**3GPP TSG RAN WG1 #106bis-e R1-210xxxx**

**e-Meeting, October 11th – 19th, 2021**

**Agenda item:** 8.17.7

**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 8.17.7 regarding UE features for UE power saving enhancements and captures the following email discussion.

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| [106bis-e-R17-UE-features-PowSav-01] Email discussion UE features for UE power savings enhancements – Shinya (DOCOMO)* 1st check point: October 14
* Final check point: October 19
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In the preliminary RAN1 UE features list for Rel-17 NR [1], there are following feature groups for UE power saving enhancements.

* 29-1 Paging enhancement
* 29-2 TRS resources for idle/inactive UEs
* 29-3 PDCCH monitoring adaptation within an active BWP

Based on the discussions summarized in Sections 2-4, following is the suggested list of issues to be discussed and priority order considering RAN2 impact especially for capability signaling design, which are tagged and colour coded with High priority, Medium priority, or Low priority.

**FL proposal of list of issues/proposals and priority:**

* **High priority issues (such as a certain FG is necessary or not):**
	+ **Discuss whether/how to separate the capability for UE subgroup indication from FG 29-1**
	+ **Discuss whether to separate the capability for receiving L1 indication for TRS availability (i.e., component 2 in FG 29-2) as another FG**
	+ **Discuss whether to separate the capability for receiving PEI based indication for TRS availability as another FG**
	+ **Discuss whether/how to separate the capabilities of FG 29-3**
* **Medium priority issues (such as components and type that have capability signaling impacts):**
	+ **Discuss whether capability signaling is necessary for FG 29-1**
	+ **Discuss whether the type of FG 29-1 should be per UE or per band**
	+ **Discuss whether capability signaling is necessary for FG 29-2**
	+ **Discuss whether the type of FG 29-2 should be per UE or per band**
	+ **Discuss whether the column for “Mandatory/Optional” in FG 29-3 can be updated to “Optional with capability signaling”**
	+ **Discuss whether the type of FG 29-3 should be per UE or per band**
* **Low priority issues (such as components that do not have capability signaling impacts)**
	+ **Discuss whether/how to revise the sentence in “Consequence if the feature is not supported by the UE” in FG 29-1**
	+ **Discuss whether/how to revise any other contents in FG 29-1 which do not have capability signaling impacts**
	+ **Discuss whether/how to revise the sentence in “Consequence if the feature is not supported by the UE” in FG 29-2**
	+ **Discuss whether/how to revise any other contents in FG 29-2 which do not have capability signaling impacts**
	+ **Discuss whether/how to revise the sentence in “Consequence if the feature is not supported by the UE” in FG 29-3**
	+ **Discuss whether/how to revise any other contents in FG 29-3 which do not have capability signaling impacts**

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.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 indication2. Support UE subgroup indication |  | N |  | High idle/inactive mode UE power consumption if NR SA networks | Per UE | N | N | N |  | Optional without capability signalling |

Following feedbacks are provided in contributions for the RAN1#106bis-e meeting.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| [2] | vivo | * **Subgroup indication**

RAN2 discussed UE paging subgrouping as part of the Rel-17 work on UE power saving enhancement. For example, two subgrouping approaches have been agreed, namely CN-assigned subgrouping and UEID-based subgrouping. However, how to carry subgrouping information, is related and discussed in RAN1. Considering this correlated way of discussion between RAN1 and RAN2, we expected the subgrouping indication is either separated from 29-1 or as a RAN2 feature to be discussed in RAN2.* **Descriptions of the components**

According to the RAN plenary decision [2], PDCCH based PEI is agreed. New DCI format and only Behv-A supported is agreed. Thus it should be captured in the component descriptions.***Proposal 1:*** * ***Support UE subgroup indication is either separated from 29-1 or as a RAN2 feature to be discussed in RAN2.***
* ***Update the descriptions of 29-1 as follows,***

