**3GPP TSG RAN WG1 #101 R1-2004286**

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

**Agenda Item: 7.2.11.7**

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

**Title: Summary of UE features for UE power savings**

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

# Introduction

This document was drafted by the moderator of the agenda item under the direction of the RAN1 Chairman following the below guidance whose purpose it serves:

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| * + May 18th – 22nd: preparation phase (not for Rel-17 SIs)     - May 18th – 19th: FLs to prepare summary     - May 20th – 22nd: FLs to lead the discussion identifying the set of email threads     - A single email thread is used for Rel-16 WIs with a total number of email thread budget (instead of per sub-agenda budget as for other WIs, as detailed in the next two slides)       * In the email approval phase, multiple email threads may be used (& announced accordingly)     - **Note:** PLEASE KEEP THE EMAIL DISCUSSION **SCOPE** PER EMAIL THREAD **REASONABLE!**       * **Too much scope will force Chairman/Vice Chairman to step in to do the necessary cut down using the best judgement** 🡪 **if so, no complaints please.** |

All Sections except Section 3 were exclusively prepared by the moderator of the agenda item. Specifically, Section 2 is the moderator’s summary of contributions submitted to RAN1 #101-e in this agenda item according to the Chairman’s guidance. During the preparation phase, companies were given the opportunity to revise their views in the moderator’s summary in Section 2 using revision marks as shown below, if any. Section 3 was jointly drafted by the moderator and contributing companies during the preparation phase of RAN1 #101-e whereby companies present their views on the moderator’s proposals according to the Chairman’s guidance above in the respective tables. After conclusion of the preparation phase, the moderator submitted the final document as input to RAN1 #101-e with recommendations captured in Section 4.

# Summary on UE features for UE power savings

The following table represents the latest version of the NR UE feature list for UE power savings [1].

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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 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 | | N/A | | 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. 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 |

The following table is the moderator’s summary of contributions submitted to RAN1 #101-e in this agenda item.

