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5G Broadcast System for linear TV and radio services;
LTE-based 5G terrestrial broadcast system

EBU

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Foreword

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NOTE: The EBU/ETSI JTC Broadcast was established in 1990 to co-ordinate the drafting of standards in the specific field of broadcasting and related fields. Since 1995 the JTC Broadcast became a tripartite body by including in the Memorandum of Understanding also CENELEC, which is responsible for the standardization of radio and television receivers. The EBU is a professional association of broadcasting organizations whose work includes the co-ordination of its members' activities in the technical, legal, programme-making and programme-exchange domains. The EBU has active members in about 60 countries in the European broadcasting area; its headquarters is in Geneva.

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Modal verbs terminology

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Introduction

Several 3GPP specifications have been extended or newly developed over several releases to address the use cases and requirements for dedicated 5G broadcast networks. With the completion of Release 16, a comprehensive set of 3GPP specifications is available that fulfils the use cases and requirements for a 5G Broadcast System, including:

- Support of Free-to-Air (FTA) and Receive-Only Mode (ROM) 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 that associated with typical cellular deployments.
- Support for mobility scenarios including speeds of up to 250 km/h to support receivers in cars, with external omni-directional antennas.
- Support for common streaming distribution formats such as Dynamic Streaming over HTTP (DASH), Common Media Application Format (CMAF) and HTTP Live Streaming (HLS).
- Support for IP-based services such as IPTV or ABR multicast.
- Support for different file delivery services such as scheduled delivery or file carousels.
- Support for services that use unicast and broadcast delivery methods.
- Support for typical broadcast channel bandwidths of 6/7/8 MHz.
- Support for public warning and emergency alerts based on the Cell Broadcast Service.

The present document defines the 5G Broadcast System as well as a concrete instantiation referred to as LTE-based 5G Broadcast intended for implementers of a 5G Broadcast System as well as TV/Radio Content Service Providers wanting to make use of a 5G Broadcast System.

1 Scope

The present document introduces the 5G Broadcast System along with the associated features of such a system. A concrete instantiation of a 5G Broadcast System is specified, referred to as LTE-based 5G Broadcast. LTE-based 5G Broadcast is a profile of existing 3GPP specifications that addresses all requirements of a 5G Broadcast System. Several functions and reference points are defined. Receiver categories are defined that address implementation profiles to deploy, among others, linear television and radio services.

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

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The following referenced documents are necessary for the application of the present document.

[1] ETSI TS 122 101: "Universal Mobile Telecommunications System (UMTS); LTE; Service aspects; Service principles (3GPP TS 22.101 Release 17)".

[2] ETSI TS 122 261: "5G; Service requirements for the 5G system (3GPP TS 22.261 Release 17)".

[3] ETSI TS 123 003: "Digital cellular telecommunications system (Phase 2+) (GSM); Universal Mobile Telecommunications System (UMTS); LTE; 5G; Numbering, addressing and identification (3GPP TS 23.003 Release 17)".

[4] ETSI TS 123 122: "Digital cellular telecommunications system (Phase 2+) (GSM); Universal Mobile Telecommunications System (UMTS); LTE; 5G; Non-Access-Stratum (NAS) functions related to Mobile Station (MS) in idle mode (3GPP TS 23.122 Release 17)".

[5] ETSI TS 123 246: "Universal Mobile Telecommunications System (UMTS); LTE; Multimedia Broadcast/Multicast Service (MBMS); Architecture and functional description (3GPP TS 23.246 Release 17)".

[6] ETSI TS 124 116: "LTE; Stage 3 aspects of system architecture enhancements for TV services (3GPP TS 24.116 Release 17)".

[7] ETSI TS 124 117: "LTE; TV service configuration Management Object (MO) (3GPP TS 24.117 Release 17)".

[8] ETSI TS 126 346: "Universal Mobile Telecommunications System (UMTS); LTE; 5G; Multimedia Broadcast/Multicast Service (MBMS); Protocols and codecs (3GPP TS 26.346 Release 17)".

[9] ETSI TS 126 347: "LTE; Multimedia Broadcast/Multicast Service (MBMS); Application Programming Interface and URL (3GPP TS 26.347 Release 17)".

[10] ETSI TS 126 348: "LTE; 5G; Northbound Application Programming Interface (API) for Multimedia Broadcast/Multicast Service (MBMS) at the xMB reference point (3GPP TS 26.348 Release 17)".

[11] ETSI TS 129 116: "LTE; 5G; Representational state transfer over xMB reference point between content provider and BM-SC (3GPP TS 29.116 Release 17)".

[12] ETSI TS 129 274: "Universal Mobile Telecommunications System (UMTS); LTE; 5G; 3GPP Evolved Packet System (EPS); Evolved General Packet Radio Service (GPRS) Tunnelling Protocol for Control plane (GTPv2-C); Stage 3 (3GPP TS 29.274 Release 17)".

[13] ETSI TS 129 281: "Universal Mobile Telecommunications System (UMTS); LTE; 5G; General Packet Radio System (GPRS) Tunnelling Protocol User Plane (GTPv1-U) (3GPP TS 29.281 Release 17)".

[14] ETSI TS 136 101: "LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception (3GPP TS 36.101 Release 17)".

[15] ETSI TS 136 133: "LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Requirements for support of radio resource management (3GPP TS 36.133 Release 17)".

[16] ETSI TS 136 211: "LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Physical channels and modulation (3GPP TS 36.211 Release 17)".

[17] ETSI TS 136 213: "LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Physical layer procedures (3GPP TS 36.213 Release 17)".

[18] ETSI TS 136 300: "LTE; Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Overall description; Stage 2 (3GPP TS 36.300 Release 17)".

[19] ETSI TS 136 304: "LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) procedures in idle mode (3GPP TS 36.304 Release 17)".

[20] ETSI TS 136 321: "LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Medium Access Control (MAC) protocol specification (3GPP TS 36.321 Release 17)".

[21] ETSI TS 136 331: "LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC); Protocol specification (3GPP TS 36.331 Release 17)".

[22] ETSI TS 136 440: "LTE; Evolved Universal Terrestrial Radio Access Network (E-UTRAN); General aspects and principles for interfaces supporting Multimedia Broadcast Multicast Service (MBMS) within E-UTRAN (3GPP TS 36.440 Release 17)".

[23] ISO/IEC 23009-1: "Information technology - Dynamic adaptive streaming over HTTP (DASH) - Part 1: Media presentation description and segment formats".

[24] ISO/IEC 23000-19: "Information technology - Multimedia application format (MPEG-A) - Part 19: Common media application format (CMAF) for segmented media".

[25] IETF RFC 8216: "HTTP Live Streaming".

[26] ETSI TS 136 306: "LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC); Protocol specification (3GPP TS 36.306 Release 17)".

[27] ETSI TS 136 443: "LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio access capabilities (3GPP TS 36.443 Release 17)".

[28] ETSI TS 136 104: "LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) radio transmission and reception (3GPP TS 36.104 Release 17)".

[29] ETSI TS 126 501: "5G Media Streaming (5GMS); General description and architecture (3GPP TS 26.501 Release 17)".

[30] ETSI TS 126 511: "5G Media Streaming (5GMS); Profiles, codecs and formats (3GPP TS 26.511 Release 17)".

[31] ETSI TS 126 512: "5G Media Streaming (5GMS); Protocols (3GPP TS 26.512 Release 17)".

[32] IANA (Internet Assigned Numbers Authority): "IPv4 Multicast Address Space Registry" https://www.iana.org/assignments/multicast-addresses/multicast-addresses.xhtml.

[33] IANA (Internet Assigned Numbers Authority): "IPv6 Multicast Address Space Registry" https://www.iana.org/assignments/ipv6-multicast-addresses/ipv6-multicast-addresses.xhtml.

[34] IETF RFC 6335: "Internet Assigned Numbers Authority (IANA) Procedures for the Management of the Service Name and Transport Protocol Port Number Registry".

[35] ETSI TS 123 041: "Digital cellular telecommunications system (Phase 2+) (GSM); Universal Mobile Telecommunications System (UMTS); Technical realization of Cell Broadcast Service (CBS) (3GPP TS 23.041)".

[36] ETSI TS 129 168: "Universal Mobile Telecommunications System (UMTS); LTE; 5G; Cell Broadcast Centre interfaces with the Evolved Packet Core; Stage 3 (3GPP TS 29.168 version, Release 17)".

[37] ETSI TS 102 900: "Emergency Communications (EMTEL); European Public Warning System (EU-ALERT) using the Cell Broadcast Service".

[38] OASIS Standards CAPv1.2: "Common Alerting Protocol Version 1.2" http://docs.oasis-open.org/emergency/cap/v1.2/CAP-v1.2.doc.

[39] ETSI TS 136 413: "LTE; Evolved Universal Terrestrial Radio Access Network (E-UTRAN); S1 Application Protocol (S1AP) (3GPP TS 36.413 version, Release 17)".

[40] IETF RFC 9110: "HTTP Semantics ".

[41] IETF RFC 8446: "The Transport Layer Security (TLS) Protocol Version 1.3".

[42] IETF RFC 793: "Transmission Control Protocol".

[43] IETF RFC 7323: "TCP Extensions for High Performance".

[44] IETF RFC 8200: "Internet Protocol, Version 6 (IPv6) Specification".

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] 3GPP TR 23.746: "Study on System Architecture Enhancements to eMBMS for Television Video Service".

[i.2] ETSI TR 136 976: "LTE; Overall description of LTE-based 5G broadcast (3GPP TR 36.976)".

[i.3] ETSI TR 138 913: "5G; Study on scenarios and requirements for next generation access technologies (3GPP TR 38.913)".

[i.4] ETSI TS 123 401: "LTE; General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access (3GPP TS 23.401 Release 16)".

[i.5] ETSI TR 122 968: "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Study for requirements for a Public Warning System (PWS) service (3GPP TR 22.968, Release 17)".

[i.6] ETSI TS 102 182: "Emergency Communications (EMTEL); Requirements for communications from authorities/organizations to individuals, groups or the general public during emergencies".

[i.7] ETSI TR 102 444: "Emergency Communications (EMTEL); Analysis of the Short Message Service (SMS) and Cell Broadcast Service (CBS) for Emergency Messaging applications; Emergency Messaging; SMS and CBS".

[i.8] ETSI TS 122 268: "Digital cellular telecommunications system (Phase 2+) (GSM); Universal Mobile Telecommunications System (UMTS); LTE; 5G; Public Warning System (PWS) requirements (3GPP TS 22.268, Release 17)".

[i.9] 3GPP Work Item 440005: "PWS-RAN" https://www.3gpp.org/DynaReport/WiCr--440005.htm.

[i.10] D. Vargas, S. Elliott, O. Haffenden, R. McCartney, A. Murphy, and J. J. Gimenez, Performance of 5G Broadcast and Benefits of Proposed Time-Interleaving Enhancements," in Proceedings of the. International Broadcast Conference, Amsterdam, The Netherlands, September 2020.

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the following terms apply:

5G Broadcast Client API: Application Programming Interface that enable a 5G Broadcast TV/Radio Service Application to communicate with a 5G Broadcast Receiver

5G Broadcast Receiver: entity implementing the receiver requirements of a 5G Broadcast System

5G Broadcast Service: 3GPP-based broadcast service offered according to the constraints and requirements in the present document in order to deploy linear television and radio broadcast services

5G Broadcast SA Service: 5G Broadcast Service for Service Announcement (SA)

5G Broadcast System: system dedicated to the delivery of linear television and radio broadcast services using 3GPP specifications and addressing 5G requirements for dedicated broadcast

5G Broadcast Transmitter: entity implementing the transmitter requirements of a 5G Broadcast System

5G Broadcast TV/Radio Content Service Provider: provider of linear television and/or radio content services using a 5G Broadcast System for distribution of the services

5G Broadcast TV/Radio Service Application: application in the end device that consumes one or more 5G Broadcast User Services by communicating with the 5G Broadcast Receiver through a dedicated set of 5G Broadcast Client APIs

5G Broadcast User Service: 5G Broadcast Service that provides User Data, for example a television or radio service

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

5GMS	5G Media Streaming
ABR	Adaptive Bit Rate
ADPD	Associated Delivery Procedure Document
AF	Application Function
API	Application Programming Interface
APN	Access Point Name
ARP	Allocation and Retention Priority
AV	Audio-Visual
BCCH	Broadcast Control CHannel

BCH	Broadcast CHannel
BM-SC	Broadcast/Multicast Service Centre
CAP	Common Alerting Protocol
CAS	Cell Acquisition Subframe
CBC	Cell Broadcast Centre
CBE	Cell Broadcast Entity
CBS	Cell Broadcast Service
CFI	Control Format Indicator
CMAF	Common Media Application Format
CMAS	Commercial Mobile Alert System
CP	Cyclic Prefix
CRC	Cyclic Redundancy Check
CRS	Cell-specific Reference Signal
CSG	Closed Subscriber Group
DASH	Dynamic Adaptive Streaming over HTTP
DCI	Downlink Control Information
DL-SCH	DownLink Shared CHannel
DRX	Discontinuous Reception
DVB	Digital Video Broadcasting
DVB-I	Digital Video Broadcasting Internet
EARFCN	E-UTRA Absolute Radio Frequency Channel Number
EBU	European Broadcasting Union
eMBMS	Evolved MBMS
enTV	enhanced TeleVision
EPG	Electronic Programming Guide
EPS	Evolved Packet System
ESG	Electronic Service Guide
ETWS	Earthquake and Tsunami Warning System
E-UTRAN	Evolved UTRAN
FEC	Forward Error Correction
FeMBMS	Further Evolved MBMS
FLUTE	FiLe delivery over Unidirectional Transport
FTA	Free-To-Air
GW	GateWay
HARQ	Hybrid Automatic Repeat reQuest
HbbTV®	Hybrid broadcast broadband TV
HLS	HTTP Live Streaming
HPHT	High Power High Tower
HTTP	Hyper Text Transfer Protocol
HTTPS	Hyper Text Transfer Protocol secure
IANA	Internet Assigned Numbers Authority
ID	IDentifier
IP	Internet Protocol
IPTV	Internet Protocol TeleVision
IRAT	Inter Radio Access Technology
ISD	Inter-Site Distance
KPAS	Korean Public Alert System
LTE	Long Term Evolution
MAC	Media Access Control
MBMS	Multimedia Broadcast Multicast Service
MBSFN	Multicast-Broadcast Single-Frequency Network
MBSFN-RS	Multicast-Broadcast Single Frequency Network Reference Signal
MCC	Mobile Country Code
MCCH	MBMS point-to-multipoint Control CHannel
MCH	Multicast Channel
MCS	Modulation and Coding Scheme
MIB	Master Information Block
MIME	Multipurpose Internet Mail Extensions
MME	Mobility Management Entity
MNC	Mobile Network Controller
MNO	Mobile Network Operator
MO	Management Object

MPMT	Medium Power Medium Tower
M-RNTI	MBMS Radio Network Temporary Identifier
MTCH	MBMS point-to-multipoint Traffic CHannel
NAS	Non-Access Stratum
OFDM	Orthogonal Frequency-Division Multiplexing
PBCH	Physical Broadcast CHannel
PCFICH	Physical Control Format Indicator CHannel
PDCCH	Physical Downlink Control CHannel
PDSCH	Physical Downlink Shared CHannel
PDU	Protocol Data Unit
PLMN	Public Land Mobile Network
PMCH	Physical Multicast CHannel
PRB	Physical Resource Block
PSM	Power Saving Mode
PSS	Primary Synchronization Signal
PWS	Public Warning System
QoE	Quality-of-Experience
QoS	Quality-of-Service
QPSK	Quadrature Phase-Shift Keying
RAN	Radio Access Network
RAT	Radio Access Technology
REST-API	REpresentational State Transfer - Application Programming Interface
RLC	Radio Link Control
RLC-TM	Radio Link Control Transparent Mode
RLC-UM	Radio Link Control Unacknowledged Mode
RNTI	Radio Network Temporary Identifier
RoHC	Robust Header Compression
ROM	Receive-Only Mode
RRC	Radio Resource Control
RRM	Radio Resource Management
RSRP	Reference Signal Receive Power
RTSP	Real-Time Streaming Protocol
SA	Service Announcement
SACH	Service Announcement CHannel
SAI	Service Area Identifier
SBc	reference point name northbound of CBC
SCS	SubCarrier Spacing
SDP	Session Description Protocol
SFN	Single Frequency Network
SGi	Service Gateway interface
SI	System Information
SIB	System Information Block
SIM	Subscriber Identity Module
SSL	Secure Sockets Layer
SSS	Secondary Synchronization Signal
TA	Tracking Area
TBS	Transport Block Size
TCP	Transmission Control Protocol
TLS	Transport Layer Security
TMGI	Temporary Mobile Group Identifier
TTI	Transmission Time Interval
TV	Television
UDP	User Datagram Protocol
UE	User Equipment
UHF	Ultra High Frequency
UI	User Interface
URL	Universal Resource Locator
USD	User Service Description
USIM	Universal Subscriber Identity Module
UTRAN	UMTS Terrestrial Radio Access Network
WEA	Wireless Emergency Alerts
xMB	extended MBMS interface

XML eXtended Markup Language

4 General

4.1 Background and history (informative)

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. Requirements for 3GPP enhancements for TV service support were developed in Release 14 and are documented in ETSI TS 122 101 [1], clause 32.

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 3GPP TR 23.746 [i.1], a significant set of key issues relevant for the usage of MBMS for broadcast services is identified and these issues are subsequently addressed in 3GPP Release 14 specifications:

- Support of Free-to-Air (FTA) service over 3GPP.
- Broadcast-only service for UEs with no MNO broadcast subscription.
- Support of shared eMBMS functions.
- Decoupling of content, MBMS service and MBMS transport functions.
- Exposure of eMBMS service and transport capabilities to third parties.

Beyond the service layer enhancements, also in 3GPP Release 14 the use cases and scenarios for eMBMS services based on LTE were expanded to include terrestrial broadcasting (the feature also referred to as "EnTV"). This included new requirements:

- Network dedicated to TV broadcast via eMBMS.
- Single Frequency Network (SFN) deployments with Inter-Site Distance (ISD) significantly larger than a typical ISD associated with typical cellular deployments.
- Support for Receive-Only Mode (ROM) services and devices.

With the development of 5G from Release 15 onwards, 3GPP formulated requirements for the system and radio access technology (RAT) in ETSI TS 122 261 [2] as part of the initial release for 5G, namely Release 15. In particular, broadcast is addressed in clause 6.13 of ETSI TS 122 261 [2]. Whereas the requirements are generic for a flexible broadcast/multicast system, only a subset of the requirements apply to broadcasting linear television and radio services, in particular those for 5G dedicated broadcast networks.

Several 3GPP specifications have been extended or newly developed over several releases to address the use cases and requirements for 5G dedicated broadcast networks. While it is expected that 3GPP will continue to address all the requirements for a flexible broadcast/multicast system in clause 6.13 of ETSI TS 122 261 [2] in future releases, with the completion of the Release 17, a comprehensive set of 3GPP specifications is available that fulfils the use cases and requirements for a 5G Broadcast System.

The present document 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 in order to address these features.

4.2 Basic features of a 5G Broadcast System

4.2.1 General

Based on the collected use cases and requirements in clause 4.1, a 5G Broadcast System for linear television and radio services as defined in the present document addresses the following features and functionalities:

- 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) [23], HTTP Live Streaming (HLS) [25] and Common Media Application Format (CMAF) [24].
- Support for IP-based services such as IPTV or ABR multicast.
- Support for different file delivery services such as scheduled delivery or file carousels.
- Support for services that use unicast and broadcast delivery methods.
- Support for typical broadcast channel bandwidths of 6/7/8 MHz.
- Support for public warning and emergency alerts based on cell broadcast services.

Note that these features are independent of the access or core network technology.

