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650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
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Foreword

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1 Scope

The present document defines the NR UE Radio Access Capability Parameters.

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 38.101-1: "NR; User Equipment (UE) radio transmission and reception Part 1: Range 1 Standalone".
- [3] 3GPP TS 38.101-2: "NR; User Equipment (UE) radio transmission and reception Part 2: Range 2 Standalone".
- [4] 3GPP TS 38.101-3: "NR; User Equipment (UE) radio transmission and reception Part 3: Range 1 and Range 2 Interworking operation with other radios".
- [5] 3GPP TS 38.133: "NR; Requirements for support of radio resource management".
- [6] 3GPP TS 38.211: "NR; Physical channels and modulation".
- [7] 3GPP TS 37.340: "Evolved Universal Terrestrial Radio Access (E-UTRA) and NR Multi-connectivity".
- [8] 3GPP TS 38.321: "NR; Medium Access Control (MAC) protocol specification".
- [9] 3GPP TS 38.331: "NR; Radio Resource Control (RRC) protocol specification".
- [10] 3GPP TS 38.212: "NR; Multiplexing and channel coding".
- [11] 3GPP TS 38.213: "NR; Physical layer procedures for control".
- [12] 3GPP TS 38.214: "NR; Physical layer procedures for data".
- [13] 3GPP TS 38.215: "NR; Physical layer measurements".
- [14] 3GPP TS 36.101: "Evolved Universal Terrestrial Radio Access (E-UTRA) radio transmission and reception".
- [15] 3GPP TS 36.306: "Evolved Universal Terrestrial Radio Access (E-UTRA) User Equipment (UE) radio access capabilities".
- [16] 3GPP TS 38.323: "NR; Packet Data Convergence Protocol (PDCP) specification".
- [17] 3GPP TS 36.331: "Evolved Universal Terrestrial Radio Access (E-UTRA) Radio Resource Control (RRC); Protocol Specification".
- [18] 3GPP TS 38.101-4: "NR; User Equipment (UE) radio transmission and reception Part 4: Performance requirements".
- [19] 3GPP TS 36.213: "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical layer procedures".

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].

Fallback band combination: A band combination that would result from another band combination by releasing at least one SCell or uplink configuration of SCell, or SCG. An intra-band non-contiguous band combination is not considered to be a fallback band combination of an intra-band contiguous band combination.

Fallback per band feature set: A feature set per band that has same or lower values than the reported values from the reported feature set per band for a given band.

Fallback per CC feature set: A feature set per CC that has lower value of UE supported MIMO layers and BW while keeping the numerology and other parameters the same from the reported feature set per CC for a given carrier per band.

3.2 Symbols

For the purposes of the present document, the following symbols apply:

MaxDLDataRate:	Maximum DL data rate
MaxDLDataRate_MN:	Maximum DL data rate in the MN
MaxDLDataRate_SN:	Maximum DL data rate in the SN
MaxULDataRate:	Maximum UL data rate

3.3 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].

BC	Band Combination
DL	Downlink
FS	Feature Set
FSPC	Feature Set Per Component-carrier
MAC	Medium Access Control
MCG	Master Cell Group
MN	Master Node
MR-DC	Multi-RAT Dual Connectivity
PDCP	Packet Data Convergence Protocol
RLC	Radio Link Control
RTT	Round Trip Time
SCG	Secondary Cell Group
SDAP	Service Data Adaptation Protocol
SN	Secondary Node
UL	Uplink

4 UE radio access capability parameters

4.1 Supported max data rate

4.1.1 General

The DL and UL max data rate supported by the UE is calculated by band or band combinations supported by the UE. A UE supporting NR (NR SA, MR-DC) shall support the calculated DL and UL max data rate defined in 4.1.2.

4.1.2 Supported max data rate

For NR, the approximate data rate for a given number of aggregated carriers in a band or band combination is computed as follows.

$$\text{data rate (in Mbps)} = 10^{-6} \cdot \sum_{j=1}^J \left(v_{\text{Layers}}^{(j)} \cdot Q_m^{(j)} \cdot f^{(j)} \cdot R_{\text{max}} \cdot \frac{N_{\text{PRB}}^{BW^{(j)},\mu} \cdot 12}{T_s^\mu} \cdot (1 - OH^{(j)}) \right)$$

wherein

J is the number of aggregated component carriers in a band or band combination

$R_{\text{max}} = 948/1024$

For the j -th CC,

$v_{\text{Layers}}^{(j)}$ is the maximum number of supported layers given by higher layer parameter *maxNumberMIMO-LayersPDSCH* for downlink and maximum of higher layer parameters *maxNumberMIMO-LayersCB-PUSCH* and *maxNumberMIMO-LayersNonCB-PUSCH* for uplink.

