during protection period.

The *terminationRandomization* element shall contain the *randomTimePeriod* attribute. The *randomTimePeriod* attribute expresses the length of a time interval (in seconds) over which the operations are deferred. The MBMS UE shall calculate a random time for the execution of the termination procedure. The method provides for statistically uniform distribution over a relevant period of time.

If the MBMS UE is switched off during the termination randomization, the MBMS UE shall cancel the termination randomization.

The *r8:alternativeAccessDelivery* element shall extend the list of elements of the MBMS *deliveryMethod* element. Whenever present, it shall contain at least one *unicastAccessURI* element. The *unicastAccessURI* element provides unicast server information for OMA push for MBMS download service when the UE is outside of home network and file download delivery method is used. The *unicastAccessURI* element refers to a URI to be used for unicast access to the streaming service. If the *r8:alternativeAccessDelivery* element is available then the UE shall select one of the *unicastAccessURI* elements included. The *timeShiftingBuffer* attribute of *r8:alternativeAccessDelivery* may be used to indicate the minimal size of the time shifting buffer that will be provided for the current service by the PSS servers that are referenced in the list. The actual size of the timeshifting buffer of the selected server is returned in the SETUP response from the PSS Server.

The *r12:inbandMetadata* attribute of the *deliveryMethod* element, if present and set to "true" or "1", indicates that the MBMS download session associated with this *deliveryMethod* instance shall be the one exclusively used to carry all USD metadata fragments eligible for in-band delivery (namely, the Associated Delivery Procedure Description, Schedule Description, Filter Description and Media Presentation Description metadata fragments) along with MBMS User Service content(s).

The *r12:appComponent* child element of the *deliveryMethod* element, if present, identifies the application content component(s) carried on the MBMS delivery session associated with that *deliveryMethod* instance. One or more instances of *r12:appComponent* may be present under a given *deliveryMethod* instance, to indicate the same number and types of application content component(s) carried on the corresponding delivery session. The collection of *r12:appComponent* attribute names across all *deliveryMethod* instances of an MBMS User Service represents the complete set of application content components available to the MBMS application affiliated with that MBMS User Service.

The *r12:serviceArea* child element of the *deliveryMethod* element, if present, specifies the service area(s) for which non-DASH streaming content carried on the MBMS delivery session associated with that instance of *deliveryMethod*, are available for UE reception. The semantics of *r12:serviceArea* shall comply to the *MBMS Service Area Identity* as defined in TS 23.003 [4] and TS 36.443 [104].

If the *contentType* attribute within the *r12:appService* element, itself a child of the *userServiceDescription* element, indicates a UE supported value, then

- The presence of one or more *r12:broadcastAppService* element(s) under a given instance of the *deliveryMethod* element shall declare the one or more application service content items delivered over the FLUTE session associated with that *deliveryMethod* instance.
- The presence of the *r12:unicastAppService* element under a given instance of the *deliveryMethod* element declares the one or more application service content items delivered over unicast bearer(s) in support of unicast fallback delivery.
- Each instance of *r12:broadcastAppService.basePattern* or *r12:unicastAppService.basePattern* denotes a content item of a single application service delivered over broadcast or unicast, respectively. Each broadcast content item may be designated as being available in specific MBMS service area(s) as given by the corresponding *r12:broadcastAppService.serviceArea* element(s). If present, the serviceArea elements shall be a subset of the MBMS service area(s) present for the current serviceId under *userServiceDescription.availabilityInfo.infoBinding.serviceArea* elements. When one or more *serviceArea* element(s) are included under one or more *r12:broadcastAppService*, the union of all the MBMS Service Area Identities identified by the *serviceArea* elements under all the *r12:broadcastAppService* shall match the list of MBMS Service Area Identities included in the *userServiceDescription.availabilityInfo.infoBinding.serviceArea* elements for the same *serviceId*. Each broadcast content item under its containing Period is identified by its *basePattern* value whose format and usage are described in clauses 7.6.2.1 and 7.6.2.3. Each unicast content item under its containing Period is identified by its *basePattern* value whose format and usage are described in clauses 7.6.2.2 and 7.6.2.3.

If the *contentType* attribute of the *r12:appService* element, itself a child of the *userServiceDescription* element, indicates a value not supported by the UE, then a UE compliant with the present document shall ignore *r12:broadcastAppService* and the *r12:unicastAppService* elements in the *deliveryMethod* element.

A USD may include a *r7:unicastAccessURI* element for support of Release 7 UEs. UEs of release 8 onwards shall use *alternativeAccessDelivery* element for both OMA Push file download and unicast streaming.

The *serviceClass* attribute, if present, shall extend the list of attributes of the MBMS Release 6 *userServiceDescription* element. The *serviceClass* attribute is optional and contains the service class identifier for the delivered service according to the syntax defined in clause E.1.2 of [90].

NOTE 0: Annex E of [90] also foresees the registration of service class identifiers with the Open Mobile Naming Authority. The service class identifier is similar to MIME media types and provides a unique identity to services. An MBMS UE may determine the receiving application instance from the service class identifier.

A User Service Description may belong to a group of User Service Descriptions, which represent alternative configurations of the same User Service. An example is an MBMS User Service that is delivered over a non-MBSFN bearer with a low bit rate and over MBSFN bearer with a high bit rate. In such a case, the UE is only expected to consume one variant of the service. The UE recognizes that a set of User Service Descriptions applies to one User Service based on the *serviceGroup* element.

The *userServiceDescription* element may include a *Registration* element. If present, then the UE shall send the registration and deregistration to the given URI. In such a case, the User Service Bundle Description fragment may not be complete in the service announcement. Instead, it may contain references to metadata fragments (e.g. the session description) that are not embedded in the service announcement. When registration is requested, the *userServiceDescription* element shall contain a *Registration* element that describes the requested registration procedure.

The *registrationURI* indicates the URI element to the server with whom the registration procedure shall be performed. In case more than one *registrationURI* is indicated, the UE shall select one randomly. The *registrationThreshold* is a number that indicates the percentage of UEs that are requested to register. The UE shall randomly select a number between 0 and 100 and compare it against the threshold. In case the selected number is lower than the indicated threshold, the UE should perform registration. The threshold value "100" indicates that the UE shall perform registration, which is e.g. necessary when the User Service Description is not complete.

The *userServiceDescription* element may include an *r9:mediaPresentationDescription* element when the associated MBMS User Service carries 3GP-DASH-formatted content using the download delivery method. The *userServiceDescription* element may also, or instead, include an *r12:appService* element containing a reference to an Application Service Description fragment which in turn contains descriptions for contents of an application service delivered over either unicast, or broadcast, or both unicast and broadcast modes. If *r12:appService* element is present, and its *mimeType* attribute indicates a UE supported value, then it shall be used by MBMS UEs complying with the present document. If *r12:appService* is absent or its *mimeType* attribute indicates a value not supported by the UE, and if *r9:mediaPresentationDescription* is present, then the *r9:mediaPresentationDescription* shall be used by MBMS UEs complying with this release of the present document. The UE should expect that the received files correspond to a DASH Media Presentation as described by the MPD in TS 26.247 [98]. The referenced MPD provides a reference to a corresponding Media Presentation Description metadata fragment whose contents are identical to the MPD as defined in TS 26.247 [98]. The Media Presentation Description fragment may refer, via the *InitializationSegmentURL*, to one or more Initialization Segment Description (ISD) metadata fragments, whose contents are identical to the Initialization Segment as defined in TS 26.247 [98]. If the *r12:appService* element is present, the associated application service shall be a DASH Media Presentation delivered as an MBMS User Service.

The *r12:appService* element may contain the child elements *identicalContent* and/or *alternativeContent* which designate the sets of identical and/or alternative versions, respectively, of content items that may be substituted for one another. Additional description of the contents and semantics of the *r12:appService* element are specified in clause 7.6.3. If the *r12:appService* element is included, and its *mimeType* attribute indicates a value not supported by the UE, then a UE compliant with the present document shall ignore all of the *r12:appService* child elements, and all of its child attributes.

A User Service Description may include a *schedule* element. If present, the *schedule* element includes a URI reference to the MBMS User Service schedule information, the latter corresponding to a Schedule Description metadata fragment as defined in clause 11.2A.

The Schedule Description fragment may include a URI reference to the Filter Description metadata fragment to signify the intended use of content filtering. Each filter data instance contains associated criteria or rules for use by UEs to selectively receive contents at the session level or the file level.

- At the session level, the filter rules enable a UE to decide whether it should receive the entire contents of the associated delivery session(s) of the User Service.
- At the file level, the filter rules enable a UE to decide whether it should receive individual files of the User Service, during the corresponding file delivery schedule(s).

Additional description of the association between Schedule Description and Filter Description fragments and intended usage are given in clauses 11.2A and 11.2B.

A User Service Description may include an *availabilityInfo* element. If present, it shall extend the list of child elements of the MBMS *userServiceDescription* element by indicating the presence of additional data pertaining to the availability of the service.

The *availabilityInfo* element shall include one or more *infoBinding* elements. The *infoBinding* element shall contain the child elements *serviceArea* and *radiofrequency*. A UE shall be capable of processing an *infoBinding* element that does not contain the child element *serviceArea*.

NOTE 0a: For backwards compatibility reasons, *serviceArea* needs to be indicated as optional in the USD schema (i.e. 'minOccurs="0"').

- The *serviceArea* element declares the one or more service areas over which this MBMS User Service is provided. This element is designated by the *MBMS Service Area Identity* (SAI) as defined in 3GPP TS 36.443 [104] and 3GPP TS 23.003 [77]. According to 3GPP TS 36.443 [104], *MBMS Service Area Identity* is frequency agnostic and can be mapped onto one or more cells. The specific usage of the *MBMS Service Area Identity*, or its correlation to other network identification information, is not defined in the present document.

- The *radioFrequency* element indicates the one or more RF frequencies in the E-UTRAN downlink which transmit this MBMS User Service over the service area(s) identified by the *serviceArea* element. The frequency parameter is coded as EARFCN in TS 36.101 [105].

The MBMS Client shall forward the service area and radio frequency information received in the USD to the lower layers, and the UE is expected to make use of such information in accordance with TS 36.300 [96] clause 15.4 as well as TS 36.304 [108] and TS 36.331 [97].

PLMN, *p-serviceArea*, and *group* may be present as attributes of the *deliveryMethod* element. The attribute *PLMN* or *p-serviceArea* identifies the area(s) by PLMN-ID or one or more MBMS SAI's in which this instance of *deliveryMethod* is applicable. The UE is expected to use the Session Description fragment referenced by the *deliveryMethod* whose *PLMN* or *p-serviceArea* matches the UE's location by the corresponding area type. Presence of either *PLMN* or *p-serviceArea* under *deliveryMethod*, but not both, is permitted. Multiple *deliveryMethod* elements sharing the same *group* attribute shall be considered as alternatives by the UE. For each group that the *deliveryMethod*'s affiliated *PLMN* or *p-serviceArea* matches the UE's location, the UE shall acquire the content delivered on the corresponding FLUTE session. In the event of *deliveryMethod* instances associated with multiple groups, the UE shall acquire the content delivered on the FLUTE sessions from each of the group with matching *PLMN* or *p-serviceArea* to the UE's location. The *PLMN* attribute, when present, indicates the PLMN-ID in which the contents carried by the current *deliveryMethod* is accessible, and is defined as a concatenation of MCC and MNC, each represented as a 3-digit hexadecimal number. The *p-serviceArea* attribute, when present, indicates the one or more MBMS SAIs, each represented by a decimal number between 0 and 65,535 (inclusive), in which the contents carried by the current *deliveryMethod* is accessible.

The *r12:KeepUpdatedService* element indicates if the referenced *userServiceDescription* describes a keep-updated service. The URL to one or more registration servers is provided in the *registrationServer* element. If more than one *registrationServer* URL element is present, the MBMS UE shall choose one randomly.

The presence of the *r12:consumptionReporting* element indicates whether the UE shall perform consumption reporting as defined in clause 9.4A.2. The *consumptionReportingURI* attribute references an Associated Delivery Procedure Description including only the *r12:consumptionReport* element as defined in clause 9.4A.

The presence of the *r12:mooDConfiguration* element indicates whether the UE shall include the Mood Header (as defined in clause 12) in its request for the service consumed over unicast and disable unicast Consumption Reporting.

The *r12:mooDConfiguration* element should be used to specify the Mood configuration information and shall take precedence over the OMA DM MO as defined in clause 12.2.2, if such a DM configuration object exists on the UE. The *r12:mooDConfiguration* element is used to configure offloading for any type of eligible content accessed over the unicast network via HTTP or RTP. If present, this element contains the rules to which the UE shall comply for attaching the Mood Header (as defined in clause 12) in its requests for the service consumed over unicast and disable unicast Consumption Reporting. If the *r12:mooDConfiguration* element is present, then:

- The UE shall include the Mood Header in its request for the service delivery over unicast, in accordance to the criteria expressed in the *mooDHeaderAttachment* element;
- In the case of DASH-formatted content, the *dASHContent@rule* attribute under *mooDHeaderAttachment* specifies the rule on how the Mood header should be included in unicast requests sent to the proxy server: with every Media Segment request, or with every MPD request. Specifically:
 - *rule* = "1" means that the Mood header shall be attached to each Media Segment request by the DASH client;
 - *rule* = "2" means that the Mood header shall be attached to each MPD request by the DASH client;
 - *rule* = "0" shall not be used;
 - *rule* values in the range from 3 to 255 are reserved for future use.
- If the element *dASHContent* is not present, the default is *rule* = "1" (i.e. the Mood header shall be attached to each Media Segment request by the DASH client).
- The UE shall include the *serviceId* in the Mood Header from the *userServiceDescription@serviceId* attribute;
- If at least one *proxyServer* child element is present, then the UE shall select one proxy server address from the list of proxy servers, which is provided by the *proxyServer* child elements. The UE shall keep that proxy server URI for its subsequent requests for the same service delivery over unicast. If the *proxyServer* element is not

present, and the Mood MO does not exist in the UE, then the Mood header shall be attached in the unicast content request to the HTTP server whose location is given by the URL of the associated content request.

- The UE shall include its location in the Mood Header as CGI, ECGI or MBMS SAI, according to the *locationType* attribute. Possible values of the *locationType* attribute are "CGI", "ECGI" or "MBMS SAI".

Otherwise, if *r12:moodConfiguration* element is absent, the UE shall report unicast and broadcast consumption reporting as specified in clause 9.4A.2.

The *userServiceDescription* element may include the *r14:romService* attribute which when set to "true" is an indication that the corresponding MBMS User Service is a Receive-Only-Mode (ROM) service. This attribute enables both "regular" MBMS UEs, and UEs configured in Receive Only Mode, to determine the availability of ROM service offering(s) from a Service Announcement service that describes both ROM and non-ROM services (MBMS User Services whose TMGIs are outside the standardized range of values as defined in TS 24.116 [131]). If the *r14:romService* attribute is not present, its default value shall be "false". As indicated in TS 23.246 [4], UEs configured in Receive Only Mode shall not attempt to acquire non-ROM services.

The *userServiceDescription.deliveryMethod* element may include the *r15:supplementaryUnicastAppService* child element to indicate the presence of one or more supplementary application service content items delivered over unicast and providing an additional user experience. Each such content item is indicated by an instance of the *basePattern* child element of *r15:supplementaryUnicastAppService*.

The *userServiceDescription* element may include the *r15:ROMSvcRfParams* child element to indicate RF information associated with the delivery of a Receive Only Mode (ROM) service. If this element is present, it shall contain a child element *Frequency*, coded as EARFCN as defined in TS 36.101 [105], which in turn shall contain the attributes *subcarrierSpacing* and *bandwidth*. The value of *subcarrierSpacing* shall be restricted to be one of the following numbers in units of kHz: 1.25, 7.5 or 15. The value of *bandwidth* shall be restricted to be one of the following numbers in units of MHz: 1.4, 3, 5, 10, 15 and 20.

The *userServiceDescription* element may include the *r16:ROMSvcRfParams* child element to indicate RF information associated with the delivery of a Receive-Only Mode (ROM) service. If this element is present, it shall contain a child element *Frequency*, coded as EARFCN as defined in 3GPP TS 36.101 [105], which in turn shall contain the attributes *subcarrierSpacing* and *bandwidth*. The value of *subcarrierSpacing* shall be restricted to be one of the specified subcarrier spacing (Δf) values in TS 36.211 [145]. The value of *bandwidth* shall be restricted to be one of the specified channel bandwidth values in TS 36.104 [146]. Similar to *r15:ROMSvcRfParams*, presence of the *r16:ROMSvcRfParams* element in the USD does not imply that the RF channel as denoted by the *Frequency* child element of *r16:ROMSvcRfParams* has to correspond to a carrier frequency operated by the serving eNodeB of the UE, nor that the serving eNodeB is transmitting any MBMS services.

A User Service Bundle Description fragment complying with this version of the present document, and delivered on the ROM Service Announcement Channel (SACH), shall include the *r16:ROMSvcRfParams* element but not the *r15:ROMSvcRfParams* element.

It should be noted that if *r16:ROMSvcRfParams* is present in the User Service Bundle Description, the RF channel denoted by its *Frequency* child element does not necessarily correspond to a carrier frequency operated by the serving eNodeB of the UE, nor does it imply that the serving eNodeB is transmitting any MBMS services.

The Release 7 extensions to the User Service Bundle Description schema are specified in listing 11.2.1.2-1 below. The filename of this schema is "TS26346_UserServiceBundleDescription_Extensions_Rel-7.xsd".

Listing 11.2.1.2-1: User Service Bundle Description schema extensions (Release 7)

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:3GPP:metadata:2007:MBMS:userServiceDescription"
  xmlns="urn:3GPP:metadata:2007:MBMS:userServiceDescription"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  elementFormDefault="qualified">
  <xs:annotation>
    <xs:documentation>MBMS User Service Bundle Description schema extensions
    (Release 7)</xs:documentation>
    <xs:documentation>3GPP TS 26.346 clause 11.2.1.2</xs:documentation>
    <xs:documentation>Copyright © 2007, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI,
    TSDSI, TTA, TTC). All rights reserved.</xs:documentation>
  </xs:annotation>

  <xs:element name="initiationRandomization">
    <xs:complexType>
      <xs:attribute name="initiationStartTime" type="xs:unsignedInt" use="optional"/>
      <xs:attribute name="protectionPeriod" type="xs:unsignedInt" use="required"/>
      <xs:attribute name="randomTimePeriod" type="xs:unsignedInt" use="required"/>
    </xs:complexType>
  </xs:element>

  <xs:element name="terminationRandomization">
    <xs:complexType>
      <xs:attribute name="protectionPeriod" type="xs:unsignedInt" use="required"/>
      <xs:attribute name="randomTimePeriod" type="xs:unsignedInt" use="required"/>
    </xs:complexType>
  </xs:element>

  <xs:element name="serviceGroup" type="serviceGroupType"/>

  <xs:complexType name="serviceGroupType">
    <xs:attribute name="groupID" type="xs:anyURI" use="required"/>
  </xs:complexType>

  <xs:element name="unicastAccessURI" type="xs:anyURI"/>

  <xs:attribute name="serviceClass" type="xs:string"/>
</xs:schema>
```

The Release 8 extensions to the User Service Bundle Description schema are specified in listing 11.2.1.2-2 below. The filename of this schema is "TS26346_UserServiceBundleDescription_Extensions_Rel-8.xsd".

Listing 11.2.1.2-2: User Service Bundle Description schema extensions (Release 8)

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:3GPP:metadata:2008:MBMS:userServiceDescription"
  xmlns="urn:3GPP:metadata:2008:MBMS:userServiceDescription"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  elementFormDefault="qualified">
  <xs:annotation>
    <xs:documentation>MBMS User Service Bundle Description schema extensions
    (Release 8)</xs:documentation>
    <xs:documentation>3GPP TS 26.346 clause 11.2.1.2</xs:documentation>
    <xs:documentation>Copyright © 2008, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI,
    TSDSI, TTA, TTC). All rights reserved.</xs:documentation>
  </xs:annotation>

  <xs:element name="alternativeAccessDelivery">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="unicastAccessURI" type="xs:anyURI" minOccurs="0"
        maxOccurs="unbounded"/>
      </xs:sequence>
      <xs:attribute name="timeShiftingBuffer" type="xs:unsignedInt" use="optional"
      default="0"/>
    </xs:complexType>
  </xs:element>

  <xs:element name="Registration">
    <xs:complexType>
      <xs:sequence>
```

```

        <xs:element name="registrationURI" type="xs:anyURI" minOccurs="1"
maxOccurs="unbounded"/>
      </xs:sequence>
      <xs:attribute name="registrationThreshold" type="xs:unsignedInt" use="optional"
default="100"/>
    </xs:complexType>
  </xs:element>
</xs:schema>

```

The Release 9 extensions to the User Service Bundle Description schema are specified in listing 11.2.1.2-3 below. The filename of this schema is "TS26346_UserServiceBundleDescription_Extensions_Rel-9.xsd".

Listing 11.2.1.2-3: User Service Bundle Description schema extensions (Release 9)

```

<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:3GPP:metadata:2009:MBMS:userServiceDescription"
xmlns="urn:3GPP:metadata:2009:MBMS:userServiceDescription"
xmlns:xs="http://www.w3.org/2001/XMLSchema"
elementFormDefault="qualified">
  <xs:annotation>
    <xs:documentation>MBMS User Service Bundle Description schema extensions
(Release 9)</xs:documentation>
    <xs:documentation>3GPP TS 26.346 clause 11.2.1.2</xs:documentation>
    <xs:documentation>Copyright © 2009, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI,
TSDSI, TTA, TTC). All rights reserved.</xs:documentation>
  </xs:annotation>

  <xs:element name="mediaPresentationDescription">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="mpdURI" type="xs:anyURI"/>
      </xs:sequence>
    </xs:complexType>
  </xs:element>

  <xs:element name="schedule">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="scheduleDescriptionURI" type="xs:anyURI"/>
      </xs:sequence>
    </xs:complexType>
  </xs:element>

  <xs:element name="availabilityInfo">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="infoBinding" maxOccurs="unbounded">
          <xs:complexType>
            <xs:sequence>
              <xs:element name="serviceArea" type="xs:unsignedShort" minOccurs="0"
maxOccurs="unbounded"/>
              <xs:element name="radioFrequency" type="xs:unsignedInt"
maxOccurs="unbounded"/>
            </xs:sequence>
          </xs:complexType>
        </xs:element>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
</xs:schema>

```

The Release 12 extensions to the User Service Bundle Description schema are specified in listing 11.2.1.2-4 below. The filename of this schema is "TS26346_UserServiceBundleDescription_Extensions_Rel-12.xsd".

The schema version attribute (part of the schema instruction) shall be included in the UE schema and the network schema.

NOTE 1: The value of the *version* attribute is intended to be increased by 1 in every future release where new element(s) or attribute(s) are added to this extension. The value in the version attribute is used in the selection of the version of the current extension which may be used in a given version of the main USD schema. See clause J.1 for details.

Listing 11.2.1.2-4: User Service Bundle Description schema extensions (Release 12)

```

<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:3GPP:metadata:2013:MBMS:userServiceDescription" version="1"
  xmlns="urn:3GPP:metadata:2013:MBMS:userServiceDescription"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  elementFormDefault="qualified">
  <xs:annotation>
    <xs:documentation>MBMS User Service Bundle Description schema extensions
    (Release 12)</xs:documentation>
    <xs:documentation>3GPP TS 26.346 clause 11.2.1.2</xs:documentation>
    <xs:documentation>Copyright © 2013, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI,
    TSDSI, TTA, TTC). All rights reserved.</xs:documentation>
  </xs:annotation>

  <xs:element name="broadcastAppService">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="basePattern" type="xs:anyURI" maxOccurs="unbounded"/>
        <xs:element name="serviceArea" type="xs:unsignedShort" minOccurs="0"
maxOccurs="unbounded"/>
        <xs:any namespace="##other" processContents="lax" minOccurs="0"
maxOccurs="unbounded"/>
      </xs:sequence>
      <xs:anyAttribute processContents="skip"/>
    </xs:complexType>
  </xs:element>

  <xs:element name="unicastAppService">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="basePattern" type="xs:anyURI" maxOccurs="unbounded"/>
        <xs:any namespace="##other" processContents="lax" minOccurs="0"
maxOccurs="unbounded"/>
      </xs:sequence>
      <xs:anyAttribute processContents="skip"/>
    </xs:complexType>
  </xs:element>

  <xs:element name="appService" type="appServiceType"/>
  <xs:complexType name="appServiceType">
    <xs:sequence>
      <xs:element name="identicalContent" minOccurs="0" maxOccurs="unbounded">
        <xs:complexType>
          <xs:sequence>
            <xs:element name="basePattern" type="xs:anyURI" minOccurs="2"
maxOccurs="unbounded"/>
            <xs:any namespace="##other" processContents="lax" minOccurs="0"
maxOccurs="unbounded"/>
          </xs:sequence>
          <xs:anyAttribute processContents="skip"/>
        </xs:complexType>
      </xs:element>
      <xs:element name="alternativeContent" minOccurs="0" maxOccurs="unbounded">
        <xs:complexType>
          <xs:sequence>
            <xs:element name="basePattern" type="xs:anyURI" minOccurs="2"
maxOccurs="unbounded"/>
            <xs:any namespace="##other" processContents="lax" minOccurs="0"
maxOccurs="unbounded"/>
          </xs:sequence>
          <xs:anyAttribute processContents="skip"/>
        </xs:complexType>
      </xs:element>
      <xs:any namespace="##other" processContents="lax" minOccurs="0"
maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:attribute name="appServiceDescriptionURI" type="xs:anyURI" use="required"/>
    <xs:attribute name="mimeType" type="xs:string" use="required"/>
    <xs:anyAttribute processContents="skip"/>
  </xs:complexType>
  <xs:attribute name="inbandMetadata" type="xs:boolean"/>
  <xs:element name="appComponent" type="xs:string"/>
  <xs:element name="serviceArea" type="xs:unsignedShort"/>
  <xs:element name="KeepUpdatedService">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="registrationServer" type="xs:anyURI" maxOccurs="unbounded"/>

```

```

        </xs:sequence>
      </xs:complexType>
    </xs:element>

    <xs:element name="consumptionReporting">
      <xs:complexType>
        <xs:sequence>
          <xs:any namespace="##other" minOccurs="0" maxOccurs="unbounded"
processContents="lax"/>
        </xs:sequence>
        <xs:attribute name="consumptionReportingURI" type="xs:anyURI"
use="required"/>
        <xs:anyAttribute processContents="skip"/>
      </xs:complexType>
    </xs:element>

    <xs:element name="mooDConfiguration">
      <xs:complexType>
        <xs:sequence>
          <xs:element name="proxyServer" type="xs:anyURI" minOccurs="0"
maxOccurs="unbounded"/>
          <xs:element name="mooDHeaderAttachment">
            <xs:complexType>
              <xs:sequence>
                <xs:element name="dASHContent" minOccurs="0">
                  <xs:complexType>
                    <xs:attribute name="rule" type="xs:unsignedByte"
use="required">
                      <xs:annotation>
                        <xs:documentation>0: not used
1: Media Segment requests
2: MPD requests
3-255: reserved for future use </xs:documentation>
                      </xs:annotation>
                    </xs:attribute>
                    <xs:anyAttribute processContents="skip"/>
                  </xs:complexType>
                </xs:element>
                <xs:any namespace="##other" processContents="lax" minOccurs="0"
maxOccurs="unbounded"/>
              </xs:sequence>
            </xs:complexType>
          </xs:element>
          <xs:any namespace="##other" processContents="lax" minOccurs="0"
maxOccurs="unbounded"/>
        </xs:sequence>
      </xs:complexType>
    </xs:element>
    <xs:any namespace="##other" processContents="lax" minOccurs="0"
maxOccurs="unbounded"/>
  </xs:sequence>
</xs:complexType>
</xs:element>
<xs:attribute name="locationType" type="xs:string" use="required"/>
<xs:anyAttribute processContents="skip"/>
</xs:complexType>
</xs:element>
</xs:schema>

```

The Release 14 extensions to the User Service Bundle Description schema are specified in listing 11.2.1.2-5 below. The filename of this schema is "TS26346_UserServiceBundleDescription_Extensions_Rel-14.xsd".

Listing 11.2.1.2-5: User Service Bundle Description schema extensions (Release 14)

```

<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:3GPP:metadata:2017:MBMS:userServiceDescription" version="2"
xmlns="urn:3GPP:metadata:2017:MBMS:userServiceDescription"
xmlns:xs="http://www.w3.org/2001/XMLSchema"
elementFormDefault="qualified">
  <xs:annotation>
    <xs:documentation>MBMS User Service Bundle Description schema extensions
(Relase 14)</xs:documentation>
    <xs:documentation>3GPP TS 26.346 clause 11.2.1.2</xs:documentation>
    <xs:documentation>Copyright © 2017, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI,
TSDSI, TTA, TTC). All rights reserved.</xs:documentation>
  </xs:annotation>

  <xs:attribute name="romService" type="xs:boolean" default="false"/>
</xs:schema>

```

The Release 15 extensions to the User Service Bundle Description schema are specified in listing 11.2.1.2-6 below. The filename of this schema is "TS26346_UserServiceBundleDescription_Extensions_Rel-15.xsd".

Listing 11.2.1.2-6: User Service Bundle Description schema extensions (Release15)

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:3GPP:metadata:2018:r15:MBMS:userServiceDescription" version="3"
  xmlns="urn:3GPP:metadata:2018:r15:MBMS:userServiceDescription"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  elementFormDefault="qualified">
  <xs:annotation>
    <xs:documentation>MBMS User Service Bundle Description schema extensions
    (Release 15)</xs:documentation>
    <xs:documentation>3GPP TS 26.346 clause 11.2.1.2</xs:documentation>
    <xs:documentation>Copyright © 2018, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI,
    TSDSI, TTA, TTC). All rights reserved.</xs:documentation>
  </xs:annotation>

  <xs:element name="supplementaryUnicastAppService">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="basePattern" type="xs:anyURI" maxOccurs="unbounded"/>
        <xs:any namespace="##other" processContents="lax" minOccurs="0"
maxOccurs="unbounded"/>
      </xs:sequence>
      <xs:anyAttribute processContents="skip"/>
    </xs:complexType>
  </xs:element>

  <xs:element name="ROMSvcRfParams">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="Frequency" maxOccurs="unbounded">
          <xs:annotation>
            <xs:documentation>Coded as EARFCN per 3GPP TS 36.101.</xs:documentation>
          </xs:annotation>
          <xs:complexType>
            <xs:attribute name="subcarrierSpacing" use="required">
              <xs:annotation>
                <xs:documentation>Restricted to one of the following values in
kHz: [1.25, 7.5, 15].</xs:documentation>
              </xs:annotation>
            </xs:attribute>
            <xs:attribute name="bandwidth" use="required">
              <xs:annotation>
                <xs:documentation>Restricted to one of the following values in
MHz: [1.4, 3, 5, 10, 15, 20].</xs:documentation>
              </xs:annotation>
            </xs:attribute>
          </xs:complexType>
        </xs:element>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
</xs:schema>
```

The Release 16 extensions to the User Service Bundle Description schema are specified in listing 11.2.1.2-7 below. The filename of this schema is "TS26346_UserServiceBundleDescription_Extensions_Rel-16.xsd".

Listing 11.2.1.2-7: User Service Bundle Description schema extensions (Release 16)

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:3GPP:metadata:2020:MBMS:userServiceDescription" version="4"
  xmlns="urn:3GPP:metadata:2020:MBMS:userServiceDescription"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  elementFormDefault="qualified">
  <xs:annotation>
    <xs:documentation>MBMS User Service Bundle Description schema extensions
    (Release 16)</xs:documentation>
    <xs:documentation>3GPP TS 26.346 clause 11.2.1.2</xs:documentation>
    <xs:documentation>Copyright © 2020, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI,
    TSDSI, TTA, TTC). All rights reserved.</xs:documentation>
  </xs:annotation>

  <xs:element name="ROMSvcRfParams">
```

```

<xs:complexType>
  <xs:sequence>
    <xs:element name="Frequency" maxOccurs="unbounded">
      <xs:annotation>
        <xs:documentation>Coded as EARFCN per 3GPP TS 36.101.</xs:documentation>
      </xs:annotation>
      <xs:complexType>
        <xs:attribute name="subcarrierSpacing" type="xs:decimal" use="required">
          <xs:annotation>
            <xs:documentation>Restricted to one of the subcarrier spacing
values as specified in 3GPP TS 36.211.</xs:documentation>
          </xs:annotation>
        </xs:attribute>
        <xs:attribute name="bandwidth" type="xs:decimal" use="required">
          <xs:annotation>
            <xs:documentation>Restricted to one of the channel bandwidth
values as specified in 3GPP TS 36.104.</xs:documentation>
          </xs:annotation>
        </xs:attribute>
      </xs:complexType>
    </xs:element>
  </xs:sequence>
</xs:complexType>
</xs:element>
</xs:schema>

```

11.2.2 Example User Service Bundle Description instances

All examples in this clause are generated out of the network supporting the current release USD schema.

The following User Service Bundle Description instance is an example of a simple fragment. This fragment includes only the mandatory elements.

Listing 11.2.2-1: Simple User Service Bundle Description example

```

<?xml version="1.0" encoding="UTF-8"?>
<bundleDescription xmlns="urn:3GPP:metadata:2005:MBMS:userServiceDescription"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:sv="urn:3gpp:metadata:2009:MBMS:schemaVersion"
  xsi:schemaLocation="urn:3GPP:metadata:2005:MBMS:userServiceDescription
TS26346_UserServiceBundleDescription.xsd">

  <userServiceDescription serviceId="urn:3gpp:0010120123hotdog">
    <deliveryMethod sessionDescriptionURI="http://www.example.com/3gpp/mbms/session1.sdp">
      <sv:delimiter>0</sv:delimiter>
      <sv:delimiter>0</sv:delimiter>
      <sv:delimiter>0</sv:delimiter>
    </deliveryMethod>

    <sv:delimiter>0</sv:delimiter>
    <sv:delimiter>0</sv:delimiter>
    <sv:delimiter>0</sv:delimiter>
    <sv:delimiter>0</sv:delimiter>
  </userServiceDescription>

  <sv:schemaVersion>7</sv:schemaVersion>
</bundleDescription>

```

The following User Service Bundle Description instance is an example of a fuller fragment.

Listing 11.2.2-2: Fuller User Service Bundle Description example

```

<?xml version="1.0" encoding="UTF-8"?>
<bundleDescription xmlns="urn:3GPP:metadata:2005:MBMS:userServiceDescription"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:sv="urn:3gpp:metadata:2009:MBMS:schemaVersion"
  xsi:schemaLocation="urn:3GPP:metadata:2005:MBMS:userServiceDescription
TS26346_UserServiceBundleDescription.xsd"
  fecDescriptionURI="http://www.example.com/3gpp/mbms/session1-fec.sdp">

  <userServiceDescription serviceId="urn:3gpp:1234567890coolcat">
    <name lang="EN">Welcome</name>

```

```

<name lang="DE">Willkommen</name>
<name lang="FR">Bienvenue</name>
<name lang="FI">Tervetuloa</name>

<serviceLanguage>EN</serviceLanguage>
<serviceLanguage>DE</serviceLanguage>

<requiredCapabilities>
  <feature>0</feature>
</requiredCapabilities>

<deliveryMethod accessGroupId="1"
  sessionDescriptionURI="http://www.example.com/3gpp/mbms/session1.sdp">
  <sv:delimiter>0</sv:delimiter>
  <sv:delimiter>0</sv:delimiter>
  <sv:delimiter>0</sv:delimiter>
</deliveryMethod>
<deliveryMethod sessionDescriptionURI="http://www.example.com/3gpp/mbms/session2.sdp"
  associatedProcedureDescriptionURI="http://www.example.com/3gpp/mbms/procedureX.xml">
  <sv:delimiter>0</sv:delimiter>
  <sv:delimiter>0</sv:delimiter>
  <sv:delimiter>0</sv:delimiter>
</deliveryMethod>
<deliveryMethod sessionDescriptionURI="http://www.example.com/3gpp/mbms/session3.sdp"
  associatedProcedureDescriptionURI="http://www.example.com/3gpp/mbms/procedureY.xml">
  <sv:delimiter>0</sv:delimiter>
  <sv:delimiter>0</sv:delimiter>
  <sv:delimiter>0</sv:delimiter>
</deliveryMethod>
<deliveryMethod accessGroupId="2"
  sessionDescriptionURI="http://www.example.com/3gpp/mbms/session4.sdp">
  <sv:delimiter>0</sv:delimiter>
  <sv:delimiter>0</sv:delimiter>
  <sv:delimiter>0</sv:delimiter>
</deliveryMethod>

<accessGroup id="1">
  <accessBearer>3GPP.R6.GERAN</accessBearer>
  <accessBearer>3GPP.R6.UTRAN</accessBearer>
</accessGroup>
<accessGroup id="2">
  <accessBearer>3GPP.R6.UTRAN</accessBearer>
</accessGroup>

<sv:delimiter>0</sv:delimiter>
<sv:delimiter>0</sv:delimiter>
<sv:delimiter>0</sv:delimiter>
<sv:delimiter>0</sv:delimiter>
</userServiceDescription>

<sv:schemaVersion>7</sv:schemaVersion>
</bundleDescription>

```

The following User Service Bundle Description instance is an example of a Release 7 fragment.

Listing 11.2.2-3: User Service Bundle Description example using Release 7 extensions

```

<?xml version="1.0" encoding="UTF-8"?>
<bundleDescription xmlns="urn:3GPP:metadata:2005:MBMS:userServiceDescription"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:sv="urn:3gpp:metadata:2009:MBMS:schemaVersion"
  xmlns:r7="urn:3GPP:metadata:2007:MBMS:userServiceDescription"
  xsi:schemaLocation="urn:3GPP:metadata:2005:MBMS:userServiceDescription
TS26346_UserServiceBundleDescription.xsd"
  fecDescriptionURI="http://www.example.com/3gpp/mbms/session1-fec.sdp">

  <userServiceDescription serviceId="urn:3gpp:1234567890coolcat">
    <name lang="EN">Welcome</name>
    <name lang="DE">Willkommen</name>
    <name lang="FR">Bienvenue</name>
    <name lang="FI">Tervetuloa</name>
    <serviceLanguage>EN</serviceLanguage>
    <serviceLanguage>DE</serviceLanguage>

    <deliveryMethod accessGroupId="1"
      sessionDescriptionURI="http://www.example.com/3gpp/mbms/session1.sdp">

```

```

        <sv:delimiter>0</sv:delimiter>
        <sv:delimiter>0</sv:delimiter>
        <sv:delimiter>0</sv:delimiter>
    </deliveryMethod>
    <deliveryMethod sessionDescriptionURI="http://www.example.com/3gpp/mbms/session2.sdp"
        associatedProcedureDescriptionURI="http://www.example.com/3gpp/mbms/procedureX.xml">
        <sv:delimiter>0</sv:delimiter>
        <sv:delimiter>0</sv:delimiter>
        <sv:delimiter>0</sv:delimiter>
    </deliveryMethod>
    <deliveryMethod sessionDescriptionURI="http://www.example.com/3gpp/mbms/session3.sdp"
        associatedProcedureDescriptionURI="http://www.example.com/3gpp/mbms/procedureY.xml">
        <sv:delimiter>0</sv:delimiter>
        <sv:delimiter>0</sv:delimiter>
        <sv:delimiter>0</sv:delimiter>
    </deliveryMethod>
    <deliveryMethod accessGroupId="2"
        sessionDescriptionURI="http://www.example.com/3gpp/mbms/session4.sdp">
        <sv:delimiter>0</sv:delimiter>
        <sv:delimiter>0</sv:delimiter>
        <sv:delimiter>0</sv:delimiter>
    </deliveryMethod>

    <accessGroup id="1">
        <accessBearer>3GPP.R6.GERAN</accessBearer>
        <accessBearer>3GPP.R6.UTRAN</accessBearer>
    </accessGroup>
    <accessGroup id="2">
        <accessBearer>3GPP.R6.UTRAN</accessBearer>
    </accessGroup>

    <r7:serviceGroup groupId="http://www.example.com/mbms/serviceGroup1"/>

    <r7:initiationRandomization initiationStartTime="3468452458" protectionPeriod="600"
randomTimePeriod="300"/>
    <r7:terminationRandomization protectionPeriod="300" randomTimePeriod="120"/>

    <sv:delimiter>0</sv:delimiter>
    <sv:delimiter>0</sv:delimiter>
    <sv:delimiter>0</sv:delimiter>
    <sv:delimiter>0</sv:delimiter>
</userServiceDescription>

    <sv:schemaVersion>7</sv:schemaVersion>
</bundleDescription>

```

The following example User Service Bundle Description instance adds an RTSP URI for alternative access to the delivery method.