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| Company | Summary |
| Vivo [2] | Vivo observes that the PDCCH-based power saving signal/channel has no big difference to PDCCH reception, and thus there is **no strong need to differentiate licensed/unlicensed for FG 19-1**.  Vivo thinks it is not necessary to add a pre-requisite for 19-2 that there is **no need to differentiate licensed/unlicensed for FG 19-2**.  Vivo argues FG 19-3 is designed to save UE power by reducing baseband processing, reducing RF path and other implementation oriented approaches. Furthermore, vivo notes the maximum MIMO layer configuration is band-specific configuration. Considering potential different RF implementations across different bands vivo thinks **FG 19-3 should be per band**.  Vivo believes that **for FG 19-4a there is no need to licensed/unlicensed differentiation** |
| ZTE [3] | ZTE notes that DRX ON is a time duration and that the wording of “drx\_OnDurationTimer does not start at the DRX ON” is confusing. In their view, when drx\_OnDurationTimer does not start, whether the time duration indicated by drx\_OnDurationTimer can be referred to as DRX ON is unclear. Furthermore, ZTE observes that DRX ON is not defined in current specifications.  According to past agreements, ZTE argues, the flags ps-TransmitOtherPeriodicCSI and ps-TransmitPeriodicL1-RSRP are used to configure a UE whether or not to report periodic CSI outside Active Time during drx\_OnDurationTimer and moreover, the flag ps-TransmitOtherPeriodicCSI controls the reportQuantity apart from L1-RSRP. Hence, ZTE proposed to update the components in feature group 19-1.  According to ZTE, candidate values of minimum time gap have been almost confirmed, and hence, they suggest to add them in the Note column in feature group 19-1.   |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 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 the start of drx\_onDurationTimer 2. Indication of UE whether  or not to start drx\_OnDuration timer for the next long DRX cycle 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 periodic CSI report apart from L1-RSRP when  impacted by DCI format 2\_6 that drx\_OnDurationTimer does not start for the next long DRX cycle 5. Configured periodic L1-RSRP report when  impacted by DCI format 2\_6 that drx\_OnDurationTimer does not start for the next long DRX cycle |  | *Yes* | N/A |  | Per UE | No | Yes |  | The minimum time gap between the end of the slot of last DCI format 2\_6 monitoring occasion and the beginning of the slot where the UE would start the drx\_onDurationTimer is a UE capability based on subcarrier spacing.   * The reporting is per SCS in units of slots of the respective SCS * The candidate value set for 15kHz SCS: {1,3} slots * The candidate value set for 30kHz SCS: {1,6} slots * The candidate value set for 60kHz SCS: {1,12} slots * The candidate value set for 120kHz SCS: {2,24} slots   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 |   ZTE continues that FG 19-3 indicates whether or not a UE supports per DL BWP maximum number of MIMO layer configuration. ZTE thinks it is enough to have the type of this feature group “Per UE” instead of “Per Band Combination”.  ZTE doesn’t think there is a need to differentiate licensed and unlicensed bands in UE power saving features. They provide the following analysis:   * **FG 19-1:** In CA mode, if UE reports different capabilities of feature group 19-1 for licensed and unlicensed band, it should be discussed whether and how to configure DCI format 2\_6. Considering the DCI format 2\_6 indicates whether or not to start the onduaration timer of the DRX cycle, which is configured per-MAC entity, network does not configure the monitoring occasion of DCI format 2\_6 if the reported capabilities for licensed and unlicensed band are different. To the end, it makes sense for UE to report the same capability of feature group 19-1 for licensed and unlicensed band and the differentiated capability is not needed. * **FG 19-2:** The feature group 19-2 of indicates a minimum scheduling offset between PDCCH and the scheduled PDSCH/PUSCH, which only impacts the location of PDSCH/PUSCH. If UE supports it for licensed band, there is no additional complexity to support it for unlicensed band, as well. * **FG 19-3:** Regarding feature group 19-3 of maximum MIMO layer adaptation, considering UE may have different RF chains for FR1 and FR2, differentiation between FR1 and FR2 is enough. * **FG 19-4a:** The feature group 19-4a indicates whether or not UE supports to report preferred minimum K0/K2 via UE assistance information. The reported preferred minimum K0/K2 and the corresponding configurations are per UE. If UE reports different capabilities of feature group 19-4a for licensed and unlicensed band, it should be discussed first whether to configure UE to report this assistance information. If UE is configured to report a preferred configuration via UE assistance information, gNB may apply the assistance information by RRC reconfiguration. In fact, the reconfiguration of higher layer parameters for UE can be triggered by more than UE assistance information. No additional complexity is observed as long as UE is configured to report UE assistance information. Therefore, there is no need to differentiate licensed and unlicensed band for feature group 19-4a. |