4.2.2 Reference architecture

The general architecture for a 5G Broadcast System is provided in figure 4.2.2-1. The principal actors in the system are as follows:

- A **5G Broadcast TV/Radio Content Service Provider** runs a head-end providing linear television and radio services.
- A **5G Broadcast TV/Radio Service Application** runs on devices that include a **5G Broadcast Receiver**.
- A **5G Broadcast System** operator runs a 5G Broadcast System with **5G Broadcast Transmitters** for use by devices including 5G Broadcast Receivers.
- A 5G Broadcast TV/Radio Content Service Provider makes services available using the 5G Broadcast System.
- A 5G Broadcast TV/Radio Service Application is able to consume the service by communicating with the 5G Broadcast Receiver through a dedicated set of **5G Broadcast Client API**s.

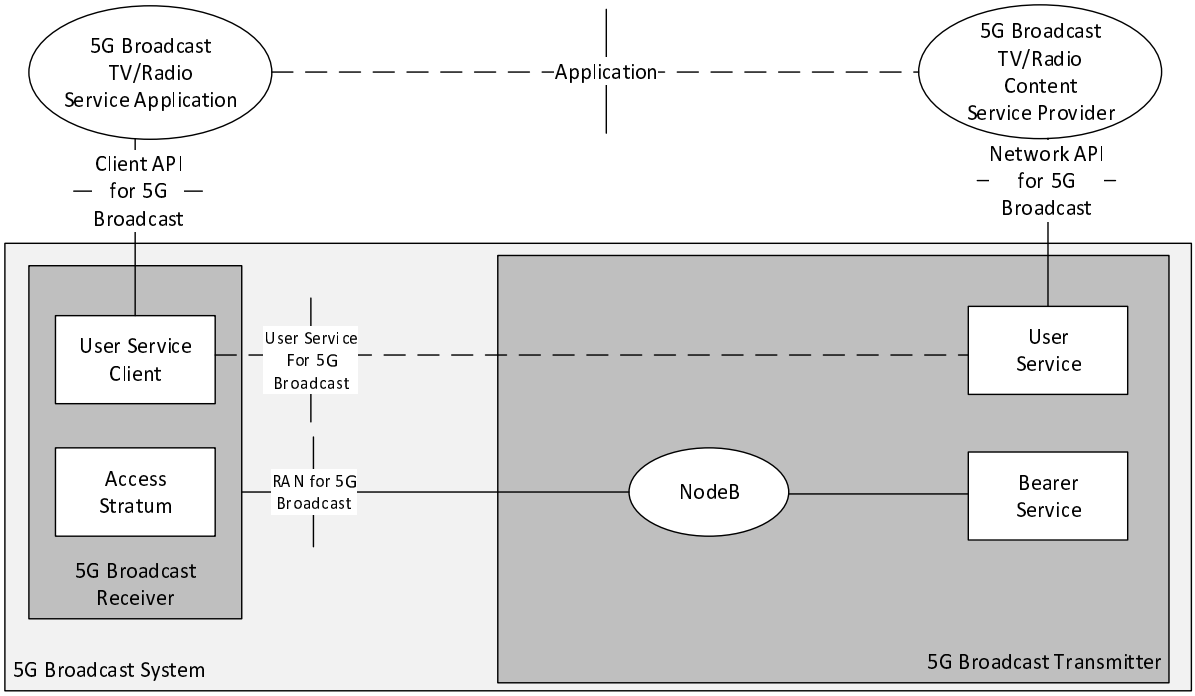


Figure 4.2.2-1: Reference architecture for 5G Broadcast System

The **5G Broadcast Service** consists of a **Bearer Service** and a **User Service**. The latter provides the announcement of 5G Broadcast User Services and also provides information about how to discover and access them. The former provides the distribution means for 5G Broadcast User Services, including a radio bearer. A RAN interface is defined that supports the features documented in clause 4.2.1, including a **NodeB** in the 5G Broadcast Transmitter and an Access Stratum modem in the 5G Broadcast Receiver.

4.2.3 Services

The 5G Broadcast System is based on a service concept. A 5G Broadcast Service is offered by the 5G Broadcast System and provides a transport-level service, delivered by a broadcast bearer service across a Radio Access Network (RAN). Such 5G Broadcast Services are announced and can be discovered. Different types of services may be offered, namely **5G Broadcast User Service**s - such as streaming or file delivery - in order to deliver user data, as well as 5G Broadcast Service Announcement services in order to announce 5G Broadcast User Services. 5G Broadcast Services are assigned dedicated discoverable bearer resources that allow 5G Broadcast Receivers to discover and access them. Among others, 5G Broadcast Services also have assigned types, delivery methods, schedules and other relevant properties.

4.2.4 TV/Radio Content Provider and Application requirements

A Content Provider wanting to make use of a 5G Broadcast System needs to provision the 5G Broadcast Services and publish content using the **Network API for 5G Broadcast**.

In addition, a device capable of receiving 5G Broadcast Services needs to integrate a 5G Broadcast TV/Radio Service Application (for example provisioned by the device in hardware, pre-installed software and/or a downloaded application) that makes use of the **Client API for 5G Broadcast**.

Service management and mapping between the application space and 5G Broadcast Services is left to the application.

Also, details on the supported content formats such as codecs, resolutions, frame rates, encryption, packaging, etc. are left to the application.

4.2.5 Public Warning System

ETSI TR 122 968 [i.5] is the output of a 3GPP feasibility study for a Public Warning System (PWS) service capable of sending emergency alerts and public warning messages via the 5G System to a UE-hosted message reception function. The EMTEL specification ETSI TS 102 182 [i.6], ETSI TR 102 444 [i.7], requirements from Japan for ETWS and requirements from the USA for the Commercial Mobile Alert System (CMAS) were used as input. From this study, 3GPP specified its general requirements for the PWS in ETSI TS 122 268 [i.8]. The Earthquake and Tsunami Warning System (ETWS), Wireless Emergency Alert (WEA)/CMAS, EU-Alert and Korean Public Alert System (KPAS) are considered regional adaptations of the PWS service.

Based on these requirements, relevant specifications in 3GPP have been created and updated to address these requirements, in particular the system specifications for the Cell Broadcast Service (CBS) ETSI TS 123 041 [35] and ETSI TS 129 168 [36] as well as the extension of several RAN specifications [i.9].

Based on these specifications, for example ETSI published a specification that defines the system requirements for a European Public Warning Service using the Cell Broadcast Service in ETSI TS 102 900 [37] as a means of message distribution and delivery to User Equipment (UE). Other regions in the world, such as the US, Korea and Japan have developed similar specifications based on the Cell Broadcast Service.

The Cell Broadcast Service (CBS) does not require authentication with a PLMN. Hence, a network that is accessible in Receive-only Mode (ROM) is inherently compatible with the Cell Broadcast Service as defined in ETSI TS 123 041 [35]. This aspect is leveraged in the present document to support public warnings and emergency alerts in the 5G Broadcast System.

4.3 5G Broadcast Systems

4.3.1 General

A 5G Broadcast System for linear television and radio services shall address the requirements and use cases in clause 4.1, as well as the feature list summarized in clause 4.2.1, the reference architecture described in clause 4.2.2 and the service model documented in clause 4.2.3.

4.3.2 LTE-based 5G Broadcast System

The LTE-based 5G Broadcast System is an instantiation of a 5G Broadcast System addressing the basic features documented in clause 4.2 that is based on a profile of 3GPP specifications available in Release 17.

As a background, in order to address the identified key issues and requirements, 3GPP developed service layer specifications documented in ETSI TS 123 246 [5], annexes D and E, ETSI TS 124 116 [6], ETSI TS 124 117 [7], ETSI TS 126 346 [8] and ETSI TS 126 347 [9] during Release 12, Release 13 and Release 14 that address the following key issues:

- Support of Free-to-Air (FTA) service.
- Broadcast-only service for UEs with no MNO broadcast subscription.
- Support of shared eMBMS functions.
- Decoupling of content, MBMS service and MBMS transport functions.
- Exposure of eMBMS service and transport capabilities to third party.
- Support for user service announcement through broadcast.
- Support for Dynamic Adaptive Streaming over HTTP (DASH) [23].
- Support for different file delivery services such as scheduled delivery or file carousels.
- Support for client APIs for simplified access to MBMS services.

For RAN, in Release 14, in order to address the features:

- Network dedicated to TV broadcast via eMBMS.

- Single Frequency Network (SFN) deployments with Inter-Site Distance (ISD) significantly larger than those associated with typical cellular deployments.
- Support for Receive-Only Mode (ROM) services and devices.

The following key RAN enhancements were made to the specifications to enable LTE terrestrial broadcast:

- MBMS-dedicated cell in ETSI TS 136 300 [18].
- MBSFN subframes using Δf = 1,25 kHz in ETSI TS 136 211 [16], with a cyclic prefix duration of 200 μs and a symbol duration of 1 ms.
- New information blocks on PBCH and PDSCH of CAS (see ETSI TS 136 300 [18] and ETSI TS 136 331 [21]):
  - *MIB-MBMS* is transmitted with a 40 ms periodicity and updated every 160 ms; and
  - *SIB1-MBMS* is transmitted with an 80 ms periodicity and updated every 160 ms, containing information relevant for receiving MBMS service and, optionally, the scheduling of other system information blocks.
- *MBMSInterestIndication* RRC signalling procedure.

In Release 16, a gap analysis was carried out and documented in ETSI TR 136 976 [i.2] that compared the Release 14 LTE terrestrial broadcasting capabilities (i.e. what is specified by the "enTV" work item) with the requirements for 5G dedicated broadcast networks in ETSI TR 138 913 [i.3], clause 9.1. As a result of this analysis, the following two requirements were deemed unfulfilled by Release 14 LTE eMBMS:

1) Support for service over large geographic area, including SFN with ISD > 100 km.
2) Support for mobility scenarios including speeds of up to 250 km/h.

The first requirement is associated with receivers with high-gain rooftop directional antennas, low mobility and a predominantly line-of-sight channel. The second requirement is associated with receivers in moving vehicles, with external omni-directional antennas.

Based on this, in Release 16 the following RAN enhancements were made to address the use cases described in clause 4.2:

- MBSFN subframes using Δf = 0,37 kHz, with a cyclic prefix duration of 300 μs and a symbol duration of 3 ms, for the support of large ISD.
- MBSFN subframes using Δf = 2,5 kHz, with a cyclic prefix duration of 100 μs and a symbol duration of 0,5 ms, for the support of high mobility.
- The following enhancements on the CAS:
  - PDCCH enhancements:

    CFI indication in MIB ETSI TS 136 331 [21] to avoid the need to decode PCFICH; and new aggregation level 16.
- Repetition of PBCH to increase its robustness.

As part of Release 17, the following RAN enhancement was introduced to enable deployment in broadcast UHF spectrum, where the channelization is 6/7/8 MHz (depending on regional channel spacing):

- PMCH bandwidth of 30, 35 and 40 PRBs (corresponding to 6/7/ 8MHz), applicable for CAS bandwidth of 15 or 25 PRBs (corresponding to 3 and 5 MHz).

These RAN enhancements are complemented by improvements to MBMS User Services documented in ETSI TS 126 346 [8] and ETSI TS 126 347 [9], for example the exposure of MBMS functionalities to third-party application through device APIs and the support of common distribution formats such as Common Media Application Format (CMAF) [24], HTTP Live Streaming (HLS) [25] and hybrid DASH/HLS services. An important aspect in ETSI TS 126 346 [8] is the definition of dedicated profiles for service announcements and file delivery methods including DASH/HLS-based streaming.

The LTE-based 5G Broadcast System instantiation is fully specified in the remaining clauses of the present document. In particular:

- Clause 5 provides a description of the LTE-based 5G Broadcast System architecture and all interfaces and reference points.
- Clause 6 provides the requirements for an LTE-based 5G Broadcast Transmitter.
- Clause 7 provides the requirements for an LTE-based 5G Broadcast Receiver.
- Clause 8 provides spectrum and frequency considerations.
- Clause 9 provides some considerations on hybrid services, in case receivers also include a unicast receiver.
- Clause 10 defines 5G Broadcast Receiver categories, and in particular it defines the LTE-based 5G Broadcast Main receiver based on the LTE-based 5G Broadcast Receiver.
- Clause 11 and clause 12 are dedicated to implementation guidelines for LTE-based 5G Broadcast Transmitters and 5G Broadcast Receivers respectively.

5 LTE-based 5G Broadcast System

5.1 Introduction

According to the introduction in clause 4, and in particular clause 4.3.2, the remainder of the present document defines a 5G Broadcast System based on a continuous evolution of MBMS to meet the use cases and requirements for a dedicated broadcast system for linear television and radio broadcast services, referred to as the LTE-based 5G Broadcast System.

In the remainder of the present document, the term "5G Broadcast" is used synonymously with "LTE-based 5G Broadcast".

5.2 Architecture

5.2.1 Reference architecture

Figure 5.2.1-1 depicts the reference architecture for the LTE-based 5G Broadcast System as defined in the present document. This architecture is a simplified version of the EPS architecture for E-UTRAN only, as defined in ETSI TS 123 246 [5].

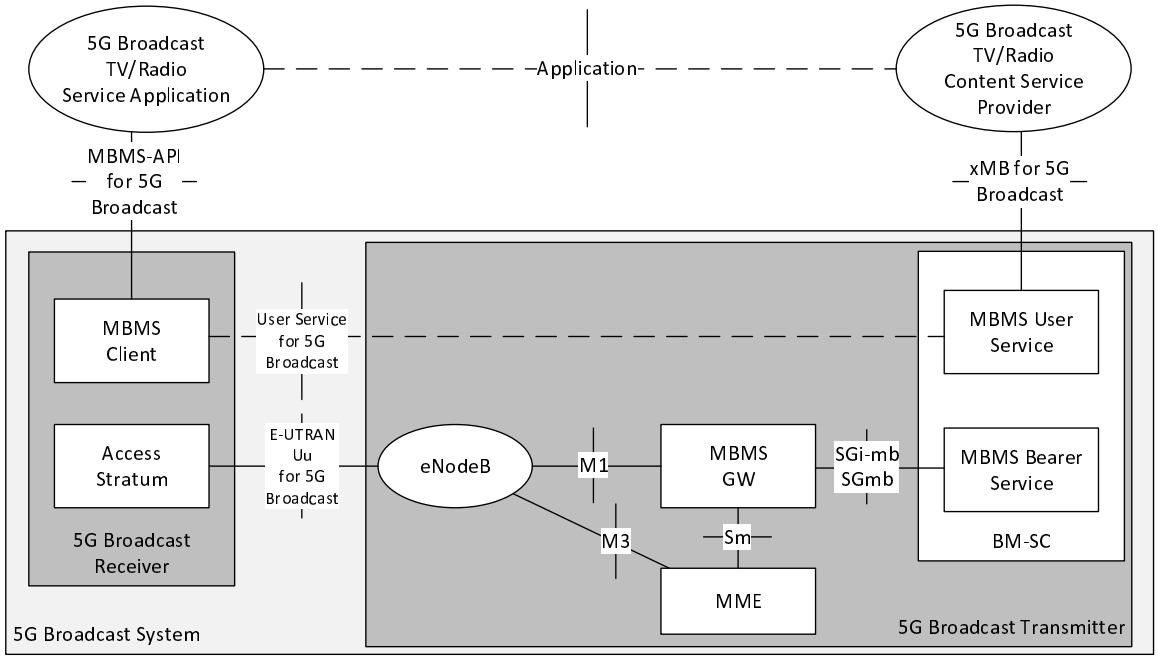


Figure 5.2.1-1: Reference architecture for 5G Broadcast System for linear TV and radio services with LTE-based 5G Broadcast instantiation

NOTE: The following reference points are applicable for the E-UTRAN MBMS Broadcast Mode only (without use of the MBMS Service Counting procedure as defined in ETSI TS 136 300 [18]).

M1: reference point between MBMS GW and E-UTRAN/UTRAN for MBMS data delivery. IP Multicast is used on this interface in the forwarding of user plane Protocol Data Units (PDUs) from the MBMS GW to the eNodeB(s) in the E-UTRAN.

M3: reference point for the control plane between MME and E-UTRAN.

SGi-mb: reference point for the user plane between BM-SC and MBMS GW.

SGmb: reference point for the control plane between BM-SC and MBMS GW.

xMB: reference point between TV/Radio Content Service Provider and BM-SC.

MBMS-API: reference point between MBMS Client and 5G Broadcast TV/Radio Service Application.

Application: end-to-end logical association between 5G Broadcast TV/Radio Content Service Provider and 5G Broadcast TV/Radio Service Application. This association is not in scope of the present document but may be used to exchange service configuration information, for example using a TV Service Configuration MO as defined in ETSI TS 124 117 [7].

The generic 5G Broadcast System architecture in figure 4.2.2-1 is instantiated into figure 5.2.1-1. This simplified architecture, and the reference points for the 5G Broadcast System as defined in the present document, are also provided in figure 5.2.1-1. The key aspects are the requirements for:

1) The 5G Broadcast Transmitter in terms of the reference points including:

   a) For the northbound Network API for 5G Broadcast, a profile of xMB as defined in ETSI TS 126 348 [10] and ETSI TS 129 116 [11] is specified in the present document.

   b) For the User Service for 5G Broadcast, a profile of the MBMS User Service as defined in ETSI TS 123 246 [5] and ETSI TS 126 346 [8] is specified in the present document.

   c) For the RAN for 5G Broadcast, a profile of E-UTRAN Uu as defined in ETSI TS 136 300 [18], ETSI TS 136 211 [16] and ETSI TS 36 331 [21] is specified in the present document.

2) The 5G Broadcast Receiver including:

   a) For the User Service for 5G Broadcast, a profile of the MBMS User Service as defined in ETSI TS 123 246 [5] and ETSI TS 126 346 [8] is specified in the present document.

   b) For the RAN for 5G Broadcast, a profile of E-UTRAN Uu as defined in ETSI TS 136 300 [18], ETSI TS 136 211 [16] and ETSI TS 136 331 [21] is specified in the present document.

   c) For the Client API for 5G Broadcast, a profile of the MBMS-APIs as defined in ETSI TS 126 347 [9] is specified in the present document.

3) The 5G Broadcast TV/Radio Service Application in order to make use of the 5G Broadcast System.

Details for the reference points are provided in clause 5.5. The requirements for 5G Broadcast Transmitters are provided in clause 6 and the requirements for 5G Broadcast Receivers are provided in clause 7.

Protocol assumptions:

- The **Sm** reference point is based on GTPv2-C as defined in ETSI TS 129 274 [12].
- The **M1** reference point is based on GTPv1-U as defined in ETSI TS 129 281 [13].

Extensions of the basic 5G Broadcast System to support the 3GPP Public Warning System (as introduced in clause 4.2.5) are provided in clause 5.15.

5.2.2 Deployment models (informative)

5.2.2.0 Introduction

This clause introduces a non-exhaustive list of deployment models based on the logical reference architecture presented in clause 5.2.1.

5.2.2.1 Deployment with separated Core and RAN functions

In a typical deployment of an LTE-based 5G Broadcast System, the core functions of the MBMS GW, MME and BM-SC may be integrated into a single physical device that manages all the 5G Broadcast Services of a 5G Broadcast System. In this case, only a restricted set of 5G Broadcast Transmitter interfaces are of relevance, namely: **M1**, **M3**, **xMB** and **Uu**. All other interfaces in the 5G Broadcast Transmitter are private and the internal structure of the implementation may be simplified compared with the reference architecture. **MBMS-API** and the **Application** interface apply on the User Equipment side.

This deployment model is depicted in figure 5.2.2-1. It is suitable for operating a network comprised of multiple eNodeB instances with a common core function. When operated as a Single Frequency Network, transmissions are synchronized to a schedule determined by a common core function.

