**3GPP TSG-RAN WG4 Meeting # 96-e R4-2011680**

**Electronic Meeting, 17-28 Aug., 2020**

**Agenda item:** 8

**Source:** CMCC

**Title:** RAN4 UE features list for Rel-16

**Document for:** Approval

1. Introduction

This is a document for Rel-16 LTE and NR UE features. The document in previous RAN4 meeting is R4-2009174.

1. NR UE feature
   1. NR-based access to unlicensed spectrum

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| Features | Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (V2X WI only)”. | **Consequence if the feature is not supported by the UE** | **Type**  **(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional |
|  | 4-1 | Reception in intra-carrier guardband | Capability of reception in the intra-cell guardband between contiguous subbands in DL wideband carrier operation mode 2 or mode 3 wider than 20MHz | [10-19b] or [10-19c] | yes | no | UE cannot receive in the guardband, it could only receive in the subbands | per Band | No | No |  |  | Optional with capability signalling |
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* 1. NR mobility enhancement

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| 5. Mobility Enhancement | 5-1 | Synchronous DAPS handover for intra-frequency case | 1. Support of synchronous DAPS handover for intra-frequency case |  | Yes | N/A | The network cannot configure UE with DAPS HO in corresponding scenario | Note 1 | No | No | N/A |  | Optional with capability signalling |
| 5-2 | Asynchronous DAPS handover for intra-frequency case | 1. Support of asynchronous DAPS handover for intra-frequency case |  | Yes | N/A | The network cannot configure UE with DAPS HO in corresponding scenario | Note 1 | No | No | N/A |  | Optional with capability signalling |
| 5-3 | Synchronous DAPS handover for inter-frequency case | 1. Support of synchronous DAPS handover for inter-frequency case |  | Yes | N/A | The network cannot configure UE with DAPS HO in corresponding scenario | Per BC | No | No | N/A |  | Optional with capability signalling |
| 5-4 | Asynchronous DAPS handover for inter-frequency case | 1. Support of asynchronous DAPS handover for inter-frequency case |  | Yes | N/A | The network cannot configure UE with DAPS HO in corresponding scenario | Per BC | No | No | N/A |  | Optional with capability signalling |
| 5-5 | Simultaneous UL transmission for DAPS handover for intra-frequency | 1. Support of simultaneous UL transmission for DAPS handover for intra-frequency case | 1) Support any FG of 5-1, 5-2, 5-3 and 5-4  2) Supports any of the power sharing FG (in RAN1 feature list) 21-2/2a/2b | Yes | N/A | The network cannot configure the UE with simultaneous uplink transmission for DAPS handover in corresponding scenario | Note 1 | No | No | N/A | If the 5-5 is absent, the default is UE does NOT support simultaneous transmission | Optional with capability signalling |
| 5-6 | Simultaneous UL transmission for DAPS handover for inter-frequency | 1. Support of simultaneous UL transmission for DAPS handover for inter-frequency case | 1) Support any FG of 5-1, 5-2, 5-3 and 5-4  2) Supports any of the power sharing FG (in RAN1 feature list) 21-2/2a/2b | Yes | N/A | The network cannot configure the UE with simultaneous uplink transmission for DAPS handover in corresponding scenario | Per BC | No | No | N/A | If the 5-6 is absent, the default is UE does NOT support simultaneous transmission | Optional with capability signalling |
| 5-7 | Support of multi TAG for intra-frequency | 1. Support of different TAGs in source and target cells for intra-frequency case | Support any FG of 5-1, 5-2, 5-3 and 5-4 | Yes | N/A | The network cannot configure the different TAGs for uplink transmission for DAPS HO | Note 1 | No | No | N/A | If the 5-7 is absent, the default is UE supports different TAGs in source and target cells | Optional with capability signalling |
| 5-8 | Support of multi TAG for inter-frequency | 1. Support of different TAGs in source and target cells for inter-frequency case | Support any FG of 5-1, 5-2, 5-3 and 5-4 | Yes | N/A | The network cannot configure the different TAGs for uplink transmission for DAPS HO | Per BC | No | No | N/A | If the 5-8 is absent, the default is UE supports different TAGs in source and target cells | Optional with capability signalling |
| 5-9 | Support of different SCS-s in source and target cells for intra-frequency | 1. Support of different SCS-s in source and target cells for intra-frequency case | Support any FG of 5-1, 5-2, 5-3 and 5-4 | Yes | N/A | The network cannot configure different SCS-s in source and target cells | Note 1 | No | No | N/A | If the 5-9 is absent, the default is UE does NOT support different SCS-s in source and target cells | Optional with capability signalling |
| 5-10 | Support of different SCS-s in source and target cells for inter-frequency | 1. Support of different SCS-s in source and target cells for inter-frequency case | Support any FG of 5-1, 5-2, 5-3 and 5-4 | Yes | N/A | The network cannot configure different SCS-s in source and target cells | Per BC | No | No | N/A | If the 5-10 is absent, the default is UE does NOT support different SCS-s in source and target cells | Optional with capability signalling |
| Note 1: RAN4 agreed not to further discuss the type of capabilities signalling for intra-frequency DAPS features 5-1, 5-2, 5-5, 5-7 and 5-9. Decision can be made in RAN2.  Note 2: RAN4 assumes RAN2 will include all parameters mentioned in LS (R4-1915781) into the UE capabilities signalling. | | | | | | | | | | | | | |
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* 1. Multi-RAT Dual-Connectivity and Carrier Aggregation enhancements