| CATT [4] | **DRX Adaptation**  According to CATT, Rel-15 DRX configuration provides UE power saving by allowing UE to switch off period of time and on for data reception a period of time. CATT continues that UE would be configured with PDCCH-based power saving signal/channel to trigger UE wakeup or not at next DRX ON in order to achieve power saving of no unnecessary wakeup without any DL data reception at the DRX ON. CATT explains the general procedure for UE adaptation to the DRX operation as follows and concludes the DRX adaptation feature should be per UE:   * WUS monitoring occasion and processing time before DRX ON - 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 * Indication of UE wakeup - Indication of UE whether or not to start drx-OnDurationTimer at the DRX ON by detection of DCI format 2\_6   1. MAC starts the drx-OnDurationTimer for all cels in the same time. The principle of Feature 19-1 is UE to adapt to the DRX operation based on the wakeup indication of DCI format 2\_6. If Feature 19-1 is configured per band, it means that UE only supports the wakeup indication by DCP on those supported bands. For those bands not support of Feature 19-1 would follow Rel-15 DRX operation, which UE always wakes up at the DRX ON and does not adapt to DRX based on indication from DCP.   If UE feature 19-1 can have differentiation between FR1/FR2, the MAC protocol needs to modify to trigger the selected FR1 cells or FR2 cells in starting the drx-OnDurationTimer based on UE feedback.  The current specification does not support it. Therefore, it should be per UE based on the MAC control of starting drx-OnDurationTimer for all cells in the same time   * 1. UE feature of SCell dormancy indication outside Active Time is captured in MR DC/CA feature * Miss-detection of DCI format 2\_6 - Configured UE wakeup or not when DCI format 2\_6 is not detected at all monitoring occasions outside Active time * Maintaining of channel quality measurement for link adaptation and beam management   1. Configured P-CSI report when impacted by DCI format 2\_6 that drx-OnDurationTimer does not start at the DRX ON   2. Configured L1-RSRP report when impacted by DCI format 2\_6 that drx-OnDurationTimer does not start at the DRX ON   CATT argues the UE can start the drx-OnDurationTimer in Rel-16 DRX adaptation based on DCP wakeup indication in both licensed and unlicensed band and the only difference between operation in licensed and unlicensed bands is that UE would monitor PDCCH and perform CSI measurements at the given time (e.g., start of DRX cycle for PDCCH monitoring) with operation in licensed bands but not necessary for operation in unlicensed band.  CATT also proposes the DRX adaptation feature should be **per UE without FRx differentiation**.  **Cross-Slot Scheduling**  CATT explains UE power saving by cross-slot scheduling is to allow UE not to buffer and decode PDSCH at the same slot to achieve power saving. CATT continues: the cross-slot scheduling is to select the subset of time domain resource allocation in TDRA table with K0 > 0 and aperiodic CSI-RS triggering offset not in the same slot. Catt notes Rel-16 UE power saving also supports dynamic switching between same slot and cross-slot scheduling with 1-bit indication of minimum scheduling offset K0 and K2 in DCI format 0\_1 and 1\_1. CATT concludes there is no prerequisite of feature 5-30 or 5-30a.  According to CATT, for FG 19-2, UE would have constraint of minimum scheduling offset K0min/K2min in the DCI but follow the TDRA for Tx/Rx in time domain. CATT argues the uncertainty of time domain resource allocation for operation in unlicensed band remains the same for Feature 19-2 cross-slot scheduling comparing to Rel-16 NRU operation and hence there is no need for differentiation between licensed and unlicensed bands for FG 19-2 which thus can be **per UE.**  **Maximum MIMO Layer Adaptation**  CATT explains the UE feature of Maximum MIMO layer adaptation is to allow UE switching off the Tx/Rx antenna to achieve power saving by turning off parts of transceivers when the rank of MIMO channel is less than the maximum rank. CATT believes the maximum MIMO layer support could be different for different bands. Hence, CATT proposes the maximum MIMO layer adaptation should be **per band combination**.  **UE Assistance Information**  CATT explains UE assistance information is for UE to provide the preferred system configuration, such as DRX configuration, aggregated bandwidth, SCell configuration, MIMO configuration, release request and minimum scheduling offset K0/K2. CATT believes most of the UE assistance information features belong to RAN2 and only the minimum scheduling offset K0/K2 should be discussed in RAN1.  CATT thinks each value of minimum scheduling offset K0min/K2min would have similar UE power saving gain but different UPT and the differentiation of operation in licensed and unlicensed bands does not have any benefit of operation, testing or power saving. Hence, CATT proposes the UE assistance information is **per UE** without differentiation between operation in licensed and unlicensed bands. |
