**3GPP TSG RAN WG1 #101-e R1-2005119**

**e-Meeting, 25th May – 5th June, 2020**

**Agenda item:** 6.2.5

**Source:** Moderators (AT&T, NTT DOCOMO, INC.)

**Title:** Updated RAN1 UE features list for Rel-16 LTE after RAN1#101-e

**Document for:** Information

1. Introduction

This contribution includes Rel-16 LTE RAN1 UE features list based on the agreements made after the RAN1#101-e meeting during email discussion/approval [101-e-Post-NR(LTE)-UE-Features-06] To finalize the LTE V2X UE feature list, till 6/10 – Ralf (AT&T).

1. LTE\_eMTC5

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| Features | Index | Feature group | Components | Prerequisite feature groups | Need for the eNB to know if the feature is supported | Need for the UE to know if the feature is supported (only for V2X WI, where the PC5-RRC capability signalling is delivered between the UEs) | **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 | Capability interpretation for mixture of FDD/TDD | Note | Mandatory/Optional |
| 1. LTE\_eMTC5 | 1-1 | UE-group wake-up signal (Group WUS) without group resource alternation | 1. UE-group wake-up signal (Group WUS) without group resource alternation | Rel-15 MWUS | Yes | N/A | The UE will be paged with Rel-15 MWUS or without MWUS instead of Group WUS. | Per UE | Yes | N/A |  | Optional with capability signalling |
| 1-2 | UE-group wake-up signal (Group WUS) with group resource alternation | 1. UE-group wake-up signal (Group WUS) with group resource alternation | 1-1 | Yes | N/A | If UE does not support group resource alternation and the eNB enables group resource alternation, UE falls back to Rel-15 MWUS when Rel-15 MWUS is configured or no MWUS when Rel-15 MWUS is not configured. | Per UE | Yes | N/A |  | Optional with capability signalling |
| 1-3 | Transmission in preconfigured UL resources (PUR) for full-PRB in CEmodeA | 1. Transmission in preconfigured UL resources (PUR) for full-PRB in CEmodeA | CEmodeA | Yes | N/A | UL data transmission will use EDT or connected mode instead of PUR in CEmodeA. | Per UE | Yes | N/A | RAN2 has agreed that PUR with UP and CP solutions have separate indications, but this is not captured in this RAN1 UE feature list. | Optional with capability signalling |
| 1-3a | Combination of PUR for full-PRB in CEmodeA with max UL TBS 2984 bits | 1. Combination of PUR for full-PRB in CEmodeA with max UL TBS 2984 bits | 1-3,  and *ce-PUSCH-NB-MaxTBS* | Yes | N/A | PUR transmission will not use the larger UL TBS. | Per UE | Yes | N/A |  | Optional with capability signalling |
| 1-4 | Transmission in preconfigured UL resources (PUR) for full-PRB in CEmodeB | 1. Transmission in preconfigured UL resources (PUR) for full-PRB in CEmodeB  2. Potential UE-specific cyclic shift for DMRS | 1-3,  and CEmodeB | Yes | N/A | UL data transmission will use EDT or connected mode instead of PUR in CEmodeB. | Per UE | Yes | N/A | RAN2 has agreed that PUR with UP and CP solutions have separate indications, but this is not captured in this RAN1 UE feature list. | Optional with capability signalling |
| 1-5 | Transmission in preconfigured UL resources (PUR) for sub-PRB in CEmodeA | 1. Transmission in preconfigured UL resources (PUR) for sub-PRB in CEmodeA | 1-3,  and UL sub-PRB | Yes | N/A | PUR will not use sub-PRB allocation in CEmodeA. | Per UE | Yes | N/A | RAN2 has agreed that PUR with UP and CP solutions have separate indications, but this is not captured in this RAN1 UE feature list. | Optional with capability signalling |
| 1-6 | Transmission in preconfigured UL resources (PUR) for sub-PRB in CEmodeB | 1. Transmission in preconfigured UL resources (PUR) for sub-PRB in CEmodeB | 1-4,  and UL sub-PRB | Yes | N/A | PUR will not use sub-PRB allocation in CEmodeB. | Per UE | Yes | N/A | RAN2 has agreed that PUR with UP and CP solutions have separate indications, but this is not captured in this RAN1 UE feature list. | Optional with capability signalling |
| 1-7 | PUR with serving cell RSRP TA validation | 1. PUR with serving cell RSRP for TA validation | 1-3 | Yes | N/A | PUR will not use serving cell RSRP for TA validation. | Per UE | Yes | N/A | TA validation mechanisms based on ‘Serving cell changes’ and ‘TA timer for idle mode’ (and ‘TA always valid’) are mandatory for PUR UEs. | Optional with capability signalling |
| 1-8 | PUR frequency hopping | 1. Frequency hopping for PUR | 1-3 | Yes | N/A | PUR will not use frequency hopping. | Per UE | Yes | N/A |  | Optional with capability signalling |
| 1-9 | PUR L1 ACK | 1. L1 ACK for PUR | 1-3 | Yes | N/A | PUR will not use L1 ACK. | Per UE | Yes | N/A |  | Optional with capability signalling |
| 1-10 | Multi-TB scheduling for unicast in DL in CEmodeA | 1. Multi-TB scheduling for unicast in DL in CEmodeA | CEmodeA | Yes | N/A | Each DCI will schedule a single TB instead of multiple TBs in DL in CEmodeA. | Per UE | Yes | N/A | Following legacy capabilities are reused to support combinations.  o Rel-14 feature for 2984 bits max UL TBS in 1.4 MHz in CE mode A  o Rel-14 feature for new numbers of repetitions for PUSCH in CE mode A  o Rel-14 feature for modulation restrictions for PDSCH/PUSCH in CE mode A  o Rel-15 features for flexible starting PRB for PDSCH/PUSCH in CE mode A/B | Optional with capability signalling |
| 1-11 | Multi-TB scheduling for unicast in DL in CEmodeB | 1. Multi-TB scheduling for unicast in DL in CEmodeB | CEmodeB | Yes | N/A | Each DCI will schedule a single TB instead of multiple TBs in DL in CEmodeB. | Per UE | Yes | N/A |  | Optional with capability signalling |
