**3GPP TSG RAN WG1 #102e R1-2006966**

**e-Meeting, August 17th – 28th, 2020**

**Source: Moderator (NTT DOCOMO, INC.)**

**Title: Summary on UE features for eMTC**

**Agenda Item:** **6.2.5**

**Document for:** **Discussion and Decision**

1. Introduction

This contribution summarizes the discussions and proposals in AI 6.2.5 regarding UE features for eMTC.

Based on the discussions summarized in Section 2, following is one of the suggested email discussions/approvals for AI 6.2.5.

**FL proposal of email discussion/approval:**

**Email discussion/approval on UE features for eMTC (17th – 19th August)**

* **Whether to change FG name of FG1-15 to “Multi-TB scheduling for unicast with HARQ bundling for CE mode A”**
* **Whether to change the description in the consequence if the feature is not supported by the UE to “Resource to avoid collision with NR cannot be reserved in the unit of subframe in time domain and with RBG-level in frequency domain” for FG1-23/24/25/26**
* **Whether to change the description in the consequence if the feature is not supported by the UE to “Resource to avoid collision with NR cannot be reserved in the unit of slot/symbol in time domain and with RBG-level in frequency domain” for FG1-23a/24a/25a/26a**

Companies are encouraged to check above FL proposal and to provide feedback if any in below.

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| Company | Comment |
| Ericsson | We do not see a need for any email discussion or any UE feaure list updates.  For discussion point #1, it should already be clear enough from the Prerequisites column in the existing UE feature list that FG 1-15 concerns CE mode A. There will be a need to update 36.306 since the UE capability description there does not correctly capture the contents of the Prerequisites column in the existing UE feature list, but we do not think this motivates any UE feature list update from RAN1.  For discussion point #2, we think that the current content of the Consequences column in the existing UE feature list is correct. If a UE does not support subframe-level resources reservation, then the avoidance of NR resources would need to be performed using legacy invalid subframe configuration instead. And if a UE does not support slot/symbol-level resource reservation, then the avoidance of NR resources would need to be performed either using legacy invalid subframe configuration or subframe-level resource reservation and in both these cases the invalid or reserved resources come with a PRB pair resolution or even more coarse resolution. So, we do not see any need for a UE feature list update from RAN1. |
| Qualcomm | Agree with Ericsson. These changes are editorial and would have no impact on TS 36.306 or TS 36.331. Unless there is a strong request from most companies, we would prefer not to discuss this. |
| ZTE, Sanechips | This is indeed editorial changes. But the intention here is to remove ambiguity and incorrect description in the feature list.  For example, for point #1, right now for eMTC sections, all FGs which are only applied to CE mode A have the term ‘in CE mode A’ in the FG name, except for FG 1-25. Any reason for this different treatment? For us this is something that will cause ambiguity.  For point #2, the current description in consequences column are not accurate. For example, FG 1-25 and FG-26 (UL subframe reservation), different from DL there is no frequency-domain reservation element in UL. The consequences column is ‘Whole UL subframe(s) may need to be configured as invalid in order to avoid NR collision’. This is not correct, since even with FG 1-25 and FG-26 supported, you still need to configure the whole UL subframe as invalid in order to avoid NR collision. So, this is not the ‘consequence’ if this FG is not supported, since even with the FG supported, it is still the case.  So at least for these two FGs, the consequences column should be changed. Either based on the general description given in the original proposal. (We are providing a general description in the original proposal).  If people still prefer something similar to the current wording, then the following is another alternative:  ‘UL subframe(s) may need to be configured as invalid by cell specific signalling in order to avoid NR collision’. |
| Nokia | We have similar view as Ericsson and Qualcomm and therefore do no see the need to update the UE feature list. |
| Moderator | Thank you very much for the inputs!  Based on the inputs so far, only one company want to discuss proposed changes in R1-2005473 while other companies do not see the need to discuss them.  Therefore, the updated proposal is to have no email discussion on eMTC UE features in 6.2.5 for RAN1#102-e meeting.  But since further explanation on the motivation for proposed changes is provided by the proponent company, I’d like to ask companies to check the explanation and to provide feedback if any. |
| Ericsson 2 | Regarding point #1, for the unicast multi-TB features, FG 1-10 through 1-13 are the basic features and FG 1-14 through 1-19 are add-ons, and it was thought that it would be sufficient to indicate through the Prerequisites column which basic features that can have the add-ons. Since then there has been some additions of tags like “for CE mode A” here and there, which is of course fine. There is nothing wrong with the proposal to add “for CE mode A” to FG 1-15. The only question is whether it is a need to do it if this triggers an LTE-MTC UE feature list update that may cause unnecessary confusion and work in RAN2.  Regarding point #2, for the resource reservation features FG 1-23 through 1-26a, like the other LTE-MTC FGs, the Consequences column has been expressed in a positive way rather than a negative way wherever it makes sense, so rather than stating that a resource cannot be reserved if the feature is not supported, it states that the whole subframe would instead need to be configured as invalid using legacy funcionality. The current content of the Consequences column seems to be correct, even for FG 1-25 and 1-26, since if UL subframe-level resource reservation is not supported then the affected UL subframes cannot be reserved and may need to be configured as invalid instead. Note that the proposed rephrasing would not make the Consequences column more correct for FG 1-25 and 1-26 than the current wording, since the proposal talks about frequency-domain resource reservation that is only supported for the DL FGs, not for the UL FGs 1-25 and 1-26. So, we do not see a need for an update. |

