**3GPP TSG RAN WG1 #108-e R1-22xxxxx**

**e-Meeting, February 21st – March 3rd, 2022**

**Agenda item:** 8.16.7

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

**Title:** [draft] Summary on UE features for UE power saving enhancements

**Document for:** Discussion and Decision

# **Introduction**

This document summarizes contributions submitted to AI 8.16.7 regarding UE features for UE power saving enhancements and captures the following email discussion.

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| --- |
| [108-e-R17-UE-features-PowSav-01] Email discussion on UE features for UE power savings enhancements – Shinya (DOCOMO)   * 1st check point: February 25 * Final check point: March 3 |

In the updated RAN1 UE features list for Rel-17 NR after RAN1 #107bis-e [1], there are following feature groups for UE power saving enhancements.

* 29-1 Paging enhancement
* 29-2 TRS resources for idle/inactive UEs
* 29-3a PDCCH skipping
* 29-3b 2 search space sets group switching
* 29-3c 3 search space sets group switching
* 29-3d 2 search space sets group switching with PDCCH skipping

The issues to be discussed are tagged and colour coded with High priority, Medium priority, or Low priority, considering RAN2 impact especially for capability signaling design.

In this round of the discussion, companies are requested to provide comments on the proposals and questions tagged FL1.

# **29-1: Paging enhancement**

In [1], FG 29-1 is captured as 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 (Sidelink 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 |
| 29. NR\_UE\_pow\_sav\_enh | 29-1 | Paging enhancement | 1. Support paging early indication  2. Support UE subgroup indication |  |  |  | UE does not support paging enhancement | Per UE | N | N | N | For component 2, it is up to RAN2 whether/how to separate the capability for UE subgroup indication  Leave RAN2 to decide whether ‘optional with capability signalling’ or ‘optional without capability signalling’  Leave RAN2 to decide whether Need for the gNB to know if the feature is supported is Yes or No | Optional |

Following feedbacks are provided in contributions for the RAN1#108-e meeting.