$Q_m^{(j)}$ is the maximum supported modulation order given by higher layer parameter *supportedModulationOrderDL* for downlink and higher layer parameter *supportedModulationOrderUL* for uplink.

$f^{(j)}$ is the scaling factor given by higher layer parameter *scalingFactor* and can take the values 1, 0.8, 0.75, and 0.4.

μ is the numerology (as defined in TS 38.211 [6])

T_s^μ is the average OFDM symbol duration in a subframe for numerology μ , i.e. $T_s^\mu = \frac{10^{-3}}{14 \cdot 2^\mu}$. Note that normal cyclic prefix is assumed.

$N_{\text{PRB}}^{BW^{(j)},\mu}$ is the maximum RB allocation in bandwidth $BW^{(j)}$ with numerology μ , as defined in 5.3 TS 38.101-1 [2] and 5.3 TS 38.101-2 [3], where $BW^{(j)}$ is the UE supported maximum bandwidth in the given band or band combination.

$OH^{(j)}$ is the overhead and takes the following values

0.14, for frequency range FR1 for DL
 0.18, for frequency range FR2 for DL
 0.08, for frequency range FR1 for UL
 0.10, for frequency range FR2 for UL

NOTE: Only one of the UL or SUL carriers (the one with the higher data rate) is counted for a cell operating SUL.

The approximate maximum data rate can be computed as the maximum of the approximate data rates computed using the above formula for each of the supported band or band combinations.

For EUTRA in case of MR-DC, the approximate data rate for a given number of aggregated carriers in a band or band combination is computed as follows.

$$\text{Data rate (in Mbps)} = 10^{-3} \cdot \sum_{j=1}^J TBS_j$$

wherein

J is the number of aggregated EUTRA component carriers in MR-DC band combination

TBS_j is the total maximum number of DL-SCH transport block bits received within a 1ms TTI for j -th CC, as derived from TS36.213 [19] based on the UE supported maximum MIMO layers for the j -th CC, and based on the maximum modulation order for the j -th CC and number of PRBs based on the bandwidth of the j -th CC according to indicated UE capabilities.

The approximate maximum data rate can be computed as the maximum of the approximate data rates computed using the above formula for each of the supported band or band combinations.

For MR-DC, the approximate maximum data rate is computed as the sum of the approximate maximum data rates from NR and EUTRA.

4.1.3 Void

4.1.4 Total layer 2 buffer size

The total layer 2 buffer size is defined as the sum of the number of bytes that the UE is capable of storing in the RLC transmission windows and RLC reception and reordering windows and also in PDCP reordering windows for all radio bearers.

The required total layer 2 buffer size in MR-DC and NR-DC is the maximum value of the calculated values based on the following equations:

- $MaxULDataRate_{MN} * RLCRTT_{MN} + MaxULDataRate_{SN} * RLCRTT_{SN} + MaxDLDataRate_{SN} * RLCRTT_{SN} + MaxDLDataRate_{MN} * (RLCRTT_{SN} + X2/Xn \text{ delay} + \text{Queuing in SN})$
- $MaxULDataRate_{MN} * RLCRTT_{MN} + MaxULDataRate_{SN} * RLCRTT_{SN} + MaxDLDataRate_{MN} * RLCRTT_{MN} + MaxDLDataRate_{SN} * (RLCRTT_{MN} + X2/Xn \text{ delay} + \text{Queuing in MN})$

Otherwise it is calculated by $MaxDLDataRate * RLC \text{ RTT} + MaxULDataRate * RLC \text{ RTT}$.

NOTE: Additional L2 buffer required for preprocessing of data is not taken into account in above formula.

The required total layer 2 buffer size is determined as the maximum total layer 2 buffer size of all the calculated ones for each band combination and the applicable Feature Set combination in the supported MR-DC or NR band combinations. The RLC RTT for NR cell group corresponds to the smallest SCS numerology supported in the band combination and the applicable Feature Set combination.

wherein

$X2/Xn \text{ delay} + \text{Queuing in SN} = 25\text{ms}$ if SCG is NR, and 55ms if SCG is EUTRA

$X2/Xn \text{ delay} + \text{Queuing in MN} = 25\text{ms}$ if MCG is NR, and 55ms if MCG is EUTRA

RLC RTT for EUTRA cell group = 75ms

RLC RTT for NR cell group is defined in Table 4.1.4-1

Table 4.1.4-1: RLC RTT for NR cell group per SCS

SCS (KHz)	RLC RTT (ms)
15KHz	50
30KHz	40
60KHz	30
120KHz	20

4.2 UE Capability Parameters

4.2.1 Introduction

The following clauses define the UE radio access capability parameters. Only parameters for which there is the possibility for UEs to signal different values are considered as UE radio access capability parameters. Therefore, mandatory features without capability parameters that are the same for all UEs are not listed here.