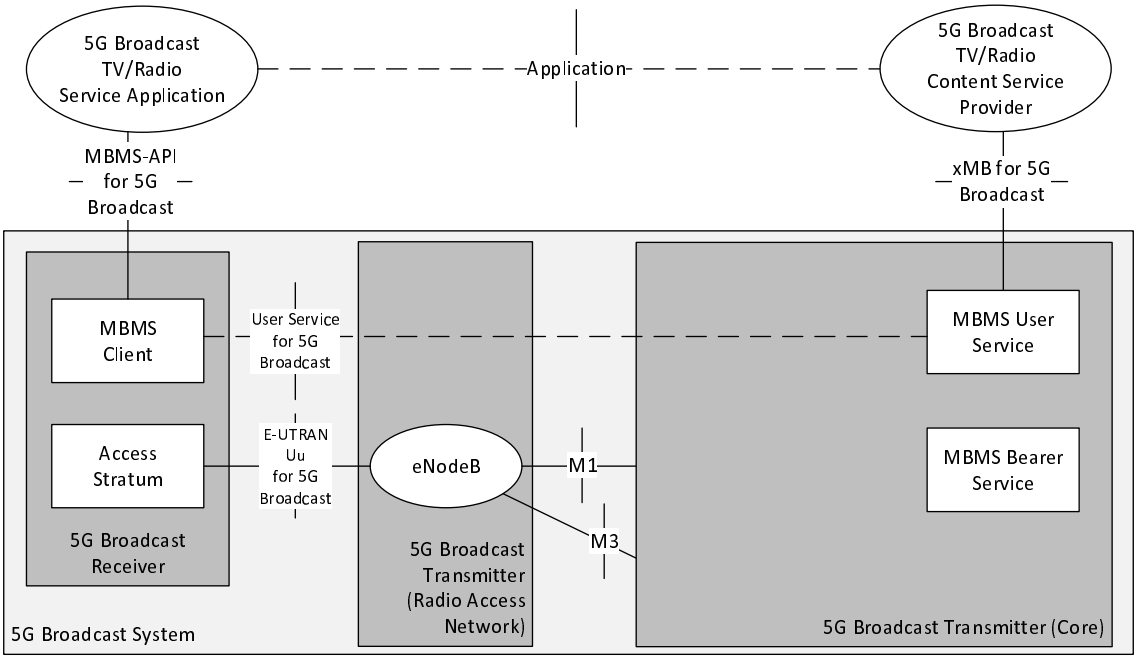


Figure 5.2.2-1: Deployment of LTE-based 5G Broadcast instantiation with integrated core components and separated Radio Access Network

5.2.2.2 Deployment with self-contained 5G Broadcast Transmitter

If a deployment of the 5G Broadcast System requires only one eNodeB, or if Single Frequency Network operation is not required, the eNodeB may be integrated into the same physical entity as the core functions. In this case, only interfaces **xMB** and **Uu** are exposed externally by the 5G Broadcast Transmitter, as shown in figure 5.2.2-2. All internal interfaces of the 5G Broadcast Transmitter are private and its internal structure may be simplified compared with the reference architecture. Content needs to be published separately to each 5G Broadcast Transmitter at xMB.

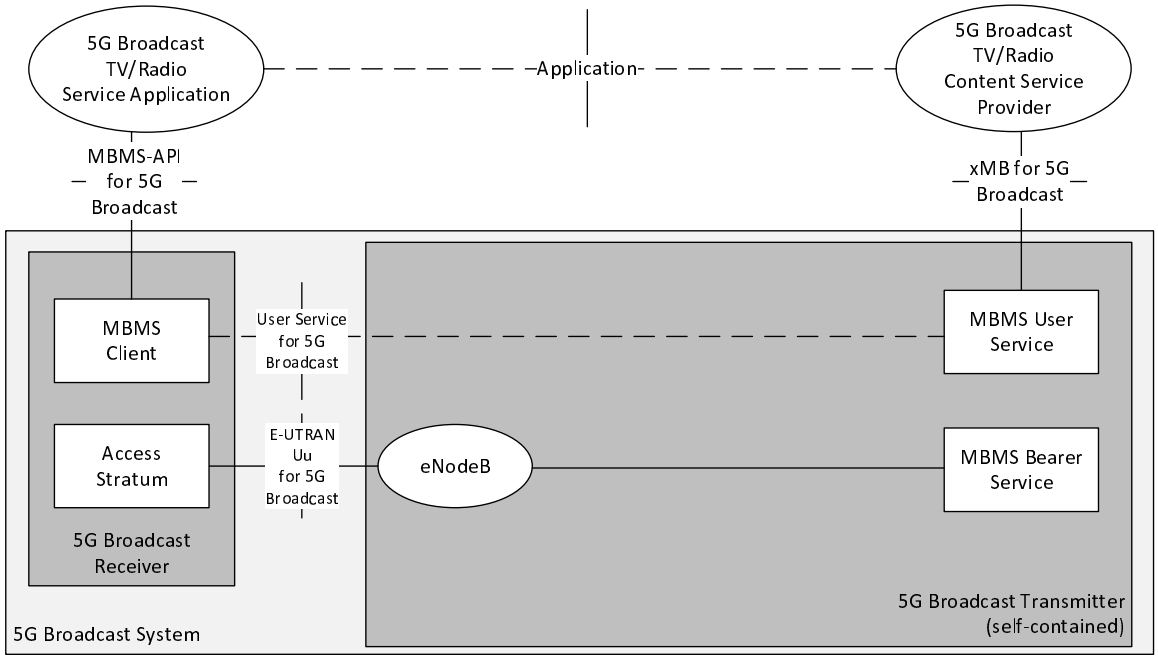


Figure 5.2.2-2: Deployment of LTE-based 5G Broadcast instantiation with integrated core and Radio Access Network functions

5.3 5G Broadcast Services

5.3.1 Definition

LTE-based 5G Broadcast, as defined in the present document, instantiates 5G Broadcast Services with MBMS User Services as defined in ETSI TS 123 246 [5] and with the constraints and requirements in the present document in order to carry linear television and radio broadcast services. MBMS User Services are uniquely identified by a Temporary Mobile Group Identifier (TMGI).

In particular, a 5G Broadcast Service is an MBMS Service that is also a "broadcast TV service" as defined in ETSI TS 124 116 [6], clause 6. A "broadcast TV service" is uniquely identified as the combination of the carrier frequency and the lowest-five hexadecimal digits of the MBMS Service ID. For details refer to clause 5.11.

A 5G Broadcast Service may be available in a PLMN. In order to provision and configure a network for a 5G Broadcast Service as defined in the present document, an MBMS User Service shall use any of the TMGIs from the reserved TMGI range for Receive-Only Mode, as defined in clause 5.12.

5.3.2 Service types

The following of types of 5G Broadcast Service are defined:

1) A 5G Broadcast SA Service: A 5G Broadcast Service that provides Service Announcement and originates in the BM-SC (or in the 5G Broadcast Transmitter) and terminates in the MBMS Client (or in the 5G Broadcast Receiver).

2) 5G Broadcast User Service: A 5G Broadcast Service that provides user data, for example a linear television or radio service. The User Service originates in the Content Provider and terminates in the Application. Based on the delivery modes available for MBMS User Services, the following User Service types are defined in the present document:

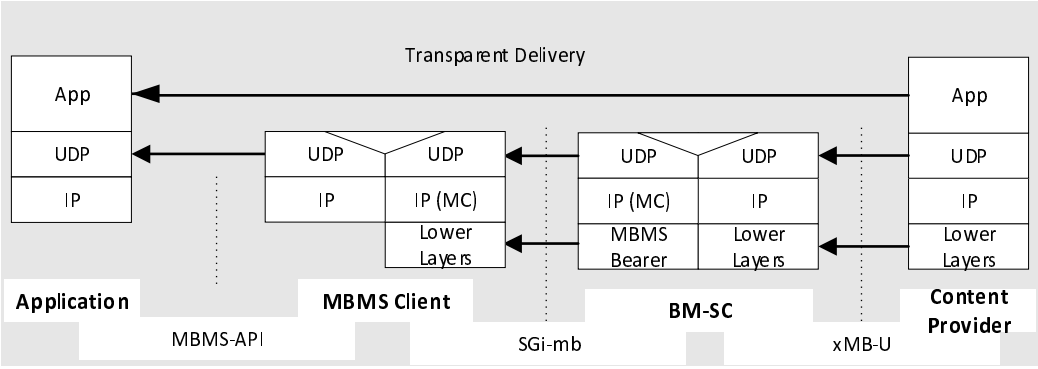
   a) *UDP Proxy*, supported by the Transport-only Proxy Delivery Mode.

   b) *IP Packet Routing*, supported by the Transport-only Forward-only Delivery Mode.

   c) *File Delivery*, supported by the download delivery mode and non-real-time file delivery in order to distribute files on a scheduled basis or in carousels.

   d) *Segment Streaming*, supported by the download delivery mode and real-time segment delivery in order to distribute segment streaming services such as DASH, HLS and hybrid DASH/HLS.

As an example, figure 5.3.2-1 illustrates the end-to-end service data delivery across application layer endpoints at the Content Provider server and the UE Application for one of the delivery modes, namely the UDP Proxy User Service. In this case, IP multicast packets flow between the BM-SC and the MBMS Client.



NOTE: Transparent delivery refers to the App and UDP flows between the leftmost and rightmost vertical dashed lines, i.e. the UDP payloads are handed transparently through the system.

Figure 5.3.2-1: End-to-end IP multicast with UDP Proxy User Service

5.3.3 Service provisioning, configuration, announcement and selection

A 5G Broadcast TV/Radio Content Service Provider using a 5G Broadcast System shall support all relevant service provisioning and ingest procedures as defined in clause 5.5.2.

5G Broadcast User Services shall be announced in at least one 5G Broadcast SA Service. To facilitate the discovery of 5G Broadcast Services, in particular 5G Broadcast SA Services, the 5G Broadcast Receiver device may in addition be provided with a well-defined TV Service Configuration MO, as specified in ETSI TS 124 116 [6], clause 6.1. The present document also addresses the usage of the TV Service Configuration MO as defined in clause 5.10 of ETSI TS 124 117 [7] as well as the ability to configure service discovery provisioning through the MBMS-APIs.

The TV Service Configuration MO contains a list of PLMNs that carry 5G Broadcast SA Services. For each entry of the list, the following information should be available:

1) The PLMN ID of the PLMN for which the configuration applies; the format of the PLMN ID is specified in ETSI TS 123 003 [3].

2) RAN information where the 5G Broadcast SA Service is available, to assist in PLMN search, predominantly the E-UTRA Absolute Radio Frequency Channel Number (EARFCN). This is a 32-bit long unsigned integer in the range 0–262143. The format of the EARFCN is specified in ETSI TS 136 101 [14], clause 5.7.3.

3) The list of TMGIs on which 5G Broadcast SA Services are available. TMGIs are specified in ETSI TS 123 003 [3]. For details on the format of the TMGI for 5G Broadcast Services, refer to clause 5.11.

4) The list of TMGIs on which the 5G Broadcast User Service is available, along with the associated User Service Description information for the MBMS User Service.

In order to receive a 5G Broadcast Service, the 5G Broadcast Receiver performs network selection for "broadcast TV service" as described in clause 5 of ETSI TS 124 116 [6] and selects the PLMN for the 5G Broadcast Service. Details on service discovery are provided in clause 5.11.

5.4 Operation modes

5.4.1 General

For the LTE-based 5G Broadcast System, the BROADCAST MODE as defined in ETSI TS 123 246 [5], clause 5.4.3 shall apply. The phases of MBMS broadcast service provision include:

- Service Announcement, for details see clause 5.4.2.
- Session Start, for details see clause 5.4.3.
- MBMS Notification, for details see clause 5.4.4.
- Data Transfer, for details see clause 5.4.5.
- Session Stop, for details see clause 5.4.6.

In addition, for 5G Broadcast Services the Receive-Only Mode (ROM) as defined in ETSI TS 123 246 [5] shall be used. For details, see clause 5.4.8.

5.4.2 Service announcement and discovery

In order to access a 5G Broadcast Service, the service and its associated parameters need to be properly announced. The MBMS User Service announcement/discovery mechanisms allow receivers to be informed about the MBMS User Services available. Service Announcement is used to distribute to 5G Broadcast Receivers information about the service, parameters required for service acquisition (e.g. delivery method, bearer and media information, IP multicast address(es)) and possibly other service-related parameters (e.g. delivery schedule, or hybrid unicast-broadcast related functions such as QoS reporting, file repair).

LTE-based 5G Broadcast requires the usage and support of 5G Broadcast SA Services for service announcements. For this purpose, 5G Broadcast SA Services shall use the SACH as well as a set of TMGIs corresponding to the reserved range of values defined in ETSI TS 124 116 [6] for service announcements. For details on TMGI values, refer to clause 5.11.

In addition, the TV Service Configuration MO (as introduced also in clause 5.10) may be used as follows:

- the TV Service Configuration MO may be pre-configured and pre-stored in the 5G Broadcast Receiver, for example by the device manufacturer or a mobile network operator using operator configuration; or

- the 5G Broadcast TV/Radio Content Service Provider may provide a TV Service Configuration MO as defined in ETSI TS 124 117 [7] using private application-specific means and then through the MBMS-API. As an example, the MO can be provisioned by unicast communication, for example if a receiver also includes a 5G unicast capability.

5.4.3 Session Start

Session Start is the point at which the BM-SC is ready to send data. For details, see ETSI TS 123 246 [5], clause 4.4.3.2.

5.4.4 MBMS notification

See ETSI TS 123 246 [5], clause 4.4.3.3.

5.4.5 Data transfer

See ETSI TS 123 246 [5], clause 4.4.3.4.

5.4.6 Session Stop

See ETSI TS 123 246 [5], clause 4.4.3.5.

5.4.7 Session Update

Session Update is aligned with ETSI TS 123 246 [5], clause 4.4.3.6, but the following constraints apply:

1) Session Update is used to update specific parameters of an ongoing MBMS Broadcast session. The only parameter which can be updated is the MBMS Service Area.

2) Session Update due to QoS (ARP parameter only) is not supported.

5.4.8 Receive-Only Mode (ROM)

LTE-based 5G Broadcast Services shall be Receive-Only Mode (ROM), i.e. they are intended for consumption on 5G Broadcast Receivers operating in Receive-Only Mode (ROM).

According to ETSI TS 123 246 [5], Receive-Only Mode (ROM) is defined as a UE configuration option that allows a UE to receive an eMBMS broadcast service without the need to access and register with the PLMN offering the eMBMS service. A UE configured to operate in ROM receives an MBMS service only on a standardized TMGI value range. The UE uses the acquired system information to receive MBMS broadcast. Use of ROM does not require USIM for the UE.

Hence, LTE-based 5G Broadcast Services shall be restricted to TMGI value ranges for ROM services. For details on TMGI, refer to clause 5.11.

Detailed procedures for a UE operating in ROM are defined in ETSI TS 123 246 [5], annex E as well as in ETSI TS 124 116 [6].

5.5 Reference points and protocols

5.5.1 General

According to figure 5.2.1-1, this clause defines the reference points and protocols for the LTE-based 5G Broadcast System instantiation, namely:

- For the northbound Network API for 5G Broadcast, a profile of xMB is defined in clause 5.5.2.
- For the User Service for 5G Broadcast, a profile of the MBMS User Service is defined in clause 5.5.3.
- For the RAN for 5G Broadcast, a profile of E-UTRAN Uu and enTV is defined in clause 5.5.4.
- For the Client API for 5G Broadcast, a profile of the MBMS-APIs is defined in clause 5.5.5.

5.5.2 xMB profile for 5G Broadcast

The Application Programming Interfaces (APIs) for Multimedia Broadcast/Multicast Service (MBMS) at reference point xMB are defined in ETSI TS 126 348 [10] and ETSI TS 129 116 [11].

The xMB reference point provides the ability for the Content Provider to:

- Authenticate and authorize BM-SC(s).
- Create, modify and terminate a service.
- Create, modify and terminate a session.
- Query information.
- Deliver content to the BM-SC(s).

The xMB reference point provides the ability for the BM-SC to:

- Authenticate and authorize a content provider.
- Notify the content provider of the status of an MBMS user service usage, if applicable.
- Retrieve content from the content provider.

For 5G Broadcast Services, the following procedures on xMB shall be supported:

1) Authentication and Authorization as defined in clause 5.2 of ETSI TS 126 348 [10].
2) Service Management Procedures as defined in clause 5.3 of [10] with the following additional considerations:
   a) All Service Management Procedures apply, i.e.:
      - Create Service as defined in clause 5.3.2 of ETSI TS 126 348 [10].
      - Get Service Procedure as defined in clause 5.3.3 of ETSI TS 126 348 [10].
      - Update Service Procedure as defined in clause 5.3.4 of ETSI TS 126 348 [10].
      - Terminate Service Procedure as defined in clause 5.3.5 of ETSI TS 126 348 [10].
   b) Service Notifications as defined in clause 5.3.6 of ETSI TS 126 348 [10] applies.
   c) For the Service Properties defined in clause 5.3.7, table 5.3-1 of ETSI TS 126 348 [10], the following constraints apply:
      - The Receive-Only Mode property shall be set to 'true'.
      - The Consumption Reporting configuration shall be set to 'false'.
      - The Service Announcement Mode property shall be set to 'SACH'.

3) Session Management Procedures as defined in clause 5.4 of ETSI TS 126 348 [10] with the following additional restrictions:

   a) All Session Management Procedures apply, i.e.:

      - Create Session as defined in clause 5.4.2 of ETSI TS 126 348 [10].
      - Get Session Procedure as defined in clause 5.4.3 of ETSI TS 126 348 [10].
      - Update Session Procedure as defined in clause 5.4.4 of ETSI TS 126 348 [10].
      - Terminate Session Procedure as defined in clause 5.4.5 of ETSI TS 126 348 [10].

   b) For the Session Properties defined in clause 5.4.6, table 5.4.-1 of ETSI TS 126 348 [10], the following constraints apply:

      - The *Max Delay* parameter shall not be used.
      - The *QoE Reporting* parameter shall not be used.
      - The *Session Type* parameter shall be set to one of the following modes:
        - *Files*.
        - *Application*.
        - *Transport-Mode*.
      - Header Compression shall not be used.

   c) For the additional Session Properties for *Transport-Mode* defined in clause 5.4.6, table 5.4-2 of ETSI TS 126 348 [10], the following constraints apply:

      - "Delivery Mode Configuration for User Plane" property shall be set to *Proxy* or *Forward-Only*.
      - "Session Description Parameters for User Plane" property:
        - Type shall be set to 'embedded'.
        - Access URL shall be the URL of an SDP file that describes a multicast stream associated with the BM-SC ingest session.
        - The User Plane Parameters are set according to the Service Announcement Mode as follows:
          - If "Delivery Mode Configuration for user plane" is set to *Forward Only*, User Plane Parameters shall contain a complete Session Description and a single xMB-U reception UDP port. This port is used by the BM-SC for Service Announcement delivery over the SACH. For the usage of the information, refer to clause 5.4.6, table 5.4-2 of ETSI TS 126 348 [10].
          - If "Delivery Mode Configuration for user plane" is set to *Proxy*, User Plane Parameters shall contain a Session Description template and a list of the transmitted UDP flows to be forwarded on the established MBMS bearer for the session. For usage of the Session Description information, refer to clause 5.4.6, table 5.4-2 of ETSI TS 126 348 [10].
      - Delivery Session Description Parameters shall not be used.

   d) For the additional Session Properties for *Application* as defined in clause 5.4.6, table 5.4-4 of ETSI TS 126 348 [10], all parameters may be used with the following constraints:

      - Application Service Description shall be set to the MIME content type of the Application Service, namely either `application/dash+xml` for DASH [23] or `application/vnd.apple.mpegurl` for HLS [25].
      - Alternative Application Service Description may be present and, if present, shall be set to either `application/dash+xml` for DASH or `application/vnd.apple.mpegurl` for HLS.

e) For the additional Session Properties for *Files* as defined in clause 5.4.6, table 5.4-5 of ETSI TS 126 348 [10], all parameters may be used, but the following constraints apply:

- The SA file URL may be present to support Service Announcement through content provider mode.