| MediaTek Inc. [5] | For FG 19-1 to clearly describe the function of wakeup indication provided by DCI format 2\_6 and periodic L1-RSRP report, MediaTek suggests to revise the components as follows:   * **Component 2:** Indication of UE whether or not to start drx\_OnDurationTtimer ~~at~~ for the next long DRX cycle~~ON~~ by detection of DCI format 2\_6 * **Component 5:** Configured periodic L1-RSRP report when impacted by DCI format 2\_6 that drx\_OnDurationTimer does not start at the DRX ON   In MediaTek’s view, if the signaling type is “per UE with/without FRx differentiation” the indication for licensed/unlicensed band differentiation is needed. They argue:   * If 19-x with “per UE” signaling is introduced in licensed band and unlicensed band at the same time, it is likely that the feature cannot be supported in licensed band (or unlicensed band) firstly because the feature cannot be tested in both bands. * On FG 19-1, the SSB existence before wake-up signal for AGC or pre-sync cannot be guaranteed especially in unlicensed band, it may degrade the wake-up signal performance. In this case, the benefit of wake-up signal is questionable.   In conclusion, MediaTek thinks **for FG 19-1, 19-2, 19-3 and 19-4a licensed/unlicensed band differentiation is needed** if the signaling type is “per UE with/without FRx differentiation”. |
| Intel Corporation [6] | Regarding FG 19-3Intel thinks the reporting should be **per band**. Intel argues it may be possible that a UE does not support that feature in some bands and reporting per UE would lead gNB to treat every band equally. For a given band, Intel continues, it is possible that a UE may not do power saving and operate at full Rx antenna support for max data rate.  Intel discusses xDD, FRx , and licensed/unlicensed differentiation in Others [14]. |
| OPPO [7] | OPPO believes component (1) of FG 19-1 should be the (capability for) “detect format 2-6 during the PS-offset and before the minimum gap” as the current text “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” seems to only mean the capability for PS-offset.  For cross-slot scheduling, OPPO believes a further feature group should be considered. In the current version, the capability is only about if the UE can be configured with minimum ks values. OPPO thinks the purpose for the indication of cross-slot is unclear. Specifically, they continue, there are 2 motivations for introducing the explicit description: for the UE capability, it would be more informative to indicate that by the minimum k indication, the UE can go to more power efficient state. Also, according to OPPO, it was well discussed in power saving study that UE can also save power if configured only TDRA tables with all larger values, even without a minimum k been configured. OPPO thus recommends introducing FG 19-2a to indicate that UE can save power by assuming all possible data scheduling has k0/k2 > 0. Alternatively, OPPO proposes to add a new component to FG 19-2 as: “(4) UE power saving for time domain resource allocation with K0>0 for PDSCH, aperiodic CSI-RS triggering offset>0 and K2>0 for PUSCH”.  OPPOS proposed all capabilities should be **per UE for all feature groups**. Since the licensed spectrum requires same operation for Power Saving behavior as unlicensed spectrum, introducing licensed/unlicensed differentiation is unnecessary in OPPO’s view. |
| Huawei, HiSilicon [8] | Huawei has the following comments:  FG 19-1:   * For component (1): it is not mentioned that minimum time gap is reported by the UE. Therefore, it is proposed to add ‘reported’ before the minimum time gap; * Capture the following agreement as new component: if the UE does not have any PDCCH monitoring occasions for detection of DCI format 2\_6 outside Active Time of a next DRX cycle, the UE shall start the drx-onDurationTimer for the next DRX cycle   FG 19-2:   * It is one important component of cross-slot scheduling based power saving to jointly indicate the scheduling offset restriction for *minimumSchedulingOffsetK0* and *minimumSchedulingOffsetK2*. It is proposed to reflect the joint indication as a new component.   FG 19-3:   * The feature group is defining the UE capability to support the per-BWP configured Maximum MIMO layers. It does not need to be per band defined. It is enough to define as **per UE feature with FR1/FR2 differentiation**   Huawei thinks there is **no need to differentiate licensed and unlicensed band** for any UE power savings Rel. 16 feature |
