**3GPP TSG-RAN WG2 Meeting #130 R2-250xxxx**

**Malta, May 19 – 23, 2025**

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| *CR-Form-v12.3* |
| **CHANGE REQUEST** |
|  |
|  | **38.300** | **CR** | draftCR | **rev** | **-** | **Current version:** | **18.5.0** |  |
|  |
| *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:***  | Introduction of Ambient IoT |
|  |  |
| ***Source to WG:*** | CMCC |
| ***Source to TSG:*** | R2 |
|  |  |
| ***Work item code:*** | Ambient\_IoT\_solutions |  | ***Date:*** | 2025-05-19 |
|  |  |  |  |  |
| ***Category:*** | B |  | ***Release:*** | Rel-19 |
|  | *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-17 (Release 17)Rel-18 (Release 18)Rel-19 (Release 19) Rel-20 (Release 20)* |
|  |  |
| ***Reason for change:*** | Introduction of the Ambient IoT |
|  |  |
| ***Summary of change:*** | Changes after RAN2#129: * Add skeleton for A-IoT stage 2 specifications
* Add general section, architecture and MAC layer functions according to agreements.

Changes after RAN2#129bis:- Refine and add MAC layer functions according to agreements. |
|  |  |
| ***Consequences if not approved:*** | Rel-19 Ambient IoT can not be supported by TS 38.300. |
|  |  |
| ***Clauses affected:*** | 2, 3.1, 3.2, 16.x (new) |
|  |  |
|  | **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 ...  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** |  |

# 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 26.517: "5G Multicast-Broadcast User Services; Protocols and Formats".

[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".

[56] 3GPP TS 38.214: "Technical Specification Group Radio Access Network; NR; Physical layer procedures for data".

[57] 3GPP TR 38.835: "NR; Study on XR enhancements for NR".

[58] 3GPP TS 26.522: "5G Real-time Media Transport Protocol Configurations".

[59] 3GPP TS 38.215: "NR; Physical layer measurements".

[60] 3GPP TS 23.256: "Support of Uncrewed Aerial Systems (UAS) connectivity, identification and tracking; Stage 2".

[61] IETF RFC 9330: "Low Latency, Low Loss, Scalable Throughput (L4S) Internet Service: Architecture".

[62] IETF RFC 9331: "Explicit Congestion Notification (ECN) Protocol for Very Low Queuing Delay (L4S)".

[63] IETF RFC 9332: "Dual-Queue Coupled Active Queue Management (AQM) for Low Latency, Low Loss, and Scalable Throughput (L4S)".

[64] 3GPP TS 28.105: "Management and orchestration; Artificial Intelligence/ Machine Learning (AI/ML) management".

[65] 3GPP TS 38.351: "NR; Sidelink Relay Adaptation Protocol (SRAP) Specification".

[xx] 3GPP TS 38.391: "Ambient IoT Medium Access Control Protocol specification".

[xx] 3GPP TS 38.291: "Ambient IoT Physical Layer".

[xx] 3GPP TS 23.369: "Architecture support for Ambient power-enabled Internet of Things".

# 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

A2X Aircraft-to-Everything

A-CSI Aperiodic CSI

AGC Automatic Gain Control

AI Artificial Intelligence

A-IoT Ambient Internet of Things

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

ATG Air to Ground

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

BRID Broadcast Remote Identification

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

cellDTRX-RNTI Cell Discontinuous Transmission and Reception RNTI

CFA Contention Free Access

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

D2R Device to Reader

DAA Detect And Avoid

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

DCR Direct Communication Request

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

DTX Discontinuous Transmission

E-CID Enhanced Cell-ID (positioning method)

