**3GPP TSG RAN Meeting #97-e**

**, September 12 – 16, 2022**

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| *CR-Form-v12.2* |
| **CHANGE REQUEST** |
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|  |  | **CR** |  | **rev** | **4** | **Current version:** |  |  |
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| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* |
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| ***Proposed change affects:*** | UICC apps |  | ME | **X** | Radio Access Network | **X** | Core Network |  |

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| ***Title:***  | Corrections on MBS |
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| ***Source to WG:*** |  |
| ***Source to TSG:*** | Nokia, Nokia Shanghai Bell |
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| ***Work item code:*** | NR\_MBS-Core |  | ***Date:*** | 2022-09-12 |
|  |  |  |  |  |
| ***Category:*** | F |  | ***Release:*** | Rel-17 |
|  | *Use one of the following categories:****F*** *(correction)****A*** *(mirror corresponding to a change in an earlier release)****B*** *(addition of feature),* ***C*** *(functional modification of feature)****D*** *(editorial modification)*Detailed explanations of the above categories canbe found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | *Use one of the following releases:Rel-8 (Release 8)Rel-9 (Release 9)Rel-10 (Release 10)Rel-11 (Release 11)…Rel-16 (Release 16)Rel-17 (Release 17)Rel-18 (Release 18)Rel-19 (Release 19)* |
|  |  |
| ***Reason for change:*** | 1. When service is de-activated, the gNB might not release MRB for the UE, and in that case, *Reconfiguration* message is not necessary when activating;
2. Clarify the case that UE stops monitoring for group notifications related to MBS;
3. Multicast CFR is configured by *RRCReconfiguration* message, *RRCReconfiguration* message should be used instead of SRB;
4. It’s UE implementation to trigger unicast before or after reselecting to a cell. Current description may cause unnecessary unclarity;
5. Keep consistent with other specs on gNB’s behaviour of using MII information, according to TS 38.331“NOTE: If the UE prioritises MBS broadcast reception and unicast/multicast data cannot be supported because of congestion on the MBS carrier(s), NG-RAN may for example initiate release of unicast bearers/multicast MRBs.”;
6. R17 NR MBS has agreed that the multicast service can be delivered in RRC\_CONNECTED and the broadcast service can be delivered in RRC\_IDLE, RRC\_INACTIVE and RRC\_CONNECTED. These functions should be added in the function description of the corresponding RRC state in clause 7.2 of TS 38.300;
7. For NR MBS the USD-related information is defined in TS 26.346. Currently the wrong specification number is used in the References part and clause 16.10.6.5 of TS 38.300;
8. RAN2 118 e-meeting has reached an agreement that the priority in MII message means that the UE prioritizes the broadcast reception over both unicast and multicast reception:

The priority in MII message means the reception of broadcast services is prioritized compared to unicast bearer and also multicast MRB. In addition, RAN2 118 e-meeting has reached an agreement that if SIB20 for SCell is provided to UE by dedicated signalling in PCell, UE is allowed to include the interested broadcast services when setting the contents of MII message:P3: Clarify in specifications that if *SIB20* for SCell is provided (by dedicated signalling), UE is allowed to initiate the transmission of MII message and include TMGIs when setting the contents of MII, under the condition that the UE’s PCell is providing *SIB21*. (detailed wording of the condition FFS). The above two agreements have been well reflected in TS 38.331 but are not captured in clause 16.10.6.5 of TS 38.300;1. For MTCH transmission, multiplexing multiple MAC SDUs from different MTCHs is feasible in MBS broadcast. However, in the latest stage-2 spec, the downlink layer 2 architecture for broadcast session has missed the multiplexing functionality;
2. Clarify the different cases when gNB may release a multicast UE to RRC\_IDLE or RRC\_INACTIVE;
3. Clarify the use of group notification;
4. Section 16.10.1: There is no definition in 38.300 as to what is MBS service area;
5. Section 16.10.4: The term “group transmission” is not defined in 38.300, and the abbreviation of “Point to Multipoint" is not used；
6. Section 16.10.5.2: The term “UEs reconnect to network” could be taken to mean RRC establishment which applies for RRC\_IDLE to RRC\_CONNECTED transition but for RRC\_INACTIVE to RRC\_CONNECTED transition, a resume procedure is used;
7. Section 16.10.5.4: Inconsistent use of terminology;
8. There’s no abbreviation for common Frequency resource;
9. The agreement of PDCP of MRBs made in RAN2#119-e meeting is not reflected:

For MRBs, PDCP can either be re-established or remain as it is;1. There’s no description of broadcast data reception method;
2. The structure of section 16.10.6 for broadcast handling does not align with section 16.10.5 for broadcast handling;
3. Some editorial clarifications required for readability.
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| ***Summary of change:*** | 1. The description of gNB behaviour when multicast session is activated is changed to an optional behaviour in section 16.10.5.2;
2. The UE enters RRC\_CONNECTED state is added as one case that UE stops monitoring for group notifications related to MBS in section 16.10.5.2;
3. For the common frequency resource configuring message, it is changed from “SRB” to “*RRCReconfiguration* message” in section 16.10.5.7;
4. Add “NOTE: UE can request unicast reception of the service after moving to a cell not providing the MBS broadcast service(s) using PTM transmission.” as one possible UE behaviour in section 16.10.6.5.1;
5. Consistency is improved with TS 38.331 about the consequence of reporting MBS Interest Indication by UE in section 16.10.6.5.2;
6. R17 NR MBS has agreed that the multicast service can be delivered in RRC\_CONNECTED and the broadcast service can be delivered in RRC\_IDLE, RRC\_INACTIVE and RRC\_CONNECTED. These functions should be added in the function description of the corresponding RRC state in clause 7.2 of TS 38.300;
7. Change the description of “User Service Description (USD), as defined in TS 23.346 [46]” in clause 16.10.6.5 of TS 38.300 into “User Service Description (USD), as defined in TS 26.346 [46]”, and in the reference part;
8. Clarify the meaning of the priority in MII message in clause 16.10.6.5 of TS 38.300 by changing the description of “Priority between the reception of all listed MBS frequencies and the reception of any unicast bearer” into “Priority between the reception of all listed MBS frequencies and the reception of any unicast bearer and multicast MRB”.

