**3GPP TSG-RAN WG2 Meeting #123bis *R2-23xxxxx***

**Xiamen, China, 09 – 13 October 2023**

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| *CR-Form-v12.2* | | | | | | | | |
| **DRAFT CHANGE REQUEST** | | | | | | | | |
|  | | | | | | | | |
|  | **38.300** | **CR** | **Num** | **rev** | **-** | **Current version:** | **17.5.0** |  |
|  | | | | | | | | |
| *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:*** | XR Enhancements | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | Nokia, Qualcomm (Rapporteurs) | | | | | | | | | |
| ***Source to TSG:*** | R2 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | NR\_XR\_enh-Core | | | | |  | ***Date:*** | | | 2023-10-19 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | **B** |  | | | | | ***Release:*** | | | Rel-18 |
|  | *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 can be 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:*** | | New mechanisms have been agreed for the support of XR services in NR. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | | An overview of the new mechanisms for the support of XR services is added:   1. Description of XR Awareness based on TS 23.501 2. Power Saving Enhancements 3. Capacity Enhancements | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | | A stage 2 overview of the agreed mechanisms for the support of XR services in NR is missing. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | 2, 3.1, 3.2, 16.X (new) | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | | **x** |  | Other core specifications | | | | TS 38.321 ... CR ...  TS 38.322 ... CR ...  TS 38.323 ... CR ...  TS 38.331 ... CR ...  TS 38.306 ... CR ... | | |
| ***affected:*** | |  | **x** | Test specifications | | | |  | | |
| ***(show related CRs)*** | |  | **x** | O&M Specifications | | | |  | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | |  | | | | | | | | |

*First Modified Subclause*

# 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".

[52] 3GPP TS 38.211: "NR; Physical channels and modulation".

[53] 3GPP TS 24.587: "Vehicle-to-Everything (V2X) services in 5G System (5GS)".

[54] 3GPP TS 23.041: "Technical realization of Cell Broadcast Service (CBS)".

[AA] 3GPP TR 38.835: "NR; Study on XR enhancements for NR".

[BB] 3GPP TS 26.522: "5G Real-time Media Transport Protocol Configurations".

*Next Modified Subclause*

## 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

AR Augmented Reality

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

DSR Delay Status Report

E-CID Enhanced Cell-ID (positioning method)

EHC Ethernet Header Compression

ePWS enhancements of Public Warning System

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

GNSS Global Navigation Satellite System

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

NCL Neighbour Cell List

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

PDB Packet Delay Budget

PDC Propagation Delay Compensation

PDCCH Physical Downlink Control Channel

PDSCH Physical Downlink Shared Channel

PEI Paging Early Indication

PER Packet Error Rate

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

PSDB PDU Set Delay Budget

PSER PDU Set Error Rate

PSI PDU Set Importance

PSIHI PDU Set Integrated Handling Information

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

SHR Successful Handover Report

SIB System Information Block

SI-RNTI System Information RNTI

SLA Service Level Agreement

SMC Security Mode Command

SMF Session Management Function

SMTC SS/PBCH block Measurement Timing Configuration

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

XR eXtended Reality

*Next Modified Subclause*

## 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.

**Data Burst:** A set of multiple PDUs generated and sent by the application in a short period of time, as defined in TS 23.501 [3].

**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.

**Group ID for Network Selection**: an identifier used during SNPN selection to enhance the likelihood of selecting a preferred SNPN that supports a Default Credentials Server or a Credentials Holder, as specified in TS 23.501 [3].

**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 whose F1 and/or RRC connections are terminated 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). LEO operates at altitudes between 300 km and 1500 km and MEO at altitudes between 7000 km and 25000 km, approximately.

**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 ProSe communication (including ProSe non-Relay and UE-to-Network Relay communication) as defined in TS 23.304 [48], between two or more nearby UEs, using NR technology but not traversing any network node.

**NR sidelink discovery**: AS functionality enabling ProSe non-Relay Discovery and ProSe UE-to-Network Relay discovery for Proximity based Services 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**.**

**PDU Set**: one or more PDUs carrying the payload of one unit of information generated at the application level (e.g. frame(s) or video slice(s) for XR Services), as defined in TS 23.501 [3].

**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.

*Next Modified Subclause (new)*

## 16.X eXtended Reality Services

### 16.X.1 General

This subclause describes the functionalities for the support of eXtended Reality (XR) services that require high data rate and low latency communications. An overview of XR services is available in TR 38.835 [AA], while the service requirements are documented in TS 22.261 [19].