| 1-12 | Multi-TB scheduling for unicast in UL in CEmodeA | 1. Multi-TB scheduling for unicast in UL in CEmodeA | CEmodeA | Yes | N/A | Each DCI will schedule a single TB instead of multiple TBs in UL in CEmodeA. | Per UE | Yes | N/A |  | Optional with capability signalling |
| 1-13 | Multi-TB scheduling for unicast in UL in CEmodeB | 1. Multi-TB scheduling for unicast in UL in CEmodeB | CEmodeB | Yes | N/A | Each DCI will schedule a single TB instead of multiple TBs in UL in CEmodeB. | Per UE | Yes | N/A |  | Optional with capability signalling |
| 1-14 | Multi-TB scheduling for unicast with TB interleaving | 1. TB interleaving for multi-TB scheduling for unicast | 1-10 or 1-11 or 1-12 or 1-13 | Yes | N/A | Multi-TB unicast will not use TB interleaving. | Per UE | Yes | N/A |  | Optional with capability signalling |
| 1-15 | Multi-TB scheduling for unicast with HARQ bundling | 1. DL HARQ bundling for multi-TB scheduling for unicast | 1-10 | Yes | N/A | Multi-TB unicast will not use HARQ bundling. | Per UE | Yes | N/A |  | Optional with capability signalling |
| 1-16 | Multi-TB scheduling for unicast with UL sub-PRB | 1. UL sub-PRB allocation for multi-TB scheduling for unicast | 1-12 or 1-13,  and UL sub-PRB | Yes | N/A | Multi-TB unicast will not use UL sub-PRB. | Per UE | Yes | N/A |  | Optional with capability signalling |
| 1-17 | Multi-TB scheduling for unicast with UL early termination | 1. UL early termination for multi-TB scheduling for unicast | One of {1-12, 1-13} | Yes | N/A | Multi-TB unicast will not use UL early termination. | Per UE | Yes | N/A | For HD-FDD, the necessary UL gaps can be created using feature groups 1-25 and 1-26 | Optional with capability signalling |
| 1-18 | Multi-TB scheduling for unicast with DL 64QAM for CE mode A | 1. DL 64QAM for multi-TB scheduling for unicast for CE mode A | 1-10,  and DL 64QAM | Yes | N/A | Multi-TB unicast will not use DL 64QAM. | Per UE | Yes | N/A |  | Optional with capability signalling |
| 1-19 | Multi-TB scheduling for unicast withfrequency hopping | 1. Frequency hopping for multi-TB scheduling for unicast | 1-10 or 1-11 or 1-12 or 1-13 | Yes | N/A | Multi-TB unicast will not use frequency hopping. | Per UE | Yes | N/A |  | Optional with capability signalling |
| 1-21 | Multi-TB scheduling for SC-MTCH in CEmodeA | 1. Multi-TB scheduling for SC-MTCH in CEmodeA  2. Potential scheduling gaps for multi-TB scheduling for SC-MTCH in CEmodeA | CEmodeA,  and SC-PTM | Up to RAN2 | N/A | UE will not be able to receive SC-PTM transmissions using multi-TB scheduling in CEmodeA. | Per UE | Yes | N/A | The basic multicast (SC-PTM) functionality was introduced for LTE-M/NB-IoT in Rel-14 without capability signaling. | Up to RAN2 |
| 1-22 | Multi-TB scheduling for SC-MTCH in CEmodeB | 1. Multi-TB scheduling for SC-MTCH in CEmodeB  2. Potential scheduling gaps for multi-TB scheduling for SC-MTCH in CEmodeB | CEmodeB,  and SC-PTM | Up to RAN2 | N/A | UE will not be able to receive SC-PTM transmissions using multi-TB scheduling in CEmodeB. | Per UE | Yes | N/A | The basic multicast (SC-PTM) functionality was introduced for LTE-M/NB-IoT in Rel-14 without capability signaling. | Up to RAN2 |
| 1-23 | DL resource reservation with subframe-level granularity in CEmodeA | 1. DL time-domain resource reservation with subframe-level granularity in CE mode A  2. DL frequency-domain resource reservation with RBG-level granularity in CE mode A | CEmodeA | Yes | N/A | Whole DL subframe(s) may need to be configured as invalid in order to avoid NR collision. | Per UE | Yes | N/A |  | Optional with capability signalling |
| 1-23a | DL resource reservation with slot/symbol-level granularity in CEmodeA | 1. DL time-domain resource reservation with slot/symbol-level granularity in CE mode A  2. DL frequency-domain resource reservation with RBG-level granularity in CE mode A | 1-23 | Yes | N/A | Whole DL PRB pair(s) may need to be configured as invalid in order to avoid NR collision. | Per UE | Yes | N/A |  | Optional with capability signalling |
| 1-24 | DL resource reservation with subframe-level granularity in CEmodeB | 1. DL time-domain resource reservation with subframe-level granularity in CE mode B  2. DL frequency-domain resource reservation with RBG-level granularity in CE mode B | CEmodeB | Yes | N/A | Whole DL subframe(s) may need to be configured as invalid in order to avoid NR collision. | Per UE | Yes | N/A |  | Optional with capability signalling |
| 1-24a | DL resource reservation with slot/symbol-level granularity in CEmodeB | 1. DL time-domain resource reservation with slot/symbol-level granularity in CE mode B  2. DL frequency-domain resource reservation with RBG-level granularity in CE mode B | 1-24 | Yes | N/A | Whole DL PRB pair(s) may need to be configured as invalid in order to avoid NR collision. | Per UE | Yes | N/A |  | Optional with capability signalling |
| 1-25 | UL resource reservation with subframe-level granularity in CEmodeA | 1. UL time-domain resource reservation with subframe-level granularity in CE mode A | CEmodeA | Yes | N/A | Whole UL subframe(s) may need to be configured as invalid in order to avoid NR collision. | Per UE | Yes | N/A |  | Optional with capability signalling |
| 1-25a | UL resource reservation with slot/symbol-level granularity in CEmodeA | 1. UL time-domain resource reservation with slot/symbol-level granularity in CE mode A | 1-25 | Yes | N/A | Whole UL PRB pair(s) may need to be configured as invalid in order to avoid NR collision. | Per UE | Yes | N/A |  | Optional with capability signalling |
