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

Foreword 6

1 Scope 8

2 References 8

3 Definitions of terms, symbols, and abbreviations 9

3.1 Terms 9

3.2 Abbreviations 10

4 5G Media Streaming General Service Architecture and Principles 10

4.1 Introduction 10

4.2 Related 5G multicast and broadcast work in 3GPP 11

4.2.1 General 11

4.2.2 Existing 3GPP specifications on MBMS 11

4.2.2.1 Introduction 11

4.2.2.2 MBMS Delivery Methods 11

4.2.2.3 MBMS User Service 12

4.2.2.4 xMB reference point between content provider and BM-SC 12

4.2.2.5 MB2 reference point 15

4.2.2.6 MBMS reference client architecture 17

4.2.2.7 MBMS Application Programming Interface and URL 17

4.2.3 SA2 5MBS study item on architectural enhancements for 5G multicast-broadcast 18

4.3 Related multicast and broadcast streaming standardization efforts outside 3GPP 22

4.3.2 DVB‑MABR Phase 1 22

4.3.2.1 Motivation 22

4.3.2.2 DVB‑MABR data plane 23

4.3.2.3 DVB‑MABR control plane 24

4.3.2.4 DVB‑MABR deployment architecture 24

4.3.2.5 DVB‑MABR session bootstrapping 24

4.4 Common architectural requirements and principles 25

4.4.1 General 25

4.4.2 5G Media Streaming (5GMS) general architecture 25

4.4.3 5G Multicast–Broadcast Services (5MBS) system architecture 26

4.4.4 Baseline Network Reference Architectures 26

4.4.4.1 General 26

4.4.4.2 5GMSA functions in the Trusted DN 27

4.4.4.3 5GMSA functions in an External DN 28

4.4.5 Client Architectures 28

4.4.5.1 Introduction 28

4.4.5.2 Standalone 5MBS client architecture 29

4.4.5.3 5GMS client architecture using 5MBS (option A) 31

4.4.5.4 5GMS client architecture using 5MBS (option B) 32

5 Key Issues 34

5.1 General 34

5.2 Key Issue#1: Support of multicast ABR in 5G Media Streaming Architecture 34

5.2.1 Description 34

5.2.2 Scenario #1: MABR operation of 5MBS-enhanced 5GMS System 35

5.2.3 Scenario #2: External DVB‑MABR System interworking with 5MBS-enhanced 5GMS System 35

5.2.4 Initial assessment 36

5.2.5 Scope of study 36

5.2.6 Identified gaps 37

5.2.6.1 Scenario #1: MABR operation of 5MBS-enhanced 5GMS System 37

5.2.6.2 Scenario #2: External DVB‑MABR System interworking with 5MBS-enhanced 5GMS System 37

5.2.7 Conclusions and next steps 38

5.3 Key Issue 2: Nmb2 Design Considerations 38

5.3.1 Description 38

5.3.1.1 General 38

5.3.1.2 Model of a BM-SC User-Plane Function for MBMS Download Delivery 39

5.3.1.3 Handling of In-band ancillary Information for MBMS Download Delivery 40

5.3.1.4 Multiplexing of In-band ancillary information 41

5.3.1.5 Review of existing xMB properties for MBMS Download MBSTF configuration 41

5.3.1.6 Model of a BM-SC User-Plane Function for Group Communication Delivery 43

5.3.2 Identified gaps 44

5.3.3 Conclusions 45

5.4 Key Issue #3: Collaboration and deployment scenarios 45

5.4.1 Description 45

5.4.2 Collaboration A 45

5.4.3 Collaboration B 47

5.4.4 Collaboration C 49

5.4.5 Collaboration D 49

5.4.6 Conclusion 50

5.5 Key Issue #4: Reuse of MBMS service layer 50

5.5.1 Description 50

5.5.2 Conclusions 50

5.6 Key Issue #5: Client Architecture Options 51

5.6.1 Description 51

5.6.2 Approach to solve 51

5.6.3 Conclusions 51

5.7 Key Issue #6: Hybrid Services 52

5.7.1 Description 52

5.7.1.1 Definition 52

5.7.1.2 Use Case 1: External Hybrid Service 53

5.7.1.3 Use Case 2: 5GMS Hybrid Service 54

5.7.2 Identified Issues 55

5.7.2.1 General 55

5.7.2.2 Use Case 1: External Hybrid Service 55

5.7.2.3 Use Case 2: 5GMS Hybrid Service 55

5.7.3 Conclusions and Next Steps 56

5.8 Key Issue #7: 5GMS via eMBMS 57

5.8.1 Description 57

5.8.2 Identified Issues 57

5.8.2.1 Introduction 57

5.8.2.2 Option A: 5GMS uses MBMS User Service 58

5.8.2.2 Option B: 5MBS uses MBMS Transport-only Mode 59

5.8.2.3 Option C: 5GC integration of MBMS 59

5.8.2.4 Comparison of options 60

5.8.3 Conclusions 60

5.8.4 Recommended Next Steps 60

6 Potential Standardization Areas 61

6.1 General 61

6.2 Potential Standardization Areas 61

6.2.1 Introduction 61

6.2.2 5MBS User Service Architecture 61

6.2.3 5GMS Hybrid Services 62

7 Potential Solutions 64

7.1 General 64

7.2 Support of multicast ABR in 5G Media Streaming Architecture 64

7.2.1 Mapping of DVB‑MABR and CableLabs MABR reference architectures to 5MBS reference architecture for Scenario #1 64

7.2.1.1 Introduction 64

7.2.1.2 Mapping of logical functions 65

7.2.1.3 Mapping of logical reference points 66

7.2.1.4 Mapping to Collaboration B0 68

7.2.2 Interworking of DVB‑MABR reference architecture with 5MBS reference architecture for Scenario #2 70

7.2.2.1 Introduction 70

7.2.2.2 Interworking architecture for Collaboration C 71

7.2.2.3 Interworking architecture for Collaboration D 74

7.3 Multicast–Broadcast User Service 76

7.3.1 Introduction 76

7.3.2 MBSF 77

7.3.3 MBSTF 77

7.3.4 5MBS together with 5G Media Streaming Architecture 78

7.3.5 Hybrid 5GMS unicast and 5MBS services 79

8 Conclusions and Next Steps 79

8.1 General 79

8.2 Conclusions 80

8.3 Recommended normative work 80

Annex A (informative):Change history 82

# 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 OC-TR-IP-MULTI-ARCH-C01: "IP Multicast Adaptive Bit Rate Architecture Technical Report", October 2016. Internet Available https://www.cablelabs.com/specifications/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", October 2012.

[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.

[26] 3GPP TS 23.247, v0.1.0: "Architectural enhancements for 5G multicast-broadcast services; Stage 2;" Release 17.

[27] 3GPP TS 26.511: "5G Media Streaming (5GMS); Profiles, codecs and formats".

[28] 3GPP TS 26.512: "5G Media Streaming (5GMS); Protocols".

# 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].

**5MBS User Service:** Services provided to the end user by means of 5MBS transport and possibly other capabilities.

**Broadcast MBS Session:** See TS 23.247 [26].

**MBS Session:** See TS 23.247 [26].

**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.

**Multicast MBS Session:** See TS 23.247 [26].

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

## 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.

5MBS 5G Multicast/Broadcast Service

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

MBSF Multicast/Broadcast Service Function

MBSTF Multicast/Broadcast Service Transport Function

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 (described in clause 4.2.2.2) and user services (see clause 4.2.2.3), and the procedures between an Application Service Provider and the BM-SC function.

NOTE: The terms "Application Service Provider" and "Application and Content Provider" are used interchangably in TS 26.347 [21]. These, in turn, are equivalent to the term "Content Provider" used in TS 26.348 [15].



Figure 4.2.2.1-1: End-to-end architecture for Application Service Providers using eMBMS for delivery

Figure 4.2.2.1‑1 above (reproduced from TS 26.347 [21] clause 4.1) shows the end-to-end application architecture of the MBMS System between an Application Service Provider and an MBMS-aware Application running on a UE.

1. The Application Service Provider publishes content to a BM‑SC in the network via reference point xMB (see clause 4.2.2.4).

2. The BM‑SC uses MBMS User Services as well as MBMS Bearer Services and unicast bearers to communicate with an MBMS Client embedded in the UE.

3. The MBMS-aware Application communicates with the MBMS Client via a set of Application Programmer’s Interfaces called MBMS-APIs specified in TS 26.347 [21]. The APIs may be invoked directly by the MBMS-aware Application, or the MBMS URL Handler may use the MBMS-APIs after receiving an MBMS URL from a generic application (see clause 4.2.2.7).

#### 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 TS 26.348 [15] specified the xMB interface between a Content Provider and the 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) 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) 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 reference client architecture



Figure 4.2.2.6‑1: General client reference architecture

Figure 4.2.2.6‑1 above (reproduced from TS 26.347 [21] clause 5.1) shows a general service architecture including a reference client.

1. On the network side, an Application and Content Provider publishes media content to a BM-SC, typically through the xMB-U interface, and initiates MBMS services and sessions through the xMB-C interface (see clause 4.2.2.4).

2. 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 multicast/broadcast bearers.

3. A client-side component called the MBMS Client communicates with the BM‑SC according to the interface specified in TS 26.346 [16]. This includes both unicast and broadcast/multicast services. The MBMS Client offers a set of Application Programming Interfaces called the MBMS-APIs to the MBMS-aware Application.

4. The MBMS-aware Application intiaites communication with the MBMS Client either by directly invoking the MBMS-API, or indirectly via URL handlers (see clause 4.2.2.7 below).

5. The MBMS Client identifies the relevant services and supplies received user data to the MBMS-Aware Application.

6. The MBMS-aware Application controls the Media Client.

#### 4.2.2.7 MBMS Application Programming Interface and URL

Figure 4.2.2.7-1 (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.

An MBMS-URL is a universal resource locator that enables a general (i.e. non-MBMS-aware) 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 4.2.2.7-1: MBMS Application Programming API

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.

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

3GPP SA2 workgroup has been exploring potential solutions to enhance 5G multicast-broadcast functionalities in TR 23.757 [7]. This 5MBS study item was completed in March 2021, except for those aspects with RAN2 decisions needed. This clause reviews the SA2 working group’s activities on enhanced 5G multicast-broadcast architecture from TR 23.757 [7].

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:



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

The MBSF 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 the MBSTF (if it is used).

The MBSTF performs the following functions:

- Modification of encoding of MBS data.

- Media anchor for MBS data traffic if needed.

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

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

4.3.1 Introduction

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.

### 4.3.2 DVB‑MABR Phase 1

#### 4.3.2.1 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 4.3.2.1‑1 below, that specifies the logical functions of the system as well as named reference points at the interfaces between them.



Figure 4.3.2.1‑1: Simplified DVB-MABR functional architecture

#### 4.3.2.2 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 4.3.2.1‑1 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.

#### 4.3.2.3 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].

#### 4.3.2.4 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.

#### 4.3.2.5 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

### 4.4.1 General

The following common architectural requirements and principles apply.

### 4.4.2 5G Media Streaming (5GMS) general architecture

The architecture reference model defined in TS 26.501 [1] is used as the baseline architecture for supporting multicast and broadcast services in this study. In particular, Figure 4.4.2-1 shows the 5G Media Streaming general architecture.

Figure 4.4.2-1: 5G Media Streaming General Architecture

### 4.4.3 5G Multicast–Broadcast Services (5MBS) system architecture

Figure 4.4.3‑1 below illustrates the 5G Multicast–Broadcast Services (5MBS) system architecture in reference point representation. It is logically identical to Figure 5.1‑2 in TS 23.247 [26].

C:\Users\t841804\AppData\Local\Microsoft\Windows\INetCache\Content.Word\5MBS System Architecture - Reference point representation 2020-05-12.emf

Figure 4.4.3-1: 5G Multicast–Broadcast Services system architecture in reference point representation

### 4.4.4 Baseline Network Reference Architectures

#### 4.4.4.1 General

This clause presents a variant of the network reference architecture in clause 5 of TS 23.247 [26] with the following changes:

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

- 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 4.4.4.2-1 and Figure 4.4.4.3-1:

- Blue boxes: control plane functions as shown in TS 23.247 Figure 5.1-2.

- Orange boxes: user plane functions as shown in TS 23.247 Figure 5.1-2.

- White boxes: Application servers and functions, for example, a 5GMSd AF and AS.

- 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 for 5MBS in the 5GMS architecture.

#### 4.4.4.2 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.

C:\Users\t841804\AppData\Local\Microsoft\Windows\INetCache\Content.Word\5MBS reference architecture - Converged architecture mapping to 5GMS 2021-05-12.emf

Figure 4.4.4.2-1: 5MBS architecture combined with 5GMS hosted in Trusted DN

#### 4.4.4.3 5GMSA functions in an External DN

The following diagram illustrates a network reference architecture with all 5GMS within an external DN. Only the MBSTF 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.

C:\Users\t841804\AppData\Local\Microsoft\Windows\INetCache\Content.Word\5MBS reference architecture - Converged architecture mapping to 5GMS (external) 2021-05-12.emf

Figure 4.4.4.3-1: 5MBS architecture combined with 5GMS hosted in External DN

### 4.4.5 Client Architectures

#### 4.4.5.1 Introduction

Clause 4.4.4 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 4.4.5.2.

2. **5MBS combined with 5GMS.** In this case the 5GMS Application Provider is potentially unaware of 5MBS being used for media distributions in clause 4.4.5.3.

#### 4.4.5.2 Standalone 5MBS client architecture

Figure 4.4.5.2-1 provides an architecture for which 5MBS is used independently of 5GMS. Note that the network part may have different instantations and implementation models, and is hence is not fully documented.



Figure 4.4.5.2-1: 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 of 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 as defined in TS 26.346 [21].

3. An interface between the 5MBS Client and the MBSTF for the purpose of 5MBS user data exchange at MBS‑4. This interface includes:

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

Editor’s Note: Whether or not the architecture requires an interface MBS-4-UC for bidirectional and unicast-based delivery between the 5MBS AS and the 5MBS Client, and how the 5MBS AS is configured, is for further study.

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 manage and control 5MBS services. It is expected that this API has similar functionalities to the control interfaces defined in clause 6 of TS 26.347 [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 TS 26.347 [21].

NOTE: In the case where the 5MBS Client is deployed in a 5G Residential Gateway and the 5MBS-Aware Application is deployed in a separate end device, reference points MBS‑6 and MBS‑7 span the network interface between these devices.

A further decomposition of the above client architecture is provided in Figure 4.4.5.2-2 for which the 5MBS Client is separated into two components, namely:

*-* An **MBSF Client** communicating with the MBSF function and predominantly dealing with user service description aspects. This function exposes the aforementioned MBS-6 API.

*-* An **MBSTF Client** communicating with the MBSTF function for delivery functions. This function exposes the aforementioned MBS-7 API.



Figure 4.4.5.2-2: Extended 5MBS architecture independent of 5GMS

Two new APIs are introduced, namely:

*-* MBS-6′ that predominantly provides an API to control and manage the delivery functions of the MBSTF 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 5.6 key issues):

*-* Are there deployments that do not require an MBSF Client and hence, MBS‑6′ 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 MBSTF 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.

#### 4.4.5.3 5GMS client architecture using 5MBS (option A)

Based on the architectures in clause 4.4.5.2, the 5GMS Client can be viewed as a 5MBS-Aware Application and the 5GMS-Aware Application is basically unaware of 5MBS usage. The network aspects are again not detailed here: it is assumed that MBSF and MBSTF exist.



Figure 4.4.5.3-1: Combined 5GMS and MBS client architecture (option A)

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 through MBS-6.