EC Energy Cost

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

LBT Listen Before Talk

LDPC Low Density Parity Check

LEO Low Earth Orbit

LTM L1/L2 Triggered Mobility

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

ML Machine Learning

MMTEL Multimedia telephony

MNO Mobile Network Operator

MO-SDT Mobile Originated SDT

MP Multi-Path

MPE Maximum Permissible Exposure

MRB MBS Radio Bearer

MT Mobile Termination

MT-SDT Mobile Terminated SDT

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

N3C Non-3GPP Connection

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

NES Network Energy Savings

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

PDRCH Physical Device-to-Reader 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

PQI PC5 5QI

PRACH Physical Random Access Channel

PRB Physical Resource Block

PRDCH Physical Reader-to-Device Channel

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

R2D Reader to Device

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

RVQoE RAN visible QoE

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-PRS Sidelink Positioning Reference Signal

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

SpCell Special Cell

SPR Successful PSCell Addition/Change Report

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

TSS Timing Synchronization Status

U2N UE-to-Network

U2U UE-to-UE

UAV Uncrewed Aerial Vehicle

UCI Uplink Control Information

UDC Uplink Data Compression

UDM Unified Data Management

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].

**2Rx XR UE**: two antenna port XR UE as specified in TS 38.101-1 [18].

**A2X communication**: A communication to support A2X services leveraging PC5 reference points. A2X services are realized by various types of A2X applications, i.e. BRID or DAA.

**A-IoT device:** A device that supports A-IoT radio interface towards gNB-reader, as defined in 16.x.

**A-IoT MSG1:** firstD2R message transmission in the A-IoT CBRA procedure, as defined in 16.x.

**A-IoT MSG2:** R2D message in response to A-IoT MSG1 in the A-IoT CBRA procedure, as defined in 16.x.

**Aerial UE communication:** functionality enabling Aerial UE function, as defined in 16.18.

**Air to Ground network:** An NG-RAN consisting of ground-based gNBs, which provide cell towers that send signals up to an aircraft's antenna(s) of onboard ATG terminal, with typical vertical altitude of around 10,000m and take-off/landing altitudes down to 3000m.

**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].

**eRedCap UE**: a UE with enhanced reduced capabilities as specified in clause 4.2.22.1 in TS 38.306 [11].

**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.

**gNB-reader**: node providing A-IoT protocol terminations towards the A-IoT device, as defined in 16.x.

**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.

**L1/L2 Triggered Mobility**: a cell switch procedure that the network triggers via MAC CE based on L1 or L3 measurement report.

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

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

**Mobile-IAB cell**: a cell of a mobile IAB-DU.

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

**Mobile IAB-DU migration**: procedure for a mobile IAB-node as defined in TS 38.401 [4].

**Mobile IAB-MT**: mobile IAB-node function that terminates the Uu interface to the parent node using the procedures and behaviours specified for UEs unless stated otherwise.

**Mobile IAB-MT migration**: procedure for a mobile IAB-MT as defined in TS 38.401 [4].

**Mobile IAB-node**: RAN node that supports NR access links to UEs and an NR backhaul link to a parent node, and that can conduct physical mobility across the RAN area. The mobile IAB-node function used in 38-series of 3GPP Specifications corresponds to the MBSR function defined in TS 23.501 [3].

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

**MP Remote UE**: a UE that communicates with the network via a direct Uu link and a MP Relay UE.

**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.

**NCR-Fwd**: Network-Controlled Repeater node function, which performs amplifying-and-forwarding of UL/DL RF signals between gNB and UE. The behaviour of the NCR-Fwd is controlled according to the side control information received by the NCR-MT from a gNB.

**NCR-Fwd access link**: link used for transmissions between the NCR-Fwd and UEs.

**NCR-Fwd backhaul link**: link used for backhauling between the NCR-Fwd and gNB.

**NCR-MT**: NCR-node entity which communicates with a gNB via a control link to receive side control information. The control link is based on NR Uu interface.