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| Features | Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (V2X WI only)”. | **Consequence if the feature is not supported by the UE** | **Type**  **(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional |
| 6. LTE\_NR\_DC\_CA\_enh | [6-1] | [Only supporting single switched UL ] | [Only supporting single switched UL for specific ENDC combination] | N/A | Yes | N/A | UE can’t support the specific ENDC combination | Per BC | No | FR1 only | N/A | This capability is only allowed for specific band combinations that are specified in 38.101-3. If this capability isn’t supported for the specific ENDC combination, the UE can support simultaneous UL transmissions when the ENDC combination is supported. UE can’t simultaneously report this capability and IE “*singleUL-Transmission*” for the specific ENDC combination. IE “*tdm-Pattern*” will be reused to indicate whether the UE supports the *tdm-PatternConfig* for this capability associated functionality. The field doesn’t apply to any other fallback band combinations.  For super set combination, the UL configuration can refer to sub-clause 5.5B.4.1 from 38.101-3. | Optional with capability signalling |
| 6-2 | Support of beam level Early Measurement Reporting | Supporting of beam level measurement and reporting when in NR Idle/Inactive mode for Early Measurement Reporting at connection setup. | *idleInactiveNR-MeasReport-r16* | Yes | N/A | Network cannot configure beam-level reporting to UE for EMR | Per UE | No | Yes | N/A |  | Optional with capability signalling |
| 6-3a | Support of beam level Early Measurement Reporting | Supporting of NR beam level measurement and reporting when in LTE Idle/Inactive mode for Early Measurement Reporting at connection setup for FR1 | endc-IdleInactiveMeasFR1-r16 | Yes | N/A | Network cannot configure beam-level reporting to UE for EMR | Per UE | No | N/A | N/A |  | Optional with capability signalling |
| 6-3b | Support of beam level Early Measurement Reporting | Supporting of NR beam level measurement and reporting when in LTE Idle/Inactive mode for Early Measurement Reporting at connection setup for FR2 | endc-IdleInactiveMeasFR2-r16 | Yes | N/A | Network cannot configure beam-level reporting to UE for EMR | Per UE | No | N/A | N/A |  | Optional with capability signalling |
| Note 1: 6-3a and 6-3b are LTE features. | | | | | | | | | | | | | |
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* 1. RF requirements for NR frequency range 1 (FR1)

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| 7. RF requirements for NR frequency range 1 (FR1) | 7-1 | Dynamic Tx switching between two uplink carriers | 1. Indicate support of dynamic UL Tx switching between two uplink carriers for inter-band UL CA, SUL or inter-band EN-DC 2. Indicate the supported switching period for Tx switching between two uplink carriers in inter-band EN-DC, inter-band UL CA or SUL band combinations |  | Yes | N/A | UE does not support Tx switching between two uplink carriers for inter-band EN-DC, inter-band UL CA and SUL band combinations. | UE signals supported switching period per pair of UL bands per band combination | No need | FR1 only | N/A | Candidate value set for UL CA and SUL combinations: {35us, 140 us, 210us}  Candidate value set for EN-DC:  {35us, 140 us}  NOTE: Signalling structure is up to RAN2  If UE reports support of this feature group, it means UE supports both components. | Optional with capability signalling |
| 7-2 | Application of DL interruptions due to UL Tx switching between two uplink carriers | Capability to indicate that for the band where DL interruption is needed, the RRM interruption requirements defined in RAN4 shall be applied for duplex mode combinations except the combinations   * SUL+TDD * TDD+TDD CA with the same UL-DL pattern * TDD+TDD EN-DC with the same UL-DL pattern | 7-1 | Yes | N/A | UE not reporting this capability means DL interruption is not required | UE capability is defined as per band per band combination for each band pair supporting UL Tx switching | No need | FR1 only | N/A | The capability is introduced according to the agreement in R4-2005665.  NOTE: Signalling structure is up to RAN2  The following duplex mode combinations do not require DL interruption (carrier 1+ carrier 2):   * SUL+TDD, * TDD+TDD CA with the same UL-DL pattern, * TDD+TDD EN-DC with the same UL-DL pattern   RAN4 will specify for UL CA and EN-DC for which band combinations DL interruptions are allowed. | Optional with capability signalling |
| 7-3a | NR CA class List for intra-band non-contiguous CA | [Option 2:]  Indicate the maximum UL frequency separation that UE can support which includes the gap between two non-contiguous CCs for intra-band non-contiguous CA  Note: maximum UL frequency separation means maximum frequency span between lower edge of lowest component carrier and upper edge of highest component carrier that UE can support in uplink | Intra-band UL non-contiguous CA band combination | Yes | N/A | [Network cannot schedule intra-band non-contiguous UL CA transmission properly] | For Option 1 in component item: Type 3 (per BC)  For Option 2 in component item: Type 4 (per FS)  For Option 3 in component item, Type 3 (per-BC) for component 1 and 2, Type 5 (per FSPC) for component 3 | No need | FR1 only | N/A | Based on the agreed WF R4-2005660 both 1PA and 2PA architecture for intra-band non-contiguous UL CA will be considered for UE capability, and MIMO supporting with 4TX for 2PA UL NC CA should not be excluded.  The maximum UL CC number for intra-band UL CA is 2 in Rel-16.  [NC CA bandwidth class candidate values:   * Class1: NC CA separation class≤ 100MHz * Class2: 100< NC CA separation class≤ 200MHz * Class3: NC CA separation class > 200MHz and <600MHz] | Optional with capability signalling |
| 7-3b | NR CA class List for Intra-band contiguous CA | 1. Indicate the contiguous CA bandwidth class that UE can support 2. [On the condition that component 1 is indicated, indicate the PA architecture, i.e, 1PA or 2PA] 3. [On the condition that component 1 and component 2 are indicated, indicate the MIMO layer number for each UL CC separately]   NOTE1: there is dependency for the three components as given above | Intra-band UL contiguous CA band combination | Yes | N/A | Network cannot schedule intra-band contiguous UL CA transmission properly | Type3 | No need | FR1 | N/A | for each contiguous CA bandwidth class, if 2PA architecture is indicated, MIMO is not supported for both UL CCs by default | Optional with capability signalling, |
| [7-4] | [Transient period]  Note: Whether to introduce this feature group depends on RAN4 agreement] | FFS |  | FFS | FFS | FFS | FFS | FFS | FFS | FFS | FFS | FFS |
| 7-5 | DC location for intra-band CA | indicate whether UE support Additional DC location reporting for intra-band UL CA |  | Yes | N/A | The gNB cannot correctly calculate the DC location of intra-band CA | 3 | No need | FR1 and FR2 |  |  | Optional with capability signalling |
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* 1. NR RF requirement enhancements for frequency range 2 (FR2)