- Initialize the Media Player through M7, to the extent that 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 5.6 key issues):

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

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

#### 4.4.5.4 5GMS client architecture using 5MBS (option B)

The alternative client architecture depicted in Figure 4.4.5.4‑1 below combines the 5GMS architecture with that of 5MBS. It differs from Figure 4.4.5.3‑1 in the use of an additional core function, the 5MBS AS, to terminate unicast file repair requests from the 5MBS Client at reference point MBS-4-UC. The interface at this reference point is technically identical to that at M4, i.e. unicast HTTP. The Media Player continues to use reference point M4 for non-5MBS media retrieval from the 5GMS AS.



Figure 4.4.5.4-1: Combined 5GMS and MBS client architecture (option B)

In practical deployments that combine 5G Media Streaming with 5MBS, the MBSF is likely to be co-located with the 5GMS AF, as described in clause 4.4.1 of the present document. In addition, the 5MBS AS is likely to be co-located with the 5GMS AS in such deployments because the two functions share a high degree of commonality. Figure 4.4.5.4‑2 below illustrates this likely deployment architecture.

C:\Users\t841804\AppData\Local\Microsoft\Windows\INetCache\Content.Word\FS_5GMS_Multicast - Client architecture - Combined 5GMS and 5MBS (alternative v4) 2021-05-12.emf

Figure 4.4.5.4-2: Combined 5GMS and MBS client architecture (option B) depicting likely co-location

In both of the above figures, the 5MBS AS exposes an interface at reference point MBS‑4‑UC that is technically identical to M4, and which is potentially useful to the 5MBS Client in at least the following contexts:

1. **Fast 5GMS session start-up** via unicast while the 5MBS Client is waiting for initial multicast/broadcast packets to start arriving via MBS‑4.

2. **Unicast recovery** of the application payload data carried in multicast/broadcast packets that are not successfully received via MBS‑4, in a manner that is transparent to the 5GMS Client.

3. **5GMS session continuity** when multicast/broadcast service is temporarily unavailable, in a manner that is transparent to the 5GMS Client.

4. Switching the operating mode of a 5GMS session to unicast under the direction of network-based **multicast operation on demand** (MooD), in a manner that is transparent to the 5GMS Client.

Relevant issues to be studied include:

- How the 5MBS AS is configured.

- Shared use of a single PDU Session by M4 and MBS‑4‑UC. (The solution to this may be trivial.)

- Whether the presentation manifest is delivered via M4 or MBS-7.

- How different deployment scenarios such as hybrid operation and MooD are realised.

# 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:

1. 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.

2. 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.

### 5.2.6 Identified gaps

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

In connection with the mapping to Collaboration B0, the following gaps are identified in clause 7.2.1:

1. A named reference point between the MBSF and 5MBS AS to enable the former to publish 5BMS User Services session descriptions to the latter so that they can be retrieved via unicast in cases where they are not conveyed in a service announcement channel.

2. The procedures for a 5MBS Client to retrieve these session descriptions via MBS‑4‑UC.

3. The means to announce these unicast-hosted session descriptions to the 5MBS Client at MBS‑5.

4. The means to describe multiple object delivery sessions corresponding to different representations of the same media adaptation set within a 5MBS User Services session description consumed by the 5MBS Client.

NOTE 1: Clause 5.2.2.2 of TS 26.346 permits one FLUTE Download session to be described by each session description instamce. It permits multiple session description instances to be contained in one session description object, but this is not further specified. Alternatively, the constraint on the number of FLUTE channels per FLUTE Download session specified in clause 7.3.2.2 of TS 26.346 could be relaxed.

NOTE 2: In the Scenario #1 mapping presented in clause 7.2.1 it is assumed that dynamic adaptation is performed by the 5MBS Client, but alternative implementations are also possible.

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

For interworking between an external Application Function and the 5MBS System according to Collaboration C, the following gaps are identified in clause 7.2.2.2:

1. Configuration of a transparent multicast delivery session at Nmbsmf such that it can be advertised in a 5MBS User Services session description and consumed by a 5MBS Client.

2. The means to describe multiple transparent object delivery sessions within a 5MBS User Services session description provided via Nmbsmf, and the means to deliver this session description to the 5BMS Client via MBS‑5.

3. Client-side injection of a synthetic 5MBS User Services session description from the 5MBS-Aware Application to the 5MBS Client at MBS‑6.

For interworking between an external Application Function and the 5MBS System according to Collaboration D, the following gaps are identified in clause 7.2.2.3:

4. Configuration of a transport-only multicast delivery session at Nmbsmf such that it can be advertised in a 5MBS User Services session description and consumed by a 5MBS Client.

5. The means to describe multiple transport-only object delivery sessions within a 5MBS User Services session description provided via Nmbsmf, and the means to deliver this session description to the 5MBS Client via MBS‑5.

6. Exposure of 5MBS User Services session descriptions to the 5MBS‑Aware Application at MBS‑6.

7. Control over multicast session delivery selection by the 5MBS‑Aware Application at MBS‑6.

### 5.2.7 Conclusions and next steps

Through the exercise of mapping the relevant MABR logical functions into 5G Multicast/Broadcast Service architecture, it is agreed that Multicast ABR is a useful service layer feature that can be realised on top of the generic 5MBS architecture proposed in TR 23.757 [7] and specified in TS 23.247 [26].

- The potential solution for Scenario #1 documented in clause 7.2.1 describes how the multicast ABR feature could be directly integrated into a 5MBS System.

- The potential solutions for Scenario #2 documented in clause 7.2.2 demonstrate two different ways in which an external Application Function can use a 5MBS System to realise multicast ABR operation by means of interworking. This level of analysis is helpful in identifying potential gaps. To support Scenario #2, however, the gaps are not only in the 5G System: the DVB-MABR System additionally needs to support required interfaces such as Nmbsmf, N33 and N6. Specifying how to achieve this interworking lies beyond the scope of 3GPP.

As agreed in clause 7.3.1, 5MBS-delivered ABR media streaming could be realised as a 5MBS User Service that allows streaming of DASH content as defined in TS 26.501 [1], using a 5MBS Session to deliver the DASH segments in multicast. When delivering content to a 5MBS Client, the MBSTF uses one or more 5MBS Delivery Methods.

In order to support Scenario #1, it is proposed that normative work includes the following objectives:

1. Provide a general description and architecture for delivering media services over 3GPP multicast/‌broadcast in TS 26.501 [1], with reference to the Collaboration B0 mapping in clause 7.2.1.4.

2. Define a logical reference point between the MBSF and the 5MBS AS that allows 5BMS User Services session descriptions to be published by the former to the latter.

3. Define a procedure that allows the 5MBS Client to retrieve 5MBS User Services session descriptions via logical reference point MBS‑4‑UC.

4. Define a procedure at logical reference point MBS‑5 for announcing to the 5MBS Client a set of 5MBS User Services session descriptions that are hosted on the 5MBS AS.

5. Define the means to describe multiple object delivery sessions in a 5MBS User Services session description.

6. Define procedures for discovering and establishing a Multicast ABR session, for dynamically (de)selecting 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.

## 5.3 Key Issue 2: Nmb2 Design Considerations

### 5.3.1 Description

#### 5.3.1.1 General

In 5MBS, the existing BM-SC function is split into control plane (MBSF) and user plane (MBSTF) functions, so that a single control plane function can (potentially) control one or more user plane functions. A new interface Nmb2 is introduced between the control and user plane functions.

According to TR 23.757 [7]:

- The new user plane function (MBSTF) receives the traffic using (an evolution of) the xMB‑U interface and/or the MB2-U interface.

- The new control plane function (MBSF) receives provisioning and control commands using either existing MB2‑C or (an evolution of) xMB-C.

The present key issue studies how existing control plane procedures from xMB-C impact Nmb2 transactions. It is assumed that corresponding BM-SC features (like the MBMS Download Delivery, Streaming Delivery or Transparent Delivery) are migrated into 5MBS.

NOTE: The present clause uses BM-SC function terminology. For 5MBS, the functions may be renamed.

#### 5.3.1.2 Model of a BM-SC User-Plane Function for MBMS Download Delivery

The model in Figure 5.3.1.2-1 below assumes that a FLUTE function according to MBMS Download Delivery (clause 7 in TS 26.346 [16]) is mapped into the MBSTF.

NOTE: FLUTE is used in this clause for illustrative purposes to study the interface between a BM-SC control and user-plane. The reuse, evolution or replacement of this object delivery protocol in Release 17 should be studied in a separate Key Issue.

The purpose of this simplified model is to help identify the xMB-C parameters (xMB Service and Session Parameters) needed to configure an MBSTF at Nmb2.

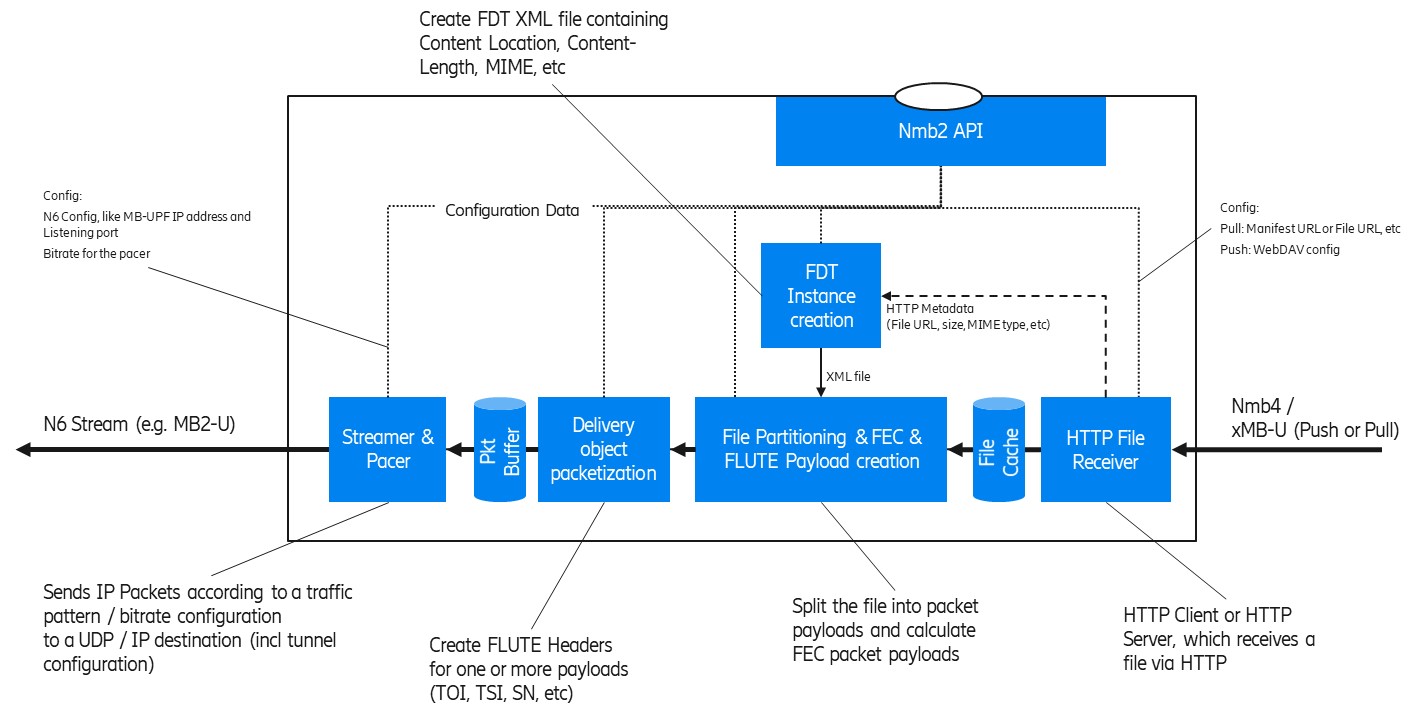


Figure 5.3.1.2-1: Simplified User Plane model for FLUTE (as an MBSTF function)

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 MBSTF 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 MBSTF pulls resources from an upstream HTTP server, such as the 5GMSd AS. In this mode, the Nmb2 API is used to provide individual URLs to be downloaded.

b) **HTTP Push**, in which resources are uploaded to the MBSTF by an upstream client using HTTP PUT. In this mode, the Nmb2 API is used to provide a base URL for ingesting data to the API invoker.

2. The MBSTF 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 Nmb2 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 **Delivery object packetization** function creates a sequence of IP packets (incl UDP and FLUTE packet headers) for the delivery object. It 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.

#### 5.3.1.3 Handling of In-band ancillary Information for MBMS Download Delivery

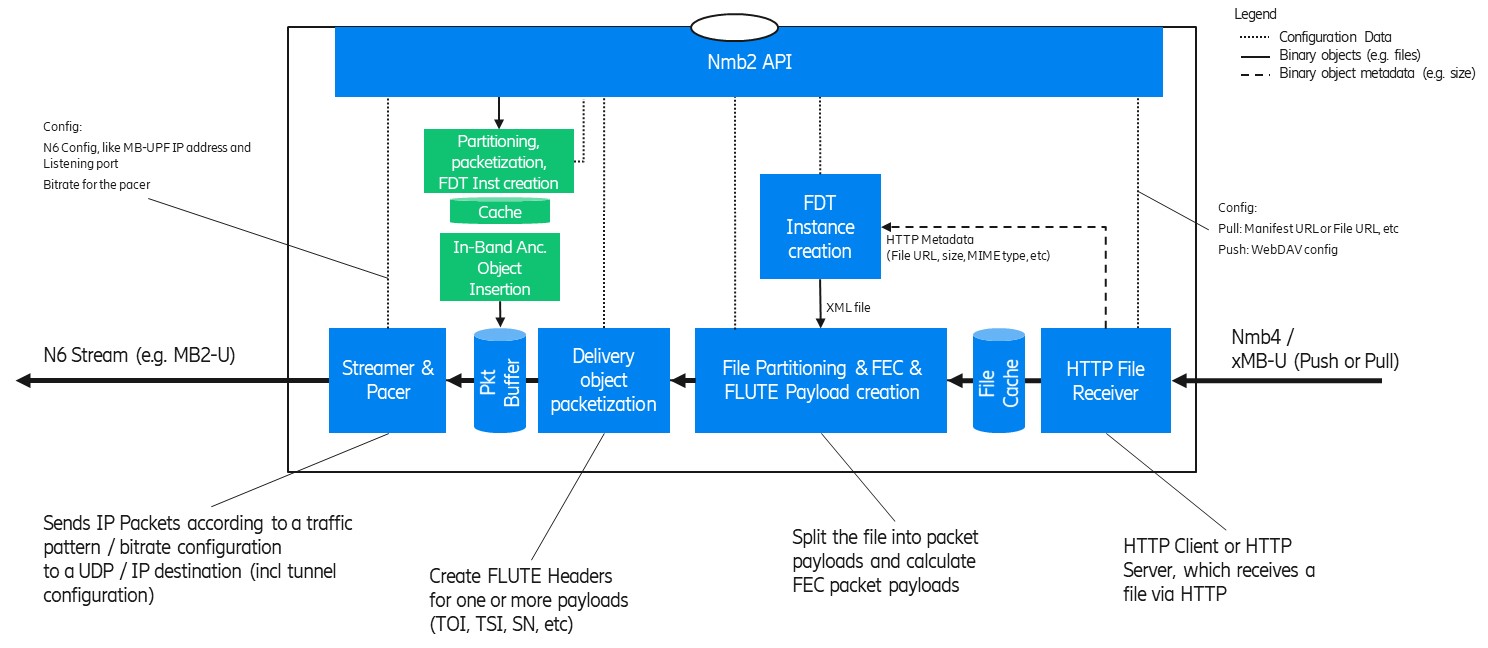
TS 26.346 [16] allows transmission of Service Announcement Metadata fragments in band with the session or out of band. Annex L.2.8 of [16] further defines handling of in-band fragments within the Service Announcement Channel (SACH) profile.