### 16.X.2 Awareness

XR-Awareness relies on QoS flows, PDU Sets, Data Bursts and traffic assistance information (see TS 23.501 [3]).

The following **PDU Set QoS Parameters** may be provided by the SMF to the gNB as part of the QoS profile of the QoS flow, and to enable PDU Set based QoS handling at least one of them shall be provided:

- PDU Set Delay Budget (PSDB): as defined in TS 23.501 [3], upper bound for the duration between the reception time of the first PDU (at the UPF for DL, at the UE for UL) and the time when all PDUs of a PDU Set have been successfully received (at the UE in DL, at the UPF in UL). A QoS Flow is associated with only one PSDB, and when available, it applies to both DL and UL and supersedes the PDB of the QoS flow.

- PDU Set Error Rate (PSER): as defined in TS 23.501 [3], upper bound for a rate of non-congestion related PDU Set losses between RAN and the UE. A QoS Flow is associated with only one PSER, and when available, it applies to both DL and UL and supersedes the PER of the QoS flow.

NOTE 1: In this release, a PDU set is considered as successfully delivered only when all PDUs of a PDU Set are delivered successfully.

- PDU Set Integrated Handling Information (PSIHI): indicates whether all PDUs of the PDU Set are needed for the usage of PDU Set by application layer, as defined in TS 23.501 [3].

NOTE 2: The PDU Set QoS parameters are common for all PDU Sets within a QoS flow.

In addition, the UPF can identify PDUs that belong to PDU Sets, and may indicate to the gNB the following **PDU Set Information** in the GTP-U header:

- PDU Set Sequence Number;

- Indication of End PDU of the PDU Set;

- PDU Sequence Number within a PDU Set;

- PDU Set Size in bytes;

- PDU Set Importance (PSI), which identifies the relative importance of a PDU Set compared to other PDU Sets within the same QoS Flow.

The following **traffic assistance information** may also be provided by 5GC to the gNB:

- Via TSCAI (for both GBR and non-GBR QoS flows):

- UL and/or DL Periodicity;

- N6 Jitter Information (i.e. between UPF and Data Network) associated with the DL Periodicity.

- Indication of End of Data Burst in the GTP-U header of the last PDU in downlink.

In the uplink, the UE needs to be able to identify PDU Sets and Data Bursts dynamically, including PSI. How this is done is left up to UE implementation but when possible for a QoS flow, this is indicated to the gNB via UE Assistance Information.

### 16.X.3 Power Saving

Most XR video frame rates (15, 30, 45, 60, 72, 90 and 120 fps) correspond to periodicities that are not an integer (66.66, 33.33, 22.22, 16.66, 13.88, 11.11 and 8.33 ms respectively). The gNB may configure DRX cycle(s) expressed in rational numbers so that the DRX cycle(s) matches those periodicities, e.g. for the traffic with a frame rate of 60 fps, the network may configure the UE with a DRX cycle of 50/3 ms.

Configured grants may be configured without the need for the UE to monitor possible UL retransmissions, thus increasing the number of power saving opportunities for the UE.

### 16.X.4 Capacity

#### 16.X.4.1 Physical Layer Enhancements

The following enhancements for configured grant-based PUSCH transmission are introduced:

- Support of multiple CG PUSCH transmission occasions within a single period of a CG configuration;

- Indication of unused CG PUSCH occasion(s) of a CG configuration with Uplink Control Information multiplexed in CG PUSCH transmission of the CG configuration.

#### 16.X.4.2 Layer 2 Enhancements

##### 16.X.4.2.1 Assistance Information

In order to enhance the scheduling of uplink resources for XR, the following improvements are introduced:

- One additional buffer status table to reduce the quantisation errors in BSR reporting (e.g. for high bit rates):

- Whether, for an LCG, the new table can be used in addition to the regular one is configured by the gNB;

- When the new table is configured for an LCG, it is used whenever the amount of the buffered data of that LCG is within the range of the new table, otherwise the regular table is used.

- One Delay Status Report (DSR) of buffered data via a dedicated MAC CE:

- Triggered for an LCG when the remaining time before discard of any buffered PDCP SDU goes below a configured threshold (threshold configured per LCG by the gNB);

- When triggered for an LCG, reports the amount of data buffered with a remaining time before discard below the configured threshold, together with the shortest remaining time of any PDCP SDU buffered.

- Reporting of uplink assistance information (jitter range, burst arrival time, UL data burst periodicity) per QoS flow by the UE via UE Assistance Information.