**NCR-node**: RAN node comprising NCR-MT and NCR-Fwd.

**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-Cell Defining SSB**: an SSB without an RMSI associated.

**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/or A2X communication as defined in TS 23.256 [60] and/or 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 or mobile IAB-MT's next hop neighbour node; the parent node can be an IAB-node or IAB-donor-DU

**PC5 Relay RLC channel**: an RLC channel between L2 U2N Remote UE and L2 U2N Relay UE, or between L2 U2U Remote UE and L2 U2U Relay UE, which is used to transport packets over PC5 for L2 UE-to-Network/UE-to-UE 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.

**RACH-less LTM**: an LTM cell switch procedure where UE skips the random access procedure.

**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).

**Special Cell:** For Dual Connectivity operation the term Special Cell refers to the PCell of the MCG or the PSCell of the SCG, otherwise, in case of NR Standalone, the term Special Cell refers to the PCell.

**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.

**U2U Relay UE**: a UE that provides functionality to support connectivity between two U2U Remote UEs.

**U2U Remote UE**: a UE that communicates with other UE(s) via a U2U Relay UE.

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

**Uu Relay RLC channel**: an RLC channel between L2 U2N Relay UE or MP Relay UE and gNB, which is used to transport packets over Uu for L2 UE-to-Network Relay or for indirect path in case of MP.

**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.

# 16 Verticals Support

## 16.x Support of Ambient IoT

### 16.x.1 General

A-IoT radio interface provides the communication between A-IoT device(s) and gNB-reader as illustrated in Figure 16.x.1-1. A-IoT radio interface can support both inventory procedure and command procedure as defined in TS 23.369 [xx]. The A-IoT device monitors the R2D message as long as it has sufficient energy.



Figure 16.x.1-1: Architecture supporting the A-IoT radio interface.

### 16.x.2 Architecture

Editor Notes: RAN3 is responsible for this section and RAN3 BL CR to 38.300 will be merged when it is stable.

### 16.x.3 Radio Protocol Architecture for A-IoT Communication

The AS protocol stack for A-IoT radio interface contains A-IoT MAC layer and A-IoT physical layer as shown in Figure 16.x.3-1. The AS layer control information and data are handled by A-IoT MAC layer and A-IoT physical layer. For A-IoT radio interface, there is no differentiation between the control plane and the user plane.



Figure 16.x.3-1: AS protocol stack for A-IoT

### 16.x.4 A-IoT Physical Layer Functions

Editor Notes: RAN1 is responsible for this section.

### 16.x.5 A-IoT MAC Layer Functions

#### 16.x.5.1 Services and functions

The main services and functions of A-IoT MAC layer include (see TS 38.391 [xx]):

- construct MAC PDUs to be mapped onto D2R transport blocks and delivered to the physical layer;

- process MAC PDUs from R2D transport blocks delivered from the physical layer;

- paging;

- access;

- transfer of upper layer data;

- D2R segmentation;

- failure detection;

#### 16.x.5.2 A-IoT Paging

A-IoT paging allows the gNB-reader to trigger one or more A-IoT device(s) to perform A-IoT CBRA or A-IoT CFA. The A-IoT paging message is sent on PRDCH. The A-IoT paging may include one paging identifier or no paging identifier. If a paging identifier is included, the A-IoT paging message may be addressed to a single A-IoT device or a group of A-IoT devices. If no paging identifier is included, the A-IoT paging message is addressed to all A-IoT devices. The A-IoT paging message may also provide configuration for A-IoT random access procedure.

#### 16.x.5.3 A-IoT Access Procedure

Both A-IoT CBRA procedure and A-IoT CFA procedure are supported for A-IoT access. The A-IoT device initiates either A-IoT CBRA or A-IoT CFA based on the indication in the A-IoT paging message.