The usage of in-band fragments to update service announcement metadata fragments is specifically needed in cases of eMBMS-only transmissions, e.g. in areas of high receiver density or when offering services through a Shared MBMS Network (cf. TS 23.247, Clause 7.5). The usage of unicast is preferably avoided in areas of high receiver density to prevent congestion situations.

The service announcement for 5MBS User Services may evolve. In-band ancillary information is logically part of the 5MBS User Service announcement, and the information objects are sent in-band with the content stream using the same MBS Session. Only 5MBS Clients that have activated reception of the 5MBS Session will receive the in-band ancillary information.

In-band ancillary information objects are typically XML instance documents formatted as regular FLUTE transmission objects and received by the 5MBS Client. In-band ancillary information may be interleaved with other content objects, i.e. the BM-SC sends the packets comprising the in-band ancillary information interleaved with those comprising content object(s). In-band ancillary information may be repeated multiple times in carousel fashion to assist with unsynchronised acquisition by the MBMS Client. When repeating the transmission object corresponding to an in-band ancillary information object it is beneficial to keep the same FLUTE parameters, specifically the Transport Object Identifier (TOI), so that the FLUTE receiver in the 5MBS Client can efficiently detect and ignore repetitions.

The model in Figure 5.3.1.3-1 below extends the FLUTE model from clause 5.3.1.2 to include in-band ancillary information. The in-band-related functions are depicted in green; blue components are identical to those in Figure 5.3.1.2‑1.

 Figure 5.3.1.3-1: In-band ancillary information related functions (in green) of an MBSTF

Two categories of in-band ancillary information objects are considered in the context of 5MBS:

1: ***5MBS Delivery function related***, i.e. sending ancillary information objects (in band) to the 5MBS Client, such as file repair configuration information.

2: ***5MBS User Service function related***, i.e. sending ancillary information objects (in band) to an application component behind the 5MBS Client, such as a Media Player.

The model adds in-band ancillary information related functions to the user plane model:

1. The **Ingest** function is responsible for receiving the control object for in-band delivery. It may support push- or pull-based ingest (similar to xMB-U). Alternatively, in-band ancillary information may be embedded in an Nmb2 control payload, e.g. using Base64 encoding. The control object is typically an XML instance doucment.

2. The **Partitioning, packetization and FDT Instance Creation** function is converting the ingested control object into a sequence of FLUTE packets, including the corresponding FDT Instance object. In-band control objects are identified in the FDT Instance by a distinct MIME content type.

3. The **Cache** function is used to retain a copy of the packetised control object for repetitions.

4. The **In-band ancillary information** **insertion** function interleaves the in-band control object packets with those of other user plane objects.

#### 5.3.1.4 Multiplexing of In-band ancillary information

In-band ancillary information can be multiplexed on different levels into the main 5MBS data stream. The 5MBS client need to filter out and process in-band ancillary information.

a) MBS session/TMGIs

b) Multicast addresses

c) UDP Ports

d) FLUTE Transport Session Id (TSI)

e) FLUTE Transport Object Id (TOI), e.g. FDT Instances always on TOI 0

f) MIME Type (Today in eMBMS)

#### 5.3.1.5 Review of existing xMB properties for MBMS Download MBSTF configuration

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 MBSTF need to be provisioned with the property value. Likely, the property is exposed via Nmb2.

Table 5.3.1.5-1: List of existing xMB Service Properties

|  |  |  |
| --- | --- | --- |
| Property Name | Related to User Plane (i.e. forwarded to MBSTF) | 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 5.3.1.5-2: List of existing xMB Session Properties

|  |  |  |
| --- | --- | --- |
| Property Name | Related to User Plane (i.e. forwarded to MBSTF) | Note |
| id |  |  |
| Session start | Yes | The MBSTF needs to know when to start generating user plane packets. |
| Session stop | Yes | The MBSTF 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 MBSTF is not handling it. |
| Mission Critical | | |
| MC-Extension |  |  |
| TMGI | no | The MBSTF only need the MB-N6 tunnel information to ingest the data into the MB-UPF. The MBSF handles the TMGI. |
| QoS‑Information | no | The MBSTF is not responsible for control plane interactions with the MB-SMF. |

#### 5.3.1.6 Model of a BM-SC User-Plane Function for Group Communication Delivery

The model in Figure 5.3.1.6-1 below assumes that the BM-SC FEC encoding function according to Group Communication Delivery Method (Clause 8A in TS 26.346 [16]) is mapped into the MBSTF. According to TR 23.757 [7], the MBSTF exposes an MB2-U interface, which should be used (only?) when FEC needs to be added to Group Communication. When no FEC is needed, the GCS AS may directly send the traffic to the MB-UPF using N6.

The purpose of this simplified model is to help identify the MB2-C parameters needed to configure an MBSTF at Nmb2. The function “FEC Payload creation” generates a new RTP flow carrying the FEC redundancy information to protect one or more RTP media flows.

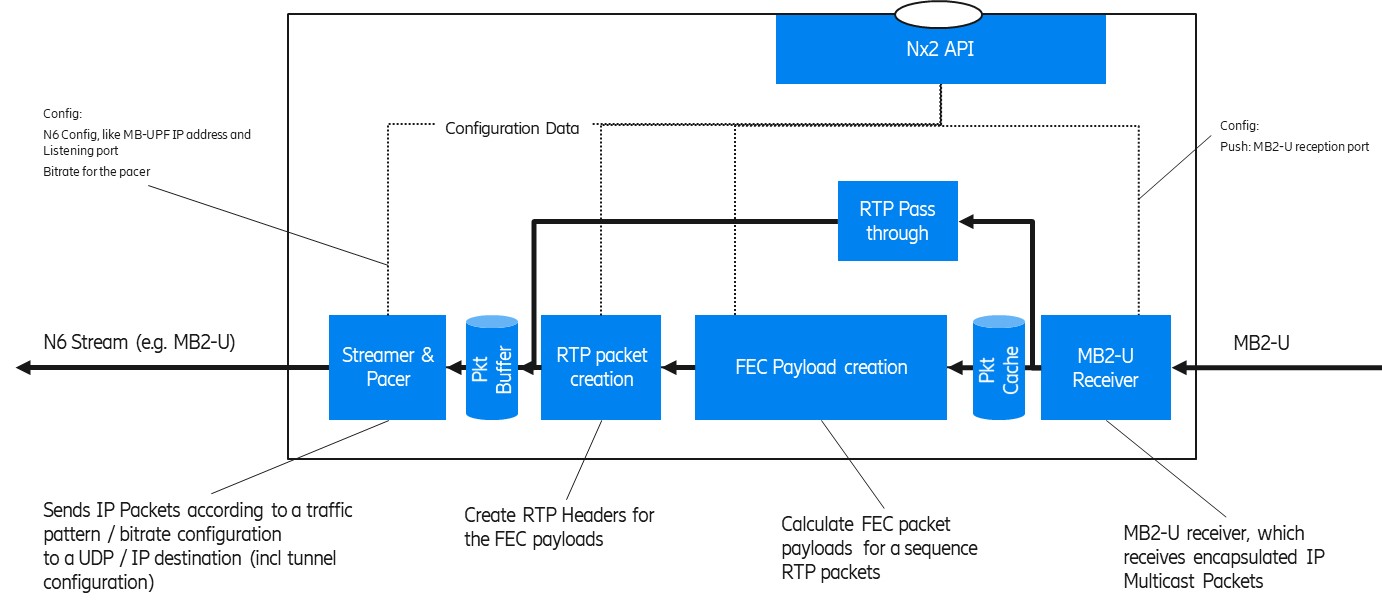


Figure 5.3.1.6-1: Simplified User Plane model for Group Communication Delivery with FEC  
(as an MBSTF function)

The model depicts some key functions from an MB2-U ingest to an MB-UPF ingest (N6). In the case of Group Communication Delivery the MBSTF operates as follows:

1. The **MB2-U Receiver** is responsible for receiving the MB2-U packets. The IP multicast user plane packets are encapsulated into the MB2-U packets. The MB2-U receiver may duplicate the packets so that the original packet can be passed through to the output and the copy remains in the Packet Cache for FEC source block creation.

2. The **RTP Passthrough** passesthe source packets directly to the output.

Editor’s Note: It is ffs, whether the RTP Passthough function appends FEC information (like a source block id), without modifying the original parts.

3. **FEC Payload Creation** calculates the FEC redundancy information which is then carried as a separate RTP flow to the receiver.

4. **RTP packet creation** prepends RTP header fields to the payloads of the FEC flow.

5. The **Streamer & Pacer** ensures a smooth output bit rate according to the configured Guaranteed Bit Rate.

NOTE: Since FEC redundancy is added to the stream, the output bit rate is higher than the input bit rate.

When a GCS AS activates an MB2 session with FEC, the GCS AS provides the following information to the BM‑SC:

- **FEC configuration information** (see clause 6.4.27 of TS 29.468 [18]). A list of the FEC Framework configuration information according to clause 8A.5 of TS 26.346 [16] is depicted in Figure 5.3.1.5-2 below.

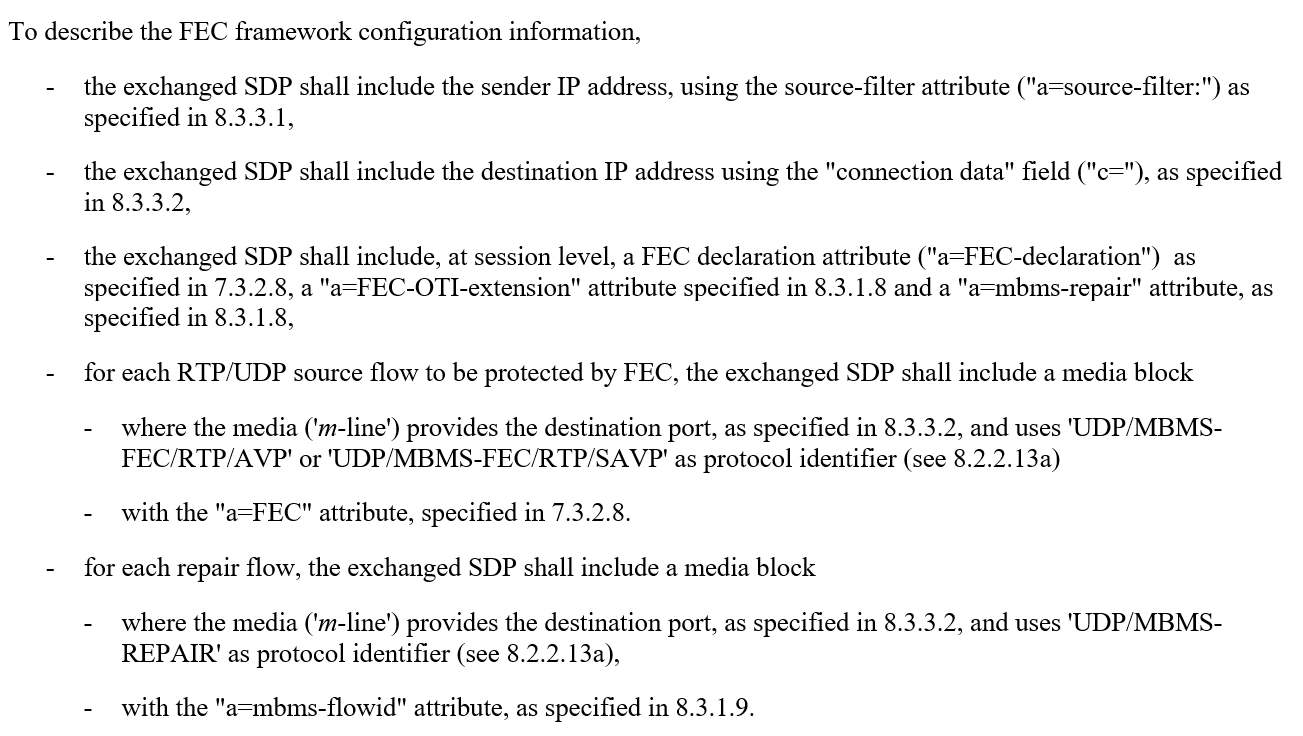


Figure 5.3.1.6-2: FEC Framework configuration information according to TS 26.346 Clause 8A.5

As response, the GCS AS receives the MB2-U tunnel endpoint information (i.e. the BM‑SC Address AVP and BM‑SC Port AVP).

When the BM‑SC is split into MBSF and MBSTF, the MBSF interacts with the MB-SMF in order to obtain the N6 ingest parameters for the MB-UPF. The MBSF provides the FEC framework configuration information together with the MB-UPF N6 ingest information to the MBSTF via Nmb2. The MBSTF allocates the MB2-U tunnel endpoint information and passes the MB2-U ingest information back to the MBSF.

The MBSF may pass the FEC Framework configuration information to the MBSTF as an Octet Stream (see clause 6.4.27 of TS 29.468 [18]) so that the MBSTF parses the SDP information.

### 5.3.2 Identified gaps

1. For the 5MBS Object Delivery Method (former Download Delivery), the Nmb2 API should re-use the xMB-C property for configuration. The configuration should be extended with N6-mb parameters and Streamer parameters (e.g. bit rate). A TMGI or MBS Session Id is not needed.

2. For the 5MBS Transparent delivery methods and Group Communication delivery method, the Nmb2 API should accommodate FEC Framework configuration data. In addition, the N6mb parameters and Streamer parameters (e.g. bit rate) are needed. A TMGI or MBS Session Id is not needed.

3. It is for discussion whether the MBSTF functionality for the Group Communication delivery method can be merged with the Transparent delivery method. It seems that the only differences are configuration aspects, such as usage of MB2-C or xMB-C.

4. The MBSTF is a user plane only function and should not create any ancillary information. The MBSF and/or the AF/AS should be the source of any in-band ancillary information, which are ingested and transmitted by the MBSTF according to Nmb2 received instructions.

5. The Nmb2 API should support the ingest of in-band ancillary information. A separate ingest point to the delivery function is needed to provide the ancillary information, either embedded in Nmb2 or as separate interface.

NOTE: Ancillary information may be distributed either using unicast or 5MBS. Distribution of ancillary information in-band with other MBS data on the same MBS Session (c.f. MBMS Bearer) may only be needed in some scenarios.

6. The existing xMB-C API does not support the ingest of 5MBS User Service related in-band ancillary information. The 5MBS version of xMB-C (Nmbsf) should be evolved to include this suppport.

### 5.3.3 Conclusions

In order to support 5MBS User Service features through two separate network functions (i.e. MBSF and MBSTF), it is proposed that normative work includes the following objectives.

1. Define the API at the Nmb2 reference point between the MBSF and MBSTF which is used to control the transport services offered by the MBSTF.

a. The Nmb2 API should re-use the xMB-C concepts and properties identified in clause 5.3.1.4.

b. The Nmb2 API should support configuration with N6-mb parameters.

c. The Nmb2 API should allow selection and configuration of different 5MBS delivery methods, in particular a new 5MBS object delivery method and a 5MBS transparent delivery method.

2. It is assumed that the MBSTF does not need to support a separate Group Communication method. Instead, the MBSF instantiates a version of a 5MBS transparent delivery method. It is recommended that an informative clause describes the usage of 5MBS transparent delivery for Group Communication support.

3. The MBSF is the control plane function, which generates and manages metadata to access the 5MBS User Service session. In some cases, the 5MBS User Service session access metadata is sent as ancillary information in band with user plane data. The Nmb2 API should support the ingest of in-band ancillary information. It is for study whether a separate ingest point should be supported or whether the ancillary information objects can be embedded in Nmb2.

4. Decide multiplexing level of in-band ancillary information (e.g. keep MIME Type based like in eMBMS). In case a different QoS profile is used for in-band ancillary information, then the MB-UPF needs to filter/identify the in-band ancillary information.

5. The existing xMB-C API does not support the ingest of 5MBS User Service related in-band ancillary information. The 5MBS version of xMB-C (Nmbsf) should be evolved to include this suppport.