| Ericsson [9] | Ericsson addresses the following remaining issues:  **For all FGs (19-1/2/3/4a):**   * Regarding the “FFS: whether or how to handle licensed/unlicensed differentiation”, our view is that the power saving features can be supported all cases including licensed and unlicensed spectrum since latter is just another spectrum/band. See R1-2004586 for our view on this topic in general. With respect to the UE power savings features, we do not see a need to handle licensed vs unlicensed differentiation specially. Even if licensed and unlicensed bands are not deployed at the same time, implementations will be reused between the two and new testing should not be needed.   + For features like 19-3 and 19-4a, such differentiation is not required at all as the features correspond to RRC parameter configuration or UE assistance based on RRC signaling which should be transparent to the band/spectrum where such signaling occurs.   **FG 19-1:**   * Regarding FR1/FR2 differentiation bit meaning, our view is that the bit allows a UE to indicate whether the UE supports DCI 2-6 monitoring on primary cell in FR1 or on primary cell is in FR2.   + Whether the UE is also configured with Scells in same or different frequency range should not impact the meaning of this bit – note DCI 2-6 triggers the DRX ON duration timer which is applied for DRX which is common across all serving cells, and moreover support of DRX itself is a per-UE capability without any dependencies on FR1/FR2 differentiation, etc. * Also, since the UE indicates the minimum time gap value that it supports for a given SCS of primary cell. The absence of the minimum time gap value for a SCS can imply that UE does not support the DCI 2-6 monitoring with the corresponding numerology.   **FG 19-2:**   * From our perspective, having FR1/FR2 differentiation would still be useful, especially given supporting the feature in FR1 does not necessarily mean it should automatically work for FR2. However, we do acknowledge that this has been agreed but hope there could be consensus to add FR1/FR2 differentiation.   **FG 19-3:**   * The per-BWP MIMO layer parameter under discussion is just an indication of the UE’s ability to tell the NW that NW can configure different max MIMO layers for different BWPs and hence we do not see why using that parameter as part of configuration should be precluded. It is of course up to the UE if it can or cannot use this for power savings in some or all bands. Signaling per UE is enough with FR1/FR2 differentiation * We propose to have per-UE indication, and allow indicating differentiation between FRx. (Same as current proposal, removing brackets.) |
| NTT DOCOMO, INC. [10] | Docomo observes that after RAN1 #100bis-e an interpretation issue was raised if the type is not “per UE without FR1/FR2 differentiation”. Assuming a UE which supports 19-1 in FR1 but not in FR2 is configured FR1 as PCell and FR2 as SCell, Docomo’s view is as follows since DRX is per MAC entity but the function on monitoring DCI can be different between FR1 and FR2:   * UE supports to monitor DCI format 2\_6 and all rerated functions as long as PCell is FR1. * If UE does not start drx-onDurationTimer by DCI format 2\_6, the UE does not monitor PDCCH in both PCell and SCell.   Regarding the type of FG 19-3, Docomo believes the UE just reports whether or not to support the function of maximum MIMO layer adaptation, although the maximum number of MIMO layers is different per BC. Thus, the type of this feature should be **per UE** according to Docomo. Regarding FR differentiation, Docomo is okay to have **FR1/FR2 differentiation**. |
| Qualcomm Incorporated [11] | According to Qualcomm, the intention of past agreements is to allow periodic CSI, L1-RSRP, or L1-SINR reporting, by configuration, during the time duration indicated by drx\_onDurationTimer. Therefore, they propose to update component (5) as: (5) Configured periodic L1-RSRP report when impacted by DCI format 2\_6 that drx\_OnDurationTimer does not start at the DRX ON  Qualcomm thinks that for all UE power saving FGs, **differentiation between licensed and unlicensed bands is necessary**. Qualcomm argues this is not because there are significant implementation challenges specifically in unlicensed band or vice versa, but because it is unlikely that deployment schedules of NR in licensed and unlicensed bands are the same. They continue, if a feature is based on per-UE signaling, in order to introduce the feature for either licensed or unlicensed band, it requires IODT for both licensed and unlicensed bands, and thus the introduction of the feature could be delayed. According to Qualcomm, if the feature is differentiated between licensed and unlicensed, the feature can be introduced for licensed band after IODT in the licensed band first and without IODT in the unlicensed band, and vice versa.  Qualcomm prefers “Per Band” signaling to support licensed-unlicensed differentiation.  Regarding the concern that “Per Band” signaling or FR1/FR2 differentiation may not be compatible with FG 19-1 since there is only one MAC entity across all bands (i.e., CA) that controls the DRX adaptation, Qualcomm offers the following view:   * Interpretation #1 is the correct understanding and “Per-Band” signaling is still compatible with FG 19-1: The description of FG 19-1 is PHY-oriented and is mostly about the UE’s behavior of monitoring DCI format 2\_6, indicating MAC to start drx-onDurationTimer, and performing CSI/L1-RSRP measurement/reporting outside Active Time. From some implementation perspective, the feature may be related to whether the UE support “pre-wake-up” before the DRX on duration to monitor DCI format 2\_6. Therefore, if the feature supports per-band signaling, it implied that the UE behavior related to DCI format 2\_6 monitoring can be configured on the PCell within the reported band. The description does not restrict any MAC features and a single MAC entity can still be maintained. |