Listing 11.2.2-4: User Service Bundle Description with alternative access

```

<?xml version="1.0" encoding="UTF-8"?>
<bundleDescription xmlns="urn:3GPP:metadata:2005:MBMS:userServiceDescription"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns:sv="urn:3gpp:metadata:2009:MBMS:schemaVersion"
    xmlns:r7="urn:3GPP:metadata:2007:MBMS:userServiceDescription"
    xmlns:r8="urn:3GPP:metadata:2008:MBMS:userServiceDescription"
    xsi:schemaLocation="urn:3GPP:metadata:2005:MBMS:userServiceDescription
TS26346_UserServiceBundleDescription.xsd">

    <userServiceDescription serviceId="urn:3gpp:1234567890MobileTVChannelBundleCh1"
        r7:serviceClass="urn:oma:bcast:ext_bsc_3gpp:example_service:1.0">
        <deliveryMethod sessionDescriptionURI="http://www.example.com/3gpp/mbms/channel1.sdp">
            <r8:alternativeAccessDelivery timeShiftingBuffer="3600">
                <r8:unicastAccessURI>rtsp://www.example.com/3gpp/mbms/channel1_pss.sdp
                </r8:unicastAccessURI>
            </r8:alternativeAccessDelivery>

            <sv:delimiter>0</sv:delimiter>
            <sv:delimiter>0</sv:delimiter>
            <sv:delimiter>0</sv:delimiter>
        </deliveryMethod>

        <sv:delimiter>0</sv:delimiter>
        <sv:delimiter>0</sv:delimiter>
        <sv:delimiter>0</sv:delimiter>
    </userServiceDescription>

```



```

    <sv:delimiter>0</sv:delimiter>
  </userServiceDescription>

  <sv:schemaVersion>7</sv:schemaVersion>
</bundleDescription>

```

The following example User Service Bundle Description instance indicates that a registration procedure is requested for 50% of the UEs before the consumption of the MBMS User Service.

Listing 11.2.2-5: User Service Bundle Description requiring registration

```

<?xml version="1.0" encoding="UTF-8"?>
<bundleDescription xmlns="urn:3GPP:metadata:2005:MBMS:userServiceDescription"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:sv="urn:3gpp:metadata:2009:MBMS:schemaVersion"
  xmlns:r7="urn:3GPP:metadata:2007:MBMS:userServiceDescription"
  xmlns:r8="urn:3GPP:metadata:2008:MBMS:userServiceDescription"
  xsi:schemaLocation="urn:3GPP:metadata:2005:MBMS:userServiceDescription
TS26346_UserServiceBundleDescription.xsd">

  <userServiceDescription serviceId="urn:3gpp:1234567890MobileTVChannelBundleCh1"
    r7:serviceClass="urn:oma:bcast:ext_bsc_3gpp:example_service:1.0">
    <deliveryMethod sessionDescriptionURI="http://www.example.com/3gpp/mbms/channel1.sdp">
      <sv:delimiter>0</sv:delimiter>
      <sv:delimiter>0</sv:delimiter>
      <sv:delimiter>0</sv:delimiter>
    </deliveryMethod>

    <r8:Registration registrationThreshold="50">
      <r8:registrationURI>http://www.example.com/3gpp/mbms/register.php</r8:registrationURI>
    </r8:Registration>

    <sv:delimiter>0</sv:delimiter>
    <sv:delimiter>0</sv:delimiter>
    <sv:delimiter>0</sv:delimiter>
    <sv:delimiter>0</sv:delimiter>
  </userServiceDescription>

  <sv:schemaVersion>7</sv:schemaVersion>
</bundleDescription>

```

The following example User Service Bundle Description instance depicts an MBMS User Service carrying a DASH Media Presentation which is delivered over the MBMS bearer as a single Representation. It is assumed that the same Representation, along with an alternative Representation, are also available for unicast access, and that the broadcast and unicast versions are exchangeable for one another.

Listing 11.2.2-6: User Service Bundle Description with DASH presentation and interchangeable broadcast and unicast versions

```

<?xml version="1.0" encoding="UTF-8"?>
<bundleDescription xmlns="urn:3GPP:metadata:2005:MBMS:userServiceDescription"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:r7="urn:3GPP:metadata:2007:MBMS:userServiceDescription"
  xmlns:r8="urn:3GPP:metadata:2008:MBMS:userServiceDescription"
  xmlns:r9="urn:3GPP:metadata:2009:MBMS:userServiceDescription"
  xmlns:r12="urn:3GPP:metadata:2013:MBMS:userServiceDescription"
  xmlns:sv="urn:3gpp:metadata:2009:MBMS:schemaVersion"
  xsi:schemaLocation="urn:3GPP:metadata:2005:MBMS:userServiceDescription
TS26346_UserServiceBundleDescription.xsd"
  fecDescriptionURI="http://www.example.com/3gpp/mbms/session1-fec.sdp">

  <userServiceDescription serviceId="urn:3gpp:777888bigbob">
    <name lang="EN">The Big Bob Show</name>

    <serviceLanguage>EN</serviceLanguage>

    <deliveryMethod associatedProcedureDescriptionURI="
http://www.example.com/3gpp/mbms/procedureX.xml" sessionDescriptionURI="
http://www.example.com/3gpp/mbms/session1.sdp">
      <sv:delimiter>0</sv:delimiter>
      <r12:broadcastAppService>
        <r12:basePattern>http://example.com/bc/per-1/rep-512</r12:basePattern>

```

```

        <r12:basePattern>http://example.com/bc/per-2/rep-512</r12:basePattern>
        <r12:basePattern>http://example.com/bc/per-3/rep-512</r12:basePattern>
        <r12:serviceArea>65535</r12:serviceArea>
    </r12:broadcastAppService>

    <r12:unicastAppService>
        <r12:basePattern>http://example.com/uc/per-1/rep-512</r12:basePattern>
        <r12:basePattern>http://example.com/uc/per-2/rep-512</r12:basePattern>
        <r12:basePattern>http://example.com/uc/per-3/rep-512</r12:basePattern>
        <r12:basePattern>http://example.com/uc/per-1/rep-256</r12:basePattern>
        <r12:basePattern>http://example.com/uc/per-2/rep-256</r12:basePattern>
        <r12:basePattern>http://example.com/uc/per-3/rep-256</r12:basePattern>
        <r12:basePattern>http://example.com/uc2/per-1/rep-512</r12:basePattern>
        <r12:basePattern>http://example.com/uc2/per-2/rep-512</r12:basePattern>
        <r12:basePattern>http://example.com/uc2/per-3/rep-512</r12:basePattern>
        <r12:basePattern>http://example.com/uc2/per-1/rep-256</r12:basePattern>
        <r12:basePattern>http://example.com/uc2/per-2/rep-256</r12:basePattern>
        <r12:basePattern>http://example.com/uc2/per-3/rep-256</r12:basePattern>
    </r12:unicastAppService>

    <sv:delimiter>0</sv:delimiter>
    <sv:delimiter>0</sv:delimiter>
</deliveryMethod>

<r9:mediaPresentationDescription>
    <r9:mpdURI>http://example.com/MPD.mpd</r9:mpdURI>
</r9:mediaPresentationDescription>

<r9:schedule>
    <r9:scheduleDescriptionURI>http://www.example.com/3gpp/mbms/schedule123.xml
    </r9:scheduleDescriptionURI>
</r9:schedule>

    <sv:delimiter>0</sv:delimiter>
    <r12:appService appServiceDescriptionURI="http://www.example.com/MPD2.mpd"
mimeType="application/dash+xml;profiles=urn:3GPP:PSS:profile:DASH10">
        <r12:identicalContent>
            <r12:basePattern>http://example.com/bc/per-1/rep-512</r12:basePattern>
            <r12:basePattern>http://example.com/uc/per-1/rep-512</r12:basePattern>
            <r12:basePattern>http://example.com/uc2/per-1/rep-512</r12:basePattern>
        </r12:identicalContent>
        <r12:identicalContent>
            <r12:basePattern>http://example.com/bc/per-2/rep-512</r12:basePattern>
            <r12:basePattern>http://example.com/uc/per-2/rep-512</r12:basePattern>
            <r12:basePattern>http://example.com/uc2/per-2/rep-512</r12:basePattern>
        </r12:identicalContent>
        <r12:identicalContent>
            <r12:basePattern>http://example.com/bc/per-3/rep-512</r12:basePattern>
            <r12:basePattern>http://example.com/uc/per-3/rep-512</r12:basePattern>
            <r12:basePattern>http://example.com/uc2/per-3/rep-512</r12:basePattern>
        </r12:identicalContent>
        <r12:alternativeContent>
            <r12:basePattern>http://example.com/bc/per-1/rep-512</r12:basePattern>
            <r12:basePattern>http://example.com/uc/per-1/rep-256</r12:basePattern>
            <r12:basePattern>http://example.com/uc2/per-1/rep-256</r12:basePattern>
        </r12:alternativeContent>
        <r12:alternativeContent>
            <r12:basePattern>http://example.com/bc/per-2/rep-512</r12:basePattern>
            <r12:basePattern>http://example.com/uc/per-2/rep-256</r12:basePattern>
            <r12:basePattern>http://example.com/uc2/per-2/rep-256</r12:basePattern>
        </r12:alternativeContent>
        <r12:alternativeContent>
            <r12:basePattern>http://example.com/bc/per-3/rep-512</r12:basePattern>
            <r12:basePattern>http://example.com/uc/per-3/rep-256</r12:basePattern>
            <r12:basePattern>http://example.com/uc2/per-3/rep-256</r12:basePattern>
        </r12:alternativeContent>
    </r12:appService>

    <sv:delimiter>0</sv:delimiter>
    <sv:delimiter>0</sv:delimiter>
    <sv:delimiter>0</sv:delimiter>
    <sv:delimiter>0</sv:delimiter>
</userServiceDescription>

    <sv:schemaVersion>7</sv:schemaVersion>
</bundleDescription>

```

The following example User Service Bundle Description instance indicates the presence of four *deliveryMethod* element instances, two each of which are associated with [group=1, PLMN-ID=0x019509] and [group=2, PLMN-ID=0x01950A], and whereby each *deliveryMethod* element contains a reference to a unique Session Description fragment.

Listing 11.2.2-7: User Service Bundle Description with grouped delivery methods

```
<?xml version="1.0" encoding="UTF-8"?>
<bundleDescription xmlns="urn:3GPP:metadata:2005:MBMS:userServiceDescription"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:sv="urn:3gpp:metadata:2009:MBMS:schemaVersion"
  xsi:schemaLocation="urn:3GPP:metadata:2005:MBMS:userServiceDescription
TS26346_UserServiceBundleDescription.xsd">

  <userServiceDescription serviceId="urn:3gpp:0010120123hotdog">
    <deliveryMethod group="1" PLMN="0x019509"
sessionDescriptionURI="http://www.example.com/3gpp/mbms/session1.sdp">
      <sv:delimiter>0</sv:delimiter>
      <sv:delimiter>0</sv:delimiter>
      <sv:delimiter>0</sv:delimiter>
    </deliveryMethod>
    <deliveryMethod group="1" PLMN="0x01950A"
sessionDescriptionURI="http://www.example.com/3gpp/mbms/session2.sdp">
      <sv:delimiter>0</sv:delimiter>
      <sv:delimiter>0</sv:delimiter>
      <sv:delimiter>0</sv:delimiter>
    </deliveryMethod>
    <deliveryMethod group="2" PLMN="0x019509"
sessionDescriptionURI="http://www.example.com/3gpp/mbms/session3.sdp">
      <sv:delimiter>0</sv:delimiter>
      <sv:delimiter>0</sv:delimiter>
      <sv:delimiter>0</sv:delimiter>
    </deliveryMethod>
    <deliveryMethod group="2" PLMN="0x01950A"
sessionDescriptionURI="http://www.example.com/3gpp/mbms/session4.sdp">
      <sv:delimiter>0</sv:delimiter>
      <sv:delimiter>0</sv:delimiter>
      <sv:delimiter>0</sv:delimiter>
    </deliveryMethod>

    <sv:delimiter>0</sv:delimiter>
    <sv:delimiter>0</sv:delimiter>
    <sv:delimiter>0</sv:delimiter>
    <sv:delimiter>0</sv:delimiter>
  </userServiceDescription>

  <sv:schemaVersion>2</sv:schemaVersion>
</bundleDescription>
```

The following example User Service Bundle Description instance declares an MBMS User Service carrying an audio/video DASH Media Presentation featuring an English audio track that is delivered over both the MBMS bearer and the unicast bearer. In addition, a Spanish audio track for the Media Presentation is indicated as delivered over the unicast bearer to be supplementary to the broadcast resources.

Listing 11.2.2-8: User Service Bundle Description with multilingual DASH presentation

```
<?xml version="1.0" encoding="UTF-8"?>
<bundleDescription xmlns="urn:3GPP:metadata:2005:MBMS:userServiceDescription"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:r7="urn:3GPP:metadata:2007:MBMS:userServiceDescription"
  xmlns:r8="urn:3GPP:metadata:2008:MBMS:userServiceDescription"
  xmlns:r9="urn:3GPP:metadata:2009:MBMS:userServiceDescription"
  xmlns:r12="urn:3GPP:metadata:2013:MBMS:userServiceDescription"
  xmlns:r14="urn:3GPP:metadata:2017:r14:MBMS:userServiceDescription"
  xmlns:r15="urn:3GPP:metadata:2018:r15:MBMS:userServiceDescription"
  xmlns:sv="urn:3gpp:metadata:2009:MBMS:schemaVersion"
  xsi:schemaLocation="urn:3GPP:metadata:2005:MBMS:userServiceDescription
TS26346_UserServiceBundleDescription.xsd"
  fecDescriptionURI="http://www.example.com/3gpp/mbms/session1-fec.sdp">

  <userServiceDescription serviceId="urn:3gpp:12345superduper">
    <name lang="EN">The Super Duper Service</name>

    <serviceLanguage>EN</serviceLanguage>
```

```

    <deliveryMethod associatedProcedureDescriptionURI="
http://www.example.com/3gpp/mbms/procedureX.xml" sessionDescriptionURI="
http://www.example.com/3gpp/mbms/session1.sdp">
      <sv:delimiter>0</sv:delimiter>
      <r12:broadcastAppService>
        <r12:basePattern>http://example.com/bc/rep-512k</r12:basePattern>
        <r12:basePattern>http://example.com/bc/en</r12:basePattern>
      </r12:broadcastAppService>

      <r12:unicastAppService>
        <r12:basePattern>http://example.com/uc/rep-256k</r12:basePattern>
        <r12:basePattern>http://example.com/uc/en</r12:basePattern>
      </r12:unicastAppService>

      <sv:delimiter>0</sv:delimiter>
      <r15:supplementaryUnicastAppService>
        <r15:basePattern>http://example.com/uc/es</r15:basePattern>
      </r15:supplementaryUnicastAppService>

      <sv:delimiter>0</sv:delimiter>
    </deliveryMethod>

    <r9:mediaPresentationDescription>
      <r9:mpdURI>http://example.com/MPD.mpd</r9:mpdURI>
    </r9:mediaPresentationDescription>

    <r9:schedule>
      <r9:scheduleDescriptionURI>http://www.example.com/3gpp/mbms/schedule123.xml
    </r9:scheduleDescriptionURI>
    </r9:schedule>

    <sv:delimiter>0</sv:delimiter>
    <r12:appService appServiceDescriptionURI="http://www.example.com/MPD2.mpd"
mimeType="application/dash+xml;profiles=urn:3GPP:PSS:profile:DASH10"/>

    <sv:delimiter>0</sv:delimiter>
    <sv:delimiter>0</sv:delimiter>
    <sv:delimiter>0</sv:delimiter>
    <sv:delimiter>0</sv:delimiter>
  </userServiceDescription>

  <sv:schemaVersion>7</sv:schemaVersion>
</bundleDescription>

```

The following example User Service Bundle Description instance declares an MBMS User Service carrying an Receive-Only Mode (ROM) TV service, targeted to MBMS UEs which lack unicast communication capability.

Listing 11.2.2-9: User Service Bundle Description with Receive-Only Mode TV service

```

<?xml version="1.0" encoding="UTF-8"?>
<bundleDescription xmlns="urn:3GPP:metadata:2005:MBMS:userServiceDescription"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:r7="urn:3GPP:metadata:2007:MBMS:userServiceDescription"
  xmlns:r8="urn:3GPP:metadata:2008:MBMS:userServiceDescription"
  xmlns:r9="urn:3GPP:metadata:2009:MBMS:userServiceDescription"
  xmlns:r12="urn:3GPP:metadata:2013:MBMS:userServiceDescription"
  xmlns:r14="urn:3GPP:metadata:2017:MBMS:userServiceDescription"
  xmlns:sv="urn:3gpp:metadata:2009:MBMS:schemaVersion"
  xsi:schemaLocation="urn:3GPP:metadata:2005:MBMS:userServiceDescription
TS26346_UserServiceBundleDescription.xsd"
  fecDescriptionURI="http://www.example.com/3gpp/mbms/session1-fec.sdp">

  <userServiceDescription serviceId="urn:3gpp:12345dancemonkey" r14:romService="true">
    <name lang="EN">Dancing with Monkeys</name>

    <serviceLanguage>EN</serviceLanguage>

    <deliveryMethod sessionDescriptionURI="http://www.example.com/3gpp/mbms/session1.sdp">
      <sv:delimiter>0</sv:delimiter>
      <sv:delimiter>0</sv:delimiter>
      <sv:delimiter>0</sv:delimiter>
    </deliveryMethod>

    <r9:schedule>
      <r9:scheduleDescriptionURI>http://www.example.com/3gpp/mbms/schedule543.xml
    </r9:scheduleDescriptionURI>
    </r9:schedule>
  </userServiceDescription>
</bundleDescription>

```

```

        </r9:scheduleDescriptionURI>
    </r9:schedule>

    <sv:delimiter>0</sv:delimiter>
    <r12:appService appServiceDescriptionURI="http://www.example.com/MPD2.mpd"
mimeType="application/dash+xml;profiles=urn:3GPP:PSS:profile:DASH10"/>

    <sv:delimiter>0</sv:delimiter>
    <sv:delimiter>0</sv:delimiter>
    <sv:delimiter>0</sv:delimiter>
    <sv:delimiter>0</sv:delimiter>
    </userServiceDescription>

    <sv:schemaVersion>7</sv:schemaVersion>
</bundleDescription>

```

11.2A Schedule Description metadata fragment

11.2A.0 Introduction

The XML schema for the Schedule Description metadata fragment is specified in clause 11.2A.2.

The procedures associated with the elements of the schema are specified in clause 11.2A.1.

11.2A.1 Procedures for Schedule Description metadata fragment

11.2A.1.1 Initial definition

This clause specifies the semantics of the Schedule Description metadata fragment in Release 11. The corresponding XML schema is specified in clause 11.2A.2.1. It is further extended in subsequent releases in clause 11.2A.1.2.

A schedule description instance may be delivered to the MBMS Clients:

- during a User Service Discovery/Announcement prior to the MBMS download session along with the session description (out-of-band of that session); or
- in-band within a MBMS download session; or
- via an MBMS download session dedicated to the transport of file schedule information.

The most recently delivered schedule file shall take priority, such that schedule parameters received prior to, and out-of-band, of the download session they apply to are regarded as "initial defaults", and schedule parameters received in-band with the download session, overwrite the earlier received schedule parameters. The MBMS Metadata Envelope, see clause 11.1, applies for the reception of schedule parameters.

The schedule description instance is clearly identified using a URI, to enable UE cross-referencing of in and out-of-band schedule files.

The MIME media type for the Schedule information is "application/mbms-schedule+xml"

Availability of the schedule description metadata fragment is indicated by the presence of the *schedule* element in the User Service Bundle Description fragment. The URI to the Schedule Description fragment is provided by the element *scheduleDescriptionURI* in the *schedule* element.

The start and stop time of a single *fileSchedule* is specified by the *start* and *end* attributes. The start and stop time of a single *sessionSchedule* is specified by the *start* and *stop* elements. The time is specified as the absolute date and time. The duration may be determined by subtracting the start time from the stop time.

The UE may only activate reception of that service within the *sessionSchedule* (and the *fileSchedule* if present) time window. The service shall be available to the UE during the time interval(s) announced by the session schedule (i.e. *scheduleDescription.serviceSchedule.sessionSchedule* element of the Schedule Description), for either unicast or broadcast reception. In particular, for unicast reception, the Schedule Description is indicative of the time availability for unicast access of an MBMS User Service while the TMGI for the service is not activated (as specified in

clauses 9.4.A and 11.2.1.2), as well as for unicast fallback reception when the UE is not located in the MBMS coverage area for the service (as described in clause 7.6).

When a *fileSchedule* element is present in a *serviceSchedule* element, then:

- The UE should not expect that a file described by a *fileSchedule* will be updated during a time window instance, defined by *start* and *end* attributes within a *deliveryInfo* element of that *fileSchedule*.
- There shall be only one file version (as defined in the *Content-MD5* attribute in the FDT) transmitted in a time window defined by the *start* and *end* attributes within a *deliveryInfo* element for a given *fileSchedule* element.
- If *fileMD5* attribute is not present, the files transmitted in the time windows from different *deliveryInfo* elements in a *fileSchedule* should not be expected to be the same file version.
- If *fileMD5* attribute is present, there shall be only one file version transmitted in all of the time windows delimited by the start and end attributes of each of the one or more *deliveryInfo* elements.
- In-band Schedule Description fragment updates can be used to provide a dynamic schedule update to override the existing delivery schedule, such as using the *cancelled* attribute mechanism specified in this clause.
- A *sessionSchedule* element in the same *serviceSchedule* element shall be present, and its *start* and *stop* elements shall specify a time window that completely overlaps the time windows specified in each of the *fileSchedule* elements of the same *serviceSchedule*.

When a *sessionSchedule* is present and there are no *fileSchedule* in a *serviceSchedule*, then the UE should download each new file, independently to whether the session is used for file delivery or DASH over MBMS.

The *reoccurrencePattern* element if included shall have a value of either "daily", "weekly" or "monthly".

The number of recurrences of an event may be indicated by either specifying the end time, as indicated by the *reoccurrenceStopTime* element, or by specifying the number of recurrences, with the *numberOfTimes* element. If there are no reoccurrence, then the *reoccurrencePattern*, *numberOfTimes* and *reoccurrenceStopTime* elements are not included.

The *fileSchedule* element specifies details about the files delivered during a session. The *sessionId* attribute is as defined in clause 9.4.6. If present, it identifies the delivery session for each file. If not present, a UE shall determine the transport session as defined by the session description for the download session. The *fileMD5* attribute is the MD5 hash value of the file. If present, the purpose of this hash is to enable a UE to determine if a file has changed since a prior reception without having to download the file.

The *scheduleUpdate* element specifies a time after which UE shall seek to update its schedule information.

An *index* element is included as a child of the *sessionSchedule* element.

- If the *sessionSchedule* does not describe any session reoccurrence then the index corresponds to the single session occurrence.
- If the *sessionSchedule* describes one or more reoccurrences, the index is the starting index of the first session occurrence with the index value increased by one for each session recurrence.

A *cancelled* attribute is defined as a child of the *fileURI* element, itself a child of the *fileSchedule* element. If *cancelled* is set to "true" or "1", then the transmission of the file identified by the *fileURI* element is cancelled, and the UE shall cancel any applicable file repair and/or reception reporting procedures for that file. If this file schedule-level cancellation indication in the updated schedule description is received after the associated file has already been delivered, then any related file repair, or reception reporting for that file (associated with its parent service), either in progress or yet to occur, shall be aborted. If *cancelled* is set to "false" or "0" or is absent, then nominal file transmission and associated delivery procedures, if applicable, shall occur.

A *sessionScheduleOverride* element is defined as a child of the *serviceSchedule* element. If included, the *sessionScheduleOverride* element indicates either the cancellation of the session occurrence, or schedule override, as follows:

- If the *cancelled* attribute (a child of the *sessionScheduleOverride* element) is set to "true" or "1", then the transmission of the session identified by the *index* attribute (a child of the *sessionScheduleOverride* element) is cancelled, and the UE shall cancel any applicable file repair and/or reception reporting for all files belonging to that session. If this session schedule-level cancellation indication in the updated schedule description is received

after any of the associated files have already been delivered, then any related file repair, or reception reporting for those files (associated with their parent service(s)), either in progress or yet to occur, shall be aborted.

- If the *cancelled* attribute (a child of the *sessionScheduleOverride* element) is set to "false" or "0" or is absent, then the *start* and *stop* time elements (children of *sessionScheduleOverride* element) shall override the nominal start and stop time of the transmission schedule of the session as identified by the *index* attribute (a child of the *sessionScheduleOverride* element).

The value of the *index* attribute in the *sessionScheduleOverride* element corresponds to any of the value of the *index* element in the *reoccurrenceStartStopType* in the *sessionSchedule* element.

Schedule information received in the Schedule Description metadata fragment shall take precedence over timing information that may have been received in SDP (t or/and r lines).

The child element *receptionFiltering* may be present in either the *sessionSchedule* or *fileSchedule* elements of the Schedule Description fragment. If it appears in the session schedule, *receptionFiltering* signifies the presence of the Filter Description metadata fragment for use by the UE to perform selective reception of contents, in their entirety, sent during the corresponding session(s) of the User Service. If it appears in the file schedule, *receptionFiltering* signifies the presence of the Filter Description metadata fragment for use by the UE to perform selective reception of the corresponding file(s) of the User Services, during its(their) scheduled delivery time(s). Should *receptionFiltering* be present in both the *sessionSchedule* and *fileSchedule* elements, *fileSchedule* shall take precedence. The *filterDescriptionReference* attribute of the Schedule Description fragment identifies the Filter Description fragment of concern, and each instance of the *data* child element of *receptionFiltering* identifies a unique filter data instance in the Filter Description fragment to be applied for content filtering and selective reception. Multiple *data* elements may appear under *receptionFiltering*, to accommodate the presence of different categories or types of filtering data. More details on the composition of filtering data are given in clause 11.2B.

11.2A.1.2 Extension to the Schedule Description metadata fragment

The Schedule Description schema specified in this clause extends the MBMS Release 11 schema of clause 11.2A.1.1.

Optional reference to an FDT Instance is provided in the session schedule by the *r12:FDTInstanceURI* element. When this element is present and the *index* (see clause 11.2A.1.1) is described in the *sessionSchedule*, then the *r12:FDTInstanceURI* element concatenated together with the *index* value of the session occurrence provides the location of an FDT Instance that describes all of the files delivered during the associated session occurrence. An MBMS Client that has missed receiving files and their FDT Instances (e.g., MBMS Client is outside of MBMS coverage or is just tuning in between session occurrences) may use the URI formed by concatenating the index value of any previously missed session occurrence after the value of the *r12:FDTInstanceURI* element (i.e., *FDTInstanceURI|index*) to obtain an FDT Instance following the procedures specified in clause 9.3.9.3.

When the *r12:FDTInstanceURI* element is present and the *index* is not described in the *sessionSchedule* then the *r12:FDTInstanceURI* element by itself provides the location of an FDT Instance that describes all the files delivered during the session.

When the *r12:unicastOnly* attribute is set to true by the Keep Updated service, as specified in clause 7.7, it indicates that the file referenced by the fileURI is accessible via unicast only.

Optional presence of the *r12:recurrenceAndMonitoring* element in the session schedule signals that the associated MBMS User Service is the Datacasting type. The attribute *mode*, when set to "true" or "1" indicates the scheduled-and-periodic delivery mode of the Datacasting service, and when set to "false" or "0" indicates the back-to-back delivery mode.

The child element *interval* under *r12:recurrenceAndMonitoring* signals a time interval associated with the delivery mode. When *mode* = "true" or "1" (scheduled-and-periodic delivery mode), the value of *interval* represents the time duration between successive scheduled transmissions. When *mode* = "false" or "0" (back-to-back delivery mode), the value of *interval* represents the nominal duration of successive updates of files carried on the Datacasting service.

In either the scheduled-and-periodic or back-to-back Datacasting file transmission modes, the session duration is given by the difference between the *start* and *stop* elements of *sessionSchedule*. One or more content files of the Datacasting service are delivered during each session. In the scheduled-and-periodic transmission mode, the number of session recurrences can be indicated in one of two ways:

- a) by specifying the recurrence end time, as indicated by the *reoccurrenceStopTime* element, in conjunction with the *interval*, or

b) by specifying the number of recurrences via the *numberOfTimes* element.

The *r12:sessionDescriptionURI* attribute of the *sessionSchedule* element, if present, identifies the MBMS download session to which the associated instance of the session schedule applies.

11.2A.2 Schedule Description metadata fragment syntax

11.2A.2.1 Extended Schedule Description metadata fragment schema

The formal XML syntax of the Schedule Description is specified in listing 11.2A.2.1-1 below. Instance documents following this schema can be identified with the MIME media type "application/mbms-schedule+xml" defined in clause C.14. The filename of the XML schema for Schedule Description is "TS26346_ScheduleDescription.xsd".

In this version of the present document the network shall set the content of the *schemaVersion* element, defined as a child of the *scheduleDescription* element, to the value 3.

The schema *version* attribute (part of the schema instruction) shall be included in the UE schema and the network schema.

NOTE: The value of the *schemaVersion* element and *version* attribute is intended to be increased by 1 in every future release where new element(s) or attribute(s) are added.

When a UE receives an instantiation of a Schedule Description compliant to this schema, it shall determine the schema version required to parse the instantiation as follows:

- If the UE supports one or more versions of the Schedule Description schema with the schema *version* attribute, then the UE shall use the schema that has the highest schema *version* attribute value that is equal to or less than the value in the received *schemaVersion* element;

The XML schema "TS26346_SchemaVersion.xsd" is specified in clause J.2.

Listing 11.2A.2.1-1: Extended Schedule Description schema

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:3gpp:metadata:2011:MBMS:scheduleDescription" version="3"
  xmlns="urn:3gpp:metadata:2011:MBMS:scheduleDescription"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  xmlns:r11="urn:3gpp:metadata:2012:MBMS:scheduleDescription"
  xmlns:r12="urn:3gpp:metadata:2013:MBMS:scheduleDescription"
  xmlns:sv="urn:3gpp:metadata:2009:MBMS:schemaVersion"
  elementFormDefault="qualified">
  <xs:annotation>
    <xs:documentation>Extended MBMS Schedule Description schema</xs:documentation>
    <xs:documentation>3GPP TS 26.346 clause 11.2A.2.1</xs:documentation>
    <xs:documentation>Copyright © 2013, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI,
TSDSI, TTA, TTC). All rights reserved.</xs:documentation>
  </xs:annotation>

  <xs:import schemaLocation="TS26346_ScheduleDescription_Extensions_Rel-11.xsd"
namespace="urn:3gpp:metadata:2012:MBMS:scheduleDescription"/>
  <xs:import schemaLocation="TS26346_ScheduleDescription_Extensions_Rel-12.xsd"
namespace="urn:3gpp:metadata:2013:MBMS:scheduleDescription"/>
  <xs:import schemaLocation="TS26346_SchemaVersion.xsd"
namespace="urn:3gpp:metadata:2009:MBMS:schemaVersion"/>

  <xs:element name="scheduleDescription" type="scheduleDescriptionType"/>
  <xs:complexType name="scheduleDescriptionType">
    <xs:sequence>
      <xs:element ref="sv:schemaVersion"/>
      <xs:element name="serviceSchedule" maxOccurs="unbounded">
        <xs:complexType>
          <xs:sequence>
            <xs:element name="sessionSchedule" type="reoccurrenceStartStopType"
minOccurs="0" maxOccurs="unbounded"/>
            <xs:element name="sessionScheduleOverride" minOccurs="0"
maxOccurs="unbounded">
              <xs:complexType>
                <xs:sequence minOccurs="0">
                  <xs:element name="start" type="xs:dateTime"/>
                  <xs:element name="stop" type="xs:dateTime"/>
                </xs:sequence>
              </xs:complexType>
            </xs:element>
          </xs:sequence>
        </xs:complexType>
      </xs:element>
    </xs:sequence>
  </xs:complexType>
</xs:schema>
```



```

        </xs:sequence>
        <xs:attribute name="index" type="xs:unsignedInt" use="required"/>
        <xs:attribute name="cancelled" type="xs:boolean"/>
    </xs:complexType>
</xs:element>
<xs:element name="fileSchedule" minOccurs="0" maxOccurs="unbounded">
    <xs:complexType>
        <xs:sequence>
            <xs:element name="fileURI">
                <xs:complexType>
                    <xs:simpleContent>
                        <xs:extension base="xs:anyURI">
                            <xs:attribute name="cancelled"
type="xs:boolean"/>
                        </xs:extension>
                    </xs:simpleContent>
                </xs:complexType>
            </xs:element>
            <xs:element name="deliveryInfo" minOccurs="0"
maxOccurs="unbounded">
                <xs:complexType>
                    <xs:attribute name="start" type="xs:dateTime"/>
                    <xs:attribute name="end" type="xs:dateTime"/>
                    <xs:anyAttribute processContents="skip"/>
                </xs:complexType>
            </xs:element>
            <xs:element ref="r11:receptionFiltering" minOccurs="0"/>
            <xs:element ref="sv:delimiter"/>
            <xs:any namespace="##other" processContents="lax"
minOccurs="0" maxOccurs="unbounded"/>
        </xs:sequence>
        <xs:attribute ref="r11:sessionId" use="optional"/>
        <xs:attribute ref="r11:fileMD5" use="optional"/>
        <xs:attribute ref="r12:unicastOnly"/>
        <xs:anyAttribute processContents="skip"/>
    </xs:complexType>
</xs:element>
<xs:any namespace="##other" processContents="lax" minOccurs="0"
maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:attribute name="serviceId" type="xs:anyURI"/>
    <xs:attribute name="serviceClass" type="xs:string" use="optional"/>
    <xs:anyAttribute processContents="skip"/>
</xs:complexType>
</xs:element>
<xs:any namespace="##other" processContents="lax" minOccurs="0"
maxOccurs="unbounded"/>
</xs:sequence>
<xs:attribute name="scheduleUpdate" type="xs:dateTime"/>
<xs:attribute ref="r11:filterDescriptionReference"/>
<xs:anyAttribute processContents="skip"/>
</xs:complexType>

<xs:complexType name="reoccurrenceStartStopType">
    <xs:sequence>
        <xs:element name="start" type="xs:dateTime"/>
        <xs:element name="stop" type="xs:dateTime"/>
        <xs:element name="reoccurrencePattern" type="xs:string" minOccurs="0"/>
        <xs:element name="numberOfTimes" type="xs:unsignedInt" minOccurs="0"/>
        <xs:element name="reoccurrenceStopTime" type="xs:dateTime" minOccurs="0"/>
        <xs:element name="index" type="xs:unsignedInt" minOccurs="0"/>
        <xs:element ref="r11:receptionFiltering" minOccurs="0"/>
        <xs:element ref="sv:delimiter"/>
        <xs:element ref="r12:FDTInstanceURI" minOccurs="0"/>
        <xs:element ref="r12:recurrenceAndMonitoring" minOccurs="0"/>
        <xs:element ref="sv:delimiter"/>
        <xs:any namespace="##other" processContents="lax" minOccurs="0"
maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:attribute ref="r12:sessionDescriptionURI"/>
    <xs:anyAttribute processContents="skip"/>
</xs:complexType>
</xs:schema>

```

11.2A.2.2 Release 11 extensions to Schedule Description schema

Listing 11.2A.2.2-1 below specifies the Release 11 extensions to the Schedule Description schema. The schema filename is "TS26346_ScheduleDescription_Extensions_Rel-11.xsd".

Listing 11.2A.2.2-1: Schedule Description schema extensions (Release 11)

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:3gpp:metadata:2012:MBMS:scheduleDescription"
  xmlns="urn:3gpp:metadata:2012:MBMS:scheduleDescription"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  elementFormDefault="qualified">
  <xs:annotation>
    <xs:documentation>MBMS Schedule Description schema extensions (Release
11)</xs:documentation>
    <xs:documentation>3GPP TS 26.346 clause 11.2A.2.2</xs:documentation>
    <xs:documentation>Copyright © 2012, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI,
TSDSI, TTA, TTC). All rights reserved.</xs:documentation>
  </xs:annotation>

  <xs:attribute name="sessionId" type="xs:string"/>

  <xs:attribute name="fileMD5" type="xs:base64Binary"/>

  <xs:attribute name="filterDescriptionReference" type="xs:anyURI"/>

  <xs:element name="receptionFiltering">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="data" maxOccurs="unbounded">
          <xs:complexType>
            <xs:attribute name="filterID" type="xs:anyURI" use="required"/>
          </xs:complexType>
        </xs:element>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
</xs:schema>
```

11.2A.2.3 Release 12 Extension to Schedule Description schema

Listing 11.2A.2.3-1 below specifies the Release 12 extension to the Schedule Description schema. The schema filename is "TS26346_ScheduleDescription_Extensions_Rel-12.xsd".