## 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 Nmbsf is an evolution of xMB-C and Nmbstf 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 MBSTF 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 MBSTF 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 Nx2 API to configure and control the multicast delivery functions. The 5GMSd AS might be extended to cut-though any push ingest into the Nmbstf (former xMB-U).

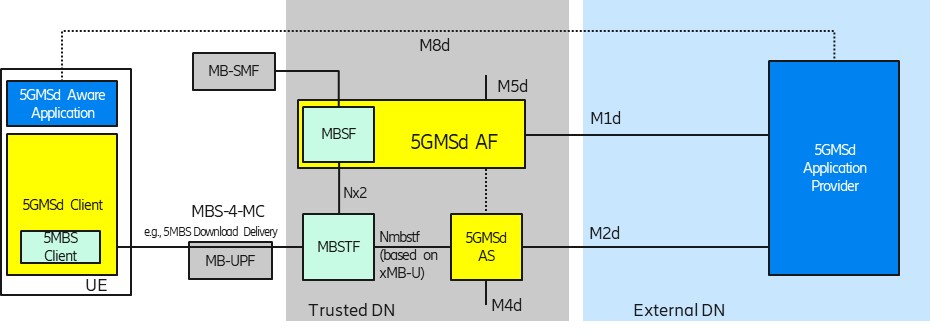


Figure 5.4.2-1: Collaboration A0: MBSF integrated within the 5GMSd AF

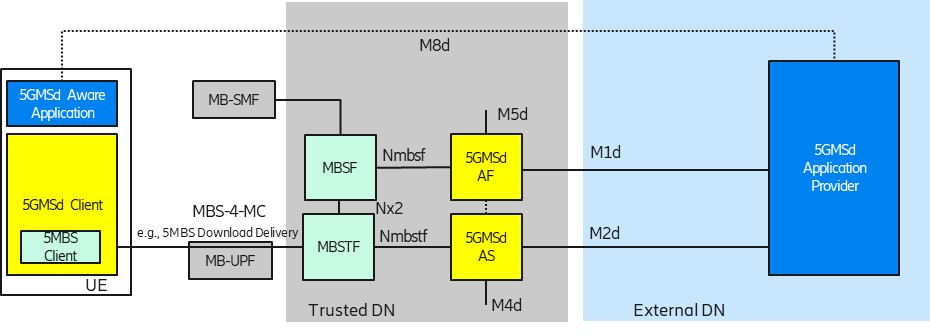


Figure 5.4.2-2: Collaboration A1: Fully separated functions

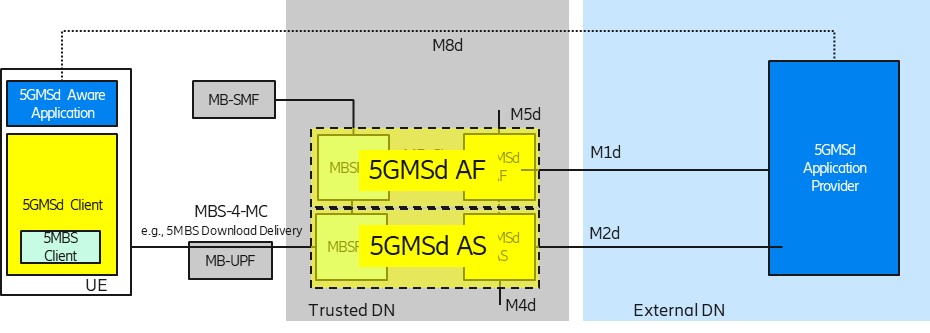


Figure 5.4.2-3: Collaboration A2: Integrated Control and User Plane functions

### 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 Nmbsf interface (based on xMB-C) 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 with Collaboration B because the MBSF and MBSTF 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 MBSTF is used.

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

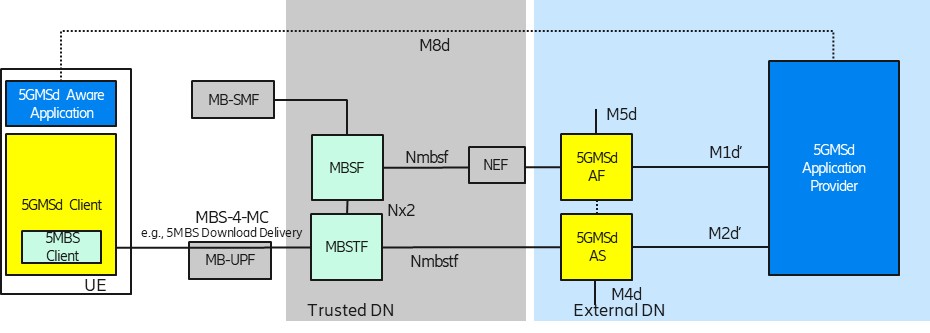


Figure 5.4.3-1: Collaboration B0: Mixed external and Trusted DN functions

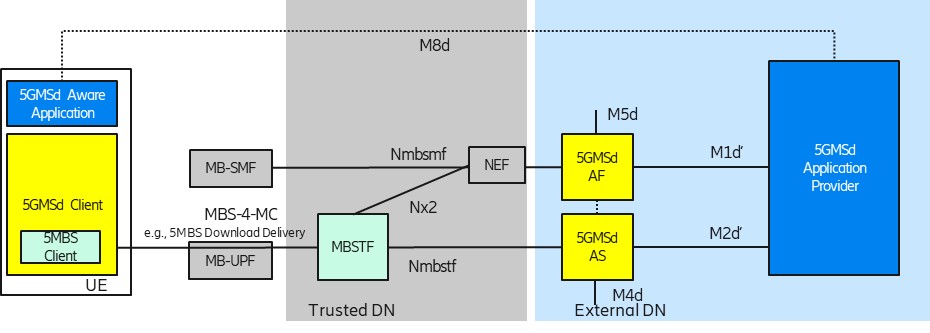


Figure 5.4.3-2: Collaboration B1: Mixed external and trusted DN functions

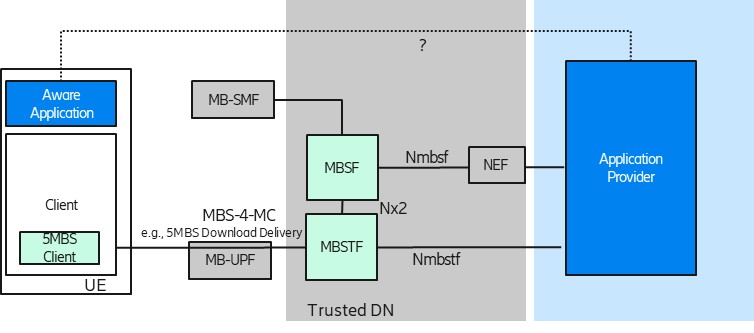


Figure 5.4.3-3: Collaboration B2: Mixed external and trusted DN functions deployed without 5GMS functions

### 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.

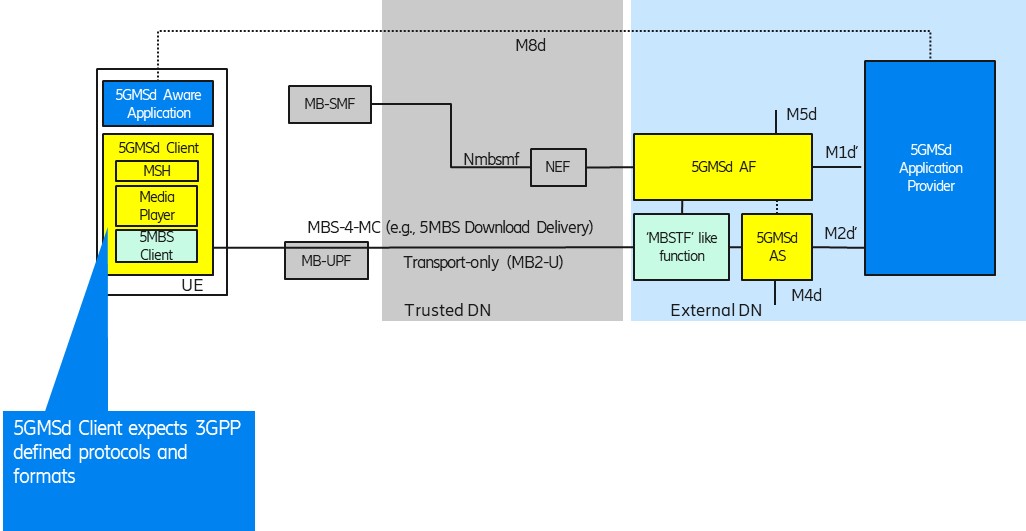


Figure 5.4.4-1: Collaboration C: All media functions in external DN

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 “MBSTF-like” function would generate a bit stream compliant with TS 26.346 [16]. 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 [7]).

### 5.4.5 Collaboration D

**Collaboration D** depicts a deployment similar to Collaboration #4 in TS 26.501 [1]. 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 [7]). Still, a 3GPP-defined Media Session Handler is interacting with a 3GPP-defined 5GMSd AF.

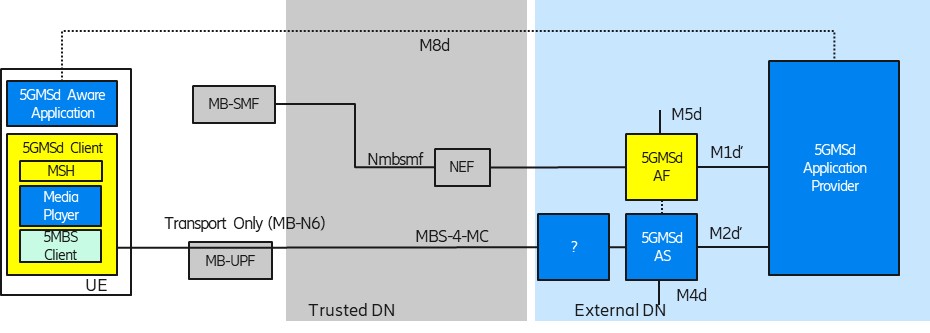


Figure 5.4.5-1: Collaboration D: Usage of transport-only delivery with non-3GPP protocols at M4d-mb

### 5.4.6 Conclusion

Different collaboration scenarios have been studied. It is concluded that the normative work should focus on Collaboration B2.

Collaboration scenario B1 will not be supported because the MBSTF must be in the same Data Network (e.g. within the trusted data network) as the controlling MBSF.

Other collaboration and deployment scenarios will be supported by the technical specification. It is recommended to illustrate the different collaboration and deployment scenarios (independently from 5GMS) in the new 5MBS User Service Technical Specification.

## 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:

o Service Announcement and Discovery as defined in TS 26.346.

o Download Delivery method, File Delivery as defined in TS 26.346, clause 7.

o DASH/HLS over MBMS (both broadcast/multicast only as well as hybrid) as defined in TS 26.346, clause 5.3.

o Transparent delivery method as defined in TS 26.346, clause 8B.

o 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 TS 26.501 and TS 26.512) with APIs defined in TS 26.348 (xMB), TS 26.346 (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 TS 26.347 is control, clause 7 in TS 26.347 is user).

### 5.5.2 Conclusions

Based on the discussions in this TR, the following re-use aspects are proposed.

1. The following “user service” functionalities (as defined in TS 26.346) with proper mapping to 5G MBS architecture (as to be defined in Rel-17, TS 23.247) are proposed to be reused and extended if needed. The combination with 5G Media Streaming is one deployment scenario.

a) Service Announcement and Discovery as defined in TS 26.346 based on userServiceDescription. Stage-3 aspects may be reconsidered, for example to align with 5GS design principles.

b) Object delivery Method that includes:

- Download delivery method, File Delivery as defined in TS 26.346, clause 7.

- DASH/HLS over MBMS as defined in TS 26.346, clause 5.6 and 5.7, including Low-Latency CMAF as defined in 5GMS.

c) A common packet delivery method that includes the relevant delivery aspects of transparent delivery method, group communication delivery method and streaming delivery method as defined in TS 26.346, clause 8B, 8A and 8 respectively.

d) The relevant functions as now defined as Associated Delivery Procedures in TS 26.346, clause 9, and aligning with 5GMS.

2. Define the necessary extensions of relevant “MBMS Service Layer” functionalities to support 5GS and 5G MBS Sessions (as to be defined in Rel-17, TS 23.247). This pre-dominantly includes the definition or proper delivery method establishment.

3. Provide the relevant functions and protocols for northbound interfaces based on the xMB API defined in TS 26.348.

4. Define the separation of the User Plane and Control Plane Functionalities of “BM-SC” (now MBSF and MBSTF) and define the API between MBSF and MBSTF (named 'Nmb2').

5. Define the User Plane and Control Plane Functionalities/APIs of the 5MBS Client based on the MBMS Client functions as defined in TS 26.347 (Clause 6 is control, clause 7 is user-plane).

## 5.6 Key Issue #5: Client Architecture Options

### 5.6.1 Description

Clause 4.4.2 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).

### 5.6.3 Conclusions

It is proposed to define the User Plane and Control Plane Functionalities and APIs of a 5MBS Client, as the counterpart of “MBMS Client” API in clause 6 in TS 26.347 for the control plane and clause 7 in TS 26.347 for the user plane. As significant similarities between MBMS-APIs and 5MBS-APIs are expected, an extension of TS 26.347 may be considered to also include 5MBS-APIs.

## 5.7 Key Issue #6: Hybrid Services

### 5.7.1 Description

#### 5.7.1.1 Definition

A hybrid service is defined as a service that fulfills at least one of the following aspects:

1. The same service is available on different delivery systems, for example on multicast, on broadcast or on unicast

2. A service available on one delivery system may be enhanced by additional resources available on a different delivery system

3. The service include sufficient information such that a client can synchronize or seamlessly replace the service on one delivery system with the one on a different one.

The following key aspects need to be studied:

 Study the support for external hybrid services (as defined in clause 5.7.1.2) including live TV services with latency constraints) to support different functionalities such as service continuity etc.

 Study the support for 5GMS-based hybrid services (as defined in clause 5.7.1.3) (including live TV services with latency constraints) to support different functionalities such as service continuity etc.

#### 5.7.1.2 Use Case 1: External Hybrid Service

An overview of the considered system is shown below for which DVB-I (including DVB-I Service Discovery, ABR multicast, DVB-DASH and DVB-AVC codecs) can be used to suitable distribute DVB services to any type of device.

A service provider offers a service in a service list. The services are the same content services, but they are distributed over different distribution means. The service provider wants to include all relevant 5G distribution systems available up to Rel-17.

1. 5GMS using APIs as defined in TS 26.501

2. 5G based broadcast as defined in ETSI TS 103 720 with APIs based on TS 26.348.

5MBS delivery as is expected to be defined in Rel-17.