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Features | Index | Feature group | Components | Prerequisite feature groups |
|  29. NR\_UE\_pow\_sav\_enh | 29-1-1 | Paging enhancement | ~~1. Support paging early indication~~1. Support of configured window for detection of DCI format XXX with CRC scrambled with YYY for paging early indication2. Support of Behv-A if UE does not detect PEI for all monitored PEI occasion(s) for the PO~~2. Support UE subgroup indication~~ |  |
| 29. NR\_UE\_pow\_sav\_enh | 29-1-2 | Paging enhancement | Support UE subgroup indication |  |

 |
| [3] | Huawei, HiSilicon | **Feature 29-1**1. There can be two ways in general to inform the network about the UE capability on PEI for IDLE/inactive mode UE. One is using NAS signaling to inform the core network. And the other one is using RRC signaling to inform the gNB, e.g. when the UE firstly does the registration procedure to the network. This gNB can inform the UE’s capability regarding PEI to the core network. Especially considering that RAN2 has agreed that there would be two subgrouping methods, CN assigned subgrouping and UE ID based subgrouping. It seems it would be better to leave RAN2 to decide the details. Therefore, we suggest just to use “optional” in the table and leave the details to RAN2 for decision. The column of “Need for the gNB to know if the feature is supported” should be also updated to “Y” accordingly.
2. It was concluded in RAN#93 that PDCCH based PEI is supported as the only option. Therefore, the component 1 should be updated to “Support PDCCH based paging early indication”.

Therefore, we have the following proposed change on Feature 29-1:***Proposal 1: adopt the following change in the UE feature table for PEI:***

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 29. NR\_UE\_pow\_sav\_enh | 29-1 | Paging enhancement   | 1. Support PDCCH based paging early indication2. Support UE subgroup indication |  | ~~N~~Y |  | High idle/inactive mode UE power consumption if NR SA networks | Per UE | N | N | N |  | Optional ~~without capability signalling~~ |

 |
| [4] | CATT | The UE feature of UE power saving enhancement for NR includes paging enhancement for IDLE/Inactive UEs, PDCCH monitoring adaptation for CONNECTED mode UEs, and RLM measurement relaxation. The UE features for CONNECTED mode UEs would be critical to the network configuration and gNB scheduling since network will receive the feedback of UE capability to indicate whether UE supports the UE features. However, network might not know whether IDLE/Inactive UE supports the IDLE/Inactive UE features since the UE capability inquiry by network and UE response through RRC signaling only when UE is in RRC\_CONNECTED mode. Thus, the UE feature for IDLE/Inactive mode UE should be designed as the feature indication is transparent to the network since the UE capability of UE support of this feature would not be completely known by the network. **Proposal 1: The UE feature for IDLE/Inactive mode UE should be designed as the feature indication is transparent to the network since the UE capability of UE support of this feature would not be completely known by the network.** 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#104bis-e that paging subgrouping is indicated by L1 signaling either included in PEI and/or paging DCI. The configuration of physical channel and monitoring occasions, such as PDCCH-based PEI or paging PDCCH at PO with L1 signaling for paging subgroup indication needs to be broadcasted to IDLE/Inactive UEs, Thus, the UE capability should be centered with the UE support of paging subgrouping whether L1 signaling is included in the PEI or paging DCI. The configuration of physical channel, either PDCCH-based PEI or PDCCH at PO, and the contents in the new DCI formats for PEI or paging DCI would be broadcasted to IDLE/Inactive UEs regardless UE capability in support of paging subgrouping for decoding L1 signaling in the PEI or paging DCI is fed back to the network. **Proposal 2: UE capability for IDLE/Inactive UE power saving should be based on the support of the configuration of physical channel and monitoring occasions for paging subgroup indication.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| NR\_UE\_pow\_sav\_enh | 29-1 | Paging enhancement   | Paging subgroup indication for IDLE/Inactive UE1. Support of paging subgroup configuration. 2, Support of L1 signaling of paging subgroup indication3. Support of new DCI format for paging subgroup indication (PEI) 4. Support of PEI monitoring occasion(s) |  | N |  | IDLE/Inactive UE follows legacy paging procedure at each Paging Occasion.  | Per UE | N | N | N |  | Optional |