Listing 11.2A.2.3-1: Schedule Description schema extensions (Release 12)

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:3gpp:metadata:2013:MBMS:scheduleDescription"
  xmlns="urn:3gpp:metadata:2013:MBMS:scheduleDescription"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  elementFormDefault="qualified">
  <xs:annotation>
    <xs:documentation>MBMS Schedule Description schema extensions (Release
12)</xs:documentation>
    <xs:documentation>3GPP TS 26.346 clause 11.2A.2.3</xs:documentation>
    <xs:documentation>Copyright © 2013, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI,
TSDSI, TTA, TTC). All rights reserved.</xs:documentation>
  </xs:annotation>

  <xs:attribute name="unicastOnly" type="xs:boolean" default="false"/>

  <xs:element name="FDTInstanceURI" type="xs:anyURI"/>

  <xs:element name="recurrenceAndMonitoring" type="recurrenceAndMonitoringType"/>
  <xs:complexType name="recurrenceAndMonitoringType">
    <xs:sequence>
      <xs:element name="interval" type="xs:duration"/>
      <xs:any namespace="##other" processContents="lax" minOccurs="0"
maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:attribute name="mode" type="xs:boolean"/>
    <xs:anyAttribute processContents="skip"/>
  </xs:complexType>
```

```
<xs:attribute name="sessionDescriptionURI" type="xs:anyURI"/>
</xs:schema>
```

11.2A.3 Examples of the Schedule Description metadata fragment

11.2A.3.1 Example 1

In this instantiation example, the following key points can be noted:

- The version of the schema used to generate this instantiation is version 3, as indicated by the *schemaVersion* element. Thus, a receiver of this instantiation that has multiple schedule schema versions (say 1, 2, 3 and 4), should use the schedule schema version equals to 3, as indicated in the version attribute of the schema instruction "schema". A receiver that has only older versions (version1 and/or 2 in this case) of the schedule schema should use the schema that has the highest version number for validating the instantiation, but extensions made in higher versions of the schema will be ignored by the receiver. The receiver should avoid using schema version higher than 3, since the instantiation would fail verification against such schema version.
- The *scheduleUpdate* element indicates UTC time February 1st 2012 at time 00 hour 00 min 00 sec. Thus, an MBMS UE should seek to update the schedule instance after this time.
- There are two *serviceSchedule* elements.
- In the first *serviceSchedule*, it includes
 - a *sessionSchedule* that starts at UTC March 1st 2012 23:00:00 and ends at UTC March 1st 2012 23:30:00;
 - a first *fileSchedule* used for FOTA (firmware update over the air) for oem-1 model-1 with a filename of image032212.apk, which delivery starts at UTC March 1st 2012 23:00:00 and ends at March 1st 2012 23:10:00, thus 10 minutes duration;
 - a second *fileSchedule* used for FOTA for oem-1 model-2 with filename image098798.apk, whose delivery starts at UTC March 1st 2012 23:10:00 and ends at UTC March 1st 2012 23:20:00, thus 10 minutes duration;
 - a third *fileSchedule* used for FOTA for oem-1 model-3 with filename image765987.apk, whose delivery starts at UTC March 1st 2012 23:20:00 and ends at UTC March 1st 2012 23:30:00, thus 10 minutes duration.
- In the second *serviceSchedule*, it includes
 - a *sessionSchedule* that starts at UTC March 7th 2012 10:00:00 and ends at UTC March 7th 2012 10:30:00;
 - a first *fileSchedule* used for FOTA for oem-1 model-4 with a filename of image456345.apk, whose delivery starts at UTC March 7th 2012 10:00:00 and ends at March 7th 2012 10:15:00, thus 15 minutes duration;
 - a second *fileSchedule* used for FOTA for oem-1 model-2 with filename image504123.apk, whose delivery starts at UTC March 7th 2012 10:15:00 and ends at UTC March 7th 2012 10:30:00, thus 15 minutes duration.

Listing 11.2A.3.1-1: Schedule Description example 1

```
<?xml version="1.0" encoding="UTF-8"?>
<scheduleDescription xmlns="urn:3gpp:metadata:2011:MBMS:scheduleDescription"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:sv="urn:3gpp:metadata:2009:MBMS:schemaVersion"
  xsi:schemaLocation="urn:3gpp:metadata:2011:MBMS:scheduleDescription
TS26346_ScheduleDescription.xsd"
  scheduleUpdate="2012-02-01T00:00:00Z">

  <sv:schemaVersion>3</sv:schemaVersion>

  <serviceSchedule>
    <sessionSchedule>
      <start>2012-03-01T23:00:00Z</start>
      <stop>2012-03-01T23:30:00Z</stop>

      <sv:delimiter>0</sv:delimiter>
      <sv:delimiter>0</sv:delimiter>
    </sessionSchedule>
```

```

<fileSchedule>
  <fileURI>file://fota.operator.com/swupdate/oem-1/model-1/image032212.apk</fileURI>
  <deliveryInfo start="2012-03-01T23:00:00Z" end="2012-03-01T23:10:00Z"/>
  <sv:delimiter>0</sv:delimiter>
</fileSchedule>
<fileSchedule>
  <fileURI>file://fota.operator.com/swupdate/oem-1/model-2/image098798.apk</fileURI>
  <deliveryInfo start="2012-03-01T23:10:00Z" end="2012-03-01T23:20:00Z"/>
  <sv:delimiter>0</sv:delimiter>
</fileSchedule>
<fileSchedule>
  <fileURI>file://fota.operator.com/swupdate/oem-1/model-3/image765987.apk</fileURI>
  <deliveryInfo start="2012-03-01T23:20:00Z" end="2012-03-01T23:30:00Z"/>
  <sv:delimiter>0</sv:delimiter>
</fileSchedule>
</serviceSchedule>

<serviceSchedule>
  <sessionSchedule>
    <start>2012-03-07T10:00:00Z</start>
    <stop>2012-03-07T10:30:00Z</stop>

    <sv:delimiter>0</sv:delimiter>
    <sv:delimiter>0</sv:delimiter>
  </sessionSchedule>

  <fileSchedule>
    <fileURI>file://fota.operator.com/swupdate/oem-1/model-4/image456345.apk</fileURI>
    <deliveryInfo start="2012-03-07T10:00:00Z" end="2012-03-07T10:15:00Z"/>
    <sv:delimiter>0</sv:delimiter>
  </fileSchedule>
  <fileSchedule>
    <fileURI> file://fota.operator.com/swupdate/oem-1/model-5/image504123.apk</fileURI>
    <deliveryInfo start="2012-03-07T10:15:00Z" end="2012-03-07T10:30:00Z"/>
    <sv:delimiter>0</sv:delimiter>
  </fileSchedule>
</serviceSchedule>
</scheduleDescription>

```

11.2A.3.2 Example 2

In this instantiation example, the following key points can be noted:

- The version of the schema used to generate this instantiation is version 3, as indicated by the *schemaVersion* element. Thus, a receiver of this instantiation that has multiple schedule schema versions (say 1, 2, 3 and 4), should use the schedule schema version equals to 3, as indicated in the version attribute of the schema instruction "schema". A receiver that has only older versions (version1 and/or 2 in this case) of the schedule schema should use the schema that has the highest version number for validating the instantiation, but extensions made in higher versions of the schema will be ignored by the receiver. The receiver should avoid using schema version higher than 3, since the instantiation would fail verification against such schema version.
- The *scheduleUpdate* element indicates UTC time February 1st at time 00 hour 00 min 00 sec. Thus UE should seek to update the schedule instance after this time.
- There is one *serviceSchedule* element, which includes:
 - a *sessionSchedule* that
 - Has a first occurrence that starts at UTC March 7th 2012 23:00:00 and ends at UTC March 7th 2012 23:30:00;
 - Has subsequent occurrences every day at the same time until UTC March 14th 2012 00:00:00
 - A first *fileSchedule* used for FOTA for oem-1 model-1 with a filename of image032212.apk, whose delivery starts at UTC March 7th 2012 23:00:00 and ends at March 7th 2012 23:10:00, thus 10 minutes duration;
 - A second *fileSchedule* used for FOTA for oem-1 model-2 with a filename of image098798.apk, whose delivery starts at UTC March 7th 2012 23:10:00 and ends at March 7th 2012 23:20:00, thus 10 minutes duration;

- A third *fileSchedule* used for FOTA for oem-1 model-3 with a filename of image765987.apk, whose delivery starts at UTC March 7th 2012 23:20:00 and ends at March 7th 2012 23:30:00, thus 10 minutes duration;

Listing 11.2A.3.2-1: Schedule Description example 2

```
<?xml version="1.0" encoding="UTF-8"?>
<scheduleDescription xmlns="urn:3gpp:metadata:2011:MBMS:scheduleDescription"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:sv="urn:3gpp:metadata:2009:MBMS:schemaVersion"
  xsi:schemaLocation="urn:3gpp:metadata:2011:MBMS:scheduleDescription
TS26346_ScheduleDescription.xsd"
  scheduleUpdate="2012-02-07T00:00:00Z" version="764">

  <sv:schemaVersion>3</sv:schemaVersion>

  <serviceSchedule>
    <sessionSchedule>
      <start>2012-03-07T23:00:00Z</start>
      <stop>2012-03-07T23:30:00Z</stop>
      <reoccurrencePattern>daily</reoccurrencePattern>
      <reoccurrenceStopTime>2012-03-14T00:00:00Z</reoccurrenceStopTime>
      <sv:delimiter>0</sv:delimiter>
      <sv:delimiter>0</sv:delimiter>
    </sessionSchedule>

    <fileSchedule>
      <fileURI>file://fota.operator.com/swupdate/oem-1/model-1/image032212.apk</fileURI>
      <deliveryInfo start="2012-03-07T23:00:00Z" end="2012-03-07T23:10:00Z"/>
      <sv:delimiter>0</sv:delimiter>
    </fileSchedule>
    <fileSchedule>
      <fileURI>file://fota.operator.com/swupdate/oem-1/model-2/image098798.apk</fileURI>
      <deliveryInfo start="2012-03-07T23:10:00Z" end="2012-03-07T23:20:00Z"/>
      <sv:delimiter>0</sv:delimiter>
    </fileSchedule>
    <fileSchedule>
      <fileURI>file://fota.operator.com/swupdate/oem-1/model-3/image765987.apk</fileURI>
      <deliveryInfo start="2012-03-07T23:20:00Z" end="2012-03-07T23:30:00Z"/>
      <sv:delimiter>0</sv:delimiter>
    </fileSchedule>
  </serviceSchedule>
</scheduleDescription>
```

11.2A.3.3 Example 3

In this instantiation example, the following key points can be noted:

- The version of the schema used to generate this instantiation is version 3, as indicated by the *schemaVersion* element. Thus a receiver of this instantiation that has multiple schedule schema versions (say 1, 2, 3 and 4), should use the schedule schema version equals to 3, as indicated in the version attribute of the schema instruction "schema". A receiver that has only older versions (version 1 and/or 2 in this case) of the schedule schema should use the schema that has the highest version number for validating the instantiation, but extensions made in higher versions of the schema will be ignored by the receiver. The receiver should avoid using schema version higher than 3, since the instantiation would fail verification against such schema version. The *scheduleUpdate* element indicates UTC time February 1st at time 00 hour 00 min 00 sec. Thus, an MBMS UE should seek to update the schedule instance after this time.
- There is one *serviceSchedule* element, which includes:
 - a *sessionSchedule* that
 - Has a first occurrence that starts at UTC March 1st 2012 23:00:00 and ends at UTC March 1st 2012 23:30:00;
 - Has subsequent occurrences every day at the same time until UTC March 7th 2012 00:00:00

Listing 11.2A.3.3-1: Schedule Description example 3

```
<?xml version="1.0" encoding="UTF-8"?>
<scheduleDescription xmlns="urn:3gpp:metadata:2011:MBMS:scheduleDescription"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:sv="urn:3gpp:metadata:2009:MBMS:schemaVersion"
  xsi:schemaLocation="urn:3gpp:metadata:2011:MBMS:scheduleDescription
TS26346_ScheduleDescription.xsd"
  scheduleUpdate="2012-02-01T00:00:00Z">

  <sv:schemaVersion>3</sv:schemaVersion>

  <serviceSchedule>
    <sessionSchedule>
      <start>2012-03-01T23:00:00Z</start>
      <stop>2012-03-01T23:30:00Z</stop>
      <reoccurrencePattern>daily</reoccurrencePattern>
      <reoccurrenceStopTime>2012-03-07T00:00:00Z</reoccurrenceStopTime>

      <sv:delimiter>0</sv:delimiter>
      <sv:delimiter>0</sv:delimiter>
    </sessionSchedule>
  </serviceSchedule>
</scheduleDescription>
```

11.2B Filter Description metadata fragment

11.2B.1 Introduction

This clause describes the procedures, usage and XML schema of the Filter Description metadata fragment.

The procedures associated with the elements of the Filter Description metadata fragment are specified in clause 11.2B.2.

The basic building block of a location filter is referred to as the location rule. Multiple location rules or constituent location filters built from these rules can be combined by using logical relationships (AND, OR, NOT) and recursion to form the overall, composite location filter. Such usage and semantics are described in clause 11.2B.3.

The group filter usage and semantics are described in clause 11.2B.3A.

The XML schema for the Filter Description Metadata Fragment is specified in clause 11.2B.4.

The UE may support the Filter Description fragment, and it may support the location filter data carried in this fragment.

11.2B.2 Procedures for Filter Description metadata fragment

A Filter Description metadata fragment instance may be delivered to the MBMS Client:

- during MBMS User Service Discovery/Announcement prior to the MBMS download session along with the session description (out-of-band of that session); or
- in-band within a MBMS download session; or
- via an MBMS download session dedicated to the transport of filter metadata information.

The most recently delivered Filter Description instance (i.e. the one with the highest version number - as given in the MBMS Metadata Envelope specified in clause 11.1.3) shall take the highest priority, such that filter data parameters received prior to, and out-of-band, of the download session they apply to are regarded as "initial defaults", and filter data parameters received in-band with the download session overwrite the earlier received filter data parameters.

The Filter Description instance is clearly identified using a URI to enable UE cross-referencing of in and out-of-band filter data files.

The Media Type for the filter data information is "application/mbms-filter description+xml"

Availability of the Filter Description fragment is indicated by the presence of the *receptionFiltering* element in the Schedule Description fragment, as child element of either the *sessionSchedule* or the *fileSchedule* element. Each *filterData* element is identified by its *id* attribute, which enables cross-referencing with the *filterID* attribute in the Schedule Description fragment.

11.2B.3 Usage of location filter

The overall location filter, representing the filtering criteria for positive reception of an associated location-specific content item or service, is expressed by the contents of the complex element *locationFilter* whose syntax is specified by the schema of the Filter Description fragment in clause 11.2B.4. The fundamental component or "atomic" building block of the location filter is the child element *locationRule*. It may be combined, via the element *logicalOperation* along with the use of recursion, with additional location rules and/or intermediate location filters to form the composite location filter. From the schema in 11.2B.4, possible decompositions of the location filter are as follows:

- a) LF = locationFilter = locationFilter1 = LF1;
- b) " = locationFilter2 = LF2;
- c) " = locationRule = LR;
- d) " = locationFilter1 logicalOperation locationRule = LF1 **LO** LR;
- e) " = locationFilter1 logicalOperation locationFilter2 = LF1 **LO** LF2;
- f) " = logicalOperation locationFilter2 = **LO** LF2;

The string value of *logicalOperation* (abbreviated as **LO** in the above) may correspond to the binary operator 'AND' or 'OR', or the unary operator 'NOT'. In the decomposition of (f), the only allowed value for this element is 'NOT'.

The basic location rule, defined by the element *locationRule*, comprises one or more target areas for which the required presence may additionally be associated with temporal and confidence level criteria. Each target area, represented by the child element *targetArea*, shall in turn comprise one or more cell-IDs and/or one or more shapes, the latter parameter defined by OMA MLP [109]. Permitted shapes in this version of the present document are 'Polygon' and 'CircularArea' as defined by [109].

If present, temporal parameters shall include the elements *startTime* and *endTime*, and optionally the element *duration*. Presence of only *startTime* and *endTime* is an indication that reception of the associated content item or service is conditioned by the location of the UE in any one of the instantiated target areas for the entire interval given by the difference between the start and end time values. Additional presence of *duration* means that UE presence in the target area is only required for the interval given by the value of this element, with $duration < (endTime - startTime)$.

In addition to temporal criteria, targeted reception of the content or service may be further conditioned by a minimum required level of confidence from the UE's perspective, and given by the element *confidenceLevel*, that the location of the UE fulfils both the associated target area and time criteria. In the event that the filter criterion corresponds to the present/current UE location in a target area defined strictly by cell-ID(s), both the time and confidence level parameters shall be absent. Defining targeted reception of a content or service by multiple time intervals requires multiple instances of *locationRule* in the composite location filter, since a single location rule can only be associated with a single temporal criterion.

The evaluation of whether an instance of location filtering criteria is satisfied is a device-internal mechanism and implementation-specific issue outside the scope of the present document.

11.2B.3A Usage of group filter

The group filter may be included as part of the filter description metadata fragment. The syntax of the group filter is specified by the schema of the Filter Description fragment in clause 11.2B.4.

The group filter is composed of *groupID* elements: each *groupFilter* element is instantiated with a list of string identifiers classifying the targeted groups as *groupID* elements. Multiple instantiations of this element may be used to classify content targeted to different groups and could be mapped to various types of target group information, e.g., social group, age group, gender, profession, ethnic group, etc. An MBMS Client may selectively receive contents with the group filter values known to match the profile of the user.

11.2B.4 Extended Filter Description metadata fragment syntax

The formal XML syntax of the Filter Description metadata fragment is specified in listing 11.2B.4-1 below, containing location filtering data as represented by the element *locationFilter* and grouping data as represented by the element *groupFilter*. Documents following this schema can be identified with the MIME media type "application/mbms-filter-description+xml" defined in clause C.15. The filename of the XML schema for Filter Description is "TS26346_FilterDescription.xsd".

In this version of the present document the network shall set the content of the *schemaVersion* element, defined as a child of the *filterDescription* element, to the value 2.

The schema version attribute (part of the schema instruction) shall be included in the UE schema and the network schema.

NOTE: The value of the *schemaVersion* element and *version* attribute is intended to be increased by 1 in every future release where new element(s) or attribute(s) are added.

When a UE receives an instantiation of a Filter Description compliant to this schema, it shall determine the schema version required to parse the instantiation as follows:

- If the UE supports one or more versions of the Filter Description schema with the schema *version* attribute, then the UE shall use the schema that has the highest schema *version* attribute value that is equal to or less than the value in the received *schemaVersion* element;

The schema filename of the Filter Description schema is FilterDescription.xsd. The XML schema "schema-version.xsd" is specified in clause J.2.

Listing 11.2B.4-1: Extended Filter Description schema

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:3gpp:metadata:2011:MBMS:filterDescription" version="2"
  xmlns="urn:3gpp:metadata:2011:MBMS:filterDescription"
  xmlns:r12="urn:3gpp:metadata:2013:MBMS:filterDescription"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  xmlns:sv="urn:3gpp:metadata:2009:MBMS:schemaVersion"
  elementFormDefault="qualified">
  <xs:annotation>
    <xs:documentation>Extended MBMS Filter Description schema</xs:documentation>
    <xs:documentation>3GPP TS 26.346 clause 11.2B.4</xs:documentation>
    <xs:documentation>Copyright © 2013, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI,
    TSDSI, TTA, TTC). All rights reserved.</xs:documentation>
  </xs:annotation>

  <xs:import schemaLocation="TS26346_FilterDescription_Extensions_Rel-12.xsd"
    namespace="urn:3gpp:metadata:2013:MBMS:filterDescription"/>
  <xs:import schemaLocation="TS26346_SchemaVersion.xsd"
    namespace="urn:3gpp:metadata:2009:MBMS:schemaVersion"/>

  <xs:element name="filterDescription" type="filterDescriptionType"/>
  <xs:complexType name="filterDescriptionType">
    <xs:sequence>
      <xs:element ref="sv:schemaVersion"/>
      <xs:element name="filterData" maxOccurs="unbounded">
        <xs:complexType>
          <xs:sequence>
            <xs:element name="locationFilter" type="locationFilterType"
minOccurs="0"/>
            <xs:element ref="r12:groupFilter" minOccurs="0"/>
            <xs:element ref="sv:delimiter"/>
            <xs:any namespace="##other" processContents="lax" minOccurs="0"
maxOccurs="unbounded"/>
          </xs:sequence>
          <xs:attribute name="id" type="xs:anyURI" use="required"/>
        </xs:complexType>
      </xs:element>
    </xs:sequence>
    <xs:anyAttribute processContents="skip"/>
  </xs:complexType>

  <xs:complexType name="locationFilterType">
    <xs:sequence>
      <xs:element name="locationFilter1" type="locationFilterType" minOccurs="0"/>
    </xs:sequence>
  </xs:complexType>
</xs:schema>
```



```

    <xs:element name="logicalOperation" minOccurs="0">
      <xs:simpleType>
        <xs:restriction base="xs:string">
          <xs:enumeration value="AND"/>
          <xs:enumeration value="OR"/>
          <xs:enumeration value="NOT"/>
        </xs:restriction>
      </xs:simpleType>
    </xs:element>
    <xs:choice>
      <xs:element name="locationRule" minOccurs="0">
        <xs:complexType>
          <xs:sequence>
            <xs:element name="targetArea" maxOccurs="unbounded">
              <xs:complexType>
                <xs:sequence>
                  <xs:element name="cellID" type="xs:unsignedLong"
minOccurs="0" maxOccurs="unbounded"/>
                  <xs:element name="shape" minOccurs="0">
                    <xs:complexType>
                      <xs:sequence>
                        <xs:element name="Polygon" minOccurs="0"
maxOccurs="unbounded">
                          <xs:annotation>
                            <xs:documentation>See [OMA
MLP].</xs:documentation>
                          </xs:annotation>
                        </xs:element>
                        <xs:element name="CircularArea" minOccurs="0"
maxOccurs="unbounded">
                          <xs:annotation>
                            <xs:documentation>See [OMA
MLP].</xs:documentation>
                          </xs:annotation>
                        </xs:element>
                        <xs:any namespace="##other"
processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
                      </xs:sequence>
                    </xs:complexType>
                  </xs:element>
                  <xs:any namespace="##other" processContents="lax"
minOccurs="0" maxOccurs="unbounded"/>
                </xs:sequence>
              </xs:complexType>
            </xs:element>
            <xs:element name="startTime" type="xs:unsignedInt" minOccurs="0"/>
            <xs:element name="endTime" type="xs:unsignedInt" minOccurs="0"/>
            <xs:element name="duration" type="xs:unsignedInt" minOccurs="0"/>
            <xs:element name="confidenceLevel" minOccurs="0">
              <xs:simpleType>
                <xs:restriction base="xs:decimal">
                  <xs:minInclusive value="0"/>
                  <xs:maxInclusive value="1"/>
                </xs:restriction>
              </xs:simpleType>
            </xs:element>
          </xs:sequence>
        </xs:complexType>
      </xs:element>
      <xs:element name="locationFilter2" type="locationFilterType" minOccurs="0"/>
    </xs:choice>
  </xs:sequence>
</xs:complexType>

<xs:complexType name="locationRuleType">
  <xs:sequence>
    <xs:element name="targetArea" type="targetAreaType" maxOccurs="unbounded"/>
    <xs:element name="startTime" type="xs:unsignedInt" minOccurs="0"/>
    <xs:element name="endTime" type="xs:unsignedInt" minOccurs="0"/>
    <xs:element name="duration" type="xs:unsignedInt" minOccurs="0"/>
    <xs:element name="confidenceLevel" minOccurs="0">
      <xs:simpleType>
        <xs:restriction base="xs:decimal">
          <xs:minInclusive value="0"/>
          <xs:maxInclusive value="1"/>
        </xs:restriction>
      </xs:simpleType>
    </xs:element>
  </xs:sequence>
</xs:complexType>

```

```

        </xs:sequence>
      </xs:complexType>

      <xs:complexType name="targetAreaType">
        <xs:sequence>
          <xs:element name="cellID" type="xs:unsignedLong" minOccurs="0" maxOccurs="unbounded" />
          <xs:element name="shape">
            <xs:complexType>
              <xs:sequence>
                <xs:element name="Polygon" minOccurs="0" maxOccurs="unbounded">
                  <xs:annotation>
                    <xs:documentation>See [OMA MLP].</xs:documentation>
                  </xs:annotation>
                </xs:element>
                <xs:element name="CircularArea" minOccurs="0" maxOccurs="unbounded">
                  <xs:annotation>
                    <xs:documentation>See [OMA MLP].</xs:documentation>
                  </xs:annotation>
                </xs:element>
              </xs:sequence>
            </xs:complexType>
          </xs:element>
        </xs:sequence>
      </xs:complexType>
    </xs:element>
  </xs:sequence>
</xs:complexType>
</xs:schema>

```

The following schema is the Release 12 extension to the Filter Description schema. The schema filename is "TS26346_FilterDescription_Extensions_Rel-12.xsd".

Listing 11.2B.4-2: Filter Description schema extensions (Release 12)

```

<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:3gpp:metadata:2013:MBMS:filterDescription"
  xmlns="urn:3gpp:metadata:2013:MBMS:filterDescription"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  elementFormDefault="qualified">
  <xs:annotation>
    <xs:documentation>MBMS Filter Description schema extensions (Release
12)</xs:documentation>
    <xs:documentation>3GPP TS 26.346 clause 11.2B.4</xs:documentation>
    <xs:documentation>Copyright © 2013, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI,
TSDSI, TTA, TTC). All rights reserved.</xs:documentation>
  </xs:annotation>

  <xs:element name="groupFilter" type="groupFilterType"/>
  <xs:complexType name="groupFilterType">
    <xs:sequence>
      <xs:element name="groupID" type="xs:string" maxOccurs="unbounded"/>
    </xs:sequence>
  </xs:complexType>
</xs:schema>

```

11.3 Security Description metadata fragment

11.3.1 Security Description metadata fragment syntax

The Security Description fragment is referenced by the *protectionDescriptionURI* of a *deliveryMethod* element. The Security Description fragment shall be identified by the MIME media type "application/mbms protection-description+xml" as defined in clause C.6.

The root element of Security Description is the *securityDescription* element. It contains three different elements, the *keyId* element identifies the key(s) for each media flow, the *keyManagement* element the key management servers that the load is distributed over and the parameters in use, and the *fecProtection* element that configures the FEC protection of the point to multi-point distributed key flows.

The *keyManagement* element defines the list of key management servers (i.e. BM-SC). The MBMS UE must register with a key management server to receive key material. A receiver shall select a key management server following the same procedure defined for selecting a file repair server defined in clause 9.3.5.

The attribute *uiccKeyManagement* defines whether UICC based key management is required for the present MBMS User Service.

The *offsetTime* and *randomTimePeriod* attributes define the back off behavior of the UE when requesting MSKs. This uses the procedure defined in clause 9.3.4 where *offsetTime* specifies the offset time defined in clause 9.3.4.1 and *randomTimePeriod* the length of the random window in accordance with clause 9.3.4.2. The units for both attributes are in seconds.

The element *keyId* contains a list of media flows for which keys are required. For each media flow a key identifier is provided in addition to that media flows additional security parameters. The media flow is identified by a destination tuple providing an address followed by a port number separated by a "/", i.e. <IP-destination-address>/<destination-port>. The port number is for RTP session the RTP port number, and not RTCP's. The *MSK* element identifies the key uniquely by specifying both the *keyDomainID* and the *MSKID* as defined in clause 6.3.2.1 of TS 33.246 [20]. The *MSKID* is 4 bytes long binary with byte 3 and 4 equal to 0x00, i.e. the current key that are Base64 [82] when written into the element. The *keyDomainID* is a 3 byte long binary value as specified in clause 6.3.2.1 of [20] and shall also be base64 encoded when written in the XML document.

The presence of the *fecProtection* element indicates that any MIKEY packet with a multicast destination IP address equal to any of the used destination address in the *userServiceDescription* instance's delivery methods, are FEC protected and encapsulated in FEC source packets, see clause 8.2.2.4. The attributes *fecEncodingId*, *fecInstanceID*, and *fecOtiExtension* specify the FEC payload ID used in the source packet. All Security Description instances referenced by a User Service Bundle Description instance shall use the same FEC parameters.

NOTE: The term *service protection description* as used in TS 33.246 [20] is identical to the *Security Description* in the present document with regards to the associated User Service Bundle Description metadata fragment.

The Security Description schema is specified in listing 11.3.1-1 below. The filename of this schema is "TS26346_securityDescription.xsd".

Listing 11.3.1-1: Security Description schema

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:3GPP:metadata:2005:MBMS:securityDescription"
  xmlns="urn:3GPP:metadata:2005:MBMS:securityDescription"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  elementFormDefault="qualified">
  <xs:annotation>
    <xs:documentation>MBMS Security Description schema</xs:documentation>
    <xs:documentation>3GPP TS 26.346 clause 11.3.1</xs:documentation>
    <xs:documentation>Copyright © 2005, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI,
    TSDSI, TTA, TTC). All rights reserved.</xs:documentation>
  </xs:annotation>

  <xs:element name="securityDescription" type="securityDescriptionType"/>
  <xs:complexType name="securityDescriptionType">
    <xs:sequence>
      <xs:element name="keyManagement" type="keyManagementType" minOccurs="0"/>
      <xs:element name="keyId" type="keyIdType" maxOccurs="unbounded"/>
      <xs:element name="fecProtection" type="fecProtectionType" minOccurs="0"/>
      <xs:any namespace="##other" minOccurs="0" maxOccurs="unbounded"
processContents="lax"/>
    </xs:sequence>
    <xs:anyAttribute processContents="skip"/>
  </xs:complexType>

  <xs:complexType name="keyManagementType">
    <xs:sequence>
      <xs:element name="serverURI" type="xs:anyURI" maxOccurs="unbounded"/>
      <xs:any namespace="##other" minOccurs="0" maxOccurs="unbounded"
processContents="lax"/>
    </xs:sequence>
    <xs:attribute name="offsetTime" type="xs:unsignedLong" use="optional" default="0"/>
    <xs:attribute name="randomTimePeriod" type="xs:unsignedLong" use="optional" default="0"/>
    <xs:attribute name="uiccKeyManagement" type="xs:boolean" use="optional" default="true"/>
    <xs:anyAttribute processContents="skip"/>
  </xs:complexType>

  <xs:complexType name="keyIdType">
    <xs:sequence>
      <xs:element name="mediaFlow" maxOccurs="unbounded">
```

```

        <xs:complexType>
          <xs:sequence>
            <xs:element name="MSK" type="MSKType" maxOccurs="1"/>
          </xs:sequence>
          <xs:attribute name="flowID" type="xs:string" use="required"/>
          <xs:anyAttribute processContents="skip"/>
        </xs:complexType>
      </xs:element>
    </xs:sequence>
  </xs:complexType>

  <xs:complexType name="fecProtectionType">
    <xs:attribute name="fecEncodingId" type="xs:unsignedLong" use="optional" default="0"/>
    <xs:attribute name="fecInstanceId" type="xs:unsignedLong" use="optional"/>
    <xs:attribute name="fecOtiExtension" type="xs:string" use="optional"/>
    <xs:anyAttribute processContents="skip"/>
  </xs:complexType>

  <xs:complexType name="MSKType">
    <xs:sequence>
      <xs:element name="keyDomainID" type="xs:base64Binary" minOccurs="1" maxOccurs="1"/>
      <xs:element name="MSKID" type="MSKIDType" minOccurs="1" maxOccurs="1"/>
    </xs:sequence>
  </xs:complexType>

  <xs:simpleType name="MSKIDType">
    <xs:restriction base="xs:base64Binary">
      <xs:length value="4"/>
    </xs:restriction>
  </xs:simpleType>
</xs:schema>

```

11.3.2 Security Description example

Listing 11.3.2-1: Security Description example

```

<?xml version="1.0" encoding="UTF-8"?>
<securityDescription xmlns="urn:3GPP:metadata:2005:MBMS:securityDescription"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="urn:3GPP:metadata:2005:MBMS:securityDescription
TS26346_SecurityDescription.xsd">

  <keyManagement offsetTime="5" randomTimePeriod="10" uiccKeyManagement="true">
    <serverURI>http://register.operator.umts/</serverURI>
    <serverURI>http://register2.operator.umts/</serverURI>
  </keyManagement>

  <keyId>
    <mediaFlow flowID="224.1.2.3/4002">
      <MSK>
        <keyDomainID>aMoM</keyDomainID>
        <MSKID>aMoAAA==</MSKID>
      </MSK>
    </mediaFlow>
    <mediaFlow flowID="224.1.2.3/4004">
      <MSK>
        <keyDomainID>GM8M</keyDomainID>
        <MSKID>aMkAAA==</MSKID>
      </MSK>
    </mediaFlow>
  </keyId>

  <fecProtection fecEncodingId="1" fecInstanceId="0"
fecOtiExtension="1SCxWEMNe397m24SwgyRhg==" />
</securityDescription>

```

11.4 Service Protection Registration request

11.4.1 Service Protection Registration request syntax

The XML schema specified in listing 11.4.1-1 below defines a format used by the MBMS Client to register with the key management servers according to the procedure in TS 33.246 [20]. The MIME media type for this format is defined in clause C.9. The *serviceID* element identifies the service uniquely and is the same as the *serviceId* used in the *userServiceDescription* format defined in clause 11.2.1.

The filename of the Service Protection Registration schema is "TS26346_ServiceProtectionRegistrationRequest.xsd".

Listing 11.4.1-1: Service Protection Registration request schema

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:3GPP:metadata:2005:MBMS:securityRegistration"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  elementFormDefault="qualified" attributeFormDefault="unqualified">
  <xs:annotation>
    <xs:documentation>MBMS Service Protection Registration request schema</xs:documentation>
    <xs:documentation>3GPP TS 26.346 clause 11.4.1</xs:documentation>
    <xs:documentation>Copyright © 2005, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI,
    TSDSI, TTA, TTC). All rights reserved.</xs:documentation>
  </xs:annotation>

  <xs:element name="mbmsSecurityRegister">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="serviceID" type="xs:anyURI" maxOccurs="unbounded"
minOccurs="1"/>
        <xs:any namespace="##other" minOccurs="0" maxOccurs="unbounded"
processContents="lax"/>
      </xs:sequence>
      <xs:anyAttribute processContents="skip"/>
    </xs:complexType>
  </xs:element>
</xs:schema>
```

11.4.2 Service Protection Registration request example

The below example is used to register to a service identified by the serviceID "urn:3gpp:mbms:example:service:identification:123456789abcdef".

Listing 11.4.2-1: Service Protection Registration request example

```
<?xml version="1.0" encoding="UTF-8"?>
<mbmsSecurityRegister xmlns="urn:3GPP:metadata:2005:MBMS:securityRegistration"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="urn:3GPP:metadata:2005:MBMS:securityRegistration
  TS26346_ServiceProtectionRegistrationRequest.xsd">

  <serviceID>urn:3gpp:mbms:example:service:identification:123456789abcdef</serviceID>
</mbmsSecurityRegister>
```

11.5 Service Protection Deregistration request

11.5.1 Service Protection Deregistration request syntax

This format is used to de-register from the key management server(s) according to the procedure in TS 33.246 [20]. The MIME media type for this format is defined in clause C.10. The *serviceID* element is defined exactly as in clause 11.4.1.

The filename of the Service Protection Deregistration is "TS26346_ServiceProtectionDeregistrationRequest.xsd".

Listing 11.5.1-1: Service Protection Deregistration request schema

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:3GPP:metadata:2005:MBMS:securityDeregistration"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  elementFormDefault="qualified" attributeFormDefault="unqualified">
  <xs:annotation>
    <xs:documentation>MBMS Service Protection Deregistration request schema</xs:documentation>
    <xs:documentation>3GPP TS 26.346 clause 11.5.1</xs:documentation>
    <xs:documentation>Copyright © 2005, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI,
TSDSI, TTA, TTC). All rights reserved.</xs:documentation>
  </xs:annotation>

  <xs:element name="mbmsSecurityDeregister">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="serviceID" type="xs:anyURI" maxOccurs="unbounded"
minOccurs="1"/>
        <xs:any namespace="##other" minOccurs="0" maxOccurs="unbounded"
processContents="lax"/>
      </xs:sequence>
      <xs:anyAttribute processContents="skip"/>
    </xs:complexType>
  </xs:element>
</xs:schema>
```

11.5.2 Service Protection Deregistration request example

The below example is used to deregister from the services identified by the serviceID "urn:3gpp:mbms:example:service:identification:123456789abcdef".

Listing 11.5.2-1: Service Protection Deregistration request example

```
<?xml version="1.0" encoding="UTF-8"?>
<mbmsSecurityDeregister xmlns="urn:3GPP:metadata:2005:MBMS:securityDeregistration"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="urn:3GPP:metadata:2005:MBMS:securityDeregistration
TS26346_ServiceProtectionDeregistrationRequest.xsd">

  <serviceID>urn:3gpp:mbms:example:service:identification:123456789abcdef</serviceID>
</mbmsSecurityDeregister>
```

11.6 Service Protection MSK request

11.6.1 Service Protection MSK request syntax

This format is used to request from the key management server(s) the delivery of one or more MSK identities as defined in clause 11.3.1. The MIME media type for this format is defined in clause C.8.

The filename of the Service Protection MSK request schema is "TS26346_ServiceProtectionMSKRequest.xsd".

Listing 11.6.1-1: Service Protection MSK request schema

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:3GPP:metadata:2005:MBMS:mskRequest"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  xmlns="urn:3GPP:metadata:2005:MBMS:mskRequest"
  elementFormDefault="qualified" attributeFormDefault="unqualified">
  <xs:annotation>
    <xs:documentation>MBMS Service Protection MSK request schema</xs:documentation>
    <xs:documentation>3GPP TS 26.346 clause 11.6.1</xs:documentation>
    <xs:documentation>Copyright © 2005, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI,
TSDSI, TTA, TTC). All rights reserved.</xs:documentation>
  </xs:annotation>

  <xs:element name="mbmsMSKRequest">
    <xs:complexType>
      <xs:sequence>
```

```

        <xs:element name="MSK" type="MSKType" minOccurs="1" maxOccurs="unbounded"/>
      </xs:sequence>
      <xs:anyAttribute processContents="skip"/>
    </xs:complexType>
  </xs:element>

  <xs:complexType name="MSKType">
    <xs:sequence>
      <xs:element name="keyDomainID" type="xs:base64Binary" minOccurs="1" maxOccurs="1"/>
      <xs:element name="MSKID" type="MSKIDType" minOccurs="1" maxOccurs="1"/>
    </xs:sequence>
  </xs:complexType>

  <xs:simpleType name="MSKIDType">
    <xs:restriction base="xs:base64Binary">
      <xs:length value="4"/>
    </xs:restriction>
  </xs:simpleType>
</xs:schema>

```

11.6.2 Service Protection MSK request example

The below example is used to request a single MSK with keyDomainID "uHCd" and a MSK ID part "aMkAAA==".

Listing 11.6.2-1: Service Protection MSK request example

```

<?xml version="1.0" encoding="UTF-8"?>
<mbmsMSKRequest xmlns="urn:3GPP:metadata:2005:MBMS:mskRequest"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="urn:3GPP:metadata:2005:MBMS:mskRequest
TS26346_ServiceProtectionMSKRequest.xsd">

  <MSK>
    <keyDomainID>uHCd</keyDomainID>
    <MSKID>aMkAAA==</MSKID>
  </MSK>
</mbmsMSKRequest>

```

11.7 Service Protection Registration/Deregistration response

11.7.1 Service Protection Registration/Deregistration response syntax

This format is used in the response of the key management server(s) to a Service Protection Registration message (see clause 11.4) or Deregistration message (see clause 11.5). The format of the response codes is defined in 3GPP TS 33.246 [20]. The MIME media type for this format is defined in appendix C.13.

The filename of the Service Protection Registration and Deregistration response schema is "TS26346_ServiceProtectionRegistrationResponse.xsd".

Listing 11.7.1-1: Service Protection Registration and Deregistration response schema

```

<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:3GPP:metadata:2005:MBMS:securityRegistrationResponse"
  xmlns="urn:3GPP:metadata:2005:MBMS:securityRegistrationResponse"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  elementFormDefault="qualified" attributeFormDefault="unqualified">
  <xs:annotation>
    <xs:documentation>MBMS Service Protection Registration/Deregistration response
schema</xs:documentation>
    <xs:documentation>3GPP TS 26.346 clause 11.7.1</xs:documentation>
    <xs:documentation>Copyright © 2005, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI,
TSDSI, TTA, TTC). All rights reserved.</xs:documentation>
  </xs:annotation>

  <xs:element name="mbmsSecurityRegisterResponse">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="Response" type="ResponseType" maxOccurs="unbounded"/>

```

```

        <xs:any namespace="##other" minOccurs="0" maxOccurs="unbounded" />
      </xs:sequence>
    </xs:complexType>
  </xs:element>

  <xs:complexType name="ResponseType">
    <xs:sequence>
      <xs:element name="serviceID" type="xs:anyURI" />
      <xs:element name="ResponseCode" type="xs:string" />
      <xs:any namespace="##other" processContents="lax" minOccurs="0"
maxOccurs="unbounded" />
    </xs:sequence>
  </xs:complexType>
</xs:schema>

```

11.7.2 Service Protection Registration/Deregistration response example

Listing 11.7.2-1: Service Protection Registration/Deregistration response example

```

<?xml version="1.0" encoding="UTF-8"?>
<mbmsSecurityRegisterResponse xmlns="urn:3GPP:metadata:2005:MBMS:securityRegistrationResponse"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="urn:3GPP:metadata:2005:MBMS:securityRegistrationResponse
TS26346_ServiceProtectionRegistrationResponse.xsd">

  <Response>
    <serviceID>urn:3gpp:mbms:example:service:identification:123456789abcdef</serviceID>
    <ResponseCode>200 OK</ResponseCode>
  </Response>

  <Response>
    <serviceID>urn:3gpp:mbms:example:service:identification:fedcba987654321</serviceID>
    <ResponseCode>200 OK</ResponseCode>
  </Response>
</mbmsSecurityRegisterResponse>

```

11.8 Service Protection MSK response

11.8.1 Service Protection MSK response syntax

This format is used in the response of the key management server(s) to an MSK Request message (see clause 11.6). The format of the response codes are defined in 3GPP TS 33.246 [20]. The MIME media type for this format is defined in clause C.12.

The filename of the Service Protection MSK response schema is "TS26346_SecurityProtectionMSKResponse.xsd".

Listing 11.8.1-1: Service Protection MSK response schema

```

<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:3GPP:metadata:2005:MBMS:mskResponse"
  xmlns="urn:3GPP:metadata:2005:MBMS:mskResponse"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  elementFormDefault="qualified" attributeFormDefault="unqualified">
  <xs:annotation>
    <xs:documentation>MBMS Service Protection MSK response schema</xs:documentation>
    <xs:documentation>3GPP TS 26.346 clause 11.8.1</xs:documentation>
    <xs:documentation>Copyright © 2005, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI,
TSDSI, TTA, TTC). All rights reserved.</xs:documentation>
  </xs:annotation>

  <xs:element name="mbmsMSKResponse">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="Response" type="ResponseType" maxOccurs="unbounded" />
        <xs:any namespace="##other" minOccurs="0" maxOccurs="unbounded" />
      </xs:sequence>
    </xs:complexType>
  </xs:element>

```



```

<xs:complexType name="MSKType">
  <xs:sequence>
    <xs:element name="keyDomainID" type="xs:base64Binary"/>
    <xs:element name="MSKID" type="MSKIDType"/>
  </xs:sequence>
</xs:complexType>

<xs:simpleType name="MSKIDType">
  <xs:restriction base="xs:base64Binary">
    <xs:length value="4"/>
  </xs:restriction>
</xs:simpleType>

<xs:complexType name="ResponseType">
  <xs:sequence>
    <xs:element name="MSK" type="MSKType"/>
    <xs:element name="ResponseCode" type="xs:string"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0"
maxOccurs="unbounded"/>
  </xs:sequence>
</xs:complexType>
</xs:schema>

```

11.8.2 Service Protection MSK response example

Listing 11.8.2: Service Protection MSK response example

```

<?xml version="1.0" encoding="UTF-8"?>
<mbmsMSKResponse xmlns="urn:3GPP:metadata:2005:MBMS:mskResponse"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="urn:3GPP:metadata:2005:MBMS:mskResponse
TS26346_ServiceProtectionMSKResponse.xsd">

  <Response>
    <MSK>
      <keyDomainID>uHCd</keyDomainID>
      <MSKID>aMkAAA==</MSKID>
    </MSK>
    <ResponseCode>200 OK</ResponseCode>
  </Response>

  <Response>
    <MSK>
      <keyDomainID>uHCd</keyDomainID>
      <MSKID>JMtEAA==</MSKID>
    </MSK>
    <ResponseCode>200 OK</ResponseCode>
  </Response>
</mbmsMSKResponse>

```

11.9 MBMS feature requirements

MBMS features enable the BM-SC to signal to the UE the set of capabilities that are required for the consumption of the MBMS user service. The required capability list is indicated in the MBMS User Service Description of the corresponding MBMS user service as defined in clause 11.2.1.

The MBMS UE shall not attempt to receive the service if it detects that at least one required capability, indicated in the USD, is not supported or not understood. The introduction of new features is possible and assumes that unidentified features shall be interpreted by the UE as a requirement that cannot be fulfilled.

The list of features is defined in table 11.9-1.

Table 11.9-1: MBMS Feature Requirement List

Service Capability	References	Recognized Feature Values (Integer)
Speech	as defined in clause 10.2	0
AMR-WB	as defined in clause 10.2	1
Enhanced aacPlus	as defined in clause 10.3	2
Extended AMR-WB	as defined in clause 10.3	3
Synthetic audio	as defined in clause 10.4	4
H.263	as mentioned in clause 10.5	5
H.264 Constrained Baseline Profile Level 1b	as defined in clause 10.5 (of Release 10)	6
Still images	as defined in clause 10.6	7
Bitmap graphics	as defined in clause 10.7	8
Vector graphics	as defined in clause 10.8	9
Text	as defined in clause 10.9	10
Timed text	as defined in clause 10.10	11
3GPP file format	as defined in clause 10.11	12
H.264 Constrained Baseline Profile Level 1.2	as defined in clause 10.5 (of Release 7)	13
Scene Description	as defined in clause 10.12	14
MBSFN mode in UTRAN	as defined in TS 25.346 (of Release 7)	15
H.264 Constrained Baseline Profile Level 1.3	as defined in clause 0.5 (of Release 9)	16
AHS	as defined in clause 5.6 (of Release 9)	17
3GP-DASH	as defined in clause 5.6 (of Release 10)	18
H.264 Progressive High Profile Level 3.1	as defined in clause 10.5 (of Release 11)	19
Frame-packed stereoscopic 3D video	as defined in clause 10.5 (of Release 11)	20
H.265 (HEVC) Main Profile, Main Tier, Level 3.1	as defined in clause 10.5 (of Release 12)	21
MBMS User Service Discovery/ Announcement Profile 1a	Service capabilities as defined in clause L.2	22
MBMS User Service Discovery/ Announcement Profile 1b	Service capabilities as defined in clause L.3	23
MBMS User Service Discovery / Announcement Profile for Transparent delivery	Service capabilities as defined in clause L.5	24
Virtual Reality	Service capabilities as defined in clause 10.13	25
Profile 1c	Service capabilities as defined in clause L.3A	26
Service for LTE-based 5G Broadcast Base Receiver (see NOTE 1)	Service capability as defined in ETSI TS 103 720 [148], clause 10.2.	27
Service for LTE-based 5G Broadcast Main Receiver (see NOTE 1)	Service capability as defined in ETSI TS 103 720 [148], clause 10.3.	28
5GMSd service	Generic Application Service as defined in clause 5.7 for which formats conform to 5G Media Streaming M4d formats according to TS 26.511 [150] and TS 26.512 [151].	29
Service for 5GMS via LTE-based 5G Broadcast Receiver (see NOTE 1)	Service capability as defined in ETSI TS 103 720 [148], clause 10.4.	30
NOTE 1: "LTE-based 5G Broadcast" refers to TR 36.976 [149] "Overall description of LTE-based 5G broadcast".		