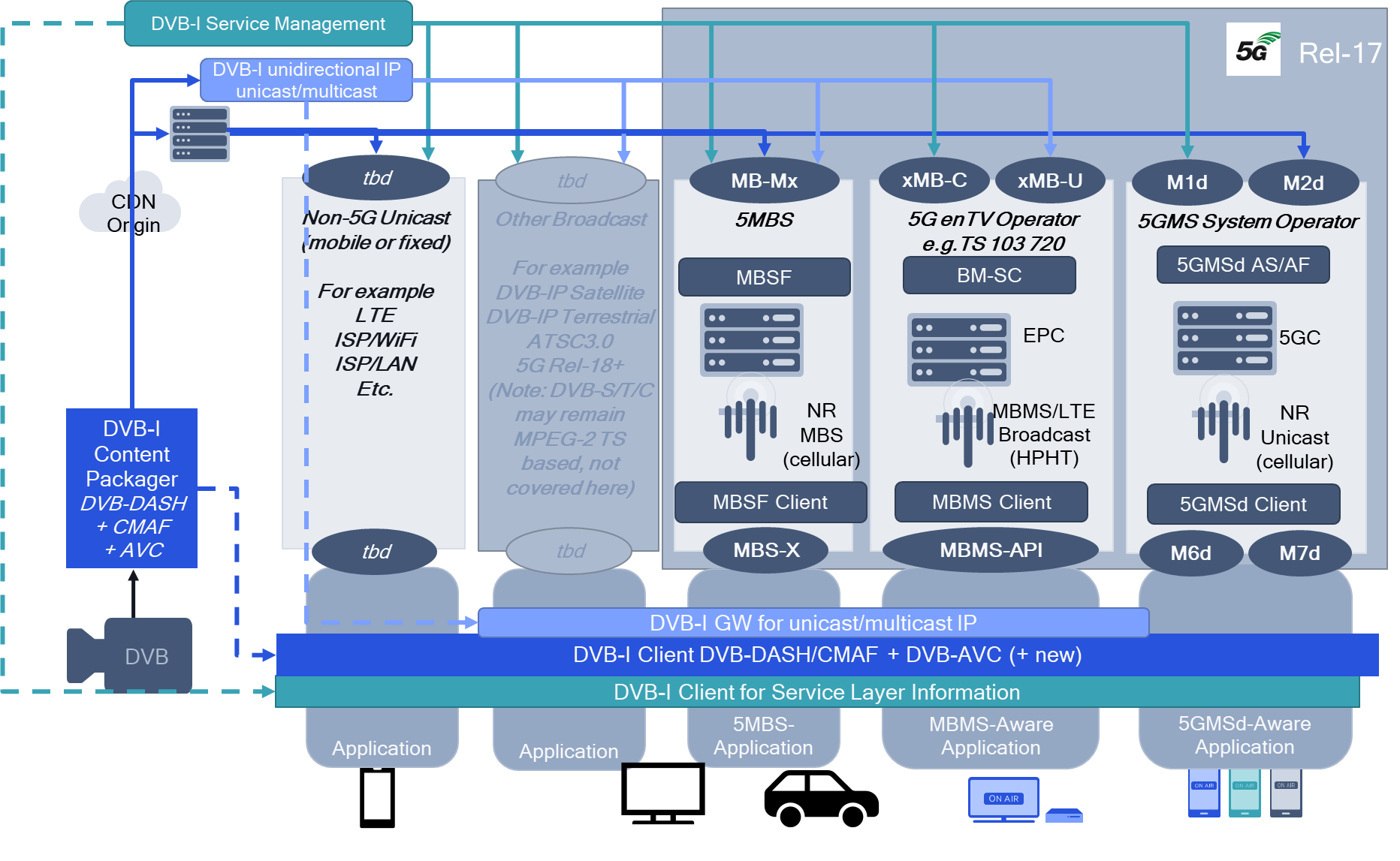


Figure 5.7.1.2-1: External hybrid service

Services may be made available completely or partially on different delivery means. Clients capable of one or multiple 5G Media distribution systems should be able to select suitable delivery services, combine them and/or dynamically switch across these systems. In particular relevant is the hybrid combination that allows that a service may not only be available through a single distribution mean, but may be augmented and enhanced by other means, for example in case no broadcast coverage is available.

One potential use case is provided in the following:

*-* A Broadcast operator operates a HPHT distribution, for example in a dedicated broadcast spectrum or any other spectrum that is accessible for HPHT distribution

*-* The Broadcast operator primarily targets non-TV devices (smart phones, tablets, etc.) but also provides the services to TV devices (TV, STB).

*-* The Broadcast operator provides multiple services, for example public free-to-air or private.

*-* Broadcast operator has the ambition to run a hybrid service (integrated broadcast/unicast distribution) from day one, for some of the following reasons:

o Perceptually good service continuity to ensure coverage, in particular indoor and urban.

o Providing the same services to devices that do not support broadcast/multicast reception.

o Unicast-based ad insertion (targeted to users, regions, etc.).

o Targeted regional content.

o Service Signalling.

o Content Protection on service/app level (for subscription services).

o QoE metrics reporting.

o Consumption Reporting for operational purposes.

o Enhanced content quality by additional unicast (e.g. through scalable/layered coding or equivalent means) subject to availability of DVB codecs supporting this.

o Fast service start-up and service acquisition while maintaining efficient delivery on broadcast. Different aspects may matter depending on device and service types.

o Unicast-based error recovery if reception on a primary distribution is lossy.

o Auxiliary components on unicast, for example alternative languages or views.

o Audience Measurement

o Ad Tracking

The key aspects of the use case for 5MBS are as follows:

*-* The service needs to be provisioned

*-* Ingest needs to be enabled

*-* The service needs to be announced and discovered

*-* The MBS-aware application may dynamically monitor and switch on/off the service reception

*-* The MBS-aware application expects sufficient information to switch across delivery methods

*-* The MBS-aware application expects sufficient information to consume media received on different delivery systems jointly.

#### 5.7.1.3 Use Case 2: 5GMS Hybrid Service

In a similar fashion as discussed in clause 5.7.1.2, a hybrid service is now offered by an MNO as part of 5G Media Streaming, according to the client architecture depicted in Figure 4.4.2.3‑1. The service integrates 5GMS unicast-based and 5MBS-based delivery. The integration of 5G Broadcast based on enTV as defined in ETSI TS 103 720 is covered in key issue #7 in clause 5.8.

In the hybrid case, the following functionalities are supported:

*-* Same service is offered through 5GMS unicast and 5MBS. Client decides which service to use depending on among others its capabilities, reception quality, etc.

*-* Content may be targeted, for example for ad insertion (targeted to users, regions, etc.).

*-* Enhanced content quality by additional unicast (e.g. through scalable/layered coding or equivalent means) subject to availability of DVB codecs supporting this.

*-* Content may be offered that certain components are available on unicast only, but are combined in the 5GMS client for a combined service.

*-* Fast service start-up and service acquisition while maintaining efficient delivery on broadcast. Different aspects may matter depending on device and service types.

*-* Unicast-based error recovery if reception on a primary distribution is lossy.

*-* Auxiliary components on unicast, for example alternative languages or views.

*-* Audience Measurement.

*-* Ad Tracking.

### 5.7.2 Identified Issues

#### 5.7.2.1 General

This clause collects identified issues for different flavours of the hybrid use case.

#### 5.7.2.2 Use Case 1: External Hybrid Service

For use case 1, this is expected to be solved outside 3GPP. A service provider may provide the same service with different instances over different 5G distribution systems. DVB is currently developing the relevant Commercial Requirements for this purpose.

No immediate gaps in 3GPP are identified.

#### 5.7.2.3 Use Case 2: 5GMS Hybrid Service

The use case is depicted in the figures provided in clause 4.4.5.3 and 4.4.5.4. Three different options are considered, that only marginally differentiate.

In the following, ten different scenarios are identified:

1. **Fast 5GMS session start-up** via unicast while the 5MBS Client is waiting for initial multicast/broadcast packets to start arriving via MBS‑4.

2. **Unicast recovery** of the application payload data carried in multicast/broadcast packets that are not successfully received via MBS‑4, in a manner that is transparent to the 5GMS Client.

3. **5GMS session continuity** when multicast/broadcast service is temporarily unavailable, in a manner that is transparent to the 5GMSd-aware application.

4. Switching the operating mode of a 5GMS session to unicast under the direction of network-based **multicast operation on demand** (MooD), in a manner that is transparent to the 5GMS Client.

5. **Enhanced service quality**, for which content quality is enhanced by additional unicast (e.g. through scalable/layered coding or equivalent means).

6. **Component replacement**, for example a component provided over 5MBS session is replaced by a unicast component.

7. **Time-shifted viewing**: a 5GMSd client decided to watch the service in timeshift mode and hence switches to unicast distribution.

8. **Content may be targeted**, for example for ad insertion (targeted to users, regions, etc.).

9. **Reporting** is done also for the 5MBS service.

10. **Interactive Service** for example with a presentation layer being included.

Categorization of the scenarios above can be done in the following four dimensions:

A. Is the same content provided through 5GMS unicast and 5MBS?

- yes: scenario 2 (unicast recovery), scenario 3 (session continuity) and scenario 4 (MooD).

- no: scenario 5 (enhanced service quality), scenario 6 (component replacement), scenario 8 (content targeting) and 10 (interactive service).

- unclear: scenario 1 (Fast Start-up) and scenario 7 (time-shifted viewing).

- orthogonal: scenario 9 (Reporting).

B. Is only one delivery mode (i.e. either 5MBS or unicast) consumed at the same time or multiple simultaneously?

- multiple continuously: scenario 5 (enhanced service quality), scenario 6 (component replacement), scenario 9 (Reporting), 10 (interactive service).

- multiple sporadically: scenario 1 (Fast Startup), scenario 2 (unicast recovery).

- only one mode at a time: scenario 3 (session continuity), scenario 4 (MooD), scenario 7 (time-shifted viewing), scenario 8 (content targeting).

C. Which entity decides the delivery mode (unicast, 5MBS) to be used: Application, Media Player, Media Ssession Handler, 5MBS Client, 5GMS AF, MBSTF?

- Application: 10 (interactive service).

- Media Session Handler: scenario 9 (Reporting).

- Media Player: scenario 1 (Fast Start-up), scenario 5 (enhanced service quality), scenario 6 (component replacement), scenario 7 (time-shifted viewing), scenario 8 (content targeting).

- 5MBS client: scenario 2 (unicast recovery) scenario 3 (session continuity).

- AF: scenario 4 (MooD).

D. Which setups provide requirements for 5GMSd AS to Media Player delivery latency?

- Unicast and 5MBS the same: scenario 3 (session continuity), scenario 4 (MooD), scenario 5 (enhanced service quality), scenario 6 (component replacement).

- Unicast faster than 5MBS: scenario 1 (Fast Startup), scenario 2 (unicast recovery).

- No requirements: scenario 9 (Reporting), 10 (interactive service).

- 5MBS faster than unicast: scenario 7 (time-shifted viewing), scenario 8 (content targeting).

### 5.7.3 Conclusions and Next Steps

As a result of the content of this technical report, the following next steps are proposed:

1. Architectural Extensions: Architecture and call flows for the following hybrid 5GMS unicast and 5MBS scenarios with high priority (based on existing functionalities in eMBMS): (i) Interactive Service, (ii) Session Continuity, (iii) Time-shifted viewing, (iv) Targeted content replacement, (v) Reporting, and (vi) Unicast recovery. Additional functionalities such as (i) Enhanced service quality, (ii) Component replacement, and (iii) Fast start-up may be addressed as well if time permits.

2. Protocol Extensions: The required functions of the reference points for hybrid services need to be checked against existing functions in TS 26.501, TS 26.511, TS 26.512, TS 26.346, TS 26.347 and TS 26.348 and extended if needed.

## 5.8 Key Issue #7: 5GMS via eMBMS

### 5.8.1 Description

This key issue proposes to study interworking of 5GMS with EPC and in particular with eMBMS and provide a solution such that the same service may be provided through EPC (unicast/broadcast) and 5GC (unicast/multicast).

In particular relevant is a 5GMS service with eMBMS and ROM-services as well as High-Power High Tower (HPHT) and Single Frequency Network (SFN) services, that are not supported in Rel-17 5MBS.



Figure 5.8.1-1 Interworking of 5GMS with EPC

The following aspects need to be considered

*-* The AF may be an “old” AF and only use 3GPP Release 16 xMB APIs

*-* The AF may be a “new” AF and may support both, 3GPP Rel 16 xMB APIs and new 3GPP Rel 17 M1 or MB-M1 APIs.

A similar topic referred to as Interworking is also studied TR 23.757 [7]. In particular, solution 46 addresses some aspects on this matter. However, this proposes a solution to maintain service continuity when a UE moves between an NG-RAN that supports MBS and an E-UTRAN that supports eMBMS. The solution is based on solution 10 and architecture A.2 and requires the deployment of N26. It is not considered further in the present document.

### 5.8.2 Identified Issues

#### 5.8.2.1 Introduction

The key issue under consideration in this key topic is the ability for a network provider to deploy 5GMS-based media streaming, using eMBMS bearers as developed for TV-distribution in Rel-16 to address the 5G Broadcast requirements to distribute the entire service or parts of the service. The combination of the two technologies is expected to be done to support use cases similarly as documented in clause 5.7.2.3 on the Hybrid 5MBS/5GMS service.

The combination of 5GMSd-based distribution with 5MBS is not considered in this key issue, because it relates to the hybrid service in clause 5.7. The main identified issue is the combination of 5GMSd unicast and eMBMS.

The core issues under discussion are different architecture options.

#### 5.8.2.2 Option A: 5GMS uses MBMS User Service



Figure 5.8.2-1 Hybrid Services of 5GMS with eMBMS User Service (Option A)

In Option A, the 5GMSd Service provider acts as an eMBMS Content Provider. Figure 5.8.2-1 provides an architecture for which a 5GMSd Service provider uses xMB and MBMS user services for the distribution. Either of the following cases is expected to be of interest:

- The unicast option is unavailable, and the content is distributed via eMBMS only.

- The unicast option is available, and the hybrid functionalities as defined in clause 5.7.2 are supported.

#### 5.8.2.2 Option B: 5MBS uses MBMS Transport-only Mode



Figure 5.8.2-2 Hybrid Services of 5GMS with eMBMS Transport only mode (Option B)

In Option B, provides the case for which the 5G MBS Service provider uses the transport-only mode of eMBMS in order to deliver content generated in the MBSTF. Figure 5.8.2-2 provides an architecture for which a 5G MBS Service provider interfaces with the relevant BM‑SC functionalities into MBSTF and MBSF for the theMBMS distribution. Again, both use cases are of interest:

- The unicast option is unavailable, and the content is distributed via MBMS Bearer only.

- The unicast option is available, and the hybrid functionalities as defined in clause 5.7.2 are supported.

At the client side, the 5MBS client acts as a MBMS-aware application and translates the service announcement into an MBMS service.

#### 5.8.2.3 Option C: 5GC integration of MBMS

In a third option (Option C), support of physical layer distribution over enTV is supported in 5GC. This option is not considered as it would have impacts on 5GC outside of the control of SA4.

#### 5.8.2.4 Comparison of options

Table 5.8.2-1 provides an overview of benefits and drawbacks.

Table 6.3.2-1: Impacted Reference Points for different scenarios

|  |  |  |
| --- | --- | --- |
| Options | Benefits | Drawbacks |
| Option A: 5GMS uses MBMS User Service | This has no impact on the 5MBS System; only 5GMS needs to be updated to provide content over eMBMS and the 5GMS client can find the MBMS service and connect to get access to the bearer.  It is a benefit that 5GMS can be combined quite easily with eMBMS for delivering 5GMS content over eMBMS as well as to provide hybrid services. | Someone deploying 5MBS and eMBMS needs to implement both, BMSC and MBSF/MBSTF functionalities on the server and the MBMS client and the 5MBS client need to be implement. |
| Option B: 5MBS uses MBMS transport-only mode | It is expected that the MBSTF will provide most of the delivery functions that are anyway needed from the BM‑SC. Based on this, adding the relevant MBMS Bearer service to the MBSTF should be trivial.  The delivery functions can re-used and harmonized in a single specification.  The benefits of extensions to the new interfaces and protocols defined in 5MBS are also available to the MBMS Bearer service. | The MBSTF needs a new interface to provide connection to BMSC for transport-only delivery. The same for the MBSF. Similar the 5MBS client needs these interfaces.  To deliver 5GMS content via eMBMS, 5MBS needs to be implemented. |
| Option C: 5MBS implements MBMS M1 interface | The equipment needed to support both enTV and and 5MBS is minimized as 5MBS includes the MBMS GW functionality. | MBMS GW functionality is simple, so no benefit for this. |

### 5.8.3 Conclusions

Based on the discussion, it is proposed to

1) focus on Option A as it is the simplest way to distribute 5GMS content via MBMS

2) further study option B to what extent this option is feasible based on the SA2 defined architecture

3) not pursue option C.