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| [2] | Huawei, HiSilicon | Regarding the type of the UE feature, “per band” type is preferred considering it could reduce the IODT work to deploy the feature. Even if the UE type is defined as “per UE”, it should be at least “per UE” with FR1/FR2 differentiation.  Regarding the capability of monitoring PDCCH for DCI format 2\_7, the common understanding is based on the legacy mandatory UE capability, i.e. FG 3-1 in 38.822.  The related description in FG 3-1 is as following:  *“- For type 1 CSS without dedicated RRC configuration and for type 0, 0A, and 2 CSS, the monitoring occasion can be any OFDM symbol(s) of a slot, with the monitoring occasions for any of Type 1- CSS without dedicated RRC configuration, or Types 0, 0A, or 2 CSS configurations within a single span of three consecutive OFDM symbols within a slot”*  There is no description about the new agreed Type2A CSS for PEI PDCCH in the FG3-1. To keep no touch on FG 3-1, which is stable from Rel-15, it is proposed to add a similar sentence to FG 29-1 to capture the above UE mandatory capability to support 29-1:  *“- For type 2A CSS, the monitoring occasion can be any OFDM symbol(s) of a slot, with the monitoring occasions for any of Type 1- CSS without dedicated RRC configuration, or Types 0, 0A, 2 or 2A CSS configurations within a single span of three consecutive OFDM symbols within a slot”*  ***Proposal 1: Make the following update for UE feature 29-1:***   * ***Update the UE feature 29-1 as ‘per band’ or “per UE” with FR1/FR2 differentiation.*** * ***Add a component 3 to capture the PDCCH monitoring of type2A-CSS based on legacy UE capability FG3-1: “For type 2A CSS, the monitoring occasion can be any OFDM symbol(s) of a slot, with the monitoring occasions for any of Type 1- CSS without dedicated RRC configuration, or Types 0, 0A, 2 or 2A CSS configurations within a single span of three consecutive OFDM symbols within a slot”.***  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 29. NR\_UE\_pow\_sav\_enh | 29-1 | Paging enhancement | 1. Support paging early indication  2. Support UE subgroup indication  3. For type 2A CSS, the monitoring occasion can be any OFDM symbol(s) of a slot, with the monitoring occasions for any of Type 1- CSS without dedicated RRC configuration, or Types 0, 0A, 2 or 2A CSS configurations within a single span of three consecutive OFDM symbols within a slot |  |  |  | UE does not support paging enhancement | ~~Per UE~~  Per band | N | N | N | For component 2, it is up to RAN2 whether/how to separate the capability for UE subgroup indication  Leave RAN2 to decide whether ‘optional with capability signalling’ or ‘optional without capability signalling’  Leave RAN2 to decide whether Need for the gNB to know if the feature is supported is Yes or No | Optional | |
| [3] | ZTE, Sanechips | As to the type of UE FG 29-1, differentiating the feature among multiple aspects, such as frequency range, TDD/FDD, etc., is not beneficial to exploit the best UE power saving benefits. Therefore, per-UE is sufficient for paging enhancement.   1. The capability type of feature group 29-1 is per UE. |
| [4] | vivo | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 29. NR\_UE\_pow\_sav\_enh | 29-1 | Paging enhancement | 1. ~~Support paging early indication~~Support of detection of DCI format 2\_7 with CRC scrambled with PEI-RNTI for early indication of paging  2. Support UE subgroup indication |  |  |  | UE does not support paging enhancement | Per UE | N | N | N | For component 2, it is up to RAN2 whether/how to separate the capability for UE subgroup indication  Leave RAN2 to decide whether ‘optional with capability signalling’ or ‘optional without capability signalling’  Leave RAN2 to decide whether Need for the gNB to know if the feature is supported is Yes or No | Optional | |
| [5] | CATT | RAN2 agreed in RAN2#116e that “UE’s capability of supporting the UE ID-based subgrouping is reported to RAN by AS UE capability signalling while R2 assumes that UE’s capability of supporting the CN-assigned subgrouping is reported to CN by NAS signalling” as in RAN2 LS [2]. It implies that UE would report its capability of supporting the UE ID-based subgrouping to RAN if UE has been in RRC\_CONNECTED state. It will be useful for network to track UEs in RRC\_Inactive. For UE in RRC\_IDLE state and not yet having AS security activation in RRC\_CONNECTED state, UE has not reported its UE capability to the network. The network does not know the number of UEs not reporting its capability in supporting UE ID-based subgrouping. If RAN would like to capture UE capability of UE ID-based subgrouping for all IDLE/Inactive UEs, the IDLE/Inactive UE procedures and the UE capability transfer need to be enhanced to support the UE capability report of UE ID-based subgrouping when UE camping at each cell.  Based on RAN2 agreements in reporting UE ID-based subgrouping, UE features of power saving enhancement for IDLE/Inactive UEs should be “optional with capability signaling”.  **Proposal 1: UE features of power saving enhancement for IDLE/Inactive UEs should be optional with capability signalling**  For objective of NR enhancements for IDLE/Inactive UE power saving, the paging subgrouping and PDCCH-based PEI are supported for reducing the unnecessary paging reception. The paging subgrouping was assigned by the CORE network through NAS signaling or derived from UE ID for randomization as agreed in RAN2. It was agreed in RAN1#106b-e that paging subgroup is indicated by PEI only. The configuration of PDCCH-based PEI and monitoring occasions for paging subgroup indication needs to be broadcasted by RRC and/or NAS signaling to IDLE/Inactive UEs, The UE capability of paging enhancement should include the UE support of both paging subgrouping and PDCCH-based PEI. The configuration of PDCCH-based PEI and the contents in the DCI format 2\_7 for PEI would be specified with parameters broadcasted and derived by IDLE/Inactive UEs regardless UE capability in support of paging subgrouping for decoding L1 signaling in the DCI format 2\_7.  If UE supports paging enhancement at one band, the procedure of deriving PEI monitoring occasions should be the same for each band. There is no additional procedure for early IODT for different band. Thus, the FG29-1 paging enhancement should be per UE.  **Proposal 2: UE capability of FG29-1 paging enhancement for IDLE/Inactive UE power saving should be based on the support of both PDCCH-based PEI with new DCI format and paging subgroup indication. The paging enhancement should be per UE.** |
| [6] | Samsung | **Proposal 1: Support the following modification on the description of components for FG 29-1 if a separate FG for component 2 is introduced,**   * **1. Support paging early indication in DCI format 2\_7** * **2. Support UE subgroup indication in DCI format 2\_7** |
| [7] | NTT DOCOMO, INC. | Type should be per UE |
| [8] | Qualcomm Incorporated | **Proposal 1: According to RAN2 LS in R1-2200005, FG 29-1 should be based on ‘optional with capability signaling’ and the ‘Need for the gNB to know if the feature is supported’ should be ‘Y’.**  **Proposal 4: Unless otherwise stated, the type for the UE power saving feature should be at least per band (or preferably a type with finer granularity), given the potential UE testing differentiation among licensed, unlicensed, and NTN band.** |
| [9] | OPPO | Regarding the “Components” contents of FG 29-1, one company also suggest a modifying as below. Whether UE support paging subgrouping or not, it need have the capability to receive DCI format 2\_7. The modifying is OK for us.  ***Proposal 1: Prefer component 2 is separated from 29-1.***  Regarding the type of the UE feature, in terms of power saving, per band is a little more complicated, we think per-UE is sufficient.  ***Proposal 2: For the UE feature 29-1, the capability type is per UE.*** |
| [10] | Intel Corporation | Since UE sub-grouping information is only carried via PEI, then it makes sense to group support of PEI and UE subgrouping indication under a common FG.  Some companies raised concern on signaling overhead if Per band is used. Per band capability signaling was mostly motivated considering licensed/unlicensed band differentiation. However, licensed/unlicensed band differentiation can also be achieved using separate bit in per UE capability signaling. Hence, as compromise, we are supportive of per UE with separate bits to indicated support for licensed and unlicensed bands, such as follows:  **Proposal 1: Support of PEI and UE sub-grouping can be a common FG 29-1.**   * **Support of this FG can be Per UE with licensed/unlicensed band differentiation.**   **Proposal 2: Support of FG 29-1 should be optional with capability signalling.**  **Proposal 3: Update FG 29-1 component description as follows:**   |  | | --- | | 1. Support receiving paging early indication via DCI format 2\_7  2. Support receiving UE subgroup indication via DCI format 2\_7 | |
| [11] | Apple | ***Proposal 1: Make the following update for UE feature 29-1:***   * ***Update the UE feature 29-1 as ‘per band’ or “per UE” with FR1/FR2 differentiation.*** * ***Add a component 3 to capture the PDCCH monitoring of type2A-CSS based on legacy UE capability FG3-1: “For type 2A CSS, the monitoring occasion can be any OFDM symbol(s) of a slot, with the monitoring occasions for any of Type 1- CSS without dedicated RRC configuration, or Types 0, 0A, 2 or 2A CSS configurations within a single span of three consecutive OFDM symbols within a slot”.***  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 29. NR\_UE\_pow\_sav\_enh | 29-1 | Paging enhancement | 1. Support paging early indication  2. Support UE subgroup indication  3. For type 2A CSS, the monitoring occasion can be any OFDM symbol(s) of a slot, with the monitoring occasions for any of Type 1- CSS without dedicated RRC configuration, or Types 0, 0A, 2 or 2A CSS configurations within a single span of three consecutive OFDM symbols within a slot |  |  |  | UE does not support paging enhancement | ~~Per UE~~  Per band | N | N | N | For component 2, it is up to RAN2 whether/how to separate the capability for UE subgroup indication  Leave RAN2 to decide whether ‘optional with capability signalling’ or ‘optional without capability signalling’  Leave RAN2 to decide whether Need for the gNB to know if the feature is supported is Yes or No | Optional | |
| [12] | Ericsson | o Component description should be updated to reflect that paging early indication is supported via DCI format 2\_7.  o In last RAN1 meeting, an LS was sent to RAN2 informing consequences of separating the component 2 into a separate FG. Thus, it is preferable to wait for further RAN2 input on this and continue with other aspects of finalizing FG 29-1.  o It may be helpful if RAN1 can also indicate the reporting granularity (as per UE or per Band) in case ‘optional with capability signalling’ is identified as essential by RAN2. The granularity can be per UE or at most per Band, OK to use per band to avoid differentiation FR1/FR2, licensed/unlicensed, etc.   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 29. NR\_UE\_pow\_sav\_enh | 29-1 | Paging enhancement | 1. Support paging early indication via DCI format 2\_7  2. Support UE subgroup indication |  |  |  | UE does not support paging enhancement | ~~Per UE~~ Per Band | N/A | N/A | N/A | For component 2, it is up to RAN2 whether/how to separate the capability for UE subgroup indication  Leave RAN2 to decide whether ‘optional with capability signalling’ or ‘optional without capability signalling’  Leave RAN2 to decide whether Need for the gNB to know if the feature is supported is Yes or No | Optional | |
| [13] | MediaTek Inc. | **Proposal 1: For FG 29-1, considering it would be desired to minimize the signalling overhead of subgrouping reported to RAN or CN, and UE can fallback to monitor its PO as defined in 38.304 if in some scenario (ex. some band) UE is not able to support FG 29-1**   * **The “Type” of FG29-1 should be “per UE”** |
| [14] | CMCC | **Proposal 1. The type of FG 29-1 should be per UE.** |
| [15] | Nokia, Nokia Shanghai Bell | * **29-1:**   + Confirm the component descriptions   + Per UE |