4) User Plane Procedures as defined in clause 5.5 of ETSI TS 126 348 [10] with the following additional considerations:

a) File Distribution is as defined in clause 5.5.2 of ETSI TS 126 348 [10].

b) Transport sessions are as defined in clause 5.5.4 of ETSI TS 126 348 [10].

c) Content Provider reception of Notification Messages is as defined in clause 5.5.5, table 5.5-1 of ETSI TS 126 348 [10], with the following constraints:

- Message Class "Information" shall not be used.

- For Message Class "Session", only the message name "SessionStateChange" shall be used.

The Session Parameter settings and protocol stack are provided in annex A of ETSI TS 126 348 [10].

5.5.3 MBMS User Service profile

MBMS User Service protocols and codecs are documented in ETSI TS 126 346 [8] and that specification defines the reference point between the BM-SC (the origin of an MBMS User Service) and the MBMS Client. Only a subset of the MBMS User Service protocols and functionalities are applicable to 5G Broadcast Services.

The User Service Description of an LTE-based 5G Broadcast Service shall include at least one capability for a 5G Broadcast Receiver as defined in clause 10, table 10.1-1. The capabilities are allocated in clause 11.9 of ETSI TS 126 346 [8].

In order to support 5G Broadcast Service Announcement and User Services for 5G Broadcast, MBMS Profiles for MBMS User Services are defined in annex L of ETSI TS 126 346 [8].

For Service Announcement the MBMS User Service Discovery/Announcement Profile 1b as documented in clause L.3 of ETSI TS 126 346 [8] shall apply with the following constraints:

- The Associated Delivery Procedure Description (ADPD) fragment may be absent. If present, it may be ignored by the MBMS Client in the 5G Broadcast Receiver if the MBMS Client does not support unicast connectivity. For some deployment options, refer to clause 9 of the present document.

- The *userServiceDescription* element shall include the *r14:romService* attribute set to "true" to indicate that the corresponding MBMS User Service is a Receive-Only Mode (ROM) service.

- The User Service Description should include the *r16:ROMSvcRfParams* child element and signal EARFCN for subcarrier spacing and bandwidth. According to ETSI TS 126 346 [8], the value of *subcarrierSpacing* shall be restricted to be one of the following numbers in units of kHz: 0,37; 1,25; 2,5; 7,5 or 15. The value of *bandwidth* shall be restricted to be one of the channel bandwidth values specified in ETSI TS 136 104 [28].

- If the 5G Broadcast Service is offered on different frequencies in different service areas:

  - This shall be signalled in the SIB15 messages (see clause 6.5 for more details).

  - The User Service Description should not include the *r9:availabilityInfo* element.

  - If the *r9:availabilityInfo* element is present, each *infoBinding* child element contains the child elements *radioFrequency* and *serviceArea* in order to provide a binding between the frequency-agnostic Service Area Identifier (SAI) and the radio frequency following the semantics as defined in System Information Block 15 (SIB). In this profile, the UE shall ignore the *radioFrequency* child element of *infoBinding*. Instead, the UE shall read and use the radio frequency from the E-UTRAN System Information Block 15 (SIB), which provides the binding between the frequency-agnostic Service Area Identifier (SAI) and the radio frequency. For details refer to clause 6.5.

    - If the *r9:availabilityInfo* element is absent, then the device may assume that the corresponding MBMS User Service offering is not geographically constrained within the service area footprint of the 5G Broadcast System.

- The Service Announcement shall include a required capability '23' as defined in clause 11.9 of ETSI TS 126 346 [8].

- FLUTE packets comprising the Service Announcement Channel for Receive-Only-Mode are addressed to:

    - The multicast destination group 224.0.0.120 (registered in IANA's IPv4 Multicast Address Space Registry [32] with the allocation name "3GPP MBMS SACH"), as specified in clause C.17 of ETSI TS 126 346 [8], in the case that IPv4 is used to convey the FLUTE packets.

    - The multicast destination group FF02::177 (registered in IANA's IPv6 Multicast Address Space Registry [33] with the allocation name "3GPP MBMS SACH"), as specified in clause C.18 of ETSI TS 126 346 [8], in the case that IPv6 is used to convey the FLUTE packets.

    - The UDP destination port number 55555, a value in the "Dynamic Ports" range defined in IETF RFC 6335 [34], as specified in clause 5.2.3.1.1 of ETSI TS 126 346 [8].

For File Delivery or Segment Streaming User Services, the MBMS Download profile as documented in clause L.4 of ETSI TS 126 346 [8] shall apply with the following constraints:

- RTSP Control of FLUTE Sessions as defined in clause L.4.6 of ETSI TS 126 346 [8] shall not be used.

For UDP Proxy User Services, the Transparent Delivery Method as defined in clause 8B of ETSI TS 126 346 [8] shall apply with the following constraints:

- MBMS transparent delivery sessions shall be operated strictly in Proxy mode, whereby the transport protocol and session description as described in clauses 8B.2 and 8B.3 of ETSI TS 126 346 [8] shall apply:

    - The transport framing protocol shall not be used.

    - *Delivery Mode Configuration* for user plane shall be set to *Proxy*.

    - RoHC as defined in clause 8B.4 of ETSI TS 126 346 [8] shall not be used.

    - FEC as defined in clause 8B.5 of ETSI TS 126 346 [8] shall not be used.

For IP Packet Routing User Services, the Transparent Delivery Method as defined in clause 8B of ETSI TS 126 346 [8] shall apply with the following constraints:

- MBMS transparent delivery sessions shall be operated strictly in Forward-only mode.

- The transport protocol on top of IP is opaque to the MBMS system.

5.5.4 E-UTRAN Uu profile for 5G Broadcast

The E-UTRAN Uu for 5G Broadcast relies on two main principles:

1) A radio network comprising only MBMS-dedicated cells (as defined in ETSI TS 136 300 [18]) as transmitters; MBMS-dedicated cells support only MBMS transmission and do not support uplink transmission.

2) Receive-Only-Mode (ROM) devices (as defined in ETSI TS 123 246 [5]) as receivers; ROM devices support only ROM service (as defined in ETSI TS 126 346 [8]). ROM service uses one of the reserved TMGI values (as defined in ETSI TS 124 116 [6]).

For bandwidth values 6, 7 and 8 MHz:

- The system is bootstrapped with the Cell Acquisition Subframe (CAS) transmitted using a legacy channel bandwidth of 15 or 25 PRBs (corresponding to 3 and 5 MHz respectively). System acquisition signals PSS/SSS and physical channels PBCH, PDCCH and PDSCH are received within this bandwidth.

- The system information blocks include signalling for the PMCH bandwidth, which can be indicated to be larger than the carrier bandwidth according to ETSI TS 136 443 [27]. Additional PMCH bandwidths of 30, 35 and 40 PRBs (corresponding to 6/7/8 MHz) are specified according to ETSI TS 136 300 [18]. The physical layer procedures related to the larger bandwidths (Transport Block Size determination, tone mapping, etc.) are specified according to ETSI TS 136 211 [16] and ETSI TS 136 213 [17]. For reasons of backwards compatibility, different MBSFN areas in the same cell (or set of cells) may be configured with different bandwidth values for PMCH.

- UE capabilities to indicate the support of 6/7/8 MHz PMCH bandwidths are specified in ETSI TS 136 306 [26] and ETSI TS 136 331 [21].

Details for E-UTRAN Uu reference point for 5G Broadcast are defined in clause 6.4 and clause 7.2.

5.5.5 Client APIs for 5G Broadcast

For the Client API for 5G Broadcast, the MBMS Application Programming Interfaces (MBMS-APIs) are specified in ETSI TS 126 347 [9] and define the application service interfaces between the MBMS Client and the MBMS-Aware Application.

For 5G Broadcast Services, the following MBMS-APIs shall apply:

1) For File Delivery User Services:

   - The File Delivery Application User Service as specified in clause 4.3.2 of ETSI TS 126 347 [9] shall apply.

   - The File Delivery Application Service API as specified in clause 6.2 of ETSI TS 126 347 [9] shall apply.

   - The file copy interface as specified in clause 7.2 of ETSI TS 126 347 [9] or the HTTP Interface as defined in clause 7.3 of ETSI TS 126 347 [9] shall be used.

2) For Segment Streaming User Services:

   - The Media Application User Service as specified in clause 4.3.3 of ETSI TS 126 347 [9] shall apply.

   - The Media Streaming Service API as specified in clause 6.3 of ETSI TS 126 347 [9] shall apply.

   - The DASH-specific interface as specified in clause 7.4 of ETSI TS 126 347 [9] or the HLS-specific interface in clause 7.6 of ETSI TS 126 347 [9] shall be used.

3) For UDP Proxy as well as IP Packet Routing User services:

   - The MBMS Transparent User Service as specified in clause 4.3.5 of ETSI TS 126 347 [9] shall apply.

   - The MBMS Packet Delivery Service API as specified in clause 6.4 of ETSI TS 126 347 [9] shall apply with the following constraint:

     - The `serviceType` shall be set to `TRANSPARENT-ROM`;

   - The packet data interface as specified in clause 7.6 of ETSI TS 126 347 [9] is used.

4) Improved Service Announcement may be supported by either of the following means:

   - The application provides a Service Announcement file to the MBMS Client using the relevant MBMS-API. The Service Announcement file is specified in clause 6.2.3.22 of ETSI TS 126 347 [9].

   - By usage of the TV Service Configuration MO delivered to the MBMS Client as defined in ETSI TS 124 117 [7]. For details refer to clause 5.10 in the present document.

For Service Announcement, the File Delivery Application User Service and File Delivery Application API apply. An MBMS-URL enables applications to find Service Announcements which indicate availability of services as defined in clause 8 in ETSI TS 126 347 [9]. For Receive-only Mode (ROM), an extended MBMS-URL is used with prefix `mbms://rom.3gpp.org` and additional mid-part name–value pairs indicated according to table 8.2.4-1 in ETSI TS 126 347 [9].

5.6 5G Broadcast procedures

The following MBMS procedures specified in ETSI TS 123 246 [5] shall be supported for LTE-based 5G Broadcast:

- MBMS Session Start Procedure for E-UTRAN and UTRAN for EPS.
- MBMS Session Stop Procedure for E-UTRAN and UTRAN for EPS.
- MBMS Broadcast Service Activation.
- MBMS Broadcast Service De-activation.
- BM-SC-initiated Session Update for EPS with E-UTRAN and UTRAN.

5.7 Security

For 5G Broadcast, the following security considerations apply:

- A ROM device does not support signalling procedures, including registration with a PLMN.
- A ROM device is not equipped with a USIM. Therefore, security procedures with a PLMN are not supported.

If security is required for 5G Broadcast, it shall be implemented using application-level procedures.

5.8 Charging

For 5G Broadcast, the following charging considerations apply:

- A ROM device does not support signalling procedures, including registration with a PLMN.
- A ROM device is not equipped with a USIM. Therefore, charging by a PLMN is not supported.

If charging is required for 5G Broadcast, charging can be implemented using application-level procedures.

5.9 Roaming

Roaming does not apply.

5.10 TV Service Configuration Management Object

If the Service Announcement is further supported by an application to MBMS Client communication through the MBMS-API, then the receiver configuration procedure for a 5G Broadcast Receiver can be achieved by the application providing relevant information obtained from a TV Service Configuration MO to the MBMS Client.

The TV Service Configuration MO is defined in ETSI TS 124 117 [7]. When this Management Object is used in a 5G Broadcast System, the following constraints apply:

- The MO identifier shall be: urn:oma:mo:ext-3gpp-tv-config:1.0.

The Management Object provides information about the TMGIs associated with the services, as well as the carrier frequency for each service.

NOTE: The 5G Broadcast Receiver could also discover the 5G Broadcast Services provided by the serving PLMN by scanning the reserved range of TMGIs for broadcast TV service.

5.11 Temporary Mobile Group Identity

5.11.1 Introduction

The Temporary Mobile Group Identity (TMGI) is used for MBMS notification purposes to uniquely identify MBMS bearer services.

The BM-SC allocates a globally unique TMGI per MBMS bearer service. The structure of the TMGI is defined in clause 15.2 of ETSI TS 123 003 [3], but also shown in figure 5.11.1-1. The TMGI is a radio resource-efficient MBMS bearer service identification, which is equivalent to the MBMS bearer service identification consisting of an IP multicast destination group address and an APN.

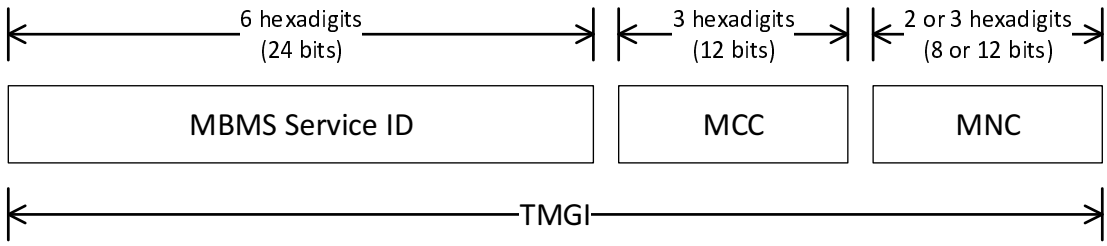


Figure 5.11.1-1: Temporary Mobile Group Identity (TMGI)

Generally, the TMGI is composed of three parts:

1) *MBMS Service ID*, consisting of three octets. MBMS Service ID consists of a 6-digit fixed-length hexadecimal number between 0x000000 and 0xFFFFFF. MBMS Service ID uniquely identifies an MBMS bearer service within a PLMN. The structure of MBMS Service ID for services for Receive-Only Mode is defined in ETSI TS 124 116 [6].

2) *Mobile Country Code (MCC)*, consisting of three hexadecimal digits. The MCC identifies uniquely the country of domicile of the BM-SC, except for the MCC value of 901, which does not identify any country and is assigned globally by ITU.

3) *Mobile Network Code (MNC)*, consisting of two or three hexadecimal digits (depending on the assignment to the PLMN by its national numbering plan administrator). The MNC identifies the PLMN which the BM-SC belongs to, except for the MNC value of 56 when the MCC value is 901, which does not identify any PLMN. For more information on the use of the TMGI, see ETSI TS 123 246 [5].

5.11.2 TMGIs for 5G Broadcast Services

An LTE-based 5G Broadcast Service is a Receive-Only Mode (ROM) service as well as a broadcast TV service.

According to clause 6.3 of ETSI TS 124 116 [6], for the TMGI in the case of Receive-Only Mode, the first hexadecimal digit (i.e. the four most significant bits) of the *MBMS Service ID* is used to signal the type of service.

For LTE-based 5G Broadcast Services, two options exist for the TMGI of the actual service as well as for the service announcement:

1) The service provider may use a TMGI with the globally assigned PLMN ID 901 56. For assignment of the MBMS Service ID, see below.

2) The service provider may use a TMGI with PLMN ID other than 901 56 to provide an LTE-based 5G Broadcast Service. In this case, it is the service provider's responsibility to assign a correct MBMS Service ID.

For broadcast TV service targeting Receive-Only Mode, the type of service shall be set to 0x0. This leaves five additional digits (i.e. 20 bits) for signalling broadcast TV services in the MBMS Service ID.

Furthermore, for LTE-based 5G Broadcast services, the following applies:

- MBMS Service ID values 0x000000 to 0x00000F inclusive are used only for TMGIs associated with the 5G Broadcast SA Service as defined in clauses 5.4 and 5.5.3; and
- the remaining values of the MBMS Service ID are used for TMGIs associated with the 5G Broadcast User Services as defined in clauses 5.4 and 5.5.3.

5.11.3 TMGI Management for 5G Broadcast Services

Two different types of 5G Broadcast Service provider exist:

1) A 5G Broadcast Service provider may use TMGIs from the reserved range on the globally assigned PLMN ID 901 56. However, note that MBMS Service IDs are not globally unique in the sense that two service providers may use the same TMGI from the reserved range for different 5G Broadcast Services.

NOTE 1: It is recommended that in this case a regional consortium assigns a proper MBMS Service ID for each service following the rules in clause 5.11.2.

2) A Service provider owns a PLMN ID and provides a 5G Broadcast Service using a TMGI according to clause 5.11.2 within the allocated PLMN ID. In this case, the management of TMGIs for 5G Broadcast Services is at the discretion of the 5G Broadcast System operator. A UE that is a 5G Broadcast Receiver and also includes a SIM card may discover such services, as PLMN IDs are stored on the SIM card.

NOTE 2: It is critical that the 5G Broadcast Service provider pre-configures the 5G Broadcast Receiver to access such a service, because services outside the globally assigned PLMN ID are not automatically discoverable by a 5G Broadcast Receiver.

5.12 Discovering 5G Broadcast Services

For discovering all available 5G Broadcast Services, a 5G Broadcast Receiver shall identify all PLMNs that carry 5G Broadcast Services.

NOTE: PLMNs may be identified by RAN parameters as defined in clause 5.3.3.

Then, for each identified PLMN carrying at least one 5G Broadcast Service, a 5G Broadcast Receiver shall find the 5G Broadcast SA services in the range of associated TMGIs as defined in clause 5.11.2.

For each service announced in the 5G Broadcast SA service a 5G Broadcast Receiver shall find the 5G Broadcast User Services in the range of associated TMGIs as defined in clause 5.11.3 based on the received service announcement.

In order to support the search for PLMNs carrying 5G Broadcast Services:

1) The 5G Broadcast Receiver may be pre-configured with PLMNs and the associated RAN parameters.
2) The PLMN information may be provided through the SA configuration in the TV Management Object information (see clause 5.10).
3) The PLMN information may be provided through the SA configuration in the application, in which case the application shall provide the information to the 5G Broadcast Receiver through the MBMS-API (see clause 5.5.5).
4) Once a 5G Broadcast SA service is discovered, the PLMN information may be provided through the SA information in the USD when receiving SA information in the 5G Broadcast SA service.

The MBMS Client then forwards the RAN information (service area and radio frequency information) to the lower layers, and the UE is expected to make use of such information in accordance with ETSI TS 136 300 [18], clause 15.4 as well as ETSI TS 136 304 [19] and ETSI TS 136 331 [21] to access the MBMS bearer service that carries the 5G Broadcast Service.

5.13 RAN configuration options (informative)

Two important features for the radio access network documented in clause 4.2 are the support for:

- Single Frequency Network (SFN) deployments with Inter-Site Distance (ISD) significantly larger than a typical ISD 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.
- Mobility scenarios including speeds of up to 250 km/h to support receivers in cars, with external omni-directional antennas.

FeMBMS (as defined in Release 16) supports different numerologies (from 15 kHz down to 0,37 kHz) designed for operation with different Inter-Site Distances (ISDs) and potentially high Doppler spread. However, it is not a single RAN configuration that can support all the above features at the same time. An overview of different configurations available in FeMBMS is provided:

- eMBMS as defined in Release 14 supports an initial set of numerologies for typical cellular ISDs and typical mobile speeds.
- The original enTV configuration defined in Release 14 with 1,25 kHz subcarrier spacing provides good and balanced performance at low-to-moderate mobility for larger ISDs than typical cellular ones.
- In FeMBMS, the numerology with 0,37 kHz subcarrier spacing is introduced to support the scenario of large ISDs up to 125 km. This RAN configuration is tailored to rooftop reception from Medium Power Medium Tower (MPMT) transmitter sites as well as High Power High Tower (HPHT) transmitters.
- Also introduced in FeMBMS is the support of high mobility up to 250 km/h for mobile and portable UEs. For this, a numerology with 2,5 kHz subcarrier spacing is supported in FeMBMS to support this high mobility scenario.