 |
| [5] | Samsung | For the component, we think UE subgroup indication is part of paging early indication. No need to separate them if both of them are carried by the same physical layer channel in a single DCI format. It can be changed to “paging early indicator with UE subgrouping per PO”For the consequence, we think it’s not critical. UE just need to monitor the paging PDCCH directly in configured PO if they don’t support this feature. We suggest to capture the impact to default or legacy UE behavior if any as the consequence. Whether or not idle/inactive UE power consumption is high depends on gNB configuration and real-time traffic, such as group paging rate, DRX cycle, and etc. It’s not the consequence of not supporting this feature. Also, the power saving gain for PDCCH based PEI depends on UE implementation, such as whether or not to reuse RRM measurement for synchronization, and no consensus in RAN1. **Proposal 1: For FG 29-1:*** **Merge “paging early indication” and “UE subgroup indication” to “paging early indication with UE subgrouping per PO” as the component;**
* **Capture default UE behavior, i.e. UE monitors paging PDCCH in configured PO, as consequence.**
 |
| [7] | Intel | For the FG 29-1, we have the following suggestions:* If UE sub-grouping information is only carried via PEI, then it is fine to group support of PEI and UE subgrouping indication under a common FG.
	+ If paging DCI is also supported for UE subgrouping information then, a separate FG would be needed
* Capture that support of PEI is based on a DCI format
* We do not agree the description in the column “Consequence if the feature is not supported by the UE”. It is sufficient to say “UE does not support PEI and UE sub grouping indication” as consequence.
* “Note” column should capture the following
	+ maximum number of sub-groups per PO can be eight
	+ Behv-A for PEI detection

**Observation 1: If UE sub-grouping information is only carried via PEI, then support of PEI and UE subgrouping indication can be grouped under a common FG.****Observation 2: If paging DCI is also supported for UE subgrouping information then, a separate FG would be needed.** |
| [8] | DOCOMO | 1. FG 29-1:
* For the Components: In the RAN plenary#93, support of PDCCH based PEI is agreed and the following should be added.
	+ New DCI format

In addition to the above, TRS availability indication via PEI is working assumption. Thus, this should be added with bracket.

|  |  |  |  |
| --- | --- | --- | --- |
| **Features** | **Index** | **Feature group** | **Components** |
|  29. NR\_UE\_pow\_sav\_enh | 29-1 | Paging enhancement  | 1. Support paging early indication2. Support UE subgroup indication3. Support New DCI Format4. [Support TRS availability] |

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| [9] | ZTE, Sanechips | For the UE capability of paging enhancement, it should be optional without UE capability signalling, instead of mandatory, which is similar with feature group19-6 of relaxed measurement in Rel-16.1. The feature group 29-1 of paging enhancement should be optional without UE capability signalling.
 |
| [10] | Apple | For paging enhancements, there are two features: paging early indication and UE subgroup indication. These two are different functions, we should **define two separate FGs for paging early indication and UE subgroup indication**.Regarding whether some of the FGs need to be reported to the network, we think **the FGs for paging enhancements should be reported to the gNB**.* For paging early indication, it is not absolutely necessary for the UE to report. However, if it is not reported, the gNB would always need to transmit PEI, even if the UE does not support it. So it is beneficial for the UE to report the capability, so that the gNB can decide whether to transmit PEI based on the capability of UEs to be paged.
* For subgroup indication, the UE capability needs to be reported to the gNB so that the gNB can forward it to the core network. When there is paging for a UE, the core network knows whether the UE supports subgroup indication, and if yes, the core network can send the corresponding information to the gNB so that the gNB can deliver subgroup indication properly.
* In addition, **for subgroup indication, it may be better to leave it to RAN2 to decide** how to define the FG. According to the RAN2 LS R2-2108917, CN-based subgrouping and UEID-based subgrouping have been agreed. It is better to leave it to RAN2 to decide whether separate reporting is needed for the two approaches.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 29. NR\_UE\_pow\_sav\_enh | 29-1a | Paging early indication   | 1. Support paging early indication |  | Y |  | High idle/inactive mode UE power consumption in NR SA networks | Per UE | N | N | N |  | Optional with capability signalling |
| [29. NR\_UE\_pow\_sav\_enh] | [29-1b] | [Paging subgroup indication] | [1. Support UE subgroup indication] |  | [Y] |  | [Higher power consumption due to false paging wakeup for IDLE/INACTIVE UEs] | [Per UE] | [N] | [N] | [N] |  | [Optional with capability signalling] |

 |
| [11] | Ericsson | Below are some of the main changes proposed for the FGs (using track changes in below table). * For FGs 29-1 (PEI) and 29-2 (TRS occasions), allow optional UE capability signalling as it is useful for NW to know when to turn on these features. Alternatively, the last column can be left blank and discussed later.
* The ‘consequence if feature is not supported by the UE’ should be left empty’ and making generalized statements about deployments, etc should be avoided. It is clear that all features being developed in the WI are for UE power savings.
* For FG(29-3), component 3) should be added as per the WA from RAN1#106-e.

