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| 3rd Generation Partnership Project;  Technical Specification Group Services and System Aspects;  Multicast Architecture Enhancement for 5G Media Streaming  (Release 17) | |
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# Foreword

This Technical Report 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

where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

3 or greater indicates TSG approved document under change control.

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.

In the present document, modal verbs have the following meanings:

**shall** indicates a mandatory requirement to do something

**shall not** indicates an interdiction (prohibition) to do something

The constructions "shall" and "shall not" are confined to the context of normative provisions, and do not appear in Technical Reports.

The constructions "must" and "must not" are not used as substitutes for "shall" and "shall not". Their use is avoided insofar as possible, and they are not used in a normative context except in a direct citation from an external, referenced, non-3GPP document, or so as to maintain continuity of style when extending or modifying the provisions of such a referenced document.

**should** indicates a recommendation to do something

**should not** indicates a recommendation not to do something

**may** indicates permission to do something

**need not** indicates permission not to do something

The construction "may not" is ambiguous and is not used in normative elements. The unambiguous constructions "might not" or "shall not" are used instead, depending upon the meaning intended.

**can** indicates that something is possible

**cannot** indicates that something is impossible

The constructions "can" and "cannot" are not substitutes for "may" and "need not".

**will** indicates that something is certain or expected to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

**will not** indicates that something is certain or expected not to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

**might** indicates a likelihood that something will happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

**might not** indicates a likelihood that something will not happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

In addition:

**is** (or any other verb in the indicative mood) indicates a statement of fact

**is not** (or any other negative verb in the indicative mood) indicates a statement of fact

The constructions "is" and "is not" do not indicate requirements.

# 1 Scope

This Technical Report identifies and evaluates potential enhancements to the 5G Media Streaming (5GMS) [1] in order to provide multicast-broadcast media streaming services. It has the following objectives:

* Define scenarios where multicast ingestion or multicast distribution might be used, including potential IGMP termination options [2], [3], and [4]. Examples for such collaboration scenarios are transparent multicast delivery, multicast linear IPTV delivery, hybrid unicast/multicast (e.g. MooD or service continuity), and multicast Adaptive Bit Rate (ABR) for Over the Top (OTT) live streaming.
* Identify the relevant key issues and gaps in 5GMS to support the above scenarios based on the existing 5GS multicast architecture.
* Document architecture extensions and procedures to support the above-defined scenarios.
* Identify protocols to support the above extensions and procedures in 5GMS.
* Identify Procedures for managing downlink multicast streaming and session lifecycle.
* Select a subset of relevant scenarios that should be supported in extensions to 5G Media Streaming.

# 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*.

[1] 3GPP TS 26.501: "5G Media Streaming (5GMS); General description and architecture”".

[2] IETF RFC 2236: "Internet Group Management Protocol, Version 2".

[3] IETF RFC 4604: "Using Internet Group Management Protocol Version 3 (IGMPv3) and Multicast Listener Discovery Protocol Version 2 (MLDv2) for Source-Specific Multicast".

[4] IETF RFC 3376: "Internet Group Management Protocol, Version 3".

[5] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[6] 3GPP TS 23.246: "MBMS Architecture and functional description".

[7] 3GPP TR 23.757: “Study on architecture enhancements for 5G multicast-broadcast services".

[8] 3GPP TS 23.316: "Wireless and wireline convergence access support for the 5G system".

[9] 3GPP TS 23.501: "System architecture for the 5G System (5GS)".

[10] 3GPP TS 23.502: "System architecture for the 5G System (5GS)".

[11] 3GPP TS 23.503: "System architecture for the 5G System (5GS)".

[12] ETSI TS 103 769: "Digital Video Broadcasting (DVB); Adaptive media streaming over IP multicast", v1.1.1, November 2020.

[13] CableLabs: "IP Multicast Adaptive Bit Rate Architecture Technical Report", Internet Available <https://specification-search.cablelabs.com/ip-multicast-adaptive-bit-rate-architecture-technical-report>

[14] ETSI TS 103 285: "Digital Video Broadcasting (DVB); MPEG-DASH Profile for Transport of ISO BMFF Based DVB Services over IP Based Networks".

[15] 3GPP TS 26.348: "Northbound Application Programming Interface (API) for Multimedia Broadcast/Multicast Service (MBMS) at the xMB reference point", Release 16.

[16] 3GPP TS 26.346: "Multimedia Broadcast/Multicast Service (MBMS); Protocols and Codecs", Release 16.

[17] ATSC A/331: "ATSC Standard: Signaling, Delivery, Synchronization, and Error Protection".

[18] 3GPP TS 29.468: "Group Communication System Enablers for LTE (GCSE\_LTE); MB2 Reference Point; Stage 3".

[19] 3GPP TS 23.468: "Group Communication System Enablers for LTE (GCSE\_LTE); Stage 2".

[20] RFC 6733: "Diameter Base Protocol".

[21] 3GPP TS 26.347: "Multimedia Broadcast/Multicast Service (MBMS); Application Programming Interface and URL", Release 16.

[22] 3GPP TS 22.146: "Multimedia Broadcast/Multicast Service (MBMS); Stage 1", Release 16.

[23] RFC 5053: “Raptor Forward Error Correction Scheme for Object Delivery”, October 2007

[24] RFC 5445: “Basic Forward Error Correction (FEC) Schemes”, March 2009

[25] RFC 3695: “Compact Forward Error Correction (FEC) Schemes”, February 2004

# 3 Definitions of terms, symbols, and abbreviations

## 3.1 Terms

For the present document, the terms given in 3GPP TR 21.905 [5], TS 26.501 [1], TR 23.757 [7] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [5] or TS 26.501 [1].

**Multimedia Broadcast/Multicast Service (MBMS):** See TS 22.146 [22].

**Broadcast Session:** See TR 23.757 [7].

**Multicast Session:** See TR 23.757 [7].

**MBS Session:** See TR 23.757 [7].

**Multicast adaptive bit rate (MABR):** a method of media streaming in which source media segments are encapsulated into the delivery units of a multicast media transport protocol, and are delivered over a multicast-capable network to a client-side function that is capable of switching dynamically between available unicast or multicast delivery of the ABR media with differing technical characteristics (e.g. different quality and bit rate) according to prevailing packet reception conditions.

NOTE: The multicast-capable network could be a 3GPP or non-3GPP network. Specifically in the present document, the multicast-capable network refers to 5MBS network.

## 3.2 Abbreviations

For the present document, the abbreviations given in TR 21.905 [5] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905.

5GMS 5G Media Streaming.

ABR Adaptive Bit Rate.

AL‑FEC Application-Level Forward Error Correction

ATSC Advanced Television Systems Committee

BM-SC Broadcast-Multicast - Service Centre

CMAF Common Media Application Format

DASH Dynamic Adaptive Streaming over HTTP

DNS Domain Name Service

DVB Digital Video Broadcasting

FEC Forward Error Correction

FLUTE File deLivery over Unidirectional Transport

HLS HTTP Live Streaming

HTTP HyperText Transfer Protocol

IGMP Internet Group Management Protocol

IPTV Internet Protocol Television

ISO BMFF International Standardization Organization Base Media File Format

MABR Multicast ABR

MBMS Multimedia Broadcast/Multicast Service

MBS Multicast/Broadcast Service

MLD Multicast Listener Discovery

MPEG Moving Picture Experts Group

OTT Over-The-Top

RoHC Robust Header Compression

ROUTE Real-time transport Object delivery over Unidirectional Transport

TMGI Temporary Mobile Group Identity

XML Extensible Markup Language

# 4 5G Media Streaming General Service Architecture and Principles

## 4.1 Introduction

3GPP has originally developed MBMS and later eMBMS [6] to support multicast/broadcast streaming services. Most recently, multicast/broadcast is viewed as one of the basic capabilities of 5G. Architecture enhancement for 5G multicast-broadcast services is being studied in SA2 in the scope of TR 23.757 [7]. The objective is to support general multicast and broadcast communications services, e.g. transparent IPv4/IPv6 multicast delivery, IPTV, software delivery over wireless, group communications and IoT applications, V2X applications, and public safety.

Additionally, without assuming any multicast capability in NR, a multicast IPTV architecture has also been specified in TS 23.316 [8], as enhancements of the stage 2 system architecture, procedures and flows, policy and charging control for the 5G system (5GS) defined in TS 23.501 [9], TS 23.502 [10], and TS 23.503 [11] in order to support wireline access network and fixed wireless access. Specifically, in clause 7.7.1.1.3 of TS 23.316, a procedure is specified on how to transmit multicast packets related to IPTV service over 5GC.

The unicast downlink streaming architecture and associated procedures are specified in TS 26.501 [1]. A multicast/‌broadcast architecture has the potential to play an important role in 5G media streaming. However, the impact on TS 26.501 of the abovementioned multicast/broadcast-related 5G service requirements and existing architecture in TS 23.316 has not yet been studied. In addition to 3GPP, DVB [12] and CableLabs’ work on multicast ABR [13] is gaining traction in industry. There is a desire to understand its potential implications on 5GMS as well.

## 4.2 Related 5G multicast and broadcast work in 3GPP

### 4.2.1 General

This clause provides a brief summary of existing multicast and broadcast related specifications in 3GPP as well as ongoing multicast and broadcast standardization work in 3GPP.

### 4.2.2 Existing 3GPP specifications on MBMS

#### 4.2.2.1 Introduction

The existing MBMS architecture in 3GPP allows data to be transmitted from a single source entity to multiple recipients. This clause summarises the MBMS delivery methods and user services, and the procedures between a content provider and the BM-SC function.

#### 4.2.2.2 MBMS Delivery Methods

Four delivery methods are defined, namely download, streaming, transparent, and group communications. These delivery methods are used to transmit downstream service content received over the interface between the Content Provider and the BM-SC. The delivery method is set based on “Session Type” property, as described in tables 5.4A-2, 5.4A-3, 5.4A-4, 5.4A-5, and 5.4A-6 in TS 26.346 [16].