The list of features may be extended in the future.

12 MBMS operation on Demand (MooD)

12.1 Introduction

In the operation of "MBMS operation on Demand", or MooD, certain content that is initially delivered over the unicast network may be turned into an MBMS User Service, in order to efficiently use network resources when the traffic volume exceeds a certain threshold. Such dynamic conversion from unicast delivery to MBMS delivery is also referred to as "MBMS offloading". The MBMS offloading may apply to unicast traffic carried over HTTP or RTP/RTSP. In the former case, the MBMS download delivery method is used, and in the latter, the MBMS streaming method based on RTP is used, for delivering the offloaded content.

There are two types of MBMS offloading: UE-Elected and Network-Elected offloading. In both types, there could be a network proxy/server to detect whether unicast traffic volume for the same service or content exceeds a certain threshold, and to indicate such occurrence to the BM-SC to enable MBMS offloading. To assist the MooD decision, the network proxy/server may obtain UE location from the UE per operator's policy. Alternatively, the network proxy/server may act as an Application Function in requesting from the PCRF, via the Rx reference point, the UE's location information via the 3GPP-User-Location-Info AVP defined in TS 29.214 [117]. Other receiver-specific AVPs as defined in TS 29.214 [117] are outside the scope of MooD. The network proxy/server may also use LCS procedure defined in TS 23.271 [118] to obtain the UE's location information. The network proxy/server may deliver user location information to the BM-SC for MooD decision. The interface between the network proxy/server and the BM-SC is outside the scope of this specification.

12.2 UE-elected offloading

12.2.0 General procedures

UE-elected offloading means that a MooD-capable UE will send its unicast requests, for content eligible for conversion to delivery as an MBMS service (as described by the MooD Configuration Management Object (MO) based on the request domains), to a designated proxy server.

If the UE receives a MooD redirect response (containing the MooD header field), it will activate the MBMS Client by providing it with entry point information to the USD that is already provisioned or that is provided in the MooD header field. The MooD redirect response is sent by the network proxy server in one of the following ways:

- For an HTTP GET request of a large, non-real-time (NRT) file object: by an HTTP 3xx/Redirection response that requires the UE to obtain that file delivered on an MBMS bearer, via the MBMS download method;
- For an HTTP GET or partial GET request of DASH-formatted streaming content: by an HTTP 2xx/Success response that contains, in addition to the aforementioned MooD header, the requested content;
- For an RTSP PLAY request of a media stream: by a 3xx redirection response message requesting the UE to switch to MBMS reception;
- Using an RTSP REDIRECT request from the RTSP server to the client informing the UE to obtain the content delivered on an MBMS bearer, via the MBMS streaming method.

Subsequently, when the MBMS Client is operational, having acquired the USD fragments (including the Media Presentation Description fragment in the case of DASH-formatted content) for the new MBMS service, and has begun receiving contents over the MBMS bearer, future requests for content by the client application (e.g., the DASH client) will be served by the MBMS Client. Via OMA-DM (Device Management) based MooD Configuration MO, the UE is provisioned with configuration information pertaining to MooD operation as described in clause 12.2.2. Configuration parameters may include the proxy server over which unicast content requests have to be sent, identification of contents for which offloading to MBMS is eligible, and the location of the USD for UE to acquire service announcement information.

The redirection message shall contain the 3GPP-specified MooD header field that triggers the activation of the MBMS receiver in the UE, as defined below in clause 12.2.1.

A UE that is not able to handle the redirection message appropriately shall not use the proxy server for the requests. UEs that comply with this specifications shall support handling of the redirection message.

12.2.1 Mood header field

12.2.1.0 General

In order for a UE to differentiate between a regular redirection message (i.e. HTTP redirection status code or RTSP redirection request) and a Mood redirect response (i.e., MBMS offloading request), a new 3GPP header field, i.e., Mood header, is defined. The Mood header field applies both to RTSP and HTTP redirections. If the UE detects the presence of the Mood header, it shall assume that this is an indication to activate the MBMS Client. If the MBMS Client is already activated or operational, the header represents an implicit notification that updated User Service Bundle Description fragments must be acquired. The Mood header field may contain entry point information to the MBMS USBD fragment which in turn enables reception of the dynamically-established MBMS service. The precedence rules for UE acquisition of User Service Bundle Description fragments as result of the UE receiving the Mood header are given below, in decreasing order of priority (refer to clause 12.2.2 regarding the details of the Mood Configuration Management Object):

- i) If the URL is present in the Mood header, the MBMS Client shall use it to retrieve the USBD fragment over unicast.
- ii) If the URL to the User Service Bundle Description fragment is not present in the header, but the URL to User Service Description information, i.e. `/<X>/USDLocation/URL` is present in the Mood Configuration MO, the MBMS Client shall use it to retrieve User Service Bundle Description fragments over unicast.
- iii) If the URL to the USBD fragment is not present in the Mood header, nor is `"/<X>/USDLocation"` present in the Mood Configuration MO, but pre-configured session parameters to the dedicated MBMS download session carrying the USBD fragment is available in the UE, the MBMS Client shall use that information to acquire the User Service Bundle Description fragments over broadcast.

During the interim period beginning from when the MBMS Client starts to acquire the User Service Bundle Description fragments until it has received contents of the on-demand MBMS service over the MBMS bearer, the MBMS Client should continue to request contents via the unicast network, to avoid service disruption or a "break before make" switching from unicast to broadcast content reception. Upon readiness of the MBMS Client to supply content received over MBMS delivery to the application client, a switch in reception mode from unicast to broadcast is expected to occur internally to the UE.

The Mood header field shall also be used by the MBMS Client to indicate its current location to the Mood proxy server, if requested to do so by the information in the Mood Configuration MO. In this case, the current location shall be formatted according to the "LocationType" value as described in clause 12.2.2. If the MBMS Client has acquired the serviceId from the User Service Bundle Description (see clause), then the service-id shall also be included.

The ABNF syntax for the Mood header field is defined as follows:

Mood = "3gpp-mbms-offloading" ":" [(absolute-URI ";" service-id) / (relative-ref ";" service-id) / (currentLocation ";" service-id) / currentLocation ";" ";" service-id], where

- <absolute-URI> and <relative-ref> are as defined in RFC 3986 [19], and
- <currentLocation> represents the serving cell-ID(s) or a list of MBMS SAI of the UE whose format is defined by the location type in the `/<X>/LocationType` leaf of the Mood Configuration MO as defined in clause 12.2.2, whereby the one or more entries of cell-ID or SAI are specified as a string of comma-separated values, and
- <service-id> represents the associated *serviceId* attribute (as defined in clause 11.2.1.1) of the MBMS User Service. The *serviceId* content in the Mood header shall be formatted according to the rules specified in section 5 of RFC 9110 [155], in particular regarding handling of special characters in field values that have to be quoted (section 5.6.4 of RFC 9110 [155]).

The serving cell-ID(s) should correspond to all cells from which the UE receives the service, i.e., the PCell and any SCell(s), if Carrier Aggregation as defined in TS 36.300 [96] is employed in the E-UTRAN.

If location type is CGI or ECGI, the serving cell-Id text format follows the format defined in clause 8.4.2.8.

Else, if location type is MBMS SAI, the <currentLocation> field is as follows:

- List of MBMS SAI = intra-f-SAI "-" inter-f-SAI "-" intersected-SAI

- <intra-f-SAI> Comma-separated list of SAI from *mbms-SAI-IntraFreq-r11* in SIB15 (see TS 36.331 [97]) if present.
- <inter-f-SAI> Comma-separated list of SAI from the one or more *mbms-SAI-InterFreqList-r11* in SIB 15 [97]) if present.
- <intersected-SAI> Comma-separated list of SAIs corresponding to the intersection between the SAIs in SIB15 [97] intersected and the list of MBMS Service Area Identities included in the *userServiceDescription.availabilityInfo.infoBinding.serviceArea* elements for the same *serviceId*. Before the intersection is created, all SAIs from intra-frequency neighbour cells shall be removed from the SIB15 SAI list (see TS 36.331 [97] for details SAIs from intra-frequency neighbour cells).

12.2.1.1 Mood header in HTTP-based unicast content access

In unicast content access via HTTP, the following rules apply regarding the Mood header contained in HTTP GET request messages:

- a) If the UE contains the Mood Configuration MO, and the "/<X>/LocationType" leaf node is present, then the Mood header shall include the <currentLocation> field-value.
- b) If the UE does not contain the Mood Configuration MO, but is Mood-capable and is preconfigured with the rule to include its location in the HTTP request, then the <currentLocation> field-value shall be contained in the Mood header.
- c) If the UE does not contain the Mood Configuration MO, but is Mood-capable and is not preconfigured with the rule to include its location in the HTTP request, then the Mood header containing solely the field-name followed by a colon (":"), i.e. "3gpp-mbms-offloading:", is sent to indicate that the UE is Mood-capable.

Upon network determination of high usage demand and decision to perform MBMS offloading, a subsequent Mood redirect response will contain the Mood header instantiated in one of the following ways:

- The Mood header comprises the concatenation of field-name "3gpp-mbms-offloading", a colon (":"), and the service-id;
- The Mood header comprises the concatenation of the field-name "3gpp-mbms-offloading", a colon (":"), an HTTP_URL representing the location of the USBD fragment for unicast HTTP acquisition, a semi-colon (";"), and the service-id;
- The Mood header comprises the concatenation of the field-name "3gpp-mbms-offloading", a colon (":"), a relative reference to the USBD fragment which can be resolved by using a base URI, a semi-colon (";"), and the service-id.

12.2.1.2 Mood header in RTP/RTSP-based unicast content access

In unicast content access via RTP/RTSP, the following rules apply regarding the use of the Mood header in RTSP PLAY request messages:

- a) If the UE contains the Mood Configuration MO, and the "/<X>/LocationType" leaf node is present, then the Mood header shall include the <currentLocation> field-value.
- b) If the UE does not contain the Mood Configuration MO, but is Mood-capable and is preconfigured with the rule to always include its location in the RTSP request, then the <currentLocation> field-value shall be contained in the Mood header.
- c) If the UE does not contain the Mood Configuration MO, but is Mood-capable and is not preconfigured with the rule to always include its location in the RTSP request, the Mood header containing solely the field-name followed by a colon (":"), i.e. "3gpp-mbms-offloading:", is sent to indicate that the UE is Mood-capable.

Upon network determination of high usage demand and decision to perform MBMS offloading, a subsequent Mood redirect response will contain the Mood header instantiated in one of the following ways:

- The Mood header comprises the concatenation of field-name "3gpp-mbms-offloading", a colon (":"), and the service-id;

- The Mood header comprises the concatenation of the field-name "3gpp-mbms-offloading", a colon (":"), an RTSP_URL representing the location of the USBD fragment for unicast RTP/RTSP acquisition, a semi-colon (";"), and the service-id;
- The Mood header comprises the concatenation of the field-name "3gpp-mbms-offloading", a colon (":"), a relative reference to the USBD fragment which can be resolved by using a base URI, a semi-colon (";"), and the service-id.

12.2.2 Mood configuration Management Object

12.2.2.1 General

OMA-DM should be used to specify the Mood configuration information. If such a DM configuration object exists on the UE, the UE shall use it whenever it elects to support MBMS offloading. The OMA DM management object is used to configure offloading for any type of eligible content accessed over the unicast network via HTTP or RTP.

The Management Object Identifier shall be set to *urn:oma:mo:ext-3gpp-mbmsmood:1.0*. The MO is compatible with OMA Device Management protocol specifications, version 1.2 and upwards, and is defined using the OMA DM Device Description Framework as described in the Enabler Release Definition OMA-ERELED_DM-V1_2 [94].

NOTE: The MO information may be translated into a Proxy Auto-Config (PAC) file that can be used by the UE to automatically pick the proxy server for the eligible content.

Figure 19 depicts the nodes and leaf objects contained under the 3GPP_MBMS Mood MO, if an MBMS Client supports the feature described in this clause (information on the DDF for this MO is given below):

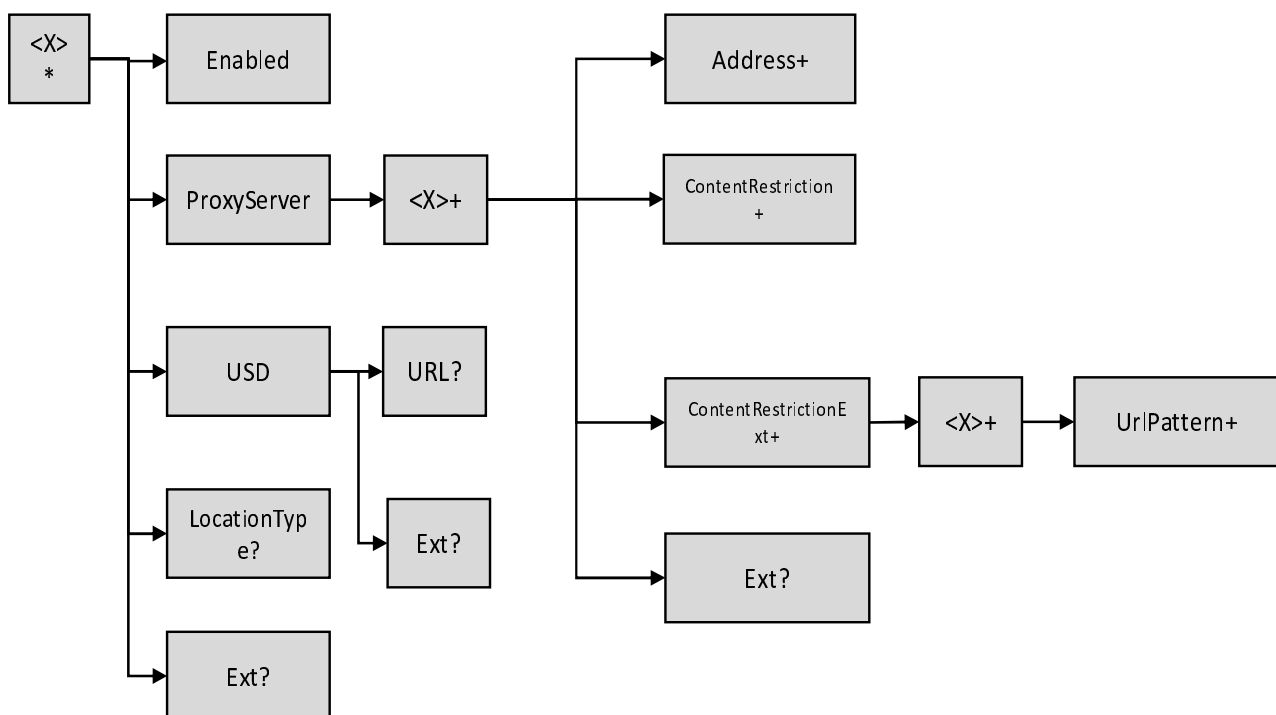


Figure 19: 3GPP Mood MO

12.2.2.2 Node: /<X>

This interior node specifies the unique object id of a MBMS Mood management object. The purpose of this interior node is to group together the parameters of a single object.

- Occurrence: ZeroOrOne
- Format: node

- Minimum Access Types: Get

The following interior nodes shall be contained if the UE supports the "MBMS Mood Management Object".

12.2.2.3 /<X>/Enabled

This leaf indicates if Mood is supported by the BM-SC.

- Occurrence: One
- Format: bool
- Minimum Access Types: Get

12.2.2.4 /<X>/ProxyServer

This node represents the one or more Proxy Servers that the UE shall use for all its unicast requests to resources that it elects to potentially receive over MBMS.

- Occurrence: One
- Format: node
- Access Types: Get, Replace
- Values: N/A

12.2.2.5 /<X>/ProxyServer/<X>

This interior node acts as a placeholder for one or more instances of ProxyServer information as addresses associated with content restriction identifiers for proxy server selection. Should more than one proxy server satisfy the conditions of the content restriction, the UE may randomly select one of them.

- Occurrence: OneOrMore
- Format: node
- Access Types: Get, Replace

12.2.2.6 /<X>/ProxyServer/<X>/Address

This leaf indicates the one or more address of a ProxyServer in the form of a Fully-Qualified Domain Name (FQDN), and is associated with a set of content restrictions of which at least one must be satisfied in order for a UE to use that/those Proxy Server(s) for all its unicast requests to resources that it elects to potentially receive over MBMS.

- Occurrence: OneOrMore
- Format: chr
- Access Types: Get, Replace
- Values: FQDN (one or more)

12.2.2.7 /<X>/ ProxyServer/<X>/ContentRestriction

The *ContentRestriction* leaf contains one or more domain names for matching against the HTTP(s) or RTSP URL of the resource request issued by the UE to determine whether the requested content is eligible for conversion from unicast access to an MBMS User Service, and if so, the corresponding Proxy Server to use. A match between this value and the requested resource URL indicates that the requested resource may be switched to MBMS delivery, and the associated proxy server shall be used by the UE for unicast access of that resource.

- Occurrence: OneOrMore
- Format: chr

- Access Types: Get, Replace
- Values: concatenation of URI scheme as defined in RFC 3986 [3] with a domain name as defined in RFC 1035 [114]

12.2.2.8 /<X>/ ProxyServer/<X>/ContentRestrictionExt/<X>

The *ContentRestrictionExt* node allows for more refined definition of the Mood eligible content and the rules on when to use the proxy server to query for availability of content over MBMS. If both *ContentRestriction* and *ContentRestrictionExt* exist, then the UE shall apply both of them to determine if a particular resource URL is Mood eligible and needs to be sent through the Mood proxy. In particular, if a *ContentRestriction* element exists and none of the provided FQDNs match, then the UE shall assume that the content is not eligible. If the *ContentRestriction* is not available, then it shall be assumed that all FQDNs are Mood eligible but only those that match at least one of the patterns in *ContentRestrictionExt* will use the Mood proxy.

- Occurrence: ZeroOrMore
- Format: node
- Access Types: Get, Replace

12.2.2.9 /<X>/ ProxyServer/<X>/ContentRestrictionExt/<X>/UrlPattern

The *UrlPattern* leaf provides a regular expression as specified in [126] that the request URL will be matched against. If the request matches, the requested resource is marked as Mood eligible.

- Occurrence: OneOrMore
- Format: chr
- Access Types: Get, Replace
- Values: a regular expression as defined in [126].

12.2.2.10 /<X>/ProxyServer/<X>/Ext

The *Ext* node is an interior node where vendor-specific information can be placed (vendor meaning application vendor, device vendor, etc.), pertaining to UE selection of the proxy server. Usually, the vendor extension is identified by a vendor-specific name under the *Ext* node. The tree structure under the identified vendor is not defined and can therefore include one or more non-standardized sub-trees.

- Occurrence: ZeroOrOne
- Format: node
- Minimum Access Types: Get, Replace

12.2.2.11 /<X>/USD

The *USD* node is the starting point of the MBMS User Service Discovery/Announcement information definitions.

- Occurrence: ZeroOrOne
- Format: node
- Minimum Access Types: Get, Replace

12.2.2.12 /<X>/USD/URL

This leaf provides a URL to an aggregated service announcement document encapsulating all relevant metadata fragments for the demand-based MBMS user service, which the UE can fetch using the unicast channel. It may also be used by the network when the network redirects the UE to switch MBMS reception. Should a redirection message

provide an alternative redirection link to service announcement information, it shall take precedence over the URL provided by the MO.

- Occurrence: ZeroOrOne
- Format: chr
- Minimum Access Types: Get
- Values: <HTTP(S) URL>

12.2.2.13 /<X> USD/Ext

The Ext node is an interior node where vendor-specific information can be placed ("vendor" may correspond to an application vendor, device vendor, etc.). Usually, the vendor extension is identified by a vendor-specific name under the Ext node. The tree structure under the vendor identified is not defined and can therefore include one or more un-standardized sub-trees.

- Occurrence: ZeroOrOne
- Format: node
- Minimum Access Types: Get

12.2.2.14 /<X>/LocationType

This leaf provides a location type for UE to report in the unicast content request. Exactly one of the following entries: one or more serving cell-ID(s) (cell-ID in the form of CGI (Cell Global Identification) or ECGI (E-UTRAN Cell Global Identification)) or MBMS SAI may be present. CGI, ECGI and MBMS SAI are defined in TS 23.003 [4]. The serving cell-ID(s) should correspond to all cells from which the UE receives the service, i.e., the Primary Cell or P-Cell and any Secondary Cell(s) or S-Cell(s), if Carrier Aggregation per TS 36.300 [96] is employed in the E-UTRAN. When present, the UE should send its location as part of the Mood header field together with the requests that it sends to a Mood proxy server. If the *LocationType* is set to MBMS SAI, the UE includes the SAIs present in SIB15 as specified in TS 36.331 [97].

- Occurrence: ZeroOrOne
- Format: chr
- Minimum Access Types: Get
- Values: Exactly one of the following location information types: CGI, ECGI, MBMS SAI, and whereby one or more entries of the specified type may be included.

12.2.2.15 /<X>/Ext

The Ext node is an interior node where vendor-specific information can be placed ("vendor" may correspond to an application vendor, device vendor, etc.). Usually, the vendor extension is identified by a vendor-specific name under the Ext node. The tree structure under the identified vendor is not defined and can therefore include one or more non-standardized sub-trees.

- Occurrence: ZeroOrOne
- Format: node
- Minimum Access Types: Get

12.3 Network-elected offloading

A Mood-capable UE may include the Mood header field in the HTTP GET request if the Mood Configuration MO is not present in the UE, and is preconfigured with a rule (e.g. in compliance to the home service operator requirement) to indicate its Mood-capability. The Mood header may be sent in one of two ways, in accordance to rules (b) and (c) in clause 12.2.1.1, and shall follow the syntax defined in clause 12.2.1.

Once the UE receive a network proxy/server response containing the Mood header field, it shall follow the same procedure as defined in clause 12.2.1.

Annex A (normative): FLUTE support requirements

This clause provides a table representation of the requirement levels for different features in FLUTE. Table A.1 includes requirements for an MBMS Client and an MBMS server for FLUTE support as well as the requirements for a FLUTE client and a FLUTE server according to the FLUTE protocol (RFC 3926 [9]). The terms used in table A.1 are described underneath.

Table A.1: Overview of the FLUTE support requirements in MBMS servers and clients

	FLUTE Client support requirement as per [9]	MBMS FLUTE Client support requirement as per present document	FLUTE Server use requirement as per [9]	MBMS FLUTE Server use requirement as per present document
FLUTE Blocking Algorithm	Required	Required	Strongly recommended	Required
Symbol Encoding Algorithm	Compact No-Code algorithm required. Other FEC building blocks are undefined optional plug-ins.	Compact No-Code algorithm required. MBMS Forward Error Correction required	Compact No-Code algorithm is the default option. Other FEC building blocks are undefined optional plug-ins.	Compact No-Code algorithm is the default option. MBMS Forward Error Correction.
Congestion Control Building Block (CCBB) / Algorithm	Congestion Control building blocks undefined.	Single channel support required	Single channel without additional CCBB given for the controlled network scenario.	Single channel support required
Content Encoding for FDT Instances	Optional	Optional	Optional	Shall not be used
Content Encoding for any other file than FDT Instances	Optional	Required	Optional	Optional
A flag active (header)	Required	Optional (see Note at the end of this Annex)	Optional	Set to zero (see Note at the end of this Annex)
B flag active (header)	Required	Required	Optional	Not recommended to use
T flag active and SCT field (header)	Optional	Optional	Optional	Set to zero
R flag active and ERT field (header)	Optional	Optional	Optional	Set to zero
Content-Location attribute (FDT)	Required	Required	Required	Required
TOI (FDT)	Required	Required	Required	Required
FDT Expires attribute (FDT)	Required	Required	Required	Required
Complete attribute (FDT)	Required	Required	Optional	Optional
FEC-OTI-Maximum-Source-Block-Length	Required	Required	Required	Required
FEC-OTI-Encoding-Symbol-Length	Required	Required	Required	Required
FEC-OTI-Max-Number-of-Encoding-Symbols.	Required	Required	Required	Required
FEC-OTI-FEC-Instance-ID	Required	Optional	Required	Optional
FEC-OTI-Scheme-Specific-Info	n/a	Required	n/a	Required if MBMS FEC used

The following are descriptions of the above terms:

- **Blocking algorithm:** The blocking algorithm is used for the fragmentation of files. It calculates the source blocks from the source files.
- **Symbol Encoding algorithm:** The symbol encoding algorithm is used for the fragmentation of files. It calculates encoding symbols from source blocks for Compact No-Code FEC. It may also be used for other FEC schemes.
- **Congestion Control Building Block:** A building block used to limit congestion by using congestion feedback, rate regulation and receiver controls (RFC 3048 [17]).
- **Content Encoding for FDT Instances:** FDT Instance may be content encoded for more efficient transport, e.g. using GZIP.
- **Content Encoding for any other file than FDT Instances:** Files may be content encoded for more efficient transport, e.g. using GZIP.
- **A flag:** The Close Session flag for indicating the end of a session to the receiver in the ALC/LCT header. See the Note at the end of this Annex.
- **B flag:** The Close Object flag is for indicating the end of an object to the receiver in the ALC/LCT header.
- **T flag:** The T flag is used to indicate the use of the optional "Sender Current Time (SCT)" field (when T=1) in the ALC/LCT header.
- **R flag:** The R flag is used to indicate the use of the optional "Expected Residual Time (ERT)" field in the ALC/LCT header.
- **Content Location attribute:** This attribute provides a URI for the location where a certain piece of content (or file) being transmitted in a FLUTE session is located.
- **Transport Object Identifier (TOI):** The TOI uniquely identifies the object within the session from which the data in the packet was generated.
- **FDT Expires attribute:** Indicates to the receiver the time until which the information in the FDT is valid.
- **Complete attribute:** This may be used to signal that the given FDT Instance is the last FDT Instance to be expected on this file delivery session.
- **FEC-OTI-Maximum-Source-Block-Length:** This parameter indicates the maximum number of source symbols per source block.
- **FEC-OTI-Encoding-Symbol-Length:** This parameter indicates the length of the Encoding Symbol in bytes.
- **FEC-OTI-Max-Number-of-Encoding-Symbols:** This parameter indicates the maximum number of Encoding Symbols that can be generated for a source block.
- **FEC-OTI-FEC-Instance-ID:** This field is used to indicate the FEC Instance ID, if a FEC scheme is used.
- **FEC-OTI-Scheme-Specific-Info:** Carries Object Transmission Information which is specific to the FEC scheme in use.

NOTE: The means to signal the end of the FLUTE session or the end of individual file transmissions can be provided by the Schedule Description fragment, via the *sessionSchedule* and *fileSchedule* elements. If the Schedule Description fragment is present, the LCT header's 'Close Session' flag (A) shall be set by the network to "0", and the UE should ignore this flag.

Annex B (normative): FEC encoder specification

This annex specifies the systematic Raptor Forward Error Correction code (see RFC 5053 [91]) and its application to MBMS. Raptor is a fountain code, i.e., as many encoding symbols as needed can be generated on the fly by the encoder from the source symbols of a block. The decoder is able to recover the source block from any set of encoding symbols only slightly more in number than the number of source symbols.

The code described in this document is a Systematic code, that is, the original source symbols are sent unmodified from sender to receiver, as well as a number of repair symbols.

B.1 Void

B.2 Void

B.3 File download

B.3.1 Void

B.3.2 Void

B.3.3 Void

B.3.4 Example parameters

B.3.4.1 Parameter derivation algorithm

Section 4.2 of RFC 5053 [91] provides recommendations for the derivation of the transport parameters G , T , Z and N .

Recommended settings for the input parameters, W , Al , K_{MIN} and G_{MAX} are as follows:

$$W = 256 \text{ KB} \quad Al = 4 \quad K_{MIN} = 1024 \quad G_{MAX} = 10$$

B.3.4.2 Examples

The above algorithm leads to transport parameters as shown in table B.3.4.2-1 below, assuming the recommended values for W , Al , K_{MIN} and G_{MAX} and $P = 512$:

Table B.3.4.2-1

File size F	G	Symbol size T	$G \cdot T$	K_t	Source blocks Z	Sub-blocks N	K_L	K_S	$T_L \cdot A$	$T_S \cdot A$
100 KB	6	84	504	1,220	1	1	1,220	1,220	N/A	N/A
100 KB	8	64	512	1,600	1	1	1,600	1,600	N/A	N/A
300 KB	2	256	512	1,200	1	2	1,200	1,200	128	128
1,000 KB	1	512	512	2,000	1	5	2,000	2,000	104	100
3,000 KB	1	512	512	6,000	1	12	6,000	6,000	44	40
10,000 KB	1	512	512	20,000	3	14	6,666	6,667	40	36

B.4 Streaming

B.4.1 Void

B.4.2 Void

B.4.3 Void

B.4.4 Example parameters

B.4.4.1 Parameter derivation algorithm

This clause provides recommendations for the derivation of the transport parameter T . This recommendation is based on the following input parameters:

- B the maximum source block size, in bytes
- P the maximum repair packet payload size, in bytes, which is a multiple of Al
- Al the symbol alignment factor, in bytes
- K_{MAX} the maximum number of source symbols per source block.
- K_{MIN} a minimum target on the number of symbols per source block
- G_{MAX} a maximum target number of symbols per repair packet

A requirement on these inputs is that $\text{ceil}(B/P) \leq K_{MAX}$. Based on the above inputs, the transport parameter T is calculated as follows:

Let,

$$G = \min\{\text{ceil}(P \cdot K_{MIN}/B), P/Al, G_{MAX}\} \quad - \quad \text{the approximate number of symbols per packet}$$

$$T = \text{floor}(P/(Al \cdot G)) \cdot Al$$

The value of T derived above should be considered as a guide to the actual value of T used. It may be advantageous to ensure that T divides into P , or it may be advantageous to set the value of T smaller to minimize wastage when full size repair symbols are used to recover partial source symbols at the end of lost source packets (as long as the maximum number of source symbols in a source block does not exceed K_{MAX}). Furthermore, the choice of T may depend on the source packet size distribution, e.g., if all source packets are the same size then it is advantageous to choose T so that the actual payload size of a repair packet P' , where P' is a multiple of T , is equal to (or as few bytes as possible larger than) the number of bytes each source packet occupies in the source block.

Recommended settings for the input parameters, Al , K_{MIN} and G_{MAX} are as follows:

$$Al = 4 \qquad K_{MIN} = 1024 \qquad G_{MAX} = 10$$

B.4.4.2 Examples

The above algorithm leads to transport parameters as shown in table B.4.4.2-1 below, assuming the recommended values for Al , K_{MIN} and G_{MAX} and $P = 512$:

Table B.4.4.2-1

Max source block size B	G	Symbol size T	G·T
40 KB	10	48	480
160 KB	4	128	512
640 KB	1	512	512

B.5 Void

B.6 Void

B.7 Void

The two tables V_0 and V_1 are defined sections 5.6.1 and 5.6.2 respectively of RFC 5053 [91].

B.8 Void

Annex C (informative): IANA registration

This annex provides the required IANA registration.

C.1 Registration of SDP Protocol Identifiers for Source packet

This specification defines two new SDP protocol identifiers for source packets. In compliance with the registration rules, these SDP protocol identifiers are defined in RFC 6064 [100].

Protocol identifier "UDP/MBMS-FEC/RTP/AVP" identifies a protocol combination of UDP per RFC 768 [7], FEC source packets (see clause 8.2.2.4), RTP per RFC 3550 [6] using the AVP profile per RFC 3551 [156]. This protocol identifier shall use the FMT space rules that are used for RTP/AVP.

Protocol identifier "UDP/MBMS-FEC/RTP/SAVP" identifies a protocol combination of UDP [7], FEC source packets (see clause 8.2.2.4), and RTP [6] using the SAVP profile per RFC 5124 [157]. This protocol identifier shall use the FMT space rules that are used for RTP/AVP.

C.2 Registration of SDP Protocol identifier for repair packets

This specification defines one new SDP protocol identifier for FEC repair packets. In compliance with the registration rules, this SDP protocol identifier are defined in [100].

Protocol identifier "UDP/MBMS-REPAIR" identifies a protocol combination of UDP [7], FEC repair packets (see clause 8.2.2.4). The FMT string is not used and shall be set to "*".

C.3 Registration of MIME type "application/simpleSymbolContainer"

The MIME Type "application/simpleSymbolContainer" denotes that the message body is a simple container of encoding symbols for the file repair procedure (see clause 9.3.5.2 - File Repair Response Message Format for HTTP Carriage of Repair Data).

Type name: application

Subtype name: simpleSymbolContainer

Required parameters:

None

Optional parameters:

None

Encoding considerations:

The content is binary and if transported in a protocol not capable of handling binary content then the object must be encoded, for example using base64 [82].

Security considerations:

The content of this media type are either source or repair symbols part of a binary file object. Thus its security considerations depends on the security requirements on the file object. As modification of the response message may corrupt the complete file object due to the FEC repair operations, integrity protection is recommended. Source authentication is also recommended to prevent man in the middle or spoofing attacks resulting in erroneous repair symbols.

Interoperability considerations:

None

Published specification:

3GPP TS 26.346

Applications which use this media type:

3GPP MBMS based applications

Additional information:

Magic number(s): None

File extension(s):

Macintosh file type code(s):

Person & email address to contact for further information:

Magnus Westerlund (magnus.westerlund@ericsson.com)
3GPP TSG SA WG4

Intended usage: COMMON

Restrictions on usage:

None

Author:

3GPP TSG SA WG4

Change controller:

3GPP TSG SA WG4

C.4 Registration of MIME type "application/mbms-user-service-description+xml"

The MIME Type "application/mbms-user-service-description+xml" denotes that the message body is a user service description instance in accordance with the XML schema "urn:3GPP:metadata:2005:MBMS:userServiceDescription" (see clause 11.2.1).

Type name: application

Subtype name: mbms-user-service-description+xml

Required parameters:

None

Optional parameters:

charset: As specified in RFC 3023 [83] for media type application/xml.

Encoding considerations:

This is an XML document and the encoding considerations are the same as for media type "application/xml" defined in RFC 3023 [83].

Security considerations:

This media format is used to configure the receiver on how to participate in a service. This format is highly susceptible to manipulation or spoofing for attacks desiring to mislead a receiver about a session. Both integrity protection and source authentication is recommended to prevent misleading of the receiver.

Interoperability considerations:

None

Published specification:

3GPP TS 26.346

Applications which use this media type:

3GPP MBMS based applications

Additional information:

Magic number(s): None

File extension(s):

Macintosh file type code(s):

Person & email address to contact for further information:

Magnus Westerlund (magnus.westerlund@ericsson.com)
3GPP TSG SA WG4

Intended usage: COMMON

Restrictions on usage: None

Author:

3GPP TSG SA WG4

Change controller:

3GPP TSG SA WG4

C.5 Registration of MIME type "application/mbms-envelope+xml"

The MIME Type "application/mbms-envelope+xml" denotes that the message body is a metadata envelope according to the XML schema "urn:3gpp:metadata:2005:MBMS:envelope" (see clause 11.1.3).

Type name: application

Subtype name: mbms-envelope+xml

Required parameters:

None

Optional parameters:

embedded:

Declares if all objects described in this envelope instance are embedded within the this envelope instance. The value is either 0 (false) or 1 (true) and when this parameter is omitted the value defaults to 0 (false).

referenced:

Declares if all objects described in this envelope instance are referenced, none is embedded within the envelope. The value is either 0 (false) or 1 (true) and when this parameter is omitted the value defaults to 0 (false).

charset:

As specified in RFC 3023 [83] for media type application/xml.

Encoding considerations:

This is an XML document and the encoding considerations are the same as for media type "application/xml" defined in RFC 3023 [83].

Security considerations:

This media format contains information about versioning and validity of files, telling the receiver if it should invalidate already received files or replace previously received files with new version contained or referenced within this format. Thus modifying or spoofing an envelope is a simple way of making denial of service attack. Thus source authentication and integrity protection of the files are recommended.

Interoperability considerations:

None

Published specification:

3GPP TS 26.346

Applications which use this media type:

3GPP MBMS based applications

Additional information:

Magic number(s): None

File extension(s):

Macintosh file type code(s):

Person & email address to contact for further information:

Magnus Westerlund (magnus.westerlund@ericsson.com)
3GPP TSG SA WG4

Intended usage: COMMON

Restrictions on usage:

Author:

3GPP TSG SA WG4

Change controller:

3GPP TSG SA WG4

C.6 Registration of MIME type "application/mbms-protection-description+xml"

The MIME-Type "application/mbms-protection-description+xml" denotes that the message body is an MBMS Security Description XML document according to the scheme identified as "urn:3GPP:metadata:2005:MBMS:securityDescription" (see clause 11.3.1).

Type name: application

Subtype name: mbms-protection-description+xml

Required parameters:

None

Optional parameters:

charset: As specified in RFC 3023 [83] for media type application/xml.

Encoding considerations:

This is an XML document and the encoding considerations are the same as for media type "application/xml" defined in RFC 3023 [83].

Security considerations:

The media format is used to configure the security functions of the MBMS delivery. Thus, a target for any attacker that would like modify a receivers understanding of the security functions, either for a denial of service attack or a session replacement attack. However, the format contains no secret information that may not be shared openly. All security keys are handled using other mechanisms. Source authentication and integrity protection is recommended.

Interoperability considerations:

None

Published specification:

3GPP TS 26.346

Applications which use this media type:

3GPP MBMS based applications

Additional information:

Magic number(s): None

File extension(s):

Macintosh file type code(s):

Person & email address to contact for further information:

Magnus Westerlund (magnus.westerlund@ericsson.com)
3GPP TSG SA WG4

Intended usage: COMMON

Restrictions on usage:

Author:

3GPP TSG SA WG4

Change controller:

C.7 Registration of MIME type "application/mbms-associated-procedure- description+xml"

The MIME-Type "application/mbms-associated-procedure-description+xml" denotes that the message body contains the associated procedure description in XML following the schema "urn:3gpp:metadata:2005:MBMS:associatedProcedure" (see clause 9.5.1).

Type name: application

Subtype name: mbms-associated-procedure-description+xml

Required parameters:

None

Optional parameters:

charset: As specified in RFC 3023 [83] for media type application/xml.

Encoding considerations:

This is an XML document and the encoding considerations are the same as for media type "application/xml" defined in RFC 3023 [83].

Security considerations:

The information present in this media format is used to configure the receiving application. Thus the usage of the format is vulnerable to attacks modifying or spoofing the content of this format. It is recommended to use source authentication and integrity protection.

Interoperability considerations:

None

Published specification:

3GPP TS 26.346

Applications which use this media type:

3GPP MBMS based applications

Additional information:

Magic number(s): None

File extension(s):

Macintosh file type code(s):

Person & email address to contact for further information:

Magnus Westerlund (magnus.westerlund@ericsson.com)
3GPP TSG SA WG4

Intended usage: COMMON

Restrictions on usage:

Author:

3GPP TSG SA WG4

Change controller:

3GPP TSG SA WG4

C.8 Registration of MIME type "application/mbms-msk+xml"

The MIME-Type "application/mbms-msk+xml" denotes that the message body contains the MSK request parameters in accordance with the XML scheme "urn:3GPP:metadata:2005:MBMS:mskRequest" (see clause 11.6 and 3GPP TS 33.246 [20]).

Type name: application

Subtype name: application/mbms-msk+xml

Required parameters:

None

Optional parameters:

charset: As specified in RFC 3023 [83] for media type application/xml.

Encoding considerations:

This is an XML document and the encoding considerations are the same as for media type "application/xml" defined in RFC 3023 [83].

Security considerations:

The usage of the format is to identify one or more MSK that the requesting entity desires to receive. Modification or changes to this format thus only result in a denial of service attack. Integrity protection would protect against such modifications.

Interoperability considerations:

None

Published specification:

3GPP TS 26.346

Applications which use this media type:

3GPP MBMS based applications

Additional information:

Magic number(s): None

File extension(s):

Macintosh file type code(s):

Person & email address to contact for further information:

Magnus Westerlund (magnus.westerlund@ericsson.com)
3GPP TSG SA WG4

Intended usage: COMMON

Restrictions on usage:

None

Author:

3GPP TSG SA WG4

Change controller:

3GPP TSG SA WG4

C.9 Registration of MIME type "application/mbms-register+xml"

The MIME-Type "application/mbms-register+xml" denotes that the message body contains the MBMS User Service Registration parameters in accordance with the XML schema "urn:3GPP:metadata:2005:MBMS:securityRegistration" (see clause 11.4 and 3GPP TS 33.246 [20]).