**Proposal 1: Update the UE feature list for UEPS as shown in below Table.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 29. NR\_UE\_pow\_sav\_enh | 29-1 | Paging enhancement   | 1. Support paging early indication2. Support UE subgroup indication |  |  |  |  | Per UE | N | N | N |  | Optional with capability signalling |
|  29. NR\_UE\_pow\_sav\_enh | 29-2 | TRS occasions for idle/inactive UEs | TRS occasions for idle/inactive UEs 1. Support reading TRS configuration from SIB2. Support receiving L1 indication for TRS availability |  |  |  |  | Per UE | N | N | N |  | Optional with capability signalling |
|  29. NR\_UE\_pow\_sav\_enh | 29-3 | PDCCH monitoring adaptation within an active BWP | 1. Support of PDCCH monitoring adaptation behaviour 1/1A
2. Support of PDCCH monitoring adaptation behaviour 2/2A/[2B]
3. Support of PDCCH monitoring adaptation behaviour 1/1A/2/2A
 |  |  |  |  | Per UE | N | N | N | FFS: Support of PDCCH monitoring adaptation behaviour 1/1A/2/2A/2B | Optional |

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| [12] | Qualcomm | For FG 29, the differentiation between licensed and unlicensed bands is necessary. It is not because there are significant implementation challenges specifically in the unlicensed band or vice versa, but because it is unlikely that deployment schedules of NR in licensed and unlicensed bands are the same. Note that NR has already been deployed worldwide in licensed bands, while the deployment for unlicensed bands has not been started. If the feature is based on per-UE signaling, in order to introduce the UE power saving feature for either licensed or unlicensed band first, it requires IODT for both licensed and unlicensed bands, and thus the introduction of the feature would be delayed. However, 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. The same argument also applies to the NTN band. Among the types of signaling, “Per Band” should be used to support the licensed-unlicensed differentiation. Otherwise, if a signaling type other than “Per Band” is used, the differentiation between licensed and unlicensed should separately be enabled with the feature.Proposal 1: Unless otherwise stated, the type for the UE power saving feature should be at least per band (or preferreably a type with finer granularity), given the potential UE testing differentiation among licensed, unlicensed, and NTN band. |
| [13] | Nokia, Nokia Shanghai Bell | * **29-1:**
	+ Simplify ”Consequence if…” as current text is not appropriate for specifications. E.g. “Paging Enhanced Indication is not supported”
	+ Optional with capability signalling: Even being for idle, the network should know if there are UEs supporting the feature. For example, sub-grouping might require signaling to CN. In any case RAN1 needs to clarify with RAN2 where to capture the support UE subgroup indication, in RAN1 or RAN2 capabilities.
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## **Discussion**

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

* **Companies are encouraged to provide views on whether/how to separate the capability for UE subgroup indication from FG 29-1, e.g.,**
	+ **Separate FG in RAN1 UE feature list**
	+ **RAN2 UE feature to be discussed in RAN2**

|  |  |
| --- | --- |
| Company | Comment |
| MTK | We prefer to not separate FG 29-1 in RAN1 since paging early indicator and UE subgroup indication are just information parsing after decoding the DCI, and can be considered to be indicated by capability report jointly. Having said so, we are open to discuss UE subgroup indication in RAN2 UE features if majority of companies prefer this way. |
| Vivo | RAN2 discussed UE paging subgrouping as part of the Rel-17 work on UE power saving enhancement. For example, two subgrouping approaches have been agreed, namely CN-assigned subgrouping and UEID-based subgrouping. We expected the subgrouping indication is either separated from 29-1 or as a RAN2 feature to be discussed in RAN2.According to the RAN plenary decision, PDCCH based PEI is agreed. New DCI format and only Behv-A supported is agreed. Thus it should be captured in the component descriptions. It is updated as follows,~~1. Support paging early indication~~1. Support of configured window for detection of DCI format XXX with CRC scrambled with YYY for paging early indication2. Support of Behv-A if UE does not detect PEI for all monitored PEI occasion(s) for the PO~~2. Support UE subgroup indication~~ |
| ZTE, Sanechips | We think it can be decided by RAN2 as there are two sub-grouping methods being discussed in RAN2, this feature may have impact on RAN2 design. |
| Nordic  | Separate FG is defined for sub-grouping and with two components one for UE-ID based subgroup ID and one for dedicated subgroup ID.  |
| Nokia, NSB | No need to separate into another RAN1 FG. OK to agree on a solution with RAN2 though.  |

