3GPP TS 38.321 V18.4.0 (2024-12)

Technical Specification

3rd Generation Partnership Project;

Technical Specification Group Radio Access Network;

NR;

Medium Access Control (MAC) protocol specification

(Release 18)

** 

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# 3 Definitions, symbols and abbreviations

## 3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1] 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].

**A2X communication**: A communication to support A2X services leveraging PC5 reference points, as defined in TS 23.256 [31]. A2X services are realized by various types of A2X applications, e.g., BRID or DAA.

**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 10,000 m and take-off/landing altitudes down to 3000 m.

**BWP for SRS for positioning Tx frequency hopping**:For SRS for positioning Tx frequency hopping, separate BWP configuration outside BWP configuration for data transmission.

**Dedicated SL-PRS resource pool**:A sidelink resource pool which can be used for the transmission of SL-PRS and cannot be used for the transmission of PSSCH.

**Dormant BWP**:The dormant BWP is one of downlink BWPs configured by the network via dedicated RRC signaling. In the dormant BWP, the UE stop monitoring PDCCH on/for the SCell, but continues performing CSI measurements, Automatic Gain Control (AGC) and beam management, if configured.

**DRX group**: A group of Serving Cells that is configured by RRC and that have the same DRX Active Time.

**eRedCap UE**: A UE with enhanced reduced capabilities as specified in clause 4.2.22.1 of TS 38.306 [25].

**HARQ information**: HARQ information for DL-SCH, for UL-SCH, or for SL-SCH transmissions consists of New Data Indicator (NDI), Transport Block Size (TBS), Redundancy Version (RV), and HARQ process ID.

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

**IAB-node**: RAN node that supports NR access links to UEs and NR backhaul links to parent nodes and child nodes.

**Listen Before Talk**: A procedure according to which transmissions are not performed if the channel is identified as being occupied, see TS 37.213 [18].

**LTM candidate cell**: A candidate cell configured for LTM as defined in TS 38.331 [5].

**Msg3**: Message transmitted on UL-SCH containing a C-RNTI MAC CE or CCCH SDU, submitted from upper layer and associated with the UE Contention Resolution Identity, as part of a Random Access procedure.

**Multi-path**: Mode of operation of a UE in RRC\_CONNECTED configured with one direct path on which the UE connects to gNB using NR Uu, and one indirect path on which the UE connects to the same gNB via another UE using PC5 unicast link or non-3GPP connection (N3C).

**Multi-PUSCH configured grant**: A configured grant configuration configured with *nrOfSlotsInCG-Period* (see TS 38.331 [5]). It includes multiple consecutive configured uplink grants within a single periodicity.

**N3C indirect path:** In Multi-path, the indirect path using Non-3GPP Connection between remote UE and relay UE.

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

**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 [19] and ProSe communication (including ProSe non-Relay, UE-to-Network Relay and UE-to-UE Relay communication (including ProSe UE-to-UE Relay communication with integrated discovery)) as defined in TS 23.304 [26], 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, ProSe UE-to-Network Relay discovery and ProSe UE-to-UE Relay discovery for Proximity based Services as defined in TS 23.304 [26], between two or more nearby UEs, using NR technology but not traversing any network node.

**NR sidelink transmission**: Any NR Sidelink-based transmission, including transmission for NR sidelink discovery, transmission for NR sidelink communication, transmission for Ranging/Sidelink Positioning, and transmission for A2X communication.

**PDCCH occasion**: A time duration (i.e. one or a consecutive number of symbols) during which the MAC entity is configured to monitor the PDCCH.

**Positioning SRS Bandwidth Aggregation**: Transmission of positioning SRS on multiple carriers in RRC\_CONNECTED and RRC\_INACTIVE where the positioning SRS resources are linked in RRC configuration as defined in TS 38.331 [5].

**PRS Processing Window**: A time window during which UE may perform PRS measurement inside the active DL BWP with the same numerology as the active DL BWP without measurement gap.

**Ranging/Sidelink Positioning**:AS functionality enabling ranging-based services and sidelink positioning as specified in TS 23.586 [30].

**RB set**: A RB set refers to a contiguous set of resource blocks (RBs) on which a channel access procedure is performed in shared spectrum as defined in TS 37.213 [18].

**RedCap UE**: A UE with reduced capabilities as specified in clause 4.2.21.1 in TS 38.306 [25].

**Serving Cell**: A PCell, a PSCell, or an SCell in TS 38.331 [5].

**Shared SL-PRS resource pool**:A sidelink resource pool which can be used for the transmission of both SL-PRS and PSSCH.

**Sidelink transmission information**: Sidelink transmission information included in an SCI for an SL-SCH transmission or SL-PRS transmission with or without SL-SCH transmission on Shared SL-PRS resource pool as specified in clause 8.3 and 8.4 of TS 38.212 [9] consists of Sidelink HARQ information including NDI, RV, Sidelink process ID, HARQ feedback enabled/disabled indicator, Sidelink identification information including cast type indicator, Source Layer-1 ID and Destination Layer-1 ID, and Sidelink other information including CSI request, SL-PRS request, SL-PRS resource ID, a priority, a communication range requirement and Zone ID and COT sharing information.