Type name: application

Subtype name: mbms-register+xml

Required parameters:

None

Optional parameters:

charset: As specified in RFC 3023 [83] for media type application/xml.

Encoding considerations:

This is an XML document and the encoding considerations are the same as for media type "application/xml" defined in RFC 3023 [83].

Security considerations:

The content of this format identifies a user service that the document creator desires to register to. Any modifications of this document would allow an attacker to change to what services the creator registers to. To prevent this integrity protection is necessary. There is also necessary to authenticate the entity performing the registration to know who is the one performing the registration request. In MBMS this is accomplished using procedures described in 3GPP TS 33.246.

Interoperability considerations:

None

Published specification:

3GPP TS 26.346

Applications which use this media type:

3GPP MBMS based applications

Additional information:

Magic number(s): None

File extension(s):

Macintosh file type code(s):

Person & email address to contact for further information:

Magnus Westerlund (magnus.westerlund@ericsson.com)
3GPP TSG SA WG4

Intended usage: COMMON

Restrictions on usage:

None

Author:

3GPP TSG SA WG4

Change controller:

3GPP TSG SA WG4

C.10 Registration of MIME type "application/mbms-deregister+xml"

The MIME-Type "application/mbms-deregister+xml" denotes that the message body contains the MBMS User Service Deregistration parameters in accordance with the XML schema "urn:3GPP:metadata:2005:MBMS:securityDeregistration" (see clause 11.5 of 3GPP TS 26.346 and 3GPP TS 33.246 [20]).

Type name: application

Subtype name: mbms-deregister+xml

Required parameters:

None

Optional parameters:

charset: As specified in RFC 3023 [83] for media type application/xml.

Encoding considerations:

This is an XML document and the encoding considerations are the same as for media type "application/xml" defined in RFC 3023 [83].

Security considerations:

The content of this format identifies a user service that the document creator desires to register to. Any modifications of this document would allow an attacker to change to what services the creator registers to. To prevent this integrity protection is necessary. There is also necessary to authenticate the entity performing the registration to know who is the one performing the registration request. In MBMS this is accomplished using procedures described in 3GPP TS 33.246.

Interoperability considerations:

None

Published specification:

3GPP TS 26.346

Applications which use this media type:

3GPP MBMS based applications

Additional information:

Magic number(s): None

File extension(s):

Macintosh file type code(s):

Person & email address to contact for further information:

Magnus Westerlund (magnus.westerlund@ericsson.com)
3GPP TSG SA WG4

Intended usage: COMMON

Restrictions on usage:

None

Author:

3GPP TSG SA WG4

Change controller:

3GPP TSG SA WG4

C.11 Registration of MIME type "application/mbms-reception-report+xml"

The MIME-type registration for "application/mbms-reception-report+xml" that identifies XML documents that follows the schema "urn:3gpp:metadata:2005:MBMS:receptionreport" defined in clause 9.5.3.

Type name: application

Subtype name: mbms-reception-report+xml

Required parameters:

None

Optional parameters:

charset: As specified in RFC 3023 [83] for media type application/xml.

Encoding considerations:

This is an XML document and the encoding considerations are the same as for media type "application/xml" defined in RFC 3023 [83].

Security considerations:

The reception report XML document instances contain information about what services and files that a particular receiver has received. Thus to prevent manipulation of that information it would need to be integrity protected. The information also has privacy relevance as it reveals what a specific receiver, which usually can be connected to a specific user, has received.

Interoperability considerations:

None

Published specification:

3GPP TS 26.346

Applications which use this media type:

3GPP MBMS based applications

Additional information:

None

Person & email address to contact for further information:

Magnus Westerlund (magnus.westerlund@ericsson.com)
3GPP TSG SA WG4

Intended usage: COMMON

Restrictions on usage:

None

Author:

3GPP TSG SA WG4

Change controller:

3GPP TSG SA WG4

C.12 Registration of MIME type "application/mbms-msk-response+xml"

The MIME Media Type "application/mbms-msk-response+xml" denotes that the message body contains the response codes to MSK request procedure in accordance with the XML scheme "urn:3GPP:metadata:2005:MBMS:mskResponse" (see clause 11.8 and 3GPP TS 33.246 [20]).

Type name: application

Subtype name: mbms-msk-response+xml

Required parameters:

None

Optional parameters:

charset: As specified in RFC 3023 [83] for media type application/xml.

Encoding considerations:

This is an XML document and the encoding considerations are the same as for media type "application/xml" defined in RFC 3023 [83].

Security considerations:

The usage of the format is to identify one or more response codes of MSK requests procedures. Modification or changes to this format thus only result in a denial of service attack. Integrity protection would protect against such modifications. In MBMS this is accomplished using procedures described in 3GPP TS 33.246.

Interoperability considerations:

None

Published specification:

3GPP TS 26.346

Applications which use this media type:

3GPP MBMS based applications

Additional information:

Magic number(s): None

File extension(s):

Macintosh file type code(s):

Person & email address to contact for further information:

Magnus Westerlund (magnus.westerlund@ericsson.com)
3GPP TSG SA WG4

Intended usage: COMMON

Restrictions on usage:

None

Author:

3GPP TSG SA WG4

Change controller:

3GPP TSG SA WG4

C.13 Registration of MIME type "application/mbms-register-response+xml"

The MIME Media Type "application/mbms-register-response+xml" denotes that the message body contains the response codes to an MBMS User Service Registration or MBMS User Service De-Register procedure in accordance with the XML schema "urn:3GPP:metadata:2005:MBMS:securityRegistrationResponse" (see clause 11.7 and 3GPP TS 33.246 [20]).

Type name: application

Subtype name: mbms-register-response+xml

Required parameters:

None

Optional parameters:

charset: As specified in RFC 3023 [83] for media type application/xml.

Encoding considerations:

This is an XML document and the encoding considerations are the same as for media type "application/xml" defined in RFC 3023 [83].

Security considerations:

The usage of the format is to identify one or more response codes of registration or deregistration procedures. Modification or changes to this format thus only result in a denial of service attack. Integrity protection would protect against such modifications. In MBMS this is accomplished using procedures described in 3GPP TS 33.246.

Interoperability considerations:

None

Published specification:

3GPP TS 26.346

Applications which use this media type:

3GPP MBMS based applications

Additional information:

Magic number(s): None

File extension(s):

Macintosh file type code(s):

Person & email address to contact for further information:

Magnus Westerlund (magnus.westerlund@ericsson.com)
3GPP TSG SA WG4

Intended usage: COMMON

Restrictions on usage:

None

Author:

3GPP TSG SA WG4

Change controller:

3GPP TSG SA WG4

C.14 Registration of MIME type "application/mbms-schedule+xml"

The MIME-Type registration for "application/mbms-schedule+xml" identifies XML documents that follows the schema "urn:3gpp:metadata:2011:MBMS:scheduleDescription" defined in clause 11.2A.2.

Type name: application

Subtype name: mbms-schedule+xml

Required parameters:

None

Optional parameters:

charset: As specified in RFC 3023 [83] for media type application/xml.

Encoding considerations:

8bit.

This is an XML document and the encoding considerations are the same as for media type "application/xml" defined in RFC 3023 [83].

Security considerations:

The information present in this media format is used to configure the receiving application. Thus the usage of the format is vulnerable to attacks modifying or spoofing the content of this format. It is recommended to use source authentication and integrity protection. The information carried in the media format does not contain any private

information such as passwords or keys. The information carried in the media format does not contain executable content. Content from other namespaces may be introduced into this media type by extensions defined by 3GPP, and thus security considerations inherited from those extensions will need to be considered as new extensions are defined in future releases.

Interoperability considerations:

None

Published specification:

3GPP TS 26.346

Applications which use this media type:

3GPP MBMS based applications

Additional information:

Magic number(s): None

File extension(s):

Macintosh file type code(s):

Person & email address to contact for further information:

Eric Turcotte (Eric.Turcotte@ericsson.com)
3GPP TSG SA WG4

Intended usage: COMMON

Restrictions on usage:

None

Author:

3GPP TSG SA WG4

Change controller:

3GPP TSG SA WG4

C.15 Registration of Media Type "application/mbms-filter-description+xml"

The Media Type registration for "application/mbms-filter-description+xml" identifies XML documents that follows the schema "urn:3gpp:metadata:2011:MBMS:filterDescription" defined in clause 11.2B.

Type name: application

Subtype name: mbms-filter-description+xml

Required parameters:

None

Optional parameters:

charset: As specified in RFC 3023 [83] for media type application/xml.

Encoding considerations:

8-bit

This is an XML document and the encoding considerations are the same as for media type "application/xml" defined in RFC 3023 [83].

Security considerations:

The information present in this media format is used to configure the receiving application. Thus the usage of the format is vulnerable to attacks modifying or spoofing the content of this format. It is recommended to use source authentication and integrity protection. The information carried in the media format does not contain any private information such as passwords or keys.

Interoperability considerations:

None

Published specification:

3GPP TS 26.346

Applications which use this media type:

3GPP MBMS based applications

Additional information:

Magic number(s): None

File extension(s):

Macintosh file type code(s):

Person & email address to contact for further information:

Charles Lo (*clo@qti.qualcomm.com*)
3GPP TSG SA WG4

Intended usage: COMMON

Restrictions on usage:

None

Author:

3GPP TSG SA WG4

Change controller:

3GPP TSG SA WG4

C.16 Registration of Media Type "application/mbms-consumption-report+xml"

The Media Type registration for "application/mbms-consumption-report+xml" identifies XML documents that follows the schema "urn:3gpp:metadata:2014:MBMS:consumptionreport" defined in clause 9.5.4.

Type name: application

Subtype name: mbms-consumption-report+xml

Required parameters:

None

Optional parameters:

charset: As specified in RFC 3023 [83] for media type application/xml.

Encoding considerations:

8-bit

This is an XML document and the encoding considerations are the same as for media type "application/xml" defined in RFC 3023 [83].

Security considerations:

The information present in this media format is used to configure the receiving application. Thus the usage of the format is vulnerable to attacks modifying or spoofing the content of this format. It is recommended to use source authentication and integrity protection. The information carried in the media format does not contain any private information such as passwords or keys.

Interoperability considerations:

None

Published specification:

3GPP TS 26.346

Applications which use this media type:

3GPP MBMS based applications

Additional information:

Magic number(s): None

File extension(s):

Macintosh file type code(s):

Person & email address to contact for further information:

Charles Lo (*clo@qti.qualcomm.com*)
3GPP TSG SA WG4

Intended usage: COMMON

Restrictions on usage:

None

Author:

3GPP TSG SA WG4

Change controller:

3GPP TSG SA WG4

C.17 Registration of IPv4 multicast address as session parameter of Service Announcement service which indicates availability of ROM service

The registered IPv4 multicast address '224.0.0.120', with the allocation name "3GPP MBMS SACH" as specified in IANA's IPv4 Multicast Address Space Registry [153] and described below is used in conjunction with other pre-defined session parameters to enable the discovery and acquisition of a Service Announcement service which in turn indicates the availability of ROM service(s).

(Requester) Full Name: Charles Lo

(Requester) E-Mail: clo@qti.qualcomm.com

Globally unique: Yes

GLOP: No

RFC 6034: No

Source-specific Multicast: No

Assignment Block: Local Network Control Block

Link Local Usage: Yes

Global Usage: Yes

Network Protocol: FLUTE/UDP/IP

Message Composition:

Functions:

FLUTE protocol is used for IP multicast delivery of 3GPP MBMS services from cellular network to receiving devices.

Application:

Broadcast-specific application content is delivered as MBMS services over FLUTE from cellular network to receiving devices.

Previous requests: Yes (See NOTE below)

Period of Use: Indefinite

Specification:

3GPP Technical Specification TS 26.346, "Multimedia Broadcast/Multicast Service; Protocols and codecs", available at <https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=1452>

Number of Addresses: One

Allocation name: 3GPP MBMS SACH

Additional Information:

NOTE: Application for assignment of this IPv4 multicast address was previously submitted to IANA during Release 14 in 2017. However, that application was not completed and was closed by IANA. Considering the history and the likelihood that Release 16 or later versions of this specification would be referenced in the initial (future) commercial deployments of MBMS ROM services and associated service announcement, the new registration and assignment of IPv4 multicast address is described in this clause.

C.18 Registration of IPv6 Multicast Address as session parameter of Service Announcement service which indicates availability of ROM service

The registered IPv6 multicast address 'FF0X:0:0:0:0:0:177', with the allocation name "3GPP MBMS SACH" as specified in IANA's IPv6 Multicast Address Space Registry [154] and described below is used in conjunction with other pre-defined session parameters to enable the discovery and acquisition of a Service Announcement service which in turn indicates the availability of ROM service(s).

(Requester) Full Name: Charles Lo

(Requester) E-mail: clo@qti.qualcomm.com

Local Scope: No

Permanence: Yes

Unicast Prefix-based Multicast: No

Source-specific Multicast: No

Assignment Block: Link-Local Scope

Link Local Usage: Yes

Global Usage: Yes

Network Protocol: FLUTE/UDP/IP

Message Composition:

Functions:

FLUTE protocol is used for IP multicast delivery of 3GPP MBMS services from cellular network to receiving devices.

Application:

Broadcast-specific application content is delivered as MBMS services over FLUTE from cellular network to receiving devices.

Previous requests: Yes (See NOTE below)

Period of Use: Indefinite

Specification:

3GPP Technical Specification TS 26.346, "Multimedia Broadcast/Multicast Service; Protocols and codecs", available at
<https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=1452>

Allocation name: 3GPP MBMS SACH

Additional Information:

NOTE: Application for assignment of this IPv6 multicast address was previously submitted to IANA during Release 14 in 2017. However, that application was not completed and was closed by IANA. Considering the history and the likelihood that Release 16 or later versions of this specification would be referenced in likely initial (future) commercial deployments of MBMS ROM services and associated service announcement, the new registration of IPv6 multicast address is described in this clause.

C.19 Void

Annex D (informative): RTP packetization guidelines

This annex provides guidelines for MBMS senders to minimize initial buffering delay between starting of the reception and starting of rendering of media data in MBMS receivers.

When H.264 (AVC) video is in use, an MBMS sender should form FEC source blocks in which the first H.264 (AVC) access unit in decoding order is an IDR access unit. When H.265 (HEVC) video is in use, an MBMS sender should form FEC source blocks in which the first H.265 (HEVC) access unit in decoding order is an IRAP access unit.

MBMS senders should transmit all application data units for a given H.264 (AVC) or H.265 (HEVC) access unit, or audio frame within one FEC source block.

MBMS senders should set the min-buffer-time MIME/SDP parameter and the minimum buffering delay elements included in FEC source blocks to values that are sufficient to cover any required de-interleaving or de-packetization of application data units, such as H.264 (AVC) or H.265 (HEVC) NAL units and coded audio frames, from their transmission order to decoding order.

When RTP timestamps are converted to the wallclock time of the MBMS receiver, the smallest RTP timestamp among the FEC source packets of a FEC source block of a stream should be equal or close to the smallest RTP timestamp among the FEC source packets of a FEC source block of any other stream of the same MBMS streaming session.

When RTP timestamps are converted to the wallclock time of the MBMS receiver, the greatest RTP timestamp among the FEC source packets of a FEC source block of a stream should be equal or close to the greatest RTP timestamp among the FEC source packets of a FEC source block of any other stream of the same MBMS streaming session.

Annex E (informative): Void

Annex F (informative): Hybrid streaming delivery

F.1 Introduction

In hybrid streaming delivery scenarios it is assumed that a set of streaming services is available over MBMS, and a set of streaming services is available over PSS. MBMS services may not be available in some service areas, in which cases those services might be alternatively provided via PSS.

Different switching cases between PSS and MBMS and vice versa may occur in these scenarios, including user-initiated content switching with access change as well as application-initiated access change. The latter can occur when a service is available over MBMS in some service areas but not available over MBMS in other service areas, assuming that the service is provided over PSS as a fall-back.

This annex describes some methods to improve switching times in such hybrid streaming delivery scenarios.

F.2 Switching between MBMS and PSS access

F.2.1 Synchronization of flows

For switching between MBMS and PSS access while receiving the same service, comparing the SSRC values of the PSS and MBMS flows gives the UE an advantage for synchronization onto the flows as described in clause 8.5.

In order to allow for an as interruption-free access switch as possible, the time offset between MBMS packet reception and PSS packet reception (including MBMS FEC buffering and PSS retransmission delays) should be as small as possible.

It is advantageous (but not always possible) that the same set of codecs is used for representing the same service over both accesses. If the same media bit rates are provided over both accesses, then at best the same media flows (identical media encoding) are used for both accesses. This gives the UE an advantage of being able to continuously using decoding buffers thus simplifying seamless access switching. In case the codecs or codec level/profiles change upon access switching, the UE needs to prepare a new set of decoders and possibly having them run in parallel for a short period of time.

F.2.2 Switching from MBMS to PSS access

Switching from MBMS to PSS can happen in two cases, user-initiated content switch with access change and application-initiated access change.

- User-initiated content switch with access change: The user requests reception of a service other than the one currently received over MBMS, and the new service is only available over PSS.
- Application-initiated switch of access: The MBMS coverage is lost, and alternative reception of the same service is possible over PSS.

The latter case may occur suddenly and without warning when the available signal strength is no longer good enough for the MBMS reception. The UE may identify the loss of MBMS access by signal strength measurements, detection of packet losses exceeding a certain threshold, or that RTP reception has stopped completely. As a result, the UE may terminate the MBMS session and initiate service reception over PSS instead.

In case MBMS coverage is lost and the corresponding PSS session is requested, the UE may use PSS time-shifting (as defined in TS 26.234 [47]) for signalling a PSS play-out start corresponding to the time instant the MBMS access was lost, giving the advantage of synchronization of the received flows.

F.2.3 Switching from PSS to MBMS access

Switching from PSS to MBMS can happen in two cases, user-initiated content switch with access change and application-initiated access change.

- User-initiated content switch with access change: The user requests reception of a service other than the one currently received over PSS, and the new service is available over MBMS.
- Application-initiated switch of access: The UE recognizes that MBMS reception of that service is alternatively possible (e.g. because MBMS reception was re-gained), such that the UE may terminate the PSS session and initiate reception over MBMS.

If the UE can receive both PSS and MBMS flows at the same time, and the time offset between MBMS packet reception and PSS packet reception (including MBMS FEC buffering and PSS retransmission delays) is small, and identical media encoding is used, then application-initiated access change from PSS to MBMS without service change is possible to be made in such a way that it is seamless.

Annex G (informative): Guidelines for channel tune-in and switch time reduction

This annex describes some methods to improve channel tune-in and switching times for MBMS streaming when using the FEC framework. It presents means for MBMS senders and receivers to minimize delay from a channel switch and initial tune-in time. Fast startup improvements for the layers below IP are not described here.

G.1 Interleaving for tune-in time reduction of FEC protected MBMS Services

Interleaving may be applied to source blocks before FEC encoding to re-arrange the order of transmission of the UDP packets. The target of the interleaving is to provide high priority and correctly decodable media units in a way that maximizes the resulting media duration at the receivers that tune in at that specific source block. The interleaver may operate at two different levels:

- Inter-stream interleaving: prioritize the media streams and arrange their transmission order according to the ascending order of priorities. In other words high priority data, e.g. audio data, is transmitted towards the end of the source block.
- Intra-stream interleaving: high priority media data units such as Random Access Points of a video stream are transmitted towards the end of a source block.

The interleaving procedure enables receivers to reliably decode and present media data that has been received from a fraction of the tune-in source block.

Interleaving is transparent to legacy receivers.

G.1.1 Timestamp offsets

The timestamp offset field may be used to signal a timestamp offset for the received media units in the FEC block as specified in clause 8.2.3.2.

The timestamp offsets may be used to reconstruct the presentation timeline at the UE. They may also be used to reduce the out time caused by the reception of a partially received interleaved FEC source block as shown in figure G.1.

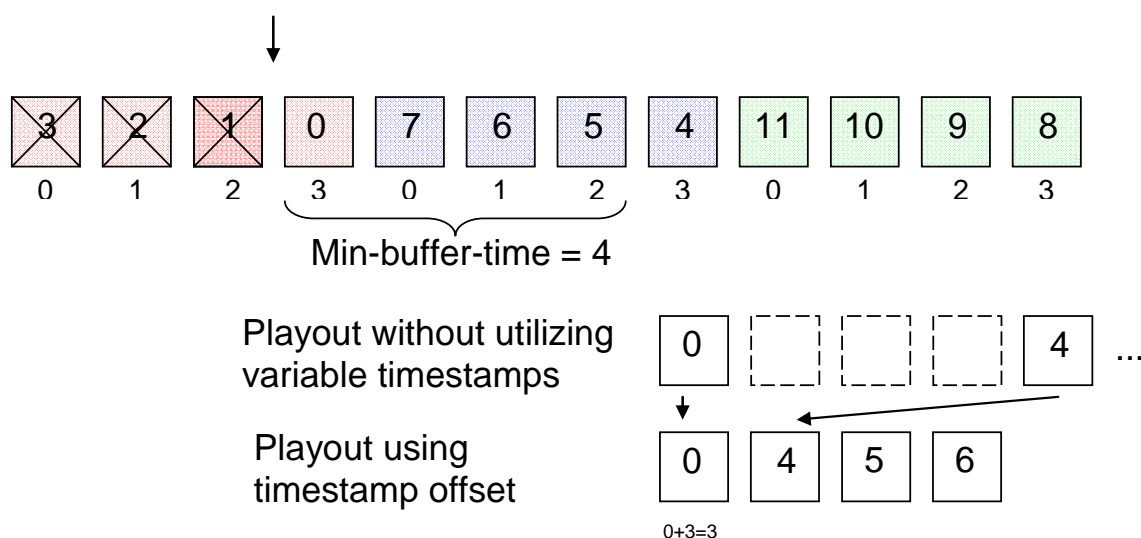


Figure G.1: Early tune-in using variable timestamps

G.1.2 Early playout

A UE that desires to make use of the interleaving to reduce the tune-in time may start the playout earlier than dictated by the min-buffer-time value.

Instead, the UE may schedule the first media unit of the succeeding source block to be played out after the min-buffer-time. It may then estimate the appropriate time for starting early playout based on the amount of media duration that was received from the current block, the playout time of the earliest media unit of the next source block, and the highest presentation time of the media units of the current source block.

The early playout behaviour is depicted by the following figure.

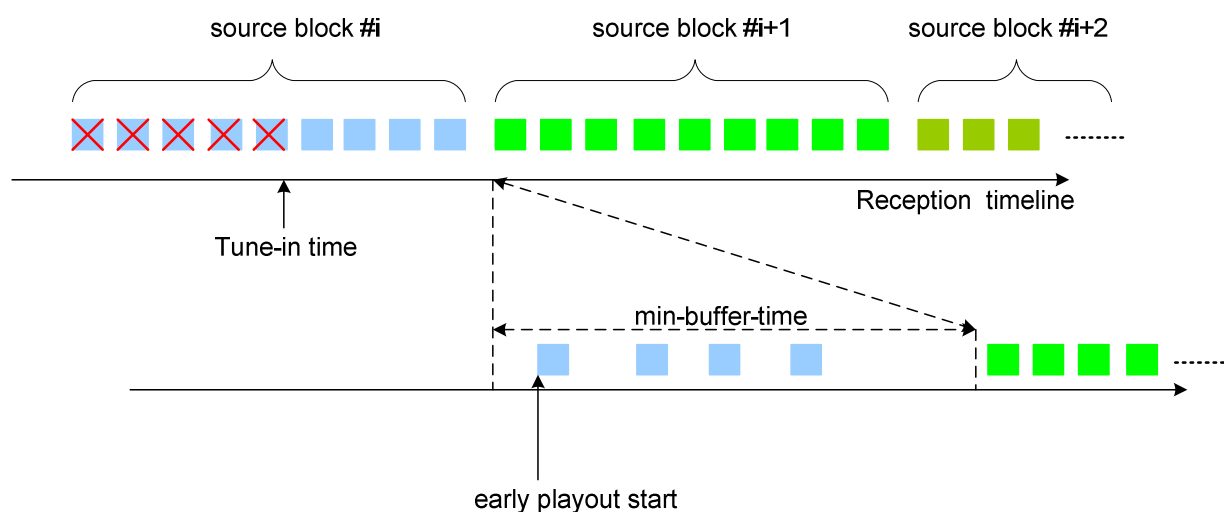


Figure G.2: Early play out of interleaved media data of a FEC protected MBMS service

G.2 FEC stream and channel bundling

G.2.1 Introduction

FEC Stream bundling is a method of improving the FEC efficiency and also to improve channel switching times. Several flows of one or more user services are "bundled" to form the source blocks for the FEC calculations. This means, that all flows must be received for potential FEC recovery.

If flows from more than one user service are bundled (i.e. channel bundling), then the receiver discards other services after FEC processing. When a switch is performed, media inside the same bundle is immediately available. Stream bundling can be performed on whole channels, parts of channels, or not at all.

NOTE: FEC Bundling does not improve start-up times.

G.2.1.1 Full channel bundling (all flows of several MBMS User Services)

When full bundling is used, more than one complete channel is bundled. A channel switch inside the bundle does not require rebuffering and can therefore be near instantaneous. However, full bundling requires the processing of all packets. In other words, at a single time instance all video streams and all audio streams are received and processed. Also, the number of channels possible is limited by the fixed bearer bandwidth.

G.2.1.2 No bundling

When no bundling is used, each channel is protected separately. In a channel switch the new channel needs to be buffered for the full min-buffer-time. At a single time instant one video stream and one audio stream is received and processed.

G.2.1.3 Partial channel bundling (some flows of several MBMS User Services)

Partial bundling may be used to combine some of the benefits of full bundling and no bundling. In this case more than one parital channel is bundled. This may be used to reduce the processing required on the terminal while retaining fast channel switching between parts of the media.

Partial bundling may be used to bundle only the audio part of channels. In other words, at a single time instance one video stream and all audio streams are received. When a switch occurs the audio is switched instantaneously as it does not need to be rebuffered. The complexity of this case is substantially lower than full bundling and the number of channels which can be bundled given a fixed bearer bandwidth is substantially increased. This is due to the fact that the audio uses a substantially lower percentage of the bitrate compared to video.

G.2.1.4 Stream bBundling (all flows of a single MBMS User Service)

When stream bundling is used, all flows of a single channel are bundled. The FEC source block is formed using audio, video and security data.

Annex H (informative):

QoE Reporting Management Object Device Description Framework

This Device Description Framework (DDF) is the standardized minimal set. A vendor can define its own DDF for the complete device. This DDF can include more features than this minimal standardized version.

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE MgmtTree PUBLIC "-//OMA//DTD-DM-DDF 1.2//EN"
"http://www.openmobilealliance.org/tech/DTD/dm_ddf-v1_2.dtd">
<MgmtTree>
  <VerDTD>1.2</VerDTD>
  <Man>--The device manufacturer--</Man>
  <Mod>--The device model--</Mod>
  <Node>
    <NodeName>3GPP_MBMSQOE</NodeName>
    <DFProperties>
      <AccessType>
        <Get/>
      </AccessType>
      <DFFormat>
        <node/>
      </DFFormat>
      <Occurrence>
        <ZeroOrOne/>
      </Occurrence>
      <Scope>
        <Permanent/>
      </Scope>
      <DFTitle>The interior node holding all 3GPP MBMS QoE Metrics Reporting objects</DFTitle>
      <DFType>
        <DDFName/>
      </DFType>
    </DFProperties>
  </Node>
  <Node>
    <NodeName>Enabled</NodeName>
    <DFProperties>
      <AccessType>
        <Get/>
      </AccessType>
      <DFFormat>
        <bool/>
      </DFFormat>
      <Occurrence>
        <One/>
      </Occurrence>
      <Scope>
        <Permanent/>
      </Scope>
      <DFTitle>The QoE reporting requested indicator</DFTitle>
      <DFType>
        <DDFName/>
      </DFType>
    </DFProperties>
  </Node>
  <Node>
    <NodeName>APN</NodeName>
    <DFProperties>
      <AccessType>
        <Get/>
      </AccessType>
      <DFFormat>
        <chr/>
      </DFFormat>
      <Occurrence>
        <ZeroOrOne/>
      </Occurrence>
      <DFTitle>The Access Point Name for QoE reporting</DFTitle>
      <DFType>
        <DDFName/>
      </DFType>
    </DFProperties>
  </Node>
</MgmtTree>
```

```
<Node>
  <NodeName>Format</NodeName>
  <DFProperties>
    <AccessType>
      <Get/>
    </AccessType>
    <DFFormat>
      <chr/>
    </DFFormat>
    <Occurrence>
      <ZeroOrOne/>
    </Occurrence>
    <DFTitle>The QoE metrics report format</DFTitle>
    <DFType>
      <DDFName/>
    </DFType>
  </DFProperties>
</Node>
<Node>
  <NodeName>Rules</NodeName>
  <DFProperties>
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      <Get/>
    </AccessType>
    <DFFormat>
      <chr/>
    </DFFormat>
    <Occurrence>
      <One/>
    </Occurrence>
    <DFTitle>The QoE metrics rules</DFTitle>
    <DFType>
      <DDFName/>
    </DFType>
  </DFProperties>
</Node>
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  <NodeName>Session</NodeName>
  <DFProperties>
    <AccessType>
      <Get/>
    </AccessType>
    <DFFormat>
      <node/>
    </DFFormat>
    <Occurrence>
      <ZeroOrOne/>
    </Occurrence>
    <DFTitle>The QoE session metrics node</DFTitle>
    <DFType>
      <DDFName/>
    </DFType>
  </DFProperties>
  <Node>
    <NodeName>Metrics</NodeName>
    <DFProperties>
      <AccessType>
        <Get/>
      </AccessType>
      <DFFormat>
        <chr/>
      </DFFormat>
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        <ZeroOrOne/>
      </Occurrence>
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        <DDFName/>
      </DFType>
    </DFProperties>
  </Node>
  <Node>
    <NodeName>Ext</NodeName>
    <DFProperties>
      <AccessType>
        <Get/>
      </AccessType>
      <DFFormat>
        <node/>
      </DFFormat>
    </DFProperties>
  </Node>
</Node>
```

```

        </DFFormat>
        <Occurrence>
        <ZeroOrOne/>
        </Occurrence>
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        <Permanent/>
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        <DFTitle> A collection of all extension objects</DFTitle>
        <DFType>
        <DDFName/>
        </DFType>
    </DFProperties>
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    <NodeName>Speech</NodeName>
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    </DFFormat>
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    </DFType>
    </DFProperties>
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    <NodeName>Metrics</NodeName>
    <DFProperties>
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```

```

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</DFType>
</DFProperties>
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  </DFFormat>
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  </DFType>
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  </AccessType>
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  </DFFormat>
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    <ZeroOrOne/>
  </Occurrence>
  <Scope>
    <Permanent/>
  </Scope>
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  </DFType>
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  <NodeName>Text</NodeName>
  <DFProperties>
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    </AccessType>
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      <node/>
    </DFFormat>
    <Occurrence>
      <ZeroOrOne/>
    </Occurrence>
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    <Get/>
  </AccessType>
  <DFFormat>
    <chr/>
  </DFFormat>
  <Occurrence>
    <ZeroOrOne/>
  </Occurrence>
  <DFType>

```

```
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  <DFProperties>
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    </DFFormat>
    <Occurrence>
      <ZeroOrOne/>
    </Occurrence>
    <Scope>
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    </DFType>
  </DFProperties>
</Node>
</Node>
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  <NodeName>Ext</NodeName>
  <DFProperties>
    <AccessType>
      <Get/>
    </AccessType>
    <DFFormat>
      <node/>
    </DFFormat>
    <Occurrence>
      <ZeroOrOne/>
    </Occurrence>
    <Scope>
      <Permanent/>
    </Scope>
    <DFTitle>A collection of all extension objects</DFTitle>
    <DFType>
      <DDFName/>
    </DFType>
  </DFProperties>
</Node>
</Node>
</MgmtTree>
```

Annex I (informative):
Void

Annex J (normative): Schemas

J.1 Extended User Service Bundle Description schema

This clause specifies the extended User Service Bundle Description schema according to the current release. In addition to the baseline User Service Bundle Description syntax specified in clause 11.2.1.1 and the extensions to this syntax specified in clause 11.2.1.2, additional provisions are specified in this clause to ensure backward and forward compatibility of compliant XML instance documents.

In this version of the present document the network shall set the content of the *schemaVersion* element, defined as a child element of the *bundleDescription* element, to the value 7.

The schema *version* attribute (part of the schema instruction) shall be included in the UE schema and the network schema.

NOTE 1: The value of the *schemaVersion* element and *version* attribute is intended to be increased by 1 in every future release where new element(s) or attribute(s) are added.

When an MBMS Client receives a User Service Bundle Description metadata fragment compliant with this schema, it shall determine the User Service Bundle Description schema version required to parse the metadata fragment as follows:

- If the MBMS Client supports one or more versions of the User Service Bundle Description schema with the *schema version* attribute, then the UE shall use the USD schema that has the highest *schema version* attribute value that is equal to or less than the value in the received *schemaVersion* element;
- Otherwise, if the MBMS Client supports a USD schema without a *schema version* attribute, or all of its User Service Bundle Description schemas with the *schema version* attribute have a value greater than the value received in the *schemaVersion* element, then the UE shall use its User Service Bundle Description schema without a *version* attribute.

NOTE 2: To avoid a schema validation error (Unique Particle Attribution rule) if an optional element from another namespace is specified just prior to the *xs:any namespace="##other"* instructions (three occurrences in the USD schema), a *schemaVersion* element is defined as the last child of the root element (*bundleDescription* element), and a *delimiter* element is specified preceding the two other occurrences of *xs:any* instructions. These two elements are defined in clause J.2, and the schema file name is "schema-version.xsd".

Release 12 USD extension schema may be extended in a future release of the present document. The version of the Release 12 User Service Bundle Description extension (as identified by the version attribute in the Rel-12 extension schema; see listing 11.2.1.2-4) that shall be selected by the UE depends on the main User Service Bundle Description schema version (as identified by the version attribute in the main User Service Bundle Description schema) selected by the MBMS Client according to the requirements above. The following table shows which version of the Release 12 User Service Bundle Description extension schema is to be used depending on which version of the main User Service Bundle Description schema version is selected at the MBMS Client.

The Release 14 User Service Bundle Description extension schema may also be extended in a future release of the present document. The version of the Release 14 User Service Bundle Description extension (as identified by the version attribute in the Rel-14 extension schema; see listing 11.2.1.2-5) that shall be selected by the MBMS Client depends on the main User Service Bundle Description schema version (as identified by the version attribute in the main User Service Bundle Description schema) selected by the MBMS Client according to the requirements above. The following table shows which version of the Release 14 User Service Bundle Description extension schema is to be used depending on which version of the main User Service Bundle Description schema version is selected at the MBMS Client.

Table J.1-1: Release 12 and Release 14 User Service Bundle Description extension schema version selection

Main USD Schema version selected	Release 12 USD Extension schema version	Release 14 USD Extension schema version
1	Not applicable	Not applicable
2	1	Not applicable
3	1	1
4	1	1
5	1	1

The Release 15 User Service Bundle Description extension schema may be extended in a future release of the present document. The version of the Release 15 User Service Bundle Description extension (as identified by the version attribute in the Rel-15 extension schema; see listing 11.2.1.2-6) that shall be selected by the MBMS Client depends on the main User Service Bundle Description schema version (as identified by the version attribute in the main User Service Bundle Description schema) selected by the UE according to the requirements above. The following table shows which version of the Release 15 User Service Bundle Description extension schema is to be used depending on which version of the main User Service Bundle Description schema version is selected at the MBMS Client.

Table J.1-1a: Release 15 User Service Bundle Description extension schema version selection

Main USD Schema version selected	Release 15 USD Extension schema version
3	Not applicable
4	3
5	3

The Release 16 User Service Bundle Description extension schema may be extended in a future release of the present document. The version of the Release 16 User Service Bundle Description extension (as identified by the version attribute in the Rel-16 extension schema; see listing 11.2.1.2-7) that shall be selected by the MBMS Client depends on the main User Service Bundle Description schema version (as identified by the version attribute in the main User Service Bundle Description schema) selected by the MBMS Client according to the requirements above. The following table shows which version of the Release 16 User Service Bundle Description extension schema is to be used depending on which version of the main User Service Bundle Description schema version is selected at the MBMS Client.

Table J.1-1b: Release 16 User Service Bundle Description extension schema version selection

Main USD Schema version selected	Release 16 USD Extension schema version
4	Not applicable
5	4
6	4

The extended User Service Bundle Description schema is specified in listing J.1-1 below. The filename of this schema is "TS26346_UserServiceBundleDescription.xsd".