Add the condition that UE can include the interested broadcast services in MII message if the SIB20 of SCell is provided to UE by dedicated signalling in clause 16.10.6.5 of TS 38.300 by changing the description of “List of MBS broadcast services the UE is interested to receive, in case SIB20 is scheduled by the UE's PCell” into “List of MBS broadcast services the UE is interested to receive, in case SIB20 is provided for PCell or SCell”;1. Add that multiplexing functionality is supported for MTCH(s);
2. The gNB may release a multicast UE to RRC\_IDLE or RRC\_INACTIVE when the CN deactivates the session and there is no unicast data or multicast data (from other multicast sessions) for some time. And the gNB may release a multicast UE to RRC\_INACTIVE when the session is activated and there is no multicast nor unicast data for some time;
3. The group notification may be used for session activation and for new multicast data during an active session separately. And only MBS session ID in the Paging message is checked when the UE monitors for group notification. The UE stops monitoring for group paging when the UE leaves the multicast session or the network releases the multicast session;
4. Section 16.10.1: Changed “multicast service area” to “MBS service area”;
5. Section 16.10.4: Changed “group transmission” to “PTM transmission” which is well explained in 38.300, and abbreviation of “Point to Multipoint” is used;
6. Section 16.10.5.2: Clarified that when group notification is sent to UE in RRC\_INACTIVE state the UE resumes the connection and moves to RRC\_CONNECTED;
7. Section 16.10.5.4: Editorial correction for consistent use of terminology;
8. Addition of CFR abbreviation;
9. Add description that for MRBs, PDCP can either be re-established or remain as it is in section 16.10.5.3.2;
10. Addition of a new section for broadcast data reception method;
11. Renumber of section 16.10.6 to keep consistent with 16.10.5;
12. Editorial changes.

**Impact analysis**Impacted 5G architecture options: StandaloneImpacted functionality: NR MBS broadcastInter-operability: 1. If the network is implemented according to the CR and the UE is not there is no inter-operability issue.

If the UE is implemented according to the CR and the network is not there is no inter-operability issue. |
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| ***Consequences if not approved:*** | 1. *RRCReconfiguration* message is send to UE in all cases;
2. Mismatch of Paging monitoring of unicast and MBS for RRC\_CONNECTED UEs;
3. Misunderstanding on all SRBs could be used to configure multicast CFR.
4. Limitation for UE’s potential behaviour;
5. Mismatch between stage 2 description and stage 3 description;
6. Editorial error exists;
7. The supported MBS function in the corresponding RRC state shall be missed;
8. The wrong specification number for reference shall occur in TS 38.300.
9. Multiplexing functionality is not supported for NR MBS broadcast;
10. The description of (temporarily) no data is not clear;
11. Misleading on the two use cases of group notification: when the session is activated and there is new multicast data for an active session;
12. Ambiguities and lack of clarity in the feature description of MBS will remain.
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| ***Clauses affected:*** | 2, 3, 7.2, 8.1, 16.10 |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** |  | **X** |  Other core specifications  | TS/TR ... CR ...  |
| ***affected:*** |  | **X** |  Test specifications | TS/TR ... CR ...  |
| ***(show related CRs)*** |  | **X** |  O&M Specifications | TS/TR ... CR ...  |
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| ***Other comments:*** | This CR includes changes from the following CRs: R2-2207031, R2-2207222, R2-2207223, R2-2208086, R2-2208181 |
|  |  |
| ***This CR's revision history:*** | **Changes in Rev 3:**This CR is a company CR revising the RAN2 agreed CR R2-2209145. It is an exact replica of of R2-2209145 with the exception of the following change in Rev 3:* In Clause 16.10.5.2, 2nd para, 1st sentence, reference to RRC\_IDLE was removed.

 **Changes in Rev 4:**Used the baseline text from 38.300 v17.1.0 for clause 16.10.5.2 to make the following changes* Removed changes on changes that Rev 3 introduced
* Fixed some editorial deletions that were done without revision marks in the agreed CR in R2-2209145
* Added a missing underscore in RRC\_IDLE in 2nd para, 2nd sentence.
 |

*START OF CHANGES*

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non‑specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

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

[3] 3GPP TS 23.501: "System Architecture for the 5G System; Stage 2".

[4] 3GPP TS 38.401: "NG-RAN; Architecture description".

[5] 3GPP TS 33.501: "Security Architecture and Procedures for 5G System".

[6] 3GPP TS 38.321: "NR; Medium Access Control (MAC) protocol specification".

[7] 3GPP TS 38.322: "NR; Radio Link Control (RLC) protocol specification".

[8] 3GPP TS 38.323: "NR; Packet Data Convergence Protocol (PDCP) specification".

[9] 3GPP TS 37.324: " E-UTRA and NR; Service Data Protocol (SDAP) specification".

[10] 3GPP TS 38.304: "NR; User Equipment (UE) procedures in Idle mode and RRC Inactive state".

[11] 3GPP TS 38.306: "NR; User Equipment (UE) radio access capabilities".

[12] 3GPP TS 38.331: "NR; Radio Resource Control (RRC); Protocol specification".

[13] 3GPP TS 38.133: "NR; Requirements for support of radio resource management".

[14] 3GPP TS 22.168: "Earthquake and Tsunami Warning System (ETWS) requirements; Stage 1".

[15] 3GPP TS 22.268: "Public Warning System (PWS) Requirements".

[16] 3GPP TS 38.410: "NG-RAN; NG general aspects and principles".

[17] 3GPP TS 38.420: "NG-RAN; Xn general aspects and principles".

[18] 3GPP TS 38.101-1: "NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone".

[19] 3GPP TS 22.261: "Service requirements for next generation new services and markets".

[20] 3GPP TS 38.202: "NR; Physical layer services provided by the physical layer"

[21] 3GPP TS 37.340: "NR; Multi-connectivity; Overall description; Stage-2".

[22] 3GPP TS 23.502: "Procedures for the 5G System; Stage 2".

[23] IETF RFC 4960 (2007-09): "Stream Control Transmission Protocol".

[24] 3GPP TS 26.114: "Technical Specification Group Services and System Aspects; IP Multimedia Subsystem (IMS); Multimedia Telephony; Media handling and interaction".

[25] Void.

[26] 3GPP TS 38.413: "NG-RAN; NG Application Protocol (NGAP)".

[27] IETF RFC 3168 (09/2001): "The Addition of Explicit Congestion Notification (ECN) to IP".

[28] 3GPP TS 24.501: "NR; Non-Access-Stratum (NAS) protocol for 5G System (5GS)".

[29] 3GPP TS 36.331: "Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC); Protocol specification".

[30] 3GPP TS 38.415: "NG-RAN; PDU Session User Plane Protocol".

[31] 3GPP TS 38.340: "NR; Backhaul Adaptation Protocol (BAP) specification".

[32] 3GPP TS 38.470: "NG-RAN; F1 application protocol (F1AP) ".

[33] 3GPP TS 38.425: "NG-RAN; NR user plane protocol".

[34] 3GPP TS 23.216: "Single Radio Voice Call Continuity (SRVCC); Stage 2".

[35] 3GPP TS 38.101-2: "User Equipment (UE) radio transmission and reception; Part 2: Range 2 Standalone".

[36] 3GPP TS 38.101-3: "User Equipment (UE) radio transmission and reception; Part 3: Range 1 and Range 2 Interworking operation with other radios".

[37] 3GPP TS 37.213: "Physical layer procedures for shared spectrum channel access".

[38] 3GPP TS 38.213: "NR; Physical layer procedures for control".

[39] 3GPP TS 22.104 "Service requirements for cyber-physical control applications in vertical domains".

[40] 3GPP TS 23.287: "Architecture enhancements for 5G System (5GS) to support Vehicle-to-Everything (V2X) services".

