**3GPP TSG-RAN WG2 Meeting #124 *R2-23xxxxx***

**Chicago, USA, 13 – 17 November 2023**

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| *CR-Form-v12.2* |
| **CHANGE REQUEST** |
|  |
|  | **38.300** | **CR** | **0724** | **rev** | **1** | **Current version:** | **17.6.0** |  |
|  |
| *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:***  | Introduction of XR Enhancements |
|  |  |
| ***Source to WG:*** | Nokia, Qualcomm (Rapporteurs) |
| ***Source to TSG:*** | R2 |
|  |  |
| ***Work item code:*** | NR\_XR\_enh-Core |  | ***Date:*** | 2023-11-0 |
|  |  |  |  |  |
| ***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 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:*** | 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 1698TS 38.322 CR 0053TS 38.323 CR 0128TS 38.331 CR 4436TS 38.413 CR 1025TS 38.423 CR 1091TS 38.415 CR 0037TS 38.425 CR 0148TS 37.483 CR 0078TS 38.473 CR 1219TS 38.410 CR 0048TS 38.420 CR 0040TS 38.470 CR 0125 |
| ***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)".

[55] 3GPP TS 24.554: "Technical Specification Group Core Network and Terminals; Proximity-services (ProSe) in 5G System (5GS) protocol".

[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

SD-RSRP Sidelink Discovery RSRP

SFI-RNTI Slot Format Indication RNTI

SHR Successful Handover Report

SIB System Information Block

SI-RNTI System Information RNTI

SLA Service Level Agreement

SL-RSRP Sidelink RSRP

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

## 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.

**Sidelink Discovery RSRP:** RSRP measurements on PC5 link related to NR sidelink discovery.

**Sidelink RSRP:** RSRP measurements on PC5 link related to NR sidelink communication.

**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].

The following functions are supported for XR services.

- XR Awareness,

- Power saving enhancements.

- Capacity enhancements.

### 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.

During the Xn-handover preparation procedure, the source gNB sends the stored PDU Set QoS Parameters as part of the QoS profile to the target NG-RAN node.

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 a DRX cycle expressed in rational numbers so that the DRX cycle 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.

5GC may provide XR traffic assistance information to gNB through NG AP TSC Assistance Information (TSCAI) as specified in clause 5.37.8 of TS 23.501[3]. This assistance information will be used by gNB to configure connected mode DRX scheme to enable UE power saving for efficient handling of XR traffic:

- UL and/or DL Periodicity;

- N6 Jitter Information associated with the DL Periodicity.

In addition, 5GC may provide the following information through NG-U as specified in clause 5.37.5.2 of TS 23.501[3]. The NG-RAN node can indicate UE to go back to sleep mode if the transmission of the Data Burst ends when the UE is configured with C-DRX.

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

### 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 size 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.

- 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.

The gNB may perform downlink PDU Set discarding based on implementation by taking at least PSDB, PSI, PSIHI parameters into account.

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

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

### 16.X.5 Non-Homogeneous support of PDU set based handling in NG-RAN

During a handover from a gNB supporting PDU Set based handling to a gNB, the source gNB signals the PDU Set Information over Xn-U if the target node has signalled the support of PDU Set based handling in the Xn Handover Request Acknowledge message.

During a handover from a gNB not supporting PDU Set based handling to a gNB supporting PDU Set based handling, the target gNB may indicate the support of PDU Set based handling to the SMF during the Path Switch Request procedure (in case of Xn handover) or Handover Resource Allocation procedure (in case of NG handover), the SMF will act as specified in TS 23.501[3]. If the indication is absent, the SMF infers that PDU Set based handling is not supported by the target NG-RAN node, then the SMF will act as specified in TS 23.501[3].

## 16.Y ECN marking for L4S and congestion information exposure

In order to support ECN marking for L4S at gNB as specified in TS 23.501[3], SMF provides ECN marking request per QoS flow level to gNB as part of PDU Session Resource Management procedure. If the gNB supports ECN marking, it provides the status indication back to SMF which is used by SMF as specified in TS 23.501[3]. During Xn Handover Preparation procedure, source gNB provides the ECN marking request to target gNB.

For ECN marking for L4S at UPF, SMF requests the gNB to report congestion information per QoS flow level as part of PDU Session Resource Management procedure. If the gNB supports ECN marking for L4S at UPF, it provides the status indication back to SMF which is used by SMF as specified in TS 23.501[3]. During Xn Handover Preparation procedure, source gNB provides the ECN marking UPF request to target gNB.

For congestion reporting from gNB to UPF, SMF requests the gNB to report congestion information per QoS flow level as part of PDU Session Resource Management procedure. If the NG-RAN supports congestion information reporting, it provides the status indication back to SMF which is used by SMF as specified in TS 23.501[3]. During Xn Handover Preparation procedure, source gNB provides the congestion information request to target gNB.

*End of Changes*