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| 8. NR RF Requirement Enhancements for FR2 | 8-1 | MPE | 1 P-MPR reporting |  | Yes | N/A | UE does not support MPE P-MPR reporting | per UE | TDD only | FR2 only | N/A |  | Optional with capability signalling |
| 8-2 | SSB based Beam correspondence | Support for beam correspondence based on SSB  A UE indicating support for beam correspondence based on SSB has the ability to select its uplink beam based on measurements of SSB.  Supported by UEs with capability *beamCorrespondenceWithoutUL-BeamSweeping = {0,1}*  If a UE supports beam correspondence based on SSB, then the network can expect the UE to also fulfill Rel-15 beam correspondence requirements. |  | Yes | N/A | If UE indicates it supports neither FG 8-2 nor FG 8-3, then the network can expect the UE to fulfill beam correspondence based on Rel-15 beam correspondence requirements. | per band | TDD only | FR2 only | N/A |  | Optional with capability signalling |
| 8-3 | CSI-RS based Beam correspondence | Support for beam correspondence based on CSI-RS  A UE indicating support for beam correspondence based on CSI-RS has the ability to select its uplink beam based on measurements of CSI-RS in scenarios when the SSB PSD is X dB below CSI-RS PSD.  Supported by UEs with capability beamCorrespondenceWithoutUL-BeamSweeping = {0,1}  If a UE supports beam correspondence based on CSI-RS, then the network can expect the UE to also fulfill Rel-15 beam correspondence requirements. |  | Yes | N/A | If UE indicates it supports neither FG 8-2 nor FG 8-3, then the network can expect the UE to fulfill beam correspondence based on Rel-15 beam correspondence requirements. | per band | TDD only | FR2 only | N/A |  | Optional with capability signalling |
| 8-4 | Non-contiguous intra-band DL CA | Support for frequency separation class for DL-only spectrum (Fsd):  DL-only spectrum is available for configuration of only DL CCs and not UL CCs.  The spectrum covered by the DL-only frequency separation extends on one-side of the bidirectional spectrum in a contiguous manner with no frequency gap between the two.  The bidirectional spectrum is defined as the UL/DL common spectrum in which the UE supports the configuration of uplink or downlink CCs and is signalled by UL and DL frequency separation from Rel-15.  The combined downlink spectrum (DL Fs + Fsd) cannot exceed 2400 MHz.  The component value range is defined in TS38.101-2 |  | Yes | N/A | UE does not support frequency separation class for DL only spectrum | per BC | TDD only | FR2 only | N/A |  | Optional with capability signalling |
| 8-5 | Inter-band DL CA | 1 Indicate the supported beam management type for inter-band CA within FR2. Beam management type can be independent beam management (IBM) or common beam management (CBM) |  | Yes | N/A | UE does not support inter-band CA within FR2 | per BC | TDD only | FR2 only | N/A | Candidate value set for beam management type: {IBM, CBM}  [For each CA configuration consisting of bands n260 and n261, and bands n259 and n257 the UE shall indicate IBM in Rel-16]  RAN4 has not defined CBM requirements in Rel-16 | Mandatory to report the supported beam management type  The capability is restricted to IBM only until CBM requirement is specified |
| 8-6 | MPR Enhancement | UE Tx power boost feature when IBE is suspended |  | yes | N/A | UE does not support Tx power boost feature when IBE is suspended | Per Band | TDD only | FR2 only | N/A |  | Optional with capability signalling |
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* 1. NR RRM requirement enhancement

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| 9. Rel-16 NR RRM Enhancement | 9-1 | BWP switching on multiple CCs RRM requirements | Incremental delay for BWP switch processing on additional CCs in timer/DCI based simultaneous BWP switching on multiple CCs | RAN1 feature 6-2, 6-3, 6-4 specified in TR 38.822 | Yes | N/A | There may be additional unclear BWP switching delay if network trigger BWP switching on multiple CC simultaneously. | Per UE | No | No | N/A | For component 2), the candidate values are:   * {100us, 200us} for UE indicates type1 in bwp-SwitchingDelay * {200us, 400us, 800us, 1000us} for UE indicates type 2 in bwp-SwitchingDelay   The total BWP switching delay will be captured in TS38.133  UE needs to indicate either of the candidate values in case it supports CA | Optional with capability signalling |
| 9-2 | Mandatory gap pattern for NR-only measurements in NR SA and NR DC | 1) Support of additional mandatory gap patterns for NR-only measurements in NR SA and NR DC, |  | Yes | N/A | Network cannot configure corresponding gap patterns for the UE. | Per UE | No | No | N/A | Note: Agreements are provided in [R4-2005846]. According to RAN4 agreement, a bitmap should be introduced | Mandatory with capability signalling |
| 9-3 | Mandatory gap pattern for NR measurement only in LTE SA, EN-DC, NE-DC | 1) Support of full set of mandatory additional gap patterns defined for NR SA and NR-DC for NR measurement only in LTE SA, EN-DC, NE-DC | 9-2 | Yes | N/A | Network cannot configure corresponding gap patterns for the UE. | Per UE | No | No | N/A | Note: Agreements are provided in [R4-2005846]. According to RAN4 agreement, a single bit should be introduced | Optional with capability signalling |
| 9-4 | SSB based inter-frequency measurement without measurement gap | 1) Support of inter-frequency measurement without MG when the inter-frequency SSB is completely contained in the active DL BWP of the UE |  | Yes | N/A | 1) gNB has to configure measurement gap for inter-frequency measurement | Per UE | No | Yes | N/A |  | Optional with capability signalling |
| 9-5 | Different SCS between PDCCH/PDSCH and SSB in inter-frequency measurement without MG | 1) Support of SSB based measurement on inter-frequency without MG and data reception of PDCCH/PDSCH in serving with different SCS | 9-4 | Yes | N/A | 2) UE cannot support of SSB based measurement on inter-frequency without MG and data reception of PDCCH/PDSCH in serving with different SCS | Per UE | No | Yes | N/A | Details can be found in RAN4 LS R4-2005350 to RAN2, wherein two options are listed, i.e.1) update existing IE (simultaneousRxDataSSB-DiffNumerology); 2) introduce a new UE capability | Optional with capability signalling |
| 9-6 | CGI reading of an NR neighbour cell | 1) Support of autonomous gap-based CGI reading of an NR neighbour cell for EN-DC, NR SA, LTE SA, NR-DC, NE-DC |  | Yes | N/A | gNB cannot configure CGI reading of NR neighbor cell | Per UE | No | Yes | N/A | Signalling details are up to RAN2. | Optional with capability signalling |
| 9-7 | CGI reading of an E-UTRA neighbour cell | 1) Support of autonomous gap-based CGI reading of an E-UTRA neighbour cell for EN-DC, NR SA, LTE SA, NR-DC, NE-DC |  | Yes | N/A | gNB cannot configure CGI reading of E-UTRA neighbor cell | Per UE | No | Yes | N/A | Signalling details are up to RAN2. | Optional with capability signalling |
| [9-8] | [Multiple SCell activation] | 1) Support of multiple SCell activation RRM requirement |  | Yes | N/A | Network cannot know the multiple SCell activation delay and corresponding interruption length for this UE. Therefore, either network may not trigger multiple SCell activation or there will be performance degradation | Per UE | No | Yes | N/A | Functionality of multiple SCell activation has already been supported since R15. RRM requirement is expected to be introduced in R16. Thus, R16 UE shall meet corresponding RRM requirement. | Optional with capability signalling |
| [9-9] | [UE specific CBW change] | 1) Support of UE-specific CBW change RRM requirement |  | Yes | N/A | Network cannot know the UE specific CBW change delay and corresponding interruption length for this UE. There will be performance degradation when UE specific CBW changes | Per UE | No | No | N/A | Functionality of UE specific CBW change has already been supported since R15. RRM requirement is expected to be introduced in R16. Thus, R16 UE shall meet corresponding RRM requirement. | Optional with capability signalling |
| [9-10] | [Spatial relation switch for uplink] | 1) Support of UL spatial relation switch RRM requirement |  | Yes | N/A | Network cannot know the uplink spatial relation switch delay for this UE. There will be performance degradation when uplink spatial relation changes | Per UE | No | No | N/A | Functionality of uplink spatial relation change has already been supported since R15. RRM requirement is expected to be introduced in R16. Thus, R16 UE shall meet corresponding RRM requirement. | Optional with capability signalling |
|  | [9-11] | [Parallel processing of BWP switching in different frequency ranges] | Support of processing BWP switching, in parallel, across FR1 and FR2 | RAN4 3-1 | Yes | N/A | Network cannot know whether UE is capable of processing BWP switching, in parallel, in FR1 and FR2. | Per UE | No | No | N/A | RAN4 agreement:  Delay requirements for DCI/timer based BWP switch = ;  If UE is capable of this feature; then N is the # of simultaneous BWP switching in the same FR.  If UE is not capable; then N is the # of simultaneous BWP switching in FR1 and FR2. | Optional with capability signaling |
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* 1. NR support for high speed train scenario

