**3GPP TSG RAN WG1 #100bis R1-200xxxx**

**e-Meeting, April 20th – 30th, 2020**

**Agenda Item: 7.2.11.7**

**Source: Moderator (AT&T)**

**Title: Summary of Email Approval [100e-b-NR-UEFeatures-Remaining] —** **UE Power Saving Aspects**

**Document for:** **Discussion/Decision**

# Introduction

This document presents the summary of email approval [100e-b-NR-UEFeatures-Remaining] following RAN1 #100bis-e (UE power saving aspects only). According to the Chairman’s Notes:

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| [100e-b-NR-UEFeatures-Remaining] Email discussion/approval of remaining issues (especially the one identified as low priority items in FL’s summaries) starting no earlier than 4/30 till next meeting – Hiroki (DCM)/Ralf (ATT) |

The following was discussed and agreed after RAN1 #100bis-e within the scope of [100e-b-NR-UEFeatures-Remaining] (UE power saving aspects only).

# Summary of Email Approval [100e-b-NR-UEFeatures-Remaining] — UE Power Saving Aspects

RAN1 endorsed the LS and RAN1 UE features list for Rel-16 NR in [1][2] after RAN1 #100bis-e. The RAN1 UE features list for Rel-16 NR in [2] is replicated in the appendix for UE power saving aspects.

The purpose of this email discussion summary document is to collect views on the remaining issues for UE power savings aspects.

Companies are invited to provide their views on the various issues in the tables below.

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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 |
| 19.UE Power Saving | 19-1 | DRX Adaptation | 1. Configured PS\_offset for the detection of  DCI format 2\_6  with CRC scrambling by PS-RNTI and minimum time gap before DRX ON duration 2. Indication of UE whether  or not to start drx\_OnDuration timer at the DRX ON by detection of DCI format 2\_6 3. Configured UE wakeup or not when DCI format 2\_6 is not detected at all monitoring occasions outside Active time 4. Configured  P-CSI report when  impacted by DCI format 2\_6 that drx\_OnDurationTimer does not start at the DRX ON 5. Configured  L1-RSRP report when  impacted by DCI format 2\_6 that drx\_OnDurationTimer does not start at the DRX ON | N/A | Yes | N/A |  | Per UE | No | Yes | N/A | The minimum time gap between the end of the slot of last DCI format 3\_0 monitoring occasion and the start of the DRX ON is a UE capability based on subcarrier spacing.   * The reporting is per SCS in units of slots of the respective SCS * The reported value for a SCS is taken from two possible values per SCS * The largest value of minimum time gap in UE capability is no more than the number of slots equal to 3 ms   UE is not required to monitor PDCCH for detection of DCI format 2\_6 during the minimum time gap  FFS: whether or how to handle licensed/unlicensed differentiation | Optional with capability signalling |