## **Discussion**

**[FL1] Medium priority question 2-1:**

* **Companies are encouraged to provide views on whether the type of FG 29-1 should be per UE or per band**
  + Per UE: ZTE, DOCOMO, Ericsson, Huawei, HiSilicon (*with FR1/FR2 differentiation*), Apple (*with FR1/FR2 differentiation*), CMCC, vivo, CATT, Nokia, MediaTek Inc, OPPO, Intel (*per UE with licensed/unlicensed band differentiation*)
    - *differentiating the feature among multiple aspects, such as frequency range, TDD/FDD, etc., is not beneficial to exploit the best UE power saving benefits*
    - *per band is a little more complicated*
    - *whether the UE is a power consumption sensitive UE is independent of band categories*
  + Per band: Huawei, HiSilicon, Ericsson, Intel, Qualcomm, Apple
    - *it could reduce the IODT work to deploy the feature*
    - *licensed/unlicensed band differentiation is necessary*

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| Company | Comment |
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**[FL1] Medium priority question 2-2:**

* **Companies are encouraged to provide views on whether FG 29-1 is supported as ‘optional with capability signalling’ or ‘optional without capability signalling’.**
  + - optional with capability signalling: Qualcomm, Intel, CATT
      * According to RAN2 LS in R1-2200005

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**[FL1] Medium priority question 2-3:**

* **Companies are encouraged to provide views on whether FG 29-1 is supported as ‘Need for the gNB to know if the feature is supported’ should be ‘Y’.**
  + - Y: Qualcomm
      * According to RAN2 LS in R1-2200005

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**Low priority question 2-4:**

* **Companies are encouraged to provide views on whether/how to revise any other contents in FG 29-1 which do not have capability signaling impacts, e.g.,** 
  + **Revise component 1 as “Support receiving paging early indication in DCI format 2\_7”**
  + **Revise component 2 as “Support receiving UE subgroup indication in DCI format 2\_7”**
  + **Add a component 3 to capture the PDCCH monitoring of type2A-CSS based on legacy UE capability FG3-1: “For type 2A CSS, the monitoring occasion can be any OFDM symbol(s) of a slot, with the monitoring occasions for any of Type 1- CSS without dedicated RRC configuration, or Types 0, 0A, 2 or 2A CSS configurations within a single span of three consecutive OFDM symbols within a slot”**

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| Company | Comment |
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# **29-2: TRS resources for idle/inactive UEs**

In [1], FG 29-2 is captured as 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 (Sidelink 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 |
| 29. NR\_UE\_pow\_sav\_enh | 29-2 | TRS resources for idle/inactive UEs | TRS occassions for idle/inactive UEs  1. Support reading TRS configuration from SIB  2. Support receving L1 indication for TRS availability |  | N |  | Lose of power saving gain on AGC, time/frequency tracking in idle/inactive mode | Per UE | N | N | N |  | Optional without capability signalling |