| 1-26 | UL resource reservation with subframe-level granularity in CEmodeB | 1. UL time-domain resource reservation with subframe-level granularity in CE mode B | CEmodeB | Yes | N/A | Whole UL subframe(s) may need to be configured as invalid in order to avoid NR collision. | Per UE | Yes | N/A |  | Optional with capability signalling |
| 1-26a | UL resource reservation with slot/symbol-level granularity in CEmodeB | 1. UL time-domain resource reservation with slot/symbol-level granularity in CE mode B | 1-26 | Yes | N/A | Whole UL PRB pair(s) may need to be configured as invalid in order to avoid NR collision. | Per UE | Yes | N/A |  | Optional with capability signalling |
| 1-27 | DL subcarrier puncturing in CE mode A | 1. DL subcarrier puncturing in CE mode A | CEmodeA | Yes | N/A | The UE will suffer a slight DL performance degradation if eNB punctures anyway. | Per UE | Yes | N/A |  | Optional with capability signalling |
| 1-28 | DL subcarrier puncturing in CE mode B | 1. DL subcarrier puncturing in CE mode B | CEmodeB | Yes | N/A | The UE will suffer a slight DL performance degradation if eNB punctures anyway. | Per UE | Yes | N/A |  | Optional with capability signalling |
| 1-29 | DL quality report in Msg3 in Idle | 1. Using 2 bits in Msg3 in Idle  2. Using 4 bits in Msg3 in Idle | CEmodeA | Up to RAN2 | N/A | The eNB will have to rely on other information, e.g. CSI reports if available. | Per UE | Yes | N/A | It is up to RAN2 whether to have separate capabilities for CE mode A and B. | Up to RAN2 |
| 1-30 | DL quality report in Connected | 1. DL quality report using 4 bits in Connected | CEmodeA | Up to RAN2 | N/A | The eNB will have to rely on other information, e.g. CSI reports if available. | Per UE | Yes | N/A | It is up to RAN2 whether to have separate capabilities for CE mode A and B. | Up to RAN2 |
| 1-31 | MPDCCH performance improvement with precoder cycling in CEmodeA | 1. MPDCCH performance improvement with precoder cycling in CEmodeA | CEmodeA | Yes | N/A | MPDCCH demodulation will rely on DMRS only (not CRS) in CEmodeA. | Per UE | Yes | N/A |  | Optional with capability signalling |
| 1-32 | MPDCCH performance improvement with precoder cycling in CEmodeB | 1. MPDCCH performance improvement with precoder cycling in CEmodeB | CEmodeB | Yes | N/A | MPDCCH demodulation will rely on DMRS only (not CRS) in CEmodeB. | Per UE | Yes | N/A |  | Optional with capability signalling |
| 1-33 | MPDCCH performance improvement with CSI-based mapping for CE mode A | 1. MPDCCH performance improvement with CSI-based mapping for CE mode A | 1-31 | Yes | N/A | MPDCCH performance improvement does not use CSI-based mapping. | Per UE | Yes | N/A |  | Optional with capability signalling |
| 1-34 | MPDCCH performance improvement with reciprocity-based candidates in TDD for CE mode A | 1. MPDCCH performance improvement with reciprocity-based candidates in TDD for CE mode A | 1-31 | Yes | N/A | MPDCCH performance improvement does not use reciprocity-based candidates in TDD. | Per UE | TDD only | N/A |  | Optional with capability signalling |
| 1-35 | CSI-RS-based feedback for non-BL UE for CE mode A | 1. CSI-RS-based feedback for non-BL UE in CEmodeA | *tm9-CE-ModeA-r13* | Yes | N/A | CSI feedback will be based on CRS. | Per UE | Yes | N/A |  | Optional with capability signalling |
| 1-35a | Codebook subset restriction for CSI-RS-based feedback for non-BL UE in CEmodeA | 1. Codebook subset restriction for CSI-RS-based feedback for non-BL UE in CEmodeA | 1-35 | Yes | N/A | CSI feedback will be based CSI-RS without codebook subset restriction (or on CRS). | Per UE | Yes | N/A |  | Optional with capability signalling |
| 1-36 | ETWS/CMAS indication in connected mode for non-BL UE in CEmodeA | 1. ETWS/CMAS indication in connected mode for non-BL UE in CEmodeA | CEmodeA | Yes | N/A | UE will need to be released to idle mode before it can receive the ETWS/CMAS indication. | Per UE | Yes | N/A |  | Optional with capability signalling |
| 1-37 | ETWS/CMAS indication in connected mode for non-BL UE in CEmodeB | 1. ETWS/CMAS indication in connected mode for non-BL UE in CEmodeB | CEmodeB | Yes | N/A | UE will need to be released to idle mode before it can receive the ETWS/CMAS indication. | Per UE | Yes | N/A |  | Optional with capability signalling |
| 1-38 | LTE control region use for MPDCCH in CEmodeA | 1. LTE control region use for MPDCCH in CEmodeA | CEmodeA | Yes | N/A | MPDCCH reception will rely only on symbols transmitted in the LTE data region. | Per UE | Yes | N/A |  | Optional with capability signalling |
| 1-39 | LTE control region use for MPDCCH in CEmodeB | 1. LTE control region use for MPDCCH in CEmodeB | CEmodeB | Yes | N/A | MPDCCH reception will rely only on symbols transmitted in the LTE data region. | Per UE | Yes | N/A |  | Optional with capability signalling |
| 1-40 | LTE control region use for PDSCH in CEmodeA | 1. LTE control region use for PDSCH in CEmodeA | CEmodeA | Yes | N/A | PDSCH reception will rely only on symbols transmitted in the LTE data region. | Per UE | Yes | N/A |  | Optional with capability signalling |
| 1-41 | LTE control region use for PDSCH in CEmodeB | 1. LTE control region use for PDSCH in CEmodeB | CEmodeB | Yes | N/A | PDSCH reception will rely only on symbols transmitted in the LTE data region. | Per UE | Yes | N/A |  | Optional with capability signalling |
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1. NB\_IOTenh3

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| Features | Index | Feature group | Components | Prerequisite feature groups | Need for the eNB to know if the feature is supported | Need for the UE to know if the feature is supported (only for V2X WI, where the PC5-RRC capability signalling is delivered between the UEs) | **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 | Capability interpretation for mixture of FDD/TDD | Note | Mandatory/Optional |