The MBMS Delivery layer uses MBMS bearers or point-to-point bearers to deliver MBMS content to a receiving application. Bearers provide a mechanism by which IP data is transported. MBMS bearers are defined in TS 23.246 [6] and TS 22.146 [22]. They provide a means of efficient one-to-many transport for multicast and broadcast traffic. The MBMS Bearer Service is identified by a TMGI. For example, in EPS, an MBMS Bearer Service could be used to transport data for one or more MBMS download, streaming, transparent or Group Communications session.

#### 4.2.2.3 MBMS User Service

The MBMS User Service enables applications. It presents a complete service offering to the end-user and allows the end-user to activate or deactivate the service. For example, a DASH-over-MBMS could use the download delivery method to deliver content to MBMS subscribers. MBMS User service interfaces to the MBMS System via the BM-SC, GGSN (for GPRS) or MBMS GW (for EPS), and the UE, as depicted in Figure 4.2.2.3-1.



Figure 4.2.2.3-1: MBMS network architecture model for EPS

MBMS User Service procedures and protocols, including User Service Discovery/Announcement, User Service Initiation/Termination, and MBMS Data Transfer Procedure are specified in clause 5 of TS 26.346 [16].

MBMS User Services as defined in TS 26.346 [16] have been evolved over several releases. In particular, the following functionalities had been introduced to support different functionalities:

* DASH-over-MBMS
* Generic Application Service to support HLS over MBMS as well as hybrid DASH/HLS over MBMS
* Service continuity to support reception of MBMS user services over unicast for different purposes
* Associated Delivery Procedures to support different functionalities such as file repair, consumption reporting, QoE reporting, etc.
* Different service announcement modes
* MBMS Operation on Demand

Relevant deployment profiles had been collected in Annex L in the document for service announcement, download delivery, and transparent delivery.

#### 4.2.2.4 xMB reference point between content provider and BM-SC

This clause and the next one summarise two existing reference points between the Content Provider and the BM-SC. For Group Communications Services, the standard interface to and from BM-SC is **MB2**, specified in TS 29.468 [18] and TS 23.468 [19]. For services other than Group Communications, the standard reference point between the content provider and the BM-SC is **xMB**, defined in TS 26.348 [15]. Clauses 4.2.2.4 and 4.2.2.5 review xMB interface and MB2 interface, respectively.

Figure 4.2.2.4-1 reproduced from TS26.348 [15] specified xMB interface between Content Provider and BM-SC. Using the xMB reference point and the procedures supported by BM-SC, the Content Provider can authenticate and authorize BM-SC, create, modify and terminate a service or a session, query information, and deliver content to the BM-SC. The BM-SC may forward the received content for unicast delivery. BM-SC, on the other hand, can use xMB reference point to authenticate and authorize a content provider, notify the content provider of the status of an MBMS user service usage, and retrieve content from the content provider.

The Content Provider can use four user plane procedures to ingest content to BM-SC. The details of these user plane procedures, including file push, file pull, RTP streaming, and transport are specified in clause 5.5 of TS 26.348 [15].

In file ingestion with Pull, the content provider provides the file URLs to the BM-SC and the BM-SC fetches the files using HTTP GET. In file ingestion with Push, the Content Provider pushes the files using HTTP PUT.



Figure 4.2.2.4-1: The xMB reference model

RTP streaming mode and transport mode are more relevant to legacy multicast live streaming. In RTP streaming mode, the BM-SC establishes an RTP session to the content provider and starts the streaming session to relay media streams.



Figure 4.2.2.4-2: MBMS Streaming with RTP

In transport mode, the BM-SC listens on one IP address and one port number to receive UDP packets. These UDP packets received over xMB-U interface are then transmitted to downstream using Transparent Delivery methods. The transparent delivery method delivers application data units as part of UDP or IP flows over an MBMS bearer to the UE.

There are two xMB-U options for the Transparent Delivery method. In Transparent delivery with proxy, as depicted in Figure 4.2.2.4-3, the payload of UDP streams is opaque to the MBMS session and MBMS Client is expected to make the UDP payloads available to an application, without further knowledge on the content. The BM-SC re-wraps the UDP payload with an IP Multicast address and uses the MBMS bearer to deliver the UDP payload.



Figure 4.2.2.4-3: Transparent Delivery with Proxy mode

The following Session Properties allow the configuration of this xMB-U mode:

*- Session Type* is set by the Content Provider to *Transport-Mode.*

*- Delivery Mode Configuration for user plane* (Session Type specific property) is set by the Content Provider to *Proxy.*

*- Session Description Parameters for User Plane* (Session Type specific property) is set by the Content Provider and contains the UDP flow mapping descriptions.

- When *Session Announcement Mode* (Session Type specific property) is set by the Content Provider to *SACH*, the BM-SC will add according session description into the SACH. In this case the MBMS Client (cf. TS 26.347 [21]) will offer the service to an application.

- When *Session Announcement Mode* (Session Type specific property) is set by the Content Provider to *Content Provider* then the Content Provider is responsible to announce services to UEs (e.g. using GC1). The BM-SC provides at least the TMGIs as the value of the *Delivery Session Description Parameters* property.

In Transparent Delivery with Forward-Only mode in Figure 4.2.2.4-4, the transport protocol on top of IP is opaque to the MBMS session and an MBMS client is expected to make the UDP payloads available to an application. In this mode, the BM-SC is not aware of the IP Multicast layer beyond UDP layer in the Content Provider.



Figure 4.2.2.4-4: Transparent Delivery with Forward-Only

The following Session Properties allow the configuration of this xMB-U mode:

- Session Type is set by the Content Provider to Transport-Mode.

- Delivery Mode Configuration for user plane (Session Type specific property) is set by the Content Provider to Forward-only.

- Session Description Parameters for User Plane (Session Type specific property) is set by the Content Provider and contains the UDP flow mapping descriptions.

- When Session Announcement Mode (Session Type specific property) is set by the Content Provider to SACH, the BM-SC will add according session description into the SACH. In this case the MBMS Client (cf. TS 26.347 [21]) will offer the service to an application.

- When Session Announcement Mode (Session Type specific property) is set by the Content Provider to Content Provider then the Content Provider is responsible to announce services to UEs (e.g. using GC1). The BM-SC provides at least the TMGIs as the value of the Delivery Session Description Parameters property.

Table 4.2.2.4-1 summarizes the xMB-U procedures and corresponding delivery methods specified in TS 26.348:

Table 4.2.2.4-1: xMB User Plane procedures and delivery options

|  |  |
| --- | --- |
| xMB User Plane procedure | xMB Delivery mode |
| File ingestion with Pull | Download |
| File ingestion with Push |
| DASH content ingestion with Pull |
| DASH content ingestion with Push |
| HLS content ingestion with Pull/Push |
| RTP streaming | MBMS streaming |
| Transport | Transparent delivery |

#### 4.2.2.5 MB2 reference point

MB2 reference point, specified in TS 29.468 [18] and TS 23.468 [19], is used when the MBMS network provides Group Communication Services (such as MCPTT) delivery to the UE [16], as shown in Figure 4.2.2.5-1.



Figure 4.2.2.5-1: MBMS network architecture model for GCS Delivery

Editor’s Note: For services other than Group Communications, the standard reference point between the content provider and the BM-SC is defined in TS 26.348, and reviewed in clause 4.2.2.4.

The MB2 interface carries both control and user plane data, and provides a standardized way for an external entity, e.g. GCS AS to connect to BM-SC. A high-level reference model of the architectural elements relevant to understand the MB2 reference point is shown in Figure 4.2.2.5-2, reproduced from [18]. More complete reference models for GCS are contained in TS 23.468 [19].



Figure 4.2.2.5-2: Reference model for MB2 reference point

For MBMS delivery, the MB2 interface provides:

- MB2‑C procedures defined in TS 23.468 [19], for requesting the BM‑SC to activate, deactivate, modify an MBMS bearer, allocate/deallocate TMGI, and apply FEC and RoHC

- Forwarding of data to be delivered via an MBMS bearer to the BM‑SC via the MB2‑U reference point.

The MBMS session is identified by TMGI and Flow Identifier, which are assigned by TMGI upon request of the AS function.

The MB2-U Protocol stack is specified in clause 7 of TS 29.468 [18], as reproduced in Figure 4.2.2.5-3:



Figure 4.2.2.5-3: The user plane protocol stack

MB2-C protocol is a Diameter-based protocol as defined in RFC 6733 [20] and TS 29.468 Annex B [18]. BM-SC is the Diameter server in the sense that it is the network element that handles action requests and sends notifications. The AS function acts as the Diameter client in the sense it is the network element requesting actions and handles notification from the BM-SC. Transport protocol of Diameter messages over MB2-C interfaces make use of SCTP or TCP.

#### 4.2.2.6 MBMS Application Programming Interface and URL

Figure 4.2.2.6-1 (reproduced from TS 26.347 [21]) provides a graphical overview of the Application Programming Interface (API) and URL between the MBMS client and MBMS-aware Application (MAA), referred to as MBMS Application Programming Interfaces (MBMS-APIs). MBMS-aware Application communicates with the MBMS client through MBMS-APIs in the user space. MBMS-URL is a universal resource locator that enables a general application to access resources delivered through an MBMS User Service using the MBMS URL handler which translates the MBMS-URL to a sequence of MBMS-API calls.



Figure 4.2.2.6-1: MBMS Application Programming API

In addition, TS 26.347 [21] defines in Figure 5.1 (reproduced below in Figure 4.2.2.6-2) a general service architecture including a reference client. On the network side, an application and content provider provides media formats to a BM‑SC, typically through the xMB interface and initiates services and sessions through the xMB interface. The BM‑SC establishes MBMS User Services and the lower layers support the delivery of the data through regular 3GPP unicast as well as MBMS broadcast bearers.