Listing J.1-1: Extended User Service Bundle Description schema

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:3GPP:metadata:2005:MBMS:userServiceDescription" version="7"
  xmlns="urn:3GPP:metadata:2005:MBMS:userServiceDescription"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  xmlns:r7="urn:3GPP:metadata:2007:MBMS:userServiceDescription"
  xmlns:r8="urn:3GPP:metadata:2008:MBMS:userServiceDescription"
  xmlns:r9="urn:3GPP:metadata:2009:MBMS:userServiceDescription"
  xmlns:r12="urn:3GPP:metadata:2013:MBMS:userServiceDescription"
  xmlns:r14="urn:3GPP:metadata:2017:MBMS:userServiceDescription"
  xmlns:r15="urn:3GPP:metadata:2018:r15:MBMS:userServiceDescription"
  xmlns:r16="urn:3GPP:metadata:2020:MBMS:userServiceDescription"
  xmlns:sv="urn:3gpp:metadata:2009:MBMS:schemaVersion"
  elementFormDefault="qualified">
  <xs:annotation>
    <xs:documentation>Extended MBMS User Service Bundle Description schema</xs:documentation>
    <xs:documentation>3GPP TS 26.346 clause J.1</xs:documentation>
  </xs:annotation>
```



```

    <xs:documentation>Copyright © 2020, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI,
    TSDSI, TTA, TTC). All rights reserved.</xs:documentation>
  </xs:annotation>

  <xs:import namespace="urn:3GPP:metadata:2007:MBMS:userServiceDescription"
    schemaLocation="TS26346_UserServiceBundleDescription_Extensions_Rel-7.xsd"/>
  <xs:import namespace="urn:3GPP:metadata:2008:MBMS:userServiceDescription"
    schemaLocation="TS26346_UserServiceBundleDescription_Extensions_Rel-8.xsd"/>
  <xs:import namespace="urn:3GPP:metadata:2009:MBMS:userServiceDescription"
    schemaLocation="TS26346_UserServiceBundleDescription_Extensions_Rel-9.xsd"/>
  <xs:import namespace="urn:3GPP:metadata:2013:MBMS:userServiceDescription"
    schemaLocation="TS26346_UserServiceBundleDescription_Extensions_Rel-12.xsd"/>
  <xs:import namespace="urn:3GPP:metadata:2017:MBMS:userServiceDescription"
    schemaLocation="TS26346_UserServiceBundleDescription_Extensions_Rel-14.xsd"/>
  <xs:import namespace="urn:3GPP:metadata:2018:r15:MBMS:userServiceDescription"
    schemaLocation="TS26346_UserServiceBundleDescription_Extensions_Rel-15.xsd"/>
  <xs:import namespace="urn:3GPP:metadata:2020:MBMS:userServiceDescription"
    schemaLocation="TS26346_UserServiceBundleDescription_Extensions_Rel-16.xsd"/>
  <xs:import namespace="urn:3gpp:metadata:2009:MBMS:schemaVersion"
    schemaLocation="TS26346_SchemaVersion.xsd"/>

  <xs:element name="bundleDescription" type="bundleDescriptionType"/>
  <xs:complexType name="bundleDescriptionType">
    <xs:sequence>
      <xs:element name="userServiceDescription" type="userServiceDescriptionType"
        maxOccurs="unbounded"/>
      <xs:element ref="r7:initiationRandomization" minOccurs="0"/>
      <xs:element ref="r7:terminationRandomization" minOccurs="0"/>
      <xs:element ref="sv:schemaVersion"/>
      <xs:any namespace="##other" processContents="lax" minOccurs="0"
        maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:attribute name="fecDescriptionURI" type="xs:anyURI" use="optional"/>
    <xs:anyAttribute processContents="skip"/>
  </xs:complexType>

  <xs:complexType name="userServiceDescriptionType">
    <xs:sequence>
      <xs:element name="name" type="nameType" minOccurs="0" maxOccurs="unbounded"/>
      <xs:element name="serviceLanguage" type="xs:language" minOccurs="0"
        maxOccurs="unbounded"/>
      <xs:element name="requiredCapabilities" type="requirementsType" minOccurs="0"/>
      <xs:element name="deliveryMethod" type="deliveryMethodType" maxOccurs="unbounded"/>
      <xs:element name="accessGroup" type="accessGroupType" minOccurs="0"
        maxOccurs="unbounded"/>
      <xs:element ref="r7:serviceGroup" minOccurs="0"/>
      <xs:element ref="r7:initiationRandomization" minOccurs="0"/>
      <xs:element ref="r7:terminationRandomization" minOccurs="0"/>
      <xs:element ref="r8:Registration" minOccurs="0"/>
      <xs:element ref="r9:mediaPresentationDescription" minOccurs="0"/>
      <xs:element ref="r9:schedule" minOccurs="0"/>
      <xs:element ref="r9:availabilityInfo" minOccurs="0"/>
      <xs:element ref="sv:delimiter"/>
      <xs:element ref="r12:appService" minOccurs="0"/>
      <xs:element ref="r12:KeepUpdatedService" minOccurs="0"/>
      <xs:element ref="r12:moodConfiguration" minOccurs="0" maxOccurs="1"/>
      <xs:element ref="r12:consumptionReporting" minOccurs="0" maxOccurs="1"/>
      <xs:element ref="sv:delimiter"/>
      <xs:element ref="r15:ROMSvcRfParams" minOccurs="0"/>
      <xs:element ref="sv:delimiter"/>
      <xs:element ref="r16:ROMSvcRfParams" minOccurs="0"/>
      <xs:element ref="sv:delimiter"/>
      <xs:any namespace="##other" processContents="lax" minOccurs="0"
        maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:attribute name="serviceId" type="xs:anyURI" use="required"/>
    <xs:attribute ref="r7:serviceClass"/>
    <xs:attribute ref="r14:romService" use="optional"/>
    <xs:anyAttribute processContents="skip"/>
  </xs:complexType>

  <xs:complexType name="accessGroupType">
    <xs:sequence>
      <xs:element name="accessBearer" type="xs:string" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:attribute name="id" type="accessGroupIdType" use="required"/>
  </xs:complexType>

```

```

<xs:complexType name="deliveryMethodType">
  <xs:sequence>
    <xs:element ref="r7:unicastAccessURI" minOccurs="0" maxOccurs="unbounded"/>
    <xs:element ref="r8:alternativeAccessDelivery" minOccurs="0"/>
    <xs:element ref="sv:delimiter"/>
    <xs:element ref="r12:broadcastAppService" minOccurs="0" maxOccurs="unbounded"/>
    <xs:element ref="r12:unicastAppService" minOccurs="0"/>
    <xs:element ref="r12:appComponent" minOccurs="0" maxOccurs="unbounded"/>
    <xs:element ref="r12:serviceArea" minOccurs="0" maxOccurs="unbounded"/>
    <xs:element ref="sv:delimiter"/>
    <xs:element ref="r15:supplementaryUnicastAppService" minOccurs="0"
maxOccurs="unbounded"/>
    <xs:element ref="sv:delimiter"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0"
maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:attribute name="accessGroupId" type="accessGroupIdType" use="optional"/>
  <xs:attribute name="associatedProcedureDescriptionURI" type="xs:anyURI" use="optional"/>
  <xs:attribute name="protectionDescriptionURI" type="xs:anyURI" use="optional"/>
  <xs:attribute name="sessionDescriptionURI" type="xs:anyURI" use="required"/>
  <xs:attribute name="accessPointName" type="xs:anyURI" use="optional"/>
  <xs:attribute name="group" type="xs:unsignedByte" use="optional"/>
  <xs:attribute name="PLMN" type="xs:string" use="optional"/>
  <xs:attribute name="p-serviceArea" type="p-serviceAreaType" use="optional"/>
  <xs:attribute ref="r12:inbandMetadata"/>
  <xs:anyAttribute processContents="skip"/>
</xs:complexType>

<xs:simpleType name="p-serviceAreaType">
  <xs:list itemType="xs:unsignedShort"/>
</xs:simpleType>

<xs:complexType name="nameType">
  <xs:simpleContent>
    <xs:extension base="xs:string">
      <xs:attribute name="lang" type="xs:language" use="optional"/>
    </xs:extension>
  </xs:simpleContent>
</xs:complexType>

<xs:simpleType name="accessGroupIdType">
  <xs:restriction base="xs:nonNegativeInteger"/>
</xs:simpleType>

<xs:complexType name="requirementsType">
  <xs:sequence>
    <xs:element name="feature" type="xs:unsignedInt" maxOccurs="unbounded"/>
  </xs:sequence>
</xs:complexType>
</xs:schema>

```

J.2 Version and Delimiter schema

This clause specifies the schema that is needed for the UE and the network side for forward and backward compatibility, and is used by the following schemas:

- Extended User Service Bundle Description (see clause J.1).
- Extended Schedule Description (see clause 11.2A.2.1).
- Extended Filter Description (see clause 11.2B.4).
- Extended File Delivery Table (see clause 7.2.10.1).

The schema defines two elements, *schemaVersion* and *delimiter*:

- The value of the *schemaVersion* is specified separately for each of the schemas above.

The *delimiter* element is specified in the various main schemas above to avoid schema validation errors due to the Unique Particle Attribution rule. The content of the *delimiter* element shall be set by the network to a value of 0, and the element content shall be ignored by the UE.

The filename used for this schema is "TS26346_SchemaVersion.xsd", and is used in the various schemas above for the "import" instruction.

Listing J.2-1: Version and Delimiter schema definition

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:3gpp:metadata:2009:MBMS:schemaVersion"
  xmlns="urn:3gpp:metadata:2009:MBMS:schemaVersion"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  elementFormDefault="qualified">
  <xs:annotation>
    <xs:documentation>MBMS Version and Delimiter schema</xs:documentation>
    <xs:documentation>3GPP TS 26.346 clause J.2</xs:documentation>
    <xs:documentation>Copyright © 2009, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI,
TSDSI, TTA, TTC). All rights reserved.</xs:documentation>
  </xs:annotation>

  <xs:element name="schemaVersion" type="xs:unsignedInt"/>
  <xs:element name="delimiter" type="xs:byte"/>
</xs:schema>
```

Annex K (informative): Guidelines for linear audio/video streaming using DASH over MBMS broadcast

K.1 Introduction

This Annex provides informative guidelines for the provision of linear audio and audio/video streaming using DASH over MBMS broadcast with broadcast-only distribution. Linear audio and audio/video services refer to audio and audio/video services where the viewer is expected to watch a scheduled program at a particular time it's offered, and on the particular channel it's presented on. These are for example continuous traditional TV and radio services or pay-per-view scheduled live services like, for example, Premier League football matches or Formula One races.

K.2 Guidelines

K.2.1 General

This clause provides service announcement, content authoring and distribution guidelines for services as described in clause X.1 using DASH over MBMS. These guidelines do not replace the general MBMS UE capabilities specified in the present specification. However, the guidelines can describe services requiring MBMS UEs to support certain typical capabilities that are not necessarily mandatory.

K.2.2 Content authoring

K.2.2.1 General

The content is encoded or transcoded according to a 3GP-DASH profile using the MBMS codecs (see clause 10). The encoder in particular ensures that the client has enough data for a continuous playout.

K.2.2.2 Media coding

High Definition video at 720p@30fps and Standard Definition at 480p@30fps are supported with H.264 (AVC) Progressive High Profile Level 3.1, if a video component is present. Audio is supported at 32kbps or higher with Enhanced aacPlus (HE-AAC v2) (see clause 10.3).

According to TR 26.906 [115], the observed minimum bit rate to achieve MOS (Mean Opinion Score)=3.5 ("Good Quality") varies with the device type e.g. tablets or smartphone, the resolution, the display size, the encoder, and the content.

The audio bitrates and recommended codec depending on content are depicted in clause 10.3.

In case subtitles (a.k.a. Closed Caption) are provided, the use of Timed Text format as specified in TS 26.245 [72] carried with the video segments is defined.

K.2.2.3 DASH formatting

The encoded bitstreams are segmented and packaged according to the 3GP-DASH specification TS 26.247 [98] according to a 3GP-DASH profile. In addition, the constraints of MPEG DASH [116] ISO BMFF live profile apply. This includes, but is not limited to:

- The Segment Template is used for URL addressing of segments.
- Each segment starts with a stream access point of type 1 or 2.

- Certain tools such as Subsets, Segment lists and so on are not used.

The duration of the media data in the segments (segment duration) is typically constant signalled by the @duration attribute. The maximum tolerance of segment duration does not typically exceed $\pm 50\%$ and the maximum accumulated deviation over multiple segments is $\pm 50\%$ of the signaled segment duration. Such fluctuations in actual segment duration may be caused by for example ad replacement or specific IDR frame placement. Note that the last segment in a Period may be shorter.

For video, the signalling of width, height and frame rate are added.

For audio, the signalling of the language is added.

For subtitles, the signalling of the role of the subtitles is to be added. In addition, the signalling of the language is to be added if different than the language of the audio.

For providing a linear media streaming service based on DASH the following parameter settings are suitable:

- **MPD@type** is set to dynamic
- **MPD@availabilityStartTime** is set to any suitable value that expresses the start time of the Media Presentation such that segment availabilities can be computed.
- **MPD@minimumUpdatePeriod** is expected to be present. If the **MPD@minimumUpdatePeriod** is provided, i.e. the exact end time of the Media Presentation is unknown. Setting the value of the minimum update period primarily affects two main service provider aspects: A short minimum update period results in the ability to change and announce new content in the MPD on shorter notice. However, by offering the MPD with a small minimum update period, the client requests an update of the MPD more frequently. However, a small value does not mean that the MPD does have to be updated, it just defines the request interval of the DASH client. Therefore, in DASH over MBMS, the **MPD@minimumUpdatePeriod** may most suitably be set to be as small as 0 and in this case MPDs can be updated basically instantaneously. Note that the value 0 implies that all segments with availability start time less than or equal to the request time of the MPD are available at the location advertised in the MPD and no Segments-URLs can be deduced and declared valid for any segment with availability start time larger than the request time of the MPD. This means for extending the list of Segments, a DASH client is expected to revalidate the MPD with the request of every new Segment.
- Segment Duration (SDURATION)
 - The segment duration typically influences the end-to-end latency, but also the switching and random access granularity as in DASH-264/AVC each segment starts with a stream access point which can also be used as switch point. In DASH over MBMS, i.e. no use of dynamic bitrate adaptivity, switching is of less relevance. The service provider sets the value taking into account at least the following:
 - the desired end-to-end latency
 - the desired compression efficiency
 - the start-up latency
 - the desired switching granularity, if content is for example offered also for unicast distribution
 - the desired amount of HTTP requests per second
 - the variability of the expected network conditions
 - Reasonable values for segment durations are between 1 second and 10 seconds.
 - More considerations in the context of DASH over MBMS are considered in clause X.2.5
- **MPD@minBufferTime** (MBT) and **Representation@bandwidth** (BW)
 - the value of the minimum buffer time does not provide any instructions to the client on how much media data to buffer. The value describes how much buffer a client would have under *ideal* network conditions. As such, MBT is not describing the burstiness or jitter in the network, it is describing the burstiness or jitter in the **content encoding**. Together with the BW value, it is a property of the content. Using the "leaky bucket" model, it is the size of the bucket that makes BW true, given the way the content is encoded. The minimum buffer time provides information that for each Stream Access Point (and in the typical case that each Media

Segment starts with a SAP, this holds for the start of the each Media Segment), the property of the stream: If the Representation (starting at any segment) is delivered over a constant bitrate channel with bitrate equal to value of the BW attribute then each segment with presentation time PT is available at the client latest at time with a delay of at most $PT + MBT$. The MBT typically may for example be set to the coded video sequence size of the content.

- **MPD@timeShiftBufferDepth** (TSB):

- If the content is to be consumed at the live edge, then the time shift buffer depth is set short. However, it is recommended that the TSB is not smaller than the recommended value of $4 \times \text{SDURATION}$ and 6 seconds in media time in order for the client to do some pre-buffering in more difficult network conditions.

NOTE: The shorter the timeShiftBufferDepth the better the time synchronization between client and segmenter.

- No restrictions on the accessibility of the content are provided, then the TSB may be set to a large value that even exceeds the media presentation duration. However, the TSB cannot exceed the capabilities of the client.
 - When joining, the MBMS Client may change this value in the MPD before forwarding it to the application to avoid that the client requests data, which is not yet received.
- **MPD@suggestedPresentationDelay** (SPD):
- If synchronized play-out with other devices adhering to the same rule is desired and/or the service providers wants to define the typical live edge of the program, then this value is provided. The service provider sets the value taking into account at least the following:
 - the desired end-to-end latency;
 - the typical required buffering in the client, for example based on the network condition;
 - the segment duration **SDURATION**;
 - the time shift buffer depth **TSB**.
 - In general ,reasonable value may be 2 to 4 times of the segment duration **SDURATION**, but it is recommended as a guideline that the time is not smaller than 4 seconds in order for the client to enable building sufficient buffer. However, for DASH over MBMS the value may be smaller as delivery guarantees minimize the jitter.

K.2.3 User Service Description (USD) and Media Presentation Description (MPD)

As a guideline, the User Service Description is usually constructed such that it contains

- At least one download delivery method. i.e. a deliveryMethod element is included in the userServiceDescription element, with a reference to an SDP indicating FLUTE;
- No streaming delivery method;
- Possibly additional download delivery methods to carry associated files;
- A reference to one Media Presentation Description fragment. That Media Presentation Description describes all transported video representations and audio representations. Note, the UE may receive MPD updates in-band with the file delivery session instance.
 - Note that only a single quality representation is made available for each content component as Adaptive Bitrate streaming is not used.
 - The MPD@type element contains the value "dynamic".
- No File Repair definition in the Associated Delivery Procedure (ADP) description;
- Possibly a Reception Reporting ADP to collect QoE (Quality of Experience) statistics from MBMS or DASH clients; Note, ADP for reception reporting may also be provided in-band with the file delivery session instance;

- Possibly a Security Description if the service requires a registration;
- The FEC scheme is described in-band with FLUTE File delivery;
- A Schedule Description when the delivery session instance is not always present; Note, the UE may receive schedule fragment updates in band within the file delivery session instance.

Additional application specific metadata may be provided together with the transport control metadata or out of band.

NOTE: The MPD is typically provided before the reception starts together with the other service description fragments. When the content of the MPD changes the updated MPD is delivered during the session in-band with the media segments on the same download delivery session. The MBMS Client keeps the latest MPD until an updated MPD is received so that the DASH player can fetch the MPD locally. It is assumed that these updates occur seldom, for instance once the session end time becomes known.

In the absence of receptions of A and B flags, the end of transmission of an object is the expires time for the latest FDT describing the object. Objects are to be described on an FDT instance with the Expires attribute indicating a time short after (e.g. 1 or 2sec) the expected transmission of the last packet for that object.

Furthermore, the client ensures that:

- media is delivered and available on time at the receiver in order for the DASH client to schedule the playout;
- it does not have to process the MPD for regular operation of the service, or at least no modifications of the MPD are necessary in order to properly operate the service.

K.2.4 Transport

The MBMS bearer is dimensioned such that it accommodates the aggregated 3GP-DASH representations bitrate for all content at any times, including header and FEC overhead.

The encoder is set such that in particular it ensures that the clients have enough data such that they are able to perform a continuous playout.

A single FLUTE Delivery Session is used. In case the linear stream is composed by multiple media components such as several audio track, timed text or video, the encoder can multiplex all components into a single media segment (using individual tracks) or generate a separate segments sequence for each component. In the latter case, all media components are carried as individual files within the same FLUTE Delivery Session.

In some cases, metadata fragments such as MPD updates, Schedule Fragment updates or Associated Delivery Procedure Description Fragments may be delivered in-band with the DASH segments on the same FLUTE delivery session.

The FEC overhead is typically adjusted to the radio conditions and the used radio configurations of the MBMS area such as to achieve a satisfactory quality of experience. Audible and visible impairments are then seldom. The target video and audio MTBF (Mean Time Between Failure) is usually set by the operator depending on the type of service.

NOTE: ITU-T G.1080 recommends ≤ 1 error event per hour for SDTV and ≤ 1 error event per 4 hours for HDTV.

K.2.5 Minimizing tune-in times, switching times and presentation delay

The presentation time end-to-end delay as well as start-up and switching times of a linear audio/video service are key factors impacting quality of experience of the users.

The choice of segment duration depends on the particular application.

- The segment duration constrains the tune-in time since the FLUTE receiver needs to buffer the segment to be able to perform FEC decoding. So one SAP at the beginning of the segment is enough.
- The segment duration constrains the end-to-end delay.

- The segment duration affects the robustness of the stream. The larger the segment durations (with multiplexed media components) the better the transport efficiency is.
- The segment duration affects the user experience on a segment loss. The larger the segment duration is the larger the disruption is. Clients can make use of partial segment data when possible to reduce the perceptual impacts.

Therefore, if the application is linear TV over an area where robustness for large coverage area is key and end-to-end delay a secondary objective, a large segment size of e.g. 10s with FEC is appropriate. In that case tune-in times can be improved with adding several SAP per segments. If the application requires a low end-to-end delay in an area where efficiency is a secondary objective, then segment durations in the order of 1s are appropriate. In DASH unicast the DASH player requests the segments depending on their availability start time which describes the time at which the segment are supposed to be available on the server for download.

In MBMS, the Media Presentation Description (MPD) indicates an AST that describes the earliest time at which the segment are supposed to be available at the DASH client (on the UE). This value needs to be set and adjusted by the system according to a worst case delay to reach some level of confidence that all MBMS Clients in all broadcast areas will receive the segments on time. The processing delay (e.g. due to FEC recovery) depends on the UE platform and implementation. It will therefore happen for several clients that the transmission delay is actually shorter. It is then possible for the DASH client to evaluate this actual segment availability time on the UE and adjust accordingly when it fetches the segments from the FLUTE receiver to minimize delay.

The client may adjust the segment availability start time by modifying the **MPD@availabilityStartTime** in the MPD prior to forwarding the MPD to the DASH client. However, for seamless operations such modifications are expected to be done consistently for any MPD updates i.e. adjusted by the same value.

As implementation guidelines, the client can optimize switching between video streams by enabling simultaneous reception of two video streams. In that case the device has to support at minimum decoding and rendering of two H.264 high profile streams, with each streams bit rate of 1.5 Mb/s, frame rate of 30 fps, and resolution of 720p (1280×720). Also, the device provides sufficient buffer to store at least 5 minutes of streaming video for 2 video streams at 1.5 Mbps per stream and has at least 1 GByte memory to support concurrent multicast services

K.2.6 Robust DASH service offering

K.2.6.1 Introduction

When operating DASH-based live services, errors and failures are typically unavoidable. In order to still provide continuous services, DASH-based service offerings should be offered in a robust manner and DASH client should implement measures to compensate any operational issues. In case of DASH-over-MBMS distribution, additional problems may occur due to segment losses or other problems. This section discusses typical problems and provides recommendations for robust service offerings. In general, DASH clients should implement the error handling technologies as defined in clause A.7 of TS 26.247 [98].

K.2.6.2 Client–server synchronization issues

In order to access the DASH segments at the proper time as announced by the segment availability times in the MPD, client and server need to operate in the same time source, in general a globally accurate wall-clock. There are different reasons why the DASH client and the media generation source may not have identical time source, such as

- DASH client is off because it does not have any protocol access to accurate timing.
- DASH client clock drifts against the system clock and the DASH client is not synchronizing frequently enough against the time-source.
- The DASH segmenter is synchronized against a different time source than DASH client.

In order to avoid synchronization issues the following recommendations are provided:

- The segment availability times announced in the MPD should be generated from a device that is synchronized to a globally accurate timing source.
- The MPD should contain at least one **UTCTiming** element: as defined in TS 26.247 [98].

K.2.6.3 Synchronization loss of segmenter

The DASH segmenter may lose synchronization against the input timeline for reasons such as power-outage, cord cuts, CRC losses in the incoming signals, etc. In this case:

- Loss of synchronization may result that the amount of lost media data cannot be predicted which makes the generation of continuous segments difficult.
- The DASH segmenter cannot predict and correct the segment timeline based on media presentation timestamps, since the presentation timeline may contain a discontinuity due to the synchronization loss
- There are cases where no media segments are available, but the MPD author knows this and just wants to communicate this to the receiver.

In order to address synchronization loss issues at the DASH segmenter, the following options from should be considered with preference according to the order below:

- The server should always offer a conforming media stream. In case the input stream or encoder is lost, the content author may add dummy content. This may be done using a separate Period structure and is possible without any modifications of the standard.
- Early terminated Periods as defined in clause 8.4.2 of TS 26.247 [98] may be used. This expresses that for this Period no more media is present and the client should await a new Period to restart. Such Periods should only be used if the Media Presentation author is experiencing issues in generating media, e.g. due to failures of a live feed. The MPD is updated using the @minimumUpdatePeriod, i.e. the timeline is progressing. This permits the DASH segmenter to signal that there is an outage of media generation, but that the service is continuing. It is then up to the client to take appropriate actions, e.g. stall the content, but provide indication to the user that the service is expected to continue.

K.2.6.4 Encoder clock drift

In certain cases, the multi-bitrate encoder is slaved to the incoming TV feed, e.g. an MPEG-2 TS, i.e. it reuses the media time stamps also for the ISO BMFF. Annex A.8 of ISO/IEC 23009-1 [116] handles drift control of the media timeline, but the impact on the segment availability time (i.e. MPD updates) is not considered or suggested. In particular when the segment fetching engine of the client is only working with the segment availability timeline (so is not parsing the presentation timeline out of the segments), the segment fetching engine will not fetch the segments with the correct interval, leading to buffer underruns or increased end-to-end delay.

In order to support robust offering even under encoder drift circumstances, the segmenter should avoid being synced to the encoder clock. In order to improve robustness, in the case of an MPD-based offering Periods may be added more frequently in a continuous manner as defined in clause 8.4.2.2 of TS 26.247 [98].

K.2.6.5 Segment unavailability

When a server cannot serve a requested segment it gives an HTTP 404 response. If the segment URL is calculated according to the information given in the MPD, the client can often interpret the 404 response as a possible synchronization issue, i.e. its time is not synchronized to the time offered in the MPD. In the DASH-over-MBMS case, a 404 response is also likely to be caused by non-reparable transport errors. This is even more likely if it has been possible to fetch segments according to the MPD information earlier. Although the client, which is normally located in the same device as the DASH player, knows what segments have been delivered via broadcast and which ones are missing in a sequence, it cannot indicate this to the DASH client using standard HTTP responses to requests for media segments.

To address signalling of segment unavailability between the client and server and to indicate the reason for this, it is recommended to use regular 404s with the Date-Header specifying the time of the server. The DASH client, when receiving a 404, knows that if its time is matching the Date Header, then the loss is due to a segment loss.

K.2.6.6 Swapping across redundant tools

In case of failures of infrastructure, redundant tools may kick in. If the state is not fully maintained across redundant tools, the service may not be perceived continuous by DASH client. Depending on the swap strategy, the interruptions are more or less obvious to the client. Similar issues may happen if DASH segmenters fail, for example the state for segment numbering is lost.

To enable swapping across redundant tools, the following should be considered with preference in the order as listed.

- the content author is offering the service redundant to the client (for example using multiple Base URLs) and the client determines the availability of one or the other. This may be possible under certain circumstances.
- Periods may be inserted at a swap instance in order to provide the new information after swap. If possible, the offering should be continuous, but the offering may also be non-continuous from a media time perspective.
- A completely new MPD is sent that removes all information that was available before any only maintains some time continuity. Despite this is not fully specified in TS 26.247 [98], DASH clients should be prepared to continue the service.

Annex L (normative): MBMS profiles

L.1 Introduction and scope

The MBMS User Services as defined in this specification offer a broad set of media delivery services such as for Live Video distribution over MBMS and evolved MBMS systems. In the historic development of the specification, as well as in the context of the broad applicability, different features and alternatives for the same functionality were added over time and different Releases.

This annex defines a set of profiles. Each profile defines a set of features and tools to support a certain set of use cases. If an MBMS Client claims to support a profile as defined in this annex, it shall implement all mandatory features of the profile. If an MBMS User services offering claims to offer a service using a specific profile, it shall only use features that are included in profile.

L.2 MBMS User Service Discovery/Announcement Profile 1a

L.2.1 Introduction

The function of Service Discovery is to allow UEs to find the available MBMS User Services defined on the MBMS enabled network and the associated service access information (e.g., FLUTE session parameters, TMGI, file repair servers, etc.) for MBMS User Services of interest. Among others, the UE needs the service access information to initiate the reception of a particular MBMS User Service and to find the data of associated with the MBMS User Service on the radio interface.

In a typical deployment scenario that is covered by this profile, the MBMS metadata fragments are announced to the UEs in advance of a MBMS session. UEs monitor with a certain periodicity a Service Announcement Channel and stores received metadata for potential later usage, so that UEs have in most cases all relevant access information when the UE wants to activate reception of an MBMS User Service. There are also use cases where it is necessary to update the metadata fragments during, and sometimes after, the completion of MBMS file download delivery.

Clause 5.2 of this specification defines multiple optional features, such as Service Announcement over MBMS and unicast bearers. The present clause specifies one profile for Service Discovery/Announcement over MBMS bearer services. The intention of this profile is to limit the number of optional features and to define the set of provided metadata fragments.

This section profiles Service Announcement over MBMS bearers as described in clause 5.2.3 by defining a Service Announcement Channel (SACH). The profile describes how the MBMS metadata (as defined in clause 5.2.2) defines the User Service access information to enable UEs to receive MBMS User Services for Live DASH, Live HLS, Live hybrid DASH/HLS service or non-real-time file delivery.

L.2.2 Definition of a Service Announcement Channel (SACH)

MBMS User Service Discovery/Announcement involves the delivery of metadata fragments to many UE receivers in a suitable manner. Multiple metadata fragments are needed to describe the access to a service.

The Service Announcement Channel (SACH) is a special type of MBMS User Service (i.e. a type of Service Announcement User Service) that shall only provide Service Announcement metadata fragments. MBMS UEs find relevant MBMS metadata fragments for each service on the SACH. The MBMS UE may find additional metadata fragments or updated metadata fragments in-band with the MBMS User Service data, once the UE has activated the reception of the MBMS User Service. From the system perspective the SACH is essentially created and managed in the same way as any other MBMS delivery session instance. From a UE perspective, the MBMS bearer for the SACH is similar to other MBMS bearers.

Similar to other MBMS user services, the SACH is also described through metadata fragments. The procedure to acquire the metadata fragments for the SACH is called SACH bootstrap procedure is defined in clause L.2.9.

The SACH is delivered by a single MBMS download delivery session. The SACH and the associated MBMS bearer shall be always activated during the lifetime of the service announcement. The SACH shall be provided in all potential MBMS Service Areas.

The metadata fragments of all scheduled and on-going services are combined into one or more service announcement file (SA files), as Multipart MIME files as described in clause L.2.3. The SA file is repeated continuously on the SACH. Each SA file shall be identified by a unique URL.

In order to keep up to date with the currently defined versions of metadata fragments (e.g., schedule updates for previously defined services, or the fragments describing a new service) UEs should check the SACH with a certain periodicity. The overall goal is to ensure that as many UEs as possible are able to receive service announcement information prior to the MBMS session. The basic approach is shown in figure L.1.

In case multiple access system bands (e.g. E-UTRAN is offered through multiple carriers) are used in the deployment, the SACH should be carried through all bands where eMBMS services are available. The intention is for the UEs not to have to move to a different band only to check the SACH for updates.

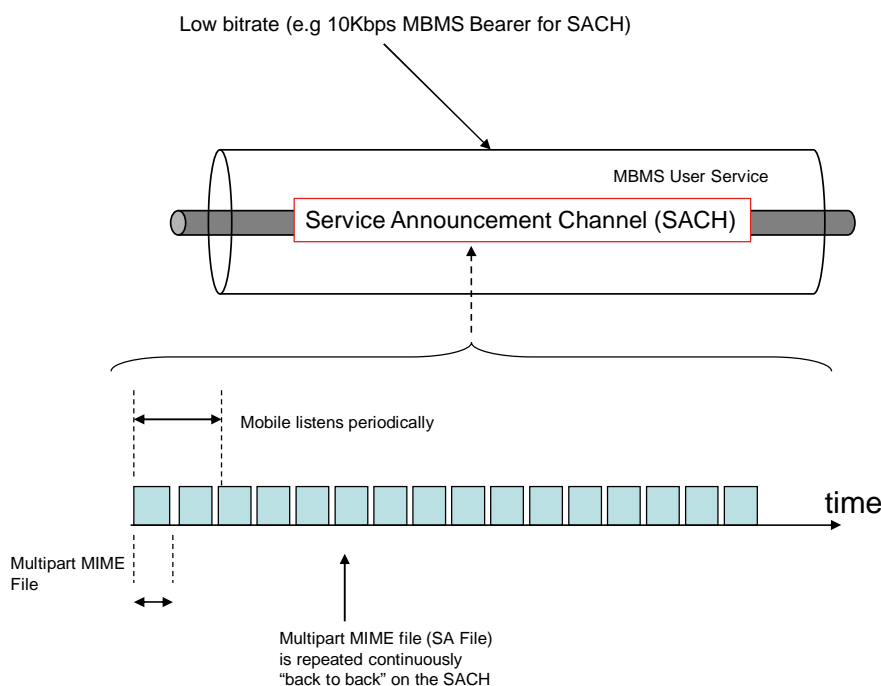


Figure L.1: Service Announcement Channel (SACH) Usage

L.2.3 Service Announcement (SA) file structure

Service announcement metadata shall be transported via MBMS Download Delivery. A Service Announcement file (SA file) shall be formatted as an aggregated Multipart MIME file of multipart/related type as defined in clause 5.2.6. All metadata fragments of one MBMS User Server shall be contained within the same SA file. The SA file may contain metadata fragments of more than one MBMS User Service.

An SA file shall be uniquely identified by its URL, and provided as the value of the Content-Location field in FDT Instances. Its MIME type is provided as value of the Content-Type field in FDT Instances. When a USBD or any other metadata fragment of an MBMS User Service is updated, an updated SA file shall be transmitted with a new Content-MD5 value in the FLUTE FDT Instance describing the file with the same URL. The UE shall use the Content-MD5 to identify new SA File versions.

The SA file shall contain exactly one *metadata envelope*, and for each service, at least an USBD (with one *userServiceDescription* element), one Session Description, and one Schedule Description fragment. Optionally, the SA file may contain Associated Delivery Procedure Description (ADPD). For DASH services, the SA file may further contain the Media Presentation Description (MPD), the Application Service Description (ASD) whose content is the unified MPD, and all Initialization Segment Description (ISD) metadata fragments of the MBMS User Service. For HLS services, the SA file may further contain the Application Service Description (ASD) whose content is the Master Playlist [144] and all Initialization Segment Description (ISD) metadata fragments [144].

Some metadata fragments may be added and / or updated in-band with the content as defined in clause L.2.8. When metadata fragments are referenced, but not delivered within the SA file, such as the case of the Associated Delivery Procedure Description, the metadata fragments shall be provided as in-band fragments as defined in clause L.2.8. The SA file might not include Associated Delivery Procedure Description (ADPD) fragments in multiple BMSC deployments where different *serviceURLs* are used to direct file repair and reception reporting to different services on each BM-SC.

The *metadata envelope* shall be included as the root body part on the SA file and shall include a list of *item* child elements, with one *item* instance for every included metadata fragment. The *metadataURI* attribute of a given *item* element shall represent a unique and absolute HTTP URL referencing the metadata fragment associated with that *item*. The *metadata envelope* in the SA file shall not include the *metadataFragment* element, i.e., the *metadata envelope* does not embed a metadata fragment, as described in clause 11.1.4. This is shown in the example in clause L.2.10.

The SA file should contain all DASH Initialization Segment Description metadata fragments, which are referenced by all broadcast Representations on any Media Presentation Description fragment, referenced by *r9:mediaPresentationDescription* element, included in the SA file. Any Initialization Segment Description fragment in the SA file shall be base64 encoded. The URL in the *metadataURI* in the *metadata envelope* and the Content-Location field in the Multipart MIME boundary header shall contain the same Initialization Segment Description URL, which is included in the MPD to reference the ISD.

The SA file should contain all HLS Initialization Segment Description fragments, each of which contains a Media Initialization Section [X], which are referenced by the broadcasted HLS Media Playlists. Any HLS Initialization Segment Description fragment in the SA file shall be base64 encoded. The URL in the *metadataURI* in the *metadata envelope* and the Content-Location field in the Multipart MIME boundary header shall contain the same Media Initialization Section URL, as given in the HLS Media Playlists with the EXT-X-MAP tag [X].

The SA file shall be compressed using the RFC 1952 [42] content/transport encoding for transmission and shall have a .gzip file extension. The multipart MIME file shall be carried as a compressed (gzipped) file and uncompressed by the MBMS Client, i.e., FLUTE level compression is not to be used.

As allowed in RFC1952, the gzip file format shall include the original file name and the FLG.FNAME flag shall be set to true. This allows for the uncompressed file name to be signalled in gzip files.

L.2.4 Metadata Envelope

The Metadata Envelope provides references to all metadata fragments within the same SA file document via the *metadataURI* attribute, each instance of which shall be unique and represents an absolute HTTP URL.

When delivering metadata fragments in-band (see clause L.2.8), the metadata fragments may be embedded in or referenced by Metadata Envelopes (see clause 11.1.4). In-band metadata fragments shall be sent on the FLUTE session of a MBMS User Service together with the actual content for that MBMS User Service, not on the SACH.

The validity time, defined by the *validFrom* and *validUntil* attributes for all metadata fragments of the same MBMS User Service shall be identical to ensure that all fragments of that the User Service are valid for the same period. Therefore, an MBMS User Service is valid only during the period between *validFrom* and *validUntil* identically defined for all fragments describing that User Service.

The *validFrom* and *validUntil* attributes in the following required metadata fragments define when a service is valid: {USBD, Session Description, Schedule Description} for file delivery services {USBD, Session Description, Schedule Description, Media Presentation Description, Application Service Description, Initialization Segment Description(s)} for DASH services and {USBD, Session Description, Schedule Description, Application Service Description, Media Initialization Section(s)} for HLS services; a service is valid (fully defined) only if each of these fragments is available during the common validity period. Note that the validity of the ADPD is not considered as it is not critical for service reception, and it might be delivered in-band only. The aligned validity information shall include the ADPD back-off and random period such that a *validUntil* occurring before the ADPD's validity period is over will not unintentionally expire the service and thus abort the ADPD procedures.

The *validUntil* value for a metadata fragment may be adjusted without an increment to the version value for that fragment. When this occurs the BM-SC shall deliver the file with an updated MD5 checksum. Upon detecting the MD5 value change, the MBMS Client shall parse the metadata envelope for the corresponding fragments and update the *validUntil* and version values that have changed.

If the version does not change, the UE only needs to update the validity information and does not need to overwrite the fragment if the version did not change. If the fragment has changed and needs to be overwritten, a new version number shall be signalled in the Metadata Envelope.

The system shall assign relatively short *validUntil* in the future for all fragments and it shall also periodically update the *validUntil* for all fragments to a new short time in the future to ensure proper memory management on the UEs. Only when the *validUntil* for the fragments of a User Service have elapsed should the UE safely delete those metadata fragments and therefore delete the associated MBMS User Service. If signaling an MBMS User Service deletion is desired before the currently defined *validUntil* for that service, the system shall set the *validUntil* for all fragments of that MBMS service to a time in the past.

Version management is handled in such a way that the system shall ensure version numbers are always increasing. When a version number change is required for a given metadata fragment, the system shall send a new version of that fragment, both in-band and via the SACH in the Multipart MIME file.

The system shall describe and signal only one version of each metadata fragment at any point in time. The eMBMS Client shall also only maintain the fragment of the highest version for each metadata fragment with the earlier version removed from the MBMS Client storage.

L.2.5 User Service Bundle Description fragment

The MBMS User Service Bundle Description (USBD) describes only a single user service in the Multipart MIME file. There shall be one *userServiceDescription* element per USBD. To announce multiple MBMS User Services, there shall be separate USBD instances for each MBMS User Service within the Multipart MIME file.

Each MBMS User Service instance is described through the following metadata fragments. For each MBMS User Service instance, exactly one *bundleDescription* element shall be present, which shall contain exactly one *userServiceDescription* element. The *userServiceDescription* element shall contain exactly one *deliveryMethod* element and exactly one *r9:schedule* element. The *deliveryMethod* element references a Session Description in the form of an SDP file, which shall describe one MBMS Download Delivery Session.

The USBD shall contain the *requiredCapabilities* element with its *feature* child element. The *feature* element value shall be set to "22", which identifies the "MBMS User Service Discovery / Announcement Profile 1a", as defined in clause 11.9.

In the case of Live DASH services, the *userServiceDescription* element shall also contain exactly one *r9:mediaPresentationDescription* element, which references a DASH Media Presentation Description (MPD).

In the case of Live DASH services, the *userServiceDescription* element may also contain one *r12:appService* element, with a MIME type containing "application/dash+xml", which references an Application Service Description whose content is a unified MPD (see clause 7.6).

In the case of Live DASH services based on a CMAF profile [116][145], the *userServiceDescription* element may also contain one *r12:appService* element, with a MIME type containing "application/dash+xml profiles='urn:mpeg:dash:profile:cmf:2019'" or a compatible signaling as documented in clause 5.6.

In the case of Live HLS services, the *userServiceDescription* element shall also contain exactly one *r12:appService* element with the *mimeType* attribute set to "application/vnd.apple.mpegurl", which references an Application Service Description whose content is an HLS Master Playlist [144].

In the case of hybrid Live DASH/HLS services, the *userServiceDescription* element:

- shall contain exactly one *r9:mediaPresentationDescription* element, which references a DASH Media Presentation Description (MPD);
- should contain one *r12:appService* element, with a MIME type containing "application/dash+xml profiles='urn:mpeg:dash:profile:cmf:2019'", which references an Application Service Description whose content is a unified MPD (see clause 7.6); and
- shall contain exactly one *r12:appService* element with the *mimeType* attribute set to "application/vnd.apple.mpegurl", which references an Application Service Description whose content is an HLS Master Playlist [144].

The USBD fragment may contain an *r9:availabilityInfo* element, with one or more *infoBinding* elements. The *infoBinding* element shall contain the child elements *radioFrequency* and *serviceArea*. If the *r9:availabilityInfo* element is absent, then the device shall assume that the corresponding MBMS User Service offering is not geographically constrained within the service area footprint of the MBMS service operator.

For this service announcement profile and for E-UTRAN, the UE shall ignore the *radioFrequency* child element. Instead, the UE shall read and use the radio frequency from the E-UTRAN System Information Block 15 (SIB), which provides the binding between the frequency agnostic Service Area ID (SAI) and the radio frequency.

This is the list of supported attributes and elements:

- Mandatory
 - bundleDescription.sv:schemaVersion
 - set as specified for the schema version in use
 - bundleDescription.userServiceDescription
 - bundleDescription.userServiceDescription.serviceId
 - bundleDescription.userServiceDescription.r7:serviceClass
 - bundleDescription.userServiceDescription.deliveryMethod
 - bundleDescription.userServiceDescription.deliveryMethod@sessionDescriptionURI
 - bundleDescription.userServiceDescription.deliveryMethod.sv:delimiter
 - set to 0 and positioned as specified by the schema version in use
 - bundleDescription.userServiceDescription.requiredCapabilities
 - bundleDescription.userServiceDescription.requiredCapabilities.feature
 - bundleDescription.userServiceDescription.r9:schedule
 - bundleDescription.userServiceDescription.sv:delimiter
 - set to 0 and positioned as specified by the schema version in use
- Mandatory for DASH services
 - bundleDescription.userServiceDescription.r9:mediaPresentationDescription

Optional for DASH services

- bundleDescription.userServiceDescription.r12:appService
- Mandatory for HLS services
 - bundleDescription.userServiceDescription.r12:appService
- Optional
 - bundleDescription.userServiceDescription.name
 - bundleDescription.userServiceDescription.serviceLanguage
 - bundleDescription.userServiceDescription.r9:availabilityInfo
 - bundleDescription.userServiceDescription.r9:availabilityInfo.infoBinding.serviceArea
 - A list of serviceArea advertises SAIs where the service is available – requires SIB15 support
 - bundleDescription.userServiceDescription.r9:availabilityInfo.infoBinding.radioFrequency
 - Includes at least one radioFrequency

- bundleDescription.userServiceDescription.deliveryMethod
- bundleDescription.userServiceDescription.deliveryMethod@associatedProcedureDescriptionURI
- bundleDescription.userServiceDescription.deliveryMethod@accessPointName
 - accessPointName – may be set to the same value for all services
- bundleDescription.userServiceDescription.deliveryMethod.r12:broadcastAppService

This is the list of not supported attributes and elements:

- bundleDescription@fecDescriptionURI.
- bundleDescription.userServiceDescription@accessGroup
- bundleDescription.userServiceDescription.serviceGroup
- bundleDescription.initializationRandomization
- bundleDescription.terminationRandomization
- bundleDescription.userServiceDescription.initializationRandomization
- bundleDescription.userServiceDescription.terminationRandomization
- bundleDescription.userServiceDescription.r8:Registration
- bundleDescription.userServiceDescription.deliveryMethod@accessGroupID
- bundleDescription.userServiceDescription.deliveryMethod@protectionDescriptionURI
- bundleDescription.userServiceDescription.deliveryMethod.r8:alternativeAccessDelivery
- bundleDescription.userServiceDescription.deliveryMethod.r12: broadcastAppService.serviceArea
- bundleDescription.userServiceDescription.deliveryMethod.r12:unicastAppService
- bundleDescription.userServiceDescription.deliveryMethod.r12:appComponent
- bundleDescription.userServiceDescription.deliveryMethod.r12:serviceArea
- bundleDescription.userServiceDescription.deliveryMethod@r12:inbandMetadata
- bundleDescription.userServiceDescription.r12:appService.identicalContent
- bundleDescription.userServiceDescription.r12:appService.alternativeContent
- bundleDescription.userServiceDescription.r12:KeepUpdatedService

L.2.6 Schedule Description fragment

The *r9:schedule* element references a *Schedule Description* Fragment, which contains at least one *serviceSchedule* element, which shall include at least one *sessionSchedule* element. The *serviceSchedule* may optionally contain one or more *fileSchedule* elements. The *sessionSchedule* describes the start and stop times of a broadcast event, e.g., live DASH streaming of a sports event, or the transmission of software images during a software upgrade window. The UE shall expect, during the time period defined by *start* and *stop* child elements of *sessionSchedule*, that the MBMS bearer is active. When *fileSchedule* is included, the *serviceSchedule* shall group a *sessionSchedule* and all *fileSchedule* elements for files transmitted during that session. Specifically, the concatenation of the one or more sets of start and end times for any *fileSchedule* instance shall represent a time interval that resides between the start and end times of the *sessionSchedule* in the associated *serviceSchedule*.