| 2. NB\_IOTenh3 | 2-1 | UE-group wake-up signal (Group WUS) with a wake-up time before the first associated PO (without group resource alternation) | 1. UE-group wake-up signal (Group WUS) with a wake-up time before the first associated PO (without group resource alternation) | Rel-15 NWUS | Yes | N/A | The network cannot wake-up a group of users with one wake-up signal | Per UE | FDD only | N/A |  | Optional with capability signalling |
| 2-2 | UE-group WUS with a wake-up time before the first associated PO (with group resource alternation) | 1. UE-group WUS with a wake-up time before the first associated PO (with group resource alternation) | 2-1 | Yes | N/A | The network cannot wake-up a group of users with one wake-up signal with group resource alternation | Per UE | FDD only | N/A | If UE does not support group resource alternation and the eNB enables group resource alternation, UE falls back to Rel-15 NWUS when Rel-15 NWUS is configured or no NWUS when Rel-15 NWUS is not configured. | Optional with capability signalling |
| 2-3 | Transmission in preconfigured UL resources (PUR) (with potential UE-specific cyclic shift for DMRS) | 1. Transmission in preconfigured UL resources (PUR) (with potential UE-specific cyclic shift for DMRS) |  | Yes | N/A | UL data transmission will use EDT or connected mode instead of PUR | Per UE | FDD only | N/A | RAN2 has agreed that PUR with UP and CP solutions have separate indications, but this is not captured in this RAN1 UE feature list. | Optional with capability signalling |
| 2-4 | PUR with serving cell RSRP for TA validation | 1. PUR with serving cell RSRP for TA validation | 2-3 | Yes | N/A | PUR will not use serving cell RSRP for TA validation | Per UE | FDD only | N/A | RAN2 has agreed that PUR with UP and CP solutions have separate indications, but this is not captured in this RAN1 UE feature list.  TA validation mechanisms based on ‘Serving cell changes’, ‘TA timer for idle mode’ and ‘TA always valid’ are mandatory for PUR UEs | Optional with capability signalling |
| 2-5 | PUR with L1 ACK | 1. PUR with L1 ACK | 2-3 | Yes | N/A | PUR will not use L1 ACK | Per UE | FDD only | N/A | RAN2 has agreed that PUR with UP and CP solutions have separate indications, but this is not captured in this RAN1 UE feature list. | Optional with capability signalling |
| 2-6 | Multi-TB scheduling for unicast in DL with a single DCI (Interleaved transmission) | 1. Multi-TB scheduling for unicast in DL with a single DCI (Interleaved transmission) | Two HARQ processes | Yes | N/A | The network cannot schedule transmission of multiple TBs in DL with a single DCI (interleaved transmission) | Per UE | FDD only | N/A |  | Optional with capability signalling |
| 2-7 | Multi-TB scheduling for unicast in DL with a single DCI (Non-interleaved transmission) | 1. Multi-TB scheduling for unicast in DL with a single DCI (Non-interleaved transmission) | Two HARQ processes | Yes | N/A | The network cannot schedule transmission of multiple TBs in DL with a single DCI (non-interleaved transmission) | Per UE | FDD only | N/A |  | Optional with capability signalling |
| 2-8 | Multi-TB scheduling for unicast in UL with a single DCI (Interleaved transmission) | 1. Multi-TB scheduling for unicast in UL with a single DCI (Interleaved transmission) | Two HARQ processes | Yes | N/A | The network cannot schedule transmission of multiple TBs in UL with a single DCI (interleaved transmission) | Per UE | FDD only | N/A |  | Optional with capability signalling |
| 2-9 | Multi-TB scheduling for unicast in UL with a single DCI (Non-interleaved transmission) | 1. Multi-TB scheduling for unicast in UL with a single DCI (Non-interleaved transmission) | Two HARQ processes | Yes | N/A | The network cannot schedule transmission of multiple TBs in UL with a single DCI (non-interleaved transmission) | Per UE | FDD only | N/A |  | Optional with capability signalling |
| 2-10 | Multi-TB scheduling for unicast in DL in a single DCI (HARQ bundling for HARQ-ACK feedback to interleaved transmission) | 1. Multi-TB scheduling for unicast in DL in a single DCI (HARQ bundling for HARQ-ACK feedback to interleaved transmission) | 2-6 | Yes | N/A | The network cannot schedule transmission of multiple TBs in DL with a single DCI (HARQ bundling for HARQ-ACK feedback to interleaved transmission) | Per UE | FDD only | N/A |  | Optional with capability signalling |
| 2-11 | Multi-TB scheduling for SC-MTCH | 1. Scheduling of multiple transport blocks for SC-MTCH in a single DCI 2. Scheduling of multiple transport blocks for SC-MTCH in a single DCI with scheduling gaps | SC-PTM | No | N/A | The network cannot schedule transmission of multiple TBs with a single DCI | Per UE | FDD only | N/A | The basic multicast (SC-PTM) functionality was introduced for LTE-M/NB-IoT in Rel-14 without capability signaling. | Up to RAN2 |
| 2-12 | DL resource reservation with subframe-level granularity of NB-IoT non-anchor carriers. | 1. DL resource reservation with subframe-level granularity of NB-IoT non-anchor carriers. |  | Yes | N/A | NB-IoT transmission may collide with NR transmission | Per UE | Yes | N/A |  | Optional with capability signalling |
| 2-12a | DL resource reservation with slot-level and symbol-level granularity of NB-IoT non-anchor carriers. | 1. DL resource reservation with slot-level and symbol-level granularity of NB-IoT non-anchor carriers. | 2-12 | Yes | N/A | NB-IoT transmission may collide with NR transmission | Per UE | Yes | N/A |  | Optional with capability signalling |