It is at the discretion of the 5G Broadcast Service provider to the select the appropriate RAN configuration, in particular the correct numerology, for its considered deployment.

The present document permits the use of any subcarrier spacing defined in FeMBMS, i.e. 3GPP Release 16, but additionally specifies the subset of subcarrier spacings that a 5G Broadcast Receiver is required to support. For details on receiver requirements on supported RAN configurations, refer to clause 10.

5.14 5G Broadcast TV/Radio Service Application requirements

5.14.1 Introduction

This clause documents the requirements for a 5G Broadcast TV/Radio Application to interface and make use of the LTE-based 5G Broadcast System to set up and consume 5G Broadcast Services.

5.14.2 Supported content formats

A 5G Broadcast TV/Radio Service Application can make of use of different 5G Broadcast User Services as defined in clause 5.3:

- UDP Proxy.
- IP Packet Routing.
- File Delivery.
- Segment Streaming.

The User Services and content formats supported by a 5G Broadcast TV/Radio Service Application using 5G Broadcast Services shall conform to any of those specified by the xMB APIs in clause 5.5.2. Typical content formats are:

- Single file delivery according to a schedule.
- Carousels of files, including updates of files.

- DASH-based streaming. For format recommendations, refer to annex K of ETSI TS 126 346 [8].
- HLS-based streaming.
- Hybrid DASH/HLS streaming based on CMAF.
- IPTV unicast streams.
- IPTV multicast streams.
- ABR multicast streams.

Specifically, 5G Media Streaming (5GMS) as defined in ETSI TS 126 501 [29] can be considered as a component included in a 5G Broadcast TV/Radio Service Application that combines 5G Broadcast and 5G Media Streaming. Specifically, the architecture provided in clause 4.6 of ETSI TS 126 501 [29], as well as the procedures documented in clause 5.10 of ETSI TS 126 501 [29], provide a detailed description on the combination of 5G Media Streaming and eMBMS, and hence are directly applicable to LTE-based 5G Broadcast as defined in the present document.

More details on the combination of 5G Broadcast and 5G Media Streaming are provided in clause 9.3.

5.14.3 Application Programming Interface conformance

The 5G Broadcast TV/Radio Service Application shall be an MBMS-Aware application that supports the Application Programming Interfaces of the MBMS-APIs as profiled in clause 5.5.5.

5.14.4 Application-based Service Announcement

The 5G Broadcast TV/Radio Service Application may support service discovery by providing either the Service Announcement generated by the BM-SC or the TV Service Configuration MO to the 5G Broadcast Receiver using the Application Programming Interfaces of the MBMS-APIs as profiled in clause 5.5.5.

5.15 Public Warning System support

5.15.1 Reference architecture

This clause extends the basic reference architecture in clause 5.2, adding the Cell Broadcast Service to support the Public Warning System (PWS) introduced in clause 4.2.5.

Figure 5.15.1-1 depicts the extended reference architecture for the LTE-based 5G Broadcast System including Public Warning System. This architecture is a simplified version of the EPS architecture for E-UTRAN only, as defined in ETSI TS 123 246 [5] and takes into account the PWS architecture in E-UTRAN as defined in clause 3.3 of ETSI TS 123 041 [35].

The primary focus is the addition of the PWS related functions and interfaces.

NOTE 1: This PWS service may be viewed independently of the 5G Broadcast User Service architecture.

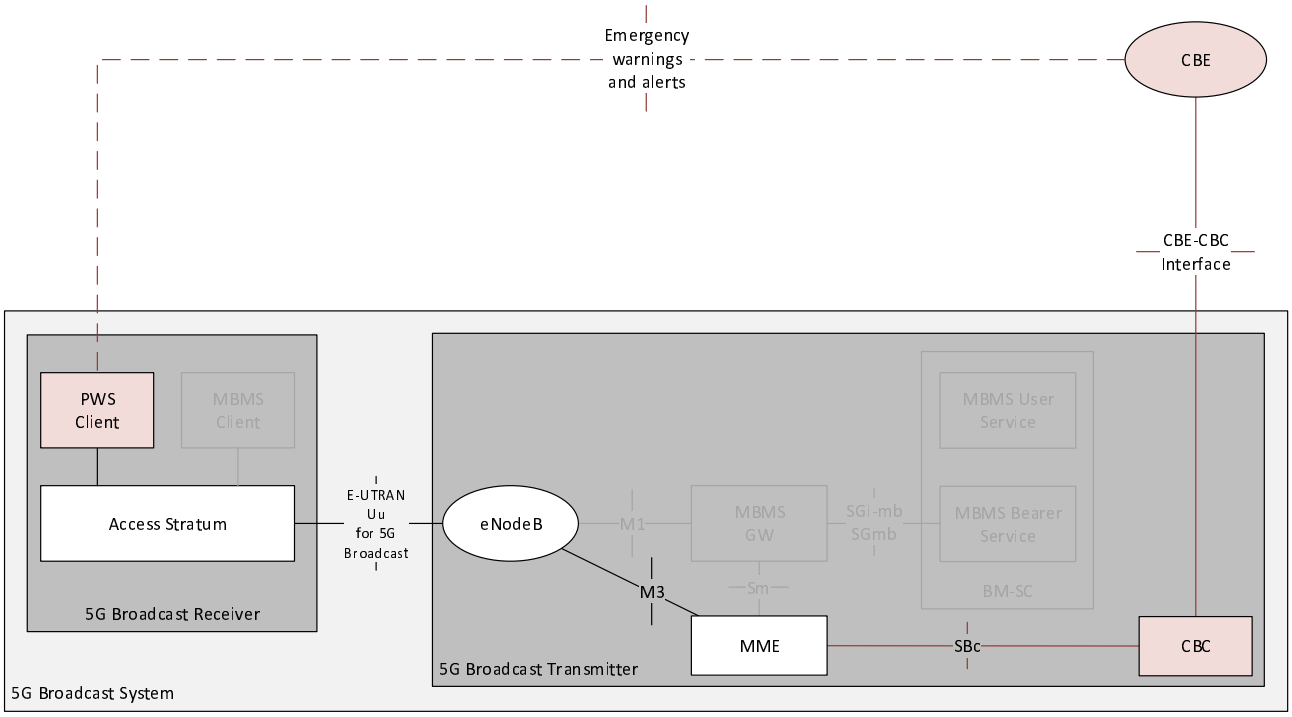


Figure 5.15.1-1: Reference architecture for LTE-based 5G Broadcast System extended with Public Warning Systems

For the PWS architecture in E-UTRAN, the following reference points are present in addition to those listed in clause 5.2 for the E-UTRAN MBMS Broadcast Mode only.

CBE-CBC: Between Cell Broadcast Entity (CBE) and Cell Broadcast Centre (CBC).

SBc: Between the CBC and the MME, as defined in ETSI TS 129 116 [11].

NOTE 2: It is expected that the 5G Broadcast Transmitter is deployed as a single physical entity and hence detailed profiling of reference point **SBc** for interoperability is not required in the present document. However, if needed, reference point **SBc** may be used unmodified in the context of the Public Warning System for LTE-based 5G Broadcast.

The extensions to support the Public Warning System in the LTE-based 5G Broadcast System are as follows:

1) The 5G Broadcast Transmitter shall include:

   a) For the CBE-CBC interface, the support of a specific profile of the Common Alerting Protocol (CAP), version v1.2 as defined in OASIS Standard CAPv1.2 [38] is supported, but other protocols may be used.

   b) The RAN extensions specified in ETSI TS 136 300 [18], ETSI TS 136 304 [19], ETSI TS 136 306 [26], ETSI TS 136 331 [21] and ETSI TS 136 413 [39] as further specified in the present document.

2) The 5G Broadcast Receiver shall include:

   a) Support for the profile of E-UTRAN Uu (as defined in ETSI TS 136 300 [18], ETSI TS 136 304 [19], ETSI TS 136 306 [26], ETSI TS 136 331 [21] and ETSI TS 136 413 [39]) specified in the present document.

   b) A *PWS Client* as defined in ETSI TS 123 041 [35] that supports the processing and presentation of public warning messages and emergency alerts independent of an application. For more details refer to clause 5.15.5.

Detailed specifications of these reference points are provided in clause 5.15.3. PWS-related requirements for 5G Broadcast Transmitters are provided in clause 6.6 and the requirements for 5G Broadcast Receivers are provided in clause 7.

5.15.2 Warning message delivery procedures

Following the description in clause 9.1.3.4 of ETSI TS 123 041 [35], the warning message to be broadcast is delivered via MMEs to multiple eNodeB instances. The eNodeB instance(s) are responsible for scheduling the broadcast of the new message and the repetitions in each cell.

The warning message delivery procedure is presented in figure 5.15.2-1.

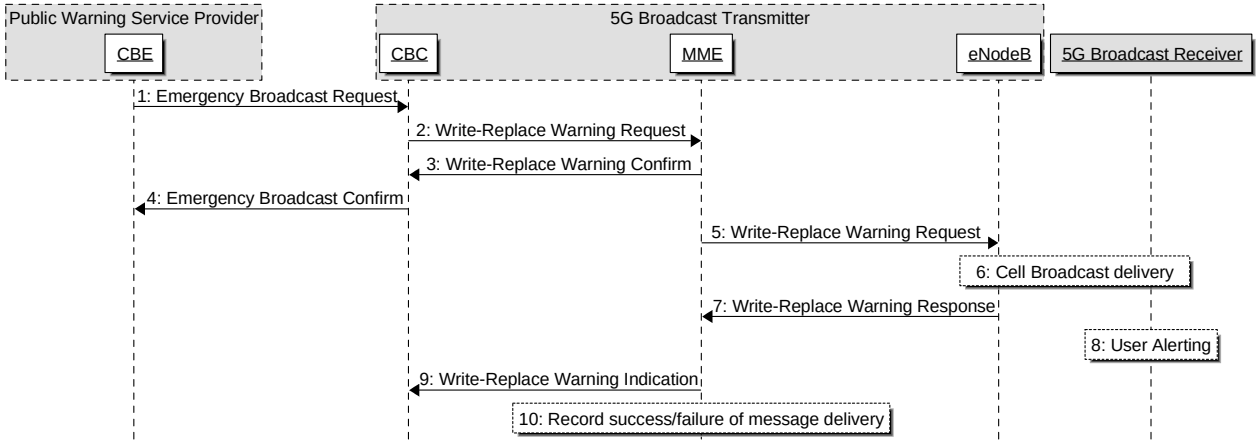


Figure 5.15.2-1: Warning message delivery procedure in 5G Broadcast

For the detailed description of the call flow, refer to clause 9.1.3.4 of ETSI TS 123 041 [35].

Specific aspects related to 5G Broadcast are:

- The Public Warning Service Provider and the 5G Broadcast Transmitter need to perform network registration and security (e.g. mutual authentication) procedures.
- Because an MME is unaware of cell coverage areas, the "Impacted area" cannot be handled at the MME level and the "Impacted area" information is translated into the Warning Area List Information Element.
- In an SFN area, all cells shall be served with the warning message and the Warning Area List may be absent. With Warning Area Coordinates present, it is expected that the UE uses this information together with its determined location in order to issue the included warning message or not.
- The UE needs to be configured to receive warning messages, and the UE is configured to accept warnings on the PLMN of the Broadcast Network.

5.15.3 Reference points and protocols for Public Warning System

5.15.3.1 General

According to figure 5.15.2-1, this clause defines the reference points and protocols for the LTE-based 5G Broadcast System instantiation of the Public Warning System, namely:

- For the CBE-CBC interface, a profile of CAP is defined in clause 5.15.3.2.
- For the 5G Broadcast RAN, a profile of E-UTRAN Uu is defined in clause 5.15.3.3.

5.15.3.2 CBE-CBC interface

Version 1.2 of the Common Alerting Protocol (CAP), as defined in [38] shall be supported at the CBE-CBC interface, together with a common set of Internet protocols. The use of this profile allows a Public Warning Service (PWS) provider acting as a CBE to connect to the CBC in the 5G Broadcast Transmitter. The protocol stack is shown in figure 5.15.3.2-1.

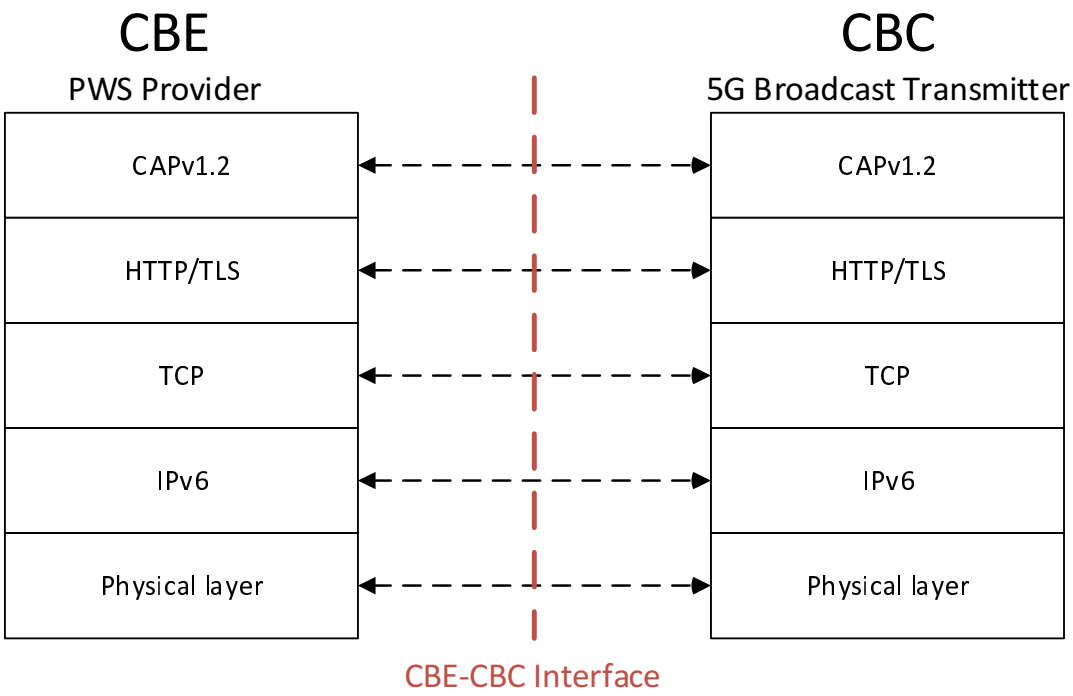


Figure 5.15.3.2-1: CBE-CBC interface and protocol stack

The CBC provides a service to receive and process PWS warning messages and sends them to 5G Broadcast Receivers. This service is invoked by the CBE. In order for minimum interoperability, a CBC function in the 5G Broadcast Transmitter shall support the following protocols and message exchange functionalities at the CBE-CBC interface:

- Application communication in the form of Extended Markup Language (XML) instance documents formatted in accordance with the OASIS Common Alerting Protocol Version 1.2 (CAPv1.2) [38]:
  - The exchange of CAPv1.2 messages follows a REST-API message exchange pattern.
- Secure Hypertext Transfer Protocol (HTTPS) according to IETF RFC 9110 [40] at the application layer.
- Transport Layer Security (TLS) protocol at least in version 1.3 (TLS 1.3) according to IETF RFC 8446 [41] to provide secure encryption and authentication of HTTP message exchanges:
  - The key used by the CBE and CBC to encrypt their TLS session is negotiated using client certificate authentication (two-way SSL).
- Transmission Control Protocol (TCP) in accordance with IETF RFC 793 [42] and IETF RFC 7323 [43] for the reliable transport of TLS records. The TCP connection setup always starts from the CBE in the direction of the CBC.
- Internet Protocol Version 6 (IPv6) packets in accordance with IETF RFC 8200 [44] for the delivery of TCP segments.
- A suitable physical layer for the transmission of IPv6 packets. The detailed specification and requirements are outside of scope of the present document, but for example an Ethernet link may be used.

Additional requirements may apply to fulfil all requirements of specific regional emergency alert requirements.

5.15.3.3 E-UTRAN Uu usage in Public Warning System for 5G Broadcast

PWS warning messages shall be sent in the 5G Broadcast System via the Commercial Mobile Alert Service (CMAS) as described in this clause. The alerts are delivered via the E-UTRAN Uu downlink within broadcast messages, called System Information Block (SIB) messages. A 5G Broadcast Transmitter (i.e. an eNodeB) broadcasts SIB messages to every 5G Broadcast receiver (i.e. a UE) that is tuned to the control channels of that eNodeB. The UE obtains necessary access information, such as the network identifier and access restrictions, from SIB messages, and uses it for the eNodeB selection procedure. Among the different types of SIB messages, SIB12 contains the CMAS notification for PWS.

For this purpose:

- ETSI TS 136 300 [18] specifies the signalling procedures for the transfer of warning messages from the MME to the eNodeB. The signalling procedures support CMAS operations.
- ETSI TS 136 331 [21] specifies the radio resource control protocol for UE-to-E-UTRAN radio interface and describes CMAS notification and warning message transfer.
- ETSI TS 136 413 [39] specifies the E-UTRAN radio network layer signalling protocol between the MME and eNodeB, and describes the warning message transfer needed for CMAS.

Details of the SIB12 message are specified in clauses 5.2.2.19 and 6.3.1 of ETSI TS 136 331 [21]. Through different fields according to clause 9.4.1.2 of ETSI TS 123 041 [35], the SIB12 message supports:

- `serialNumber` (2 octets): Identifies the CMAS message and allows the geographical area where the CMAS warning message is valid to be signalled.
- `messageIdentifier` (2 octets): Allows differentiation of different sources and types of CMAS notifications. For Public Warning Systems (PWS), networks are only allowed to use identifiers between 4352 and 6399 inclusive.

EXAMPLE: 4370 is the CMAS Identifier for a Presidential Warning Notification.

- `dataCodingScheme` (1 octet): Signals the encoding format of the CMAS warning message.
- Sending multiple pages of a CMAS warning messages, up to a maximum of 15 pages per message.
- Providing specific content of a CMAS warning message with up to 93 characters per page if 7-bit encoding is used (the page size is 82 octets).

5.15.4 CBC operation: Mapping from CBE-CBC to E-UTRAN-Uu

The functional requirements for the Cell Broadcast Centre (CBC) are described in clause 5 of ETSI TS 123 041 [35] and shall apply when a CBC is instantiated in a 5G Broadcast Transmitter. In summary, the following functions shall be supported in order to manage the Cell Broadcast System (CBS) messages that are used to convey CAPv1.2 messages:

- Allocation of serial numbers to CBS messages.
- Initiating broadcast by sending fixed-length CBS messages to the eNodeB for each language provided by the cell, and where necessary padding the pages to a length of 82 octets.
- Deleting CBS messages held by the eNodeB.
- Determining the set of cells to which a CBS message should be broadcast, and indicating the geographical scope of each CBS message within its Serial Number.
- Determining the time at which broadcast of a CBS message should commence.
- Determining the time at which broadcast of a CBS message should cease, and subsequently instructing the eNodeB to cease broadcasting of the CBS message.
- Determining the period at which broadcast of the CBS message should be repeated.
- Allocation of "emergency indication" including the "Cell ID/Service Area ID list", "warning type" and "warning message".