For CBRA, the A-IoT device randomly selects one A-IoT MSG1 resource among A-IoT MSG1 resources provided in A-IoT paging message and monitors the R2D trigger messages to determine the start of the selected MSG1 resource and transmits the A-IoT MSG1 on this resource as described in TS 38.391 [xx]. After A-IoT MSG1 transmission, the device monitors A-IoT MSG2 from the gNB-reader for contention resolution. Upon successful reception of A-IoT MSG2 which contains the same random ID as transmitted in A-IoT MSG1, the A-IoT device considers the contention resolution as successful, as shown in Figure 16.x.4.3-1(a). Otherwise, the A-IoT device considers the contention resolution as failed If contention resolution is successful, the A-IoT device shall report the inventory response in the next D2R message. If the A-IoT device considers the contention resolution as failed, the A-IoT device continues monitoring A-IoT MSG2, which may be resent by gNB-reader by implementation, and follow-up A-IoT paging messages.

For CFA, the A-IoT device shall use the dedicated resource provided in A-IoT paging message to send the first D2R message as shown in Figure 16.x.4.3-1(b).

  

 (a) A-IoT CBRA (b) A-IoT CFA

Figure 16.x.5.3-1: A-IoT Access Procedures

#### 16.x.5.4 A-IoT Upper-layer Data Transmission

##### 16.x.5.4.1 R2D and D2R data transmission

##### The A-IoT MAC sublayer supports R2D reception and D2R transmission of upper layer data, including A-IoT device identifier, upper layer command and command response. A D2R A-IoT MAC PDU can include padding bit(s). An A-IoT device adds padding bit(s) to a D2R message if the scheduled TB size of D2R message exceeds the size of the A-IoT MAC PDU.16.x.5.4.2 Segmentation

A D2R upper layer data SDU except for inventory response can be segmented in A-IoT MAC layer in case the size of the A-IoT MAC PDU exceeds the scheduled TB size.

Segmentation of R2D upper layer data SDU in A-IoT MAC layer is not supported.

#### 16.x.5.5 AS ID

To support command procedure in 16.x.7, an A-IoT device is assigned with or indicated to reuse the random ID transmitted in A-IoT MSG1 as an AS ID, which is to address the specific A-IoT device for R2D reception and scheduling resources for D2R transmission. An A-IoT device maintains at most one AS ID at a time. During A-IoT CBRA procedure, an A-IoT device can be assigned with an AS ID by A-IoT MSG2. After A-IoT CFA procedure, an A-IoT device can be assigned with an AS ID together with a R2D command message.

The A-IoT device releases the AS ID, if it is out of energy or other condition(s) specified in TS 38.391 [xx] is fulfilled.

### 16.x.6 Inventory Procedures

Editor Notes: RAN3 is responsible for this section and RAN3 BL CR to 38.300 will be merged when it is stable.

### 16.x.7 Command Procedures

Editor Notes: RAN3 is responsible for this section and RAN3 BL CR to 38.300 will be merged when it is stable.

Annex: RAN2 agreements

RAN2#129 agreements:

**RAN2 understands that the service type of A-IoT (e.g. inventory, command) and whether the service is targeted for a single or multiple devices can always be provided. The approximate number of target devices can be provided if available.**

**Agreements**

1. Parallel service requests by the same reader is not supported.
2. The device is expected to only perform one procedure at a time. FFS device behaviour if multiple requests are received in parallel (if needed).
3. The “transaction ID” can be generated by reader based on CN corelation ID. FFS how reader will generate “transaction ID”. FFS the size of transaction ID
4. 1 bit solution is excluded. FFS the size. Aim to have a reasonable size.
5. RAN2 acknowledges that multi-reader scenario may exist but we will not specify something specific for this purpose. We can rely on transaction ID and implementation to handle it.