| 2-13 | UL resource reservation with subframe-level granularity of NB-IoT non-anchor carriers. | 1. UL resource reservation with subframe-level granularity of NB-IoT non-anchor carriers. |  | Yes | N/A | NB-IoT transmission may collide with NR transmission | Per UE | Yes | N/A |  | Optional with capability signalling |
| 2-13a | UL resource reservation with slot-level and symbol(s)-level granularity of NB-IoT non-anchor carriers. | 1. UL resource reservation with slot-level and symbol(s)-level granularity of NB-IoT non-anchor carriers. | 2-13 | Yes | N/A | NB-IoT transmission may collide with NR transmission | Per UE | Yes | N/A |  | Optional with capability signalling |
| 2-14 | DL quality report in Msg3 for non-anchor access in Idle | 1. DL quality report in Msg3 for non-anchor access in Idle | *multicarrier-NPRACH-r14* | No | N/A | The network cannot receive the quality report for non-anchor carriers in IDLE mode | Per-UE | FDD only | N/A |  | Optional without capability signalling |
| 2-15 | DL quality report in Connected | 1. DL quality report in Connected other than Msg3 for anchor and non-anchor carriers |  | Yes | N/A | The network cannot receive the quality report other than in Msg3 | Per-UE | FDD only | N/A |  | Optional with capability signalling |
| 2-16 | NRS on a non-anchor carrier for paging | 1. Presence of NRS on a set of subframes on a non-anchor carrier when no paging NPDCCH is transmitted | Paging non-anchor carrier | No | N/A | UE does not know whether NRS is transmitted on a non-anchor carrier when paging is not present | Per UE | FDD only | N/A |  | Optional without capability signalling |
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1. LTE DL MIMO efficiency enhancements

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| Features | Index | Feature group | Components | Prerequisite feature groups | Need for the eNB to know if the feature is supported | Need for the UE to know if the feature is supported (only for V2X WI, where the PC5-RRC capability signalling is delivered between the UEs) | **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 | Capability interpretation for mixture of FDD/TDD | Note | Mandatory/Optional |
| 3.LTE DL MIMO efficiency enhancements | 3-1 | Additional SRS symbols within normal UL subframes without frequency hopping | 1. Support of additional 1~13 SRS symbols within normal UL subframes with repetitions, |  | Yes | N/A | Network cannot utilize additional SRS symbols within normal UL subframes | Per UE | TDD only | N/A |  | Optional with capability signalling |
| 3-1A | Additional SRS symbols within normal UL subframes with frequency hopping | with frequency hopping | 3-1 | Yes | N/A | Network cannot utilize frequency hopping for additional SRS symbols within normal UL subframes | Per UE + Per BoBC | N/A | N/A | The UE may report a single capability (per UE) that applies to all band combinations in which the BoBC capability is not present (similar to nonPrecoded-r13 or beamformed-r13)  Note: It is RAN1’s understanding that any further UE capability related details for indication of the gap for frequency hopping, if any, are within the purview of RAN4 | Optional with capability signalling |
| 3-1B | Additional SRS symbols within normal UL subframes with antenna switching | With antenna switching | 3-1 | Yes | N/A | Network cannot utilize antenna switching for additional SRS symbols within normal UL subframes | Per UE + Per BoBC | N/A | N/A | UE reports one or more of {1T2R, 1T4R, 2T4R\_2pairs, 2T4R\_3pairs}    The UE may report a single capability (per UE) that indicates that the capability for additional SRS with antenna switching is the same as the capability for legacy SRS with antenna switching (given by BandParameters-v1530 and BandParameters-v1380) that applies to all band combinations in which the BoBC capability is not present.      Note: It is RAN1’s understanding that any further UE capability related details for indication of the gap for antenna switching, if any, are within the purview of RAN4 | Optional with capability signalling |
| 3-1C | Additional SRS symbols within normal UL subframes with SRS carrier switching | 1. Support of additional 1~13 SRS symbols within normal UL subframes with SRS carrier switching | 3-1, SRS carrier switching | Yes | N/A | Network cannot utilize additional SRS symbols within normal UL subframes with SRS carrier switching | Per UE + Per Band Pair of Band combination | N/A | N/A | For each band pair for which the UE reports SRS carrier switching capability (retuningTimeInfoBandList), the UE indicates whether additional SRS within normal UL subframes can be used.    Note: if the UE supports additional SRS in all the band pairs in which it supports SRS CS, there is no need to indicate it for each band pair individually | Optional with capability signalling |
| 3-2 | Virtual cell Id | 1. Support of virtual cell ID for legacy (Rel-15 and earlier releases) SRS. |  | Yes | N/A | Network cannot utilize the virtual cell ID for SRS | Per UE | TDD only | N/A |  | Optional with capability signalling |
| 3-2A | Virtual cell Id | 1. Support of virtual cell ID for additional SRS symbol(s) within normal UL subframes. |  | Yes | N/A | Network cannot utilize the virtual cell ID for SRS | Per UE | TDD only | N/A |  | Optional with capability signalling |
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1. LTE\_TERR\_BCAST