[41] 3GPP TS 23.285: "Technical Specification Group Services and System Aspects; Architecture enhancements for V2X services".

[42] 3GPP TS 38.305: "NG Radio Access Network (NG-RAN); Stage 2 functional specification of User Equipment (UE) positioning in NG-RAN".

[43] 3GPP TS 37.355: "LTE Positioning Protocol (LPP)".

[44] 3GPP TS 29.002: "Mobile Application Part (MAP) specification".

[45] 3GPP TS 23.247: "Architectural enhancements for 5G multicast-broadcast services; Stage 2".

[46] 3GPP TS 26.346 "Multimedia Broadcast/Multicast Service (MBMS); Protocols and codecs".

[47] 3GPP TS 23.122: "Non-Access-Stratum (NAS) functions related to Mobile Station (MS) in idle mode".

[48] 3GPP TS 23.304: "Proximity based Services (ProSe) in the 5G System (5GS)".

[49] 3GPP TS 28.541: "5G Network Resource Model (NRM)".

[50] 3GPP TS 38.423: "NG-RAN; Xn Application Protocol (XnAP)".

[51] NIMA TR 8350.2, Third Edition, Amendment 1, 3 January 2000: "DEPARTMENT OF DEFENSE WORLD GEODETIC SYSTEM 1984", https://gis-lab.info/docs/nima-tr8350.2-wgs84fin.pdf.

3 Abbreviations and Definitions

3.1 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1], in TS 36.300 [2] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1] and TS 36.300 [2].

5GC 5G Core Network

5GS 5G System

5QI 5G QoS Identifier

A-CSI Aperiodic CSI

AGC Automatic Gain Control

AKA Authentication and Key Agreement

AMBR Aggregate Maximum Bit Rate

AMC Adaptive Modulation and Coding

AMF Access and Mobility Management Function

ARP Allocation and Retention Priority

BA Bandwidth Adaptation

BCCH Broadcast Control Channel

BCH Broadcast Channel

BFD Beam Failure Detection

BH Backhaul

BL Bandwidth reduced Low complexity

BPSK Binary Phase Shift Keying

C-RNTI Cell RNTI

CAG Closed Access Group

CAPC Channel Access Priority Class

CBRA Contention Based Random Access

CCE Control Channel Element

CD-SSB Cell Defining SSB

CFR Common Frequency Resource

CFRA Contention Free Random Access

CG Configured Grant

CHO Conditional Handover

CIoT Cellular Internet of Things

CLI Cross Link interference

CMAS Commercial Mobile Alert Service

CORESET Control Resource Set

CP Cyclic Prefix

CPA Conditional PSCell Addition

CPC Conditional PSCell Change

DAG Directed Acyclic Graph

DAPS Dual Active Protocol Stack

DFT Discrete Fourier Transform

DCI Downlink Control Information

DCP DCI with CRC scrambled by PS-RNTI

DL-AoD Downlink Angle-of-Departure

DL-SCH Downlink Shared Channel

DL-TDOA Downlink Time Difference Of Arrival

DMRS Demodulation Reference Signal

DRX Discontinuous Reception

E-CID Enhanced Cell-ID (positioning method)