To support 5GMS over eMBMS, it is proposed to define the architectural enhancements, call flows and procedures for 5GMS using MBMS User Services as well as hybrid 5GMS services via MBMS User Services and unicast. Stage-3 aspects to support these functionalities include extensions on 5GMS Protocols as well as extensions in xMB, MBMS user services and MBMS-APIs.

Furthermore, it is proposed to further study to what extent "5MBS uses MBMS transport-only mode” as introduced in clause 5.8.2.2 is feasible based on the SA2 defined architecture and address potential normative work at a later stage.

### 5.8.4 Recommended Next Steps

Based on the considerations in clause 5.8.2, the following aspects deserve normative documentation.

For Option A:

1. Architecture for 5GMS using MBMS User Services.

2. Call flows for:

a. 5GMS uses MBMS User Services without unicast support.

b. Hybrid 5GMS services using MBMS User Services and unicast.

3. M1d extensions to provision MBMS User Service delivery.

4. xMB extensions to identify content as 5GMSd Service.

5. M5d extensions provide the Service Access Information for MBMS.

6. 5GMSd extensions to support the MBMS-APIs.

7. Support for hybrid cases in combination with 7.3.4.

For option B, it is proposed to further study to what extent this option is feasible based on the SA2 defined architecture and address potential normative work at a later stage. Initially, it has been identified the following aspects need to be further studied

1. For stand-alone service without unicast:

a. Nmb2 extensions to provision for using xMB as ingest.

b. M5d extensions provide the service signaling for MBMS-based 5MBS.

c. Extensions to deliver 5GMS content through support MBMS transport-only mode using the MBSTF.

2. In addition, for a service that also leverages the use of 5GMSd unicast, the selected hybrid scenarios introduced in clause 6.2.3 may be provided.

# 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

### 6.2.1 Introduction

Initially, the following areas are identified as potential standardization areas:

- Create Delivery Methods in the MBSTF to support 5MBS User Service to use 5MBS capabilities.

- Define Service aspects in MBSF, such as User Service Announcements.

- Using 5MBS together with 5G Media Streaming Architecture is one scenario.

- Define Nmb6 (based on xMB-C) and Nmb4 (based on xMB-U). It is assumed that MB2 interface will be supported in Release 17 “as is”.

- Define the realization of Nmb2 (between MBSF and MBSTF), which configures and controls the delivery functions (like object delivery).

- Expect to have a new spec TS 26.502 to document these potential standardization areas.

### 6.2.2 5MBS User Service Architecture

Figure 6.2-1 provides a view of the network architecture for 5MBS User Service delivery and control. In this figure, two potential standardization areas are identified:

1. How AF and MBSF interact to support MBS session operations and transport (i.e. xMB-C and MB2-C reference points).

2. How to provide MBSTF functionality related to MBS data handling (e.g. encoding) via xMB-U and MB2-U interfaces. Based on the definition in TS 23.247, MBSTF performs generic packet transport functionalities available to any IP multicast-enabled application such as framing, multiple flows, packet FEC (encoding). It also performs multicast/broadcast delivery of input files as objects or object flows. If needed, MBSTF provides a media anchor for MBS data traffic and sourcing of IP multicast.



Figure 6.2-1: Network Architecture for 5MBS User Service Delivery and Control

### 6.2.3 5GMS Hybrid Services

With reference to the architecture depicted in Figure 4.4.5.4-2, Table 6.3.2-1 provides impacted reference points for the ten different hybrid scenarios described in clause 5.7.2.3.

Table 6.3.2-1: Impacted Reference Points for different hybrid scenarios

|  |  |  |
| --- | --- | --- |
| Scenario | Impacted reference points | Requirements |
| 1 - Fast startup | M1: General Provisioning and fast startup feature is provisioned.  M2: General ingest and signaling of unicast fast start-up Representations in presentation manifest.  M4: Signaling of the unicast available content and the content available on 5MBS in the manifest.  M4: Signaling availability of unicast fast start-up Representations in manifest.  Nmb2: Identification of content for 5MBS distribution.  Nmb4/xMB-U: Ingest of content by MBSTF for 5MBS distribution.  M5: Potential usage of dynamic policies and/or network assistance for unicast fast start-up Representations.  MBS-4-MC: 5BMS object delivery of non-fast-start up Representations.  MBS-6: Announcement of non-fast-start up Representations by 5MBS Client.  MBS-7: Providing the non-fast-start up Representations from 5MBS Client. | Fast start-up Representations need to be available on 5GMS AS for early access.  The Media player needs to be able to switch to 5MBS distribution once the same content is available on unicast. |
| 2 - Unicast recovery | M1: General Provisioning  M2: General Ingest.  MBS-5: Service announcement including signaling of unicast repair server.  Nmb2: Identification of content for 5MBS distribution.  Nmb4/xMB-U: Ingest of content by MBSTF for 5MBS distribution.  MBS-4-MC: 5MBS object delivery of content Representations.  MBS-4-UC: File repair.  MBS-7: Partial file delivery in case repair fails or delivery timeline is expired. | The unicast URLs need to be announced to the 5MBS Client. |
| 3 - Session continuity | M1: Session-continuity feature is provisioned.  M2: Ingest of content by 5GMS AS.  M4: Signaling availability of different content on different delivery means in the manifest, on 5GMS AS and on 5MBS.  Nmb2: Identification of content for 5MBS distribution.  Nmb4/xMB-U: Ingest of content for 5MBS distribution.  MBS-5: Signaling of identical and alternative content.  MBS-4-MC: 5MBS object delivery of content Representations.  MBS-4-UC: File repair for session continuity for certain amount of time.  MBS-7: Dynamic switching of Media Player from 5MBS content to unicast content (panic button) when unicast repair starts to fail.  MBS-6/M6: Availability information of 5MBS distribution. | The 5MBS client needs to inform the Media Player about the (non-) availability and of resources through 5MBS distribution.  The service also needs to work with low-latency DASH. |
| 4 - MooD | No considerations for this Release | None. |
| 5 - Enhanced service quality | M1: General provisioning and enhanced service quality feature is provisioned.  M2: General Ingest including of enhanced quality content ingest by 5GMS AS.  M4: Signaling availability of different content on different delivery means in the manifest, on 5GMS AS and on 5MBS.  Nmb2: Identification of content for 5MBS distribution.  Nmb4/xMB-U: Ingest of content by MBSTF for 5MBS distribution.  MBS-4-MC: 5MBS distribution of content Representations.  M4: Unicast distribution of enhanced service quality.  M5: Optional use of dynamic policy and network assistance on unicast distribution. | The 5MBS Client needs to support the retrieval of components from 5MBS and unicast at the same time.  The service also needs to work with low-latency DASH. |
| 6 - Component replacement | M1: General provisioning Component replacement feature is provisioned.  M2: Ingest of replacement content by 5GMS AS.  M4: Signaling availability of different content on different delivery means in the manifest, on 5GMS AS and on 5MBS..  Nmb2: Identification of content for 5MBS distribution.  Nmb4/xMB-U: Ingest of content by MBSTF for 5MBS distribution.  MBS-4-MC: 5MBS object delivery of content Representations.  M4: Unicast distribution of replacement component.  M5: Optional use of dynamic policy and network assistance on unicast distribution. | The 5MBS client needs to support to retrieve components from 5MBS and unicast at the same time.  The service also needs to work with low-latency DASH. |
| 7 - Time-shifted viewing | M1: Time-shifted viewing feature is provisioned.  M2: Ingest of time-shifted content.  M4: Signaling availability of different content on different delivery means in the manifest, on 5GMS AS and on 5MBS..  Nmb2: identification of content for 5MBS distribution.  Nmb4/xMB-U: Ingest of content by MBSTF for 5MBS distribution.  MBS-4-MC: 5MBS object delivery of content Representations.  M4: distribution of time-shifted content. | The transition should be seamless, i.e. in a way that the user is not aware that the delivery mode is changed. |
| 8 – Targeted content replacement | M1: Replacement content on unicast is provisioned.  M2: Ingest of replacement content.  M4: Signaling availability of different content on different delivery means in the manifest, on 5GMS AS, and on 5MBS.  Nmb2: Identification of content for 5MBS distribution.  Nmb4/xMB-U: Ingest of content by MBSTF for 5MBS distribution.  MBS-4-MC: 5BMS distribution of live main content.  M4: Distribution of targeted unicast content for replacement.  M5: Optional use of dynamic policy and network assistance on unicast distribution. | The transition between unicast targeted content and 5MBS content is expected to be seamless |
| 9 – Reporting | M1: Reporting feature is provisioned.  Nmb2: Identification of content for 5MBS distribution.  Nmb4/xMB-U: Ingest of content by MBSTF for 5MBS distribution.  MBS-4-MC: 5MBS object delivery of content.  M5: Reporting. |  |
| 10 - Interactive service | M1: Interactive content distribution is provisioned.  M2: Ingest of interactive content.  Nmb2: Identification of content for 5MBS distribution.  M8: Content is announced through interactive application.  M4: Presentation Layer content is delivered that includes reference to multiple content items delivered over 5MBS.  M6/M7/MBS-6: Find content on 5MBS.  Nmb4/xMB-U: Ingest of content by MBSTF for 5MBS distribution.  MBS-4-MC: 5MBS object delivery of content. |  |

# 7 Potential Solutions

## 7.1 General

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

## 7.2 Support of multicast ABR in 5G Media Streaming Architecture

### 7.2.1 Mapping of DVB‑MABR and CableLabs MABR reference architectures to 5MBS reference architecture for Scenario #1

#### 7.2.1.1 Introduction

With reference to Multicast ABR operation of a 5MBS-enhanced 5GMS Systerm as described in Scenario #1 (see clause 5.2.2), it is useful to map the logical functions and reference points of the DVB‑MABR and CableLabs ABR reference models into the proposed 5MBS and 5GMS combined functional architecture that is summarised in clause 4.4 of the present document. In addition, a mapping to the existing MBMS User Services architecture is also provided for illustrative purposes.

Multicast ABR Scenario #1 may be realised by the following deployment models outlined in clause 5.4 of the present document:

- **Collaboration A** (see clause 5.4.2) where all 5MBS and 5GMSd functions are deployed inside the Trusted DN.

- **Collaboration B** (see clause 5.4.3) where the 5MBS functions are deployed inside the Trusted DN and the 5GMSd functions are deployed in an External DN.

In both collaborations, the objective is to achieve Multicast ABR operation over a 5MBS Segment Streaming service that is roughly equivalent to the forerunner MBMS Download Delivery service.

#### 7.2.1.2 Mapping of logical functions

Table 7.2.1.2 below provides a mapping of the DVB-MABR logical functions [12] reproduced in Figure 4.3.1.1‑1, and those of the CableLabs reference model described in [13] to the xMB reference model from TS 26.348 [15] reproduced as Figure 4.2.2.4‑1 in the present document, to the MBMS User Services architecture in TS 26.347 [21] and to the 5MBS and 5GMS combined functional architecture proposed in clause 4.4.2 of the present document.

Table 7.2.1.2: Mapping of DVB-MABR and CableLabs M‑ABR logical functions  
to the 5MBS reference model

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| DVB‑MABR logical function | CableLabs M‑ABR function | xMB reference model function [15] | MBMS User Services reference model function [21] | | Candidate function | |
| 5MBS | 5GMS |
| Content Provider control | Multicast controller | Content Provider | Application and Content Provider | |  | 5GMS Application Provider |
| Content Provider metrics capture |
| Content preparation | Packager |
| Content hosting (as content source) | Origin/CDN | Content Source | Media and Content Server | |  | 5GMS AS (MBSTF content source) |
| Provisioning | BSS, NMS | Content Provider | MBMS Management System | |  | 5GMS AF |
| Multicast server | Multicast server | BM‑SC | | | MBSF, MBSTF |  |
| Application | IP STB | Content Receiver | MBMS-Aware Application | | 5MBS-Aware Application | 5GMS-Aware Applic |
| Content playback | Media Client | |  | Media player |
| Multicast rendezvous service | *Transparent sessions handled using channel mapping technique.* | *Transparent session initiation not supported. Non-transparent mbms: URL can instead be used for session initiation.* | | | MBSF Client? | Media Session Handler? |
| Multicast gateway | Embedded Multicast Gateway inside Gateway | MBMS Client | | | 5MBS Client (incorporating MBSF Client and MBSTF Client) |  |
| Content hosting (for HTTP file-based repair) | Origin/CDN | BM‑SC (byte range file repair over HTTP) | | | 5MBS AS |  |
| Unicast repair (see NOTE 1) | Multicast server (optional support for negative acknowledgements) |  | | BM‑SC (symbol-based file repair service over HTTP) | *It is proposed that symbol-based unicast repair is not supported for 5G Media Streaming (see NOTE 2).* | |
| NOTE 1: This function offers packet-level ("symbol-based") repair only to the Multicast gateway.  NOTE 2: it is assumed that the 5MBS Client is able to perform efficient object-level ("file-based") unicast repair either directly or indirectly with the 5MBS AS function and that packet-level ("symbol-based") unicast repair is not required in order to support 5G Media Streaming. Packet-level unicast repair may, however, be required to support other uses of 5MBS. | | | | | | |

The following open questions remain concerning this mapping:

1. Which function provides the equivalent mechanism to the DVB Multicast rendezvous service (see clause 4.3.1.5) to support transparent session bootstapping to a 5GMS-Aware Application that is unaware of 5MBS operation. This function could be provided by the Media Session Handler or by the MBSF Client.

#### 7.2.1.3 Mapping of logical reference points

Table 7.2.1.3 below provides a mapping of the reference points defined by DVB-MABR logical reference model [12] reproduced in Figure 4.3.1.1‑1, and those of the CableLabs reference model [13] to the proposed 5MBS and 5GMS combined functional architecture.

Table 7.2.1.3: Mapping of DVB-MABR and CableLabs logical reference points  
to the 5MBS reference model

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| DVB‑MABR reference point | | CableLabs M‑ABR reference point | MBMS reference point | Candidate reference point | |
| 5MBS | 5GMS |
| **CCP** | Content provider provisioning | mc-pkg | xMB-C | Configuration of MB‑SMF by MBSF (Npcf, Nmbsmf) | M1 |
| **CMS** | Multicast server configuration | mc-ms | Nx2 (based on xMB‑C) |  |
| **CMR** | Multicast gateway configuration | mc-emc | Service Annoucement over unicast (OMA) or in-band via SACH  SG-mb + M1 + Uu? | MBS‑5 |  |
| **—** | Multicast rendezvous configuration | *Implicit* | MBS‑5 Session Announcement? | M5 configuration of Media Session Handler? |
| **Pin** | Content ingest by Content hosting from Content preparation (unicast) | pkg-cdn | *Out of scope* |  | M2 |
| **Pin′** | Push-based content ingest by Multicast server from Content preparation (unicast) | pkg-ms | xMB-U (push mode) | xMB‑U (Rel‑17) (push mode) |  |
| **Oin** | Pull-based content ingest by Multicast server from Content hosting (unicast) | cdn-ms | xMB-U  (pull mode) | xMB‑U (Rel‑17) (pull mode) |  |
| **M** | Multicast transport | ms-emc | SGi-mb + M1 +Uu | MBS‑4-MC |  |
| **B** | Session bootstrap (unicast) | *Implicit* | *Explicit use of mbms: URL across MBMS-API.* |  | M6 or M7? |
| **L** | Content playback retrieval (unicast) | cpe | MBMS-API |  | M7 |
| **U** | Packet-based repair (unicast) | ms-emc | HTTP(S) over point-to-point bearer | *Not supported for 5G Media Streaming* | |
| **A** | File-based repair (unicast) | cdn-gw | MBS‑4‑UC |  |
| **RPM** | Metrics reporting from Content playback | *Out of scope* | *DASH QoE metrics via Reception reporting procedure below.* |  | M6, M5 |
| **RS** | Metrics reporting from Multicast gateway | mc-emc | Reception reporting and consumption reporting via unnamed reference point | MBS‑5 |  |
| **RCP** | Reporting from Provisioning to Content provider | ossi | *Out of scope for xMB* |  | M1 |

A number of open questions arise from this initial mapping exercise:

1. The reference point used by the MBSTF to ingest content from the 5GMS AS (designated xMB-U in the SA2 study [7]) needs to be studied. If it resembles the media ingest interface, supporting both push- and pull-based operating modes, it could be similar to M2; if it more closely resembles the media consumption interface, it could instead be more like M4.