All timestamps in the Schedule Description Fragments shall be UTC timestamps, i.e. the timezone indication shall always be present. When a Schedule Description fragment describes multiple sessions or a file whose delivery spans daylight savings time changes, the UTC times indicated shall properly account for the daylight saving time change.

A Schedule Description instance shall be delivered to the UE as part of the SA file in the SACH and shall also be sent in-band within a MBMS Download delivery session for the respective MBMS User Service. The most recently delivered Schedule Description fragment will take priority on the UE as indicated by the metadata envelope.

The list of supported attributes and elements of the Schedule Description fragment is as follows:

- Mandatory
 - scheduleDescription.sv:schemaVersion
 - scheduleDescription.serviceSchedule.sessionSchedule
 - scheduleDescription.serviceSchedule.sessionSchedule.start
 - scheduleDescription.serviceSchedule.sessionSchedule.stop
 - scheduleDescription.serviceSchedule.sessionSchedule.index
- Optional
 - scheduleDescription.serviceSchedule.sessionScheduleOverride
 - scheduleDescription.serviceSchedule.sessionScheduleOverride@index
 - scheduleDescription.serviceSchedule.sessionScheduleOverride@cancelled
 - scheduleDescription.serviceSchedule.fileSchedule
 - scheduleDescription.serviceSchedule.fileSchedule.fileURI
 - scheduleDescription.serviceSchedule.fileSchedule.fileURI@cancelled
 - scheduleDescription.serviceSchedule.deliveryInfo
 - scheduleDescription.serviceSchedule.deliveryInfo@start
 - scheduleDescription.serviceSchedule.deliveryInfo@stop

The list of non-supported attributes and elements in Schedule Description is as follows:

- scheduleDescription@scheduleUpdate
- scheduleDescription.serviceSchedule@serviceId
- scheduleDescription.serviceSchedule@serviceClass
- scheduleDescription.serviceSchedule.sessionSchedule.reccurencePattern
- scheduleDescription.serviceSchedule.sessionSchedule.numberOfTimes
- scheduleDescription.serviceSchedule.sessionSchedule.reccurenceStopTime
- scheduleDescription.serviceSchedule.sessionSchedule.r11:receptionFiltering
- scheduleDescription.serviceSchedule.sessionSchedule.r12:FDTInstanceURI
- scheduleDescription.serviceSchedule.sessionSchedule.r12:recurrenceAndMonitoring
- scheduleDescription.serviceSchedule.sessionSchedule.r12:sessionDescriptionURI
- scheduleDescription.serviceSchedule.sessionScheduleOverride@Start
- scheduleDescription.serviceSchedule.sessionScheduleOverride@stop

L.2.7 Associated Delivery Procedure Description fragment

The serviceURIs in an Associated Delivery Procedure Description (ADPD) fragment may be different in multiple BM-SCs deployments. The system shall support defining multiple ADPD fragments for a User Service, in which case the ADPD fragments shall be sent in-band only, and not as part of the SA file sent on the SACH (the deliveryMethod for a User Service can only describe one ADPD URL, and multiple versions of the ADPD fragment for the same User Service cannot be defined for a single SA file).

When multiple ADPD fragments are used in a given deployment, the MBMS Client shall detect a new in-band ADPD when moving to the coverage area of a different BMSC. Therefore, the MBMS Client shall use the updated list of service URLs in the most recent ADPD.

When an updated ADPD fragment no longer includes a *postFileRepair* element, then all outstanding file repair procedures for the service shall be cancelled.

Changes to the offset time or the random time period attributes in the *postFileRepair* shall reset any previously set timer according to the new parameters on the MBMS Client. Traffic impacts must be taken into account before any changes to the offset time period and the random time parameters are made in the system.

The list of supported attributes and elements of the ADPD fragment is as follows:

- Optional
 - associatedProcedureDescription.postFileRepair
 - associatedProcedureDescription.postFileRepair@offsetTime
 - associatedProcedureDescription.postFileRepair@randomTimePeriod
 - associatedProcedureDescription.postFileRepair.serviceURI
 - associatedProcedureDescription.postReceptionReport
 - associatedProcedureDescription.postReceptionReport@offsetTime
 - associatedProcedureDescription.postReceptionReport@randomTimePeriod
 - associatedProcedureDescription.postReceptionReport@samplePercentage
 - associatedProcedureDescription.postReceptionReport@forceTimeIndependence
 - associatedProcedureDescription.postReceptionReport@reportType
 - associatedProcedureDescription.postReceptionReport.serviceURI

The non-supported attributes and elements in Associated Delivery Procedure Description are:

- associatedProcedureDescription.bmFileRepair
- associatedProcedureDescription.r12:consumptionReport

L.2.8 In-band fragments

The prime source for service announcement metadata fragments is the Service Announcement Channel (SACH) as defined in clause L.2.2. In some cases, service announcement fragments need to be updated or are only provided in-band via the MBMS Download session carrying the content for the MBMS User Service.

The MBMS Client shall receive and process all in-band metadata fragments. The MBMS Client may notify the application upon newly received information (e.g. when the session schedule has changed) or the application may query for newly received information (e.g. the Media Presentation Description).

The specific use cases requiring fragments to be sent in-band of an existing delivery session instance are:

- As a means of cancelling all file repair and reception reporting for a User Service (both for the current session being in broadcast as well as for previous sessions for which file repair and reception reporting may still occur). This option is to be used when not cancelling sessions selectively via the `scheduleFragment.sessionScheduleOverride @index` and `@cancel`.
- Extending or modifying file repair, reception reporting (both for the current session being broadcast as well as for previous sessions for which file repair and reception reporting may still occur).
- Re-scheduling and updates to services or extensions to e.g. live MPEG-DASH broadcasts requiring the extension of a broadcast session.
- Adding or updating MPDs with e.g. new Periods or information for the session end.
 - Since Initialization Segments are only sent in the SA File, all Initialization Segments that can be used in the MBMS User Service need to be defined ahead of time for inclusion on the SA File.

The Associated Delivery Procedure Description (ADPD), Media Presentation Description (MPD) and Schedule Description fragments may be distributed and / or updated in-band with the content stream. In-band fragments shall be repeated with a certain periodicity and over a certain duration to increase reception robustness.

For the naming of in-band fragments that are embedded on a separate metadata envelope the following rules shall apply:

- The URL for the included fragment shall be described in the *metadataURI* attribute of *metadatEnvelope* and shall match the same URL in the USBD.
- A unique fileURL shall be used for each Metadata Envelope embedding a different metadata fragment.
- The fileURL for the envelope in the FDT Instance shall be different than that in the *metadataURI* for the embedded fragment. The FDT Instance for the envelope with the embedded fragment shall also describe the envelope MIME type.
- The fileURLs for the envelope file shall not be changed when the validity info or the fragment is changed.

The MBMS Client shall collect in-band fragments based on the *Content-Type* attribute of the FDT Instance and when an envelope file has a new version as indicated by a new *Content-MD5* value in the FDT Instance. The BM-SC shall add the *Content-MD5* for each in-band fragment. The MBMS Client shall process the updated metadata fragment.

The FLUTE packets of in-band fragments may be interleaved with the FLUTE packets of other content files for a specific file download session.

L.2.9 SACH bootstrapping

The Service Announcement Channel (SACH) is a special type of MBMS User Service. The SACH is described through a set of metadata fragments.

Clause 5.2.3.1 lists four alternatives for obtaining the needed metadata fragments. The default procedure shall be alternative d), where the MBMS Client constructs the bootstrap URL from MNC and MCC. The other alternatives are optional. Furthermore, the MBMS Client may be pre-provisioned with a default bootstrap URL.

The USBD describing the SACH shall contain the *requiredCapabilities* element with its *feature* child element.

L.2.10 Example Service Announcement file

The example below shows a section of a Multipart MIME file for Service Announcement illustrating a metadata envelope referencing three USBD fragments, where each USBD includes only one *userServiceDescription* element, which in turn references its own Session Description and Schedule fragments. USBD-1 describes a file download service whereas USBD-2 and USBD-3 describe two different multimedia MPEG DASH streaming services and therefore also reference a respective MPD (MPD-2 and MPD-3).

In the examples below, it is shown some instantiations of USBD and Schedule Description fragment that are generated from the USBD schema version 1, and the Schedule fragment schema version 1. It would also be possible to generate instantiations using schema versions greater than 1, and still be compliant to the current MBMS Service Announcement profile 1a. A UE of a previous release will also be able to parse the instantiations, since the UE will ignore the new elements/attributes added in the most recent version of the schemas, given the already specified schema extension mechanisms built into the older version of the schema that the UE built to a previous release will use.

MIME-Version: 1.0 Content-Type: multipart/related; boundary="112233445566778899"; type="application/mbms-envelope+xml" Content-Description: LTE MBMS Service Announcement

```
--112233445566778899
Content-Type: application/mbms-envelope+xml Content-Location:
http://usd.ex.com/fragments/envelope.xml
<?xml version="1.0" encoding="UTF-8" standalone="no" ?>
<metadataEnvelope xmlns="urn:3gpp:metadata:2005:MBMS:envelope"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="urn:3gpp:metadata:2005:MBMS:envelope MetadataEnvelope.xsd">

  <item contentType="application/sdp" metadataURI="http://usd.ex.com/fragments/sdp-1.sdp"
  validFrom="2012-03-01T18:53:10Z" validUntil="2012-03-07T18:53:10Z" version="1"/>
  <item contentType="application/mbms-schedule+xml" metadataURI="http://usd.ex.com/fragments/schedule-
  1.xml" validFrom="2012-03-01T18:53:10Z" validUntil="2012-03-07T18:53:10Z" version="1"/>
  <item contentType="application/mbms-user-service-description+xml"
  metadataURI="http://usd.ex.com/fragments/usdBundle-1.xml" validFrom="2012-03-01T18:53:10Z"
  validUntil="2012-03-07T18:53:10Z" version="1"/>
  <item contentType="application/sdp" metadataURI="http://usd.ex.com/fragments/sdp-2.sdp"
  validFrom="2012-03-01T18:53:10Z" validUntil="2012-03-07T18:53:10Z" version="1"/>
  <item contentType="application/dash+xml" metadataURI="http://usd.ex.com/fragments/mpd-2.xml"
  validFrom="2012-03-01T18:53:10Z" validUntil="2012-03-07T18:53:10Z" version="1"/>
  <item contentType="application/mbms-schedule+xml" metadataURI="http://usd.ex.com/fragments/schedule-
  2.xml" validFrom="2012-03-01T18:53:10Z" validUntil="2012-03-07T18:53:10Z" version="1"/>
  <item contentType="video/3gpp" metadataURI="http://usd.ex.com/fragments/is-0.3gp" validFrom="2012-
  03-01T18:53:10Z" validUntil="2012-03-07T18:53:10Z" version="1"/>
  <item contentType="video/3gpp" metadataURI="http://usd.ex.com/fragments/is-1.3gp" validFrom="2012-
  03-01T18:53:10Z" validUntil="2012-03-07T18:53:10Z" version="1"/>
  <item contentType="application/mbms-user-service-description+xml"
  metadataURI="http://usd.ex.com/fragments/usdBundle-2.xml" validFrom="2012-03-01T18:53:10Z"
  validUntil="2012-03-07T18:53:10Z" version="1"/>
  <item contentType="application/sdp" metadataURI="http://usd.ex.com/fragments/sdp-3.sdp"
  validFrom="2012-02-29T20:53:10Z" validUntil="2014-07-04T10:11:12Z" version="1"/>
  <item contentType="application/dash+xml" metadataURI="http://usd.ex.com/fragments/mpd-3.xml"
  validFrom="2012-02-29T20:53:10Z" validUntil="2014-07-04T10:11:12Z" version="1"/>
  <item contentType="video/3gpp" metadataURI="http://usd.ex.com/fragments/is-2.3gp" validFrom="2012-
  02-29T20:53:10Z" validUntil="2014-07-04T10:11:12Z" version="1"/>
  <item contentType="video/3gpp" metadataURI="http://usd.ex.com/fragments/is-3.3gp" validFrom="2012-
  02-29T20:53:10Z" validUntil="2014-07-04T10:11:12Z" version="1"/>
  <item contentType="video/3gpp" metadataURI="http://usd.ex.com/fragments/is-4.3gp" validFrom="2012-
  02-29T20:53:10Z" validUntil="2014-07-04T10:11:12Z" version="1"/>
  <item contentType="video/3gpp" metadataURI="http://usd.ex.com/fragments/is-5.3gp" validFrom="2012-
  02-29T20:53:10Z" validUntil="2014-07-04T10:11:12Z" version="1"/>
  <item contentType="application/mbms-schedule+xml" metadataURI="http://usd.ex.com/fragments/schedule-
  3.xml" validFrom="2012-02-29T20:53:10Z" validUntil="2014-07-04T10:11:12Z" version="1"/>
  <item contentType="application/mbms-user-service-description+xml"
  metadataURI="http://usd.ex.com/fragments/usdBundle-3.xml" validFrom="2012-02-29T20:53:10Z"
  validUntil="2014-07-04T10:11:12Z" version="1"/>
</metadataEnvelope>
--112233445566778899
```

The SA file will also contain the referenced USBD, SDP, Schedule and MDP and associated initialization segment elements as individual separate body parts in the multipart MIME, for example below usdBundle1 is described and references schedule-1.

```
--112233445566778899
Content-Type: application/mbms-user-service-description+xml
Content-Location: http://usd.ex.com/fragments/usdBundle-1.xml
<?xml version="1.0" encoding="UTF-8" standalone="no" ?>
<bundleDescription
xmlns="urn:3GPP:metadata:2005:MBMS:userServiceDescription"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:sv="urn:3gpp:metadata:2009:MBMS:schemaVersion"
xmlns:r7="urn:3GPP:metadata:2007:MBMS:userServiceDescription"
xmlns:r9="urn:3GPP:metadata:2009:MBMS:userServiceDescription"
xsi:schemaLocation="urn:3GPP:metadata:2005:MBMS:userServiceDescription USD-schema-main.xsd">
  <userServiceDescription serviceId="urn:3GPP:metadataSoftwareUpdate-1"
  r7:serviceClass="urn:oma:bcast:ext_bsc_3gpp:exApp:FOTA">
```

```

    <name>Software Update</name>
    <requiredCapabilities>
      <feature>22</feature>
    </requiredCapabilities>
    <deliveryMethod accessPointName="fota.ex.com"
sessionDescriptionURI="http://usd.ex.com/fragments/sdp-1.sdp">
      <sv:delimiter>0</sv:delimiter>
    </deliveryMethod>
    <r9:schedule>
      <r9:scheduleDescriptionURI>http://usd.ex.com/fragments/schedule-
1.xml</r9:scheduleDescriptionURI>
    </r9:schedule>
    <sv:delimiter>0</sv:delimiter>
  </userServiceDescription>
  <sv:schemaVersion>1</sv:schemaVersion>
</bundleDescription>
--112233445566778899.

Content-Type: application/mbms-schedule+xml
Content-Location: http://usd.ex.com/fragments/schedule-1.xml
<?xml version="1.0" encoding="UTF-8" standalone="no" ?>
<scheduleDescription xmlns="urn:3gpp:metadata:2011:MBMS:scheduleDescription"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:sv="urn:3gpp:metadata:2009:MBMS:schemaVersion"
xsi:schemaLocation="urn:3gpp:metadata:2011:MBMS:scheduleDescription ScheduleDescription.xsd"
scheduleUpdate="2012-02-01T00:00:00Z">
  <sv:schemaVersion>1</sv:schemaVersion>
  <serviceSchedule>
    <sessionSchedule>
      <start>2012-03-01T23:00:00Z</start>
      <stop>2012-03-01T23:30:00Z</stop>
    </sessionSchedule>
    <fileSchedule>
      <fileURI>file://fota.ex.com/swupdate/oem-1/model-1/image032212.apk</fileURI>
      <deliveryInfo start="2012-03-01T23:00:00Z" end="2012-03-01T23:10:00Z"/>
    </fileSchedule>
    <fileSchedule>
      <fileURI>file://fota.ex.com/swupdate/oem-1/model-2/image098798.apk</fileURI>
      <deliveryInfo start="2012-03-01T23:10:00Z" end="2012-03-01T23:20:00Z"/>
    </fileSchedule>
    <fileSchedule>
      <fileURI>file://fota.ex.com/swupdate/oem-1/model-3/image765987.apk</fileURI>
      <deliveryInfo start="2012-03-01T23:20:00Z" end="2012-03-01T23:30:00Z"/>
    </fileSchedule>
  </serviceSchedule>
  <serviceSchedule>
    <sessionSchedule>
      <start>2012-03-07T10:00:00Z</start>
      <stop>2012-03-07T10:30:00Z</stop>
    </sessionSchedule>
    <fileSchedule>
      <fileURI>file://fota.ex.com/swupdate/oem-1/model-4/image456345.apk</fileURI>
      <deliveryInfo start="2012-03-07T10:00:00Z" end="2012-03-07T10:15:00Z"/>
    </fileSchedule>
    <fileSchedule>
      <fileURI>file://fota.ex.com/swupdate/oem-1/model-5/image504123.apk</fileURI>
      <deliveryInfo start="2012-03-07T10:15:00Z" end="2012-03-07T10:30:00Z"/>
    </fileSchedule>
  </serviceSchedule>
</scheduleDescription>
--112233445566778899

```

L.3 MBMS User Service Discovery/Announcement Profile 1b

The function of Service Discovery is to allow UEs to find the available MBMS User Services defined on the MBMS enabled network and the associated service access information (e.g. FLUTE session parameters, TMGI, file repair servers, etc.) for MBMS User Services of interest. The UE needs the service access information to initiate the reception of a particular MBMS User Service, and to find the data associated with the MBMS User Service on the radio interface.

The Service Announcement Profile defined in this clause follows the principles of the Service Announcement Profile 1a as defined in clause L.2 with the following constraints:

- Service Announcement metadata fragments shall be delivered as one SA file.
- In the case of Live DASH Services, the SA file shall contain the Media Presentation Description (MPD) fragment for the MBMS User Service, referenced by the *r9:mediaPresentationDescription* element in the USBD. If the USBD also references an Application Service Description fragment with the *r12:appService* element, the SA file shall also contain the Application Service Description fragment whose content is the unified MPD fragment.
- In the case of Live HLS Services, the SA file shall contain the Application Service Description fragment whose content is a Master Playlist as defined in [144] for the MBMS User Service, referenced by the *r12:appService* element in the USBD.
- In the case of Live hybrid DASH/HLS Services, the SA file shall contain:
 - the Media Presentation Description (MPD) fragment for the MBMS User Service, referenced by the *r9:mediaPresentationDescription* element;
 - the Application Service Description (ASD) fragment whose content is the unified MPD, if the USBD also references an ASD fragment with the *r12:appService* element whose MIME type contains "application/dash+xml"; and
 - the Application Service Description (ASD) fragment whose content is the HLS master playlist fragment for the MBMS User Service, referenced by the *r12:appService* element in the USBD, with the *mimeType* attribute set to "application/dash+xml profiles='urn:mpeg:dash:profile:cmf:2019'".
- In the case of Live DASH Services, the SA file shall contain (all) needed Initialization Segment Description (ISD) fragments for the MBMS User Service.

In the case of Live HLS Services, the SA file shall contain (all) needed Initialization Segment Description (ISD) fragments whose content is a Media Initialization Section ([144]) for the MBMS User Service.-

In the case of Live hybrid DASH/HLS Services, the SA file shall contain (all) needed Initialization Segment Description (ISD) fragments for the MBMS user service, used as Initialization Segment by the DASH clients, and used as Media Initialization Section by the HLS clients.

- Each In-Band Fragment shall be embedded in one Metadata Envelope as defined in clause 11.1.4. Each metadata envelope shall contain exactly one metadata fragment.
- The *feature* child element of the *requiredCapabilities* element shall have the value "23", corresponding to the "MBMS User Service Discovery/Announcement Profile 1b", as defined in clause 11.9.

L.3A Profile 1c

The profile defined in this section is for use by content providers who desire to provide the service access information using its own method to the MBMS Clients.

The Service Announcement Profile defined in this clause follows the principles of the Service Announcement Profile 1b as defined in clause L.3 with the following constraints:

- In case multiple user services, as described by service announcement information, are offered, all content components of those services shall be delivered on a single MBMS bearer.
- The SACH is not used. The SA file which contains the metadata fragments is not transmitted in a MBMS download delivery session. Instead, the content provider can employ a method of its choosing for delivering the SA file to its customers' UEs.
- The *feature* child element of the *requiredCapabilities* element shall contain the value "26", corresponding to the "MBMS User Service Discovery/Announcement Profile 1c", as defined in clause 11.9.

L.4 MBMS Download Profile

L.4.1 Introduction

The MBMS Download Profile primarily defines the required, expected and permitted usage of FLUTE FDT attributes and elements by the BM-SC, and the corresponding mandatory versus optional support for those FDT parameters by the MBMS Client. The MBMS Download Profile is associated with the delivery of both non-real-time (NRT) file delivery services as well as DASH-formatted streaming services, using the FLUTE protocol. The FDT attributes and elements are categorized at the FDT-Instance level (i.e., the *FDT-Instance* element of the FDT) and at the File level (i.e., the *File* element of the FDT). The Download Profile constrains the large set of FDT parameters specified in clause 7.2 of the present document, which includes both the FDT elements and attributes defined by the IETF FLUTE standard, RFC 3926 [9] and various 3GPP-defined FDT extensions for MBMS. The MBMS Download Profile is based on existing and planned deployments of eMBMS services containing both NRT file contents as well as DASH-formatted media components.

Other topics addressed by the MBMS Download Profile include the usage of the XML Schema elements *schemaVersion* and *delimiter* for forward and backward compatibility support, RTSP control of FLUTE sessions, Application Layer FEC, usage of the LCT Header Extension *EXT_FTI*, the means to signal the end of the FLUTE session or the end of individual file transmissions, and timing-related fields in LCT such as Sender Current Time (SCT), Expected Residual Time (ERT), and the LCT Extension Header *EXT_TIME*.

The usage of OMA Push and RTSP (as defined in clause 7.4) are excluded from the MBMS Download Profile.

In addition, an implementation profile of the SDP for a FLUTE session is included, based on the description in clause 7.3 of the present document.

L.4.2 Common FDT-Instance and File Attributes

The following FDT attributes, defined at both the FDT-Instance and File levels, shall be carried in the FDT sent by the FLUTE sender, under either the *File-Instance* or *File* element, and shall be supported by the FLUTE receiver:

- Content-Type
- FEC-OTI-FEC-Encoding-ID
- FEC-OTI-Maximum-Source-Block-Length
- FEC-OTI-Encoding-Symbol-Length
- FEC-OTI-Scheme-Specific-Info

NOTE 1: See clause L.4.4 on the usage rule for these parameters at the File level of the FDT.

The following FDT attribute, defined at both the FDT-Instance and File levels, may be carried in the FDT sent by the FLUTE sender, under either the *File-Instance* or *File* element, and shall be supported by the FLUTE receiver:

- Content-Encoding set to 'gzip'

The following FDT parameters, defined at both the FDT-Instance and File levels, shall not be used by the FLUTE sender, in either the *File-Instance* or *File* element:

- Content-Encoding attribute set to a value other than 'gzip'
- FEC-OTI-FEC-Instance-ID attribute (not applicable to Release 9 FEC schemes)
- Group element

NOTE 2: These parameters are optional to support by the FLUTE receiver.

L.4.3 FDT-Instance specific Elements and Attributes

The following parameters, defined at the FDT-Instance level, shall not be used by the FLUTE sender:

- *Complete* attribute
- *mbms2008:FullFDT* attribute
- *MBMS-Session-Identity-Expiry* element

NOTE: With the exception of *Complete*, which is mandatory, these parameters are optional to support by the FLUTE receiver.

L.4.4 FDT File-specific elements and attributes

The following attributes, defined at the File level, shall be carried in the FDT sent by the FLUTE sender, and shall be supported by the FLUTE receiver, subject to the qualifications indicated below:

- Content-Location
- TOI
- Content-Length
- Content-MD5
 - This attribute should be included in the FDT for non-DASH services
 - This attribute may be included in the FDT for DASH Segments.

The following element may be carried in the FDT sent by the FLUTE sender, and shall be supported by the FLUTE receiver:

- *mbms2007:Cache-Control*

The following attributes shall only be carried in the in the *File* element of the FDT sent by the FLUTE sender, for the purpose of replacing or overriding corresponding attributes at the FDT-Instance level.

- Content-Type
- FEC-OTI-FEC-Encoding-ID
- FEC-OTI-Maximum-Source-Block-Length
- FEC-OTI-Encoding-Symbol-Length
- FEC-OTI-Scheme-Specific-Info

The following attributes shall not be carried in the FDT sent by the FLUTE sender:

- Transfer-Length
- *mbms2009:Decryption-KEY-URI*
- *mbms2012:FEC-Redundancy-Level*
- *MBMS-Session-Identity*

NOTE: With the exception of *Transfer-Length*, which is mandatory, these parameters are optional to support by the FLUTE receiver.

L.4.5 Version and delimiter schema

As indicated in clause J.2, this specification defines two XML Schema elements necessary for the UE and the network side to maintain forward and backward compatibility: *schemaVersion* and *delimiter*. These elements are used by the following schemas: USBD, Schedule Description, Filter Description and FDT. Whichever schema version supported by the UE will not affect compliance to this Download Delivery Profile. If the UE supports multiple versions of the FDT schema, the UE selects the schema version according to the rules specified in clause 7.2.10.1. As indicated in clause J.2, the supported *delimiter* element has value = "0" as set by the network, and the element content should be ignored by the UE.

L.4.6 Void

L.4.7 Other aspects of FLUTE delivery

Regarding Application Layer FEC support, the two FEC schemes referenced in this specification, the Compact No-Code FEC scheme as specified in RFC 3695 [13], and the Raptor FEC scheme as specified in RFC 5053 [91] are optional to implement by the BM-SC and mandatory to support by the UE. File fragmentation into blocks is supported. In the case of the Compact No-Code FEC scheme, the blocking algorithm as defined in RFC 3695 [13] should be used. For the Raptor FEC scheme, specification of the blocking algorithm should comply with the recommendations on the derivation of the relevant parameters as defined in RFC 5053 [91].

As indicated in clause 7.2.4 of this specification, congestion control is not used for FLUTE delivery in MBMS, and therefore, FLUTE channelization should be provided by a single FLUTE channel with single rate transport.

Regarding FLUTE session description, an instance of Session Description fragment, comprising an SDP file, will contain all parameters as defined in clause 7.3 of this specification.

The LCT Header Extension *EXT_FTI* as defined by RFC 3450 [10], for the purpose of communicating FEC Object Transmission Information, should be used in FLUTE packets that carry symbols of FDT Instance(s). FEC Object Transmission Information in FLUTE packets which carry symbols of content files should be conveyed by the FEC-OTI parameters in the FDT, and for which the expectations on network usage and UE support are specified in clauses 5.2.1.1 and 5.2.1.2.

Timing related fields in LCT corresponding to Sender Current Time (SCT) and Expected Residual Time (ERT), either in the form of the T and R flags in the LCT header, or carried in the LCT Extension Header *EXT_TIME*, are not used in the Download Delivery Profile. The network should set these flags/fields to zero, and the UE should ignore them.

L.4.8 SDP parameters for FLUTE Session

This clause specifies the implementation profile for the SDP parameters of an MBMS download delivery session, which are identified and described in clause 7.3.2 and its sub-clauses. It should be noted that not all of these SDP parameters (carried in the Session Description fragment of MBMS User Service Announcement) are necessarily applicable. Table L.4.8-1 summarizes those that are mandatory, optional or not applicable (should not be present in the SDP), along with clarification text, for an associated FLUTE session. The MBMS receiver is required to support both the mandatory and optional SDP parameters.

Table L.4.8-1: SDP Profile for FLUTE Session

SDP Parameter	Required	Optional	Not Applicable	Clarification
No. of channels in FLUTE session			✓	Only one FLUTE channel is allowed per FLUTE session.
Source IP address	✓			As defined in clause 7.3.2.1.
Destination IP address	✓			As defined in clause 7.3.2.3.
TSI	✓			As defined in clause 7.3.2.4.
Session timing		✓		As defined in clause 7.3.2.6. If both the SDP's session timing parameters and the Schedule Description metadata fragment are present, the session schedule in the latter shall take precedence.
Transport protocol ID	✓			As defined in clause 7.3.2.13.
Media type and format description	✓			As defined in clause 7.3.2.14.
Data rate	✓			As defined in clause 7.3.2.10.
Mode of MBMS bearer per media	✓			As defined in clause 7.3.2.7.
FEC capabilities and related parameters		✓		As defined in clauses 7.3.2.8 and 7.3.2.11.
Per-media service language			✓	For DASH-formatted content, is described by the @lang attribute in the MPD. Not applicable for NRT content.
QoE metrics		✓		As defined in clauses 8.3.2.1 and 8.4.
Alternative TMGI		✓		As defined in clause 7.3.2.12.

L.5 MBMS User Service Discovery/Announcement Profile for Transparent Delivery Services

This section profiles Service Announcement over MBMS bearers as described in clause 5.2.3 by defining a Service Announcement Channel (SACH). The profile describes how the MBMS metadata (as defined in clause 5.2.2) defines the User Service access information to enable UEs to receive MBMS User Services for using the Transparent Delivery method as defined in clause 8B.

The function of Service Discovery is to allow UEs to find the available MBMS User Services defined on the MBMS enabled network for MBMS User Services of interest. The UE needs the service access information to initiate the reception of a particular MBMS User Service, and to find the data associated with the MBMS User Service on the radio interface.

The Service Announcement Profile defined in this clause follows the principles of the Service Announcement Profile 1a as defined in clause L.2 with the following constraints:

- Service Announcement metadata fragments shall be delivered as one SA file.
- Only the Transparent Delivery shall be announced in the *bundleDescription.userServiceDescription.deliveryMethod*.
- in-band fragments shall not be used, i.e all Service Announcement information is provided on the SACH.
- The Associated Delivery Procedure Description (ADPD) fragment should not be present and shall be ignored by the MBMS Client.

A Transparent Delivery Service that is announced over SACH, shall indicate the required capability "24" in the USD to ensure correct processing at the receiver side.

L.6 Profiled FLUTE FDT schema

L.6.1 Profiled FLUTE FDT syntax

The profiled FLUTE FDT schema, consolidating all schema extensions specified in clause 7.2.10.2 relevant to annex L of the present document, is specified in listing L.6.1-1. The name of the file is "TS26346_FLUTE-FDT_Profiled.xsd".

Listing L.6.1-1: Consolidated FLUTE FDT schema

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:3GPP:metadata:2022:FLUTE:FDT" version="2"
  xmlns="urn:3GPP:metadata:2022:FLUTE:FDT"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  elementFormDefault="qualified">
  <xs:annotation>
    <xs:documentation>Consolidated MBMS FLUTE File Delivery Table schema</xs:documentation>
    <xs:documentation>3GPP TS 26.346 clause L.6.1</xs:documentation>
    <xs:documentation>Copyright © 2022, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI,
TSDSI, TTA, TTC). All rights reserved.</xs:documentation>
  </xs:annotation>

  <xs:element name="FDT-Instance" type="FDT-InstanceType"/>
  <xs:complexType name="FDT-InstanceType">
    <xs:sequence>
      <xs:element name="File" type="FileType" maxOccurs="unbounded"/>
      <xs:element name="schemaVersion" type="xs:unsignedInt"/>
      <xs:any namespace="##other" processContents="skip" minOccurs="0"
maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:attribute name="Expires" type="xs:string" use="required"/>
    <xs:attribute name="Complete" type="xs:boolean" use="optional"/>
    <xs:attribute name="Content-Type" type="xs:string" use="optional"/>
    <xs:attribute name="Content-Encoding" type="xs:string" use="optional"/>
    <xs:attribute name="FEC-OTI-FEC-Encoding-ID" type="xs:unsignedLong" use="optional"/>
    <xs:attribute name="FEC-OTI-FEC-Instance-ID" type="xs:unsignedLong" use="optional"/>
    <xs:attribute name="FEC-OTI-Maximum-Source-Block-Length" type="xs:unsignedLong"
use="optional"/>
    <xs:attribute name="FEC-OTI-Encoding-Symbol-Length" type="xs:unsignedLong"
use="optional"/>
    <xs:attribute name="FEC-OTI-Max-Number-of-Encoding-Symbols" type="xs:unsignedLong"
use="optional"/>
    <xs:attribute name="FEC-OTI-Scheme-Specific-Info" type="xs:base64Binary" use="optional"/>
    <xs:anyAttribute processContents="skip"/>
  </xs:complexType>

  <xs:complexType name="FileType">
    <xs:sequence>
      <xs:element name="Cache-Control" type="CacheControlType" minOccurs="0"/>
      <xs:any namespace="##other" processContents="skip" minOccurs="0"
maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:attribute name="Expires" type="xs:string" use="optional"/>
    <xs:attribute name="Content-Location" type="xs:anyURI" use="required"/>
    <xs:attribute name="TOI" type="xs:positiveInteger" use="required"/>
    <xs:attribute name="Content-Length" type="xs:unsignedLong" use="optional"/>
    <xs:attribute name="Transfer-Length" type="xs:unsignedLong" use="optional"/>
    <xs:attribute name="Content-Type" type="xs:string" use="optional"/>
    <xs:attribute name="Content-Encoding" type="xs:string" use="optional"/>
    <xs:attribute name="Content-MD5" type="xs:base64Binary" use="optional"/>
    <xs:attribute name="FEC-OTI-FEC-Encoding-ID" type="xs:unsignedLong" use="optional"/>
    <xs:attribute name="FEC-OTI-FEC-Instance-ID" type="xs:unsignedLong" use="optional"/>
    <xs:attribute name="FEC-OTI-Maximum-Source-Block-Length" type="xs:unsignedLong"
use="optional"/>
    <xs:attribute name="FEC-OTI-Encoding-Symbol-Length" type="xs:unsignedLong"
use="optional"/>
    <xs:attribute name="FEC-OTI-Max-Number-of-Encoding-Symbols" type="xs:unsignedLong"
use="optional"/>
    <xs:attribute name="FEC-OTI-Scheme-Specific-Info" type="xs:base64Binary" use="optional"/>
    <xs:attribute name="FEC-Redundancy-Level" type="xs:unsignedInt" use="optional"/>
    <xs:attribute name="File-ETag" type="xs:string" use="optional"/>
    <xs:anyAttribute processContents="skip"/>
  </xs:complexType>
```

```
<xs:complexType name="CacheControlType">
  <xs:choice>
    <xs:element name="no-cache" type="xs:boolean" fixed="true"/>
    <xs:element name="max-stale" type="xs:boolean" fixed="true"/>
    <xs:element name="Expires" type="xs:unsignedInt"/>
  </xs:choice>
  <xs:anyAttribute processContents="skip"/>
</xs:complexType>
</xs:schema>
```

The syntax defined by the above schema is illustrated in figure L.6.1-1 below.

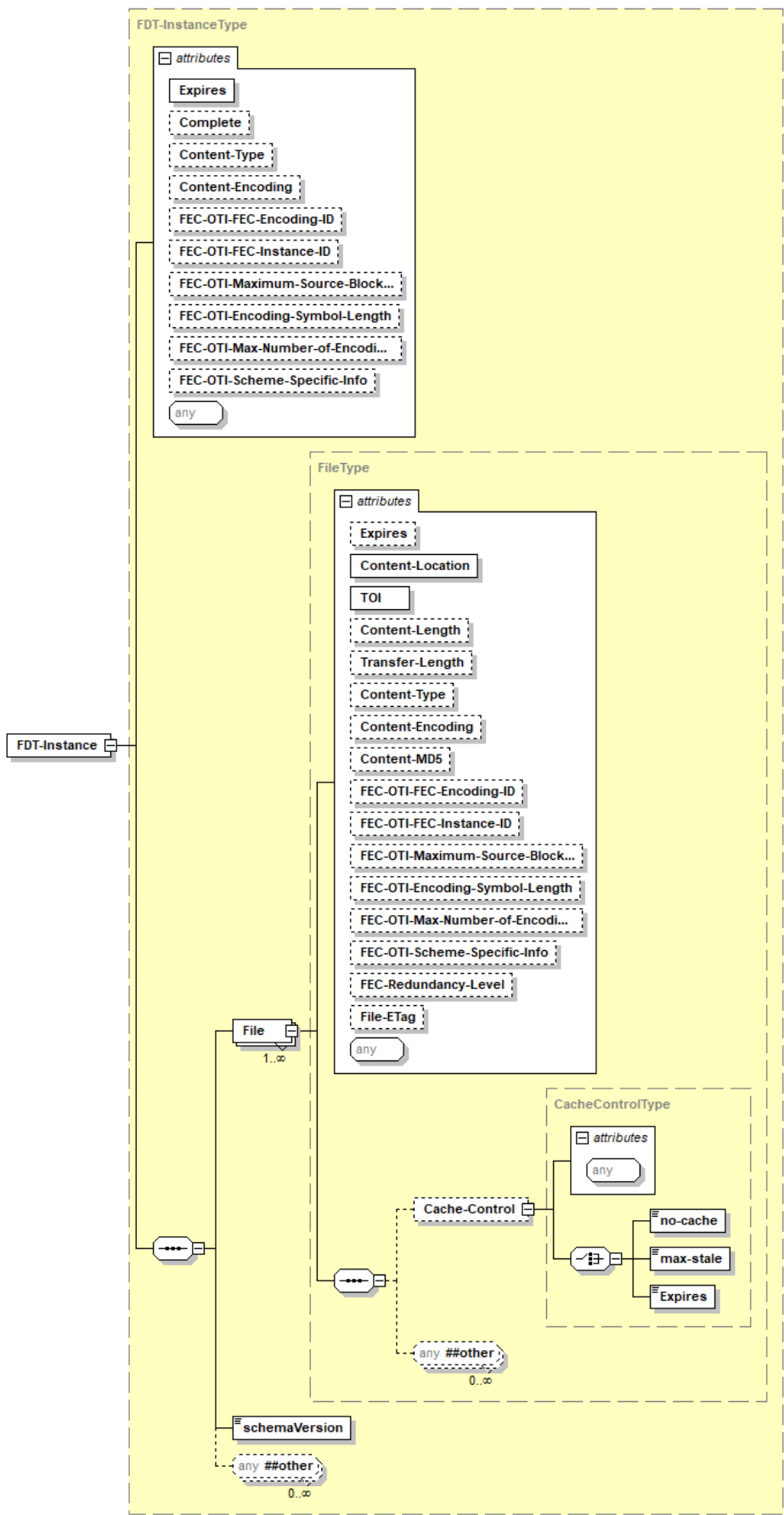


Figure L.6.1-1: Visualisation of consolidated FLUTE FDT schema

L.6.2 Profiled FLUTE FDT semantics

The semantics of the elements and attributes defined in the schema at clause L.6.1 are as follows:

- Usage of the *schemaVersion* element is specified in clause L.6.3.
- When the optional *File@Expires* attribute is provided, its value shall take precedence over that of the *FDT@Expires* attribute.
- The child elements of the *Cache-Control* element are defined in clause 7.2.13.
- The attribute *FEC-Redundancy-Level* is defined in clause 7.2.10.6.
- The *File-ETag* represents the value of the entity tag as specified in section 8.8.3 of RFC 9110 [155] which may also serve as the version identifier of the file object described by the FDT Instance.

NOTE: The signalling of object repair within the FDT Instance is for further study.

L.6.3 Schema version

To maintain forward and backward compatibility between the sender and the receiver, the schema defines the *schemaVersion* element. The BM-SC shall set the *schemaVersion* element to 2 in all instance documents that comply with the FDT schema specified in clause 6.1. NOTE: The value of the *schemaVersion* element and *version* attribute is intended to be increased by 1 in every future release where new element(s) or attribute(s) are added to the schema definition.

When an MBMS Client receives an FDT instance document compliant with this schema, it shall determine the schema version required to parse the instantiation as follows:

- If the MBMS Client supports one or more versions of the FDT schema with the schema *version* attribute, then it shall use the schema that has the highest schema *version* attribute value that is equal to or less than the value in the received *schemaVersion* element;
- The *delimiter* element shall be set by the network to a value of 0, and the element content shall be ignored by the receiver.

L.6.3A Schema extensibility

The profiled FDT schema specified in clause 6.1 may be extended in future versions of the present document.

Additional elements of future extensions shall be defined in another namespace and inserted just prior to the *xs:any namespace="##other"* element. To comply with the Unique Particle Attribution rule, if a new element is optional, a *delimiter* element from the namespace *urn:3gpp:metadata:2009:MBMS:schemaVersion* (see clause J.2), shall be included between this new element and the *xs:any namespace="##other"* instruction.

L.6.4 Example of FDT

Listing L.6.4-1: Example FDT Instance compliant with clause L.6.2

```
<?xml version="1.0" encoding="UTF-8"?>
<FDT-Instance xmlns="urn:3GPP:metadata:2022:FLUTE:FDT"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="urn:3GPP:metadata:2022:FLUTE:FDT TS26346_FLUTE-FDT_Profiled.xsd"
  Expires="331129600">