**Whether or how to handle licensed/unlicensed differentiation for FG 19-1**

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| Huawei, HiSilicon | There is no need to differentiate licensed and unlicensed band. |
| CATT | No differentiation in operation between licensed and unlicensed band. We have technical concern on the FR1/FR2 differentiation. Since drx-OnDurationTimer is per MAC entity (wake up indication applying on both FR1 and FR2), there is no UE behavior being specified if UE supporting 19-1 on either FR1 or FR2 only. What happens to DRX in FR2 if UE is triggered not to wake up at PCell on FR1 and UE capability indicating supporting 19-1 for FR1 and not supporting 19-1 for FR2? |
| ZTE | No need to differentiate licensed and unlicensed band. |
| Vivo | Suggested change for description of component (4) as follows  (4) Configured  P-CSI / L1-SINR report when  impacted by DCI format 2\_6 that drx\_OnDurationTimer does not start at the DRX ON  Suggested change for Note  The minimum time gap between the end of the slot of last DCI format ~~3\_0~~ 2\_6 monitoring occasion and the start of the DRX ON is a UE capability based on subcarrier spacing.  FFS: whether or how to handle licensed/unlicensed differentiation  The PDCCH-based power saving signal/channel has no big difference to the PDCCH reception, thus no strong need to differentiate licensed/unlicensed. |
| Panasonic | For the differentiation between licensed and unlicensed band, from actual UE implementation perspective, it would not be so big difference. On the other hand, we are not so certain the network based test (IODT) is available in both licensed and unlicensed with same schedule. When the test of licensed operation of 19-1 is finished and the UE supporting unlicensed band but unlicensed band operation of 19-1 is not finished is required to say "not to support 19-1" is unfortunate. Therefore, our view is licensed band and unlicensed band should be differentiated.  We agree vivo's comment on DCI format 3\_0 typo and missing L1-SINR. |
| Ericsson | No need for differentiation between licensed and unlicensed spectrum for UE PS. |
| Qualcomm | The differentiation between licensed and unlicensed is necessary, because it is unlikely that the feature would be introduced at the same time for licensed and unlicensed bands, while IODT differentiation is necessary. In this regard, the feature should be per band signaling, which enables deployment in unlicensed without being tested in licensed and vice versa |
| MediaTek | We share the similar view with Panasonic and Qualcomm, licensed/unlicensed band differentiation is needed if FG 19-1 is per UE signaling.  In addition, in our understanding, the SSB existence before wake-up signal for AGC/pre-sync cannot be guaranteed in unlicensed band, it may degrade the wake-up signal performance. In this case, the benefit of wake-up signal is questionable. So, we prefer to have the differentiation for better UE flexibility. |
| Intel | We do not see need for differentiation between licensed and 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 |
|  | 19-2 | Cross Slot Scheduling | 1. Dynamic indication of applicable minimum scheduling restriction by  DCI format 0\_1 and 1\_1   minimumSchedulingOffset K0 configuration for PDSCH and aperiodic CSI-RS triggering offset  (2)    minimumSchedulingOffset K2 configuration for PUSCH | FFS | Yes | N/A | Dynamic adaptation of the minimum value of K0min/K2min for cross-slot scheduling is not supported | Per UE | No | No | N/A | FFS: whether or how to handle licensed/unlicensed differentiation | Optional with capability signalling |

**Prerequisite feature groups for FG 19-2**

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| Company | Comments/Questions/Suggestions |
| Huawei, HiSilicon | During online clarification, it is allowed to configure two zero values of *MinimumSchedulingOffsetK0/MinimumSchedulingOffsetK2* for a BWP. In light of this understanding/clarification, it is not essential to take feature group 5-30 or 5-30a as prerequisite features. The network can configure values based on the reported UE capabilities accordingly. |
| CATT | There is no prerequisite from other feature group 5-30 or 5-30a |
| Vivo | Whether 19-2 is a pre-requisite of ***dl-SchedulingOffset-PDSCH-TypeA*** or ***dl-SchedulingOffset-PDSCH-TypeB***  Considering minimumSchedulingOffset K2 configuration for PUSCH is not relevant to ***dl-SchedulingOffset-PDSCH-TypeA*** or ***dl-SchedulingOffset-PDSCH-TypeB,*** we think it is not necessary to add any pre-requisite of 19-2. |
| Ericsson | Adding pre-requisites for this is not necessary. |
| MediaTek | No need to add pre-requisite. |
| Intel | We do not see necessity to add pre-requisite. |