**Agreements on paging ID**

1. The “one identifier” in the paging message includes both the case of “one single device identifier” and “one group identifier”/”filtering criteria”, while the exact format of latter is supposed to be designed by SA2.
2. The current assumption is that the paging identifier is transparent to the A-IoT MAC Layer and carried by upper layer. FFS if there is really a need for visibility in the MAC layer

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| **Agreements** 1. The A-IoT paging message can include a number of msg1 resources
2. From RAN2 perspective, after initial paging message, the R2D transmission which determines the Msg1 resource(s), can be achieved by one of the below two ways, unless RAN1 concludes to use L1 signaling later:

**Way-1**: introducing new R2D message other than the paging message, e.g., QueryRep-like; or**Way-2***:* reusing the same paging message, using field(s) to indicate it is only to determine the Msg1 resource(s) and omitting the paging identifier (device ID/group ID) field3. The service type of A-IoT (e.g., inventory only, inventory + command) is not included in paging message. |

**Agreements**

1. For Rel-19, only 3-step CBRA is supported for A-IoT
2. We will specify both CBRA and CFRA.
3. Re-use the subsequent paging message to trigger re-access. There is no need to differentiate msg1 resource for initial access vs re-access.

**Agreements**

1. NACK based mechanism is supported for D2R messages to determine re-access for at least msg3. FFS details including whether we need a timer or explicit message and when reader sends feedback
2. RAN2 assumes that device randomly selects among FDMA occasions as the baseline.

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| **Agreements** 1. For CBRA, it is up to Reader to decide whether to reuse the random ID as the AS ID or to assign a new AS ID. FFS how this is signalled, which message is used and size of AS ID.
2. From device perspective, it is only required to use one AS ID.
3. CFRA is not supported for group ID
4. RAN2 assumes, AS ID is needed for CFRA at least for inventory + command procedure
5. For CFRA, if a valid AS ID is not already assigned, continue the discussion on AS-ID assignment based on the following options:
* Option 2: the device includes a random ID in “Msg 1”. And same as CBRA, it is up to Reader to decide whether to reuse the random ID as the AS ID or to assign a new AS ID.
* Option 3: New “Msg 2” for AS ID assignment, complementary option or independent from option 2
* Option 4: “Msg 2” (including the “Command”) for AS ID assignment, complementary option or independent from option 2
 |

**Agreements on segmentation**

1. To support segmentation, a 1 bit indication is introduced to indicate whether there is more data or not, if SA2 indicates that CN can provide an estimated expected D2R message size. If not possible, FFS if the 1 bit is sufficient.
2. Segment retransmission is supported.
3. For segment retransmission, reader explicitly indicates an offset in the MAC layer– e.g. number of bits successfully received so far (from the start). FFS This implies that unsegmented packet can also be retransmitted. FFS if this applies to msg3
4. R2D segmentation is not supported for R19 A-IoT.

**Agreements**

From RAN2 perspective only the following types of procedures will be considered in the normative phase: “Inventory only” and “Inventory and command”.

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| **Agreements on MAC PDU format design**1. Aim to design simple MAC PDU format design
2. Support multiplexing of information for multiple devices in R2D message for msg2. FFS others for multicast messages
3. At least the following field are required for at least for R2D in the MAC header– message type, length for SDU and variable part(s).
4. FFS whether for D2R we need message type field, any length and need for padding
5. Specify message types and contents. As starting point consider the following MAC message types.
	* + R2D MAC PDU (Paging/R2D trigger (depending on agreement on WF))
		+ D2R MAC PDU (MSG1) (FFS if this requires a MAC header or not)
		+ R2D MAC PDU (MSG2)
		+ D2R MAC PDU (MSG3 and data)
		+ R2D MAC PDU (R2D data)
		+ Other message types are FFS. The message types may evolve based on functionality agreements.
 |

RAN2#129bis agreements:

**Agreements**

* FFS which solution if any for device behavior if it gets a new service request while one procedure is still ongoing or leave it to implementation.
* RAN2 aims to design Rel-19 AIoT R2D messages extensible to accommodate devices and features of future release.

Agreements on CFRA

* Introduce an explicit 1 bit indication to indicate whether it is CFRA or CBRA per paging message.