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| Features | Index | Feature group | Components | Prerequisite feature groups | Need for the eNB to know if the feature is supported | Need for the UE to know if the feature is supported (only for V2X WI, where the PC5-RRC capability signalling is delivered between the UEs) | **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 | Capability interpretation for mixture of FDD/TDD | Note | Mandatory/Optional |
| 4. LTE\_TERR\_BCAST | 4-1 | 2.5kHz PMCH | 1. Support of 2.5kHz SCS for PMCH | Support of fembmsMixedCell or fembmsDedicatedCell | Yes | N/A | UE cannot receive services transmitted with 2.5kHz numerology | Per band | No | N/A | Need to add capability for support, plus scaling factor, like mbms-ScalingFactor1dot25. The values for the scaling factor are {2, 4, 6, 8} | Optional with capability signalling |
| 4-2 | 0.370kHz PMCH with T\_d = 2 | 1. Support of 0.370kHz SCS for PMCH with stagger length of 2 slots | Support of fembmsMixedCell or fembmsDedicatedCell | Yes | N/A | UE cannot receive services transmitted with 0.370kHz numerology and reference signal with stagger length of 2 slots | Per band | No | N/A | Need to add capability for support, plus scaling factor, like mbms-ScalingFactor1dot25. The values for the scaling factor are {12, 16, 20, 24} (the scaling factor is common for T\_d=2 and T\_d=4) | Optional with capability signalling |
| 4-3 | 0.370kHz PMCH with T\_d = 4 | 1. Support of 0.370kHz SCS for PMCH with stagger length of 4 slots | Support of fembmsMixedCell or fembmsDedicatedCell | Yes | N/A | UE cannot receive services transmitted with 0.370kHz numerology and reference signal with stagger length of 4 slots | Per band | No | N/A | Need to add capability for support, plus scaling factor, like mbms-ScalingFactor1dot25. The values for the scaling factor are {12, 16, 20, 24} (the scaling factor is common for T\_d=2 and T\_d=4) | Optional with capability signalling |
| 4-4 | PDCCH AL16 | 1. Support of PDCCH AL16 for CAS in MBMS-dedicated cell. | Support of fembmsDedicatedCell | No | N/A | Reduced coverage for PDCCH | Per UE | No | N/A |  | Optional without capability signalling |
| 4-5 | CFI indication in MIB-MBMS | 1. Support of semi-static CFI indication in MIB | Support of fembmsDedicatedCell | No | N/A | Reduced coverage for PDCCH due to PCFICH | Per UE | No | N/A |  | Optional without capability signalling |
| 4-6 | PBCH repetition | 1. Support of PBCH repetition in CAS | Support of fembmsDedicatedCell | No | N/A | Reduced coverage for PBCH | Per UE | No | N/A |  | Optional without capability signalling |
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1. 5G\_V2X\_NRSL

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| 1. Features | Index | Feature group | Components | Prerequisite feature groups | Need for the eNB to know if the feature is supported | Need for the UE to know if the feature is supported (only for V2X WI, where the PC5-RRC capability signalling is delivered between the UEs) | **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 | Capability interpretation for mixture of FDD/TDD | Note | Mandatory/Optional |
| 5. 5G\_V2X\_NRSL | 5-1 | Receiving NR sidelink configured by LTE Uu | 1) UE can receive NR PSCCH/PSSCH. Up to a total of A sidelink HARQ processes across all links are supported.  2) UE can receive X NR PSCCH in a slot.  3) UE can attempt to decode Y= NRB non-overlapping RBs per slot  4) UE supports reception of NR PSSCH according to the NR 64QAM MCS table  5) UE supports PT-RS reception in FR2.  8) UE can receive using the subcarrier spacing and CP length defined for a given band in RAN4  10) Supports 14-symbol SL slot with all DMRS patterns corresponding to {#PSSCH symbols} = {12, 9} for slots w/wo PSFCH. If UE signals support of ECP, support 12-symbol SL slot with all DMRS patterns corresponding to {#PSSCH symbols} = {10,7} for slots w/wo PSFCH  12) UE can receive using 30 kHz subcarrier spacing with normal CP in FR1, 120 kHz subcarrier spacing with normal CP FR2 | [5-2],  [5-3],  5-4,  [5-5],  5-8,  [5-15],  [5-12],  [5-16] | Yes | N/A |  | Per band | N.A. | N.A. | Note: NRB is the number of RBs defined per channel bandwidth by RAN4 in 38.101-1 Table 5.3.2-1 for FR1 and 38.101-2 Table 5.3.2.-1 for FR2    Note: Component 8 is not required to be signalled in a band indicated with only the PC5 interface in 38.101-1 Table 5.2E-1  Note: Component 12 is only required in a band indicated with only the PC5 interface in 38.101-1 Table 5.2E-1  Component-1 candidate value set: {16, 24, 32, 48, 64}  Component-2 candidate value set: {floor (NRB /10 RBs), 2\*floor (NRB /10 RBs)}  Component-8 candidate value set in FR1:  {{15 kHz}, {30 kHz}, {60 kHz}, {15, 30 kHz}, {30, 60 kHz}, {15, 60 kHz}, {15, 30, 60 kHz}}  Component-8 candidate value set in FR2:  {{60 kHz}, {120 kHz}, {60, 120 kHz}}  Component-8 candidate value set for CP length: {NCP,NCP and ECP}  (ECP only applies to SCS of 60 kHz) | Optional with capability signalling |