2. How is the session bootstap mechanism (Multicast rendezvous service) configured to enable transparent operation? It could be configured by means of Session Annoumcements delivered via an MBS‑5 Session Announcement Channel, or the Session Announcements could be delivered via unicast means (e.g. via M5 to the Media Session Handler).

3. How is transparent operation achieved in practice? Which client-side function is able to intercept the initial presentation manifest request at the start of a streaming session and to determine that 5MBS operation is available? Is it necessary to modify the presentation manifest to achieve this goal, or is it possible to realise the desired transparency using HTTP redirects alone?

4. Is the file-based repair mechanism part of the 5MBS architecture, an extended use of the 5GMS AS or does it straddle both architectures?

5. Does the MBSF report 5MBS-related metrics back to the MBSF via MBS‑5?

#### 7.2.1.4 Mapping to Collaboration B0

Figure 7.2.1.4‑1 below shows how the DVB‑MABR reference model (blue functions and reference points) maps onto the 5MBS reference model proposed in the present document (green functions and reference points) and the 5MBS reference model for 5GC (grey functions and reference points) in the case of **Collaboration B0**.



Figure 7.2.1.4‑1: Mapping of the DVB‑MABR reference model onto the 5MBS reference model (Collaboration B0)

In this mapping:

1. The *Multicast server* function is realised by the MBSTF.

- Configuration at DVB‑MABR reference point **CMS** is achieved using xMB-C (Rel-17) MBS session provisioning procedures with the MBSF rather than using the DVB‑MABR multicast transport configuration. This results in configuration of the MBSTF via Nx2.

Editor’s Note: xMB-C (Rel‑17) may be redesignated Nmbsf or Nx4 following consultation with SA2.

- The Object delivery method is provisioned.

- Pull-based content ingest at reference point **Oin** is realised by provisioning xMB-U pull mode procedures.

- Push-based content at reference point **Pin′** is realised by provisioning xMB-U push mode procedures.

Editor’s Note: xMB-U may be redesignated Nmbstf or Nx5 following consultation with SA2.

2. Reference point **M** is realised by MBS‑4‑MC.

- The MBSTF generates a bitstream according to the specification of the Object delivery method.

3. The MBS session is announced to the 5MBS Client at MBS-5.

- The session descripion may be delivered via a 5MBS session announcement channel generated by the MBSTF at MBS‑4‑MC. This realises the DVB‑MABR multicast gateway configuration transport session.

- Alternatively, the 5MBS Client may retrieve the session description from the 5MBS AS via MBS‑4‑UC. This realises reference point **CMR** in the DVB‑MABR reference model.

In the UE:

3. The *Content playback* function and the *Multicast rendezvous service* are realised as a 5MBS-Aware Application.

4. The *Multicast gateway* function is realised by the 5MBS Client.

- New sessions are notified to the *Multicast rendezvous service* via MBS‑6 so that it can configure its redirect behaviour.

- The 5BMS Client provides object reassembly and repair functions in line with the 5MBS Object delivery method.

- The 5MBS Client implements dynamic adaptation between multicast transport sessions corresponding to different representations of the same adaptation set.

5. HTTP-based object repair at reference point **A** is realised by MBS‑4‑UC.

- The 5MBS AS may act as a unicast proxy for the external *Content hosting* function.

- Alternatively, the associated delivery procedures described in the 5MBS session announcement may direct the 5MBS Client to use the *Content hosting* function directly for HTTP-based object repair.

6. Reference point **L** is realised by MBS‑7.

- Intact playback delivery objects are exposed to the *Content playback* function, as required.

The following potential gaps merit study in relation to Collaboration B0:

1. What interface is used by the MBSF to publish session descriptions to the 5MBS AS?

2. How are multicast delivey sessions corresponding to different representations of the same adaptation set configured as part of a single 5MBS session description at xMB‑C (Rel‑17), Nx2 and MBS‑5?

Editor’s Note: xMB-C (Rel‑17) may be redesignated Nmbsf/Nx4 following consultation with SA2.

3. How is dynamic adaptation achieved in the 5MBS Client between multicast transport sessions corresponding to different representations of the same adaptation set?

### 7.2.2 Interworking of DVB‑MABR reference architecture with 5MBS reference architecture for Scenario #2

#### 7.2.2.1 Introduction

With reference to an external Multicast ABR system interworking with a 5MBS System as described in clause 5.2.3, a different arrangement of logical functions and reference points is needed from that of Scenario #1.

NOTE: The collaborations further elaborated in this clause illustrate how an external system may interwork with the 5MBS and 5G Media Streaming architectures. This level of analysis is helpful in identifying potential gaps. It does not imply that interworking solutions will be documented in the normative specification.

Multicast ABR Scenario #2 may be realised by the following deployment models outlined in clause 5.4 of the present document:

**- Collaboration C** (see clause 5.4.4) where all media-related functions are deployed in an External DN and a multicast packet stream (optionally encapsulated in a unicast tunnel) is injected directly into the MB‑UPF in the Trusted DN at reference point N6, as depicted in Figure 4.4.1.3‑1. The multicast packet stream may include AL‑FEC repair packets. Because the externally generated multicast packet stream emulates the candidate 5MBS Delivery Method for segmented media, the 5MBS Client can receive it and can perform AL‑FEC and unicast repair procedures on the packet payloads as needed.

In this collaboration, the *Provisioning* function plays the role of an externally hosted 5GMSd AF; the *Content hosting* function plays the role of an externally hosted 5GMSd AS and the *Multicast server* provides the “MBSTF-like” function. HTTP-based unicast repair operations use the *Content hosting* function in the External DN. The 5MBS-Aware Application resembles a 5GMSd Client, although the *Multicast rendezvous service* also needs to be provided as part of the former.

This collaboration is further described in clause 7.2.2.2 below.

- **Collaboration D** (see clause 5.4.5) which is the same as Collaboration C except that the externally generated multicast packet stream injected into the MB‑UPF at N6 is in an application-specific format that differs from the candidate 5MBS Delivery Method for segmented media, for example the DVB-MABR profile of ROUTE or the CableLabs profile of NORM. In this case, the 5MBS Client can receive the packet payloads, but cannot repair them using 5MBS AL‑FEC or 5MBS HTTP-based unicast repair procedures. The received packet payloads are instead delivered to a 5MBS-Aware Application at MBS‑7 that is responsible for media object reassembly, repair procedures and onward delivery to a media player.

In this collaboration, the DVB-MABR *Multicast gateway* function could, for example, play the role of the 5MBS-Aware Application.

This collaboration is further described in clause 7.2.2.3 below.

#### 7.2.2.2 Interworking architecture for Collaboration C

Figure 7.2.2.2‑1 below shows how the DVB‑MABR reference model (blue functions and reference points) integrates with the 5MBS reference model proposed in the present document (green functions and reference points) and the 5MBS reference model for 5GC (grey functions and reference points) in the case of Collaboration C.



Figure 7.2.2.2‑1: Interworking between the DVB‑MABR reference model and the 5MBS reference model (Collaboration C)

In the control plane of the end-to-end system:

1. An “MBSF-like” subfunction of the content provider’s *Provisioning* function in the External DN interworks with the MB‑SMF in the Trusted DN by invoking Nmbsmf APIs via the NEF. These are used to provision a transparent delivery session for each target DVB-MABR multicast transport session, plus an additional delivery session to convey the DVB-MABR multicast gateway configuration transport session.

As part of this interaction, the multicast address(es) to be used in the data plane are nominated by the MB‑SMF and returned to the “MBSF-like” subfunction.

2. The *Provisioning* function configures the DVB‑MABR multicast transport session(s) in the *Multicast server* as usual via CMS. (This replaces the notional Nx2 interface in this collaboration.)

NOTE 1: The multicast address(es) nominated by the MB‑SMF are included in the DVB-MABR multicast server configuration instance document passed at reference point CMS. (This includes the transport parameters for each multicast transport session, plus those for the multicast gateway configuration transport session.)

NOTE 2: This step is outside the scope of 3GPP standardisation.

3. The availability of the transport-only multicast delivery session(s) is advertised to the 5MBS Client in the conventional manner at reference point MBS‑5. This advertisement is realised in one of three different ways:

a. The “MBSF-like” subfunction of the Provisioning function publishes a session description to the 5MBS AS and then includes its URL in the session advertisement so that the 5MBS Client can fetch the advertisement via MBS‑4‑UC.

b. The “MBSTF-like” subfunction of the *Multicast server* derives a 5MBS-compliant session description from the configuration it has received at **CMS** and adds this to a 5MBS-compliant session announcement channel.

c. The *Multicast gateway* synthesises a 5MBS-compliant session description from the DVB‑MABR muticast gateway configuration it has received at reference point **M** and injects that into the 5MBS Client by invoking an API at MBS‑6.

The advertisement includes the address of the 5MBS AS to support interworking of HTTP-based unicast repair.

4. The DVB‑MABR *Rendezvous service* and *Multicast gateway* are notified by the 5MBS Client about the availability of transport-only multicast delivery sessions via the MBS‑6 API.

In the user plane of the end-to-end system:

5. Multicast packets produced by the *Multicast server* are likely conveyed between the External DN and the Trusted DN in a unicast tunnel.

6. The MB‑UPF transparently delivers these multicast packets to the 5MBS Client on the UE via MBS‑4‑MC, subject to traffic policing rules in the MB-UFP that protect the network from being flooded.

7. Using the notifications received from the 5MBS Client in step 4 above, the *Rendezvous service* configures itself such that presentation manifest requests made at reference point **B** are redirected to the *Multicast gateway* when the corresponding media is available from an advertised multicast delivery session.

8. Using the notifications received from the 5MBS Client in step 4 above, the combined *Multicast gateway* and 5MBS Client function subscribes to the desired multicast delivery session(s). Dynamic adaptation between multicast delivery sessions is achieved inside this function by making appropriate low-level API calls to unsubscribe from one and subscribe to another.

9. The 5MBS Client receives multicast packets at MBS‑4‑MC for subscribed multicast delivery sessions. Using the information in the session announcement received in step 3 above, the 5MBS Client applies AL‑FEC repair to the received packets.

For any unrecoverable packet payloads, the 5MBS Client performs HTTP-based unicast repair with the 5MBS AS via MBS‑4‑UC, using the relevant associated delivery procedures configuration from the session announcement received in step 3 above.

10. The 5MBS Client exposes intact playback delivery objects to the correct 5MBS-Aware Application (here, the *Content playback* function) via reference point MBS‑7. This realises DVB‑MABR reference point **L**.

11. Intact playback delivery objects are exposed to the *Content playback* function as normal at reference point L.

NOTE 3: This step is outside the scope of 3GPP standardisation.

A number of changes to the DVB‑MABR reference architecture are required in order to support interworking according to Collaboration C:

1. The *Content provisioning* function needs to implement an additional “MBSF-like” subfunction in order to provision 5MBS transparent delivery services.

2. The *Multicast server* function needs to implement an additional “MBSTF-like” subfunction in order to generate at reference point **M** a multicast packet stream compliant with MBS‑4‑MC that is suitable for consumption by the 5MBS Client.

This may include generating a session announcement channel to convey 5MBS session description delivery objects derived from the multicast server configuration instance document provided via **CMS**. This session announcement channel effectively replaces the multicast gateway configuration transport session in this collaboration.

3.. The *Content hosting* function needs to implement a “5MBS AS-like” subfunction in order to provide HTTP-based file repair at MBS‑5. (Since this is so similar to DVB‑MABR reference point **A**, this is likely to be trivial.)

The “5MBS-like” subfunction may additionally need to host 5MBS session descriptions. These effectively replace the multicast gateway configuration instance document when it is delivered via **CMR**.

The following potential gaps may be of interest in relation to Collaboration C:

1. Is it possible to configure a transparent multicast delivery session configured at Nmbsmf in such a way that it can then be successfully advertised to a 5MBS Client in a session description?

2. How are multicast delivery sessions corresponding to different representations of the same adaptation set configured as part of a single 5MBS session description at Nmbsmf and MBS‑5?

3. How is dynamic adaptation achieved in the 5MBS Client between multicast delivery sessions corresponding to different representations of the same adaptation set?

4. How is a synthetic 5MBS session description best injected into a 5MBS Client at MBS‑6?

#### 7.2.2.3 Interworking architecture for Collaboration D

Figure 7.2.2.3‑1 below shows how the DVB‑MABR reference model (blue functions and reference points) integrates with the 5MBS reference model proposed in the present document (green functions and reference points) and the 5MBS reference model for 5GC (grey functions and reference points) in the case of Collaboration D.



NOTE: Because use of the unicast path is uncoordinated with 5MBS functions in this collaboration, reference point MB‑N9 between the MB-UPF and UPF is omitted.

Figure 7.2.2.3‑1: Interworking between the DVB‑MABR reference model and the 5MBS reference model (Collaboration D)

In the control plane of the end-to-end system:

1. The content provider’s *Provisioning* function in the External DN interworks with the MB‑SMF in the Trusted DN by invoking Nmbsmf APIs via the NEF. These are used to provision a transport-only multicast delivery session for each target DVB-MABR multicast transport session, plus an additional delivery session to convey the DVB-MABR multicast gateway configuration transport session.

As part of this interaction, the multicast address(es) to be used in the data plane are nominated by the MB‑SMF.

2. The *Provisioning* function configures the DVB‑MABR multicast transport session(s) in the *Multicast server* as usual via CMS.

NOTE 1: The multicast address(es) nominated by the MB‑SMF are included in the DVB-MABR multicast server configuration instance document passed at reference point CMS. (This includes the transport parameters for each multicast transport session, plus those for the multicast gateway configuration transport session.)

NOTE 2: This step is outside the scope of 3GPP standardisation.

3. The availability of the transport-only multicast delivery session(s) is advertised to the 5MBS Client in the conventional manner at reference point MBS‑5. This advertisement is realised in one of two different ways:

a. The *Multicast server* derives a 5MBS-compliant session description from the configuration it has received at **CMS** and adds this to a 5MBS-compliant session announcement channel at MBS‑4‑MC.

b. The *Multicast gateway* synthesises a 5MBS-compliant session description from the multicast gateway configuration it has received at reference point **M** and injects that into the 5MBS Client by invoking an API at MBS‑6.

4. The DVB‑MABR *Rendezvous service* and *Multicast gateway* are notified by the 5MBS Client about the availability of transport-only multicast delivery sessions via the MBS‑6 API.

In the user plane of the end-to-end system:

5. Multicast packets produced by the *Multicast server* are likely conveyed between the External DN and the Trusted DN in a unicast tunnel.

6. The MB‑UPF transparently delivers these multicast packets to the 5BMS Client on the UE via MBS‑4‑MC, subject to traffic policing rules in the MB-UFP that protect the network from being flooded.

7. Using the notifications received from the 5MBS Client in step 4 above, the *Rendezvous service* configures itself such that presentation manifest requests made at reference point **B** are redirected to the *Multicast gateway* when the corresponding media is available from an advertised multicast delivery session.