##### 16.X.4.2.2 Discard

When the PSIHI is set for a QoS flow, as soon as one PDU of a PDU set is known to be lost, the remaining PDUs of that PDU Set can be considered as no longer needed by the application and may be subject to discard operation at the transmitter to free up radio resources.

NOTE: It cannot always be assumed that the remaining PDUs are not useful and can safely be discarded. Also, in case of Forward Error Correction (FEC), active discarding of PDUs when assuming that a large enough number of packets have already been transmitted for FEC to recover without the remaining PDUs is not recommended as it might trigger an increase of FEC packets.

In uplink, the UE may be configured with PDU Set based discard operation for a specific DRB. When configured, the UE discards all packets in a PDU set when one PDU belonging to this PDU set is discarded due to discard timer expiry.

In case of congestion, the PSI may be used for discarding. For uplink, dedicated downlink signalling is used to request the UE to apply a shorter discard timer to *low importance* PDUs in PDCP.

NOTE: How PDUs / PDU Sets are identified as *low importance* is left up to UE implementation. When a PSI is available, it can be used to classify PDUs / PDU Sets according to the guidelines specified in TS 26.522 [BB].

*End of Changes*

List of Agreements

Editor's Notes: temporary Annex to capture all WI agreements.

#### RAN2#121

- Companies should evaluate the RAN2 specification impacts and any other RAN2 aspects of their proposals for XR DRX.

- Companies should evaluate the (high-level) impacts to RAN1/4 specification from their proposals for XR DRX.

- Companies should try to coordinate with each other offline and bring joint proposals to next meeting. RAN2 aims to exclude proposals with least support in the next meeting.

- Companies should evaluate the RAN2 specification impacts and any other RAN2 aspects of their proposals for SFN wrap-around.

- Same as for DRX solutions, companies should try to coordinate with each other offline and bring joint proposals to next meeting. RAN2 aims to exclude proposals with least support in the next meeting.

- Whether the issue of retransmission-less CG for UL pose transmission is addressed in the WI needs to be discussed in RAN.

- New BSR tables are fixed (=specified) or semi-static (RRC-based).

- FFS how many BSR tables are defined.

#### RAN2#121bis-e

- RAN2 can discuss if XR traffic is only about GBR or can also be non-GBR (this may require RAN3 views)

- UE can report jitter information associated to UL XR traffic. How UE derives this jitter is left up to implementation (similarly as it is captured by SA2 for the jitter associated with the periodicity in DL. FFS what exactly is reported to the RAN (aim to have similar information as for DL). FFS on UL traffic data arrival reporting.

- FFS on whether EoDB signalling is needed.

- RAN2 will not consider solution 3, i.e. multiple active DRX configurations as a solution to the non-integer periodicity for XR traffic, i.e. UE would have only one DRX configuration.

- To address SFN wrap around, it is proposed to adopt option with a counter in DRX formula that increments at every SFN wrap around and an DRX reference SFN signalled by network. FFS if this is based on H-SFN, E-SFN or a generic counter.

- Support of new BSR table(s) is based on NW configuration and UE capability. FFS whether the UE capability can apply to non-XR UEs.

- As a working assumption, at most one BS index or BS value is reported by an LCG. This assumption can be revisited if new BSR table design cannot achieve a target level of quantization error. FFS what this target level should be.

- Design/configuration for new BSR table(s) should include support for narrower ranges (i.e. finer granularity) than the legacy. Details can be discussed after an agreement on how UE obtains new BSR table(s) (e.g. pre-definition vs RRC configuration) is made.

- At least linear distribution is used for generating code points in new BSR table(s). FFS whether exponential distribution can be considered too. FFS if piecewise linear distribution is supported.

- New BSR table(s) can be used by any UEs that support such a capability. However, design of the new BSR table(s) should be based on XR-specific use cases and requirements.

- Network can configure which BSR table(s) an LCG is eligible to use. UE determines which BSR table (i.e. legacy or something else) the LCG should use. FFS details of this determination (e.g. based on buffer size) and how network knows which BSR table each LCG uses.

- As working assumption (depending on how we create the new BSR table(s) and the MAC CE format), If more than one new BSR table are introduced, all of them have the same size BS field. FFS on the exact size.

- Deprioritize Option 2c (static + dynamic BSR tables) and Option 2d (reference table + scaling factor).