Following feedbacks are provided in contributions for the RAN1#108-e meeting.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| [2] | Huawei, HiSilicon | We have the following proposals for the FFS part of the UE feature:   1. A controversial discussion is whether to take FG 29-1 as the pre-requisite feature. To move forward as a compromise, it is proposed to update the component 2 as “Support receiving L1 indication for TRS availability via DCI format 2\_7 and DCI format 1\_0” if we could not achieve consensus on the pre-requisite feature. 2. We are fine to update the feature group as “optional without capability signaling”. 3. The UE feature 29-2 should be ‘per band’, considering it could accelerate the deployment of the feature. Even if the UE feature is defined as “per UE” type, it should be at least with FR1/FR2 differentiation. However, if we could agree the FG is “Optional without capability signaling”, it seems no need to discuss the UE type and we could simply leave the column blank. 4. ‘Consequence if the feature is not supported by the UE’ can be updated to “UE does not support TRS resources for idle/inactive UEs”.   ***Proposal 2: Make the following update on the FFS part of UE feature 29-2:***   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 29. NR\_UE\_pow\_sav\_enh | 29-2 | TRS resources for idle/inactive UEs | TRS occassions for idle/inactive UEs  1. Support reading TRS configuration from SIB  2. Support receving L1 indication for TRS availability via DCI format 2\_7 and DCI format 1\_0 |  | N |  | ~~Lose of power saving gain on AGC, time/frequency tracking in idle/inactive mode~~ UE does not support TRS resources for idle/inactive UEs | ~~Per UE~~ | N | N | N |  | Optional without capability signalling | |
| [3] | ZTE, Sanechips | according to the 38.212[5], the DCI format 2-7 (i.e., PDCCH-based PEI) can be used to carry both paging indication and TRS availability information. The TRS availability information is located after the paging indication field. Considering that when UE does not support paging indication, the start position of TRS availability information is not clear. It is expected that PEI based indication for TRS availability is to be supported if FG 29-1 is supported.  Proposal 2: Add a note that PEI based indication for TRS availability is expected to be supported if FG 29-1 is supported by the UE for feature group 29-2.  For 29-2, whether or not the TRS is used for idle or inactive UE is based on UE implementation. In addition, if idle/inactive mode UE does not use TRS, the UE can also use SSB for AGC or time/frequency tracking and without affecting the UE experience. Therefore, there is no strong need for the idle and inactive UE to report the capability.  Proposal 3: FG 29-2 is ‘optional without capability signalling’.  Proposal 4: The capability type of feature group 29-2 is per UE.  Proposal 5: Update content of column “Consequence if the feature is not supported by the UE” in FG 29-2 to “UE does not support TRS occasions for idle/inactive UEs”. |
| [4] | vivo | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 29. NR\_UE\_pow\_sav\_enh | 29-2 | TRS resources for idle/inactive UEs | TRS occassions for idle/inactive UEs  1. Support reading TRS configuration from SIB  2. Support receiving L1 indication for TRS availability via DCI 1\_0 |  | N |  | Lose of power saving gain on AGC, time/frequency tracking in idle/inactive mode | Per UE | N | N | N |  | Optional without capability signalling | | 29. NR\_UE\_pow\_sav\_enh | 29-2a | TRS resources for idle/inactive UEs | 3. Support receiving L1 indication for TRS availability via DCI 2\_7 if the UE supports reception of DCI 2\_7 | 29-1, 29-2 | N |  | Lose of power saving gain on AGC, time/frequency tracking in idle/inactive mode | Per UE | N | N | N |  | Optional without capability signalling | |
| [5] | CATT | UE could elect to retrieve L1 signaling of TRS availability indication from either PEI, paging DCI or both whenever CRC check passes at a DCI monitoring occasion. Thus, UE FG29-2 should not have any prerequisite of FG29-1 since UE could retrieve the L1 signaling from DCI format 1\_0 of paging DCI at paging occasion.  Proposal 3: The UE capability of TRS should be the UE obtaining the TRS configuration from the SIB and the L1 signaling from DCI format 2\_7 for PEI if configured and DCI format 1\_0 for Paging DCI. There is no prerequisite of UE feature support of FG29-1. |
| [6] | Samsung | **Proposal 2: Support the following modification on the description of components for FG 29-2:**   * **Support reading TRS configuration from SIB** * **Support receiving L1 indication for TRS availability via DCI format 1\_0** * **Support receiving L1 indication for TRS availability via DCI format 2\_7 if the UE supports FG 29-1** |
| [7] | NTT DOCOMO, INC. | 1. FG 29-2:    * Regarding whether to support FG 29-2 as optional with capability signaling or optional without capability signaling, we think it can be left to RAN2 discussion.    * Regarding prerequisite feature groups, given UEs that support this feature may not support FG 29-1, we don’t think FG 29-1 should be pre-requisite.    * Type should be per UE    * Regarding the note, it should be confirmed since we had the following agreement in the last meeting  |  | | --- | | **Agreement**  Confirm the following working assumption  Working Assumption  If TRS resource is configured in SIB, L1 based availability indication is always enabled based on the configuration.  **Agreement**  If SIB configures TRS resource, TRS availability indication field is present in DCI format 2\_7 (if configured) with CRC scrambled by PEI-RNTI and DCI format 1\_0 with CRC scrambled by P-RNTI  Note: Huawei, MTK and ZTE have concern on the agreement. | |
| [8] | Qualcomm Incorporated | **Proposal 2: Do not use FG 29-1 as prerequisite for FG-2. Remove the text under “Note” for FG 29-2.**  **Proposal 3: FG 29-2 is based on ‘optional without capability signalling’ and the ‘Need for the gNB to know if the feature is supported’ is ‘N’.**  **Proposal 4: Unless otherwise stated, the type for the UE power saving feature should be at least per band (or preferably a type with finer granularity), given the potential UE testing differentiation among licensed, unlicensed, and NTN band.** |
| [9] | OPPO | ***Proposal 3: For the UE feature 29-2, the capability type is per UE.***  If the UE supports 29-2 but not 29-1, then UE can only read TRS availability from paging DCI. If UE supports 29-2 and 29-1 then UE can used PEI based indication for TRS availability.  Proposal 4: Support the note “Receiving L1 indication via DCI format 2\_7 is supported only if the UE supports FG 29-1”. |