* 1. **Updated feature lead proposal**

**No email discussion/approval on UE features for eMTC in RAN1#102-e**

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| Company | Comment |
| Ericsson 2 | Ok with updated FL proposal |
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1. Discussion on LTE Rel-16 UE features for eMTC
   1. FG1-15

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 |

In [2], following proposal is made.

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| Currently, the name for FG 1-15 is ‘Multi-TB scheduling for unicast with HARQ bundling’. Considering HARQ bundling is only supported in mode A, and to align with the usage for other feature group names, it is suggested to update the FG name to ‘Multi-TB scheduling for unicast with HARQ bundling for CE mode A’.  Additionally, the component filed to ‘DL HARQ bundling for multi-TB scheduling for unicast for CE mode A’.  ***Proposal 1: For FG 1-15, update the FG field to ‘Multi-TB scheduling for unicast with HARQ bundling for CE mode A’.*** |

**Discussion point#1**

* **Whether to change FG name of FG1-15 to “Multi-TB scheduling for unicast with HARQ bundling for CE mode A”**
  1. FGs for resource reservation

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 |

In [2], following proposal is made.

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| There are two category FG for co-existence resource reservation, the first one is for subframe-level granularity, and the second category is for slot/symbol-level granularity. Currently for the ‘consequence if the feature is not supported by the UE’ field, if the UE does not support subframe level resource reservation, ‘Whole DL/UL subframe(s) may need to be configured as invalid in order to avoid NR collision’, and if the UE does not support slot/symbol level granularity, ‘Whole DL/UL PRB pair(s) may need to be configured as invalid in order to avoid NR collision’. This is not accurate and confusing. For the first feature category, it is suggested to change the field to ‘Resource to avoid collision with NR cannot be reserved in the unit of subframe and with RBG-level in frequency domain’’. For the second category, it is suggested to change the field to ‘Resource to avoid collision with NR cannot be reserved in the unit of slot/symbol and with RBG-level in frequency domain’.  ***Proposal 2: Update the‘consequence if the feature is not supported by the UE’ field of FG 1-23,1-23a,1-24,1-24a, 1-25, 1-25a, 1-26, 1-26a, 1-27, 1-27a, 1-28, 1-28a***   * ***For FG 1-23, 1-24,1-25,1-26, change the field to ‘Resource to avoid collision with NR cannot be reserved in the unit of subframe in time domain and with RBG-level in frequency domain’*** * ***For FG 1-23a, 1-24a,1-25a,1-26a, change the field to ‘Resource to avoid collision with NR cannot be reserved in the unit of slot/symbol in time domain and with RBG-level in frequency domain’*** |

**Discussion point#2**

* **Whether to change the description in the consequence if the feature is not supported by the UE to “Resource to avoid collision with NR cannot be reserved in the unit of subframe in time domain and with RBG-level in frequency domain” for FG1-23/24/25/26**
* **Whether to change the description in the consequence if the feature is not supported by the UE to “Resource to avoid collision with NR cannot be reserved in the unit of slot/symbol in time domain and with RBG-level in frequency domain” for FG1-23a/24a/25a/26a**

Reference

[1] R1-2006461 Updated RAN1 UE features list for Rel-16 LTE Moderators (AT&T, NTT DOCOMO, INC.)

[2] R1-2005473 Remaining issues on LTE Rel-16 UE Features ZTE

Appendix: UE features list for eMTC in [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 |
| 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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