EHC Ethernet Header Compression

ETWS Earthquake and Tsunami Warning System

FS Feature Set

FSA ID Frequency Selection Area Identity

G-CS-RNTI Group Configured Scheduling RNTI

G-RNTI Group RNTI

GFBR Guaranteed Flow Bit Rate

GIN Group ID for Network selection

GSO Geosynchronous Orbit

H-SFN Hyper System Frame Number

HAPS High Altitude Platform Station

HRNN Human-Readable Network Name

IAB Integrated Access and Backhaul

IFRI Intra Frequency Reselection Indication

I-RNTI Inactive RNTI

INT-RNTI Interruption RNTI

KPAS Korean Public Alarm System

L2 Layer-2

L3 Layer-3

LDPC Low Density Parity Check

LEO Low Earth Orbit

MBS Multicast/Broadcast Services

MCE Measurement Collection Entity

MCCH MBS Control Channel

MDBV Maximum Data Burst Volume

MEO Medium Earth Orbit

MIB Master Information Block

MICO Mobile Initiated Connection Only

MFBR Maximum Flow Bit Rate

MMTEL Multimedia telephony

MNO Mobile Network Operator

MPE Maximum Permissible Exposure

MRB MBS Radio Bearer

MT Mobile Termination

MTCH MBS Traffic Channel

MTSI Multimedia Telephony Service for IMS

MU-MIMO Multi User MIMO

Multi-RTT Multi-Round Trip Time

MUSIM Multi-Universal Subscriber Identity Module

NB-IoT Narrow Band Internet of Things

NCD-SSB Non Cell Defining SSB

NCGI NR Cell Global Identifier

NCR Neighbour Cell Relation

NCRT Neighbour Cell Relation Table

NGAP NG Application Protocol

NGSO Non-Geosynchronous Orbit

NID Network Identifier

NPN Non-Public Network

NR NR Radio Access

NSAG Network Slice AS Group

NTN Non-Terrestrial Network

P-MPR Power Management Maximum Power Reduction

P-RNTI Paging RNTI

PCH Paging Channel

PCI Physical Cell Identifier

PDC Propagation Delay Compensation

PDCCH Physical Downlink Control Channel

PDSCH Physical Downlink Shared Channel

PEI Paging Early Indication

PH Paging Hyperframe

PLMN Public Land Mobile Network

PNI-NPN Public Network Integrated NPN

PO Paging Occasion

PRACH Physical Random Access Channel

PRB Physical Resource Block

PRG Precoding Resource block Group

PRS Positioning Reference Signal

PS-RNTI Power Saving RNTI

PSS Primary Synchronisation Signal

PTM Point to Multipoint

PTP Point to Point

PTW Paging Time Window

PUCCH Physical Uplink Control Channel

PUSCH Physical Uplink Shared Channel

PWS Public Warning System

QAM Quadrature Amplitude Modulation

QFI QoS Flow ID

QMC QoE Measurement Collection

QoE Quality of Experience

QPSK Quadrature Phase Shift Keying

RA Random Access

RA-RNTI Random Access RNTI

RACH Random Access Channel

RANAC RAN-based Notification Area Code

REG Resource Element Group

RIM Remote Interference Management

RLM Radio Link Monitoring

RMSI Remaining Minimum SI

RNA RAN-based Notification Area

RNAU RAN-based Notification Area Update

RNTI Radio Network Temporary Identifier

RQA Reflective QoS Attribute

RQoS Reflective Quality of Service

RS Reference Signal

RSRP Reference Signal Received Power

RSRQ Reference Signal Received Quality

RSSI Received Signal Strength Indicator

RSTD Reference Signal Time Difference

RTT Round Trip Time

SCS SubCarrier Spacing

SD Slice Differentiator

SDAP Service Data Adaptation Protocol

SDT Small Data Transmission

SFI-RNTI Slot Format Indication RNTI

SIB System Information Block

SI-RNTI System Information RNTI

SLA Service Level Agreement

SMC Security Mode Command

SMF Session Management Function

S-NSSAI Single Network Slice Selection Assistance Information

SNPN Stand-alone Non-Public Network

SNPN ID Stand-alone Non-Public Network Identity

SPS Semi-Persistent Scheduling

SR Scheduling Request

SRAP Sidelink Relay Adaptation Protocol

SRS Sounding Reference Signal

SRVCC Single Radio Voice Call Continuity

SS Synchronization Signal

SSB SS/PBCH block

SSS Secondary Synchronisation Signal

SSSG Search Space Set Group

SST Slice/Service Type

SU-MIMO Single User MIMO

SUL Supplementary Uplink

TA Timing Advance

TB Transport Block

TCE Trace Collection Entity

TNL Transport Network Layer

TPC Transmit Power Control

TRP Transmit/Receive Point

TRS Tracking Reference Signal

U2N UE-to-Network

UCI Uplink Control Information

UDC Uplink Data Compression

UE-Slice-MBR UE Slice Maximum Bit Rate

UL-AoA Uplink Angles of Arrival

UL-RTOA Uplink Relative Time of Arrival

UL-SCH Uplink Shared Channel

UPF User Plane Function

URLLC Ultra-Reliable and Low Latency Communications

VR Virtual Reality

V2X Vehicle-to-Everything

Xn-C Xn-Control plane

Xn-U Xn-User plane

XnAP Xn Application Protocol

3.2 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1], in TS 36.300 [2] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1] and TS 36.300 [2].

**BH RLC channel**: an RLC channel between two nodes, which is used to transport backhaul packets**.**

**Boundary IAB-node:** as defined in TS 38.401 [4].

**Broadcast MRB:** A radio bearer configured for MBS broadcast delivery.

**CAG Cell**:a PLMN cell broadcasting at least one Closed Access Group identity.

**CAG Member Cell**:for a UE, a CAG cell broadcasting the identity of the selected PLMN, registered PLMN or equivalent PLMN, and for that PLMN, a CAG identifier belonging to the Allowed CAG list of the UE for that PLMN.

**CAG-only cell**: a CAG cell that is only available for normal service for CAG UEs.

**Cell-Defining SSB**: an SSB with an RMSI associated.

**Child node**: IAB-DU's and IAB-donor-DU's next hop neighbour node; the child node is also an IAB-node.

**Conditional Handover (CHO**): a handover procedure that is executed only when execution condition(s) are met.

**CORESET#0**: the control resource set for at least SIB1 scheduling, can be configured either via MIB or via dedicated RRC signalling.

**DAPS Handover**: a handover procedure that maintains the source gNB connection after reception of RRC message for handover and until releasing the source cell after successful random access to the target gNB.

**Direct Path**: a type of UE-to-Network transmission path, where data is transmitted between a UE and the network without sidelink relaying.

**Downstream**: Direction toward child node or UE in IAB-topology.

**Early Data Forwarding**: data forwarding that is initiated before the UE executes the handover.

**Earth-centered, earth-fixed**: A global geodetic reference system for the Earth intended for practical applications of mapping, charting, geopositioning and navigation, as specified in NIMA TR 8350.2 [51].

**Feeder link**: Wireless link between the NTN Gateway and the NTN payload.

**Geosynchronous Orbit**: Earth-centered orbit at approximately 35786 kilometres above Earth's surface and synchronised with Earth's rotation. A geostationary orbit is a non-inclined geosynchronous orbit, i.e. in the Earth's equator plane.

**gNB**: node providing NR user plane and control plane protocol terminations towards the UE, and connected via the NG interface to the 5GC.

**High Altitude Platform Station**: airborne vehicle embarking the NTN payload placed at an altitude between 8 and 50 km.

**IAB-donor**:gNB that provides network access to UEs via a network of backhaul and access links.

**IAB-donor-CU**: as defined in TS 38.401 [4].

**IAB-donor-DU**:as defined in TS 38.401 [4].

**IAB-DU**: gNB-DU functionality supported by the IAB-node to terminate the NR access interface to UEs and next-hop IAB-nodes, and to terminate the F1 protocol to the gNB-CU functionality, as defined in TS 38.401 [4], on the IAB-donor.

**IAB-MT**: IAB-node function that terminates the Uu interface to the parent node using the procedures and behaviours specified for UEs unless stated otherwise. IAB-MT function used in 38-series of 3GPP Specifications corresponds to IAB-UE function defined in TS 23.501 [3].

**IAB-node**: RAN node that supports NR access links to UEs and NR backhaul links to parent nodes and child nodes. The IAB-node does not support backhauling via LTE.

**IAB topology:** The unison of all IAB-nodes and IAB-donor-DUs that are interconnected via BH links and terminate F1 and/or RRC at the same IAB-donor-CU.

**Indirect Path**: a type of UE-to-Network transmission path, where data is forwarded via a U2N Relay UE between a U2N Remote UE and the network.

**Inter-donor partial migration:** Migration of an IAB-MT to a parent node underneath a different IAB-donor-CU while the collocated IAB-DU and its descendant IAB-node(s), if any, are terminated at the initial IAB-donor-CU. The procedure renders the said IAB-node as a boundary IAB-node.

**Intra-system Handover**:Handover that does not involve a CN change (EPC or 5GC).

**Inter-system Handover**:Handover that involves a CN change (EPC or 5GC).

**Late Data Forwarding**: data forwarding that is initiated after the source NG-RAN node knows that the UE has successfully accessed a target NG-RAN node.

**Mapped Cell ID**: In NTN, it corresponds to a fixed geographical area.

**MBS Radio Bearer:** A radio bearer configured for MBS delivery.

**MSG1**: preamble transmission of the random access procedure for 4-step random access (RA) type.

**MSG3**: first scheduled transmission of the random access procedure.

**MSGA**:preamble and payload transmissions of the random access procedure for 2-step RA type.

**MSGB**:response to MSGA in the 2-step random access procedure. MSGB may consist of response(s) for contention resolution, fallback indication(s), and backoff indication.

**Multicast/Broadcast Service:** A point-to-multipoint service as defined in TS 23.247 [45].

**Multicast MRB:** A radio bearer configured for MBS multicast delivery.

**Multi-hop backhauling**: Using a chain of NR backhaul links between an IAB-node and an IAB-donor.

**ng-eNB**: node providing E-UTRA user plane and control plane protocol terminations towards the UE, and connected via the NG interface to the 5GC.

**NG-C**: control plane interface between NG-RAN and 5GC.

**NG-U**: user plane interface between NG-RAN and 5GC.

**NG-RAN node**: either a gNB or an ng-eNB.

**Non-CAG Cell**: a PLMN cell which does not broadcast any Closed Access Group identity.

**Non-Geosynchronous orbit**: Earth-centered orbit with an orbital period that does not match Earth's rotation on its axis. This includes Low and Medium Earth Orbit (LEO and MEO).