**Agreements on paging ID length**

1. A field indicating Paging ID length information is always included together with the paging ID field in the A-IoT paging message, except the case where no ID is included in the A-IoT paging message.
2. The number of bits required for paging ID length field should be as small as possible. This would require the number of different Paging ID lengths to be small.
3. Send an LS to SA2 to tak this into account for their design.

**Agreements on msg1**

1. In case of CBRA, only 16 bits random ID is included in Msg1. FFS can be revisited if message type will be needed for other D2R messages purposes

2. RN16 is not included in the first D2R message in the CFRA procedure. AS ID is the only ID needed for addressing the device in R2D command message assuming for CFRA no multiple devices are performing the procedures with the given reader. FFS if we can assume or need to support multiple device scenario.

**Agreements on new R2D message**

1. A new R2D message other than the paging message is introduced for A-IoT device determining MSG1 resources unless RAN1 concludes to use L1 signaling. The R2D message indicates the start of a set of MSG1 resources that were configured in paging message.
2. Assumption: The R2D message does not include slot number/count down number.

**Agreements on msg 2**

1. A-IoT Msg2 contains one or multiple echoed random ID(s) from A-IoT Msg1 of different A-IoT devices.
2. Same Msg2 format is used for initial transmission and retransmission of Msg2.

**Agreements on NACK**

1. For CBRA, as a baseline, NACK based mechanism is applied only to the Msg3. May come back for D2R data, if the NACK feedback indication is needed for the purpose to stop/terminate the “on-going procedure” and release the AS ID accordingly (depending on other later discussion).
2. For msg3, we rely on whether the device receives NACK indication before subsequent R2D message to determine re-access. No need for a timer. FFS whether subsequent R2D message is trigger message or paging
3. For CFRA, NACK feedback and re-access is not supported. FFS how to achieve
4. FFS on end of procedure

**Agreements**

1 AS ID is applied for Inventory + command case;

2 AS ID is not included in D2R message except Msg 1 (RN16 in Msg 1 has been agreed.

3 For both CFRA and CBRA, the AS ID size is same as RN 16, i.e. 16 bits.

4 Do not specify the reader behaviour on how exactly the ASID is generated.

5 The device releases the AS ID upon power off (no stage 3 specification impact);

6 The device only keeps one AS ID at a time.

7 For CFRA, command message is used for AS ID assignment

8 For CBRA, Msg 2 is used for AS ID assignment

9 The device releases the AS ID at least:

 - upon receiving Paging with new transaction id for that device, i.e. different session/service

 - when it triggers new msg1 transmission as a result of receiving Paging message (i.e. it has to generate a random ID for CBRA)

 - FFS other cases for release ASID to avoid keeping it indefinitely.

**Agreements on segmentation**

1. For the retransmission of the first segment/unsegmented D2R message, the reader sends the R2D message by including the upper layer command again. FFS whether offset zero is always included.
2. FFS whether the reader always includes the command for retransmission of segments.
3. 1-bit indication is sufficient to indicate whether more D2R data will be sent
4. For inventory response, RAN2 assumes that segmentation is not applied. RAN2 assumes that the reader can avoid segmentation by reader being aware of inventory response size. Notify SA2 about this assumption.

**Agreements on MAC PDU format**

1. The MAC PDU should be byte-aligned, assuming the allocated TBS value is in the unit of byte. The actual TBS value depends on RAN1. FFS for R2D trigger message
2. RAN2 assumes that the upper layer data SDU is byte-aligned, and an LS can be sent to CT1.
3. The D2R MAC PDU size will correspond to the TBS size indicated in the R2D message
4. The MAC padding is supported at least for D2R from RAN2 perspective. The device includes padding bits if there is no more data and there is still space available in the TBS.
5. In case where MAC PDU includes both MAC SDU and padding, for D2R a field to indicate how many SDU bits are present is required. FFS how this is provided (i.e. SDU length field or padding length field). The size of length field is FFS.
* FFS whether we introduce D2R message type. Discuss after looking at the overall MAC header design and space before deciding whether we introduce message type or reserved bits