| Panasonic Corporation [12] | Regarding FG 19-1, Panasonic’s view is that from an actual UE implementation perspective, it would not be a big difference between licensed and unlicensed band. On the other hand, Panasonic questions whether IODT will be available in both licensed and unlicensed with the same schedule. Panasonic thinks when the test of licensed operation of FG 19-1 is finished but unlicensed band operation of FG 19-1 is not finished saying "not to support FG 19-1" in unlicensed bands is unreasonable. Therefore, Panasonic’s view is **licensed and unlicensed band should be differentiated**. For the case where only one type of the band is supported, Panasonic’s view is it means the carrier where DCI format 2\_6 is monitored is supported or not is expressed as UE feature since MAC is common between licensed and unlicensed band. Therefore, Panasonic argues, even if the UE says FG 19-1 is not supported in unlicensed bands, DRX can be controlled commonly over licensed and unlicensed band and the same can be applied to P-CSI and L1-RSRP controlled by DRX.  Panasonic thinks that the cross-carrier aspect needs to be clarified within FG 19-2. They observe that in Rel.15, FG 6-10 “crossCarrierScheduling-SameSCS” is defined per band. They continue that in Rel.16, the following are under the discussion in NR UE features for DC/CA enhancement (see R1-2003202) regarding "FFS [Per UE or Per band and per BC or Per FS or Per BC":   * FG 18-5 DL cross-carrier scheduling with different SCS * FG 18-5b UL cross-carrier scheduling with different SCS * FG [18-5c] [DL cross-carrier scheduling with different SCS and PDSCH processing capability 2] * FG [18-5d] [UL cross-carrier scheduling with different SCS and PUSCH processing capability 2] * FG 18-6 Cross-carrier A-CSI RS triggering with different SCS   If non-cross slot scheduling is not supported by the UE but the UE supports FG 19-2, in Panasonic’s view cross-slot scheduling with non-cross carrier only is supported.  Similar to FG 19-1, because of possible IODT schedule difference, Panasonic thinks the **separation between licensed and unlicensed band is necessary** and “supported” applies to the scheduling carrier, similar to cross-carrier scheduling capability indication.  For FG 19-3 Panasonic observes the report from UE is expressed by the following RRC parameter:  MaxMIMO-LayerPreference-r16 ::= SEQUENCE {  reducedMaxMIMO-LayersFR1-r16 SEQUENCE {  reducedMIMO-LayersFR1-DL-r16 INTEGER (1..8),  reducedMIMO-LayersFR1-UL-r16 INTEGER (1..4)  } OPTIONAL,  reducedMaxMIMO-LayersFR2-r16 SEQUENCE {  reducedMIMO-LayersFR2-DL-r16 INTEGER (1..8),  reducedMIMO-LayersFR2-UL-r16 INTEGER (1..4)  } OPTIONAL  Although Panasonic has some concern on no separation between license and unlicensed band, when a UE does not support FG 19-3, UE can simply indicate the supported capability in either FR1/2. Therefore, Panasonic is okay with **no separation between licensed and unlicensed band**.  For FG 19-4a, Panasonic observes the report from the UE is expressed by the following RRC parameter:  MinSchedulingOffsetPreference-r16 ::= SEQUENCE {  preferredK0-r16 SEQUENCE {  preferredK0-SCS-15kHz-r16 ENUMERATED {sl1, sl2, sl4, sl6} OPTIONAL,  preferredK0-SCS-30kHz-r16 ENUMERATED {sl1, sl2, sl4, sl6} OPTIONAL,  preferredK0-SCS-60kHz-r16 ENUMERATED {sl2, sl4, sl8, sl12} OPTIONAL,  preferredK0-SCS-120kHz-r16 ENUMERATED {sl2, sl4, sl8, sl12} OPTIONAL  } OPTIONAL,  preferredK2-r16 SEQUENCE {  preferredK2-SCS-15kHz-r16 ENUMERATED {sl1, sl2, sl4, sl6} OPTIONAL,  preferredK2-SCS-30kHz-r16 ENUMERATED {sl1, sl2, sl4, sl6} OPTIONAL,  preferredK2-SCS-60kHz-r16 ENUMERATED {sl2, sl4, sl8, sl12} OPTIONAL,  preferredK2-SCS-120kHz-r16 ENUMERATED {sl2, sl4, sl8, sl12} OPTIONAL  } OPTIONAL  }  Although Panasonic has some concern on no separation between license and unlicensed band, when a UE does not support the feature, UE can simply indicate the supported k0/k2 are possible. Therefore, Panasonic is okay with **no separation between licensed and unlicensed band**. |
| Nokia, Nokia Shanghai Bell [13] | According to Nokia, most of the UE power saving features defined in Rel-16 impact baseband operation only, and hence they should be “per UE” without a need for further xDD/FRx differentiation. Even with FG 19-3, according to Nokia, in practice it is only an indication of the UE’s capability of benefiting from adapting the maximum number of MIMO layers and the UE will in any case support less MIMO layers than the maximum possible as part of normal operation in any band. Nokia observes that the UE power saving features do not impact the channel access mechanisms in any way, and they do not depend on dynamic relationship with the channel occupancy time, or other specific features to operate in unlicensed spectrum. Nokia continues that while the amount of power savings obtained in licensed and unlicensed operation may change as the UE might need to perform other tasks in unlicensed band, those aspects are unrelated to the ability to support the FGs themselves. Nokia thus proposes:   * UE power saving FGs are **“per UE” without xDD/FRx differentiation** * Do not introduce licensed/unlicensed differentiation for UE power saving FGs |