The network needs to respect the signalled UE radio access capability parameters when configuring the UE and when scheduling the UE.

The UE may support different functionalities between FDD and TDD, and/or between FR1 and FR2. The UE shall indicate the UE capabilities as follows. In the table of UE capability parameter in subsequent clauses, "Yes" in the column by "FDD-TDD DIFF" and "FR1-FR2 DIFF" indicates the UE capability field can have a different value for between FDD and TDD or between FR1 and FR2 and "No" indicates if it cannot. "FD" in the column indicates to refer the associated field description. "FR1 only" or "FR2 only" in the column indicates the associated feature is only supported in FR1 or FR2 and "TDD only" indicates the associated feature is only supported in TDD.

- 1> set all fields of UE-NR/MRDC-Capability except fdd-Add-UE-NR/MRDC-Capabilities, tdd-Add-UE-NR/MRDC-Capabilities, fr1-Add-UE-NR/MRDC-Capabilities and fr2-Add-UE-NR/MRDC-Capabilities, to include the values applicable for all duplex mode(s) and frequency range(s) that the UE supports;
- 1> if UE supports both FDD and TDD and if (some of) the UE capability fields have a different value for FDD and TDD
 - 2> if for FDD, the UE supports additional functionality compared to what is indicated by the previous fields of UE-NR/MRDC-Capability:
 - 3> include field fdd-Add-UE-NR/MRDC-Capabilities and set it to include fields reflecting the additional functionality applicable for FDD;
 - 2> if for TDD, the UE supports additional functionality compared to what is indicated by the previous fields of UE-NR/MRDC-Capability:
 - 3> include field tdd-Add-UE-NR/MRDC-Capabilities and set it to include fields reflecting the additional functionality applicable for TDD;
- 1> if UE supports both FR1 and FR2 and if (some of) the UE capability fields have a different value for FR1 and FR2:
 - 2> if for FR1, the UE supports additional functionality compared to what is indicated by the previous fields of UE-NR/MRDC-Capability:
 - 3> include field fr1-Add-UE-NR/MRDC-Capabilities and set it to include fields reflecting the additional functionality applicable for FR1;
 - 2> if for FR2, the UE supports additional functionality compared to what is indicated by the previous fields of UE-NR/MRDC-Capability:
 - 3> include field fr2-Add-UE-NR/MRDC-Capabilities and set it to include fields reflecting the additional functionality applicable for FR2;

NOTE: The fields which indicate "shall be set to 1" or "shall be set to *supported*" in the following tables means these features are purely mandatory and are assumed they are the same as mandatory without capability signaling.

For optional features, the UE radio access capability parameter indicates whether the feature has been implemented and successfully tested. For mandatory features with the UE radio access capability parameter, the parameter indicates whether the feature has been successfully tested. In the table of UE capability parameter in subsequent clauses, "Yes" in the column by "M" indicates the associated feature is mandatory and "No" indicates the associated feature is optional. "CY" in the column indicates the associated feature is conditional mandatory and the condition is described in the field description. "FD" in the column indicates to refer the associated field description. Some parameters in subsequent clauses are not related to UE features and in the case, "N/A" is indicated in the column.

UE capability parameters have hierarchical structure. In the table of UE capability parameter in subsequent clauses, "Per" indicates the level the associated parameter is included. "UE" in the column indicates the associated parameter is signalled per UE, "Band" indicates it is signalled per band, "BC" indicates it is signalled per band combination, "FS" indicates it is signalled per feature set (per band per band combination), "FSPC" indicates it is signalled per feature set per component carrier (per CC per band per band combination), and "FD" in the column indicates to refer the associated field description.