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| 10. NR HST | 10-1 | RRM enhanced requirements specified within NR and NR-E-UTRAN inter-RAT measurement for NR HST | The enhanced RRM requirements specified within NR and NR-E-UTRAN inter-RAT measurement to support high speed up to 500 km/h, as specified in TS 38.133 |  | No |  | The performance of RRM in NR HST scenario cannot be guaranteed | Per UE | NO | FR1 only |  |  | Optional with capability signalling |
| 10-2 | Demodulation enhancement for HST-SFN joint transmission scheme | The enhanced demodulation processing for HST-SFN joint transmission scheme with velocity up to 500km/h, as specified in TS 38.101-4 |  | No |  | The demodulation performance of HST-SFN joint transmission cannot be guaranteed | Per UE | NO | FR1 only |  |  | Optional with capability signalling |
| 10-3 | RRM enhancement for E-UTRAN -NR inter-RAT measurement for NR HST | The enhanced RRM requirements specified for E-UTRAN-NR inter-RAT measurement to support high speed up to 500 km/h, as specified in TS 36.133 |  | No |  | The performance of RRM in NR HST scenario cannot be guaranteed | Per UE | NO | FR1 only |  |  | Optional with capability signalling |
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* 1. NR Positioning Support

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| 11. NR Positioning Support |  |  |  |  |  |  |  |  |  |  |  |  |  |
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* 1. Physical layer enhancements for NR URLLC

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| Features | Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (V2X WI only)”. | **Consequence if the feature is not supported by the UE** | **Type**  **(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional |
| B. Physical layer enhancements for NR URLLC | B-1 |  |  |  |  |  |  |  |  |  |  |  |  |
| B-2 |  |  |  |  |  |  |  |  |  |  |  |  |
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* 1. Enhancements on MIMO for NR

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| Features | Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (V2X WI only)”. | **Consequence if the feature is not supported by the UE** | **Type**  **(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional |
| C. Enhancements on MIMO for NR | C-1 |  |  |  |  |  |  |  |  |  |  |  |  |
| C-2 |  |  |  |  |  |  |  |  |  |  |  |  |
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* 1. NR RRM requirements for CSI-RS based L3 measurement

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| Features | Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (V2X WI only)”. | **Consequence if the feature is not supported by the UE** | **Type**  **(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional |
| 12. NR RRM requirements for CSI-RS based L3 measurement | [12-1] | [Simultaneous reception of CSI-RS of neighbour cell and SSB of serving cell] | UE support FDM-ed mix-numerology on simultaneous reception of CSI-RS of neighbour cell and SSB of serving cell | TBA | YES |  | The performance of CSI-RS L3 measurement cannot be guaranteed | Per UE | No | No |  |  | Optional with capability signalling |
| [12-2] | [CSI-RS measurement] | 1. Support CSI-RS measurement based on timing of each of the detected associated SSB | csi-RSRP-AndRSRQ-MeasWithSSB | Yes | n/a | UE can only use a single common timing to measure CSI-RS resources per frequency layer, and can meet the accuracy requirements only under the timing error conditions defined in 38.133. | Per UE | no | no | n/a |  | Optional with capability signalling |
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* 1. Others