# Issues for discussion during the preparation phase

Based on the summary in Section 2, the moderator proposes the following four email discussions for RAN1 #101-e:

1. Discuss whether or how to handle licensed/unlicensed differentiation for FG 19-1
2. Discuss whether or how to handle licensed/unlicensed differentiation for FG 19-2
3. Discuss whether or how to handle licensed/unlicensed differentiation for FG 19-3
   1. Note: Type and FR1/FR2 differentiation for FG 19-3 is also discussed as part of this email discussion.
4. Discuss whether or how to handle licensed/unlicensed differentiation for FG 19-4a

Companies are invited to provide their views on the moderator’s proposals in the following table.

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| MediaTek | OK to discuss above issues during RAN1 #101-e.  In addition, for FG 19-1, we find there is different understanding among companies on how to interpret the feature if the signaling type is not “per UE”, e.g., “per UE with FRx differentiation” or “per-band”. Therefore, we think the clarification is needed. |
| ZTE | We are okay to discuss the above four issues. |
| OPPO | Ok to discuss them |
| Panasonic | We agree the proposals. |
| Qualcomm | We are fine with the proposed email discussions. |
| Samsung | We are okay to discuss them. |
| CATT | Ok with the discussion of all 4 issues |
| Huawei, HiSilicon | OK to discuss whether licensed/unlicensed differentiation is needed. |
| Vivo | We are fine with the proposed issues. |

Several companies suggest updating the agreed FG 19-1:

**Alt. 1 [3]:**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 the start of drx\_onDurationTimer 2. Indication of UE whether  or not to start drx\_OnDuration timer for the next long DRX cycle 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 periodic CSI report apart from L1-RSRP when  impacted by DCI format 2\_6 that drx\_OnDurationTimer does not start for the next long DRX cycle 5. Configured periodic L1-RSRP report when  impacted by DCI format 2\_6 that drx\_OnDurationTimer does not start for the next long DRX cycle |  | *Yes* | N/A |  | Per UE | No | Yes |  | The minimum time gap between the end of the slot of last DCI format 2\_6 monitoring occasion and the beginning of the slot where the UE would start the drx\_onDurationTimer is a UE capability based on subcarrier spacing.   * The reporting is per SCS in units of slots of the respective SCS * The candidate value set for 15kHz SCS: {1,3} slots * The candidate value set for 30kHz SCS: {1,6} slots * The candidate value set for 60kHz SCS: {1,12} slots * The candidate value set for 120kHz SCS: {2,24} slots   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 |

**Alt. 2 [5]:**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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\_OnDurationTimer for the next long DRX 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 periodic 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 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 |

**Alt. 3 [7]:**

* Component (1) should be the (capability for) “detect format 2-6 during the PS-offset and before the minimum gap”. The current text “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” seems to only mean the capability for PS-offset.

**Alt. 4 [8]:**

* Add ‘reported’ before the minimum time gap for component (1)
* Capture the following agreement as new component: if the UE does not have any PDCCH monitoring occasions for detection of DCI format 2\_6 outside Active Time of a next DRX cycle, the UE shall start the drx-onDurationTimer for the next DRX cycle

**Alt. 5 [11]:**

* Update component (5) as follows: Configured periodic L1-RSRP report when impacted by DCI format 2\_6 that drx\_OnDurationTimer does not start at the DRX ON

Companies are invited to provide their views on whether updates to agreed parts of FG 19-1 should be discussed during RAN1 #101-e in the following table.

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| MediaTek | OK to discuss during RAN1 #101-e. |
| ZTE | We are okay to discuss about the potential update. |
| OPPO | ALT 1 look clear. We should discuss among alts. |
| Panasonic | We agree to discuss them. |
| Qualcomm | We are okay for the discussion. |
| Samsung | We are okay to discuss them. |
| CATT | There is no need to change. However, we are open for further discussion |
| Huawei, HiSilicon | We are OK to discuss the further updates. However, we should focus on the part supported by the agreements, and please note that ‘long DRX’ is still under discussion in RAN2. We don’t need to touch this change. |
| Vivo | We agree to discuss. |

One company suggests updating the need for FRx differentiation for FG 19-1 to “No” [4]. Companies are invited to provide their views on whether this update should be discussed during RAN1 #101-e in the following table.

