**3GPP TSG SA WG4 #114e *S4-210730***

**E-meeting, 19th – 28th May 2021**

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|  | **26.802** | **CR** | **<CR#>** | **rev** | **-** | **Current version:** | **1.0.0** |  |
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| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* |
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| ***Proposed change affects:*** | UICC apps |  | ME | **X** | Radio Access Network |  | Core Network | **X** |

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|  |
| ***Title:***  | [FS\_5GMS\_Multicast] General Updates |
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| ***Source to WG:*** |  Qualcomm Incorporated |
| ***Source to TSG:*** | SA4 |
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| ***Work item code:*** | FS\_5GMS\_Multicast |  | ***Date:*** | 2021-05-11 |
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| ***Category:*** | **B** |  | ***Release:*** | Rel-17 |
|  | *Use one of the following categories:****F*** *(correction)****A*** *(mirror corresponding to a change in an earlier release)****B*** *(addition of feature),* ***C*** *(functional modification of feature)****D*** *(editorial modification)*Detailed explanations of the above categories canbe found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | *Use one of the following releases:Rel-8 (Release 8)Rel-9 (Release 9)Rel-10 (Release 10)Rel-11 (Release 11)Rel-12 (Release 12)**Rel-13 (Release 13)Rel-14 (Release 14)Rel-15 (Release 15)Rel-16 (Release 16)* |
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| ***Reason for change:*** |  |
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| ***Summary of change:*** |  |
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| ***Consequences if not approved:*** |  |
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| ***Clauses affected:*** |  |
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|  | **Y** | **N** |  |  |
| ***Other specs*** |  | **X** |  Other core specifications  | TS/TR ... CR ...  |
| ***affected:*** |  | **X** |  Test specifications | TS/TR ... CR ...  |
| ***(show related CRs)*** |  | **X** |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** |  |
| ***56***  |  |
| ***This CR's revision history:*** |  |

**===== CHANGE =====**

# 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] ETSI TS 103 720: "5G Broadcast System for linear TV and radio services; LTE-based 5G terrestrial broadcast system".

[28] 3GPP TS 29.116: "Representational state transfer over xMB reference point between content provider and BM-SC".

[29] 3GPP TS 36.211: "LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Physical channels and modulation".

[30] 3GPP TS 36.300: "LTE; Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Overall description; Stage 2".

[31] 3GPP TS 36.331: "LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC); Protocol specification".

[32] 3GPP TR 36.976 "Overall description of LTE-based 5G broadcast".

[33] 3GPP TS 24.116: "Stage 3 aspects of system architecture enhancements for TV services".

[34] 3GPP TS 24.117: "TV service configuration Management Object (MO)".

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### 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.

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### 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.

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### 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.

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### 4.3.3 ETSI TS 103 720: LTE-based 5G Broadcast System

TR 36.976 [32] describes a subset of the MBMS System that can be deployed as an LTE-based 5G terrestrial broadcast system. ETSI TS 103 720 [27] specifies a realisation of these requirements.

While Multimedia Broadcast Multicast Services (MBMS) had been part of 3GPP specifications since Release 6 in 2005 based on UTRAN, and since Release 9 based on LTE (the evolution to LTE is also referred to as "eMBMS"), the dedicated requirements of broadcast service providers were only taken into account in Release 14 some ten years later. Based on these requirements, 3GPP specifications have gradually evolved to meet the use cases and requirements in order to support broadcasting of linear television and radio services. In particular, the following aspects are addressed

- Support of Free-to-Air (FTA) service.

- Broadcast-only service for UEs without an MNO broadcast subscription.

- Support of shared network functions across multiple 5G network operators.

- Decoupling of content, user service and transport functions.

- Exposure of broadcast service and transport capabilities to third parties.

- Support for client APIs for simplified access to broadcast services.

- Network dedicated to linear television and radio broadcast, for example transmitted using supplemental downlink channels and spectrum.