**SL-PRS delay budget**: Delay budget before which the SL-PRS is expected to be transmitted by the Tx UE.

**SL-PRS transmission information on Dedicated SL-PRS resource pool**:SL-PRS transmission information on Dedicated SL-PRS resource pool is included in an SCI for an SL-PRS transmission on Dedicated SL-PRS resource pool, as specified in TS 38.212 [9], consisting of

- SL-PRS identification information, including cast type indicator, source ID and destination ID;

- SL-PRS transmission other information, including SL-PRS priority, SL-PRS request, SL-PRS resource ID and resource reservation period.

**SRS for positioning Tx frequency hopping**: Transmit frequency hopping of positioning SRS in RRC\_INACTIVE and RRC\_CONNECTED.

**SRS positioning validity area**:An area consisting of a list of cells within which the corresponding positioning SRS configuration is considered as valid.

**Special Cell**: For Dual Connectivity operation the term Special Cell refers to the PCell of the MCG or the PSCell of the SCG depending on if the MAC entity is associated to the MCG or the SCG, respectively. Otherwise the term Special Cell refers to the PCell. A Special Cell supports PUCCH transmission and contention-based Random Access, and is always activated.

**Timing Advance Group**: A group of Serving Cells that is configured by RRC and that, for the cells with a UL configured, using the same timing reference cell and the same Timing Advance value. A Timing Advance Group containing the SpCell of a MAC entity is referred to as Primary Timing Advance Group (PTAG), whereas the term Secondary Timing Advance Group (STAG) refers to other TAGs.

**UE-gNB RTT**: For non-terrestrial networks, the sum of the UE's Timing Advance value (see TS 38.211 [8] clause 4.3.1) and *kmac*.

**V2X sidelink communication**: AS functionality enabling V2X Communication as defined in TS 23.285 [20], between nearby UEs, using E-UTRA technology but not traversing any network node.

NOTE 1: A timer is running once it is started, until it is stopped or until it expires; otherwise it is not running. A timer can be started if it is not running or restarted if it is running. A Timer is always started or restarted from its initial value. The duration of a timer is not updated until it is stopped or expires (e.g. due to BWP switching). When the MAC entity applies zero value for a timer, the timer shall be started and immediately expire unless explicitly stated otherwise.

NOTE 2: In this version of the specification, the SRS in the procedural description includes Positioning SRS except for the Positioning SRS for transmission in RRC\_INACTIVE as in clause 5.26. Positioning SRS except for the Positioning SRS for transmission in RRC\_INACTIVE is treated the same as SRS by the UE unless explicitly stated otherwise.