  <File TOI="2"
    Content-Type="application/sdp"
    Content-Length="7543"
    FEC-OTI-FEC-Encoding-ID="1"
    FEC-OTI-Maximum-Source-Block-Length="8192"
    FEC-OTI-Encoding-Symbol-Length="16"
    FEC-OTI-Scheme-Specific-Info="AAECCA=="
    Content-Location="http://www.example.com/fancy-session/main.sdp">
    <Cache-Control>
      <Expires>331129630</Expires>
    </Cache-Control>
  </File>

  <File TOI="3"
    Content-Type="String"
    Content-Length="161934"
    Expires="331129200"
    FEC-OTI-FEC-Encoding-ID="1"
    FEC-OTI-Maximum-Source-Block-Length="8192"
    FEC-OTI-Encoding-Symbol-Length="200"
    FEC-OTI-Scheme-Specific-Info="AAECCA=="
    Content-Location="http://www.example.com/fancy-session/trailer.3gp">
  </File>

  <schemaVersion>1</schemaVersion>
</FDT-Instance>
```

Annex M (informative): Guidelines for audiovisual streaming using HLS over MBMS broadcasts

M.1 Introduction

In order to interoperate with MBMS, the HLS client should be MBMS-aware. This allows it to take best advantage of broadcast content and unicast content when and where broadcast is not available.

The HLS Master Playlist of an asset pertains equally to both the broadcast and independent unicast availability of a media asset. Generally only a small subset of HLS Media Playlists published in a Master Playlist will be available via an MBMS broadcast. This subset is typically chosen to satisfy the union of all supported UE media decoder compatibilities. A shared Master Playlist is required to support the unicast fallback described in this clause.

M.2 Guidelines

M.2.1 Providing unicast fallback for both HLS and DASH

M.2.1.1 Recommended client support for unicast fallback

An MBMS-aware client should provide support for unicast fallback, although a content provider is not required to offer one. A simultaneous unicast and broadcast delivery provides a fallback for broadcast delivery. Moreover a simultaneous broadcast, with unicast fallback, affords clients the ability to transition between broadcast and non-broadcast domains such as transitioning from a WiFi to cellular service during presentation.

M.2.1.2 Recommended unicast availability for HLS and HLS/DASH Hybrid Services

It is recommended that both an MBMS HLS and Hybrid HLS/DASH service include a mechanism for unicast fallback. In this context, both the HLS Master Playlist and the unified DASH MPD serve the dual purpose of describing streams available via the MBMS bearer service and those available, separately, via unicast.

M.2.1.3 Implied unicast stream availability

In clause 7.6.2.2, Redundant Unicast Resource Specific Metadata, an explicit mechanism for nominating unicast availability is detailed. An MBMS-aware client should assume that any media playlist not included in an instance of `r12:broadcastAppService` is available via unicast.

M.2.2 Media Playlist delivery

The HLS Media Playlist specifies available segments of a given stream. Media Playlists for live content are updated each time a new segment is generated. In order to control the order of delivery, the Media Playlist corresponding to the broadcasted HLS Renditions should be delivered within the same MBMS session as the media segments.

It is recommended to transmit the updated Media Playlist with a new Content-MD5 value in the FLUTE FDT, so that the UE can identify new versions of Media Playlists. It is also recommended to use Cache-control directives in the FDT (7.2.10.5) for Media Playlists, to provide an expiration date with the *Expires* subelement, so that the UE won't keep in cache an old version.

Following requirements from clause 5.7, the MBMS delivers media segment(s) and Media Playlist in such a way that the last packet of the delivered object (that represents the Media Playlist specifying a media segment) is transmitted after the last packet of the delivered object (that represents the said media segment), as illustrated in figure M.2.2-1.

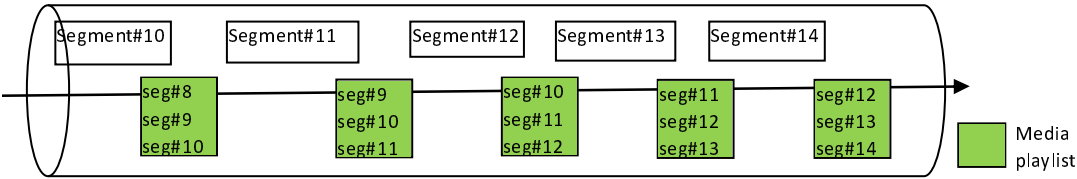


Figure M.2.2-1: Transmission of the media playlist within the MBMS session

Annex N (informative): Change history

Change history							
Date	TSG #	TSG Doc.	CR	Rev	Subject/Comment	Old	New
2005-03	27	SP-050082			Approved at TSG SA#27 Plenary	2.0.0	6.0.0
2005-06	28	SP-050250	001	1	Corrections to QoE metrics specification for MBMS	6.0.0	6.1.0
2005-06	28	SP-050250	002	1	Using two TMGIs	6.0.0	6.1.0
2005-06	28	SP-050250	003		MBMS Service Descriptions over HTTP	6.0.0	6.1.0
2005-06	28	SP-050250	004	1	Corrections to the specification of Associated Delivery Procedures for MBMS	6.0.0	6.1.0
2005-06	28	SP-050250	005	2	Usage of MBMS Session Identity	6.0.0	6.1.0
2005-06	28	SP-050250	010	1	MBMS user service announcement via point-to-point push bearers	6.0.0	6.1.0
2005-06	28	SP-050250	011		Removal of obsolete note	6.0.0	6.1.0
2005-06	28	SP-050250	013		Specification of Raptor Forward Error Correction and Streaming User Service bundling	6.0.0	6.1.0
2005-06	28	SP-050250	015		Clarification of Associated Delivery Procedure	6.0.0	6.1.0
2005-06	28	SP-050250	016		Corrections of FLUTE Support Requirements	6.0.0	6.1.0
2005-06	28	SP-050250	017		Corrections of the reference list	6.0.0	6.1.0
2005-06	28	SP-050250	018		Definition of RTP Session	6.0.0	6.1.0
2005-06	28	SP-050250	019		Corrections and editorial modifications to chapter 4	6.0.0	6.1.0
2005-06	28	SP-050250	020		MBMS Repair	6.0.0	6.1.0
2005-06	28	SP-050250	021		MBMS Media Codec Support	6.0.0	6.1.0
2005-09	29	SP-050423	0023	2	General corrections to MBMS	6.1.0	6.2.0
2005-09	29	SP-050423	0024	2	Corrections to MBMS download delivery procedure	6.1.0	6.2.0
2005-09	29	SP-050423	0025	3	FDT schema Correction	6.1.0	6.2.0
2005-09	29	SP-050423	0027	2	Specification of MIME types for MBMS	6.1.0	6.2.0
2005-09	29	SP-050423	0028	4	Correction of XML Schemas	6.1.0	6.2.0
2005-09	29	SP-050423	0029		Corrections to QoE metrics specification for MBMS	6.1.0	6.2.0
2005-09	29	SP-050423	0031	2	SDP Bug Fixes for the MBMS Download Delivery	6.1.0	6.2.0
2005-09	29	SP-050423	0035	1	Interpretation of TOI sequencing	6.1.0	6.2.0
2005-12	30	SP-050788	0034	1	MBMS User Service Announcement Application ID	6.2.0	6.3.0
2005-12	30	SP-050788	0037	3	Time Synchronization between BM-SCs and MBMS Ues	6.2.0	6.3.0
2005-12	30	SP-050788	0038	2	Reference and definition correction for MBMS user service	6.2.0	6.3.0
2005-12	30	SP-050788	0039	2	PtP file repair URI correction	6.2.0	6.3.0
2005-12	30	SP-050788	0040	2	Allocation of FEC Encoding IDs	6.2.0	6.3.0
2006-03	31	SP-060014	0041		Sender Current Time (SCT) and Expected Residual Time (ERT) Header Fields	6.3.0	6.4.0
2006-03	31	SP-060014	0042		FEC-OTI-FEC-Instance-ID support in MBMS	6.3.0	6.4.0
2006-03	31	SP-060014	0043	2	Update of AMR-WB+ RFC reference	6.3.0	6.4.0
2006-03	31	SP-060014	0045	1	Handling several Response Codes in one response message	6.3.0	6.4.0
2006-03	31	SP-060014	0046	1	Addition of a reference to TR 26.936	6.3.0	6.4.0
2006-06	32	SP-060352	0047	2	Clarification on FDT Instance data elements	6.4.0	6.5.0
2006-06	32	SP-060352	0048	1	Correction for the FEC block construction and example	6.4.0	6.5.0
2006-06	32	SP-060352	0049	1	MBMS Security function alignment	6.4.0	6.5.0
2006-06	32	SP-060352	0053	1	FEC correction	6.4.0	6.5.0
2006-06	32	SP-060357	0044	6	Scalable MBMS multicast session joining and leaving	6.5.0	7.0.0
2006-06	32	SP-060357	0050	1	Modification of MBMS User Service procedures to enable unicast bearer usage	6.5.0	7.0.0
2006-06	32	SP-060357	0051	1	Modification of MBMS User Service architecture to enable unicast bearer usage	6.5.0	7.0.0
2006-09	33	SP-060593	0057	2	Editorial modification (deletion of duplicated text)	7.0.0	7.1.0
2006-09	33	SP-060593	0059	1	Editorial Improvements and a correction of the MBMS FEC	7.0.0	7.1.0
2006-12	34	SP-060848	0055	2	Correction to the file repair request	7.1.0	7.2.0
2006-12	34	SP-060848	0061	1	Essential Correction of FLUTE FDT Content Encoding Support	7.1.0	7.2.0
2006-12	34	SP-060848	0063	1	Essential Correction of SDP for Streaming Session	7.1.0	7.2.0
2006-12	34	SP-060848	0065	2	Correction of required number of FEC Repair Symbols	7.1.0	7.2.0
2006-12	34	SP-060848	0067	1	Correction of declaration for 'xs:anyAttribute' and of missing opening tag '<keyDomainID>'	7.1.0	7.2.0
2006-12	34	SP-060848	0069	3	Inclusion of the MBMS Counting Indication to the MBMS bearer mode description	7.1.0	7.2.0
2007-03	35	SP-070024	0072	2	Essential correction for the support of multiple versions in file repair	7.2.0	7.3.0
2007-03	35	SP-070027	0073	3	Caching Directive in MBMS	7.2.0	7.3.0
2007-03	35	SP-070024	0075	1	Essential correction of a wrong Reference	7.2.0	7.3.0
2007-03	35	SP-070027	0077	2	MBMS Download in Roaming Condition	7.2.0	7.3.0
2007-03	35	SP-070024	0080	1	Essential Corrections of the Reception Reporting Procedure	7.2.0	7.3.0

2007-03	35	SP-070027	0081	4	Hybrid PSS / MBMS Streaming services and Corrections to the MBMS User Service Description Schema	7.2.0	7.3.0
2007-03	35	SP-070027	0082		FLUTE session set-up with RTSP	7.2.0	7.3.0
2007-06	36	SP-070317	0084	1	Correction of termination of unicast bearer service based services	7.3.0	7.4.0
2007-06	36	SP-070315	0086	1	Correction of references in MBMS	7.3.0	7.4.0
2007-06	36	SP-070319	0089	3	Inclusion of DIMS in MBMS	7.3.0	7.4.0
2007-06	36	SP-070317	0090	2	Signalling of Initial Buffering Period	7.3.0	7.4.0
2007-06	36	SP-070317	0091	2	MBMS download service delivery to UEs in roaming condition	7.3.0	7.4.0
2007-06	36	SP-070317	0092	2	Scalability extensions for unicast delivery of MBMS services	7.3.0	7.4.0
2007-06	36	SP-070317	0093		Optimization to allow a smooth transition between MBMS and PSS	7.3.0	7.4.0
2007-06	36	SP-070315	0095	2	Correction of HTTP Response Error Codes	7.3.0	7.4.0
2007-06	36	SP-070317	0096	1	Addition of HTTP Response Error Codes	7.3.0	7.4.0
2007-06	36	SP-070317	0097		Improved video support for MBMS	7.3.0	7.4.0
2007-09	37	SP-070630	0078	3	Service Class Handling	7.4.0	7.5.0
2007-09	37	SP-070629	0088	3	Clarification of APN association and addition of APN elements	7.4.0	7.5.0
2007-09	37	SP-070629	0100		Correcting TMGI signalling and interpretation in SDP	7.4.0	7.5.0
2007-09	37	SP-070629	0102	1	Correction of several ABNF definitions	7.4.0	7.5.0
2007-09	37	SP-070630	0103		Correction of the OMA Push application id	7.4.0	7.5.0
2007-09	37	SP-070630	0104		Correction of QoE handling for MBMS Streaming on unicast	7.4.0	7.5.0
2007-09	37	SP-070630	0107	1	Clarification to the MBMS to PSS handover	7.4.0	7.5.0
2007-09	37	SP-070630	0108	1	Reception reporting by roaming MBMS users	7.4.0	7.5.0
2007-09	37	SP-070630	0109	2	Further correction to Required Service Capability for Service Access	7.4.0	7.5.0
2007-09	37	SP-070629	0111	1	Correction to ABNF syntax of QoE metrics in MBMS	7.4.0	7.5.0
2007-09	37	SP-070629	0113	1	Clarification of HTTP Response Error Codes for File Repair	7.4.0	7.5.0
2007-09	37	SP-070630	0114	1	Clarification of Release 7 specific HTTP Response Error Codes for File Repair	7.4.0	7.5.0
2007-12	38	SP-070762	0116	2	MBSFN bearer mode signalling	7.5.0	7.6.0
2007-12	38	SP-070762	0117	1	Clarification of re-synchronization after switch to unicast delivery	7.5.0	7.6.0
2008-03	38	SP-080010	0119	1	Corrections to different MBMS XML Schemas	7.6.0	7.7.0
2008-03	38	SP-080010	0121		Clarification of the reception reporting procedure start time	7.6.0	7.7.0
2008-06	40	SP-080251	0123	1	Correction to caching directive signaling	7.7.0	7.8.0
2008-09	41	SP-080468	0125	1	H.264 MIME/SDP reference correction	7.8.0	7.9.0
2008-09	41	SP-080468	0127	2	Correction to QoE reception reporting	7.8.0	7.9.0
2008-09	41	SP-080468	0130	2	Correcting file repair response for file-group requests	7.8.0	7.9.0
2008-09	41	SP-080477	0128	3	Enhancements of the QoE feature in MBMS	7.9.0	8.0.0
2008-09	41	SP-080477	0129	2	Registration procedure for MBMS User Service consumption	7.9.0	8.0.0
2008-09	41	SP-080477	0132	2	Transmitting a Full FDT snapshot	7.9.0	8.0.0
2008-12	42	SP-080681	0135	2	Time-shifting capability indication for MBMS services	8.0.0	8.1.0
2008-12	42	SP-080681	0137	1	Updates of references in MBMS	8.0.0	8.1.0
2008-12	42	SP-080681	0138	2	Hybrid streaming delivery appendix	8.0.0	8.1.0
2008-12	42	SP-080681	0141	1	Corrections of the FEC framework for MBMS Streaming	8.0.0	8.1.0
2008-12	42	SP-080681	0142		Additional guideline to use FEC streambundling for MBMS	8.0.0	8.1.0
2008-12	42	SP-080681	0143	1	Interleaving for fast channel switching and tune-in time in FEC-protected MBMS services	8.0.0	8.1.0
2009-03	43	SP-090004	0146		Addition of Timed Text payload format	8.1.0	8.2.0
2009-03	43	SP-090004	0149		Error in SDP for QoE configuration	8.1.0	8.2.0
2009-06	44	SP-090259	0153		Corrections for MBMS HSPA evolution	8.2.0	8.3.0
2009-06	44	SP-090256	0154		Correction of the MBMS User Service registration procedure	8.2.0	8.3.0
2009-09	45	SP-090567	0159	1	Clean-up corrections	8.3.0	8.4.0
2009-09	45	SP-090572	0155	2	QoE Alignment for MBMS	8.4.0	9.0.0
2009-09	45	SP-090572	0156	1	Key indicating of protected download data in FLUTE FDT	8.4.0	9.0.0
2009-09	45	SP-090572	0158	1	Using separate MBMS bearers for UTRAN and E-UTRAN in EPS	8.4.0	9.0.0
2009-12	46	SP-090716	0160		Correction of unreadable picture	9.0.0	9.1.0
2009-12	46	SP-090710	0161	1	MBMS DDF for QoE	9.0.0	9.1.0
2009-12	46	SP-090710	0162	1	MBMS QoE reporting during buffering periods	9.0.0	9.1.0
2009-12	46	SP-090711	0163	2	Video profile and level updates	9.0.0	9.1.0
2010-03	47	SP-100024	0165	1	HTTP Streaming with MBMS	9.1.0	9.2.0
2010-06	48	SP-100298	0167	1	Correcting the Access Bearer Identifier for different MBSFNs (IMB, TDD and FDD)	9.2.0	9.3.0
2010-06	48	SP-100303	0168	1	Addition of Timed Graphics to MBMS	9.2.0	9.3.0
2010-09	49	SP-100466	0169	2	Clarification on User Service Announcement over a MBMS bearer	9.3.0	9.4.0
2011-03	51				Inclusion of LTE logo	9.4.0	9.4.1
2011-03	51				Version for Release 10	9.4.1	10.0.0
2011-09	53	SP-110550	0171	2	Time Synchronisation between UE and BM-SC	10.0.0	10.1.0
2011-09	53	SP-110550	0172	2	Clarification of the TMGI Format	10.0.0	10.1.0
2011-09	53	SP-110550	0173	2	Missing QoE Attributes For FLUTE Transport	10.0.0	10.1.0

2011-09	53	SP-110550	0174	1	On counting clarifications	10.0.0	10.1.0
2011-11	54	SP-110795	0170	5	Initialisation Segment incorporation in DASH over MBMS	10.1.0	10.2.0
2011-11	54	SP-110789	0180	1	AlternativeUnicastDelivery	10.1.0	10.2.0
2011-11	54	SP-110792	0186	2	Clarification of QoE applicability	10.1.0	10.2.0
2011-11	54	SP-110792	0191	2	Correction to MBMS Session Identity and EPS support	10.1.0	10.2.0
2011-11	54	SP-110792	0193	2	File Repair Error Code	10.1.0	10.2.0
2012-03	55	SP-120023	0197	1	DASH Layer QoE	10.2.0	10.3.0
2012-03	55	SP-120020	0200	1	Addition of complete FDT & USD schema	10.2.0	10.3.0
2012-03	55	SP-120020	0202		Correction of StaR-only sample percentage, backoff timer initialisation and RACK timer initialisation in MBMS reception reporting mechanism	10.2.0	10.3.0
2012-03	55	SP-120023	0203	1	TMGI & mbms-counting-indication correction	10.2.0	10.3.0
2012-03	55	SP-120023	0207	3	Clarification on 3GPP File Format Support for MBMS	10.2.0	10.3.0
2012-03	55	SP-120020	0209	1	Miscellaneous corrections	10.2.0	10.3.0
2012-03	55	SP-120020	0211	1	MBMS Scheduling Information	10.2.0	10.3.0
2012-03	55	SP-120020	0213		Aligning security parameters in Service Protection Description with SA3 MBMS TS	10.2.0	10.3.0
2012-03	55	SP-120026	0194	3	On MBMS video enhancements	10.3.0	11.0.0
2012-03	55	SP-120026	0195	2	USD Signaling of Frequency and Service Area Information for Service Continuity	10.3.0	11.0.0
2012-03	55	SP-120026	0215	4	Reception Reporting from Specific UEs	10.3.0	11.0.0
2012-06	56	SP-120219	0227	1	Reception reporting corrections	11.0.0	11.1.0
2012-06	56	SP-120219	0230		MBMS USD Schema correction	11.0.0	11.1.0
2012-06	56	SP-120219	0234	1	MBMS Schedule Info corrections	11.0.0	11.1.0
2012-06	56	SP-120224	0238	2	Reception Report Aggregation	11.0.0	11.1.0
2012-06	56	SP-120224	0240	2	MBMS File Repair Using Conventional HTTP Servers	11.0.0	11.1.0
2012-06	56	SP-120219	0257	4	MBMS Schema Compatibility Correction	11.0.0	11.1.0
2012-06	56	SP-120219	0260	1	MBMS Metadata Envelope Correction	11.0.0	11.1.0
2012-09	57	SP-120498	0248	4	Updates to TS 26.346 referring to IETF FECFRAME	11.1.0	11.2.0
2012-09	57	SP-120504	0261	2	Server Selection for MBMS File Repair via Conventional HTTP Servers	11.1.0	11.2.0
2012-09	57	SP-120504	0262	1	MD5 Procedures for MBMS File Repair via Conventional HTTP Servers	11.1.0	11.2.0
2012-09	57	SP-120504	0267	1	EMM-DDE file repair overload retry timer	11.1.0	11.2.0
2012-09	57	SP-120498	0273	2	MBMS Reception Reporting and USD Schema Correction	11.1.0	11.2.0
2012-09	57	SP-120498	0276		MBMS FDT Instance ID Schema correction for OMA Push Bearer	11.1.0	11.2.0
2012-09	57	SP-120504	0280		Reception Report Aggregation	11.1.0	11.2.0
2012-09	57	SP-120504	0281	1	Pre-FEC QoE Metric for Download Delivery Sessions	11.1.0	11.2.0
2012-09	57	SP-120509	0282	2	Frame Compatible Stereoscopic 3D video support	11.1.0	11.2.0
2012-09	57	SP-120508	0285	1	USD Updates on 'availabilityInfo' Description	11.1.0	11.2.0
2012-12	58	SP-120761	0265	3	Support for Location Filtering	11.2.0	11.3.0
2012-12	58	SP-120761	0266	6	Partial File Delivery via FLUTE	11.2.0	11.3.0
2012-12	58	SP-120757	0293	2	Adding LTE network resource	11.2.0	11.3.0
2012-12	58	SP-120761	0298		MBMS Reception Reporting Schema Correction	11.2.0	11.3.0
2012-12	58	SP-120757	0301	1	MBMS Schedule fragment Examples	11.2.0	11.3.0
2012-12	58	SP-120764	0304	1	MBMS UE UTC Time Synchronization	11.2.0	11.3.0
2012-12	58	SP-120761	0305	2	Correction to Byte Range-based File Repair	11.2.0	11.3.0
2013-03	59	SP-130016	0264	6	Encrypted DASH contents delivered over MBMS	11.3.0	11.4.0
2013-03	59	SP-130020	0307	1	MBMS Filter Description fragment MIME Type	11.3.0	11.4.0
2013-03	59	SP-130014	0310		MBMS Schedule fragment MIME Type	11.3.0	11.4.0
2013-03	59	SP-130014	0313		MBMS Schedule Examples Correction	11.3.0	11.4.0
2013-03	59	SP-130014	0316	2	Correction to MBMS bearer identification	11.3.0	11.4.0
2013-03	59	SP-130014	0319	2	Extend unicast bearer service to E-UTRAN	11.3.0	11.4.0
2013-06	60	SP-130187	0306	2	Confidentiality Protection of Associated Delivery Procedure Messages	11.4.0	11.5.0
2013-06	60	SP-130183	0323	2	Correction of MBMS Session Identity	11.4.0	11.5.0
2013-06	60	SP-130183	0326	1	Correction to metadata reference and USD example	11.4.0	11.5.0
2013-09	61	SP-130349	0327		Correction to Reception Reporting Aggregation postReceptionReport timer calculation	11.5.0	11.6.0
2013-09	61	SP-130346	0330		Essential Correction to Schedule Fragment MIME Type	11.5.0	11.6.0
2013-09	61	SP-130348	0332	1	Essential Corrections of DASH over MBMS	11.5.0	11.6.0
2013-12	62	SP-130562	0339	3	USD schema correction for security protection and URN	11.6.0	11.7.0
2013-12	62	SP-130562	0342	2	USD schema correction for OMA push usage for MBMS download	11.6.0	11.7.0
2013-12	62	SP-130566	0344	1	ClientID in RACK Reception Reporting	11.6.0	11.7.0
2013-12	62	SP-130568	0349		USD Schema Bug Fix	11.6.0	11.7.0
2013-12	62	SP-130566	0351		Correction to Partial File Delivery from MBMS Receiver to DASH Client	11.6.0	11.7.0
2013-12	62	SP-130575	0320	8	USD Indication of DASH Transport	11.7.0	12.0.0
2013-12	62	SP-130578	0335	3	USD Data Model Correction	11.7.0	12.0.0
2013-12	62	SP-130578	0345		StaR reporting correction	11.7.0	12.0.0

2013-12	62	SP-130575	0348	2	File Repair without FDT	11.7.0	12.0.0
2013-12	62	SP-130578	0352		Editorial and technical corrections	11.7.0	12.0.0
2014-03	63	SP-140013	0336	6	Datacasting Support	12.0.0	12.1.0
2014-03	63	SP-140013	0346	5	Keep Updated Service	12.0.0	12.1.0
2014-03	63	SP-140013	0355	1	Correction to MBMS Protocol Stack	12.0.0	12.1.0
2014-03	63	SP-140004	0359	2	Correction for fdtGroupId	12.0.0	12.1.0
2014-03	63	SP-140013	0360		USD Examples bug fix	12.0.0	12.1.0
2014-03	63	SP-140013	0361	1	Missing media decoders specification for 3GP-DASH	12.0.0	12.1.0
2014-03	63	SP-140013	0362	1	DASH signaling over USD - backward-forward compatibility	12.0.0	12.1.0
2014-03	63	SP-140016	0363	1	Absolute Domain Name instead of FQDN	12.0.0	12.1.0
2014-03	63	SP-140016	0364	1	PSS Client instead of MBMS Client	12.0.0	12.1.0
2014-03	63	SP-140009	0365	1	HEVC support	12.0.0	12.1.0
2014-06	64	SP-140214	0347	6	Proxy server-based Mood	12.1.0	12.2.0
2014-06	64	SP-140203	0369		FLUTE Cache Control Expires format correction	12.1.0	12.2.0
2014-06	64	SP-140203	0373		MBMS-mode attribute value correction	12.1.0	12.2.0
2014-06	64	SP-140213	0374		USD and Schedule schemas bug fixes	12.1.0	12.2.0
2014-06	64	SP-140216	0375	2	MBMS session nomenclature	12.1.0	12.2.0
2014-06	64	SP-140203	0379	2	Correction of NTP timestamp definition and example	12.1.0	12.2.0
2014-06	64	SP-140206	0382	2	File Repair Correction	12.1.0	12.2.0
2014-06	64	SP-140206	0385	1	Consistent Syntax for Filter Description	12.1.0	12.2.0
2014-06	64	SP-140213	0388	1	Guidelines for linear audio/video streaming using DASH over MBMS broadcast	12.1.0	12.2.0
2014-06	64	SP-140204	0392	2	UE behavior for file schedule	12.1.0	12.2.0
2014-06	64	SP-140204	0396		FEC Payload ID reference correction	12.1.0	12.2.0
2014-06	64	SP-140204	0400	1	Network Resource measurement Period correction	12.1.0	12.2.0
2014-06	64	SP-140213	0401	1	appService backward compatibility correction	12.1.0	12.2.0
2014-06	64	SP-140204	0406	3	FLUTE FDT Instance Expiry Receiver Handling	12.1.0	12.2.0
2014-06	64	SP-140204	0411	1	EXT_FTI in regular FLUTE packets	12.1.0	12.2.0
2014-06	64	SP-140206	0413		Correction on Schema Version in XML Schema for Filter Description	12.1.0	12.2.0
2014-06	64	SP-140213	0414		Selective Content Reception	12.1.0	12.2.0
2014-09	65	SP-140472	0383	4	Enabling File Repair with Content Encoded Files	12.2.0	12.3.0
2014-09	65	SP-140456	0418	1	Media- and Session-level FEC Redundancy Level Declaration	12.2.0	12.3.0
2014-09	65	SP-140472	0419	2	Delivery of MBMS User Service on Multiple FLUTE Sessions	12.2.0	12.3.0
2014-09	65	SP-140473	0421	3	More on Mood Header	12.2.0	12.3.0
2014-09	65	SP-140473	0422	2	MBMS User Service Consumption Reporting	12.2.0	12.3.0
2014-09	65	SP-140472	0424		Schedule Examples Update	12.2.0	12.3.0
2014-09	65	SP-140476	0426	1	ADPD Schema Correction for reportType	12.2.0	12.3.0
2014-09	65	SP-140473	0429	3	Updated Text on Mood Operation	12.2.0	12.3.0
2014-12	66	SP-140736	0423	2	Bootstrapping MBMS Service Announcement	12.3.0	12.4.0
2014-12	66	SP-140734	0425	2	Mood - Consumption Reporting for unicast services	12.3.0	12.4.0
2014-12	66	SP-140732	0427	3	MI-EMO FLUTE Enhancements	12.3.0	12.4.0
2014-12	66	SP-140736	0430		ABNF syntax corrections	12.3.0	12.4.0
2014-12	66	SP-140734	0432	2	Mood implementation with PAC	12.3.0	12.4.0
2014-12	66	SP-140732	0433	1	MI-EMO DASH Robustness	12.3.0	12.4.0
2015-03	67	SP-150091	0436	3	Clarification of Cell-ID in Reporting of UE's Location	12.4.0	12.5.0
2015-03	67	SP-150091	0440		ADPD Example correction	12.4.0	12.5.0
2015-03	67	SP-150092	0441		APN in deliveryMethod	12.4.0	12.5.0
2015-03	67	SP-150098	0443	1	Reference cleanup-MBMS	12.5.0	13.0.0
2015-06	68	SP-150208	0449		basePattern in deliveryMethod	13.0.0	13.1.0
2015-06	68	SP-150208	0451		SAI in USD availabilityInfo for Consumption Reporting	13.0.0	13.1.0
2015-06	68	SP-150208	0453		SAIs in broadcastAppService subset of USD availabilityInfo	13.0.0	13.1.0
2015-06	68	SP-150197	0457	1	Clarification on Distribution of Symbol Count Underrun	13.0.0	13.1.0
2015-06	68	SP-150209	0459	1	Correction on Content-Encoding and Byte-Range-Based File Repair	13.0.0	13.1.0
2015-06	68	SP-150209	0461	3	Proposed Terminology for MBMS	13.0.0	13.1.0
2015-06	68	SP-150198	0471	2	Multiple TMGIs in SDP	13.0.0	13.1.0
2015-06	68	SP-150197	0472		Correction of MBMS FEC Reference	13.0.0	13.1.0
2015-06	68	SP-150209	0476	2	Add QoE metric parameter in SDP for MBMS download session	13.0.0	13.1.0
2015-09	69	SP-150441	0454	8	Service Announcement Profile for MBMS	13.1.0	13.2.0
2015-09	69	SP-150438	0478		clientId instead of reportClientId	13.1.0	13.2.0
2015-09	69	SP-150454	0481		mbms-counting-indication	13.1.0	13.2.0
2015-09	69	SP-150437	0483	2	serviceID in Mood header	13.1.0	13.2.0
2015-09	69	SP-150432	0486		USD Example correction	13.1.0	13.2.0
2015-09	69	SP-150432	0491	1	Multiple TMGIs in SDP Bug Fixes	13.1.0	13.2.0
2015-09	69	SP-150447	0492	2	HTML5 Presentation Layer for MBMS	13.1.0	13.2.0
2015-09	69	SP-150454	0493	2	Correcting clause 5.2.1 to add support for user service announcement over point to point push bearers	13.1.0	13.2.0
2015-09	69	SP-150454	0494	2	Terminology clarification for MBMS metadata envelope instance versus metadata envelope item	13.1.0	13.2.0

2015-09	69	SP-150454	0495	2	Terminology clarification for MBMS metadata fragment and metadata fragment object	13.1.0	13.2.0
2015-09	69	SP-150454	0496	2	Removing the unclear terminology of metadata fragment session	13.1.0	13.2.0
2015-09	69	SP-150449	0497	2	Partial File Handling	13.1.0	13.2.0
2015-09	69	SP-150437	0501	3	USBD-based Consumption Report control for services over unicast	13.1.0	13.2.0
2015-09	69	SP-150441	0502	3	Correction of usage of Metadata Envelopes for DASH MPD and Initialization Segments	13.1.0	13.2.0
2015-09	69	SP-150454	0505	1	Clarifying the text related to the level of support of H.264 (AVC) in MBMS	13.1.0	13.2.0
2015-12	70	SP-150643	0506		MBMS Profiles corrections	13.2.0	13.3.0
2015-12	70	SP-150643	0511	2	SDP QoE Metric Backward Compatibility	13.2.0	13.3.0
2015-12	70	SP-150656	0512		FDT schema correction	13.2.0	13.3.0
2015-12	70	SP-150643	0513		Correction on requiredCapabilities element in SACH	13.2.0	13.3.0
2015-12	70	SP-150643	0514	4	MBMS Reception Reporting of DASH QoE Metrics	13.2.0	13.3.0
2015-12	70	SP-150643	0515	4	MBMS Download Profile	13.2.0	13.3.0
2015-12	70	SP-150836	0516	7	MBMS Group Communication Delivery Method	13.2.0	13.3.0
2015-12	70	SP-150653	0517	3	HTML5 update support	13.2.0	13.3.0
2015-12	70	SP-150641	0520	2	MBMS Generic Application Service	13.2.0	13.3.0
2016-03	71	SP-160076	0522	1	Editorial corrections to clause 8A.3.1	13.3.0	13.4.0
2016-03	71	SP-160066	0526	3	Clarifications to Schedule Description for Unicast Service Access	13.3.0	13.4.0
2016-03	71	SP-160066	0528	3	Correction to USD Data Model	13.3.0	13.4.0
2016-03	71	SP-160076	0529	1	Corrections to the GC delivery method	13.3.0	13.4.0
2016-03	71	SP-160066	0531	2	MooD Header Syntax for Location	13.3.0	13.4.0
2016-03	71	SP-160066	0532	1	ADPD sample debug	13.3.0	13.4.0
2016-03	71	SP-160069	0533		Support of Television video profiles over MBMS	13.3.0	13.4.0

Change history							
Date	Meeting	TDoc	CR	R ev	Cat	Subject/Comment	New version
2016-06	SA#72	SP-160259	0535	1	A	RFC 7798: RTP Payload Format for HEVC for MBMS	13.5.0
2016-06	SA#72	SP-160258	0537	2	A	Service Announcement Signaling of MooD Header Attachment to Unicast Requests	13.5.0
2016-06	SA#72	SP-160258	0538	2	F	MooD Proxy Server Load Limitation	13.5.0
2016-09	SA#73	SP-160590	0542	2	A	Corrections to XML Schema of MBMS Consumption Report Request Message	13.6.0
2016-09	SA#73	SP-160587	0547	1	A	MIME Type for Consumption reporting request	13.6.0
2016-09	SA#73	SP-160587	0549	1	A	Separation of Consumption Report configuration from other associated delivery procedures	13.6.0
2016-09	SA#73	SP-160587	551	1	A	Consistent Location Reporting in Consumption Reports and MooD Headers	13.6.0
2016-09	SA#73	SP-160587	0553	-	A	Correction on UE re-selection of consumption reporting server	13.6.0
2016-09	SA#73	SP-160587	0555	1	A	Correction to Consumption Report Example	13.6.0
2016-09	SA#73	SP-160586	0562	2	A	Use of ETag for Byte-Range-based File Repair Request	13.6.0
2016-09	SA#73	SP-160599	0556	1	B	Reception Reporting Periodic Reporting	14.0.0
2016-12	SA#74	SP-160872	0564	1	B	Definition of interface procedures for MBMS User Services	14.1.0
2017-03	SA#75	SP-170022	0568	2	F	Clarifications and corrections to xMB procedures	14.2.0
2017-03	SA#75	SP-170018	0571	1	A	Relaxing Requirement on Persistent TCP Connection for Consumption Reporting	14.2.0
2017-03	SA#75	SP-170018	0575	-	A	Correct the type of the serviceId attribute	14.2.0
2017-06	SA#76	SP-170327	0576	2	B	Transparent Delivery Method	14.3.0
2017-06	SA#76	SP-170318	0577	3	F	Support for User Plane and other Corrections to xMB Interface	14.3.0
2017-06	SA#76	SP-170327	0578	3	B	File Delivery Manifest for xMB-U	14.3.0
2017-06	SA#76	SP-170327	0580	2	B	Changes to Support Receive Only Mode Services	14.3.0
2017-09	SA#77	SP-170601	0582	3	F	Corrections to xMB Stage 2 Text	14.4.0
2017-12	SA#78	SP-170822	0586	3	F	Corrections Regarding USD Signaling of ROM Service	14.5.0
2017-12	SA#78	SP-170822	0593	1	F	Support for Application Programming Interface and URL in MBMS	14.5.0
2017-12	SA#78	SP-170826	0592	1	B	Support for HDR TV Video Profile in MBMS	15.0.0
2018-06	SA#80	SP-180263	0596	3	A	Proposed Changes to xMB-related Text	15.1.0
2018-06	SA#80	SP-180276	0597	2	B	Adding Support for ROHC and FEC over xMB	15.1.0
2018-06	SA#80	SP-180272	0598	1	B	Consistent Support for Hybrid Services	15.1.0
2018-09	SA#81	SP-180649	0599	1	B	Adding Support for ROHC and FEC	15.2.0
2018-09	SA#81	SP-180639	0601	1	A	Correction regarding xMB-U usage for SCEF	15.2.0
2018-09	SA#81	SP-180685	0602	2	B	Virtual Reality in MBMS	15.2.0
2018-12	SA#82	SP-180966	0605	1	A	Update xMB file status list and file carousel provisioning	15.3.0
2018-12	SA#82	SP-180970	0606	3	F	ROHC and FEC xMB Alignment to Stage 3	15.3.0
2018-12	SA#82	SP-180970	0610	2	F	SDP exchange for FEC	15.3.0
2018-12	SA#82	SP-180970	0611	4	F	Corrections for ROHC usage	15.3.0

2018-12	SA#82	SP-180973	0617	-	F	Miscellaneous Bug Fixes to MBMS USD	15.3.0
2018-12	SA#82	SP-180966	0623	2	A	Correction of the file delivery manifest to match xMB properties	15.3.0
2018-12	SA#82	SP-180979	0621	1	D	Moving xMB to 26.348	16.0.0
2018-12	SA#82	SP-180981	0624	-	C	Update of MBMS Download Delivery Profile	16.0.0
2019-03	SA#83	SP-190035	0625	1	D	Changes Pertaining to Service Interactivity Feature	16.1.0
2019-03	SA#83	SP-190033	0626	2	B	New announcement profile for mission critical services	16.1.0
2019-06	SA#84	SP-190337	0628	-	A	USD Information on MBMS ROM Parameters	16.2.0
2019-12	SA#86	SP-190997	0629	1	B	Service Interactivity Support in DASH-over-MBMS Service	16.3.0
2020-03	SA#87-e	SP-200039	0631	1	B	Support of HLS and hybrid DASH/HLS service over MBMS	16.4.0
2020-06	SA#87-e					Editorial Changes	16.4.1
2020-06	SA#88-e	SP-200397	0632	2	F	Correction of MBMS Download Profile	16.5.0
2020-06	SA#88-e	SP-200390	0633	2	F	Correction on Partial File Handling	16.5.0
2020-08	Post SA#88-e					Version 16.5.1 created because the contents of the zip file for 16.5.0 was not appropriate	16.5.1
2020-09	SA#89-e	SP-200804	0634	-	F	Removing H.263 from MBMS	16.6.0
2020-10	Post SA#89-e					Version 16.6.1 created due to changes in the Change history	16.6.1
2020-12	SA#90-e	SP-200934	0635	2	F	Correction on Subcarrier Spacing in USD for ROM Service Delivery	16.7.0
2020-12	SA#90-e	SP-200934	0656	-	B	Feature Request for 5G Broadcast	16.7.0
2020-12	SA#90-e					Minor editorial corrections pertaining to CR-0632r2 (SP-200397) which was inadvertently left over to be implemented in Section L.4.1 after SA#88-e	16.8.0
2021-03	SA#91-e	SP-210034	0657	-	F	Bug Fix on Main USD Schema in Annex J.1	16.9.0
2021-05	SA#91-e					Editorial Correction to Table 11.9-1	16.9.1
2022-03	SA#95-e	SP-220036	0658	1	B	Missing XML Data Type for Attributes in MBMS USD	16.10.0
2022-04	-	-	-	-	-	Update to Rel-17 version (MCC)	17.0.0
2022-06	SA#96	SP-220597	0659	1	C	CR 26.346 annex L on Content Encoding (Rel-17)	17.1.0
2022-06	SA#96	SP-220597	0660	1	B	[5MBP3] User Service Extensions for 5GMS via eMBMS	17.1.0
2022-06	SA#96	SP-220597	0661	1	B	[5MBP3]: Feature reduced FLUTE FDT Schema	17.1.0
2022-12	SA#98-e	SP-221040	0663	-	A	correction of implementation error of CR0657	17.2.0
2022-12	SA#98-e	SP-221041	0667	1	A	TS 26.346 Changes regarding ROM SACH	17.2.0
2022-12						Editorial correction	17.2.1
2023-03	SA#99	SP-230256	0668	1	B	[TEI17, AE_enTV-S4] Support of ETSI TS 103 720 second version	17.3.0
2023-12	SA#102	SP-231374	0669	1	F	FEC-OTI-Maximum-Source-Block-Length for FEC Compact-No-Code	17.4.0
2024-05	-	-	-	-	-	Update to Rel-18 version (MCC)	18.0.0
2025-01	SA#106					Correction of misimplementation of approved CR0661r1	18.0.1
2025-03	SA#107	SP-250140	0673	-	F	XML corrections	18.1.0

History

Document history		
V18.0.0	May 2024	Publication
V18.0.1	January 2025	Publication
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