Figure 4.2.2.6-2: General Reference Architecture for Client (based on TS 26.347 [21], Figure 5.1)

The MBMS-Aware Application initiates the communication with the MBMS Client using the MBMS-API. The MBMS Client identifies the relevant services and provides the delivered user data to the MBMS-Aware Application. Typically, the media formats are provided through interfaces and to functions that conform to well-defined media delivery formats. The MBMS-Aware Application controls the Media Client.

The focus of TS 26.347 [21] is to define interfaces and programming structures that are friendly to both application and web developers in order to enable such an MBMS-Aware Application to interact with the MBMS Client.

An MBMS-Aware Application communicates with the MBMS Client through APIs and possibly URL handlers**.** The MBMS Client is a function that implements functionalities defined in TS 26.346 and provides APIs interfaces to expose relevant functionalities to an MBMS-Aware Application.

Not repeated here, but shown in TS 26.347 [21] is also a DASH-specific instantation.

Details of the following MBMS-APIs can be found in TS 26.347 [21]:

* File Delivery Application Service API.
* Media Streaming Service API.
* MBMS Packet Delivery Service API.

In particular, clause 6 of TS 26.347 [21] defines control and management APIs for MBMS User services and clause 7 of [21] defines user-plane APIs for application and media services.

### 4.2.3 SA2 5MBS Study item on architectural enhancements for 5G multicast-broadcast

Editor’s Note: this clause is work in progress and will be updated to document the final agreements in SA2. SA4 is in continuous exchange with SA2.

3GPP SA2 workgroup has been exploring potential solutions to enhance 5G multicast-broadcast functionalities in TS 23.757 [7]. This 5MBS study item is expected to be completed in December 2020, except for those aspects with RAN2 decisions needed. Most of the key issues are under the final evaluation and conclusion phase. This clause reviews the ongoing SA2 working group’s activities on enhanced 5G multicast-broadcast architecture.

The goal of the SA2 5MBS study is to identify and evaluate potential enhancements to the 5G system architecture to provide multicast-broadcast services that might be used for different vertical businesses. How to use the provisioned capabilities in a specific service type is out of the scope of SA2 5MBS study. The objectives are:

Define the framework, including the functional split between (R)AN and CN, to support multicast/broadcast services, e.g. *ad hoc* multicast/broadcast streams, transparent IPv4/IPv6 multicast delivery, IPTV, software delivery over wireless, group communications and broadcast/multicast IoT applications, V2X applications, public safety.

Support for different levels of services (e.g., transport only mode vs. full service mode).

Enable flexible (i.e., distributed vs. centralized) network deployment and operation (e.g. separation of the control plane and user plane).

Address whether and how relevant QoS and PCC rules apply to multicast/broadcast services.

Support use cases and requirements (e.g. service continuity) for public safety, identified in SA1 and SA6 specifications (e.g., TS 22.179 and TS 22.280).

In the SA2 study, only NR or NG-RAN is considered as a wireless access technology. Support for UEs using or moving to an access network not supporting multicast/broadcast should be considered. The impact on RAN is to be analysed by and coordinated with the relevant RAN WGs. Currently, about 46 solutions are focusing on the following key issues:

1. MBS Session Management.

2. Definition of Service Levels.

3. Levels of authorization for Multicast communication services.

4. QoS level support for Multicast and Broadcast communication services.

5. Support for Broadcast TV Video and Radio communication services. *(Not within Release 17.)*

6. Local MBS service.

7. Reliable delivery method switching between unicast and multicast.

8. Reliable switching between unicast and broadcast delivery methods. *(Not within Release 17.)*

9. Minimizing the interruption of public safety services upon transition between NR/5GC and E-UTRAN/EPC.

The study assumes the sequence to establish and deliver a Multicast Broadcast (MBS) session is as follows:

1. Optional delivery of 5G MBS service information from application/service layer to 5GC.

2. UEs participate in receiving MBS flow, i.e. UE requests to join an MBS session (for Multicast Session).

3. Establishment of MBS flow transport. This step may happen before step 2 for individual UEs joining an MBS session which is already started.

4. MBS data delivery to UEs.

5. UEs stop receiving MBS flow (for Multicast Session).

6. Release of MBS flow transport (what used to be session stop).

Multiple delivery methods may be used to deliver MBS traffic in the 5GS from a single data source to multiple UEs. TR 23.757 [7] further described delivery methods in 5G CN and RAN. Two delivery methods are possible from the 5G Core Network’s point of view:

- **5GC Individual MBS traffic delivery method**: 5G CN receives a single copy of MBS data packets and delivers separate copies of those MBS data packets to individual UEs via per-UE PDU sessions.

- **5GC Shared MBS traffic delivery method**: 5G CN receives a single copy of MBS data packets and delivers a single copy of those MBS packets packet to a RAN node, which then delivers them to one or multiple UEs.

NOTE 1: The Shared MBS traffic delivery method and Individual MBS traffic delivery method are defined in SA2 WG and are listed here for reference only.

From the RAN’s point of view, in the case of the shared delivery, two delivery methods are available for the transmission of MBS packet flows over the radio interface:

- **Point-to-Point (PTP) delivery method**: a RAN node delivers separate copies of MBS data packet over radio to individual UE.

- **Point-to-Multipoint (PTM) delivery method**: a RAN node delivers a single copy of MBS data packets over radio to a set of UEs.

A RAN node may use any combination of the PTP/PTM delivery methods to deliver an MBS packet to a population of UEs. As shown in Figure 4.2.3-1, reproduced from TR 23.757 for the convenience of discussion, the Shared PTP or PTM delivery method and Individual delivery method may be used at the same time for a 5G MBS session.

NOTE 2: The PTP and PTM delivery methods are defined in RAN WG and are listed here for reference only.



Figure 4.2.3-1: Overview of User Plane for a multicast session

A set of interim requirements for 5G MBS session management are agreed in TR 23.757 [7]:

- For multicast solutions, signalling from the UE to the network to join a multicast session should be supported by UE and network. Join/leave operation via Control Plane (NAS) signalling should be supported.

- For N3 transport of the shared delivery method, GTP-U tunnelling using a transport layer IP multicast method and shared N3 (GTP-U) Point-to-Point tunnel should be supported with support for QoS.

- Both 5GC Shared MBS traffic delivery method and 5GC Individual MBS traffic delivery method should be standardized for multicast data delivery.

- The network should be able to prepare and start the multicast traffic transmission for an MBS session after MBS service is started.

- The network should support the selection of MB-SMF or SMF (depending on solution) at session join.

- For N3 transport of the 5GC shared MBS delivery method, and for unicast transport, there should be 1-1 mapping between MBS Session and GTP-U tunnel towards a RAN node. And for multicast transport, there should be 1-1 mapping between MBS Session and the GTP-U tunnel.

A reference architecture is provided in Annex A.3 of [7], reproduced as Figure 4.2.3-2 here:



Fig. 4.2.3-2: 5G MBS Reference Architecture from TR 23.757

The MBSF-C performs the following functions:

- Service level functionality to support MBS, and interworking with LTE MBMS.

- Interacting with AF and MB-SMF for MBS session operations and transport.

- Selection of MB-SMF for MBS Session.

- Controlling MBSF-U if the MBSF-U is used.

The MBSF-U performs the following functions:

- Modification of encoding of MBS data.

- Media anchor for MBS data traffic if needed.

NOTE 3: The MBSF-C and the MBSF-U may be co-located or deployed separately.

## 4.3 Related multicast and broadcast streaming standardization efforts outside 3GPP

This clause provides a review of related multicast and broadcast streaming standardization efforts outside 3GPP.

Editor’s note: We focus on streaming-related work to understand their implications on 5GMS.

### 4.3.1 DVB‑MABR Phase 1

#### 4.3.1.1 Motivation

The DVB-MABR Phase 1 technical specification [12] defines a logical reference architecture for providing linear and non-linear media services efficiently and at scale over a combination of multicast transport sessions, supplemented by optional Application-Level Forward Erasure Correction (AL‑FEC) and/or unicast repair of lost multicast packet payloads. The underlying design principles of the technical specification are:

1. To maintain compatibility with existing segmented media packaging formats, in particular DVB’s profile of MPEG‑DASH and MPEG‑CMAF [14]. (Provision is also made in the specification to support different CMAF-based segmented media streaming technologies, in particular HLS.)

2. To minimise changes to existing encoding, packaging and publication workflows that produce media in these formats.

3. To maintain compatibility with existing terminal equipment, such as IP-connected television sets and set-top boxes, that consume media in these formats.

4. To use multicast transmission as a transparent optimisation of existing unicast flows, while maintaining the use of those unicast flows in parallel for exceptional repair and fast channel change purposes. The load on unicast servers is thereby reduced to a significant degree, achieving the aforementioned scalability objective.

The DVB-MABR Phase 1 technical specification includes a logical reference architecture, summarised in Figure 4.3.1.1‑1 below, that specifies the logical functions of the system as well as named reference points at the interfaces between them.



Figure 4.3.1.1‑1: Simplified DVB-MABR functional architecture

#### 4.3.1.2 DVB‑MABR data plane

At the heart of the data plane architecture, a Multicast server function (c.f. BM‑SC in the MBMS architecture [6]) produces a set of multicast transport sessions at reference point M which are consumed by a population of Multicast gateway functions (c.f. MBMS Client).

NOTE 1: A multicast transport session is the equivalent of a FLUTE session in the MBMS architecture [16]. The equivalent of a time-bound MBMS session is called a multicast session in the DVB‑MABR architecture.

The Multicast server is responsible for ingesting media objects, such as DVB DASH segments, by means of:

a. **pull-based content ingest** at reference point Oin from an external Content hosting function which, in the case of segmented media, is technically identical to conventional unicast acquisition at reference point A; or else

b. **push-based content ingest** at reference point Pin′ directly from the Content preparation function.

NOTE 2: These two reference points are comparable with interface xMB‑U in the MBMS architecture [15].