**Non-terrestrial network**: An NG-RAN consisting of gNBs, which provide non-terrestrial NR access to UEs by means of an NTN payload embarked on an airborne or space-borne NTN vehicle and an NTN Gateway.

**NR backhaul link**: NR link used for backhauling between an IAB-node and an IAB-donor, and between IAB-nodes in case of a multi-hop backhauling.

**NR sidelink communication**: AS functionality enabling at least V2X communication as defined in TS 23.287 [40] and the 5G Proximity based Services (ProSe) as defined in TS 23.304 [48], between two or more nearby UEs, using NR technology but not traversing any network node.

**NTN Gateway**: an earth station located at the surface of the earth, providing connectivity to the NTN payload using the feeder link. An NTN Gateway is a TNL node.

**NTN payload:** a network node, embarked on board a satellite or high altitude platform station, providing connectivity functions, between the service link and the feeder link. In the current version of this specification, the NTN payload is a TNL node.

**Numerology**: corresponds to one subcarrier spacing in the frequency domain. By scaling a reference subcarrier spacing by an integer *N*, different numerologies can be defined.

**Parent node**: IAB-MT's next hop neighbour node; the parent node can be IAB-node or IAB-donor-DU

**PC5 Relay RLC channel**: an RLC channel between L2 U2N Remote UE and L2 U2N Relay UE, which is used to transport packets over PC5 for L2 UE-to-Network Relay**.**

**PLMN Cell**: a cell of the PLMN.

**RedCap UE:** A UE with reduced capabilities as specified in clause 4.2.21.1. in TS 38.306 [11].

**Relay discovery**: AS functionality enabling 5G ProSe UE-to-Network Relay Discovery as defined in TS 23.304 [48], using NR technology but not traversing any network node.

**Satellite:** a space-borne vehicle orbiting the Earth embarking the NTN payload.

**Service link:** Wireless link between the NTN payload and UE.

**SNPN Access Mode**: mode of operation whereby a UE only accesses SNPNs.

**SNPN-only cell**: a cell that is only available for normal service for SNPN subscribers.

**SNPN Identity:** the identity of Stand-alone NPN defined by the pair (PLMN ID, NID).

**Transmit/Receive Point:** Part of the gNB transmitting and receiving radio signals to/from UE according to physical layer properties and parameters inherent to that element.

**U2N Relay UE:** a UE that provides functionality to support connectivity to the network for U2N Remote UE(s).

**U2N Remote UE:** a UE that communicates with the network via a U2N Relay UE.

**Upstream**: Direction toward parent node in IAB-topology.

**Uu Relay RLC channel**: an RLC channel between L2 U2N Relay UE and gNB, which is used to transport packets over Uu for L2 UE-to-Network Relay**.**

**V2X sidelink communication**: AS functionality enabling V2X communication as defined in TS 23.285 [41], between nearby UEs, using E-UTRA technology but not traversing any network node.

**Xn**: network interface between NG-RAN nodes.

## 7.2 Protocol States

RRC supports the following states which can be characterised as follows:

**- RRC\_IDLE**:

- PLMN selection;

- Broadcast of system information;

- Cell re-selection mobility;

- Paging for mobile terminated data is initiated by 5GC;

- Transfer of MBS broadcast data to the UE over MRB(s);

- DRX for CN paging configured by NAS.

- **RRC\_INACTIVE**:

- PLMN selection;

- Broadcast of system information;

- Cell re-selection mobility;

- Paging is initiated by NG-RAN (RAN paging);

- RAN-based notification area (RNA) is managed by NG- RAN;

- DRX for RAN paging configured by NG-RAN;

- 5GC - NG-RAN connection (both C/U-planes) is established for UE;

- The UE Inactive AS context is stored in NG-RAN and the UE;

- NG-RAN knows the RNA which the UE belongs to;

- Transfer of MBS broadcast data to the UE over MRB(s);

- Transfer of unicast data and/or signalling to/from the UE over radio bearers configured for SDT.

- **RRC\_CONNECTED**:

- 5GC - NG-RAN connection (both C/U-planes) is established for UE;

- The UE AS context is stored in NG-RAN and the UE;

- NG-RAN knows the cell which the UE belongs to;

- Transfer of unicast data to/from the UE;

- Transfer of MBS multicast/broadcast data to the UE over MRB(s);

- Network controlled mobility including measurements.

# 8 NG Identities

## 8.1 UE Identities

In this clause, the identities used by NR connected to 5GC are listed. For scheduling at cell level, the following identities are used:

- C-RNTI: unique UE identification used as an identifier of the RRC Connection and for scheduling;

- CI-RNTI: identification of cancellation in the uplink;

- CS-RNTI: unique UE identification used for Semi-Persistent Scheduling in the downlink or configured grant in the uplink;

- INT-RNTI: identification of pre-emption in the downlink;

- MCS-C-RNTI: unique UE identification used for indicating an alternative MCS table for PDSCH and PUSCH;

- P-RNTI: identification of Paging and System Information change notification in the downlink;

- SI-RNTI: identification of Broadcast and System Information in the downlink;

- SP-CSI-RNTI: unique UE identification used for semi-persistent CSI reporting on PUSCH.

For power and slot format control, the following identities are used:

- SFI-RNTI: identification of slot format;

- TPC-PUCCH-RNTI: unique UE identification to control the power of PUCCH;

- TPC-PUSCH-RNTI: unique UE identification to control the power of PUSCH;

- TPC-SRS-RNTI: unique UE identification to control the power of SRS.

During the random access procedure, the following identities are also used:

- RA-RNTI: identification of the Random Access Response in the downlink;

- Temporary C-RNTI: UE identification temporarily used for scheduling during the random access procedure;

- Random value for contention resolution: UE identification temporarily used for contention resolution purposes during the random access procedure.

For NR connected to 5GC, the following UE identities are used at NG-RAN level:

- I-RNTI: used to identify the UE context in RRC\_INACTIVE.

For UE power saving purpose during DRX, the following identity is used:

- PS-RNTI: used to determine if the UE needs to monitor PDCCH on the next occurrence of the connected mode DRX on-duration.

For IAB the following identity is used:

- AI-RNTI: identification of the DCI carrying availability indication for soft symbols of an IAB-DU.

For MBS, the following identities are used:

- G-RNTI: Identifies dynamically scheduled PTM transmissions of MTCH(s);

- G-CS-RNTI: Identifies PTM transmissions of MTCH(s) scheduled with configured grant;

- MCCH-RNTI: Identifies transmissions of MCCH and MCCH change notification.

16.10 Multicast and Broadcast Services

16.10.1 General

NR system enables resource efficient delivery of multicast/broadcast services (MBS).

For broadcast communication service, the same service and the same specific content data are provided simultaneously to all UEs in a geographical area (i.e., all UEs in the broadcast service area are authorized to receive the data). A broadcast communication service is delivered to the UEs using a broadcast session. A UE can receive a broadcast communication service in RRC\_IDLE, RRC\_INACTIVE and RRC\_CONNECTED state.