4.2.2 General parameters

Definitions for parameters	Per	M	FDD-TDD DIFF	FR1-FR2 DIFF
accessStratumRelease Indicates the access stratum release the UE supports as specified in TS 38.331 [9].	UE	Yes	No	No
delayBudgetReporting Indicates whether the UE supports delay budget reporting as specified in TS 38.331 [9].	UE	No	No	No
inactiveState Indicates whether the UE supports RRC_inactive as specified in TS 38.331 [9].	UE	Yes	No	No
overheatingInd Indicates whether the UE supports overheating assistance information.	UE	No	No	No
reducedCP-Latency Indicates whether the UE supports reduced control plane latency as defined in TS 38.331 [9].	UE	No	No	No
splitSRB-WithOneUL-Path Indicates whether the UE supports UL transmission via MCG path and DL reception via either MCG path or SCG path, as specified for the split SRB in TS 37.340 [7]. The UE shall only set the bit in UE-MRDC-Capability -> generalParametersMRDC. It shall not set the FDD/TDD specific fields.	UE	No	No	No
splitDRB-withUL-Both-MCG-SCG Indicates whether the UE supports UL transmission via both MCG path and SCG path for the split DRB as specified in TS 37.340 [7]. The UE shall only set the bit in UE-MRDC-Capability -> generalParametersMRDC. It shall not set the FDD/TDD specific fields.	UE	Yes	No	No
srb3 Indicates whether the UE supports direct SRB between the SN and the UE as specified in TS 37.340 [7]. The UE shall only set the bit in UE-MRDC-Capability -> generalParametersMRDC. It shall not set the FDD/TDD specific fields. This field is not applied to NE-DC.	UE	Yes	No	No
v2x-EUTRA Indicates whether the UE supports EUTRA V2X according to <i>UE-EUTRA-Capability</i> as defined in TS 36.331 [17], independent of the configured EN-DC band combination. This field is only applied to EN-DC. In UE-NR-Capability, this field is not used, and UE does not include the field.	UE	No	Yes	No

4.2.3 SDAP Parameters

Definitions for parameters	Per	M	FDD-TDD DIFF
as-ReflectiveQoS Indicates whether the UE supports AS reflective QoS.	UE	No	No

4.2.4 PDCP Parameters

Definitions for parameters	Per	M	FDD-TDD DIFF
continueROHC-Context Defines whether the UE supports ROHC context continuation operation where the UE does not reset the current ROHC context upon PDCP re-establishment, as specified in TS 38.323 [16].	UE	No	No
maxNumberROHC-ContextSessions Defines the maximum number of header compression context sessions supported by the UE, excluding context sessions that leave all headers uncompressed.	UE	No	No
outOfOrderDelivery Indicates whether UE supports out of order delivery of data to upper layers by PDCP.	UE	No	No
pdcp-DuplicationMCG-OrSCG-DRB Indicates whether the UE supports CA-based PDCP duplication over MCG or SCG DRB as specified in TS 38.323 [16].	UE	No	No
pdcp-DuplicationSplitDRB Indicates whether the UE supports PDCP duplication over split DRB as specified in TS 38.323 [16].	UE	No	No
pdcp-DuplicationSplitSRB Indicates whether the UE supports PDCP duplication over split SRB1/2 as specified in TS 38.323 [16].	UE	No	No
pdcp-DuplicationSRB Indicates whether the UE supports CA-based PDCP duplication over SRB1/2 and/or, if EN-DC is supported, SRB3 as specified in TS 38.323 [16].	UE	No	No
shortSN Indicates whether the UE supports 12 bit length of PDCP sequence number.	UE	Yes	No
supportedROHC-Profiles Defines which ROHC profiles from the list below are supported by the UE: <ul style="list-style-type: none"> - 0x0000 ROHC No compression (RFC 5795) - 0x0001 ROHC RTP/UDP/IP (RFC 3095, RFC 4815) - 0x0002 ROHC UDP/IP (RFC 3095, RFC 4815) - 0x0003 ROHC ESP/IP (RFC 3095, RFC 4815) - 0x0004 ROHC IP (RFC 3843, RFC 4815) - 0x0006 ROHC TCP/IP (RFC 6846) - 0x0101 ROHC RTP/UDP/IP (RFC 5225) - 0x0102 ROHC UDP/IP (RFC 5225) - 0x0103 ROHC ESP/IP (RFC 5225) - 0x0104 ROHC IP (RFC 5225) A UE that supports one or more of the listed ROHC profiles shall support ROHC profile 0x0000 ROHC uncompressed (RFC 5795).	UE	No	No
uplinkOnlyROHC-Profiles Indicates which ROHC profile(s) from the list below are supported in uplink-only ROHC operation by the UE. <ul style="list-style-type: none"> - 0x0006 ROHC TCP (RFC 6846) A UE that supports uplink-only ROHC profile(s) shall support ROHC profile 0x0000 ROHC uncompressed (RFC 5795).	UE	No	No