In addition to these requirements, the following requirements apply to a CBC instantiated in a 5G Broadcast Transmitter:

- The CBC shall be able to receive, process and acknowledge CAPv1.2 warning messages via the CBE-CBC interface.
- The CBC shall be able to receive, process and acknowledge at least 10 CAPv1.2 warning messages via the CBE-CBC interface within a period of 30 seconds.
- The CBC shall be able to receive, process and acknowledge individual CAPv1.2 warning messages with a data volume of up to 10 MByte via the CBE-CBC interface.
- Based on the successfully verified CAP alert received from the CBE, the CBC shall generate, encode and format CMAS message for LTE/E-UTRAN, including splitting the message into multiple pages, if necessary.
- Based on the geographic information contained in the CAP message included in any of the attributes `area.polygon` or `area.circle` or `area.geocode`, a CBC shall determine the radio cells of the connected 5G Broadcast network which best cover (but exceed as little as possible) the geographical area identified in the received CAP message alert.
- The CBC shall ensure that a generated CBS message is transmitted completely and immediately in all selected radio cells within the capacity limits of the 5G Broadcast System.
- The CBC shall take from the `info.parameter = repetition_period` of a received CAP warning message the time period after which transmission of the associated CAP message in the affected radio cells is to be repeated at the latest.
- The CBC shall ensure that the CBS message associated with a received CAP warning message is repeatedly transmitted in the selected radio cells until either the number of transmissions defined in `info.parameter = broadcast_number` of the associated CAP warning message is reached or terminated by an associated CAP alert of type `Cancel` (`alert.msgType = Cancel`).
- If a CAP warning message could not be sent in full or could not be sent immediately to the mobile devices ready to receive within the capacity limits of the 5G Broadcast System, the CBC shall ensure that the complete transmission of the CBC messages that have not yet been sent contributes to the warning of the population released capacities of the 5G Broadcast System in the selected radio cells as quickly as possible, taking into account any CAP warning messages of the `update` or `cancel` type that may have been received in the meantime. The maximum transmission time shown in the associated CAP warning message shall be observed.
- The CBC shall log all CAP warning messages it receives from the CBE for audit purposes.

The detailed mapping of CAPv1.2 messages to CMAS messages in the CBC is left to implementation.

5.15.5 5G Broadcast Receiver support for Public Warning System

5.15.5.1 General UE functionality

A 5G Broadcast Receiver implementing a PWS Client shall process SIB12 messages received on the E-UTRAN Uu downlink within broadcast messages according to the recommendations in clause 8.1 of ETSI TS 123 041 [35]. A summary of PWS Client functionality is provided below:

- Discard corrupt CMAS messages received on the radio interface.
- The ability to discard CMAS information which is not in a suitable data coding scheme.
- The ability to discard a CMAS message which has a message identifier indicating that it is of subject matter which is not of interest to the PWS Client.
- The ability to detect duplicate messages as specified in clause 5.15.5.3.
- Receive CMAS warning messages of up to 9 600 octets length.
- Present CMAS warning messages as specified in clause 5.15.5.2.

The PWS Client in the 5G Broadcast Receiver provides a CMAS-capable User Interface, as defined in clause 6.2 of ETSI TS 122 268 [i.8]. Aligning with this and with the requirements in clause 6.1.1 in ETSI TS 102 900 [37], it is recommended that the 5G Broadcast Receiver allows the following preferences to be set by the end user and that the PWS Client honours these preferences:

- Alert notification volume level.
- Message display language.
- Opt-out from certain message types, opt-in for other message types, and no opt-out for highly critical messages.

NOTE: National regulatory requirements are expected to specify how different message types are handled by the PWS Client. For example, if EU-Alert requirements apply, the requirements in clause 6.1.1 of ETSI TS 102 900 [37] apply additionally.

5.15.5.2 Presentation of warning messages by PWS Client

The PWS Client in the 5G Broadcast Receiver provides a CMAS-capable User Interface, as defined in clause 6.2 of ETSI TS 122 268 [i.8]. According to clause 8.1 of ETSI TS 123 041 [35], the precise method of display of PWS warning messages is outside the scope of 3GPP specifications.

Aligning with the requirements in clauses 6.1.2 and 6.1.3 of ETSI TS 102 900 [37], the following is recommended:

- The presentation of PWS warning messages takes priority over all other 5G Broadcast Receiver functions, but does not pre-empt active MBMS User Sessions.
- The PWS Client supports a dedicated alerting indication (audio and vibration).
- PWS warning messages are displayed by the PWS Client upon reception and without any user interaction. (This assumes support for Class 0 type messages.)
- The EU-Alert message remains displayed until the message indication is cancelled by the end user (e.g. by pushing keys). The frequency and duration of the continued alerting indication is implementation-specific.
- The PWS Client supports reception of multiple warning messages that are received within short spaces of time (e.g. less than 5 seconds).
- The PWS Client is able to process a Uniform Resource Locator (URL), which is a reference (an address) to a resource on the internet, or an embedded telephone number.
- The PWS Client is not required to automatically fetch resources referenced by such a URL: user interaction is needed.

5.15.5.3 Duplication detection

For the detection and handling of duplicated messages, refer to clause 8.2 of ETSI TS 123 041 [35].

5.15.6 Scenarios for UEs receiving PWS warning messages from 5G Broadcast

Typically, it is assumed that MNO PLMNs distribute the same emergency alerts in a region where emergency alerts are also distributed through 5G Broadcast.

Nevertheless, there are different scenarios for which a UE with an integrated 5G Broadcast Receiver may receive PWS warning messages from the 5G Broadcast network and not from the MNO PLMN.

In one scenario, the UE consumes a service from a 5G Broadcast network. By this, the UE is already receiving system information and data in the broadcast carrier. In case of an emergency alert received through the CBE-CBC interface, the CBC in the 5G Broadcast network triggers a system information update, generates a CMAS notification and starts scheduling and sending SIB12 messages. The UE decodes the SIB12 messages and processes the CMAS message.

In a second scenario, the UE does not consume a service from a 5G Broadcast network but at the same time no other network than the 5G Broadcast network is available. Reasons for such a scenario may be that:

(i) the UE is in a remote area outside coverage of any regular PLMN;

(ii) due to a disaster the cellular infrastructure is not working and no regular PLMN is accessible; or

(iii) the device does not support any regular MNO PLMN, but only supports 5G Broadcast reception.

In this case, the UE is expected to process at least SIB1 and SIB12 messages received from the 5G Broadcast network and to monitor paging and/or SIB1 to detect scheduling of SIB12 messages containing CMAS warning messages.

5.15.7 Emergency media services delivered via 5G Broadcast

Special purpose radio or TV services may be provisioned as 5G Broadcast User Services in emergency situations using the service establishment procedures defined in clause 5.3. Service announcement for such 5G Broadcast User Services may be transmitted by the 5G Broadcast Transmitter on a regular basis. However, in order to support the announcement of 5G Broadcast User Services as part of CMAS warning messages, the textual description of the CMAS messages may include a link to the emergency media service. This is in alignment with the requirement in ETSI TS 122 268 [i.8] that a CMAS-capable User Interface (UI) is expected "...to support the ability (e.g. a "click" touch input) for the user to navigate to the URL or initiate a voice call to the phone number which may be included in the Warning Notification".

In order to support URL-based announcement of emergency media services, the MBMS-URL as introduced in clause 5.5.5 may be added to a CMAS text message.

The definition of an HTTP URL for the purpose of launching an emergency media service is for further study.

Such a URL pointing to a media emergency service may not only be included in the 5G Broadcast network CMAS warning message but may also be included in CMAS warning messages transmitted by an MNO PLMN.

6 Transmitter requirements for LTE-based 5G Broadcast

6.1 Introduction

This clause provides requirements for the transmitter of an LTE-based 5G Broadcast System as defined in clause 5. This function is referred to as 5G Broadcast Transmitter.

6.2 Broadcast-Multicast Service Centre (BM-SC)

The 5G Broadcast Transmitter shall include a BM-SC function with the following functions:

- Northbound Application Programming Interface (API) for Multimedia Broadcast/Multicast Service (MBMS) at the xMB reference point are defined in ETSI TS 126 348 [10] with the constraints described in clause 5.5.2.
- MBMS User Service Interface with the constraints described in clause 5.5.3.
- The EPS MBMS Procedures defined in clause 5.6.

6.3 MBMS GW

The 5G Broadcast Transmitter shall include an MBMS GW function. The functions of an MBMS GW in the 5G Broadcast System are specified in ETSI TS 123 246 [5].

6.4 E-UTRAN

6.4.1 General

The 5G Broadcast Transmitter shall include an eNodeB function with all functionalities defined in the rest of this clause 6.4.

6.4.2 MBMS-dedicated cells

The E-UTRAN part of a 5G Broadcast Transmitter shall consist of MBMS-dedicated cells only, as defined in ETSI TS 136 300 [18].

According to [18], MBMS-dedicated cells support strictly (downlink) MBMS transmission and do not support uplink transmission. MBSFN subframes of a MBMS-dedicated cell do not have a control region and can therefore be one hundred percent allocated to MBMS use. Non-MBSFN subframes of a MBMS-dedicated cell, also called Cell Acquisition Subframes (CAS), have the control region and are used for transmission of:

- system acquisition signals (PSS/SSS);
- PDCCH; and
- system information on PBCH and PDSCH.

CAS shall be transmitted with periodicity of 40 ms and shall use subframes with Δf = 15 kHz configured with either a normal or extended Cyclic Prefix (CP). The PBCH of an MBMS-dedicated cell shall use a different scrambling sequence initialization than the PBCH of a non-MBMS-dedicated cell, which prevents UEs that do not support MBMS-dedicated cells from camping on it.

6.4.3 Architecture, protocol stack and E-UTRAN interfaces

The E-UTRAN architecture of a 5G Broadcast System shall adhere to the MBMS architecture in ETSI TS 136 300 [18], clause 15.1.1.

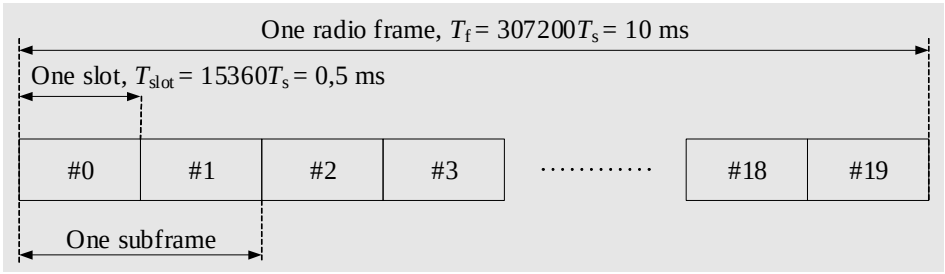
The E-UTRAN user plane and control plane protocol stacks architecture shall adhere to the description in ETSI TS 136 300 [18], clause 15.1.2 and clause 15.1.3, respectively.

The E-UTRAN interfaces shall adhere to the description in ETSI TS 136 300 [18], clause 15.1.1 and in ETSI TS 136 440 [22], except that the MBMS Service Counting procedure may not be supported by the eNodeB.

6.4.4 Frame structure and numerologies

The following applies on frame structures and numerologies:

- Only frame structure type 1 shall be used.
- All numerologies specified in ETSI TS 136 211 [16] shall be supported. For subframes using Df other than 0,370 kHz, the frame structure shall be according to figure 6.4.4-1. For transmissions using Df = 0,370 kHz, the frame structure is shown in figure 6.4.4-2.
- Physical resource elements and physical resource blocks shall be supported as specified in ETSI TS 136 211 [16], clauses 6.2 and 6.3.



NOTE: The CAS is a non-MBSFN subframe, and is configured with 15 kHz subcarrier spacing.

Figure 6.4.4-1: Frame structure type 1 for subframes not using Δf = 0,37 kHz

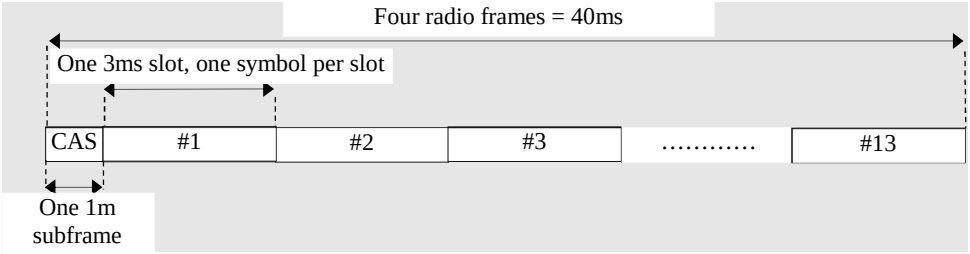


Figure 6.4.4-2: Frame structure type 1 for transmissions using Δf = 0,37 kHz

Table 6.4.4-1 summarizes the supported numerologies for MBMS transmission over PMCH. The theoretical equalization interval is obtained as the maximum channel delay spread that can be estimated from the pilot pattern, and is equal to the Symbol duration (excluding CP) divided by the frequency separation (in number of subcarriers) between two consecutive pilot tones.

Table 6.4.4-1: Summary of supported numerologies for MBMS transmission over PMCH

Subcarrier spacing	Symbol duration (excluding Cyclic Prefix)	Cyclic Prefix length	Time separation between pilots in the same subcarrier, in number of OFDM symbols	Frequency separation between pilots, in number of subcarriers (after de-stagger)
15 kHz	66,6 µs	16,6 µs	8 (see note)	1
7,5 kHz	133,3 µs	33,3 µs	4 (see note)	2
2,5 kHz	400 µs	100 µs	2	2
1,25 kHz	800 µs	200 µs	2	3
0,37 kHz	2 700 µs	300 µs	2 or 4	3
NOTE: For 15 kHz and 7,5 kHz subcarrier spacings, this denotes the separation within one subframe of one of the staggers. See ETSI TS 136 211 [16], figures 6.10.2.2-1 and 6.10.2.2-3.				

6.4.5 MBMS transmission

MBMS transmission shall be performed according to ETSI TS 136 300 [18], clause 15.3.3.

MCCH configuration and scheduling shall be performed according to [18], clause 15.3.5 and ETSI TS 136 331 [21], clause 5.8.1, except that the MBMS Service Counting procedure is not supported.

MCCH information acquisition shall be performed according to ETSI TS 136 300 [18], clause 15.3.5 and ETSI TS 136 331 [21], clause 5.8.2 except that only RRC_IDLE is supported.

6.4.6 Physical channels and signals

The E-UTRAN shall support downlink physical channels only. The general structure of downlink physical channels is specified in ETSI TS 136 211 [16]. Only the following physical channels are supported according to [16]:

- PMCH;
- PDSCH;

- PBCH;
- PCFICH;
- PDCCH;
- CRS;
- MBSFN-RS;
- PSS; and
- SSS.

NOTE: Based on 3GPP Release 17 specifications, enhancements to physical channels including PBCH repetition, CFI indication in MIB and PDCCH AL16 are inherently supported.

6.4.7 MAC layer

The MAC layer signal shall be compatible with the 5G Broadcast Receiver requirements as defined in clause 7.3.4.

6.4.8 RLC layer

The BCCH shall use the RLC-TM mode.

MTCH and MCCH shall use the RLC-UM mode.

RLC operation for MTCH and MCCH shall be used as described in ETSI TS 136 300 [18], clause 15.3.3.

6.4.9 RRC layer

The RRC layer shall be compatible with a 5G Broadcast Receiver requirements as defined in clause 7.3.6.

6.5 System Information

A 5G Broadcast Transmitter shall implement System Information (SI) as specified in ETSI TS 136 321 [20], clause 5.2.

In an MBMS-dedicated cell, non-MBSFN subframes are used for providing *MasterInformationBlock-MBMS* (MIB-MBMS) and *SystemInformationBlockType1-MBMS*. SIBs other than *SystemInformationBlockType1-MBMS* are carried in *SystemInformation-MBMS* message which is also provided on non-MBSFN subframes. SI-RNTI, with value in accordance with ETSI TS 136 321 [20], is used to address all SI messages whereas SI-RNTI with value in accordance with ETSI TS 136 321 [20] is used to address *SystemInformationBlockType1-MBMS*.

MIB-MBMS and SIB1-MBMS are repeated across four consecutive CAS with a periodicity of 160 ms. It is also possible to schedule SIB1-MBMS in additional non-MBSFN subframes according to MIB-MBMS. SIBs other than SIB1 are carried in SI messages whose mapping is configurable by SIB1.

For blind decoding of the MIB, two DCI formats are relevant. A common search space is used for MBMS-dedicated cells. DCI format 1A is used on UEs configured with transmission mode 9 or 10 and its CRC is scrambled with an SI-RNTI (System Information RNTI). SI-RNTI value 0xFFFF may be used for an MBMS-dedicated carrier. SI-RNTI value 0xFFF9 is only used for MBMS-dedicated carrier.

DCI format 1C CRC is scrambled by an M-RNTI (Multicast RNTI) to receive MCCH, System Information change notification and direct indication information. The direct indication field is only provided in an MBMS-dedicated cell or in an FeMBMS/Unicast-mixed cell with a number of Resource Blocks larger than 15. Note that MCS index information is only provided by higher layers when using DCI format 1C.

SIB1-MBMS (*SystemInformationBlockType1-MBMS*) contains information relevant for receiving MBMS services and defines the scheduling of other system information blocks on an MBMS-dedicated cell.

SIB2 informs the UE on the subframes reserved for MBSFN. Additionally, SIB13 provides information about the subframes that carry MCCH of each MBSFN area, and the MCS. SIB13 is optional in an MBMS-dedicated cell.

SIB15 includes the mapping between MBMS Service Area Identifiers (SAI) and the corresponding frequencies of the 5G Broadcast Service on neighbouring 5G Broadcast Transmitters. If the same 5G Broadcast Service is offered on different frequencies in different service areas, the relevant mappings should be present in the SIB15 messages. The information included in SIB15 may be used by UEs capable of MBMS service continuity can use SIB15 to discover the frequency of one or more MBMS SAIs associated with a given service. For more details refer to clause 7.3.4.

SIB12 messages may be sent to support CMAS warning messages as specified in clause 5.15.3.3.

The MCCH information change notifications on PDCCH are transmitted periodically on non-MBSFN subframes. These MCCH information change notification occasions are common for all MCCHs that are configured, and are configurable by parameters included in *SystemInformationBlockType13*: a repetition coefficient, a radio frame offset and a subframe index.

6.6 Cell Broadcast Centre and MME for Public Warning System

The 5G Broadcast Transmitter may include a Cell Broadcast Centre (CBC) for Public Warning System services. In this case, the 5G Broadcast transmitter shall:

- Support a CBE-CBC interface according to the requirements specified in clause 5.15.3.2.
- Generate emergency alerts and public warning messages as specified in clause 5.15.3.3.
- Operate according to the requirements in clause 5.15.4.

7 Receiver Requirements for LTE-based 5G Broadcast

7.1 Introduction

This clause provides requirements for the receiver of an LTE-based 5G Broadcast System as introduced in clause 5. This function is referred to as 5G Broadcast Receiver.

7.2 General

A 5G Broadcast Receiver shall support Receive-Only Mode (ROM) device functionalities with further constraints defined in this clause.

As examples, ROM devices support MBMS transmission but do not support uplink transmission. ROM devices may not have USIM. As such, ROM devices do not support two-way signalling procedures with the network, including connection establishment procedures and security procedures. ROM devices only support the idle mode. Not all idle mode procedures need to be supported, as described in clause 7.3.3.

For more details on ROM devices see clause 7.3 in the present document, ETSI TS 136 300 [18], clause 15.11, ETSI TS 123 246 [5], annex D and ETSI TS 124 116 [6], clause 4.

As a matter of implementation, a traditional UE, including a UE supporting FeMBMS/Unicast-mixed cells according to ETSI TS 136 300 [18], can be configured to operate as a ROM device. The means for such configuration are outside of the scope of the present document.

As a matter of implementation, a cellular device can host a ROM device and a traditional UE capable of unicast. Such device is further described in ETSI TS 123 246 [5], annex E and called a *ROM device with independent unicast*. The co-hosted UE is connected to a different cell from the MBMS-dedicated cell serving the co-hosted ROM device. If the co-hosted UE and ROM device share baseband resources, the co-hosted UE can use the *MBMSInterestIndication* signalling procedure specified in ETSI TS 136 331 [21] to inform the serving RAN about the baseband resources occupied by the co-hosted ROM device and therefore not available for unicast.