For multicast communication service, the same service and the same specific content data are provided simultaneously to a dedicated set of UEs (i.e., not all UEs in the MBS service area are authorized to receive the data). A multicast communication service is delivered to the UEs using a multicast session. A UE can receive a multicast communication service in RRC\_CONNECTED state with mechanisms such as PTP and/or PTM delivery, as defined in clause 16.10.5.4. HARQ feedback/retransmission can be applied to both PTP and PTM transmission.

16.10.2 Network Architecture

The overall NG-RAN architecture specified in clause 4 applies for NR MBS. MBS multicast can only be supported in MCG side in NE-DC and NR-DC scenarios, i.e., only for MN-terminated MCG MRB; the configuration of MBS broadcast on SCG is not supported for the UE.

The QoS model for NR MBS can be found in TS 23.247 [45].

16.10.3 Protocol Architecture

Figure 16.10.3-1 and 16.10.3-2 depict the downlink Layer 2 architecture for multicast session and broadcast session respectively, where MBS protocol stack comprises the same layer 2 sublayers as described in clause 6 with the following differences:

- SDAP sublayer provides only the following functionalities:

- Mapping between an MBS QoS flow and an MRB;

- Transfer of user plane data.

- PDCP sublayer provides only the following functionalities:

- Transfer of user plane data;

- Maintenance of PDCP SNs;

- Header compression and decompression using the ROHC protocol or EHC protocol;

- Reordering and in-order delivery;

- Duplicate discarding.

- For a multicast session, gNB provides one or more of the following multicast MRB configuration(s) to the UE via dedicated RRC signalling:

- Multicast MRB with DL only RLC-UM or bidirectional RLC-UM configuration for PTP transmission;

- Multicast MRB with RLC-AM entity configuration for PTP transmission;

- Multicast MRB with DL only RLC-UM entity for PTM transmission;

- Multicast MRB with two RLC-UM entities, one DL only RLC-UM entity for PTP transmission and the other DL only RLC-UM entity for PTM transmission;

- Multicast MRB with three RLC-UM entities, one DL RLC-UM entity and one UL RLC-UM entity for PTP transmission and the other DL only RLC-UM entity for PTM transmission;

- Multicast MRB with two RLC entities, one RLC-AM entity for PTP transmission and the other DL only RLC-UM entity for PTM transmission.

- For a multicast session, gNB may change the MRB type using RRC signalling.

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**Figure 16.10.3-1: Downlink Layer 2 Architecture for Multicast Session**

- For broadcast session, gNB provides the following broadcast MRB configuration to the UE using broadcast RRC signalling:

- Broadcast MRB with one DL only RLC-UM entity for PTM transmission.



**Figure 16.10.3-2: Downlink Layer 2 Architecture for Broadcast Session**

16.10.4 Group Scheduling

The following logical channels are used for MBS delivery:

- MTCH: A PTM downlink channel for transmitting MBS data of either multicast session or broadcast session from the network to the UE;

- DTCH: A PTP channel defined in clause 6.2.2 for transmitting MBS data of a multicast session from the network to the UE;

- MCCH: A PTM downlink channel used for transmitting MBS broadcast control information associated to one or several MTCH(s) from the network to the UE.

The following connections between logical channels and transport channels for PTM transmission exist:

- MCCH can be mapped to DL-SCH;

- MTCH can be mapped to DL-SCH.

The following depicts the usage of RNTI for PTM transmission:

- A UE can receive different services using same or different G-RNTIs;

- A UE can receive different services using same or different G-CS-RNTIs.

16.10.5 Multicast Handling

16.10.5.1 Session Management

There are two delivery modes as specified in TS 23.247 [45]:

- 5GC Shared MBS traffic delivery;

- 5GC Individual MBS traffic delivery.

As specified in TS 23.247 [45], if the gNB supports MBS, the network shall use the 5GC Shared MBS traffic delivery in which case an MBS Session Resource context for a multicast session is setup in the gNB when the first UE joins the multicast session.

For MBS shared delivery mode, shared NG-U resources are used to provide MBS user data to the gNB. The gNB initiates the Multicast Distribution Setup procedure towards the 5GC, to allocate shared NG-U resources for a multicast session. In case multiple MBS session areas are associated with the same multicast session for location dependent MBS services, multiple NG-U shared resources are established for the same multicast session per MBS Area Session ID served by the gNB.

A shared NG-U resource applies one of the following transport options:

- unicast transport;

- multicast transport.

For 5GC Shared MBS traffic delivery an MBS Session Resource comprises one or several MRBs. If minimisation of data loss is applied for a given MRB, synchronisation of allocation of PDCP COUNT values is applied by either or a combination of the following methods:

- derivation of the PDCP COUNT values by means of a DL MBS QFI Sequence Number provided on NG-U. Synchronisation in terms of MBS QoS flow to MRB mapping and PDCP SN size of the corresponding MRB among gNBs are achieved by means of network implementation.

- deployment of a Shared NG-U Termination at NG-RAN, shared among gNBs, which comprises a common entity for assignment of PDCP COUNT values. Synchronisation in terms of MBS QoS flow to MRB mapping and PDCP SN size of the corresponding MRB among gNBs may be achieved by means of network implementation.

If PDCP COUNT values are derived from a DL MBS QFI Sequence Number provided on NG-U and only one QoS Flow is mapped to an MRB, the gNB shall set the PDCP COUNT value of PDCP PDU to the value of the DL MBS QFI Sequence Number provided with the received packet over NG-U. If PDCP COUNT values are derived from a DL MBS QFI Sequence Number provided on NG-U and multiple QoS Flows are mapped to an MRB, the gNB may derive the PDCP COUNT value of the PDCP PDU from the sum of the DL MBS QFI Sequence Numbers of the QoS Flows mapped to this MRB.

NOTE: Synchronisation of PDCP COUNT values in case user data for MBS QoS flows mapped to the same MRB arrive over NG-U at different gNBs in different order or in case of loss of data over NG-U, and related handling of minimisation of data loss is left to implementation.

16.10.5.2 Configuration

A UE can receive data of MBS multicast session only in RRC\_CONNECTED state. If the UE which joined a multicast session is in RRC\_CONNECTED state and when the multicast session is activated, the gNB may send *RRCReconfiguration* message with relevant MBS configuration for the multicast session to the UE.

When there is temporarily no data to be sent to the UEs for a multicast session that is active, the gNB may move the UE to RRC\_INACTIVE state. When an MBS multicast session is deactivated, the gNB may move the UE to RRC\_IDLE or RRC\_INACTIVE state. gNBs supporting MBS use a group notification mechanism to notify the UEs in RRC\_IDLE or RRC\_INACTIVE state when a multicast session has been activated by the CN. gNBs supporting MBS use a group notification mechanism to notify the UEs in RRC\_INACTIVE state when the session is already activated and the gNB has multicast session data to deliver. Upon reception of the group notification, the UEs reconnect to the network or resume the connection and transition to RRC\_CONNECTED state. The group notification is addressed with P-RNTI on PDCCH, and the paging channels are monitored by the UE as described in clause 9.2.5. Paging message for group notification contains MBS session ID which is utilized to page all UEs in RRC\_IDLE and RRC\_INACTIVE states that joined the associated MBS multicast session, i.e., UEs are not paged individually. The UE stops monitoring for group notifications related to a specific multicast session, i.e., stops checking for the MBS session ID in the Paging message, when the UE enters RRC\_CONNECTED state. The UE does not monitor for group notifications for these cases, i.e., once this UE leaves this multicast session or the network requests the UE to leave, or the network releases the multicast session.