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| MediaTek | We think the meaning of “FRx differentiation” should be clarified firstly. If FG 19-1 is compatible with FRx differentiation, we don’t see the need to discuss whether to update it again. |
| ZTE | The meaning should be clarified, if the FRx differentiation for FG 19-1 is ”yes”. |
| OPPO | We are open for discussion. The current yes means support 2-6 detection in a FR. |
| Panasonic | We agree the view expressed by Mediatek. |
| Qualcomm | We are okay for the discussion. |
| Samsung | We don’t see the need of discussion. |
| CATT | We need to discuss this again since the FRx differentiation is not consistent with current MAC specification to have one MAC control all serving cells in CA. |
| Huawei, HiSilicon | We don’t think we need change it from “Yes” to “No”. However, it would be fine to further clarify the interpretation to align the understanding. |
| vivo | We think it is not necessary to change it from “Yes” to “No”. When FR1 is ‘yes’, FR2 is ‘no’, it should be clarified that the UE is not expected to be configured WUS on FR1 when FR1-FR2 CA is configured. However, configuration of WUS on FR1 only is still supported when UE is NOT configured as FR1 and FR2 CA. Further clarification may be needed on the ‘description’ part or somewhere. |

Two companies suggest updating the agreed FG 19-2:

* Introduce a new FG 19-2a or a new component of FG 19-2 to indicate that a UE can save power by assuming all possible data scheduling has k0/k2 > 0 [7]
* Introduce joint indication of minimumSchedulingOffsetK0 and minimumSchedulingOffsetK2 as new component [8]

Companies are invited to provide their views on whether this new FG should be discussed during RAN1 #101-e in the following table.

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| MediaTek | OK to discuss item #2 during RAN1 #101-e. |
| ZTE | Okay to discuss it. |
| OPPO | OK. For #2. The problem is gNB should know UE can save power even without DCI indication butwith all the K0/K2 in TDRA table is 1 or larger. Besides, the component 1 only talk about the capability of 1-bit indication.  We realize in Rel-15, this could be supported by UE. But gNB don’t really know if the UE can save power. We hope this component help more for apply the feature. |
| Panasonic | We are neutral on this on whether to discuss it or not. |
| Samsung | We don’t see the need of discussion. |
| CATT | We don’t see the need to discuss it. |
| Huawei, HiSilicon | Item#2 should be discussed.  For Item#1, it is not something introduced in Rel-16 power saving WI. It should not be discussed here. |
| Vivo | We are fine to discuss item#2.  For item#1, we think it is a new feature which has not been discussed during the WI. We are open to add something new features before it has been agreed in somewhere |

One company suggests updating the need for FRx differentiation for FG 19-2 to “Yes” [9]. Companies are invited to provide their views on whether this update should be discussed during RAN1 #101-e in the following table.

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| MediaTek | No, the need of FRx differentiation was already discussed in last meeting. |
| ZTE | FRx differentiation for cross slot scheduling is not needed. |
| OPPO | Not to discuss. |
| Panasonic | In what condition, "cross-slot scheduling with non-cross carrier" scheduling is supported should be clarified related to FR2 differentiation. Our view is scheduling carrier is located in FR1 or FR2 determines the "support". If cross-carrier scheduling of Rel.15 is not supported, "cross-slot scheduling with non-cross carrier" scheduling" is also not supported. |
| Samsung | We don’t see the need of discussion. |
| CATT | No need to discuss it again |
| Huawei, HiSilicon | No need to discuss it. |
| Vivo | Not sure. |

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# Conclusion

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# References

1. R1-2003195, Summary of Email Approval [100e-b-NR-UEFeatures-Remaining] — UE Power Saving Aspects, Moderator (AT&T)
2. R1-2003420, Discussion on UE features for power saving, vivo
3. R1-2003490, Discussion on UE feature for UE power saving, ZTE
4. R1-2003608, Discussion on Rel-16 UE power saving feature, CATT
5. R1-2003666, Views on Rel-16 UE features for NR UE power savings, MediaTek Inc.
6. R1-2003757, On UE features for Rel-16 UE Power Saving, Intel Corporation
7. R1-2004112, Discussion on Power Saving related UE features, OPPO
8. R1-2004153, Rel-16 UE features for UE power saving, Huawei & HiSilicon
9. R1-2004368, Discussion on UE features for UEPS, Ericsson
10. R1-2004407, Discussion on UE features for UE power saving, NTT DOCOMO, INC.
11. R1-2004482, Discussion on power saving UE features, Qualcomm Incorporated
12. R1-2004538, UE features for UE power saving, Panasonic Corporation
13. R1-2004565, On UE features for UE Power Savings, Nokia & Nokia Shanghai Bell
14. R1-2003762, Rel-16 UE feature - Others , Intel Corporation