Having ingested a media object, the Multicast server serialises it into a sequence of multicast packets compliant with a well-defined multicast media transport protocol. Two alternative multicast media transport protocols are mandated by the DVB‑MABR Phase 1 specification:

**Annex F:** An extended profile of the 3GPP FLUTE profile documented in Annex L of TS 26.346 [16].

**Annex H:** An extended profile of the ROUTE protocol specified in ATSC A/331 [17].

Implementations are required to support at least one of the two protocols. There is scope to specify additional optional multicast media transport protocols in subsequent technical specification phases.

Both protocols support low-latency modes of operation in which multicast transmission of media objects provided in accordance with clause 4.2.9 of [14] can begin before the object has been completely ingested by the Multicast server.

Provision is also made for the Multicast server to optionally transmit AL‑FEC repair packets alongside the source packets as part of a multicast transport session, addressed to the same or a different multicast destination address.

NOTE 3: The AL‑FEC mechanism is equivalent to the FEC Repair Stream in TS 26.346 [16].

The Multicast gateway subscribes to multicast transport sessions at reference point M using conventional IGMP (or MLD) interactions with the underlying network and then begins to receive a stream of multicast packets which it attempts to reassemble into the original media object. Any packet losses that cannot be made good with available AL‑FEC repair packets are repaired using efficient unicast HTTP byte-range requests to the Content hosting function at reference point A.

NOTE 4: The unicast repair feature is comparable with the byte-range-based File Repair Procedure, one of the Associated Delivery Procedures specified in clause 9 of TS 26.346 [16].

Intact media objects are presented to a generic MPEG‑DASH media player (the Content playback function in figure 4.3.1.1‑1 above) at reference point L. This interface is functionally equivalent to conventional unicast acquisition at reference point A, although the DASH presentation manifest (or HLS media playlist) may be artificially delayed or otherwise modified by the Multicast gateway in order to give it extra time to perform these multicast repair functions.

#### 4.3.1.3 DVB‑MABR control plane

DVB‑MABR Phase 1 specifies a common XML-based schema for describing multicast session configurations, and procedures for configuring both Multicast server instances (CMS) and Multicast gateway instances (CMR). The multicast gateway configuration is a subset of the multicast server configuration. The definitive current multicast session configuration resides in the Provisioning function, and both pull- and push-based RESTful HTTP interfaces are specified for transferring it from there to other functions in the system that require it.

NOTE 1: Reference point CMS is equivalent to xMB-C [15], although the latter supports only a push-based configuration method.

In addition, a special multicast gateway configuration transport session is specified which enables configuration for a large population of Multicast gateway instances to be carouselled by the Multicast server at reference point M. This is designed as a more scalable alternative to sending the multicast gateway configuration over the unicast path at CMR.

NOTE 2: This feature is especially useful in unidirectional broadcast networks that lack a return path.

NOTE 3: This feature is equivalent to the MBMS Service Announcement Channel [16].

#### 4.3.1.4 DVB‑MABR deployment architecture

In contrast to the MBMS architecture, where the MBMS Client is always embedded in the UE, the DVB‑MABR Phase 1 does not require that the Multicast gateway is embedded in a terminal device. As well as this fully embedded scenario, the DVB specification allows for a second possible deployment model where the Multicast gateway is embedded in a home gateway router device, and also a third model where this function is deployed at the access-facing edge of the core network, such as Multi-access Edge Compute node.

#### 4.3.1.5 DVB‑MABR session bootstrapping

Like the MBMS Client, a Multicast gateway operates as an HTTP reverse proxy. The aim is to make the delivery system as transparent as possible to the Content playback function, so that the latter remains unaware of the multicast optimisation. To that end, the DVB‑MABR Phase 1 reference architecture specifies a Multicast rendezvous service that has knowledge of the Multicast gateway instances deployed in the network and their current status. It also has access to the current multicast session configuration from the Provisioning function.

All presentation manifest requests from the Content playback function are initially directed to the Multicast rendezvous service at reference point B. Depending on the state of the system and the requested manifest, it responds by either:

a. redirecting the Content playback function to a local Multicast gateway at reference point L (if one is active, and if the requested presentation is part of the multicast session configuration), or else

b. redirecting the Content playback function to the Content hosting origin for conventional unicast-only playback.

Even for unidirectional broadcast deployments with no available return path, the Multicast rendezvous service function is deployed co-locally with the Multicast gateway and the same session bootstrapping sequence followed.

Alternatively, provision is made in the specification for local discovery of these two functions using, for example, multicast DNS techniques. The exact mechanism employed is left to the discretion of individual implementations.

## 4.4 Common architectural requirements and principles

The following common architectural requirements and principles apply.

Architecture reference models defined in TS 26.501 [1] is used as the baseline architecture for supporting multicast and broadcast services in this study. In particular, Figure 4.4-1 shows the 5G media streaming general architecture.

### 4.4.1 Baseline Network Reference Architectures

#### 4.4.1.1 General

Editor’s NOTE: The following two network reference architecture diagrams illustrate SA4 assumptions about the SA2 5MBS Network Reference Architecture drawing in TR 23.757 [7] (Figure A.3.2-1). TS 23.757 is not yet complete and there are multiple Editor’s Notes on function names and reference point names. The present report will align with the TR 23.757 names and terms once TR 23.757 is in a stable state. SA4 may still provide input to SA2 on some architectural findings.

Figure 4.4-1: 5G Media Streaming General Architecture

This clause presents a variant of the network reference architecture in TR 23.757 Clause A.3 with the following changes:

- The function MBSF-C is named MBSF and the function MBSF-U is named MBSU.

- Reference point “xMB” only refers to an interface that is provided by the BM-SC. For the 5MBS media delivery functions, the MBSU exposes an MB-M2 interface, which is xMB-U based.

- The MBSU is controlled by an MB-M3 interface (instead of Nmbsu). The functional scope of MB-M3 is identical to Nmbsu, however, the reference point name is aligned with 5GMSA interface namings.

- The MBSF is integrated into a 5GMS AF function that may expose an internal API resembling xMB-C. Support for standalone MBSF is for study.

- A standalone MBSF may be needed for different interworking scenarios. Interworking with legacy systems is for further study.

Legend for Figure 4.4.1.2-1 and Figure 4.4.1.3-1:

- Blue boxes: control plane functions as shown in TR 23.757 Figure A.3.2-1.

- Yellowy/orange boxes: user plane functions as shown in TR 23.757 Figure A.3.2-1.

- White boxes: 5GMS functions.

- Blue lines: control plane interfaces.

- Red lines: user plane interfaces.

- Black labeled interfaces: existing reference points from Release 16.

- Coloured labeled interfaces: newly coined reference points for Release 17.

#### 4.4.1.2 5GMSA functions in the Trusted DN

The following diagram illustrates a network reference architecture with all 5GMS and 5MBS functions within the Trusted DN. A 5GMS Application Provider (typically) in an External DN configures the 5GMS features via a Release 17 version of M1d interface. Two different models are considered:

1: The usage of 5MBS for media distribution is completely hidden from the 5GMS Application Provider. The 5GMS System selects usage of 5MBS based on internal criteria.

2: By means of 5GMS provisioning procedures at (extended) M1d, the 5GMS Application Provider explicitly controls the potential usage of 5MBS in certain areas and for certain content. For example, some content might not be authorized for 5MBS distribution by content rights owners. Or, some content might only be authorized for 5MBS distribution.

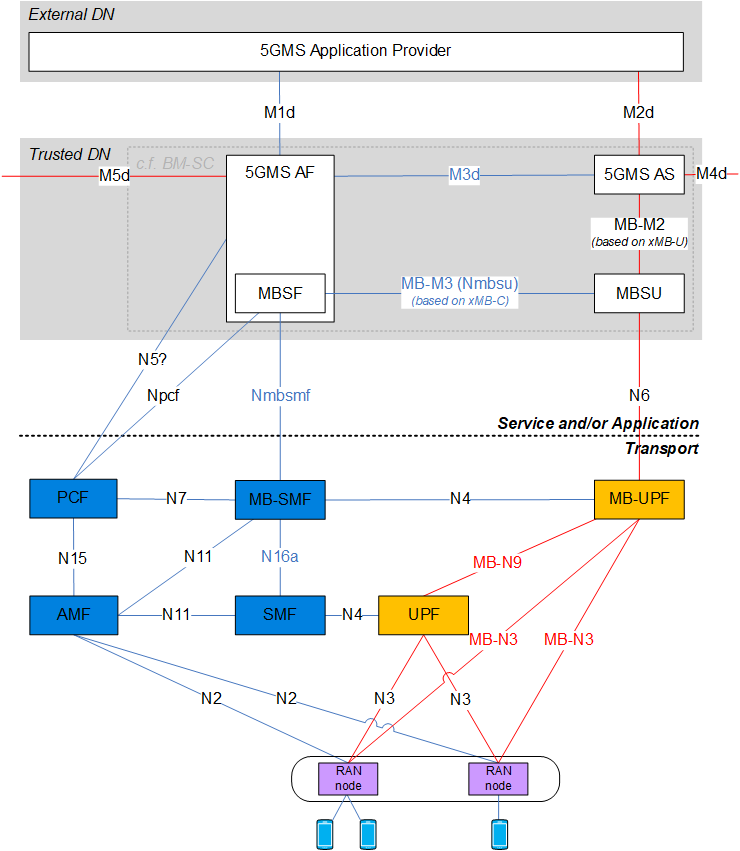


Figure 4.4.1.2-1: 5MBS architecture combined with 5GMS hosted in Trusted DN

#### 4.4.1.3 5GMSA functions in an External DN

The following diagram illustrates a network reference architecture with all 5GMS within an external DN. Only the MBSU resides inside a trusted DN. A 5GMS Application Provider (typically) in an external DN configures the 5GMS features via a Release 17 version of M1d interface.