There may be awareness at the application layer of a ROM device with independent unicast. How this awareness is created is outside of the scope of specifications.

Additional receiver requirements beyond the ROM device requirements are documented in this clause.

7.3 Access Stratum

7.3.1 General

Since a ROM device does not support uplink transmission or two-way signalling procedures, and does not include a USIM, it cannot and does not need to support all the physical layer procedures of a conventional UE. By the same token, only a subset of idle mode procedures and RRM requirements applicable to a conventional UE are required to be supported.

The remainder of clause 7.3 provides the requirements of the physical layer and idle mode procedures and the RRM requirements applicable to a ROM device, and hence for a 5G Broadcast Receiver. It also includes further constraints that apply to a 5G Broadcast Receiver.

7.3.2 Physical layer procedures

A 5G Broadcast Receiver shall support the following physical layer procedures specified in ETSI TS 136 213 [17]:

- Cell search;
- Timing synchronization;
- PDSCH procedures;
- PDCCH assignment procedure; and
- PMCH procedures.

The system shall be bootstrapped with the Cell Acquisition Subframe (CAS) transmitted using a legacy channel bandwidth of 15 or 25 PRBs (corresponding to 3 and 5 MHz respectively). System acquisition signals PSS/SSS and physical channels PBCH, PDCCH and PDSCH are received within this bandwidth.

The System Information Blocks (SIBs) may include signalling for the PMCH bandwidth, which may be indicated to be larger than the carrier bandwidth according to ETSI TS 136 443 [27]. Additional PMCH bandwidths of 30, 35 and 40 PRBs (corresponding to 6/7/8 MHz) are specified according to ETSI TS 136 300 [18] and shall be supported by the receiver. The physical layer procedures related to the larger bandwidths (Transport Block Size determination, tone mapping, etc.) as specified in ETSI TS 136 211 [16] and ETSI TS 136 213 [17] shall be supported. The UE capabilities indicating support for at least one of the three 6, 7, or 8 MHz PMCH bandwidths as specified in ETSI TS 136 306 [26] and ETSI TS 136 331 [21] shall be supported. The UE should support all three 6, 7, and 8 MHz PMCH bandwidths.

Details on the determination of the modulation order (Q_m) and Transport Block Size (TBS) based on the MCS index and sub-carrier spacing for the PMCH can be found in clause 11.1 of ETSI TS 136 213 [17]. More details on the LTE-based 5G Broadcast physical layer capacity are provided in clause 11.3.1.

7.3.3 Idle mode procedures

A 5G Broadcast Receiver shall support the following idle mode procedures specified in ETSI TS 136 304 [19]:

- Cell selection; and
- Cell reselection.

PLMN prioritization for cell reselection as specified in ETSI TS 136 304 [19], clause 5.2.4.1 shall be supported with the following exception:

- NAS layer PLMN selection does not apply to ROM devices.

PLMN selection 5G Broadcast Receiver as specified in ETSI TS 124 116 [6] for ROM devices is required to be supported.

NOTE: ROM devices do not support Discontinuous Reception (DRX).

7.3.4 MAC layer

The MAC layer of a 5G Broadcast Receiver shall support:

- BCH reception for BCCH;
- DL-SCH reception for BCCH; and
- MCH reception for MCCH/MTCH.

BCH reception and DL-SCH reception in the MAC layer of a 5G Broadcast Receiver shall use transparent MAC according to ETSI TS 136 321 [20], i.e. single a MAC PDU per TTI with no headers. The HARQ entity uses the dedicated broadcast HARQ process, defined in ETSI TS 136 321 [20].

MCH reception in the MAC layer of a 5G Broadcast Receiver is specified in ETSI TS 136 321 [20], clause 5.12 and in ETSI TS 136 300 [18], clause 15.3.3.

In case of IDLE mode (i.e. in the absence of an active unicast session between a UE and a base station, as is the case for Receive-Only Mode operation of LTE-based 5G Broadcast), service continuity is the sole responsibility of the 5G Broadcast Receiver which shall implement the procedures for cell (re)selection with MBMS prioritization defined in clauses 4.1 and 5.2 of ETSI TS 136 304 [19]. These procedures describe:

- Measuring the Reference Signal Received Power (RSRP) of the downlink to assess reception quality from the current serving cell.
- Using information signalled in SIB15 to identify neighbouring cells with potentially better reception quality.
- Switching to a different cell when the quality of reception from the serving cell falls below a threshold, as specified in clause 5.2.4 of ETSI TS 136 304 [19].

7.3.5 RLC layer

For the RLC layer of the 5G Broadcast Receiver the following applies:

- The BCCH shall support the RLC-TM mode.
- RLC operation for MTCH and MCCH shall be used as described in ETSI TS 136 300 [18], clause 15.3.3.

7.3.6 RRC layer

The RRC layer of the 5G Broadcast Receiver shall support:

- System Information reception including SIB and MIB (see ETSI TS 136 331 [21], clause 5.2) in an MBMS-dedicated cell; and
- MBMS reception (see ETSI TS 136 331 [21], clause 5.8) in an MBMS-dedicated cell.

For System Information reception, the following shall apply:

- only the message classes BCCH-BCH-Message-MBMS and BCCH-DL-SCH-Message-MBMS shall be supported;
- acquisition of System Information messages is performed according to ETSI TS 136 331 [21], clause 5.2.3b.

For MBMS reception, the following applies:

- MBMS Service Counting procedure and MBMS interest indication procedure may not be supported.

7.3.7 RRM requirements

5G Broadcast Receivers shall support the following requirements specified in ETSI TS 136 133 [15]:

- Cell selection; and
- Cell reselection, except for:
  - IRAT reselection;
  - paging-related requirements; and
  - CSG cell-related requirements.

7.3.8 Demodulation requirements

5G Broadcast Receivers shall support, for the supported features, the demodulation requirements in ETSI TS 136 101 [14], clauses 10.3.3 and 10.4.

In particular, this includes:

- Minimum performance requirements for MBMS-dedicated cells.
- Support for dual antenna reception for numerologies other than 0,37 kHz SCS.

7.4 MBMS Client

An MBMS Client for a 5G Broadcast Receiver shall support UE behaviour in Receive-Only Mode as defined in annex E of ETSI TS 123 246 [5].

A 5G Broadcast Receiver shall support:

- MBMS User Services with the constraints from clause 5.5.3.
- The MBMS-APIs with the constraints from clause 5.5.5.
- The discovery of 5G Broadcast Services according to clause 5.12.

In addition, an MBMS Client should support the simultaneous reception of multiple 5G Broadcast Services transmitted on the same carrier frequency.

NOTE: This requires the 5G Broadcast Receiver to be able to simultaneously demultiplex multiple TMGIs on the radio/access layer as well as requiring the MBMS Client to be able to simultaneously decode several MBMS User Services.

A 5G Broadcast Receiver should support simultaneous reception of at least four MBMS User Services on the same carrier with different TMGIs.

7.5 Codec and format requirements

In order to provide consistency for media consumption, a 5G Broadcast Receiver should support the 5GMS Television (TV) profile as defined in clause 5.4 of ETSI TS 126 511 [30]. The 5GMS TV Profile includes, among others:

- Requirements and recommendations on audio and video codecs, as well as subtitling.
- Requirements and recommendations on encapsulation and transport formats, as well as associated playback requirements.
- Requirements and recommendations on support for encrypted and conditionally accessed content.
- Requirements and recommendations on capability discovery.

7.6 Public Warning System support

A 5G Broadcast Receiver should support receiver functionalities for emergency alerts and public warnings as specified in clause 5.15.5.

5G Broadcast Receivers that are unable to access system information from any network other than the 5G Broadcast network should monitor the 5G Broadcast network for CMAS warning messages.

More detailed implementation guidelines are provided in clauses 12.5 and 12.6.

8 Spectrum and Frequency Bands (informative)

The supported bandwidth for LTE-based 5G Broadcast in units of MHz are 1,4; 3; 5; 6; 7; 8; 10; 15 and 20.

No additional spectrum or frequency band configurations are considered in this version of the present document.

NOTE: At the time of completion of the present document, 3GPP has ongoing work to support specific frequency bands. Details are expected in a future revision of the present document.

9 5G Media Streaming and hybrid unicast–broadcast services

9.1 General (informative)

5G Broadcast Services impose no requirements on the support of a unicast connection. However, a UE may choose to support unicast in addition to 5G Broadcast Services. As one example of such an architecture, a UE may include an independent unicast modem and stack as illustrated in ETSI TS 123 246 [5], figure E-1. The figure is adjusted in figure 9.1-1 below indicating that unicast may, for example, be served by 4G or 5G unicast technologies.

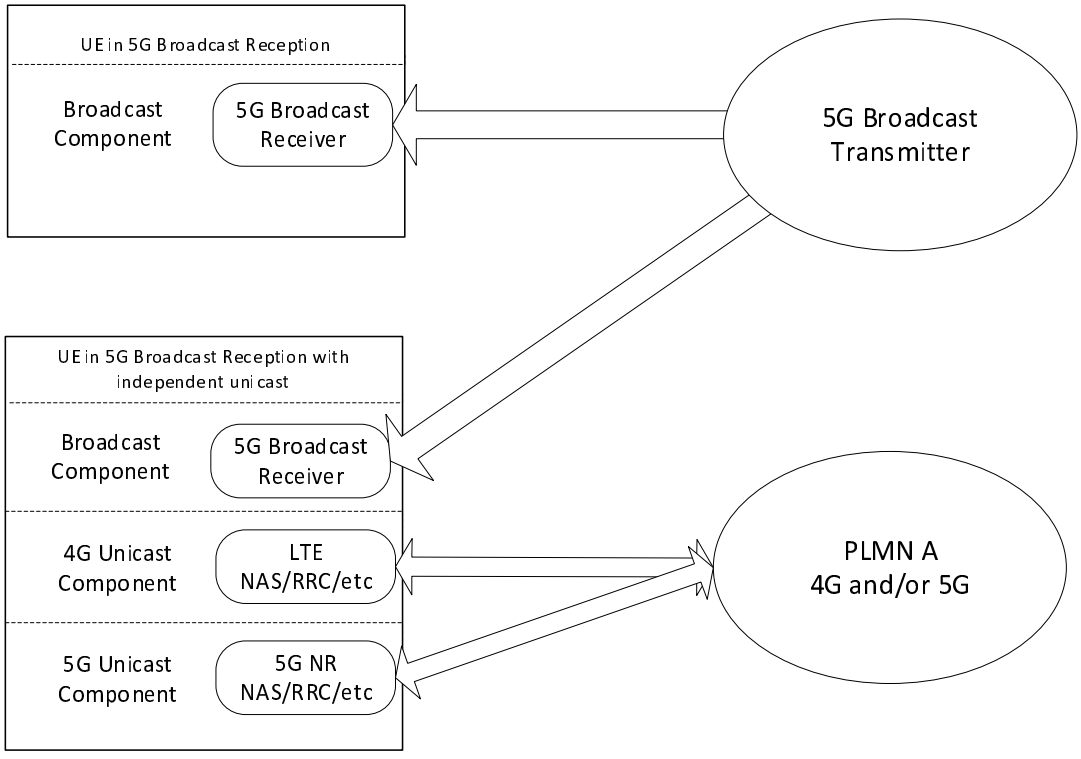


Figure 9.1-1: UE components in 5G Broadcast Reception Mode only and in 5G Broadcast Reception Mode with independent unicast

9.2 Hybrid 5G Broadcast operation (informative)

The 5G Broadcast TV/Radio service content provider may provider a richer and more advanced application service to a UE that also supports unicast. This is shown in figure 9.2-1.

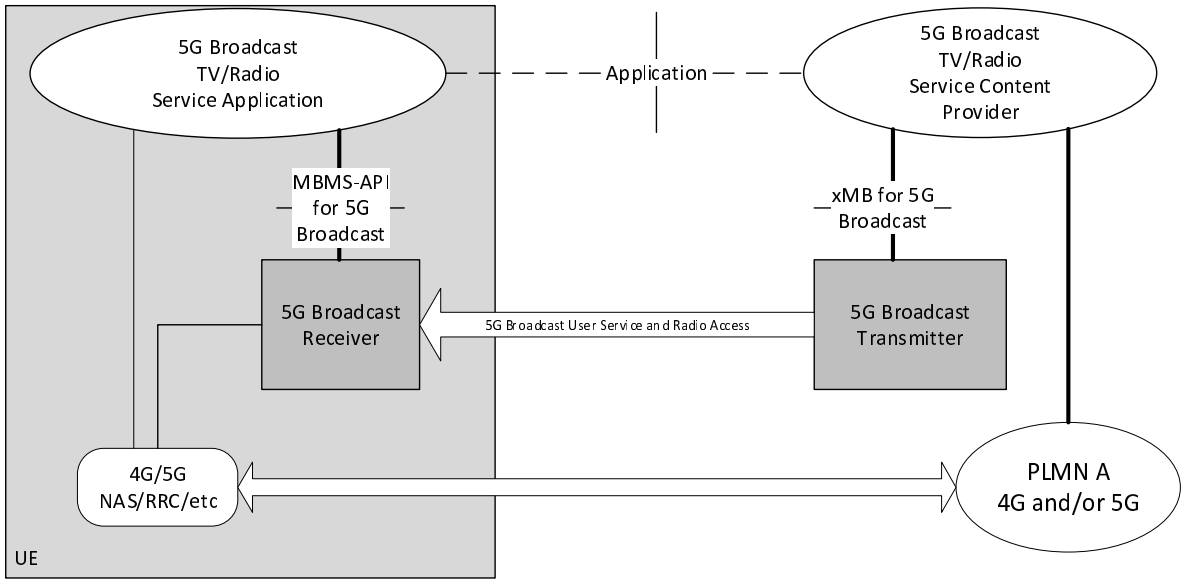


Figure 9.2-1: Application service using both 5G Broadcast and unicast

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 ETSI TS 126 348 [10]. 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).

9.3 5GMS via LTE-based 5G Broadcast

9.3.1 Overview

The 5G Media Streaming (5GMS) architecture defined in ETSI TS 126 501 [29] may be deployed on top of LTE-based 5G Broadcast using MBMS User Services as defined in ETSI TS 126 501 [29], clauses 4.6 and 5.10. This arrangement allows 5GMS-based downlink media streaming to be deployed as an MBMS-Aware Application on top of eMBMS as defined in ETSI TS 123 246 [5], ETSI TS 126 346 [8], ETSI TS 126 347 [9] and ETSI TS 126 348 [10]. In the context of the present document, it allows 5GMS-based downlink media streaming to be deployed as a 5G Broadcast TV/Radio Service Application on top of LTE-based 5G Broadcast.

Based on the architecture in ETSI TS 126 501 [29], clause 4.6 for 5G Media Streaming over eMBMS, figure 9.3.1-1 of the present document provides an instantiation of the architecture in ETSI TS 126 501 [29], clause 4.6 with LTE-Based 5G Broadcast as well as an extension to the architecture for 5G Broadcast as defined in clause 5 of the present document, for which 5G Media Streaming is a 5G Broadcast TV/Radio Service Application.

The modular architecture shown in figure 9.3.1-1 allows different collaboration models between content providers, broadcast network operators and mobile network operators. For more background, refer to annex C of ETSI TS 126 501 [29].

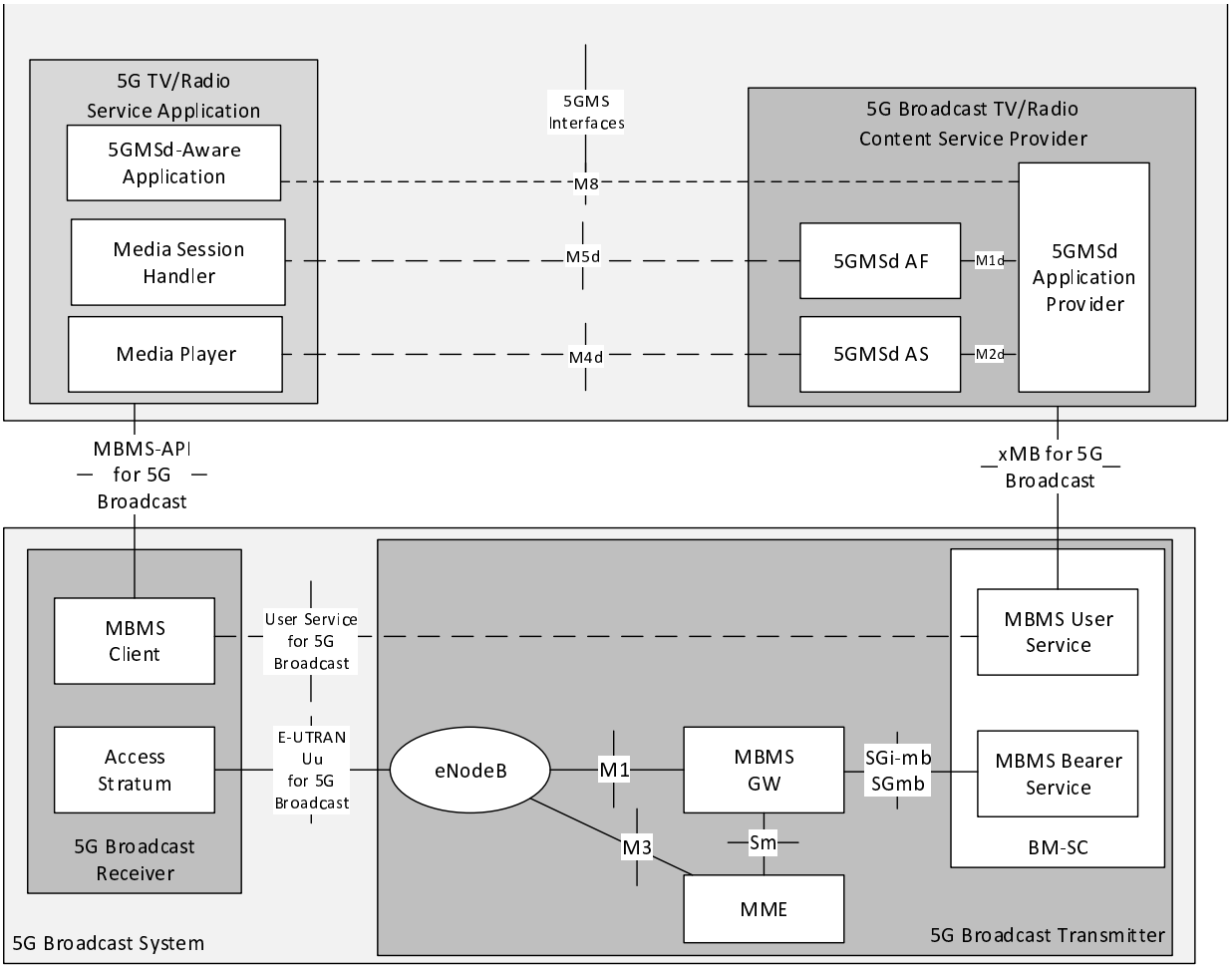


Figure 9.3.1-1: Harmonized architecture for 5G Media Streaming over LTE-based 5G Broadcast

9.3.2 Procedures

Based on the architecture described in clause 9.3.1, the procedures defined in ETSI TS 126 501 [29], clause 5.10 shall be re-used in the context of 5G Broadcast in particular to support the following scenarios:

- 5GMS content delivered exclusively via 5G Broadcast based on the procedures in ETSI TS 126 501 [29], clause 5.10.2. In this case, 5GMS media data is exclusively delivered via LTE-based 5G Broadcast, i.e. media content is not delivered via the 5GMS unicast reference point M4d, but only via 5G Broadcast User Services. The 5GMSd Client acts as an MBMS-Aware Application.