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| Features | Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (V2X WI only)”. | **Consequence if the feature is not supported by the UE** | **Type**  **(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional |
| UE RF | 2-18 | Maximum uplink duty cycle for TDD+TDD EN-DC power class 2 *(maxUplinkDutyCycle-interBandENDC-TDD-PC2-r16)* | Indicates the maximum percentage of symbols during a certain evaluation period that can be scheduled for NR uplink transmission under different EUTRA TDD uplink-downlink configurations so as to ensure compliance with applicable electromagnetic energy absorption requirements provided by regulatory bodies. This field is only applicable for inter-band TDD+TDD EN-DC power class 2 UE as specified in TS 38.101-3 [4]. If the field is absent, 30% shall be applied to all EUTRA TDD uplink-downlink configurations. If eutra-TDD-Configx is absent, 30% shall be applied to the corresponding EUTRA TDD uplink-downlink configuration.  Value n20 corresponds to 20%, value n40 corresponds to 40% and so on. |  | Yes | N/A | If UE does not report this capability, 30% shall be applied to all EUTRA TDD uplink-downlink configurations. | Per band combination | TDD only | FR1 only |  |  | Optional with capability signalling |
| [2-20] | [support co-located scenario only for inter-band EN-DC] | [Indicates the inter-band EN-DC combination supported by the UE can only work at co-located scenario, and in this scenario the PSD difference between DL carriers and MRTD can be guaranteed.  candidate values set: {type1, type2}  type 1 UE: performance guaranteed with PSD difference between DL carriers < 6dB, and MRTD=3us (current only DC\_20\_n28 has this limitation)  type 2 UE: performance guaranteed without limitation on PSD difference between DL carriers and MRTD=0.5slot] |  | Yes | N/A | If UE does not reports this capability, the performance cannot be guaranteed under inter-band non-collocated scenario. | Per band combination | N/A | FR1 only | N/A |  | Optional with capability signalling |
| [2-22] | [Maximum uplink duty cycle for FDD+TDD EN-DC power class 2] | [Indicates the maximum percentage of symbols during a certain evaluation period that can be scheduled for NR uplink transmission and EUTRA FDD uplink transmission so as to ensure compliance with applicable electromagnetic energy absorption requirements provided by regulatory bodies. This field is only applicable for inter-band FDD+TDD EN-DC power class 2 UE as specified in TS 38.101-3 [4]. If the field is absent, FFS.] |  | [Yes] | N/A | [If UE does not report this capability, FFS] | [Per band combination] | N/A | [FR1 only] |  |  | Optional with capability signalling |
| [2-23] | [Minimum value of configured maximum transmission power for EN-DC FDD-TDD PC2 operation] | [Indicates that the UE configures a total maximum transmission power for EN-DC operation exceeding a minimum value as defined in TS 38.101-3 and TS 38.213. The UE only includes this field for FDD-TDD inter-band EN-DC of power class 2 within FR1. If the field is absent, the minimum value for the band combination is set according to power class 3 as specified in TS 38.101-3.] |  | [Yes] | N/A | [The minimum value for the band combination is set according to power class 3 as specified in TS 38.101-3.] | [Per BC] | N/A | [FR1 only] |  |  | Optional with capability signalling |
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* 1. 5G\_V2X\_NRSL

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| Features | Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (V2X WI only)”. | **Consequence if the feature is not supported by the UE** | **Type**  **(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional |
| 13. 5G\_V2X\_NRSL | 13-1 | 256QAM sidelink reception for FR1 | UE can support 256QAM sidelink reception for NR V2X in FR1. | 15-1 | Yes | Yes | UE cannot receive 256QAM sidelink for NR V2X in FR1. | Per band | N/A | FR1 only | N/A |  | [optional with capability signalling] |
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1. LTE UE feature
   1. Additional MTC enhancements for LTE

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| Features | Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (V2X WI only)”. | **Consequence if the feature is not supported by the UE** | **Type**  **(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional |
| 1. LTE\_eMTC5 | 1-1 | Relaxed RRM measurements | 1. Relaxation of RRM measurements for serving cell for UEs using MWUS for at least low mobility UEs | Rel-15 MWUS | No | N/A | RRM measurement requirements will not be relaxed. | Per UE | No | N/A | No |  | Optional without capability signaling |
| 1-2 | RSS-based measurement improvement in RRC\_IDLE | 1. Improved DL RSRP measurement accuracy through use of RSS in RRC\_IDLE | Rel-15 RSS | No | N/A | Measurements will be based on CRS only (not RSS). | Per UE | Yes | N/A | No |  | Optional without capability signaling |
| 1-3 | RSS-based measurement improvement in RRC\_CONNECTED | 1. Improved DL RSRP measurement accuracy through use of RSS in RRC\_CONNECTED | Rel-15 RSS | Yes | N/A | Measurements will be based on CRS only (not RSS). | Per UE | Yes | N/A | No |  | Optional with capability signaling |
| 1-4 | RSS based measurement | Support Measurement of neighbour cell RSS in the NB of MPDCCH. | Rel-15 RSS | No | N/A | Support measurement of neighbour cell RSS only in the 2-RB of the MPDCCH NB, where the serving cell RSS is located. | Per UE | Yes | N/A | No |  | Optional without capability signaling |
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* 1. Additional enhancements for NB-IoT

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| Features | Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (V2X WI only)”. | **Consequence if the feature is not supported by the UE** | **Type**  **(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional |
| 2. NB-IoT | 2-1 | NRSRP measurement on non-anchor carrier | NRSRP measurement on non-anchor carrier using NRS | NRS on a non-anchor carrier for paging | No | N/A | UE cannot do measurement and evaluation of serving cell on non-anchor carrier | Per UE | FDD only | Applicable only to FR1 | N/A |  | Optional without capability signalling |
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* 1. Further performance enhancement for LTE in high speed scenario

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| Features | Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (V2X WI only)”. | **Consequence if the feature is not supported by the UE** | **Type**  **(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional |
| 3. LTE HST | 3-1 | Further RRM enhancement for LTE HST | The enhanced RRM requirements to support high speed with 500 km/h as specified in TS 36.133 | None | No | N/A | The performance of RRM in LTE HST scenario with 500km/h cannot be guaranteed | Per UE | No | FR1 only | No |  | Optional with capability signalling |
| 3-2 | Further RRM enhancement for LTE HST with CA | The enhanced RRM requirements to support high speed with 350 km/h for SCell measurements as specified in TS 36.133 | None | No | N/A | The performance of RRM in LTE HST scenario with 350km/h with CA cannot be guaranteed | Per UE | No | FR1 only | No |  | Optional with capability signalling |
| 3-3 | Further demodulation enhancement for HST-SFN | The enhanced demodulation processing for HST-SFN with 500km/h as specified in TS 36.101 | None | No | N/A | The demodulation performance of HST-SFN with 500km/h cannot be guaranteed | Per UE | No | FR1 only | No |  | Optional with capability signalling |
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* 1. Even further Mobility enhancement in E-UTRAN