**Whether or how to handle licensed/unlicensed differentiation for FG 19-2**

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| --- | --- |
| Company | Comments/Questions/Suggestions |
| Huawei, HiSilicon | There is no need to differentiate licensed and unlicensed band. |
| CATT | No differentiation in operation between licensed and unlicensed band |
| ZTE | No need to differentiate licensed and unlicensed band. |
| vivo | no need to licensed/unlicensed differentiation |
| Panasonic | The similar comment with 19-1. i.e. the need of the separation because when the test of licensed operation of 19-2 is finished and the UE supporting unlicensed band but unlicensed band operation of 19-2 is not finished is required to say "not to support 19-2" is unfortunate. Therefore, our view is licensed band and unlicensed band should be differentiated. |
| Ericsson | No need for differentiation between licensed and unlicensed spectrum for UE PS. |
| Qualcomm | The differentiation between licensed and unlicensed is necessary. Please see Qualcomm’s comment on FG 19-1 above. |
| MediaTek | Licensed/unlicensed differentiation is needed. |
| Intel | no need for licensed/unlicensed differentiation |

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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 |
|  | 19-3 | Maximum MIMO Layer Adaptation | 1. 1.     Support of maximum number of MIMO layer configuration  per DL BWP | See Note | Yes | N/A |  | [Per UE ] | No | [Yes] | N/A | This capability is indicated only if UE supports the network configuration of maxMIMO-Layers according to maxLayersMIMO-Indication  FFS: whether or how to handle licensed/unlicensed differentiation | Optional with capability signalling |

**Type for FG 19-3**

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| Company | Comments/Questions/Suggestions |
| Huawei, HiSilicon | It is enough to have per UE feature with FR1/FR2 differentiation. |
| CATT | It is per BC or per band since UE RF design could be different for different BC. The power saving technique of UE adaptation to maximum MIMO layer is to turn off some antenna when the MIMO rank is low. The ON/OFF would be different in the design. |
| ZTE | Per UE feature is enough, okay to have FR1/FR2 differentiation. |
| vivo | This feature should be per band.  This feature is designed to save UE power by reducing baseband processing, reducing RF path and other implementation oriented approach. Furthermore, they note maximum MIMO layer configuration is band-specific configuration. Considering potential different RF implementations across different bands it should be per band. |
| Ericsson | This should be per-UE with FR1/FR2 differentiation.  This capability is simply an indication that UE supports RRC configuration of the corresponding per-BWP parameter and we do not see a need for making this per-band capability. There is UE assistance signaling based on which UE can indicate its preference for the number of MIMO layers, and this preference can be changed by the UE more often than capability signaling. Thus, a UE can use UE assistance to indicate its MIMO layer preference and NW can make the suitable scheduling decision – then, it is up to UE implementation how to save power. |
| Qualcomm | The feature should be per band to support differentiation between licensed and unlicensed bands. |
| MediaTek | Per UE with FR1/FR2 and licensed/unlicensed differentiations |
| Intel | We think this should be per band.  It may be possible that UE does not support that feature in some band, and reporting in per UE manner would lead gNB to treat every band equally and assume UE would like to do power saving in every band, e.g., it may configure one BWP with smaller number of layers and another with larger number of layers. For a given band, it is possible that UE may not do power saving and operate at full rx antenna support for max data rate. But reporting per UE would not provide gNB additional information and gNB may end up configuring different number of MIMO layers for different BWP even for that band, going thru number of BWP switching interruption (which can be up to 3ms) when data cannot be delivered, leading to potentially waste of resources. |

**Need of FR1/FR2 differentiation for FG 19-3**

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| Company | Comments/Questions/Suggestions |
| Huawei, HiSilicon | Yes. FR1/FR2 differentiation is needed. |
| CATT | If the Type is BC or per band, there is no need for FR1/FR2 differentiation. If the Type is per UE, it needs FR1/FR2 differentiation. |
| ZTE | Okay to have FR1/FR2 differentiation. |
| Vivo | Considering different RF implementations across different FRx it should be FR1 and FR2 differential. |
| Panasonic | As implementation would be more different between FR1 and FR2, to have separation is reasonable. |
| Ericsson | Introduce FR1/FR2 differentiation. |
| MediaTek | Yes, FR1/FR2 differentiation is needed. |
| Intel | FR1/2 differentiation not needed, if it is per band |