## 3.2 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] 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].

A2X Aircraft-to-Everything

AP Aperiodic

BFR Beam Failure Recovery

BRID Broadcast Remote Identification

BSR Buffer Status Report

BWP Bandwidth Part

CE Control Element

CG Cell Group

CG-SDT Configured Grant-based SDT

CI-RNTI Cancellation Indication RNTI

CSI Channel State Information

CSI-IM CSI Interference Measurement

CSI-RS CSI Reference Signal

CS-RNTI Configured Scheduling RNTI

DAA Detect And Avoid

DAPS Dual Active Protocol Stack

DCP DCI with CRC scrambled by PS-RNTI

DL-PRS DownLink-Positioning Reference Signal

DSR Delay Status Report

DTX Discontinuous Transmission

G-CS-RNTI Group Configured Scheduling RNTI

G-RNTI Group RNTI

IAB Integrated Access and Backhaul

INT-RNTI Interruption RNTI

LBT Listen Before Talk

LCG Logical Channel Group

LCP Logical Channel Prioritization

LTM L1/L2 Triggered Mobility

MBS Multicast/Broadcast Services

MCCH MBS Control Channel

MCCH-RNTI MBS Control Channel RNTI

MCG Master Cell Group

MO-SDT Mobile Originated SDT

MPE Maximum Permissible Exposure

MTCH MBS Traffic Channel

MT-SDT Mobile Terminated SDT

N3C Non-3GPP Connection

NCD-SSB Non Cell Defining SSB

NCR Network-Controlled Repeater

NSAG Network Slice AS Group

NUL Normal Uplink

NZP CSI-RS Non-Zero Power CSI-RS

PDB Packet Delay Budget

PEI-RNTI Paging Early Indication RNTI

PHR Power Headroom Report

PQI PC5 QoS Identifier

PS-RNTI Power Saving RNTI

PSI PDU Set Importance

PTAG Primary Timing Advance Group

PTM Point to Multipoint

PTP Point to Point

QCL Quasi-colocation

PPW PRS Processing Window

PRS Positioning Reference Signal

RA-SDT Random Access-based SDT

RRH Remote Radio Head

RS Reference Signal

SCG Secondary Cell Group

SDT Small Data Transmission

SFI-RNTI Slot Format Indication RNTI

SI System Information

SL-PRS-CS-RNTI SL-PRS-Configured Scheduling-RNTI

SL-PRS-RNTI SL-PRS-RNTI

SL-CS-RNTI Sidelink-Configured Scheduling-RNTI

SL-PRS Sidelink-PRS

SL-RNTI Sidelink-RNTI

SpCell Special Cell

SP Semi-Persistent

SP-CSI-RNTI Semi-Persistent CSI RNTI

SPS Semi-Persistent Scheduling

SR Scheduling Request

SRI SRS Resource Indicator

SS Synchronization Signals

SSB Synchronization Signal Block

STAG Secondary Timing Advance Group

STx2P Simultaneous Transmission with 2 Panels

SUL Supplementary Uplink

TAG Timing Advance Group

TCI Transmission Configuration Indicator

TPC-SRS-RNTI Transmit Power Control-Sounding Reference Signal-RNTI

TRIV Time Resource Indicator Value

TRP Transmit/Receive Point

TRS CSI-RS for tracking

U2N UE-to-Network

U2U UE-to-UE

UCI Uplink Control Information

UTO-UCI Unused Transmission Occasion - UCI

UTW Uplink Time Window

V2X Vehicle-to-Everything

ZP CSI-RS Zero Power CSI-RS

# 5 MAC procedures

## 5.4 UL-SCH data transfer

### 5.4.9 Delay status reporting

The Delay Status Reporting (DSR) procedure is used to provide the serving gNB with delay status of LCGs. This delay status for an LCG includes remaining time for a certain DSR reporting threshold, which is the smallest remaining value of the running PDCP *discardTimer*s among PDCP SDUs that are buffered for the LCG but have not been transmitted in any MAC PDU as specified in clause 7.3 in TS 38.323 [4], and the total amount of UL data for a certain DSR reporting threshold for the LCG according to the data volume calculation procedure specified in clause 5.5 in TS 38.322 [3] and clause 5.15 in TS 38.323 [4] for the associated RLC and PDCP entities, respectively.

RRC controls the DSR procedure by configuring the following parameter:

- *remainingTimeThreshold* (per LCG): the DSR triggering threshold on remaining time for triggering a DSR for a logical channel within an LCG. Also serves as the DSR reporting threshold on remaining time for the content of DSR when the field *dsr-ReportingThresList* is not configured.

- *dsr-ReportingThresList* (per LCG): the DSR reporting threshold for determining the content of DSR.

If an LCG is configured for delay status reporting, the MAC entity shall for each logical channel within the LCG:

1> if the smallest remaining value of the running PDCP *discardTimer*s among all the PDCP SDUs buffered for the logical channel that have not been transmitted in any MAC PDU and have not been reported as data volume in a DSR MAC CE becomes below *remainingTimeThreshold* of the LCG; and

1> if there is no DSR pending for the logical channel:

2> trigger a DSR for the logical channel.

If there is at least one DSR pending, the MAC entity shall:

1> if UL-SCH resources are available for a new transmission and the UL-SCH resources can accommodate the DSR MAC CE plus its subheader as a result of logical channel prioritization:

2> instruct the Multiplexing and Assembly procedure to generate the DSR MAC CE as specified in clause 6.1.3.72.

1> else if there is no pending SR already triggered by the DSR procedure for the same logical channel as of this DSR:

2> trigger a Scheduling Request.

NOTE 1: The availability of UL-SCH resources for the transmission of the DSR MAC CE follows the same critieria specified in clause 5.4.5.

A PDCP SDU is considered to be associated with a DSR if it has not been transmitted in any MAC PDU and is a delay-critical PDCP SDU (as defined in TS 38.323 [4]) associated with the logical channel which triggered the DSR.

A MAC PDU shall contain at most one DSR MAC CE. A MAC PDU shall not contain a DSR MAC CE if it includes all PDCP SDUs associated with all the pending DSRs.

After a DSR is triggered, it is considered as pending until it is cancelled. The MAC entity shall cancel a pending DSR, when all the PDCP SDUs associated with the DSR have been discarded, or when a MAC PDU is transmitted and this MAC PDU includes a DSR MAC CE that contains the delay information of all the PDCP SDUs associated with the DSR (as described in the clause 6.1.3.72), or when a MAC PDU is transmitted and this MAC PDU includes all the PDCP SDUs associated with the DSR.

NOTE 2: It is up to UE implementation whether the MAC entity includes a DSR MAC CE in a MAC PDU if the MAC PDU can accommodate all PDCP SDUs associated with all the pending DSRs but is not sufficient to additionally accommodate the DSR MAC CE plus its subheader.