If the UE in RRC\_IDLE state that joined an MBS multicast session is camping on the gNB not supporting MBS, the UE may be notified about multicast session activation or data availability by CN-initiated paging where CN pages each UE individually, as described in clause 9.2.5. If the UE in RRC\_INACTIVE state that joined MBS multicast session is camping on the gNB not supporting MBS, the UE may be notified about data availability individually by RAN-initiated paging, as described in clause 9.2.5.

16.10.5.3 Service Continuity

16.10.5.3.1 General

Mobility builds on existing functionality including functions described in clause 9.2.

16.10.5.3.2 Handover between Multicast supporting cells

Mobility procedures for multicast reception allow the UE to continue receiving multicast service(s) via PTM or PTP in a new cell after handover.

During handover preparation phase, the source gNB transfers to the target gNB about the MBS sessions the UE has joined in the UE context information. To support provision of local multicast service with location dependent content, for each active multicast session, service area information per Area Session ID may be provided to the target gNB.

The source gNB may propose data forwarding for some MRBs to minimize data loss and may exchange the corresponding MRB PDCP Sequence Number with the target NG-RAN during the handover preparation:

- The lossless handover for multicast service is supported for the handover between MBS supporting cells if the UE is configured with PTP RLC AM entity in target cell MRB of a UE, regardless of whether the UE is configured with PTP RLC AM entity in the source cell or not.

- In order to support lossless handover for multicast service, the network has to ensure DL PDCP COUNT value synchronization and continuity between the source cell and the target cell. Furthermore, data forwarding from the source gNB to the target gNB and/or PDCP status report provided by a UE for an MRB for multicast session can be used during lossless handover.

For each multicast session with ongoing user data transmission for which no MBS Session Resources exist at the target gNB, the target gNB triggers the setup of MBS user plane resources towards the 5GC using the NGAP Distribution Setup procedure. If unicast transport is used, the target gNB provides the DL tunnel endpoint to be used to the MB-SMF. If multicast transport is used, the target gNB receives the IP multicast address from the MB-SMF.

During handover execution, the MBS configuration decided at target gNB is sent to the UE via the source gNB within an RRC container as specified in TS 38.331 [12]. The PDCP entities for multicast MRBs in the UE can either be re-established or remain as it is. When the UE connects to the target gNB, the target gNB sends an indication that it is an MBS-supporting node to the SMF in the Path Switch Request message (Xn handover) or Handover Request Acknowledge message (NG handover).

Upon successful handover completion, the source gNB may trigger the release of the MBS user plane resources towards the 5GC using the NGAP Distribution Release procedure for any multicast session for which there is no remaining joined UE in the gNB.

16.10.5.3.3 Handover between Multicast-supporting cell and Multicast non-supporting cell

During an active MBS multicast session, at mobility from an MBS-supporting gNB to an MBS non-supporting gNB, the target gNB sets up PDU Session Resources mapped to the multicast MBS Session. The 5GC infers from the absence of an "MBS-support" indication in the Path Switch Request message (Xn handover) or Handover Request Acknowledge message (NG handover) that MBS data packets delivery has to be switched to 5GC individual MBS traffic delivery as specified in TS 23.247 [45]. If data forwarding is applied, the source gNB infers from the handover preparation response message that the target gNB does not support MBS and changes the QFI(s) in the forwarded packets to the associated PDU Session QFI(s) if respective mapping information is available. The source gNB may be aware that the target gNB is non-MBS supporting already before Handover Preparation.

For mobility from MBS non-supporting gNB to MBS-supporting gNB, the existing Xn/NG handover procedures apply. The 5GC infers from the presence of the "MBS-support" indicator in the Path Switch Request message (Xn handover) or in the Handover Request Acknowledge message (NG handover) that MBS data packets delivery can be switched from 5GC MBS individual traffic delivery to 5GC shared traffic delivery. After Xn handover, the SMF triggers switching MBS data packets delivery from individual to shared traffic delivery by providing MBS Session IDs joined by the UE to the gNB by means of the PDU Session Resource Modification procedure. And for NG handover, the SMF provides the MBS Session IDs joined by the UE to the target gNB by means of NGAP Handover Request. Minimization of data loss and duplication avoidance may be applied by means of identical MBS QFI SNs received over both the shared NG-U and the unicast NG-U tunnels.

Mobility from a multicast-supporting cell to a multicast non-supporting cell can be achieved by switching the MRB to a DRB in the source gNB before a handover.

NOTE: A UE may be handed over to a target gNB not supporting MBS without prior reconfiguration from MRB to the DRB in the source gNB. In this case, the AS configuration may not be comprehended by the target gNB causing full configuration.

16.10.5.3.4 MRB reconfiguration

The gNB may use *RRCReconfiguration* message to configure or reconfigure a multicast MRB, e.g., add/release/modify the MRB's RLC entities as described in clause 16.10.3. In order to minimize the data loss due to MRB reconfiguration, gNB may configure UE to send a PDCP status report during reconfiguration for MRB type change.

16.10.5.4 Reception of MBS Multicast data

For multicast service, gNB may deliver Multicast MBS data packets using the following methods:

- PTP Transmission: gNB individually delivers separate copies of MBS data packets to each UEs independently, i.e., gNB uses UE-specific PDCCH with CRC scrambled by UE-specific RNTI (e.g., C-RNTI) to schedule UE-specific PDSCH which is scrambled with the same UE-specific RNTI.

- PTM Transmission: gNB delivers a single copy of MBS data packets to a set of UEs, e.g., gNB uses group-common PDCCH with CRC scrambled by group-common RNTI to schedule group-common PDSCH which is scrambled with the same group-common RNTI.

If a UE is configured with both PTM and PTP transmissions, a gNB dynamically decides whether to deliver multicast data by PTM leg and/or PTP leg for a given UE based on the protocol stack defined in clause 16.10.3, based on information such as MBS Session QoS requirements, number of joined UEs, UE individual feedback on reception quality, and other criteria. The same QoS requirements apply regardless of the decision.

16.10.5.5 Support of CA

UE can be configured to receive MBS multicast data either from a PCell or a single SCell at a time.

16.10.5.6 DRX

The following DRX configurations for PTM/PTP transmission are possible:

- For PTM transmission, multicast DRX is configured per G-RNTI/G-CS-RNTI which is independent of UE-specific DRX;

- For PTP transmission, UE-specific DRX is reused, i.e., UE-specific DRX is used for both unicast transmission and PTP transmission of MBS multicast. For PTM retransmission via PTP, UE monitors PDCCH scrambled by C-RNTI/CS-RNTI during UE-specific DRX's Active Time.