**Whether or how to handle licensed/unlicensed differentiation for FG 19-3**

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| --- | --- |
| Company | Comments/Questions/Suggestions |
| Huawei, HiSilicon | There is no need to differentiate licensed and unlicensed band. |
| CATT | No differentiation in operation between licensed and unlicensed band |
| ZTE | No need to differentiate licensed and unlicensed band. |
| vivo | No need to licensed/unlicensed differentiation |
| Panasonic | The similar comment with 19-1. i.e. we see the need of the separation because when the test of licensed operation of 19-3 is finished and the UE supporting unlicensed band but unlicensed band operation of 19-3 is not finished is required to say "not to support 19-3" is unfortunate. Therefore, our view is licensed band and unlicensed band should be differentiated. |
| Ericsson | No need for differentiation between licensed and unlicensed spectrum for UE PS. |
| Qualcomm | The differentiation between licensed and unlicensed is necessary. Please see Qualcomm’s comment on FG 19-1 above. |
| MediaTek | Licensed/unlicensed band differentiation is needed if FG 19-3 is per UE signaling. |
| Intel | licensed/unlicensed differentiations not needed |

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|  | 19-4a | UE assistance information | Support of reporting preferred minimum K0/K2 via UE assistance information   * 15kHz/30kHz SCS: {1, 2, 4, 6} slots * 60kHz/120kHz SCS: {2, 4, 8, 12} slots | 19-2 | Yes | N/A |  | Per UE | No | No | N/A | The minimum applicable value of K0 (K2) for an active DL (UL) BWP for the carrier where PDSCH(PUSCH) is transmitted  FFS: whether or how to handle licensed/unlicensed differentiation | Optional with capability signalling |

**Whether or how to handle licensed/unlicensed differentiation for FG 19-4**

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| Company | Comments/Questions/Suggestions |
| Huawei, HiSilicon | There is no need to differentiate licensed and unlicensed band. |
| CATT | No differentiation in operation between licensed and unlicensed band |
| ZTE | No need to differentiate licensed and unlicensed band. |
| Vivo | Same as 19-2, no need to licensed/unlicensed differentiation |
| Panasonic | The similar comment with 19-1. i.e. we see the need of the separation because when the test of licensed operation of 19-3 is finished and the UE supporting unlicensed band but unlicensed band operation of 19-3 is not finished is required to say “not to support 19-3” is unfortunate. Therefore, our view is licensed band and unlicensed band should be differentiated. |
| Ericsson | No need for differentiation between licensed and unlicensed spectrum for UE PS. |
| Qualcomm | The differentiation between licensed and unlicensed is necessary. Please see Qualcomm’s comment on FG 19-1 above. |
| MediaTek | Licensed/unlicensed differentiation is needed. |
| Intel | There is no need to differentiate licensed and unlicensed band. |