| 5-2 | Transmitting NR sidelink mode 1 configured by LTE Uu | 1) UE can transmit NR PSCCH/PSSCH using configured grant type 1 in NR sidelink mode 1 configured by LTE Uu. Up to 8 configured grants can be configured for a UE.  2) UE can transmit NR PSSCH according to the NR normal 64QAM MCS OFDM table.  3) UE supports PT-RS transmission in FR2.  4) UE can transmit using the subcarrier spacing and CP length it reports.  8) Supports 14-symbol SL slot with all DMRS patterns corresponding to {#PSSCH symbols} = {12, 9} for slots w/wo PSFCH. If UE signals support of ECP, support 12-symbol SL slot with all DMRS patterns corresponding to ~~{~~#PSSCH symbols} = {10,7} for slots w/wo PSFCH.  [9) Support downlink pathloss based open loop power control] | 5-1,  [5-3],  5-4,  [5-5],  5-8,  [5-15],  [5-12],  [5-16] | Yes | N/A |  | Per band | N.A. | N.A. | Note: Random selection in the exceptional pool is supported.  Component-4 candidate value set in FR1:  {{15 kHz}, {30 kHz}, {60 kHz}, {15, 30 kHz}, {30, 60 kHz}, {15, 60 kHz}, {15, 30, 60 kHz}}  Component-6 candidate value set in FR2:  {{60 kHz}, {120 kHz}, {60, 120 kHz}}  Component-4 candidate value set for CP length: {NCP,NCP and ECP}  (ECP only applies to SCS of 60 kHz)  [Note: For Component 4, if a band is not indicated with only the PC5 interface in 38.101-1 Table 5.2E-1, the reported numerology shall be the same for sidelink and uplink.]  [Component (9) is not required to be supported in a band indicated with only the PC5 interface in 38.101-1 Table 5.2E-1]  Note: Component 11 is not required to be supported in a band indicated with the PC5 interface in 38.101-1 Table 5.2E-1 | Optional with capability signalling |
| 5-3 | Transmitting NR sidelink mode 2 configured by LTE Uu | 1) UE can transmit NR PSCCH/PSSCH using NR sidelink mode 2 configured by LTE Uu. Up to B sidelink processes are supported.  2) UE can transmit NR PSSCH according to the NR normal 64QAM MCS table.  3) UE supports PT-RS transmission in FR2.  4) UE can perform mode 2 sensing and resource allocation operations.  5) UE can transmit using the subcarrier spacing and CP length it reports for FG 5-1.  8) Supports 14-symbol SL slot with all DMRS patterns corresponding to {#PSSCH symbols} = {12, 9} for slots w/wo PSFCH. If UE signals support of ECP, support 12-symbol SL slot with all DMRS patterns corresponding to {#PSSCH symbols} = {10,7} for slots w/wo PSFCH.  10) UE can transmit using 30 kHz and normal CP subcarrier spacing in FR1, 120 kHz subcarrier spacing with normal CP FR2  [11) DL pathloss based open loop power control] | 5-1,  [5-2],  5-4,  [5-5],  5-8,  [5-15],  [5-12],  [5-16] | Yes | N/A |  | Per band | N.A. | N.A. | Note: Random selection in the exceptional pool is supported.  Candidate values for B are {8, 16}  Note: Component 5 is not required to be signalled in a band indicated with only the PC5 interface in 38.101-1 Table 5.2E-1  Note: Component 10 is only required in a band indicated with only the PC5 interface in 38.101-1 Table 5.2E-1  [Note: Component 11 is not required to be supported in a band indicated with only the PC5 interface in 38.101-1 Table 5.2E-1] | Optional with capability signalling |
| 5-4 | Synchronization sources for NR sidelink | 1) UE can receive S-SSB in NR sidelink if it supports 5-1.  2) UE can transmit S-SSB in NR sidelink if it supports 5-2 or 5-3.  3) UE supports GNSS and SyncRef UE as the synchronization reference according to the synchronization procedure with sl-SyncPriority set to GNSS and sl-NbAsSync set to false.  [4) UE can transmit or receive NR sidelink based on the synchronization to an gNB]  [5) UE additionally supports gNB, GNSS and SyncRef UE as the synchronization reference according to the synchronization procedure with sl-SyncPriority set to gnbEnb].  [6) UE additionally supports gNB, GNSS and SyncRef UE as the synchronization reference according to the synchronization procedure with sl-SyncPriority set to GNSS and sl-NbAsSync set to true.] | At least one of 5-1, 5-2 and 5-3,  [5-5],  5-8,  [5-15],  [5-12],  [5-16] | Yes | N/A |  | Per band | N.A. | N.A. | [Note: Component 4 is not required to be supported in a band indicated with only the PC5 interface in 38.101-1 Table 5.2E-1]  [Note: Component 5 is not required to be supported in a band indicated with only the PC5 interface in 38.101-1 Table 5.2E-1]  [Note: Component 6 is not required to be supported in a band indicated with only the PC5 interface in 38.101-1 Table 5.2E-1] | Optional with capability signalling |
| 5-5 | Sidelink congestion control | 1) UE can report CBR measurement to eNB when operating in Mode 1 and mode 2.  2) UE can adjust its radio parameters based on CBR measurement and CRlimit.  3) UE can process CBR and CR within the time it indicates | 5-1 and at least one of 5-2 and 5-3,  5-4,  5-8,  [5-15],  [5-12],  [5-16] | Yes | N/A |  | Per band | N.A. | N.A. | Note: component 1 is not required to be supported in a band indicated with only the PC5 interface in 38.101-1 Table 5.2E-1  Component-3 candidate value set  {Congestion process time 1, Congestion process time 2} where  Congestion process time 1: 2, 2, 4, 8 slots for 15, 30, 60, 120 kHz subcarrier spacing.  Congestion process time 2: 2, 4, 8, 16 slots for 15, 30, 60, 120 kHz subcarrier spacing | Optional with capability signalling |
| 5-6 | Short-term time-scale TDM for in-device coexistence | 1. Support prioritization between LTE sidelink transmission/reception and NR sidelink transmission/reception 2. FFS: Maximum time required for the inter-RAT conflict resolution is X | At least one of 5-1, 5-2 and 5-3,  5-4,  [5-5],  5-8,  [5-15],  [5-12],  [5-16] | No | N/A |  | Per band combination | N.A. | N.A. |  | Optional with capability signalling |
| 5-7 | 256QAM sidelink transmission | 1) UE can transmit NR PSSCH according to the NR 256QAM MCS table | At least one of 5-2 and 5-3,  5-1,  5-4,  [5-5],  5-8,  [5-15],  [5-12],  [5-16] | Yes | N/A | UE does not support transmission according to the NR 256QAM MCS table | Per band | N.A. | N.A. | Note: RAN4 to decide | Optional with capability signalling |