8. Using the notifications received from the 5MBS Client in step 4 above, the *Multicast gateway* function subscribes to the multicast delivery sessions corresponding to the desired DVB‑MABR multicast transport sessions by invoking the appropriate MBS‑6 API call on the 5MBS Client. Dynamic adaptation between multicast transport sessions is achieved by making appropriate MBS‑6 API calls to unsubscribe from one and subscribe to another.

9. In particular, the *Multicast gateway* subscribes to the multicast gateway configuration transport session as soon as it is announced at MBS-6 in order to acquire the multicast gateway configuration instance document and any other multicast delivery objects provided on the multicast gateway configuration transport session, such as presentation manifests and/or initialisation segments.

10. The 5MBS Client receives multicast packets at MBS‑4‑MC for subscribed multicast delivery sessions and routes them to the correct 5MBS-Aware Application (here, the *Multicast gateway* function) via reference point MBS‑7.

NOTE 3: The 5MBS Client does not attempt to make good any missing or corrupted multicast packets in this collaboration scenario.

NOTE 4: The realisation of MBS‑7 in this collaboration is most likely a virtual network interface on the UE that supplies UDP packet payloads received by the modem directly to the 5MBS-Aware Application. The 5MBS Client remains in control and is responsible for passing the name of the appropriate virtual network interface to the 5MBS-Aware Application, but the user plane bypasses the 5BMS Client.

11. The *Multicast gateway* parses and reassembles received multicast packets into playback delivery objects, as normal. It may apply Application‑Level Forward Error Correction to repair missing packets, as configured in the multicast gateway configuration instance document received in step 9. It may also perform HTTP-based unicast repair at reference point A, as configured in the multicast gateway configuration instance document. Reference point A is realised via a conventional PDU Session.

NOTE 5: This step is outside the scope of 3GPP standardisation, beyond the use of a PDU Session.

12. Intact playback delivery objects are exposed to the *Content playback* function as normal at reference point L.

NOTE 6: This step is outside the scope of 3GPP standardisation.

A number of changes to the DVB‑MABR reference architecture are required in order to support interworking according to Collaboration D:

1. The *Content provisioning* function needs to implement Nmbsmf in order to provision 5MBS transport-only delivery services.

2. The *Multicast server* function may need to generate a session announcement channel to advertise 5MBS transport-only session description delivery objects derived from the multicast server configuration instance document provided via **CMS**. (This session announcement channel is in addition to the multicast gateway configuration transport session.)

The following potential gaps may be of interest in relation to Collaboration D:

1. Is it possible to configure a transport-only multicast delivery session configured at Nmbsmf in such a way that it can then be successfully advertised to a 5MBS Client in a session description?

2. How is a synthetic 5MBS session description best injected into a 5MBS Client at MBS‑6?

## 7.3 Multicast–Broadcast User Service

### 7.3.1 Introduction

An “MBMS user service”-like support is expected to be provided by the MBSF and MBSTF. 5MBS User Services enable applications. It presents a complete service offering to an end-user, via a set of APIs that allows the 5MBS Client to activate or deactivate reception of the service.

The 5MBS User Service architecture is independent of 5G Media Streaming (5GMS) and may be used without 5GMS. There are scenarios where 5GMS is the northbound application function, as depicted in clause 5.4 where four different deployment models are presented. In another example, 5G Multicast ABR media streaming service could be a User Service where the 5MBS User Services allow streaming of DASH content as defined in TS 26.501, and it also includes the use of an MBS session to deliver the DASH segments in multicast. When delivering content to a 5MBS Client, the MBSTF uses one or more 5MBS Delivery Methods.

Figure 7.3.1-1 depicts a potential solution for functional entities in MBSF and MBSTF to support 5G Multicast-Broadcast User Service.



Figure 7.3.1-1: 5GS multicast-broadcast user service functional entities

### 7.3.2 MBSF

The following functions in the MBSF to support 5MBS will be defined in 3GPP TS 23.247 [26]:

- Interacting with MB-SMF for MBS session operations, determination of N6mb transport parameters, and session transport (via interface Nmb1).

- Selection of serving MB-SMF for an MBS Session (via interface Nmb1).

NOTE: The equivalent reference point of Nmb1 in MBMS control plane is SGmb.

- Configuration (via interface Nmb2) of the sender IP multicast address to use for the MBS session in cases where the IP multicast stream is originated by the MBSTF.

The following MBSF functionality and procedures related to service and MBS data handling to support 5MBS User Service are studied in the present document:

- Interacting with the MBSTF (if needed) for 5MBS Delivery Method control (via Nmb2).

- Interacting with the AF (optionally via NEF) (via Nmb6/xMB-C).

NOTE: It is assumed that MB2-C interface will be supported in Release 17 “as is”, as specified in 3GPP TS 29.468 [18] and RFC 6733 [20].

- Interacting with the PCF (via Nmb7) to relay or initiate a request for different PCF treatment.

- Interacting with the UE (via MBS-5).

NOTE: The MBS-5 interface might be abstract, i.e. using an undefined/external transport.

- The User Service Discovery/Announcement provides session access information, which is necessary to initiate the reception of a 5MBS User Service. The session access information may contain information for presentation to the end-user, as well as application parameters used in generating service content to the 5MBS Client.

### 7.3.3 MBSTF

In MBSTF, the use of reference point Nmb5 to provide IP multicast traffic delivery to the MB-UPF will be defined in 3GPP TS 23.247 [26].

NOTE: The equivalent reference point of Nmb5 in MBMS is SGi-mb.

The following MBSTF functionality and Delivery Methods related to MBS data handling, to support 5MBS User Services, will be studied in the present document.

- Interacting with the AS (via interface Nmb4/xMB-U).

- Interacting with the UE (via MBS-4-MC).

A set of 5MBS Delivery Methods are provided by the MBSTF. These provide functionality such as security and key distribution, reliability control (by means of FEC techniques) and associated delivery procedures. The following Delivery Methods will be studied in the present document:

***- Object delivery method:*** Functionally, this is equivalent to the “Download Delivery Method” in TS 26.346 [16] and also supports the real-time delivery of media segments (as special objects) including Low-Latency CMAF delivery.

Figure 5.3.1.1-1 illustrates a simplified user plane model of FLUTE as an example of a possible MBSTF object delivery method. However, the protocol to support the object delivery function is for future study.

***- Transparent delivery method:*** This supports the IP streaming use cases, for which UDP payloads (also referred to as Application Data Units) are distributed as part of UDP or IP flows carried to the UE over an MBS session. Examples of higher layer protocols are RTP, packetized MPEG-2 TS or other UDP-based streams.

***- Group Communication delivery method:*** This delivers a multicast UDP/IP packet flow to the UE.

Editor’s Notes:The potential merger of the Transparent delivery method and Group Communication delivery method is for future study. For details also refer to clause 5.5.2.

The above Delivery Methods may use either a multicast or broadcast session to deliver content to a receiving application, and may also make use of a set of 5MBS associated delivery procedures.

***MBS session*** refers to a multicast session or a broadcast session, as defined in TS 23.247 [26].

- In a ***Multicast MBS session***, an MBS session delivers the multicast communication service. A Multicast MBS session is characterised by the content to send, by the list of UEs that may receive the service, and, optionally, by a multicast area in which to distribute it

- In a ***Broadcast MBS session***, an MBS session delivers the broadcast communication service. A broadcast MBS session is characterised by the content to send and the geographical area for content distribution.

### 7.3.4 5MBS together with 5G Media Streaming Architecture

Figure 7.3.4-1 depicts a deployment of 5G Media Downlink Streaming delivery over multicast. The 5GMSd Application Provider is a combined external application entity and content-specific media functionality (e.g. media creation, encoding, and formatting) that uses the 5GMS System to distribute media to a 5GMSd-Aware Application.



Figure 7.3.4-1: 5G multicast media streaming User Service functional entities

The 5GMSd AF provides 5G Media Downlink Streaming provisioning and various control functions to the Media Session Handler in the 5GMS Client located in the UE. It may relay or initiate a request for different PCF treatments.

In the deployment architecture, as shown by Figure 7.3.4-1, the 5GMSdAF and MBSF are fully separated logical functions. Alternatively, as depicted in Figure 5.4.2-1, the MBSF could be integrated within the 5GMSd AF. In such a deployment, the embedded MBSF still uses the Nmb2 to configure and control the multicast delivery functionality of the MBSTF.

Detailed deployment options in the UE are described in clause 4.4.2 of the present document.

### 7.3.5 Hybrid 5GMS unicast and 5MBS services

Based on the principle considerations in Table 6.2.3-1, for all different hybrid unicast/5MBS services except MooD, the following needs to be done:

- Architecture for Hybrid 5GMS unicast and 5MBS services,

- Call flows for the hybrid services need to be defined.

- The required functions of the reference points need to be checked against existing functions in TS 26.501, TS 26.511, TS 26.512, TS 26.346, TS 26.347 and TS 26.348.

The required functions need to be documented and extended as needed.

# 8 Conclusions and Next Steps

## 8.1 General

Table 8.1-1 points to conclusions and next steps for each of the key issues studied in the present document.

Table 8.1-1: Index of Key Issues, Conclusions, and Next Steps

|  |  |
| --- | --- |
| Key Issue | Conclusions and Next Steps clause |
| Key Issue#1: How to support multicast ABR in 5G Media Streaming Architecture | 5.2.7 |
| Key Issue#2: How to design Nmb2 interface | 5.3.3 |
| Key Issue#3: Collaboration and deployment scenarios | 5.4.6 |
| Key Issue #4: Reuse of MBMS service layer | 5.5.2 |
| Key Issue #5: Client architecture options | 5.6.3 |
| Key Issue #6: Hybrid 5GMS services | 5.7.3 |
| Key Issue #7: 5GMS via eMBMS | 5.8.3 and 5.8.4 |

## 8.2 Conclusions

Based on the conclusions for the key issues studied in the present document (as summarized in clause 8.1 above), the following consolidated conclusions are reached as an agreed baseline for potential standardization:

1. Define 5G Media Streaming services delivered via 5MBS, including hybrid services.

2. Define 5G Media Streaming services delivered via eMBMS, including hybrid services.

3. Define service aspects in the MBSF, such as the User Service announcement. This includes the definition of a data model for 5MBS services including a session model and its mapping to 5MBS transport.

4. Define the Delivery Methods in the MBSTF to realise 5MBS User Services in the MBSF using available 5MBS capabilities, including support for Group Communication delivery.

5. Define 5MBS associated delivery procedures, including file repair and delivery reporting.

6. Define the realization of Nmb2 (between MBSF and MBSTF), which configures and controls the Delivery Methods (such as object delivery).

7. Define reference point Nmb6 for provisioning the MBSF (based on xMB-C) and Nmb4 for ingesting content into the MBSTF (based on xMB-U).

NOTE: It is assumed that the existing MB2 interface will be supported in Release 17 “as is”.

8. Define the functionalities and APIs of the 5MBS Client.

9. Define procedures for discovering and establishing a Multicast ABR session, for dynamically (de)selecting multicast transport sessions, for recovering from multicast packet loss and for reporting usage statistics and Quality of Experience metrics for optimal service management.

10. Any new specification will take into consideration the need to maximize the reuse of components already specified in MBMS.

Note that the specific conclusions for each key issue as documented in Table 8.1-1 are expected to be taken into account in the detailed definition of new functionalities.

## 8.3 Recommended normative work

To document the potential standardization areas identified in clause 8.2 above, it is expected that several new specifications are produced and several existing specifications are extended.

In particular, the following normative specification work is recommended for immediate action:

1. A new architecture specification (as an example, TS 26.502) to define a 5MBS User Service architecture, including the following reference points/interfaces and entities:

a. New entities MBSF, MBSTF, 5MBS Client, and 5MBS AS.

b. The northbound reference points Nmb6 and Nmb4.

c. The reference point Nmb2 between the MBSF and the MBSTF.

d. The interfaces between the 5MBS Client and 5MBS network functions: MBS-4-UC, MBS-4-MC and MBS‑5.

e. the 5MBS Client reference points MBS-6 and MBS-7.

Editor’s Note: there is a dependency on SA2’s work on Rel-17 TS 23.247, which should be functionally frozen in June 2021.

This specification also includes:

f. Relevant call flows and procedures to support 5GMS over 5MBS.

g. Relevant call flows and procedures to support 5GMS hybrid services.

h. Relevant call flows and procedures for 5GMS independent usage of 5MBS.

2. In combination with the new 5MBS User Service Architecture specification (e.g. TS 26.502) above, extend TS 26.501 by providing a general description and architecture of:

a. 5GMS via 5MBS.

b. 5GMS hybrid services.

c. 5GMS via eMBMS.

d. Multicast ABR with 5GMS and 5MBS.

The following normative work is expected subsequently:

3. A new specification (as an example TS 26.513) to define the 5MBS User Service transport/application protocols and Delivery Methods for the interfaces defined in the 5MBS User Service Architecture specification (e.g. TS 26.502) above. This specification will take into consideration the need to maximize the reuse of components of already specified MBMS.

4. Extend TS 26.347 to provide Client APIs for 5MBS User Services, as defined in the 5MBS User Service Architecture specification (e.g. TS 26.502) above.

5. Extend relevant clauses in TS 26.512 [28] to realise the procedures defined in the 5MBS User Service Architecture specification (e.g. TS 26.502) above for 5GMS via 5MBS, 5GMS hybrid services, 5GMS via eMBMS, and Multicast ABR with 5GMS and 5MBS, as needed.

6. Extend relevant clauses in TS 26.346 [16] to define protocols and codecs for 5GMS via 5MBS, 5GMS hybrid services, 5GMS via eMBMS, and Multicast ABR with 5GMS and 5MBS, as needed.

# Annex A (informative): Change history

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Change history** | | | | | | | |
| **Date** | **Meeting** | **TDoc** | **CR** | **Rev** | **Cat** | **Subject/Comment** | **New version** |
| 2020-05 | SA4#109-e | S4-20941 | - | - | - | S4-20941: Proposed Skeleton TR 26.802 agreed in SA4#109-e | 0.0.1 |
| 2020-08 | SA4#110-e |  |  |  |  | Inclusion of documents agreed in SA4#110-e:  S4-201137 | 0.0.2 |
| 2020-11 | SA4#111-e |  |  |  |  | Inclusion of documents agreed in SA4#111-e:  S4-201628 | 0.1.0 |
| 2020-12 | SA4 MBS SWG AH Telco |  |  |  |  | Inclusion of S4aI201102 agreed in SA4 MBS SWG AdHoc Telco on Dec 10, 2020 | 0.1.8 |
| 2021-02 | SA4#112-e |  |  |  |  | Inclusion of S4-210079, S4-210152, and S4-201384 | 0.2.2 |
| 2021-02 | SA4#112-e |  |  |  |  | Inclusion of S4-210239, S4-210308, S4-210250, S4-210249 | 0.3.0 |
| 2021-03 | SA#91-e |  |  |  |  | Submitted to SA for information | 1.0.0 |
| 2021-03 | SA4-e (AH) MBS SWG post 112-e |  |  |  |  | Inclusion of S4aI201152 and S4aI201153 | 1.0.8 |
| 2021-04 | SA4#113-e |  |  |  |  | Inclusion of S4-210616, S4-210638, and S4-210588 | 1.2.0 |
| 2021-04 | SA4-4(AH) MBS SWG post 113-e |  |  |  |  | Inclusion of S4aI211172 and editorial changes | 1.2.8 |
| 2021-05 | SA4#114-e |  |  |  |  | Inclusion of S4-210901, S4-210905, S4-210906, S4-210907, S4-210922, S4-210923 | 1.3.0 |
| 2021-06 | Post SA4#114-e |  |  |  |  | Submission to SA plenary for approva; | 2.0.0 |
| 2021-06 | SA#92-e | SP-210379 |  |  |  | Specification brought under Change Control | 17.0.0 |