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| Features | Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (V2X WI only)”. | **Consequence if the feature is not supported by the UE** | **Type**  **(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional |
| 4. LTE feMob | 4-1 | Synchronous DAPS handover for intra-frequency case | Support of synchronous DAPS handover for intra-frequency case |  | Yes | N/A | The network cannot configure UE with DAPS HO in corresponding scenario | Note 1 | No | No | N/A |  | Optional with capability signalling |
| 4-2 | Asynchronous DAPS handover for intra-frequency case | Support of asynchronous DAPS handover for intra-frequency case |  | Yes | N/A | The network cannot configure UE with DAPS HO in corresponding scenario | Note 1 | No | No | N/A |  | Optional with capability signalling |
| 4-3 | Synchronous DAPS handover for inter-frequency case | Support of synchronous DAPS handover for inter-frequency case |  | Yes | N/A | The network cannot configure UE with DAPS HO in corresponding scenario | Per BC | No | No | N/A |  | Optional with capability signalling |
| 4-4 | Asynchronous DAPS handover for inter-frequency case | Support of asynchronous DAPS handover for inter-frequency case |  | Yes | N/A | The network cannot configure UE with DAPS HO in corresponding scenario | Per BC | No | No | N/A |  | Optional with capability signalling |
| 4-5 | Simultaneous UL transmission for DAPS handover for intra-frequency | Support of simultaneous UL transmission for DAPS handover for intra-frequency case | Support any FG of 4-1, 4-2, 4-3 and 4-4 | Yes | N/A | The network cannot configure the UE with simultaneous uplink transmission for DAPS HO in corresponding scenario | Note 1 | No | No | N/A | If the 4-5 is absent, the default is UE does NOT support simultaneous transmission | Optional with capability signalling |
| 4-6 | Simultaneous UL transmission for DAPS handover for inter-frequency | Support of simultaneous UL transmission for DAPS handover for inter-frequency case | Support any FG of 4-1, 4-2, 4-3 and 4-4 | Yes | N/A | The network cannot configure the UE with simultaneous uplink transmission for DAPS HO in corresponding scenario | Per BC | No | No | N/A | If the 4-6 is absent, the default is UE does NOT support simultaneous transmission | Optional with capability signalling |
| 4-7 | Support of multi TAG for intra-frequency | Support of different TAGs in source and target cells for intra-frequency case | Support any FG of 4-1, 4-2, 4-3 and 4-4 | Yes | N/A | The network cannot configure the different TAGs for uplink transmission for DAPS HO | Note 1 | No | No | N/A | If the 4-7 is absent, the default is UE supports different TAGs in source and target cells | Optional with capability signalling |
| 4-8 | Support of multi TAG for inter-frequency | Support of different TAGs in source and target cells for inter-frequency case | Support any FG of 4-1, 4-2, 4-3 and 4-4 | Yes | N/A | The network cannot configure the different TAGs for uplink transmission for DAPS HO | Per BC | No | No | N/A | If the 4-8 is absent, the default is UE supports different TAGs in source and target cells | Optional with capability signalling |
| Note 1: RAN4 agreed not to further discuss the type of capabilities signalling for intra-frequency DAPS features 4-1, 4-2, 4-5, 4-7. Decision can be made in RAN2.  Note 2: RAN4 assumes RAN2 will include all parameters mentioned in LS (R4-1915781) into the UE capabilities signalling. | | | | | | | | | | | | | |
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# **Appendix: RF and RRM features in TR38.822 v15.0.1**