| [10] | Intel Corporation | **Proposal 4: Support one of the following regarding FG 29-2:**   * **If PEI based TRS availability indication is supported, a separate FG can be created such as FG 29-2A where FG 29-1 and FG 29-2 can be prerequisite. In that case, FG 29-2 indicates support of receiving TRS availability via DCI format 1\_0 only.** * **If separate FG for PEI based availability indication cannot be agreed, then at least update component description of FG 29-2 as follows to make it more clear.**  |  | | --- | | TRS occasions for idle/inactive UEs  1. Support reading TRS configuration from SIB  2. Support receiving L1 indication for TRS availability via DCI format 1\_0  3. Support receiving L1 indication for TRS availability via DCI format 2\_7 if the UE supports FG 29-1 |   **Proposal 5: RAN2 can confirm optional with or without capability signalling for FG 29-2. Based on that, reporting type can be finalized.** |
| [11] | Apple | Our view is that a UE supports L1 indication in DCI format 2\_7 only if it reports both 29-1 and 29-2. If a UE reports 29-2 but not 29-1, the UE supports L1 indication in paging DCI only. It has been argued many times during the WI discussion that the basic feature is the support of paging DCI, and the UE may not support PEI. It was also argued that the indication in paging DCI is absolutely necessary because there are UEs that do not support PEI.  In this sense, we think 29-1 should not be the prerequisite for 29-2. Otherwise, there is no point for the network to transmit TRS availability indication in both paging DCI and DCI format 2\_7, and transmitting it in one of the DCIs would be sufficient as the UE supports both anyway.  A few different alternatives had been discussed how to capture the intention:   * Alt 1: add “Receiving L1 indication via DCI format 2\_7 is supported only if the UE supports FG 29-1” in the note   + If there is concern due to the uncertainty of the scope of FG 29-1 due to ongoing RAN2 discussion on UE subgrouping, FG 29-1 can be put in bracket. But we do not think it is necessary because FG 29-1 should include the support of DCI format 2\_7 even if UE subgrouping is defined as separate FG(s). * Alt 2: introduce a new FG 29-2a for the support of L1 indication in DCI format 2\_7, and FG 29-1/29-2 are the prerequisites for 29-2a.   We are fine either way, but Alt 1 seems a bit simpler.  The **granularity for the FGs** was also discussed during the email discussion, e.g. whether the FGs should be per UE or per band. We acknowledge the IODT issues that were raised, given that now we have more types of spectrums supported, such as unlicensed, NTN, and FR2-2. Per band is more flexible in the handling of different types of bands.  Therefore, **we prefer to define the FGs as per band**, with the exception of 29-2 if it is optional without capability signaling (in which case no type needs to be defined).   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 29. NR\_UE\_pow\_sav\_enh | 29-2 | TRS resources for idle/inactive UEs | TRS occasions for idle/inactive UEs  1. Support reading TRS configuration from SIB  2. Support receiving L1 indication for TRS availability |  | N |  | UE cannot receive TRS resources for idle/inactive mode |  | N | N | N | Receiving L1 indication  via DCI format 2\_7 is supported only if the UE supports FG 29-1. | Optional without capability signalling | |
| [12] | Ericsson | ・‘Consequence column’: The current sentence (Lose of power saving gain on AGC, time/frequency tracking in idle/inactive mode) should be removed. OK to add “UE does not support TRS occasions for idle/inactive UEs” or it can be left empty.  ・There was some discussion in last meeting on whether to add PEI (FG 29-1) as a prerequisite for receiving TRS occasions (FG 29-2). PEI is not necessary to receive TRS occasions, for which the availability indication can be received via Paging DCI instead. Therefore, we do not see need to add 29-2 as prerequisite. On the other hand, it makes sense that a UE supporting both PEI and TRS occasions should be able to receive availability indication via PEI. Components need to be updated accordingly to indicate support via DCI 1\_0 and via DCI 2\_7 (if UE supports FG29-1).  ・Allowing optional UE capability signalling can be useful for NW to know when to turn on this feature, but it is not essential to have capability signalling for this or any additional separate capabilities (for reception of L1 signalling). TRS occasion configuration and L1 availability configuration is not UE-specific. Idle/Inactive UEs can ignore any TRS occasion-related information they are not interested in/capable of receiving. If ‘optional with capability’ signalling is identified as essential, it should be per UE granularity or at most per Band, OK to use per band to avoid differentiation FR1/FR2, licensed/unlicensed, etc. As suggested by some companies, it would be also OK to leave optional with/without capability signalling to RAN2 decision   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 29. NR\_UE\_pow\_sav\_enh | 29-2 | TRS resources for idle/inactive UEs | TRS occassions for idle/inactive UEs  1. Support reading TRS configuration from SIB  2. Support receving L1 indication for TRS availability via DCI format 1\_0  3. Support receiving L1 indication for TRS availability via DCI format 2\_7 (when UE supports FG 29-1) |  | N |  | ~~Lose of power saving gain on AGC, time/frequency tracking in idle/inactive mode~~  UE does not support TRS occasions for idle/inactive UEs | ~~Per UE~~ | N/A | N/A | N/A |  | Optional without capability signalling | |
| [13] | MediaTek Inc. | **Proposal 2: For FG 29-2 "TRS resources for idle/inactive UEs", modify the contents of “Consequence if the feature is not supported by the UE” to be**   * **“UE can not receive TRS resources for idle/inactive mode”** |
| [14] | CMCC | **Proposal 2. The type of FG 29-2 should be per UE.**  **Proposal 3. The signaling of FG 29-2 should be optional without capability signaling.**  **Proposal 4.** **FG 29-2 is updated as follows:**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 29. NR\_UE\_pow\_sav\_enh | 29-2 | TRS resources for idle/inactive UEs | TRS occasions for idle/inactive UEs  1. Support reading TRS configuration from SIB  2. Support receiving L1 indication for TRS availability |  | N |  | UE cannot receive TRS resources for idle/inactive mode | Per UE | N | N | N | Receiving L1 indication via DCI format 2\_7 is supported only if the UE supports FG 29-1 | Optional without capability signalling | |
| [15] | Nokia, Nokia Shanghai Bell | * **29-2:**    + Similar treatment as for 29-1 regarding optionality, i.e. add the following notes:     - Leave RAN2 to decide whether ‘optional with capability signalling’ or ‘optional without capability signalling’     - Leave RAN2 to decide whether Need for the gNB to know if the feature is supported is Yes or No   + Per UE   + Revise ”Consequence if…” as current text is not appropriate for specifications. E.g. “UE does not support TRS occasions for idle/inactive UEs” |