- Have more discussions on Option 2a (static BSR tables) vs Option 2b (RRC configured BSR tables). In next meeting, companies should explain how BSR table(s) are created and how many tables would be needed, and how the MAC CE structure will look like. Should also explain what is the expected quantization error.

- PDU set discard is modelled using the existing PDCP discard timer for the uplink. The timer is in network control.

- There is support to adopt NTN solution for the retransmission-less CG. If adopted, RAN2 aims to only consider option1 or option 2:

- Option1: Adapt the NTN solution by disabling the HARQ RTT timer per CG configuration for CG.

- Option2: Adapt the NTN solution by disabling the HARQ RTT timer per HARQ processes for both CG and DG.

- FFS how the solution ensures consistent HARQ operation.

#### RAN2#122

- UE reports to RAN the range of jitter in its UL traffic, defined in the similar way as the one for N6 jitter.

- Reference time is defined in similar way as BAT (Burst Arrival Time) at UE side.

- UL assistance information (burst arrival time, UL jitter, FFS on periodicity) is reported per QoS flow. Network can configure for which QoS flow UE should report assistance information.

- RRC UAI framework is updated for Rel-18 to support signalling UL assistance information agreed so far for XR (Jitter, burst arrival time, FFS on periodicity).

- Do not use PIN delay budget request for jitter reporting for XR services.

- Reuse existing mechanisms (e.g. (Padding) BSR with BS value equal to zero) as implicit End of Data Burst (EoDB) indicator for the RAN.

- On the UL, the identification of PDU sets, data bursts and PSI is left to UE implementation. This doesn’t mean UE cannot use information provided by upper layers, but RAN2 does not intend to specify how.

- Define DRX cycle based on rational numbers. Inform RAN1/4 about this and ask them to indicate if this causes issues in their specifications.

- Not use broadcast signalling for counter and reference SFN in XR

- UE calculates the remaining time based on the PDCP discard timer value. FFS if UE reports one or multiple values. FFS how this is modelled in PDCP specification. FFS which UEs support this.

- When/if UE reports remaining time, the reference time for the remaining time is determined from the point of the first transmission of the information. FFS if intra-UE prioritization can impact this.

- Support one static BSR table with 8 bits BS field for Rel-18 XR (for all cases).

- We do not support additional piecewise linear BSR table in Rel-18. Can consider piecewise linearity when discussing how the BSR table values are defined.

- PDU-set discard indication for UL is configured using RRC to handle the PDU Set based discard functionality (i.e. whether UE discards all packets in PDU set when one PDU is discarded). The configuration is per PDCP entity.

- Network indicates UE to apply PSI-based XR discard mechanism via dedicated signalling.

- FFS how/whether to minimize additional UL signalling after this indication.

- FFS if the NW indication is a one-shot or also subsequent packets.

- For retransmission less CG enhancement in XR, adapt the NTN solution by disabling the HARQ RTT timer per CG configuration. Specifically, the following modifications shall be introduced:

- A new RRC parameter for disabling drx-HARQ-RTT-TimerUL for a CG configuration;

- Changes in the procedural text of DRX operations for CG in the MAC specification;

- A new UE capability for supporting disabling drx-HARQ-RTT-TimerUL for a CG configuration.

#### RAN2#123

- UE reports Burst Arrival time and Jitter associated with the UL data burst periodicity in uplink using UAI.

- UE reports UL data burst periodicity in uplink using UAI.

- All UAI fields for XR are optional fields in RRC. FFS how to handle persistency of signalled information (e.g. UE reports BAT first, then jitter).

- Consider exact jitter range later on (e.g. via email discussion)

- UE can also report there is no jitter (e.g. for pose)

- Reuse UAI framework, e.g. network can configure when UE is allowed to report UAI. Exact triggering upon being configured and change of UAI is up to UE implementation. Network can configure prohibit timer for the reporting.

- The maximum value of the counter (NSFN) is 2^16 = 65536.

- Network sets DRX reference SFN (drx-ReferenceSFN) to either 0 or 512, in the same way as in Rel-16 IIoT.

- Use the following option (option A): both the counter NSFN and the DRX reference SFN drx-ReferenceSFN are added to the DRX formula. NSFN is initialized to 0.

- Network can configure the UE whether to trigger delay status reporting. FFS if we have some thresholds per LCG.

- When UE triggers reporting delay information for a LCG, and UE also reports the buffer status associated with the remaining time.

- RAN2 aims to define a single MAC CE for the DSR reporting (including the buffer status). FFS if this extends BSR MAC CE or is a new MAC CE.