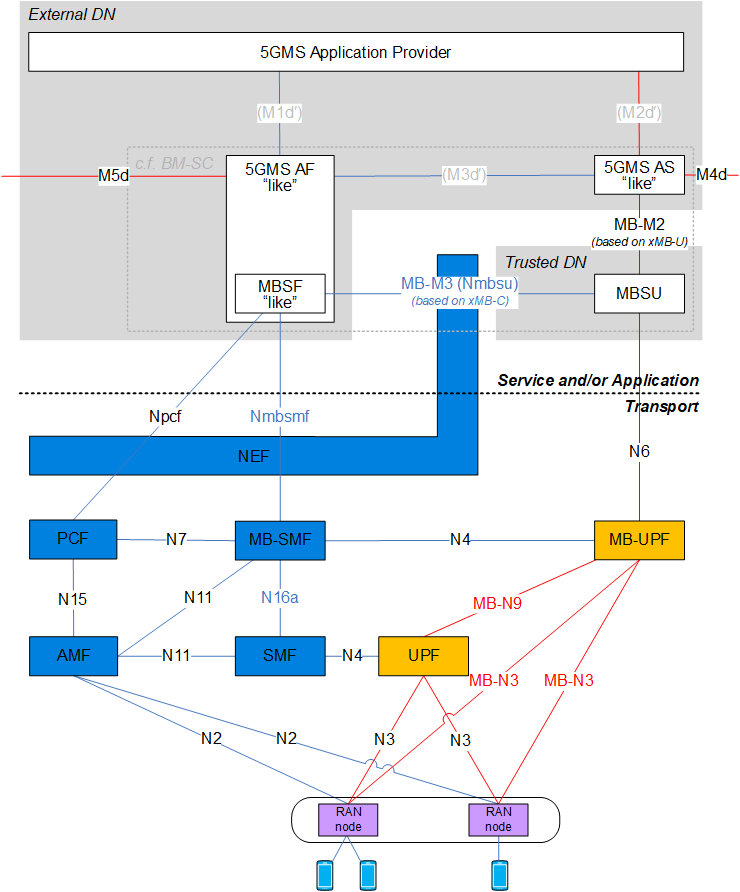


Figure 4.4.1.3-1: 5MBS architecture combined with 5GMS hosted in External DN

### 4.4.X Client architectures

#### 4.4.X.1 Introduction

Clause 4.4.1 introduces two network architectures, but client architectures are not provided. This clause provides client architectures and differentiates two different cases:

**1. 5MBS Standalone architecture.** In this case no 5G Media Streaming components may be present and may serve also the case for which 5MBS is used for other services than 5G Media Streaming in clause 4.4.x.2.

2. **5MBS combined with 5GMS.** In this case the 5GMS Application Provider is potentially unaware of 5MBS being used for media distributions in clause 4.4.X.3.

#### 4.4.X.2 Standalone 5MBS client architecture

Figure 4.4.X.2-1 provides an architecture for which 5MBS is used independently of 5GMS. Note that the network part may have different instantations and implementation models, and hence is not fully documented.



Figure 4.4.X.2-1 5MBS architecture independent of 5GMS

The key aspects of the client architecture are:

1. The existence of a **5MBS Client** on the UE. This client is expected to have similar functionalities to an MBMS Client, as defined in TS 26.346 [21].

2. An API from the 5MBS Client to the MBSF for the purpose of 5MBS control plane and service handling referred to as interface MBS-5. It is expected that this API has similar functionalities to those of the User Service Description defined in TS 26.346 [21].

3. An interface between 5MBS Client and the MBSU for the purpose of 5MBS user data exchange at MBS-4. This interface is separated into:

- MBS-4-MC dealing with unidirectional multicast delivery from the MBSU to the 5MBS client. It is expected that this interface has similar functionalities to the delivery methods defined in TS 26.346 [21].

- MBS-4-UC dealing with bidirectional unicast-based delivery from the MBSU to the 5MBS Client. It is expected that this interface has similar functionalities to the associated delivery procedures defined in TS 26.346 [21].

4. An interface MBS‑8 between the 5MBS Application Provider and the 5MBS-Aware Application in order to announce 5MBS services.

5. An API-based interface MBS‑6 exposed by the 5MBS Client and used by the 5MBS-Aware Application to the 5MBS Client to manage and control 5MBS services. It is expected that this API has similar functionalities to the control interfaces defined in clause 6 of TS26.347 [21].

6. An API-based interface MBS‑7 exposed by the 5MBS Client and used by the 5MBS-Aware Application to receive user data information about 5MBS services. It is expected that this API has similar functionalities as the data interfaces defined in clause 7 of TS26.347 [21].

An further decomposition of the above client architecture is provided in Figure 4.4.X.2-2 for which the 5MBS Client is separated into two components, namely:

* A **5MBSF Client** communicating with the MBSF function and predominantly dealing with user service description aspects. This function exposes the aforementioned MBS-6 API.
* A **5MBSU Client** communicating with the MBSU function for delivery functions. This function exposes the aforementioned MBS-7 API.



Figure 4.4.X.2-2 Extended 5MBS architecture independent of 5GMS

Two new API is introduced, namely:

* MBS-6′ that predominantly provides an API to control and manage the delivery functions of the MBSU Client.
* MBS-7′ that provides information logically assigned to MBS-5 delivery (user service information) through MBS-7′.

Some open question remain on details (see also clause 5.X key issues):

* Are there deployments that do not require an MBSF Client and hence, in which MBS-6′ is directly exposed to the 5MBS-Aware Application?
* Are there deployments for which no unicast is used? In this case, MBS-5 is completely served through MBS-7′.
* Is it useful to separate the 5MBSU Client into a multicast delivery and a unicast delivery component?
* On the MBS-4-UC requests, which unicast requests are proxied through 5MBS, for example to detect consumption, and which are served through M8?

NOTE: The 5MBS-Aware Application itself may be a media function and may include a media player, independently of the 5GMS architecture.

#### 4.4.X.3 5GMS client architecture using 5MBS

Based on the architectures in clause 4.4.X.2, 5GMS can be viewed as a 5MBS-Aware Application for which the 5GMS-Aware Application is basically unaware of 5MBS usage. The network aspects are again not detailed here: it is assumed that MBSF and MBSU exist.



Figure 4.4.X.3 Combined 5GMS and MBS client architecture

In this case:

* The Media Session Handler, based on information via M6 and M5, identifies the existence of a 5GMS service that is available through 5MBS and uses this information to:

- Initialize and control the 5MBS service through MBS-6.

- Initialize the Media Player through M7 to what extent MBS-7 is used for service delivery.

- The Media Player, based on static and dynamic information from the 5MSB client uses MBS-7 and/or M4 for receiving media.

Some open question remain on details (see also clause 5.X key issues):

* Where is the manifest served from? Through MBS-7, through M4, both, or either?

- How are different deployment scenarios in terms of hybrid, MooD realized?

# 5 Key Issues

## 5.1 General

This clause identifies relevant key issues and gaps in existing 5GMS to support collaboration scenarios where multicast ingestion or multicast distribution might be used.

## 5.2 Key Issue#1: Support of multicast ABR in 5G Media Streaming Architecture

### 5.2.1 Description

It has been observed that a small number of popular live linear TV channels account for large viewership in over-the-top media service deployment. It is expected that multicast could be used to deliver ABR-packaged media segments in 5G Media Streaming so that a shared multicast/broadcast packet stream can be delivered to the RAN nodes, without having the capacity costs associated with unicast video delivery.

Some relevant features of a generic MABR functional architecture are described below in terms of the DVB‑MABR architecture reproduced in Figure 4.3.1.1‑1:

- Media objects (e.g. presentation manifests, media segments) can be made available by the *Multicast server* on different multicast transport sessions (i.e. IP multicast groups) at reference point M, with the *Multicast gateway* function selecting between them using standard multicast join/leave procedures under the influence of requests from the *Content playback* function at reference point L.

- In the case where there is more than one set of media object streams encoded from the same source media stream (e.g. DASH adaptation set) in a presentation, an additional set of multicast transport sessions can be provided for each such set of media object streams.

- The *Content playback* function is an unmodified ABR media player (e.g. a DASH player). However, specific APIs may additionally be provided to support player operation.

- The *Multicast gateway* may be a media-aware HTTP(S) proxy or may be media-unaware.

NOTE: Bit rate adaptation by a *Multicast gateway* is for future study.

- The purpose of the *Multicast rendezvous service* is to maintain records of managed *Multicast gateway* instances, and to handle the initial request from the *Content playback* function for a presentation manifest. The *Multicast rendezvous service* redirects the *Content playback* function to use a *Multicast gateway* for a particular media presentation, when this is appropriate. This HTTP-level redirection is “sticky” and therefore is only needed in the case of the *Content playback* function’s initial request for a presentation manifest at the start of the presentation session. Subsequent requests for the presentation manifest in the same presentation session go straight to the *Multicast gateway*.

- Once the *Content playback* function has decided to use the *Multicast gateway* for a given media presentation, the request for the presentation manifest is proxied through the *Multicast gateway*. This gives the *Multicast gateway* the opportunity to modify the presentation manifest. Notably, the *Multicast gateway* can arrange for the *Content playback* function to direct certain media segment requests to the *Multicast gateway* at reference point L by selectively changing the origin in some of the URL base paths.

- The same media segments made available via multicast at reference point M are also available via unicast at reference point A. This enables a *Multicast gateway* to offer transparent unicast-based repair of media not received intact at reference point M and irreparable using AL‑FEC (if available). Unicast retrieval of media segments is also useful for supporting fast presentation start-up and for patching gaps when switching between multicast transport sessions.

Editor’s Note: Other relevant features may be identified and added at a later point during the course of the study.

In the CableLabs IP Multicast ABR architecture Technical Report [13], similar to DVB‑MABR, the term “Multicast Adaptive Bit Rate” is also used to refer to the multicast delivery of video segment files to a gateway or proxy which subsequently delivers these segments via HTTP when they are requested by a streaming video Player. As with DVB‑MABR, each multicast stream typically carries a single bit rate (e.g. a single DASH representation).