## **Discussion**

**[FL1] High priority question 3-1:**

* **Companies are encouraged to provide views on whether/how to separate the capability for receiving L1 indication for TRS availability, e.g.**
  + FG 29-2 is for the capability of Paging PDCCH based indication and another FG is defined for the capability of PEI based indication: DOCOMO, Intel

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| Moderator | Following proposal was discussed in the last RAN1 meeting but no consensus was achieved. Let’s further discuss following proposal as the starting point.  **High priority proposal 3-1:**   * **FG 29-2 is updated as follows**  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 29. NR\_UE\_pow\_sav\_enh | 29-2 | TRS resources for idle/inactive UEs | TRS occas~~s~~ions for idle/inactive UEs  1. Support reading TRS configuration from SIB  2. Support receiving L1 indication for TRS availability | FFS | N |  | ~~Lose of power saving gain on AGC, time/frequency tracking in idle/inactive mode~~  UE cannot receive TRS resources for idle/inactive mode | Per UE | N | N | N | Receiving L1 indication via DCI format 2\_7 is supported only if the UE supports FG 29-1 | Optional without capability signalling |  * Prefer to separate the capability for Receiving L1 indication via DCI format 2\_7: vivo, Intel * Prerequisite FG   + None: CATT, DOCOMO, QC, Apple, Ericsson, CMCC |
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**[FL1] Medium priority question 3-2:**

* **Companies are encouraged to provide views on whether FG 29-2 is be supported as ‘optional with capability signalling’ or ‘optional without capability signalling’.**
  + optional without capability signalling: Qualcomm, Ericsson, CMCC, ZTE, Huawei, HiSilicon, vivo, Apple
    - *whether the UE supports the idle/inactive TRS does not have much explicit impact on network implementation on whether and how TRS should be transmitted*
    - *it is up to UE how to process TRS and there is no subsequent behavior expected from UE by the NW*
  + Up to RAN2: Nokia, NSB, Intel, DOCOMO, Ericsson

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**[FL1] Medium priority question 3-3:**

* **Companies are encouraged to provide views on whether the type of FG 29-2 should be per UE or per band**
  + Per UE: Huawei, HiSilicon (*with FR1/FR2 differentiation*), ZTE, CATT, Intel, DOCOMO, Ericsson, vivo, OPPO, MediaTek, CMCC, Nokia, NSB, Intel (*with licensed/unlicensed band differentiation*)
    - *whether the UE is a power consumption sensitive UE is independent of band categories*
  + Per band: Huawei, HiSilicon, Qualcomm, Ericsson, Apple
    - *it could accelerate the deployment of the feature*
    - *differentiation between licensed and unlicensed bands is necessary*

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**Low priority question 3-4:**

* + **Companies are encouraged to provide views on whether/how to revise any other contents in FG 29-2 which do not have capability signalling impacts**

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# **29-3a to 29-3d: PDCCH monitoring adaptation within an active BWP**

In [1], FGs 29-3a to 29-3d are captured as 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 (Sidelink 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 |
| 29. NR\_UE\_pow\_sav\_enh | 29-3a | PDCCH skipping | Support of up to 2-bit indication of PDCCH skipping by scheduling DCI if SSSG is not configured |  | Y |  |  | Per UE | N | N | N |  | Optional with capability signaling |
| 29. NR\_UE\_pow\_sav\_enh | 29-3b | 2 search space sets group switching | Support of 1-bit indication of SSSG switching between 2 SSSGs by scheduling DCI, and timer based switching, without PDCCH skipping |  | Y |  |  | Per UE | N | N | N |  | Optional with capability signaling |
| 29. NR\_UE\_pow\_sav\_enh | 29-3c | 3 search space sets group switching | Support of 2-bit indication of SSSG switching among 3 SSSGs by scheduling DCI and timer based switching | 29-3b | Y |  |  | Per UE | N | N | N |  | Optional with capability signaling |
| 29. NR\_UE\_pow\_sav\_enh | 29-3d | 2 search space sets group switching with PDCCH skipping | Support of 2-bit indication of SSSG switching between 2 SSSGs with PDCCH skipping by scheduling DCI and timer based switching | 29-3a, 29-3b | Y |  |  | Per UE | N | N | N |  | Optional with capability signaling |

Following feedbacks are provided in contributions for the RAN1#108-e meeting.