**Medium priority question 2-2:**

* **Companies are encouraged to provide views on** **whether capability signaling is necessary for FG 29-1, i.e., whether to support as optional with capability signaling or optional without capability signaling**

|  |  |
| --- | --- |
| Company | Comment |
| MTK | Having read companies’ views, we think there should be some way for UE to report to gNB whether it supports this feature. As mentioned by Huawei, this can be achieved by using NAS signaling to inform the core network, or using RRC signaling to inform the gNB, e.g. when the UE firstly does the registration procedure to the network. We are not sure how this kind of notification (different from normal connected mode capability report) should be named. We are open to hear more views or consult RAN2. |
| Vivo | Reporting the capability to gNB is beneficial.  |
| ZTE, Sanechips | Similar with MTK, we think this can be decided by RAN2. |
| Nordic  | “With capability signalling”, RAN should have this information as soon as possible.  |
| Nokia, NSB | Signaling is needed, as the network needs to know if there are UEs supporting the feature in the area at all.  |

**Medium priority question 2-3:**

* **Companies are encouraged to provide views on whether the type of FG 29-1 should be per UE or per band**

|  |  |
| --- | --- |
| Company | Comment |
| MTK | Having read QC’s concern on licensed/unlicensed band differentiation, we think it’s reasonable to use “per band”. |
| Vivo | Per UE is preferred. |
| ZTE, Sanechips | We think per-UE is better. If there is concerns from other companies, a similar note as Rel-16 PS power saving feature can be added (which is copied as below).“When this field is reported, either of *sharedSpectrumChAccess-r16* or *non-SharedSpectrumChAccess-r16* shall be reported, at least.” |
| Nordic  | Per band |
| Nokia, NSB | Per UE |

**Low priority question 2-4:**

* **Companies are encouraged to provide views on whether/how to revise the sentence in “Consequence if the feature is not supported by the UE”, e.g.,**
	+ **UE monitors paging PDCCH in configured PO**
	+ **UE does not support PEI and UE subgroup indication**

|  |  |
| --- | --- |
| Company | Comment |
| MTK | We are fine with the original form or the moderator suggested revision. |
| Nokia, NSB | Support 2nd option, i.e. “UE does not support PEI and UE subgroup indication” |
|  |  |

**Low priority question 2-5:**

* **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**

|  |  |
| --- | --- |
| Company | Comment |
| MTK | No further suggestions |
|  |  |
|  |  |

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

In [1], FG 29-2 is captured as below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 SIB2. 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#106bis-e meeting.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| [2] | vivo | Support of receiving L1 indication for TRS availability also requires UE to read corresponding configurations from system information. Hence it seems UE supporting component (2) would be very easy to support component (1) if no new mechanism for system information change for idle/inactive TRS from SIB is introduced. On the other hand, only supporting component (1) is also useful, e.g., the TRS configurations does not change quite very frequently. Component (2) is useful only if the TRS configurations change quite very frequently. Hence separating these two components in different UE feature is more appropriated. ***Proposal 2:*** * ***Update the descriptions of 29-2 as follows,***

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Features | Index | Feature group | Components | Prerequisite feature groups |
|  29. NR\_UE\_pow\_sav\_enh | 29-2-1 | TRS resources for idle/inactive UEs | 1. Support reading TRS configuration from SIB for idle/inactive TRS |  |
| 29. NR\_UE\_pow\_sav\_enh | 29-2-2 | TRS resources for idle/inactive UEs | 1. Support receving L1 indication for TRS availability for idle/inactive TRS | 29-2-1 |

 |
| [3] | Huawei, HiSilicon | **Feature 29-2**1. There can be two ways in general to inform the network about the UE capability on potential TRS occasions for IDLE/inactive mode UE. One is using NAS signaling to inform the core network. And the other one is using RRC signaling to inform the gNB, e.g. when the UE firstly does the registration procedure to the network. This gNB can inform the UE’s capability regarding TRS occasions to the core network. It seems it would be better to leave RAN2 to decide the details. Therefore, we suggest just to use “optional” in the table and leave the details to RAN2 for decision. The column of “Need for the gNB to know if the feature is supported” should be also updated to “Y” accordingly.
2. For the column of “Consequence if the feature is not supported by the UE”, it is suggested to update the description as “Lose of power saving gain on AGC, time/frequency tracking in idle/inactive mode from potential TRS occasions”