This key issue is aimed at studying how to provide support two scenarios:

* For a 5G Media Streaming Service provider to implement “Multicast ABR” like functionalities in 5G Media Streaming leveraging 5G MBS functionalities. For details see clause 5.2.3.
* For an external Multicast ABR provider to interface with 5G Media Streaming and 5G MBS to distributed data over 5G System. For details see clause 5.2.4.

Where appropriate, solutions addressing this Key Issue may include the reuse of existing concepts, functions and/or interfaces from Release 16, including the 5G Media Streaming architecture and the MBMS Service Layer.

Editor’s Note: DASH-over-MBMS and the generic Application Service specified in TS 26.346 already supports many of the required functions.

### 5.2.2 Scenario #1: MABR operation of 5MBS-enhanced 5GMS System

In this scenario, a 5MBS-capable 5GMS System operator wants to deliver linear television and radio services to a population of 5GMS Clients running in mobile UEs or fixed wireless access customer premises equipment, some of which are multicast-capable. The 5GMS System operator could use 5MBS functions in the Trusted DN to generate multicast transport sessions.

With reference to the simplified DVB functional architecture depicted in figure 4.3.1.1-1, in this scenario the *Multicast server* logical function corresponds to a new function in the 5G System and the *Multicast gateway* logical function corresponds to a function in the UE.

### 5.2.3 Scenario #2: External DVB‑MABR System interworking with 5MBS-enhanced 5GMS System

In this scenario, an existing DVB-MABR System operator wants to deliver linear television and radio services to an additional population of 5MBS-capable DVB *Multicast gateway*s running on UEs in an MNO’s PLMN. The DVB-MABR System operator feeds these additional *Multicast gateway* instances from the same DVB *Multicast server* which is already used to target the *Multicast gateway* instances in non-3GPP access networks. Some other aspects of this scenario include:

1. The UE-deployed *Multicast* gateway instances discover the current set of multicast sessions using standard DVB-MABR multicast session configuration and control procedures.

2. The UE-deployed *Multicast gateway* instances are able to adapt dynamically between multicast transport sessions of the same media representation offered at different bit rates according to prevailing 5MBS reception conditions using standard 5MBS procedures.

3. The UE-deployed *Multicast gateway* instances are able to repair uncorrectable packet erasures in the currently subscribed multicast transport sessions using the DVB-MABR unicast repair mechanism.

4. The *Multicast* gateway instances use standard DVB reporting mechanisms.

### 5.2.4 Initial assessment

A summary of the aforementioned MABR operation scenario and the DVB-MABR interworking scenario is provided in Table 5.2.4-1 below.

Table 5.2.4‑1: Comparison between scenarios for MABR deployment

|  |  |  |
| --- | --- | --- |
| Category | Scenario #1 (MABR operation) | Scenario #2 (DVB-MABR interworking) |
| Deployment model | MABR is an internal network optimisation by the 5GMS System operator. | DVB-MABR delivers content to DVB *Multicast gateway* running on UEs in a MNO PLMN. |
| Network elements | MABR is a 5MBS function in a Trusted DN that generates a service addressing the requirements. | DVB-MABR *Multicast server* generates DVB-MABR multicast transport sessions. |
| Client discovery | 5GMS Client discovers MABR Session. | Discover MABR Session using DVB-MABR procedures. |
| Client ABR behaviour | 5GMS Client adapts dynamically between 5MBS-advertised multicast streams. | DVB‑MABR *Multicast gateway* adapts dynamically between DVB-advertised multicast transport sessions. |
| Repair | 5GMS Client unicast repair mechanism at M4d. | DVB‑MABR *Multicast gateway* unicast repair mechanism. |
| Gap analysis | Check correspondence with DVB-MABR functions. Re-use of TS 26.346 functionalities. | Define interfaces that permit external ABR technologies to use 5G MBS. |

### 5.2.5 Scope of study

For Scenario #1, the following is expected to be studied:

1. A mapping of relevant Multicast ABR logical functions into the 5G Multicast/Broadcast Service architecture and the 5G Media Streaming architecture, including which reference points and protocols are required to support Multicast ABR functionality.

2. Outline procedures for configuring the Multicast ABR features relevant to the scenario in the 5MBS System and/or in the (extended) 5GMS System.

3. Outline procedures for discovering and establishing a Multicast ABR session, for switching dynamically between multicast transport sessions, for recovering from multicast packet loss and for reporting usage statistics and Quality of Experience metrics for the purpose of optimal service management.

4. Identifying network provisioning of different Representations, for example using different QoS, different FEC settings etc.

Any gaps identified during the analysis will also be documented.

It is noted that Scenario #2 is primarily about wrapping the DVB-MABR architecture around SA2's 5MBS architecture and interfacing it with a 5MBS-extended 5G Media Streaming architecture. The problems relevant to 5G Media Streaming for which solutions need to be studied are:

1. How to realise the DVB *Multicast gateway* function in a 5GMS UE and how best to interface with the 5GMS Client. This includes studying options for bit stream compatibility between DVB-MABR multicast transport sessions and 5MBS.

2. How best to provide DVB-MABR multicast session configuration to a *Multicast gateway* using either native DVB-MABR mechanisms, 5MBS Service Announcements or a blend of the two.

3. How best to realise the DVB-MABR unicast repair mechanism. This could be over-the-top repair requests via the unicast PDU Session, mediated through the 5GMS AS at M4, or a blend of the two.

4. How best to integrate the *Multicast gateway* with the DVB‑MABR reporting mechanism. This could use native reporting over unicast PDU Session, or an extension of the existing reporting mechanisms between the Media Session Handler and 5GMS AF, or a blend of the two.

Editor’s Note: Whereas Scenario #2 is possibly interesting to enable such external services, it is more the duty of DVB as an example to make use of 5GS capabilities than new definitions in 3GPP. Scenario #2 is more of relevance for external organizations being users or 5GS technologies. It is thus proposed to prioritize scenario #1.

## 5.3 Key Issue 2: Review of existing xMB interface

### 5.3.1 Description

#### 5.3.1.1 Model of a BM-SC User-Plane Function

The model below assumes that a FLUTE function according to MBMS Download Delivery (Clause 7 in TS 26.346) is mapped into an MBSU. Similar models can be created for RTP streaming and transparent delivery. However, these are likely not needed.

The purpose of this simplified model is to help identify the xMB-C parameters (xMB Service and Session Parameters) needed to configure an MBSU.



Figure 5.3.1.1-1: Simplified User Plane model for FLUTE (as a MBSU function)

The model depicts some key functions from an xMB-U ingest to an MB-UPF ingest (N6). In the case of 5MBS Download (e.g. used for DASH/HLS over MBMS or generic file delivery) the MBSU operates as follows:

1. The **HTTP File Receiver** is responsible for ingesting content resources intended for multicast transmission at xMB-U. It supports two basic content ingest modes:

a) **HTTP Pull**, in which the MBSU pulls resources from an upstream HTTP server, such as the 5GMSd AS. In this mode, xMB-C is used to provide individual URLs to be downloaded.

b) **HTTP Push**, in which resources are uploaded to the MBSU by an upstream client using HTTP PUT. In this mode, xMB-C is used to provide a base URL for ingesting data to the API invoker.

2. The MBSU may store partial or complete resources in a local **File Cache** prior to transmission at N6. Optimized implementations may pipe files through with only minimal buffering/caching.

3. HTTP metadata such as Content-Location (resource URL), Content-Length (resource size), and Content-Type (MIME content type) is provided by the HTTP File Receiver to the **FDT Instance creation** function. This acts as input (with other xMB-C parameters) to form the FDT Instance XML document.

4. The **File partitioning** function segments resources (including FDT Instances) into one or more multicast packet payloads. In the case where a Forward Error Correction scheme such as Raptor FEC (RFC 5053 [23]) or Compact No-Code FEC (RFC 5445 [24]) is used, there are recommended schemes and parameters to partition a resource into a sequence of packet paylods (called encoding symbols).

5. The **FLUTE packet creation** function inserts FLUTE header parameters such as the TSI, sequence number (FEC Symbol ID according to No-Code FEC, RFC 3695 [25] or Raptor FEC, RFC 5053 [23]), etc. As result, a complete UDP packet payload is created, which can be written to a UDP socket at the appropriate time of transmission.

6. Finally, the **Streamer & Pacer** function sends the multicast UDP packets according to a defined bit rate to the configured MP-UPF ingest point, which can be an MB2-U tunnel, some direct multicast, or similar.

#### 5.3.1.2 Review of existing xMB properties

This section contains a copy of the xMB service (Clause 5.3.7) and Session (Clause 5.4.6) properties. The column “related to User Plane” indicates whether the property is related to the user plane handling, e.g. defining the xMB-U ingest, etc. In this case, the MBSU need to be provisioned with the property value. Likely, the property is exposed via MB-M3 (Nmbsu).