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| [2] | Huawei, HiSilicon | ***Proposal 3: Make the following update on the FFS part of UE feature 29-3:***   * ***Remove the highlight of component of 29-3a to endorse the component description.*** * ***The UE features of 29-3a, 29-3b, 29-3c and 29-3d are ‘per band’ UE feature or “per UE” with FR1/FR2 differentiation.***  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 29. NR\_UE\_pow\_sav\_enh | 29-3a | PDCCH skipping | Support of up to 2-bit indication of PDCCH skipping by scheduling DCI if SSSG is not configured |  | Y |  |  | ~~Per UE~~  Per band | N | N | N |  | Optional with capability signaling | | 29. NR\_UE\_pow\_sav\_enh | 29-3b | 2 search space sets group switching | Support of 1-bit indication of SSSG switching between 2 SSSGs by scheduling DCI, and timer based switching, without PDCCH skipping |  | Y |  |  | ~~Per UE~~  Per band | N | N | N |  | Optional with capability signaling | | 29. NR\_UE\_pow\_sav\_enh | 29-3c | 3 search space sets group switching | Support of 2-bit indication of SSSG switching among 3 SSSGs by scheduling DCI and timer based switching | 29-3b | Y |  |  | ~~Per UE~~  Per band | N | N | N |  | Optional with capability signaling | | 29. NR\_UE\_pow\_sav\_enh | 29-3d | 2 search space sets group switching with PDCCH skipping | Support of 2-bit indication of SSSG switching between 2 SSSGs with PDCCH skipping by scheduling DCI and timer based switching | 29-3a, 29-3b | Y |  |  | ~~Per UE~~  Per band | N | N | N |  | Optional with capability signaling | |
| [3] | ZTE, Sanechips | Proposal 6: Update FG 29-3d as “Support of 2-bit indication of SSSG switching between 2 SSSGs and PDCCH skipping by scheduling DCI and timer based switching”.  Proposal 7: As to FG 29-3, the capability type should be per UE. |
| [4] | vivo | * For 29-3a, the description of the component is stable enough so that the yellow color can be removed. * For 29-3c, the description of the component need some minor correction. It should be clearly stated that 29-3c is for without PDCCH skipping (similar to the description of 29-3b) * For all the 29-3a/3b/3c/3d, it should be per UE feature, and no need for differential for TDD/FDD, FR1/FR2  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 29. NR\_UE\_pow\_sav\_enh | 29-3a | PDCCH skipping | Support of up to 2-bit indication of PDCCH skipping by scheduling DCI if SSSG is not configured |  | Y |  |  | Per UE | N | N | N |  | Optional with capability signaling | | 29. NR\_UE\_pow\_sav\_enh | 29-3b | 2 search space sets group switching | Support of 1-bit indication of SSSG switching between 2 SSSGs by scheduling DCI, and timer based switching, without PDCCH skipping |  | Y |  |  | Per UE | N | N | N |  | Optional with capability signaling | | 29. NR\_UE\_pow\_sav\_enh | 29-3c | 3 search space sets group switching | Support of 2-bit indication of SSSG switching among 3 SSSGs by scheduling DCI and timer based switching, without PDCCH skipping | 29-3b | Y |  |  | Per UE | N | N | N |  | Optional with capability signaling | | 29. NR\_UE\_pow\_sav\_enh | 29-3d | 2 search space sets group switching with PDCCH skipping | Support of 2-bit indication of SSSG switching between 2 SSSGs with PDCCH skipping by scheduling DCI and timer based switching | 29-3a, 29-3b | Y |  |  | Per UE | N | N | N |  | Optional with capability signaling | |
| [5] | CATT | **Proposal 4: The UE capability of PDCCH monitoring adaptation for CONNECTED mode UE should be per UE.** |
| [7] | NTT DOCOMO, INC. | * + Type should be per UE |
| [8] | Qualcomm Incorporated | **Proposal 4: Unless otherwise stated, the type for the UE power saving feature should be at least per band (or preferably a type with finer granularity), given the potential UE testing differentiation among licensed, unlicensed, and NTN band.** |
| [9] | OPPO | ***Proposal 5: For the UE feature 29-3, the capability type is per UE.*** |
| [10] | Intel Corporation | **Proposal 6: Support of FG 29-3 can be per UE with licensed/unlicensed band differentiation.** |
| [11] | Apple | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 29. NR\_UE\_pow\_sav\_enh | 29-3a | PDCCH skipping | Support of up to 2-bit indication of PDCCH skipping by scheduling DCI if SSSG is not configured |  | Y |  |  | Per Band | N | N | N |  | Optional with capability signaling | | 29. NR\_UE\_pow\_sav\_enh | 29-3b | 2 search space sets group switching | Support of 1-bit indication of SSSG switching between 2 SSSGs by scheduling DCI, and timer based switching, without PDCCH skipping |  | Y |  |  | Per Band | N | N | N |  | Optional with capability signaling | | 29. NR\_UE\_pow\_sav\_enh | 29-3c | 3 search space sets group switching | Support of 2-bit indication of SSSG switching among 3 SSSGs by scheduling DCI and timer based switching | 29-3b | Y |  |  | Per Band | N | N | N |  | Optional with capability signaling | | 29. NR\_UE\_pow\_sav\_enh | 29-3d | 2 search space sets group switching with PDCCH skipping | Support of 2-bit indication of SSSG switching between 2 SSSGs with PDCCH skipping by scheduling DCI and timer based switching | 29-3a, 29-3b | Y |  |  | Per Band | N | N | N |  | Optional with capability signaling | |
| [12] | Ericsson | * + The FGs should be per UE or at most per Band, OK to use per band to avoid differentiation FR1/FR2, licensed/unlicensed, etc.   + They should be optional with capability signalling.   + ‘Consequence column’ can be left empty – there is no need to say that the feature is not supported as a consequence.  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 29. NR\_UE\_pow\_sav\_enh | 29-3a | PDCCH skipping | Support of up to 2-bit indication of PDCCH skipping by scheduling DCI if SSSG is not configured |  | Y |  |  | ~~Per UE~~ Per Band | N/A | N/A | N/A |  | Optional with capability signaling | | 29. NR\_UE\_pow\_sav\_enh | 29-3b | 2 search space sets group switching | Support of 1-bit indication of SSSG switching between 2 SSSGs by scheduling DCI, and timer based search space set group switching, without PDCCH skipping |  | Y |  |  | ~~Per UE~~ Per Band | N/A | N/A | N/A |  | Optional with capability signaling | | 29. NR\_UE\_pow\_sav\_enh | 29-3c | 3 search space sets group switching | Support of 2-bit indication of SSSG switching among 3 SSSGs by scheduling DCI and timer based search space set group switching | 29-3b | Y |  |  | ~~Per UE~~ Per Band | N/A | N/A | N/A |  | Optional with capability signaling | | 29. NR\_UE\_pow\_sav\_enh | 29-3d | 2 search space sets group switching with PDCCH skipping | Support of 2-bit indication of SSSG switching between 2 SSSGs with PDCCH skipping by scheduling DCI and timer based search space set group switching | 29-3a, 29-3b | Y |  |  | ~~Per UE~~ Per Band | N/A | N/A | N/A |  | Optional with capability signaling | |
| [13] | MediaTek Inc. | **Proposal 3: For 29-3b and 29-3c, adopt the following sentence to “Components”:**   * **if *PDCCHSkippingDurationList* is not configured** |
| [14] | CMCC | Proposal 5. The type of FG 29-3a/29-3b/29-3c/29-3d should be per UE. |
| [15] | Nokia, Nokia Shanghai Bell | * **29-3a:**   + Confirm the component description   + Per UE * **29-3b:**   + Per UE * **29-3c:**   + Per UE * **29-3d:**   + Per UE |

