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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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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.

Referenced documents which are not found to be publicly available in the expected location might be found at https://docbox.etsi.org/Reference.

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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.