Table 5.3.1.2-1: List of existing xMB Service Properties

|  |  |  |
| --- | --- | --- |
| Property Name | Related to User Plane (i.e. forwarded to MBSU) | Note |
| Id | No |  |
| ServiceID | No |  |
| Service Class | No |  |
| Service Languages | No |  |
| Service Names | No |  |
| Receive Only Mode | For Study | This flag is for ROM services. |
| Service Announcement Mode | No |  |
| Consumption Reporting Configuration | For Study |  |
| Push Notification URL | Yes |  |
| Push Notification Configuration | Yes |  |

Table 5.3.1.2-2: List of existing xMB Session Properties

|  |  |  |
| --- | --- | --- |
| Property Name | Related to User Plane (i.e. forwarded to MBSU) | Note |
| id |  |  |
| Session start | Yes | The MBSU needs to know when to start generating user plane packets. |
| Session stop | Yes | The MBSU needs to know when to stop generating user plane packets. |
| Max Bitrate | Yes |  |
| Max Delay | Yes |  |
| Session State | Partially | A session state is needed, but without the state “Session Announced”. |
| Service Announcement start time | No |  |
| Geographical Area | FFS |  |
| QoE Reporting | No |  |
| QoE Report URL | No |  |
| Session Type | yes |  |
| Header Compression | FFS | Unclear whether RoHC header compression is in RAN. |
| FEC | yes |  |
| Transport Mode | | |
| Session Description Parameters for User Plane | yes |  |
| Delivery Mode Configuration for user plane | yes |  |
| Delivery Session Description Parameters | yes |  |
| Streaming | | |
| SDP URL | yes |  |
| TimeShifting |  |  |
| Application (including DASH) | | |
| Application Service Description |  |  |
| Ingest Mode | yes |  |
| Application Entry Point URL |  |  |
| Push URL | yes |  |
| Unicast Delivery |  |  |
| Components |  |  |
| Files | | |
| Ingest Mode | yes |  |
| File List | yes | Except Unicast availability.  Target Reception Completion time is FFS, since unicast File Repair is included. |
| Carousel Mode |  |  |
| Carousel Scheduled Interval | yes |  |
| File delivery manifest URL | yes |  |
| Push URL | yes |  |
| Display Base URL | yes |  |
| SA file URL | no | An SA-file like concept is needed, but the MBSU is not handling it. |
| Mission Critical | | |
| MC-Extension |  |  |
| TMGI | no | The MBSU only need the MB-N6 tunnel information to ingest the data into the MB-UPF. The MBSF handles the TMGI. |
| QoS‑Information | no | The MBSU is not responsible for control plane interactions with the MB-SMF. |

### 5.3.2 Identified gaps

Editor’s Note: This section should summaries the identified issues

## 5.4 Key Issue #3: Collaboration and deployment scenarios

### 5.4.1 Description

In the following, four different deployment models are presented. The key guiding assumption here is that the MBSF contains key IP Multicast related BM-SC functions such as a FLUTE Sender (which belongs to the “MBMS Download and Streaming Delivery Function”). The intention is to identify important collaboration scenarios for the normative work.

The existing 5GMSA APIs M1d, M2d, M4d and M5d maybe be extended during 3GPP Release 17 with 5MBS (and other) functions.

It is further assumed that MB-M1 is an evolution of xMB-C and MB-M2 an evolaution of xMB-U.

A general assumption for all the collaboration scenarios is that the 5GMSd functions are used for unicast content distribution, e.g. CDN functionality for DASH streaming is used.

### 5.4.2 Collaboration A

**Collaboration A** depicts a deployment where all 5MBS and 5GMSd functions are deployed inside the trusted DN. Three different variants are depicted.

The 5GMSd AF and AS are responsible for unicast content distribution (e.g. CDN), i.e. M5d and M4d are exposed by the 5GMSd functions.

The MBSF and MBSU functions are for 5MBS distribution. The MBSF is the control and interacts with the MB-SMF using Nmbsmf.

- A0: The MBSF is integrated within the 5GMSd AF.

- A1: Fully separated functions.

- A2: Integrated control and user plane functions.

Collaboration A0 describes a model where the MBSF function is integrated into the 5GMSd AF and the MBSU function is still standalone. Background here is that the user plane functions are more specialized, i.e. optimized HTTP servers for unicast and optimized multicast delivery functions for multicast. The 5GMSd AF uses the newly developed MB-M3 (Nmbsu) API to configure and control the multicast delivery functions. The 5GMSd AS might be extended to cut-though any push ingest into the MB-M2.

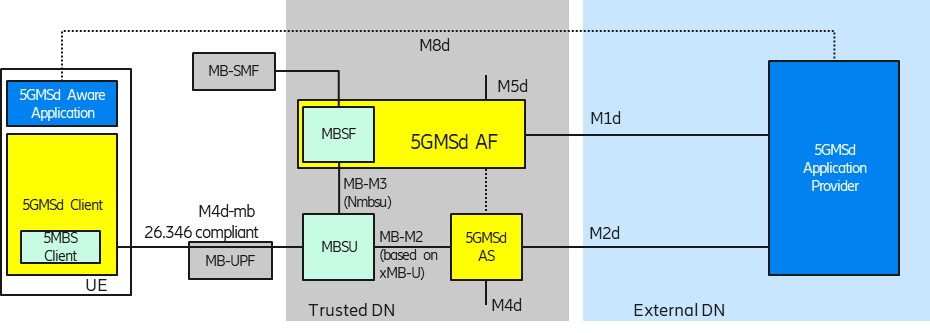


Figure 5.4.2-1: Collaboration A0: MBSF integrated within the 5GMSd AF

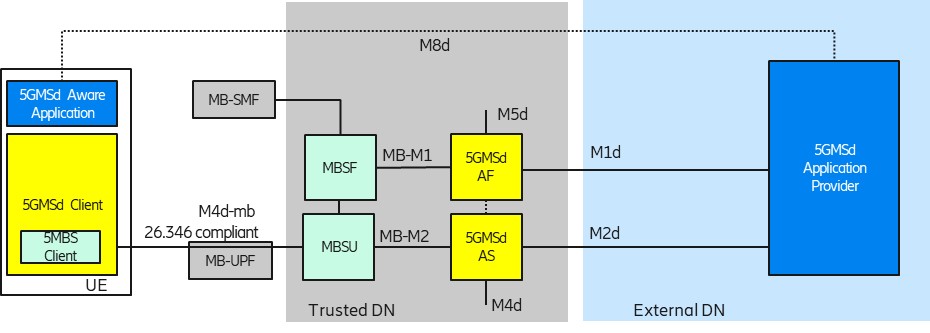


Figure 5.4.2-2: Collaboration A1: Fully separated functions

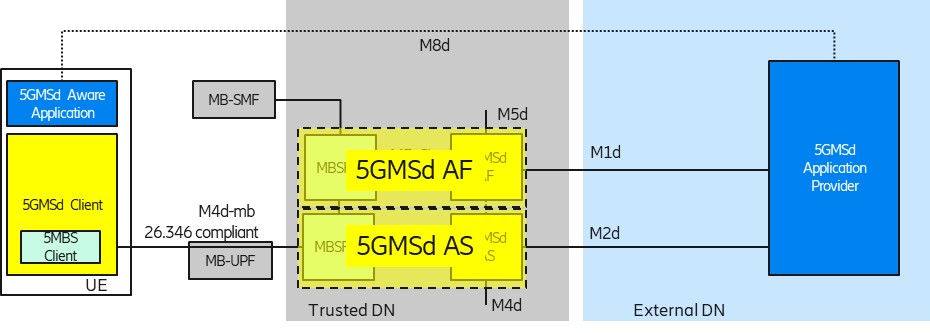


Figure 5.4.2-3: Collaboration A2: Integrated Control and User Plane functions

### 5.4.3 Collaboration B

**Collaboration B** depicts a mixed deployment where only the 5MBS related-functions are deployed in the trusted DN. Configuration B in Figure A.3.2-2 (TR 23.757) indicates that an external AF uses the NEF as control plane entry point. It is assumed that the MB-M1 interface is passed through the NEF and that the NEF adds security-related functions transparently.

Like in Collaboration A (and C), the 5GMSd functions are used for unicast content distribution, e.g. CDN functionality for DASH streaming is in an external DN. The functions in the trusted DN are leveraged to prepare the content for 5MBS delivery. Here is it assumed that unicast functions such as unicast content reception (e.g. DASH) and features like file repair can be offered by the 5GMSd AS from the external DN.

Note that Collaboration B2 does not contain 5GMSA functions. This collaboration scenario is associated to collaboration B, since the MBSF and MBSU functions are within the Trusted DN.

Also, for Collaboration B, three different variants are depicted.

- B0: The MBSF is presented in the trusted DN for service management.

- B1: The MBSF is absent and only an MBSU is used.

- B2: Only 5MBS functions, without 5GMSA functions.

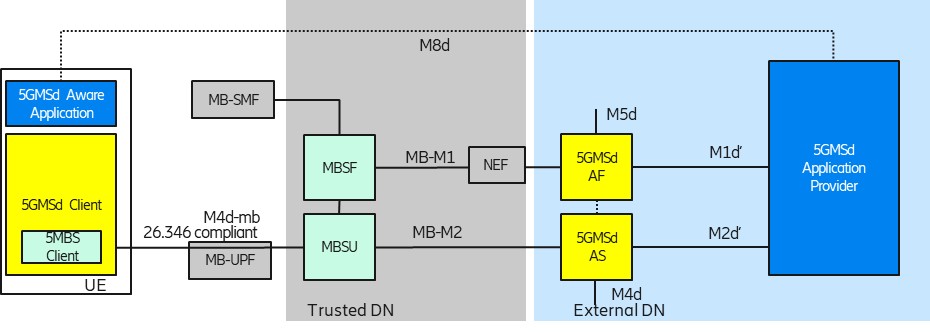


Figure 5.4.3-1: Collaboration B0: Mixed external and trusted DN functions

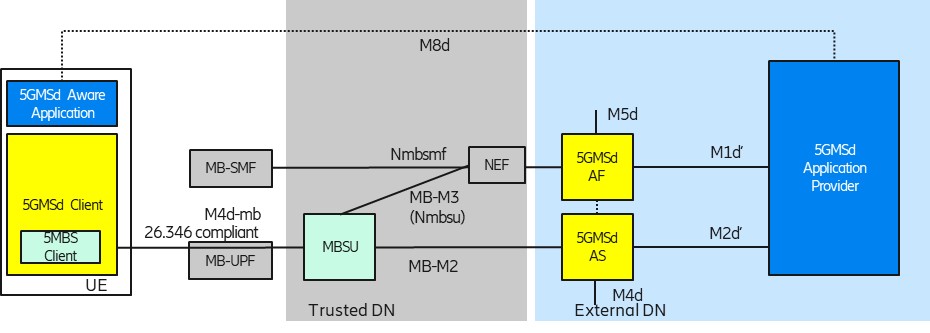


Figure 5.4.3-2: Collaboration B1: Mixed external and trusted DN functions

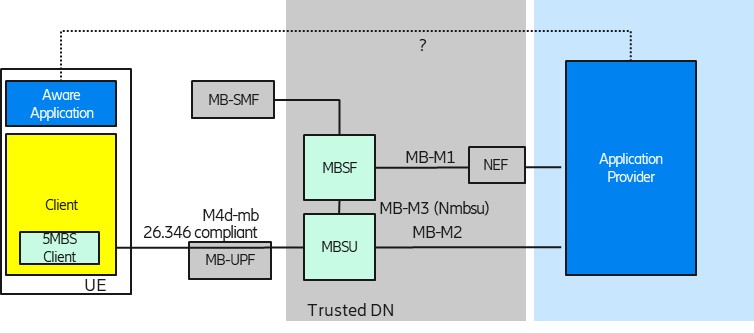


Figure 5.4.3-3: Collaboration B2: Mixed external and trusted DN functions deployedwithout 5GMS functions

### 5.4.4 Collaboration C

**Collaboration C** depicts a deployment where all media related functions are deployed in an external DN and the 5G System offers only connectivity services, i.e. either unicast connectivity or 5MBS transport-only connectivity.