- Many companies think single value per LCG is sufficient. Some companies think scheduler needs more information.

- Working assumption: Define a new separate MAC CE for DSR (remaining delay and associated data volume) reporting, e.g. DSR reporting is not coupled with BSR reporting. Detailed Definition of associated data volume is FFS.

- Support threshold based DSR reporting, e.g. DSR reporting is triggered when remaining delay of a PDU/PDU set is below a NW configured threshold. The threshold is configured per LCG. FFS whether configuring multiple thresholds for a LCG is supported. Definition of remaining time is FFS.

- PDCP discard timer for PDU sets supports cases where PDUs of a PDU Set arrive at different instances of time.

- Companies should bring detailed Stage-3 proposals, preferably co-signed by several supporters, to the next meeting, at which time RAN2 aims to decide on which solution to use.

- Send LS to RAN1 (MTK) informing them of the error in the formula and tell RAN2 will capture the HARQ process formula in RAN2 specifications. Ask RAN1 whether the validity is going to be defined in RAN1 specifications. Can ask clarifications how the validity works if there are ambiguities for RAN2 specifications.

- UE capabilities will be discussed in the next meeting(s) based on company inputs. Companies are encouraged to provide also Stage-3 details of their proposals, e.g. draftCRs on the capabilities to allow better comparison of the proposals.

- Interested companies bringing documents to this AI should contact specification rapporteur to consolidate their proposals offline.

#### RAN2#123bis

- Agreements on XR awareness

1. The definition of the BAT in the field description of the burstArrivalTime should be updated as follows: “indicates the average value of the arrival time of the first packet of the Data Burst”.

2. A choice structure comprising ReferenceTime IE and reference SFN/slot is designed for BAT reporting

- Agreements on DRX

1. New DRX cycles in rational numbers are supported for both short and long DRX cycles.

2. If short DRX cycle in rational number is configured, the length of the long DRX cycle shall be an integer multiple of the short DRX cycle, as in legacy.

3. The new DRX parameter(s) for non-integer DRX cycles are common to both DRX groups

4. At least use legacy formula and add floor () operation.

5. We will have normative text to avoid rounding errors.

6. specify the DRX cycle by different fields under a CHOICE structure and specify in the field description the correspondence between different fields and DRX cycles

- Agreements on BSR

1. Adopt an exponential BSR table. FFS on buffer size

2. The UE uses the new defined BS table if the buffered data volume is within the range of the new table, otherwise the legacy table is used.

3. New MAC CE including indication of table selection per LCG will be introduced. Exact format FFS (to be discussed in MAC CR review phase)

- Agreements on DSR

1. For triggering DSR, the shortest remaining-time left for the buffered data in UL is smaller than a configured threshold is used, if there is no pending DSR associated for that LCG.

2. One threshold per LCG for triggering purposes is enough for delay status report

3. The data volume calculation to be reported in the DSR will consider the at size of the full remaining PDUs in the PDU set (if any PDU within the PDU set is with remaining time below the threshold), if the PDU set discard is configured. FFS what to report for the case of not PDU set discard configured

4. Support single delay information per LCG as baseline for Rel-18 DSR. The remaining time (the shortest remaining time in the LCG) will be explicitly reported in the DSR.

- Agreements on Discard

1. We will use a discard timer mechanism for the low importance PDU set. We will allow a value of zero for the timer. The running discard timers are not changed.

2. It is up to UE implementation to determine which PSI levels will apply the discard mechanism

3. the gNB signals an activation/deactivation indication (e.g. when congestion situation is detection)

4. activation/deactivation is signaled using an ON/OFF mechanism on a per UE basis. Introduce new MAC CE.

- Agreements on CG

1. From RAN2 perspective, Multi-PUSCH CG is supported for Type 1 and Type 2 CG, i.e., [N] separated uplink grants occur in consecutive slots in one CG period.

2. We will specify some factors that the UE should consider when determining how to set the UTO-UCI bits in the MAC. FFS which ones we know for sure the UE shall at least consider

- Agreements on UE capabilities

1. For UL XR awareness related capabilities, UE shall not reject (i.e. not perform re-establishment) the network XR configuration even if the capability is not supported for a specific application

2. UE can indicate to RAN whether a UL QoS flow can be identified with PDU sets, as a UL traffic parameter via UE Assistance Information message.

3. Send an LS to SA2, CT1, SA4, explain assumption on RAN awareness and support for identification of UL PDU sets. It is up to SA2 whether AS/NAS interactions/signaling are required from upper layers