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| Features | Index | Feature group | Components | Prerequisite feature groups | Field name in TS 38.331 [2] | Parent IE in TS 38.331 [2] | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Note | Mandatory/Optional |
| 1. System parameter | 1-1 | 60kHz of subcarrier spacing for FR1 | 60kHz subcarrier spacing for data channel in FR1 |  | *scs-60kHz* | *Phy-ParametersFR1* | No | Applicable only to FR1 |  | Optional with capability signalling |
| 1-2 | 64QAM modulation for FR2 PDSCH | 64QAM modulation for FR2 PDSCH |  | n/a | n/a | No | Applicable only to FR2 | Capability can be discussed in future, e.g. when low cost device (e.g. IoT) and/or higher frequency band in FR2 are introduced | Mandatory without capability signalling |
| 1-3 | 64QAM for PUSCH | 64QAM for PUSCH |  | n/a | n/a | No | No | Capability can be discussed in future, e.g. when low cost device (e.g. IoT) and/or higher frequency band in FR2 are introduced | Mandatory without capability signalling |
| 1-4 | 256QAM for PDSCH | 256QAM for PDSCH |  | *pdsch-256QAM-FR1* | *Phy-ParametersFR1* | No | Yes | For FR1, it can be revisited in the future whether the 256QAM is mandated in all UE types or categories | Mandatory with capability signalling for FR1 |
| *pdsch-256QAM-FR2* | *BandNR* | For FR2, RAN4 agreed that no BS and UE requirements will be introduced in Rel.15. | Optional with capability signalling for FR2 |
| 1-5 | 256QAM for PUSCH | 256QAM for PUSCH |  | *pusch-256QAM* | *BandNR* | No | Yes | For FR1, RAN4 can further discuss to mandate 256QAM for PUSCH for FR1 in future release.  For FR2, RAN4 agreed that no BS and UE requirements will be introduced in Rel.15. | Optional with capability signalling (for both FR1 and FR2) |
| 1-6 | pi/2-BPSK for PUSCH | pi/2-BPSK for PUSCH |  | *pusch-HalfPi-BPSK* | *Phy-ParametersFRX-Diff* | No | Yes | RAN4 will define the same minimum requirements for pulse-shaped pi/2 BPSK and non-pulse shaped pi/2 BPSK for FR2. | Optional with capability signalling for FR1  Mandatory with capability signalling for FR2 |
| 1-7 | pi/2-BPSK for PUCCH format 3/4 | pi/2-BPSK for PUCCH format 3/4 |  | *pucch-F3-4-HalfPi-BPSK* | *Phy-ParametersFRX-Diff* | No | Yes |  | Optional with capability signalling for FR1  Mandatory with capability signalling for FR2 |
| 1-8 | Active BWP switching delay | Support of active BWP switching delay specified in TS38.133, candidate values set: {type1, type2} |  | *bwp-SwitchingDelay* | *Phy-ParametersCommon* | No | No | For this feature, RAN4 also sent another LS (R4-1803283).  Network cannot configure the shorter delay for certain UE type. | Mandatory to support either type 1 or type 2 with capability signalling |
| 1-9 | Support of EN-DC with LTE-NR coexistence in UL sharing from UE perspective | 1) LTE and NR UL Transmission in the shared carrier via TDM only  2) LTE and NR UL Transmission in the shared carrier via FDM only  3) LTE and NR UL transmission in the shared carrier via FDM or TDM |  | *ul-SharingEUTRA-NR* | *MRDC-Parameters* | No | Applicable only to FR1 |  | Optional with capability signalling |
| 1-10 | Switching time between LTE UL and NR UL for EN-DC with LTE-NR coexistence in UL sharing from UE perspective | Support of switching type between LTE UL and NR UL for EN-DC with LTE-NR coexistence in UL sharing from UE perspective.  Type 1: <0.5us  Type 2: <20us | 1-9 | *ul-SwitchingTimeEUTRA-NR* | *MRDC-Parameters* | No | Applicable only to FR1 | This feature is the switching time between LTE UL and NR UL in the same carrier  Per band combination signalling  UE Capability signalling elements.  1: <0.5us switching type.  2: <20us switching type. | Mandatory to support either type 1 or type 2 with capability signalling if UE reports its capability in 1-10 as 1) LTE and NR UL Transmission in the shared carrier via TDM only, or 3) LTE and NR UL transmission in the shared carrier via FDM or TDM |
| 1-11 | 7.5kHz UL raster shift | 7.5kHz UL raster shift |  | n/a | n/a | No | No |  | Mandatory in the SUL bands with uplink sharing either from UE perspective or from network perspective  7.5KHz raster shift as mandatory without capability signalling. 7.5kHz UL raster shift is mandatory for the bands described in clause 5.4.2.1 of Release 15 TS 38.101-1. RAN4 can revisit the above bands in the future release. 7.5KHz raster shift is not mandatory for other LTE refarming band except the bands which were agreed to support 7.5kHz UL raster shift as mandatory |
| 2. UE RF | 2-1 | Maximum channel bandwidth supported in each band for DL and UL separately and for each SCS that UE supports within a single CC | 1) FR1 channel bandwidths in TS38.101-1 Table 5.3.5-1  2) FR2 channel bandwidths in TS38.101-2 Table 5.3.5-1 |  | *channelBWs-DL*  *channelBWs-UL* | *BandNR* | No | No | UE capability signalling shall follow RP-172832 (Per-band capability signalling, separately for DL and UL and for each SCS)  Whether a bandwidth newly introduced in future is mandatory for UE shall be discussed case by case. | For FR1, all the bandwidths listed in TS38.101-1 v15.0.0 Table 5.3.5-1 for each band shall be mandatory with a single CC. The bandwidths listed in the slide #3 of R4-1805985 are mandatory with a single CC. 90MHz is optional for n41, n77, n78.  For FR2, the set of mandatory CBW is 50, 100, 200 MHz. |
| *supportedBandwidthDL*  *channelBW-90mhz* | *FeatureSetDownlinkPerCC* |
| *supportedBandwidthUL*  *channelBW-90mhz* | *FeatureSetUplinkPerCC* |
| 2-2 | Simultaneous reception or transmission with same or different numerologies in CA | Support of simultaneous reception or transmission with same or different numerologies in CA |  | *supportedSubcarrierSpacingDL* | *FeatureSetDownlinkPerCC* | No | No | From RAN4 perspective UE shall be able to signal the supported SCS per CC for each band combination  Same numerology for intra-band NR CA including both continuous and non-continuous is mandatory support for Rel15  The capability of supporting SCS within the single carrier in the CA configuration will be signalled separately, i.e., there is no need to mandatory UE to support mixed numerologies in CA case  If a UE supports inter-band NR CA including both FR1 band(s) and FR2 band(s), the UE shall support two mixed numerologies between FR1 band(s) and FR2 band(s) in DL and UL with capability signalling. | Same numerology for intra-band NR CA including both continuous and non-continuous is mandatory with capability in both FR1 and FR2. Two mixed numerologies between FR1 band(s) and FR2 band(s) in DL and UL are mandatory with capability if UE supports inter-band NR CA including both FR1 band(s) and FR2 band(s). Optional for other cases. |
| *supportedSubcarrierSpacingUL* | *FeatureSetUplinkPerCC* |
| 2-3 | Non-contiguous intra-band CA frequency separation class for FR2 | 1) Support of frequency separation classes to handle the total frequency span for DL for intra-band non-contiguous CA  2) Support of frequency separation classes to handle the total frequency span for UL for intra-band non-contiguous CA |  | *intraBandFreqSeparationDL* | *FeatureSetDownlink* | No | Applicable only to FR2 | UE signals the supported Frequency separation classes with per band granularity (Type 1) based on R4-1803363  Separate Frequency separation classes can be signalled for DL and UL | Mandatory to support a frequency separation class within {I, II, III} specified in TS38.101-2 with capability if UE supports non-contiguous CA in FR2 |
| *intraBandFreqSeparationUL* | *FeatureSetUplink* |
| 2-4 | Simultaneous reception and transmission for inter-band EN-DC (TDD-TDD or TDD-FDD) | Simultaneous reception and transmission for inter-band EN-DC (TDD-TDD or TDD-FDD) |  | *simultaneousRxTxInterBandENDC* | *MRDC-Parameters* | No | No | For TDD-FDD and TDD-TDD band combinations for which simultaneous RxTx capability is agreed to be supported, corresponding capability indication must be set to "supported".  Band combinations for which simultaneous RxTx capability is mandatory EN-DC combinations (Both FR1 LTE – FR1 NR and FR1 LTE- FR2 NR) are captured in TS 38.101-3. | Mandatory/Optional support depends on band combination and captured in TS 38.101-3 |