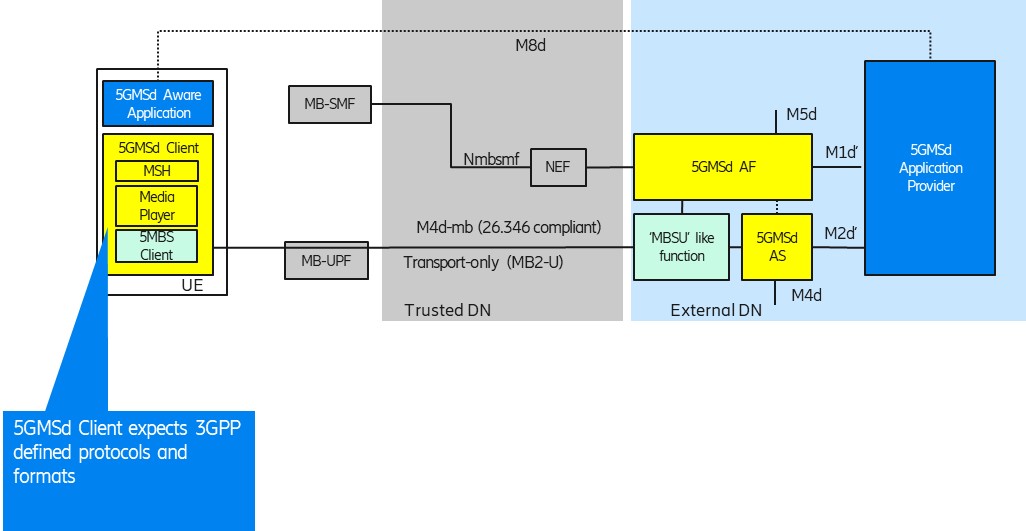


Figure 5.4.4-1: Collaboration C: All media functions in external DN

One could wonder why 3GPP should consider this deployment option. The consideration here is that a 5GMSd Client (including a new 5MBS Client) in the UE can still be leveraged as a multicast receiver, supporting reception of 3GPP-defined “DASH over 5MBS” generic file delivery and RTP streaming. An “MBSU-like” function would generate a bit stream compliant with TS 26.346. An external Application Function (AF) may use Nmbsmf (via NEF) to activate a transport-only type of delivery into the MB-UPF (according to Configuration 1 in Figure A.3.2-2 of TR 23.757).

### 5.4.5 Collaboration D

**Collaboration D** depicts a deployment similar to Collaboration #4 in TS 26.501. Here, the media plane does not follow 3GPP specifications. An Application Function (AF) may use Nmbsmf (via NEF) to activate a transport-only type of delivery into the MB-UPF (according to Configuration 1 in Figure A.3.2-2 of TR 23.757). Still, a 3GPP-defined Media Session Handler is interacting with a 3GPP-defined 5GMSd AF.

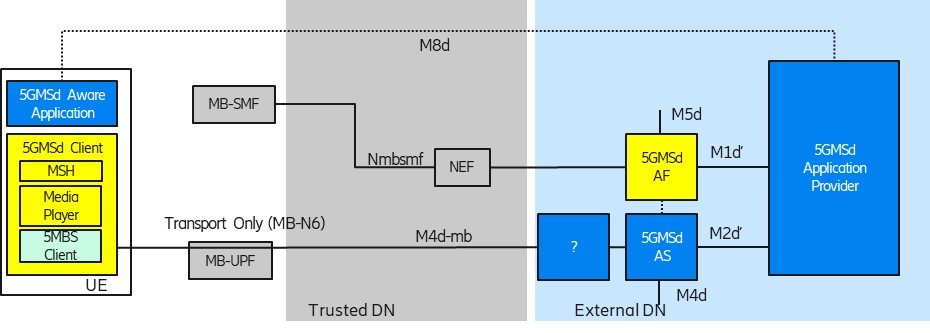


Figure 5.4.5-1: Collaboration D: Usage of transport-only delivery with non-3GPP protocols at M4d-mb

### 5.4.6 Identified gaps

Editor’s Note: Gaps to be identified. It is expected to study scenarios that should be supported and what they mean for APIs / interfaces.

## 5.5 Key Issue #4: Reuse of MBMS service layer

### 5.5.1 Description

The following aspects are proposed in order to study the reuse of MBMS service layer

1. Study the re-use of relevant “MBMS Service layer” functionalities (as defined in TS 26.346) for 5G MBS Session (as to be defined in Rel-17, TR 23.757) with full multicast support. In particular relevant functionalities are
   * Service Announcement and Discovery as defined in TS 26.346.
   * Download Delivery method, File Delivery as defined in TS 26.346, clause 7.
   * DASH/HLS over MBMS (both broadcast/multicast only as well as hybrid) as defined in TS 26.346, clause 5.3.
   * Transparent delivery method as defined in TS 26.346, clause 8B.
   * Associated delivery procedures as defined in TS 26.346, clause 9.
2. Study the necessary extensions of relevant “MBMS Service Layer” functionalities to support 5GS and 5G MBS Sessions (as to be defined in Rel-17, TR 23.757) in the context of 5G Media Streaming
3. Identify harmonization potentials for the 5G Media Streaming APIs (as defined in TS26.501 and TS 26.512) with APIs defined in TS 26.348 (xMB), TS26.346 (Protocols) and TS 26.347 (Client APIs) and integrate the “MBMS user service” relevant functions into 5G Media Streaming either by reference or by creating a new specification TS 26.51x.
4. Study the separation of the User Plane and Control Plane Functionalities of “BMSC” and map this to the relevant 5GMSd AS and AF.
5. Study the separation the User Plane and Control Plane Functionalities/APIs of “MBMS client” and map to or extend 5GMSd client functionalities/APIs (Clause 6 in TS26.347 is control, clause 7 in TS26.347 is user).
6. Study the integration of the 5G Broadcast System (EPC-based) as defined in TS 103 720 into 5GMS on both, the UE and the transmitter side.

## 5.6 Key Issue #5: Client Architecture Options

### 5.6.1 Description

Clause 4.4.X provides different client architectures. Open questions resulting from the stand-alone architecture are formulated:

* Are there deployments that do not require an MBSF client and hence, MBS-6’s is directly exposed to the 5MBS defined application.
* Are there deployments for which no unicast is used. In this case MBS-5 is completely served through MBS-7’
* Is it useful to separate the 5MBSU client into a multicast delivery and a unicast delivery component?
* On the MBS-4-UC requests, it needs to be understood what unicast requests are proxied through 5MBS, for example to detect consumption, or whether this is served through M8?

### 5.6.2 Approach to solve

In order to solve the above questions, different scenarios and use cases need to be document and call flows need to be provided. In particular the following services are studied:

* Services using transport-only mode
* Services using file delivery mode including segment-based streaming
* 5MBS multicast/broadcast only services without unicast
* Different flavours of hybrid services (see details in clause 5.7)

## 5.7 Key Issue #6: Hybrid Services

### 5.7.1 Description

Richard: Is there a case where a media player makes a request over MBS-7 and fallbacks to MBS-6 if failed?

Thomas: What does hybrid means? I don’t have an answer. E.g. MBS-4 could support multicast and unicast, which would allow file repair. This issue needs to be studied.

# 6 Potential Standardization Areas

## 6.1 General

This clause documents potential standardization areas in 5G Media Streaming Release 17 in the context of this Technical Report.

6.2 Potential Standardization Areas: Initially, the following areas are identified as potential standardization areas,

* Create a 5GMS-independendent 5MBS User Service Architecture
* Make 5GMS + MBS one scenario
* Define the interfaces and functions independent of 5GMS
* Expect to have a new spec TS 26.502 for 5MBS User Service Architecture

# 7 Potential Solutions

This clause provides potential solutions for the standardization areas identified in Clause 6.

# 8 Conclusions and Next Steps

tbd

# Annex A (informative): Change history

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Change history** | | | | | | | |
| **Date** | **Meeting** | **TDoc** | **CR** | **Rev** | **Cat** | **Subject/Comment** | **New version** |
| 2020-05-29 | SA4#109-e | S4-20941 | - | - | - | S4-20941: Proposed Skeleton TR 26.802 agreed in SA4#109-e | 0.0.1 |
| 2020-08-19 | SA4#110-e |  |  |  |  | Inclusion of documents agreed in SA4#110-e:  S4-201137 | 0.0.2 |
| 2020-11-20 | SA4#111-e |  |  |  |  | Inclusion of documents agreed in SA4#111-e:  S4-201628 | 0.1.0 |
| 2020-12-17 | SA4 MBS SWG AH Telco |  |  |  |  | Inclusion of S4aI201102 agreed in SA4 MBS SWG AdHoc Telco on Dec 10, 2020 | 0.1.8 |
| 2021-02-03 | SA4#112-e |  |  |  |  | Inclusion of S4-210079, S4-210152, S4-210153r02, S4-201384, S4-201386 | 0.2.2 |
|  |  |  |  |  |  |  |  |