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# Conclusions

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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 |
| 19.UE Power Saving | 19-1 | DRX Adaptation | 1. Configured PS\_offset for the detection of  DCI format 2\_6  with CRC scrambling by PS-RNTI and minimum time gap before DRX ON duration 2. Indication of UE whether  or not to start drx\_OnDuration timer at the DRX ON by detection of DCI format 2\_6 3. Configured UE wakeup or not when DCI format 2\_6 is not detected at all monitoring occasions outside Active time 4. Configured  P-CSI / L1-SINR report when  impacted by DCI format 2\_6 that drx\_OnDurationTimer does not start at the DRX ON 5. Configured  L1-RSRP report when  impacted by DCI format 2\_6 that drx\_OnDurationTimer does not start at the DRX ON | N/A | | Yes | | N/A |  | Per UE | No | Yes | N/A | The minimum time gap between the end of the slot of last DCI format ~~3\_0~~ 2\_6 monitoring occasion and the start of the DRX ON is a UE capability based on subcarrier spacing.   * The reporting is per SCS in units of slots of the respective SCS * The reported value for a SCS is taken from two possible values per SCS * The largest value of minimum time gap in UE capability is no more than the number of slots equal to 3 ms   UE is not required to monitor PDCCH for detection of DCI format 2\_6 during the minimum time gap  FFS: whether or how to handle licensed/unlicensed differentiation | Optional with capability signalling |
| 19-2 | Cross Slot Scheduling | (1)    Dynamic indication of applicable minimum scheduling restriction by  DCI format 0\_1 and 1\_1  minimumSchedulingOffset K0 configuration for PDSCH and aperiodic CSI-RS triggering offset  (2)    minimumSchedulingOffset K2 configuration for PUSCH | | ~~FFS~~ | | Yes | N/A | Dynamic adaptation of the minimum value of K0min/K2min for cross-slot scheduling is not supported | Per UE | No | No | N/A | FFS: whether or how to handle licensed/unlicensed differentiation | Optional with capability signalling |
| 19-3 | Maximum MIMO Layer Adaptation | 1. 1.     Support of maximum number of MIMO layer configuration  per DL BWP | | See Note | | Yes | N/A |  | [Per UE ] | No | [Yes] | N/A | This capability is indicated only if UE supports the network configuration of maxMIMO-Layers according to maxLayersMIMO-Indication  FFS: whether or how to handle licensed/unlicensed differentiation | Optional with capability signalling |
| 19-4a | UE assistance information | Support of reporting preferred minimum K0/K2 via UE assistance information   * 15kHz/30kHz SCS: {1, 2, 4, 6} slots * 60kHz/120kHz SCS: {2, 4, 8, 12} slots | | 19-2 | | Yes | N/A |  | Per UE | No | No | N/A | The minimum applicable value of K0 (K2) for an active DL (UL) BWP for the carrier where PDSCH(PUSCH) is transmitted  FFS: whether or how to handle licensed/unlicensed differentiation | Optional with capability signalling |

# References

1. R1-2003072, LS on Rel-16 RAN1 UE features lists for NR, RAN1
2. R1-2003073, RAN1 UE features list for Rel-16 NR after RAN1#100bis-E, AT&T/NTT DOCOMO, INC.

# Appendix

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
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| 19-2 | Cross Slot Scheduling | (1)    Dynamic indication of applicable minimum scheduling restriction by  DCI format 0\_1 and 1\_1  minimumSchedulingOffset K0 configuration for PDSCH and aperiodic CSI-RS triggering offset  (2)    minimumSchedulingOffset K2 configuration for PUSCH | | FFS | | Yes | N/A | Dynamic adaptation of the minimum value of K0min/K2min for cross-slot scheduling is not supported | Per UE | No | No | N/A | FFS: whether or how to handle licensed/unlicensed differentiation | Optional with capability signalling |
| 19-3 | Maximum MIMO Layer Adaptation | 1. 1.     Support of maximum number of MIMO layer configuration  per DL BWP | | See Note | | Yes | N/A |  | [Per UE ] | No | [Yes] | N/A | This capability is indicated only if UE supports the network configuration of maxMIMO-Layers according to maxLayersMIMO-Indication  FFS: whether or how to handle licensed/unlicensed differentiation | Optional with capability signalling |
| 19-4a | UE assistance information | Support of reporting preferred minimum K0/K2 via UE assistance information   * 15kHz/30kHz SCS: {1, 2, 4, 6} slots * 60kHz/120kHz SCS: {2, 4, 8, 12} slots | | 19-2 | | Yes | N/A |  | Per UE | No | No | N/A | The minimum applicable value of K0 (K2) for an active DL (UL) BWP for the carrier where PDSCH(PUSCH) is transmitted  FFS: whether or how to handle licensed/unlicensed differentiation | Optional with capability signalling |
|  |  |  |  | |  | |  |  |  |  |  |  |  |  |  |