| 2-5 | Simultaneous reception and transmission for inter band CA (TDD-TDD or TDD-FDD) | Simultaneous reception and transmission for inter band CA (TDD-TDD or TDD-FDD) |  | *simultaneousRxTxInterBandCA* | *CA-ParametersNR* | No | No | For TDD-FDD and TDD-TDD band combinations for which simultaneous RxTx capability is agreed to be supported, corresponding capability indication must be set to "supported".  Band combinations for which simultaneous RxTx capability is mandatory are captured in TS 38.101-1, TS 38.101-2 and TS 38.101-3. | Mandatory/Optional support depends on band combination and captured in TS 38.101-1, TS 38.101-2 and TS 38.101-3 |
| 2-6 | Asynchronous FDD-FDD intra-band EN-DC DC | Asynchronous FDD-FDD intra-band EN-DC |  | *asyncIntraBandENDC* | *MRDC-Parameters* | Applicable only to FDD | Applicable only to FR1 |  | Optional with capability signalling |
| 2-7 | Almost contiguous UL CP-OFDM | Support of almost contiguous UL CP-OFDM transmissions |  | *almostContiguousCP-OFDM-UL* | *Phy-ParametersFRX-Diff* | No | Yes | RAN4 had defined the requirements for "Almost contiguous UL CP-OFDM" in Rel-15. | Optional with capability signalling |
| 2-8 | UE power class | 1) Support of FR1 UE power class  2) Support of FR2 UE power class  3) Support of FR1 UE power class for EN-DC  4) Support of FR1 UE power class for NR-CA |  | *ue-PowerClass* | *BandNR* | No | No | Capability signalling  - FR1 UE power class (per band)  - FR2 UE power class (per band)  - FR1 UE power class for EN-DC (per band combination)  - FR1 UE power class for NR CA (per band combination)  Default power class for each component is indicated in TS38.101-1/2/3. If the default power class is not indicated, UE shall report supported power class. The component 2) is also used as power class for intra-band NR-CA in FR2 | Mandatory to support at least one power class with capability. The capability signalling is absent if UE supports only default power class |
| *powerClass* | *BandCombination* |
| 2-9 | Simultaneous reception and transmission for SA SUL band combinations | Simultaneous reception and transmission for SA SUL band combinations |  | *simultaneousRxTxSUL* | *CA-ParametersNR* | No | No |  | Mandatory/Optional support depends on band combination and captured in TS 38.101-1 |
| 2-10 | Multiple frequency band indication | Multiple frequency band indication |  | n/a | n/a | No | No | Per UE capability | Mandatory without capability signalling |
| 2-11 | Modified MPR behaviour | Modified MPR behaviour |  | *modifiedMPR-Behaviour* | *BandNR* | No | No | Per band capability | Optional with capability signalling |
| 2-12 | Multiple NS/P-Max | Multiple NS/P-Max |  | n/a | n/a | No | No | Per UE capability | Mandatory without capability signalling |
| 2-13 | Maximum uplink duty cycle for FR1 power class 2 UE | Maximum percentage of uplink symbols can be scheduled within a certain evaluation period provided by regulatory bodies. The value range is {60%, 70%, 80%, 90%, 100%}. If the field is absent, 50% shall be applied. |  | *maxUplinkDutyCycle-PC2-FR1* | *BandNR* | No | Applicable only to FR1 | Per band capability.  If this capability is absent and the percentage of uplink symbols transmitted in a certain evaluation period is larger than 50%, or this capability is not absent and the percentage of uplink symbols transmitted in a certain evaluation period is larger than this capability, apply all requirements for the default power class. The evaluation period is up to UE implementation, no less than one radio frame.  UE do not need to do UL duty cycle calculation when it's transmit power is below 23dBm and all the UL/DL configurations can be scheduled. | Optional with capability signalling. The capability signalling is absent if UE supports 50% |
| 2-14 | Power boosting for Pi/2 BPSK for power class 3 UE | Power boosting for Pi/2 BPSK for power class 3 UE in TDD bands n40, n77, n78 and n79 with duty cycle less than 40% | 1-6, 1-7 | *powerBoosting-pi2BPSK* | *BandNR* | Applicable only to TDD | Applicable only to FR1 | Per band capability | Optional with capability signalling |
| 2-15 | Maximum uplink duty cycle for FR2 | 1) Maximum percentage of uplink transmission time that can be scheduled within 1s time window in order to ensure compliance with applicable electromagnetic power density exposure requirements provided by regulatory bodies. The value range is {15%, 20%, 25%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%}. |  | *maxUplinkDutyCycle-FR2* | *BandNR* | No | Applicable only to FR2 | Per band capability.  If the field of UE capability is present and the percentage of uplink symbols transmitted within any 1 s evaluation period is larger than this capability, the UE follows the uplink scheduling and can apply P-MPR as in TS38.101-2. If the field of UE capability is absent, the compliance to electromagnetic power density exposure requirements are ensured by means of scaling down the power density or by other means.  This capability is applicable for all power classes in FR2 | Optional with capability signalling |
| 2-16 | PA architectures for intra-band EN-DC | Support of dual PA |  | *dualPA-Architecture* | *MRDC-Parameters* | No | No | Per band per band combination capability  Single PA is default architecture  The following requirements are involved by this capability  - A-MPR/MPR and MSD values for dual uplink. Whether two sets of requirements will be introduced in RAN4 can be further discussed for each specific band combination  - Switching time between LTE UL and NR UL in single switched UL operation mode for intra-band EN-DC | Mandatory to support either single or dual PA architectures with capability if UE supports intra-band EN-DC configuration in uplink. The capability signalling is absent if UE supports single PA architecture. |
| 2-17 | PA architectures for intra-band UL CA | Support of dual PA |  | *dualPA-Architecture* | *CA-ParametersNR-v1540* | No | No | Per band per band combination capability  Single PA is default architecture  The following requirements are involved by this capability  - A-MPR/MPR and MSD values for dual uplink. Whether two sets of requirements will be introduced in RAN4 can be further discussed for each specific band combination | Mandatory to support either single or dual PA architectures with capability if UE supports intra-band CA configuration in uplink. The capability signalling is absent if UE supports single PA architecture |
| 3. Baseband | 3-1 | Independent measurement gap configurations for FR1 and FR2 | Measurement gaps for FR1 and FR2 are configured independently. |  | *independentGapConfig* | *MeasAndMobParametersMRDC-Common* | No | No |  | Optional with capability signalling |
| 3-2 | Simultaneous reception of data and SS block with different numerologies when UE conducts the serving cell measurement or intra-frequency measurement | Simultaneous reception of data and SS block with different numerologies when UE conducts the serving cell measurement or intra-frequency measurement |  | *simultaneousRxDataSSB-DiffNumerology* | *MeasAndMobParametersFRX-Diff*  *MeasAndMobParametersMRDC-FRX-Diff* | No | Yes |  | Optional with capability signalling |
| 3-3 | Short measurement gap | Measurement gap patterns with short MGL (gap pattern#2, 3, 6, 7, 8, 10) are supported for E-UTRAN measurement. Gap patterns #6, 7, 8, 10 only apply to E-UTRAN measurement when MO includes both E-UTRAN and NR. |  | *supportedGapPattern* | *MeasAndMobParametersCommon* | No | No | Per UE capability  This capability is signalled as a part of *supportedGapPattern* in TS38.306. | Optional with capability signalling |
| 3-4 | SU-MIMO Interference Mitigation advanced receiver | 1) R-ML (reduced complexity ML) receivers with enhanced inter-stream interference suppression for SU-MIMO transmissions with rank 2 with 2 RX antennas.  2) R-ML (reduced complexity ML) receivers with enhanced inter-stream interference suppression for SU-MIMO transmissions with rank 2, 3, and 4 with 4 RX antennas. |  | n/a | n/a | No | No | UE supporting the feature is required to meet the Enhanced Receiver Type requirements in TS 38.101-4 | Optional without capability signalling |