- Single Frequency Network (SFN) deployments with Inter-Site Distance (ISD) significantly larger than those associated with typical cellular deployments, with ISD > 100 km to support receivers with high-gain rooftop directional antennas, low mobility and a predominantly line-of-sight channel.

- Support for mobility scenarios including speeds of up to 250 km/h to support receivers in moving vehicles, with external omni-directional antennas.

- Support for Receive-Only Mode (ROM) services and devices.

- Support for user service announcement through broadcast.

- Support for common streaming distribution formats such as Dynamic Adaptive Streaming over HTTP (DASH), HTTP Live Streaming (HLS) and Common Media Application Format (CMAF).

- Support for IP-based services such as IPTV or ABR multicast.

- Support for different file delivery services such as scheduled delivery or file carousels.

Several 3GPP specifications have been extended (e.g. TS 36.300 [30] and TS 36.331 [31]) or newly developed (e.g. TS 24.116 [33] and TS 24.117 [34] over several releases to address the use cases and requirements for 5G dedicated broadcast networks. For an overview of affected specifications, please see TR 36.976 [32].

ETSI TS 103 720 [27] summarizes the basic features of a 5G Broadcast System for the carriage of linear television and radio services, and documents these as an implementation profile of a subset of 3GPP specifications. The LTE-based 5G Broadcast System as defined in ETSI TS 103 720 addressing the basic features listed above and is based on a profile of 3GPP specifications available in Release 16.

Figure 4.3.3-1 depicts the reference architecture for the LTE-based 5G Broadcast System as defined in ETSI TS 103 720 [27]. In this instantiation of the architecture, the 5G Broadcast Transmitter encapsulates functions from the Evolved Packet System sufficient to transmit the MBMS User Service, and the 5G Broadcast Recevier provides the minimal set of functions to receive the MBMS User Service.



Figure 4.3.3-1: Reference architecture for 5G Broadcast System for linear TV and radio services with LTE-based 5G Broadcast instantiation (see ETSI TS 103 720 [27])

According to Figure 4.3.3-1, the reference points and protocols for the LTE-based 5G Broadcast System instantiation are:

- For the northbound Network API for 5G Broadcast, a profile of xMB as defined in TS 26.348 [15] and TS 29.116 [28] is defined in clause 5.5.2 of TS 103 720.

- For the User Service for 5G Broadcast, a a profile of the MBMS User Service as defined in TS 23.246 [6] and TS 26.346 [16] is specified in clause 5.5.3 of TS 103 720;

- For the RAN for 5G Broadcast, For the RAN for 5G Broadcast, a profile of E-UTRAN Uu as defined in TS 36.300 [30], TS 36.211 [29] and TS 36.331 [31] is specified in clause 5.5.4 of TS 103 720;

- For the Client API for 5G Broadcast, a profile of the MBMS-APIs as defined in ETSI TS 26.347 [21] is specified in the present document in clause 5.5.5 of TS 103 720.

While the specification focusses on broadcast-only distribution, a richer application service may be provided to a UE that also supports unicast. This is shown in Figure 4.3.3-2.



Figure 4.3.3-2: Application service using both LTE-based 5G Broadcast and 4G or 5G unicast

In one embodiment of the above system, the Content Provider provides information through xMB that File or Segment Streaming content is also available for unicast retrieval. For details, see TS 26.348. In this case the 5G Broadcast Transmitter provides the corresponding information in the User Service Description such that 5G Broadcast Receivers capable of using unicast can retrieve unicast components. This can, for example, be done for file repair procedures or service continuity in DASH or HLS.

In other embodiments, the 5G Broadcast TV/Radio Application itself makes use of unicast to provide an improved service. Examples for this may be in the context of HbbTV® or DVB-I Service information. This may, for example, include an Electronic Program Guide (EPG) or an Electronic Service Guide (ESG).

The specification ETSI TS 103 720 was approved in December 2020 and was submitted to ITU-R WP-6B to be introduced to ITU SG 6 documents as a broadcast technology.