- 5GMS Consumption Reporting procedures for 5G Broadcast based on the procedures in ETSI TS 126 501 [29], clause 5.10.3. In this case, 5GMS consumption reporting is used to report consumption of 5GMSd content via a 5G Broadcast service.

- 5GMS Metrics Reporting procedures for 5G Broadcast based on the procedures in ETSI TS 126 501 [29], clause 5.10.4. In this case, 5GMS metrics reporting is used to report 5GMS and eMBMS metrics to the 5GMSd AF.

- A collection of hybrid services referring to the case for which a basic service is made available at the same time via both 5G Broadcast and unicast based on the procedures in ETSI TS 126 501 [29], clause 5.10.5. The service delivered via unicast may be richer and/or extended compared with that delivered via 5G Broadcast and may provide additional user experiences. For the hybrid use cases, the content is statically provisioned on 5G Broadcast and unicast as appropriate. Procedures presented for hybrid use cases in ETSI TS 126 501 [29], clause 5.10.5 include interactive services, session continuity, time-shifted viewing, and content or component replacement.

- Procedures for dynamic provisioning of 5GMS content delivery via 5G Broadcast based on the procedures in ETSI TS 126 501 [29], clause 5.10.6. In this case, 5G Broadcast-based distribution may, for example, be used only for services in high demand, and the resources and quality of the service distributed through broadcast may be adjusted according to demand. Demand may be identified through 5GMS Consumption Reporting.

The protocols to support 5G Media Streaming in combination with 5G Broadcast are specified in ETSI TS 126 512 [31]. For more details refer to clause 9.3.3.

The codecs and formats to support 5G Media Streaming in combination with 5G Broadcast are specified in ETSI TS 126 511 [30]. For more details refer to clause 9.3.4.

Extended service signalling to support the 5G Media Streaming via 5G Broadcast is described in clause 9.3.5.

9.3.3 Protocols

In order to support 5G Media Streaming via 5G Broadcast and the scenarios and procedures described in clause 9.3.2, a system implementing 5G Media Streaming over LTE-based 5G Broadcast shall support the following protocols based on ETSI TS 126 501 [29], clause 4.6.2 and clause 4.6.3, as well ETSI TS 126 512 [31], clause 4.2, for 5GMS via eMBMS, content hosting, metrics reporting and consumption reporting, depending on whether the reference point is part of the deployment and collaboration model:

- At reference point M1d:
  - The Provisioning Sessions API as specified in ETSI TS 126 512 [31], clause 7.2.
  - The Server Certificates Provisioning API in ETSI TS 126 512 [31], clause 7.3.
  - The Content Preparation Templates Provisioning API in ETSI TS 126 512 [31], clause 7.4.
  - The Content Hosting Provisioning API in ETSI TS 126 512 [31], clause 7.6.
  - The Consumption Reporting Provisioning API as specified in ETSI TS 126 512 [31], clause 7.7.
  - The Metrics Reporting Provisioning API as specified in ETSI TS 126 512 [31], clause 7.8.
- At reference point M2d:
  - the HTTP-pull based content ingest protocol as specified in ETSI TS 126 512 [31], clause 8.2.

Use of the following protocols depends on the presence of a unicast connection as described in clause 9.1:

- At reference point M4d:
  - DASH or HLS adaptive streaming as specified in ETSI TS 126 512 [31], clause 10.
- At reference point M5d:
  - The Service Access Information API as specified in ETSI TS 126 512 [31], clause 11.2.
  - The Consumption Reporting API as specified in ETSI TS 126 512 [31], clause 11.3.
  - The Metrics Reporting API as specified in ETSI TS 126 512 [31], clause 11.4.

9.3.4 5GMS profiles, codecs and formats

In order to support 5G Media Streaming via 5G Broadcast and the scenarios and procedures defined in clause 9.3.2, a system shall support the Television (TV) profile as specified in ETSI TS 126 511 [30], clause 5.4.

9.3.5 MBMS User Service signalling

In order to signal that the application service conforms to 5G Media Streaming formats, the 5G Broadcast Transmitter should signal the MBMS features to the 5G Broadcast Receiver as specified in clause 11.9 of ETSI TS 126 346 [8], indicating that the service is a 5GMSd service (i.e. using the feature value 29).

9.3.6 Receiver requirements

A 5G Broadcast Receiver supporting 5GMS via 5G Broadcast shall support:

- The procedures in clause 9.3.2.
- The protocols and reference points in clause 9.3.3.
- The 5GMS profiles, codecs and formats in clause 9.3.4.
- The reception of services with MBMS feature value 29 as introduced in clause 9.3.5.

10 5G Broadcast Receiver Categories

10.1 Introduction

The present document defines receiver categories in order to support various deployment scenarios.

MBMS features as defined in ETSI TS 126 346 [8] enable the BM-SC to signal to the UE the set of capabilities that are required for the consumption of the MBMS user service.

The MBMS features with the respective MBMS Feature Values and service capabilities are documented in table 10.1-1 and defined in the remainder of this clause 10.

Table 10.1-1: MBMS Feature Values for 5G Broadcast Receiver Categories

MBMS Feature Value	Service Capability	Clause
27	Service that can be received by an LTE-based 5G Broadcast Base Receiver.	10.2
28	Service that can be received by an LTE-based 5G Broadcast Main Receiver.	10.3
30	Service that can be received by a 5GMS via LTE-based 5G Broadcast Receiver	10.4

10.2 LTE-based 5G Broadcast Base Receiver

Devices implementing the LTE-based 5G Broadcast Base Receiver shall support:

- All requirements in clause 7 for an LTE-based 5G Broadcast Receiver.
- The reception of signals with sub-carrier spacing of 1,25 kHz. Other sub-carrier spacings from table 6.4.4-1 may also be supported.

The requirements for the support of LTE-based 5G Broadcast Base Receiver functionalities may be signalled with the service capability code according to table 10.1-1.

10.3 LTE-based 5G Broadcast Main Receiver

Devices implementing the LTE-based 5G Broadcast Main Receiver category shall support:

- All requirements in clause 7 for an LTE-based 5G Broadcast Receiver.
- The reception of signals with all the sub-carrier spacings defined in table 6.4.4-1.

The requirements for the support of LTE-based 5G Broadcast Main Receiver functionalities may be signalled with the service capability code according to table 10.1-1.

10.4 5GMS via LTE-based 5G Broadcast Receiver

Devices implementing the 5GMS via LTE-based 5G Broadcast Receiver category shall support:

- All requirements in clause 7 for an LTE-based 5G Broadcast Receiver.
- All requirements in clause 9.3.5 for a 5GMS via 5G Broadcast Receiver.

The requirements for the support of LTE-based 5G Broadcast Main Receiver functionalities may be signalled with the service capability code according to table 10.1-1.

10.5 LTE-based 5G Broadcast Emergency Alerts Receiver

Devices implementing the LTE-based 5G Broadcast Emergency Alerts Receiver shall support:

- The requirements in clause 7 for an LTE-based 5G Broadcast Receiver to at least receive system acquisition signals PSS/SSS and physical channels PBCH, PDCCH and PDSCH.
- All requirements in clause 7.6.

More detailed implementation guidelines are provided in clauses 12.5 and 12.6.

11 Implementation Guidelines for 5G Broadcast Transmitters (informative)

11.1 Introduction

This clause provides selected implementation guidelines for 5G Broadcast Transmitters.

11.2 BM-SC, MME and MBMS GW

As BM-SC, MME and MBMS GW functionalities are significantly down-scoped by the present document, the functionalities may be provided in a single physical entity.

11.3 E-UTRAN

11.3.1 Examples of capacity for the physical layer

Tables 11.3.1-1 and 11.3.1-2 show the physical layer capacity for the supported numerologies for MBMS transmission over PMCH as summarized in table 6.4.4-1 for a bandwidth of 8 MHz (PMCH bandwidth of 40 PRBs). For both table 11.3.1-1 and table 11.3.1-2, it is assumed that the UE is configured by higher layers to decode the PMCH based on QPSK, 16QAM, 64QAM and 256QAM. The capacities in table 11.3.1-1 and table 11.3.1-2 include a capacity loss of 2,5 % due to the transmission of the Cell Acquisition Subframe (CAS).

The 0,37 kHz numerology supports two types of MBSFN-RS patterns, both with the same theoretical equalization interval (see clause 6.4.4), with a time separation between pilots in the same subcarrier (in number of OFDM symbols) equal to 2 (type 2) and 4 (type 1). The MBSFN-RS pattern type 2 provides better mobility than MBSFN-RS pattern type 1 at the expense of a higher overhead due to a denser MBSFN-RS pattern. For table 11.3.1-2, MBSFN-RS pattern type 1 is assumed.

Table 3 (columns 1 to 6) and table 4 in [i.10] provide numerical evaluations of LTE-based 5G Broadcast physical layer capacity for numerologies 2,5 kHz, 1,25 kHz, and 0,37 kHz in representative channel models of Single Frequency Network operation within a 10 MHz channel bandwidth.

Table 11.3.1-1: Physical layer capacity for subcarrier spacings 15 kHz, 7,5 kHz, 2,5 kHz, and 1,25 kHz with bandwidth of 8 MHz (40 PRBs)

MCS	Modulation	Throughput (Mbps)
0	QPSK	1,07
1		1,76
2		2,78
3		4,03
4		5,41
5	16QAM	6,79
6		7,79
7		8,92
8		10,04
9		11,16
10		11,91
11	64QAM	12,64
12		14,32
13		15,44
14		16,57
15		17,88
16		19,35
17		20,85
18		22,35
19		23,88
20	256QAM	24,82
21		25,76
22		27,63
23		28,56
24		30,91
25		32,03
26		33,16

Table 11.3.1-2: Physical layer capacity for subcarrier spacing 0,37 kHz, with bandwidth of 8 MHz (40 PRBs), and time separation between pilots in the same subcarrier of 4 OFDM symbols (MBSFN-RS pattern type 1)

MCS	Modulation	Throughput (Mbps)
0	QPSK	1,05
1		1,74
2		2,76
3		4,09
4		5,34
5		6,70
6	16QAM	7,70
7		8,90
8		9,94
9		11,05
10		11,93
11		12,75
12		14,24
13		15,24
14		16,58
15	64QAM	17,89
16		19,26
17		20,73
18		22,36
19		23,96
20		24,77
21	256QAM	25,58
22		27,55
23		28,58
24		30,49
25		31,82
26		33,10

12 Implementation guidelines for 5G Broadcast Receivers (informative)

12.1 Introduction

This clause provides selected implementation guidelines for 5G Broadcast Receivers.

12.2 UE Access Stratum

12.2.1 Idle mode measurements

Requirements for measurements in idle mode in ETSI TS 136 133 [15] are expressed in terms of DRX cycle length. A ROM device does not support the DRX cycle and E-UTRAN in the 5G Broadcast System does not support it.

Therefore, it is not to be expected that the E-UTRAN will broadcast the DRX cycle length in the System Information. As a result, the requirements for measurements in idle mode in ETSI TS 136 133 [15] are not implementable.

If the E-UTRAN does not broadcast the DRX cycle length in the System Information, the UE uses an implementation-specific DRX cycle value.

NOTE: It is for further study if the set of one or more values from which the UE selects the implementation-specific DRX cycle length needs to be specified.

12.2.2 Idle mode states

Neither the 5G Broadcast System nor ROM devices support paging. Therefore, idle mode states described in the cell selection and re-selection procedure in ETSI TS 136 304 [19] are not applicable in the form in which they are specified. In particular, the *Camped Normally* state and the *Camped on Any Cell* state mandate that the UE monitors paging channels.

A ROM device in *Camped Normally* state or *Camped on Any Cell* state in a 5G Broadcast System need not monitor paging channels.

12.2.3 Cell categories and service types

Cell categories specified in ETSI TS 136 304 [19] are not applicable to ROM devices as described. Specifically, a suitable cell has the following requirement: "*The cell is a part of at least one TA that is not part of the list of 'forbidden tracking areas for roaming' ETSI TS 123 401 [i.4], which belongs to a PLMN that fulfils the first bullet above*". A ROM device does not support the NAS procedures or the tracking areas (TA).

A suitable cell in a 5G Broadcast System need not fulfil the above requirement.

12.2.4 Out-of-coverage and out-of-service indication

3GPP specifications provide standardized mechanisms for the UE for:

- monitoring and maintaining the radio link quality ETSI TS 136 133 [15]; and
- selecting a PLMN, including indications to the upper layers when no PLMN is available ETSI TS 123 122 [4].

ROM devices cannot implement these mechanisms.

The Access Stratum should inform the MBMS Client when the service is unavailable due to the lack of coverage or the lack of service, i.e. lack of PLMNs offering 5G Broadcast Services. Signal strength/quality thresholds for out-of-coverage indications are implementation-specific.

12.2.5 Sleep mechanism

Conventional UEs employ sleep mechanisms in idle mode by selectively shutting off radio receiver and/or transmitter components in order to extend battery life. The sleep mechanism of the traditional UE is not applicable to ROM device because:

- The DRX cycle-based sleep mechanism ETSI TS 136 304 [19] in the Access Stratum does not apply since DRX is not supported;
- The sleep mechanism negotiated in the NAS protocol (PSM, eDRX, UE-specific DRX) ETSI TS 123 401 [i.4] does not apply because the NAS protocol is not supported by ROM devices.

In the absence of any sleep-related signalling from the network, the sleep mechanism for ROM device can be managed by the device using the scheduled nature of the awake times. Both the control data and the user data are transmitted on the dedicated carrier according to a schedule. This characteristic of the system can be exploited by the ROM device to manage its own sleep cycle.

A ROM device should be awake during the transmission of:

- Relevant System Information;
- Relevant MCCH transmissions and change notifications; and
- User data on MTCH/PMCH.

During all other times, a ROM device may activate its sleep mode.

12.3 MBMS Client

Implementation guidelines for MBMS Clients are provided in ETSI TS 126 347 [9], clause 6.4.

The MBMS Client handles the out-of-service and out-of-coverage indications from the Access Stratum. The action of the MBMS Client upon receiving the indication is implementation-specific (e.g. inform the application, suspend/ deactivate MBMS session, etc.).

The MBMS Client handles the following service continuity information:

- User Service Description parameters according to clause 5.5.3, including TMGI, frequency and MBMS SAI.
- System Information Block Type 15 (SIB15) parameters according to clause 6.5, including a list of current and neighbouring frequencies together with the MBMS SAIs supported for each frequency.

Clause 7.4 recommends that the MBMS Client within a 5G Broadcast Receiver should support simultaneous reception of at least four user services with four different TMGIs on the same carrier. Such a capability allows the simultaneous reception of the 5G Broadcast SA Service plus three other 5G Broadcast Services, for example an EPG file delivery service, a main television service and a picture-in-picture service.

12.4 MBMS-Aware Application

This aspect is for further study.

12.5 LTE-based 5G Broadcast Emergency Alerts Receiver

Based on the architecture in figure 5.15.1-1, the receiver functions for public warning systems and emergency alerts may be implemented independently of the 5G Broadcast Receiver functions. This is shown in figure 12.5-1 below. While such a receiver is not in the primary scope of the present document, it may be a valid deployment option. Such a receiver needs to continuously scan relevant UHF bands, or it may be pre-configured to the frequency of the 5G Broadcast service in order to process the relevant system information to support CMAS warning messages delivered via 5G Broadcast.

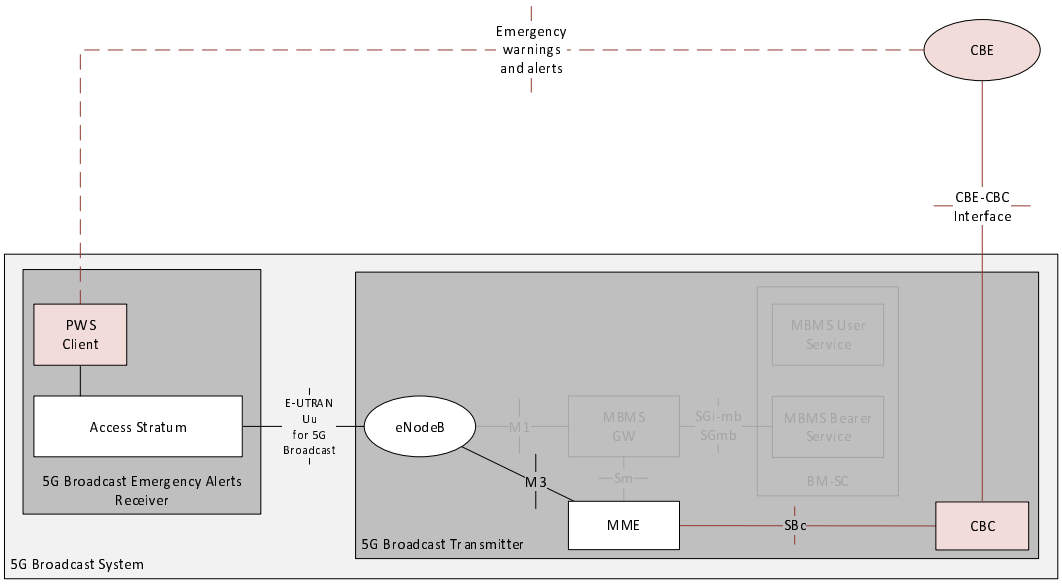


Figure 12.5-1: 5G Broadcast Emergency Alerts Receiver

12.6 Public Warning System message handling

Details of handling URLs in emergency alerts and public warning messages are for further study.

Annex A (informative): Change History

Date	Version	Information about changes
2020-01-07	0.0.1	Initial Draft
2020-09-11	0.0.2	Updates from initial review
2020-09-17	0.1.0	Improved draft for JTC Broadcast review
2020-10-22	0.1.1	Updated draft addressing JTC Broadcast review comments
2020-10-23	0.1.2	Updates after call on October 23, 2020
2020-10-28	0.1.3	Updates after call on October 28, 2020
2020-10-29	0.1.4	Updates after call on October 29, 2020
2020-10-30	0.1.5	Addressing comments from BBC on October 30, 2020
2020-10-30	0.1.6	Addressing comments from Huawei and Interdigital on October 30, 2020
2020-11-02	0.1.7	Editor's update version with revision marks on November 2, 2020
2020-11-02	0.2.0	Clean version of final draft before sent to editHelp
2022-07-21	1.1.2	Early Draft
2022-07-25	1.1.3	Comments on early draft
2022-07-27	1.1.4	Adding references to 36.211, 36.213 in clause 8
2022-09-01	1.1.5	Modification of Figure 4.2.2-1
2022-09-01	1.1.6	Adding r14:romService attribute in clause 5.5. and MBMS-URL in clause 5.5.5.
2022-09-06	1.1.7	Fixed change tracking of figure 4.2.2-1 and various minor typos.
2022-09-06	1.1.8	Clarification on MBMS-URL for SA File Delivery Application API
2022-10-26	1.1.9	Addition of demodulation requirements and simultaneous service reception
2022-10-28	1.1.10	Revision of track changes. Simultaneous services under 7.4. IP:port in 5.5.3
2022-11-24	1.1.11	Adding information on AV codecs and 5GMS over eMBMS
2022-11-24	1.1.12	Editorial corrections and clarification of IP:port in 5.5.3
2022-11-29	1.1.13	Early Draft submitted to ETSI JTC Broadcast
2023-01-27	1.1.14	Adding support for public warning and emergency alerts
2023-01-27	1.1.15	Editorial corrections, acronyms, quotation marks
2023-01-30	1.1.16	Addressing corrections on support for public warning and emergency alerts
2023-02-03	1.1.17	Addressing comments and corrections from BBC and Qualcomm
2023-02-09	1.1.18	Stable Draft sent to ETSI
2023-03-02	1.1.19	Removal of Editor's Note in 10.1 regarding new receiver category
2023-03-29	1.1.20	Adding information on support for service continuity

History

Document history		
V1.1.1	December 2020	Publication
V1.2.1	June 2023	Publication