| 5-8 | PSFCH format 0 | 1) UE can transmit and receive NR PSFCH format 0.  2) UE can receive N NR PSFCH(s) in a slot.  3) UE can transmit M NR PSFCH(s) in a slot. | At least one of 5-1 and 5-3,  5-4,  [5-5],  [5-15],  [5-12],  [5-16] | FFS | N/A |  | Per band | N.A. | N.A. | Candidate values for N are {5, 15, 25, 32, 35, 45, 50, 64}  Candidate values for M are {4, 8, 16} | Optional with capability signalling |
| 5-9 | Low-spectral efficiency 64QAM MCS table | 1) UE can transmit and receive NR PSSCH according to the NR low-spectral efficiency 64QAM MCS table | At least one of 5-1, 5-2 and 5-3,  5-4,  [5-5],  5-8,  [5-15],  [5-12],  [5-16] | Yes | N/A | UE does not support transmission/reception according to the low spectral-efficiency 64QAM MCS table | Per band | N.A. | N.A. |  | Optional with capability signalling |
| 5-10 | eNB type synchronization source for NR sidelink | 1) UE can transmit or receive NR sidelink based on the synchronization to an eNB.  2) If UE supports 5-4, UE additionally supports eNB, GNSS and SyncRef UE as the synchronization reference according to the synchronization procedure with sl-SyncPriority set to gnbEnb.  3) If UE supports 5-4, UE additionally supports eNB, GNSS and SyncRef UE as the synchronization reference according to the synchronization procedure with sl-SyncPriority set to GNSS and sl-NbAsSync set to true. | At least one of 5-1, 5-2 and 5-3,  5-4,  [5-5],  5-8,  [5-15],  [5-12],  [5-16] | Yes | N/A |  | Per band | N.A. | N.A. |  | Optional with capability signalling |
| 5-11 | Simultaneous transmission of uplink and sidelink | 1) UE supports simultaneous transmission of LTE uplink and NR sidelink (on in different bandscarriers) in all a bands combination for which the UE indicated simultaneous sidelink and uplink support in a band combination. | At least one of 5-2 and 5-3,  5-4,  [5-5],  5-8,  [5-15],  [5-12],  [5-16] | Yes | N/A |  | Per band combination | N.A. | N.A. |  | Optional with capability signalling |
| 5-12 | Support of fewer than 14 consecutive sidelink symbols in a slot | 1) UE additionally supports transmission/reception of SL slot configured with 7, 8, 9, 10, 11, 12, 13 consecutive symbols and all the corresponding DMRS patterns | At least one of 5-1, 5-2 and 5-3,  5-4,  [5-5],  5-8,  [5-15],  [5-16] | Yes | N/A | UE supports SL only in a SL slot configured with 14 consecutive symbols. | Per band | N.A. | N.A. |  | Optional with capability signalling |
|  | 5-14 | Support of rank 2 transmission | 1) UE additionally supports rank 2 PSSCH transmission | [At least one of 5-2 and 5-3],  5-4,  [5-5],  5-8,  [5-15],  [5-12],  [5-16] | No | N/A | UE supports rank 1 PSSCH transmission only. | Per band | N.A. | N.A. | RAN1 does not see a need for the eNB to know if the feature is supported but would like to leave final decision to RAN2 | Optional with capability signalling |
| 5-15 | Support of rank 2 reception | 1) UE additionally supports rank 2 PSSCH reception | [5-1],  [5-2],  [5-3],  5-4,  [5-5],  5-8,  [5-12],  [5-16] | No | N/A | UE supports rank 1 PSSCH reception only. | Per band | N.A. | N.A. | RAN1 does not see a need for the eNB to know if the feature is supported but would like to leave final decision to RAN2 | Optional with capability signalling |
| 5-16 | Support of open loop SL power control and RSRP report | 1. Support sidelink pathloss based open loop power control and RSRP report in case of unicast | 5-1 and at least one of 5-2 and 5-3, 5-4  [5-5],  5-8,  [5-15],  [5-12] | Yes | N/A |  | Per band | N.A. | N/A |  | Optional with capability signalling |
| 5-17 | Sidelink CSI report | 1) UE can transmit and receive sidelink CSI-RS with up to P antenna port(s).  2) UE supports RI and CQI feedback on sidelink. | 5-1 and at least one of 5-2 and 5-3, , 5-4  [5-5],  5-8,  [5-15],  [5-12] | No | N/A |  | Per band | N.A. | N.A. | Note: Component 1 candidate values are P = {1,2} | Optional with capability signalling |
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1. Wideband PRG size

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| Features | Index | Feature group | Components | Prerequisite feature groups | Need for the eNB to know if the feature is supported | Need for the UE to know if the feature is supported (only for V2X WI, where the PC5-RRC capability signalling is delivered between the UEs) | **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 | Capability interpretation for mixture of FDD/TDD | Note | Mandatory/Optional |
| 6. Wideband PRG size | 6-1 | Wideband PRG size for TM9/10 in subframe operation | 1. Support the precoding granularity of TM9/10 as the scheduled resource blocks in the frequency domain for subframe PDSCH. | At least one of transmission mode 9, transmission mode 10 | Yes | N/A | In decoding of subframe PDSCH, UE cannot utilize a precoding granularity of scheduled RBs in frequency domain. | Per UE | No | N/A |  | Optional with capability signalling |
| 6-2 | Wideband PRG size for TM9/10 in subslot operation | 1. Support the precoding granularity of TM9/10 as the scheduled resource blocks in the frequency domain for subslot SPDSCH. | At least one of transmission mode 9, transmission mode 10;  Subslot operation | Yes | N/A | In decoding of subslot PDSCH, UE cannot utilize a precoding granularity of scheduled RBs in frequency domain. | Per UE | No | N/A |  | Optional with capability signalling |
| 6-3 | Wideband PRG size for TM9/10 in slot operation | 1. Support the precoding granularity of TM9/10 as the scheduled resource blocks in the frequency domain for slot SPDSCH. | At least one of transmission mode 9, transmission mode 10;  slot operation | Yes | N/A | In decoding of slot PDSCH, UE cannot utilize a precoding granularity of scheduled RBs in frequency domain. | Per UE | No | N/A |  | Optional with capability signalling |