16.10.5.7 Physical Layer

A CFR configured by *RRCReconfiguration* message is defined for multicast scheduling as an 'MBS frequency region' with a number of contiguous PRBs confined within and with the same numerology as the DL BWP, and multicast scheduling may have specific characteristics (e.g., PDCCH, PDSCH and SPS configurations).

Two HARQ-ACK reporting modes are defined for MBS:

- For the first HARQ-ACK reporting mode, the UE generates HARQ-ACK information with ACK value when a UE correctly decodes a transport block or detects a DCI format indicating an SPS PDSCH release; otherwise, the UE generates HARQ-ACK information with NACK value.

- For the second HARQ-ACK reporting mode, the UE does not transmit a PUCCH that would include only HARQ-ACK information with ACK values.

HARQ-ACK feedback for multicast can be enabled or disabled by higher layer configuration per G-RNTI or per G-CS-RNTI and/or indication in the DCI scheduling multicast transmission.

16.10.6 Broadcast Handling

16.10.6.1 Session Management

For delivery of location dependent contents of a broadcast session, Area session ID is included in the NGAP broadcast session resource setup procedure associated with MBS service area information and per Area Session ID NG-U tunnels are established.

16.10.6.2 Configuration

MBS broadcast can be received by UEs in RRC\_IDLE, RRC\_INACTIVE and RRC\_CONNECTED state. A UE can receive the MBS configuration for broadcast session (e.g., parameters needed for MTCH reception) via MCCH in RRC\_IDLE, RRC\_INACTIVE and RRC\_CONNECTED state. The parameters needed for the reception of MCCH are provided via System Information.

The following principles govern the MCCH structure:

- MCCH provides the list of all broadcast services with ongoing sessions transmitted on MTCH(s) and the associated information for broadcast session includes MBS session ID, associated G-RNTI scheduling information and information about neighbouring cells providing certain service on MTCH(s). MCCH content is transmitted within periodically occurring time domain windows, referred to as MCCH transmission window defined by MCCH repetition period, MCCH window duration and radio frame/slot offset;

- MCCH uses a modification period and MCCH contents are only allowed to be modified at each modification period boundary; A notification mechanism is used to announce the change of MCCH contents due to broadcast session start, modification or stop and due to neighbouring cell information modification;

- When the UE receives a MCCH change notification, it acquires the updated MCCH in the same MCCH modification period where the change notification is sent.

16.10.6.3 Service Continuity

16.10.6.3.0 General

Mobility principles build on existing functionality including functions described in clause 9.2.

NR MBS supports MBS frequency layer prioritization for MBS broadcast sessions. The gNBs may be configured with the MBS FSA ID(s) supported by each of their cells. The gNBs may exchange this information with their neighbours within Xn Setup messages and subsequent Xn Configuration Update messages to help with frequency layer prioritization.

16.10.6.3.1 Service Continuity in RRC\_IDLE or RRC\_INACTIVE

Mobility procedures for MBS reception allow the UE to start or continue receiving MBS service(s) when changing cells. The gNB may indicate in the MCCH the list of neighbour cells providing the same MBS broadcast service(s) as provided in the serving cell. This allows the UE, e.g., to request unicast reception of the service before moving to a cell not providing the MBS broadcast service(s) using PTM transmission. To avoid the need to read MBS broadcast related system information and potentially MCCH on neighbour frequencies, the UE is made aware of which frequency is providing which MBS broadcast services via PTM, through the combination of the following MBS related information:

- User Service Description (USD), as defined in TS 26.346 [46];

- SIB21, as defined in clause 7.3.1.

NOTE: UE can request unicast reception of the service after moving to a cell not providing the MBS broadcast service(s) using PTM transmission.

In RRC\_IDLE and RRC\_INACTIVE, the UE applies the normal cell reselection rules with the following modifications:

- the UE which is receiving or interested to receive MBS broadcast service(s) via PTM and can only receive these MBS broadcast service(s) via PTM while camping on the frequency providing these MBS broadcast service(s) is allowed to make this frequency highest priority when the conditions described in TS 38.304 [10] are met;

- when the MBS broadcast service(s) which the UE is interested in are no longer available (after the end of the session) or the UE is no longer interested in receiving the service(s), the UE no longer prioritises the frequency providing these MBS broadcast service(s).

16.10.6.3.2 Service Continuity in RRC\_CONNECTED

To ensure service continuity of MBS broadcast, the UE in RRC\_CONNECTED state may send MBS Interest Indication to the gNB, consisting of the following information:

- List of MBS frequencies UE is interested to receive, sorted in decreasing order of interest;

- Priority between the reception of all listed MBS frequencies and the reception of any unicast bearer and multicast MRB;

- List of MBS broadcast services the UE is interested to receive, in case SIB20 is provided for PCell or SCell.

MBS Interest Indication information reporting can be implicitly enabled/disabled by the presence of SIB21.

The gNB may use this information, together with the information about the UE's capabilities (e.g., supported band combinations), when providing an RRC configuration and/or downlink assignments to the UE or to release of DRBs/multicast MRBs, to allow the UE to receive the MBS services the UE is interested in. MBS Interest Indication information can be exchanged between source gNB and target gNB during handover.

16.10.6.4 Reception of MBS Broadcast data

For broadcast service, gNB may deliver Broadcast MBS data packets using the following method:

- PTM Transmission: gNB delivers a single copy of MBS data packets to a set of UEs, e.g., gNB uses group-common PDCCH with CRC scrambled by group-common RNTI to schedule group-common PDSCH which is scrambled with the same group-common RNTI.

16.10.6.5 Support of CA

UE can be configured to receive MBS broadcast data and MCCH either from a PCell or a single SCell at a time. Meanwhile, dedicated RRC signalling is used for providing SIB20 of the SCell i.e., while in RRC\_CONNECTED state, UEs need not acquire broadcast SIB20 directly from the SCells.

NOTE: The UE may be able to receive MBS broadcast also from a non-serving cell, which is transparent to the network, e.g., it does not require UE capability or MBS Interest Indication to be sent by the UE.

16.10.6.6 DRX

Via MCCH, the UE can be configured with a PTM DRX configuration for G-RNTI reception. One PTM DRX configuration can be mapped to more than one G-RNTI.

16.10.6.7 Physical Layer

A CFR configured by SIB is defined for broadcast scheduling as an 'MBS frequency region' with a number of contiguous PRBs with a bandwidth equal to or larger than CORESET0, with the same numerology as CORESET0, and broadcast scheduling may have specific characteristics (e.g., PDCCH and PDSCH configurations).

The maximum number of MIMO layers is one for MBS broadcast scheduling. RB-level rate matching, and RE-level rate matching around LTE-CRS configured by higher layer signalling are supported for MCCH and MTCH. Slot-level repetition is supported for MTCH.

HARQ-ACK feedback is not supported for MBS broadcast.

Only dynamic scheduling is supported for MBS broadcast.

END OF CHANGES