## **Discussion**

**[FL1] Medium priority question 4-1:**

* **Companies are encouraged to provide views on whether the type of FG 29-3x should be per UE or per band**
  + Per UE: ZTE, CATT, DOCOMO, Ericsson, vivo, OPPO, MediaTek, CMCC, Nokia, Huawei, HiSilicon (*with FR1/FR2 differentiation*) , Intel (*per UE with licensed/unlicensed band differentiation*)
    - *whether the UE is a power consumption sensitive UE is independent of band categories*
  + Per band: Huawei, HiSilicon, Qualcomm, Ericsson, Apple
    - *it could accelerate deployment of the feature on some bands*
    - *differentiation between licensed and unlicensed bands is necessary*

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**Low priority question 4-2:**

* **Component of 29-3a is confirmed**
  + Support : Nokia, Huawei, HiSilicon, vivo

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**Low priority question 4-3:**

* **Companies are encouraged to provide views on whether/how to revise any other contents in FG 29-3 which do not have capability signaling impacts, e.g.,**
  + **Revise component in FG 29-3b as: Support of 1-bit indication of SSSG switching between 2 SSSGs by scheduling DCI, and timer based SSSG switching, without PDCCH skipping if *PDCCHSkippingDurationList* is not configured**
  + **Revise component in FG 29-3c as: Support of 2-bit indication of SSSG switching among 3 SSSGs by scheduling DCI and timer based SSSG switching, without PDCCH skipping if *PDCCHSkippingDurationList* is not configured**
  + **Revise component in FG 29-3d as: Support of 2-bit indication of SSSG switching between 2 SSSGs with PDCCH skipping by scheduling DCI and timer based SSSG switching**

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# **Conclusions**

TBD

# **References**

[1] R1-2200780 Updated RAN1 UE features list for Rel-17 NR after RAN1 #107bis-e Moderators (AT&T, NTT DOCOMO, INC.)

[2] R1-2200947 Rel-17 UE features for UE power saving enhancements Huawei, HiSilicon

[3] R1-2201125 Discussion on UE features for UE power saving enhancements vivo

[4] R1-2201134 Discussion on UE feature for UE power saving enhancements ZTE, Sanechips

[5] R1-2201288 Rel-17 UE Power Saving features OPPO

[6] R1-2201349 Discussion on UE feature of UE Power saving enhancements for NR CATT

[7] R1-2201414 On UE features for UE power saving enhancements Nokia, Nokia Shanghai Bell

[8] R1-2201507 Discussion on Rel-17 UE features for UE power saving NTT DOCOMO, INC.

[9] R1-2201732 Discussion on UE features related to UE Power Saving Intel Corporation

[10] R1-2201797 Views on UE features for Rel-17 UE power saving Apple

[11] R1-2201885 Discussion on UE features for UE power saving enhancements CMCC

[12] R1-2202044 UE features for UE power saving enhancements Samsung

[13] R1-2202053 On UE features for UE power saving enhancements MediaTek Inc.

[14] R1-2202171 UE features for UE power saving enhancements Qualcomm Incorporated

[15] R1-2202224 UE features for UEPS Ericsson