Therefore, we have the following proposed change on Feature 29-1:***Proposal 2: adopt the following change in the UE feature table for potential TRS occasions:***

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 SIB2. Support receving L1 indication for TRS availability |  | ~~N~~Y |  | Lose of power saving gain on AGC, time/frequency tracking in idle/inactive mode from potential TRS occasions | Per UE | N | N | N |  | Optional ~~without capability signalling~~ |

 |
| [4] | CATT | The UE feature of UE power saving enhancement for NR includes paging enhancement for IDLE/Inactive UEs, PDCCH monitoring adaptation for CONNECTED mode UEs, and RLM measurement relaxation. The UE features for CONNECTED mode UEs would be critical to the network configuration and gNB scheduling since network will receive the feedback of UE capability to indicate whether UE supports the UE features. However, network might not know whether IDLE/Inactive UE supports the IDLE/Inactive UE features since the UE capability inquiry by network and UE response through RRC signaling only when UE is in RRC\_CONNECTED mode. Thus, the UE feature for IDLE/Inactive mode UE should be designed as the feature indication is transparent to the network since the UE capability of UE support of this feature would not be completely known by the network. **Proposal 1: The UE feature for IDLE/Inactive mode UE should be designed as the feature indication is transparent to the network since the UE capability of UE support of this feature would not be completely known by the network.** 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#104bis-e that paging subgrouping is indicated by L1 signaling either included in PEI and/or paging DCI. The configuration of physical channel and monitoring occasions, such as PDCCH-based PEI or paging PDCCH at PO with L1 signaling for paging subgroup indication needs to be broadcasted to IDLE/Inactive UEs, Thus, the UE capability should be centered with the UE support of paging subgrouping whether L1 signaling is included in the PEI or paging DCI. The configuration of physical channel, either PDCCH-based PEI or PDCCH at PO, and the contents in the new DCI formats for PEI or paging DCI would be broadcasted to IDLE/Inactive UEs regardless UE capability in support of paging subgrouping for decoding L1 signaling in the PEI or paging DCI is fed back to the network. **Proposal 2: UE capability for IDLE/Inactive UE power saving should be based on the support of the configuration of physical channel and monitoring occasions for paging subgroup indication.**For IDLE/Inactive UE power saving by the additional TRS/CSI-RS configuration, RAN1 agreed to have SIB signaling for the configuration of TRS/CSI-RS resource with L1 signaling for the indication of TRS availability dynamically. The UE capability of TRS should be the UE decoding of the TRS configuration in the SIB and the L1 signaling from DCI formats in either Paging DCI or PEI. **Proposal 3: The UE capability of TRS should be the UE decoding of the TRS configuration in the SIB and the L1 signaling from DCI formats in either Paging DCI or PEI.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| NR\_UE\_pow\_sav\_enh | 29-2 | TRS for IDLE/Inactive UEs | TRS resource configuration for IDLE/Inactive UEsSupport of SIB decoding for the configuration of TRS resource and L1 signaling for availability indication Support paging DCI and new DCI format for PEI with additional bit for TRS availability indication  |  | N |  | IDLE/Inactive UE would not use the configured TRS resource for power saving  | Per UE | N | N | N |  | Optional |

 |
| [5] | Samsung | For the components, the agreed function was missing. We suggest to add “to support at least AGC, time/frequency tracking using available TRS resources in configured occasions”. UE may also use the available TRS resources for RRM measurement by implementation, which has been discussed in RAN1.**Proposal 2: For FG 29-2:*** **Add “to support at least AGC, time/frequency tracking using available TRS resources in configured occasions” as the component.**
 |
| [7] | Intel | For the FG 29-2, we have the following suggestions* Update component description as “Support receiving L1 indication for TRS availability via paging DCI”. It is expected that paging DCI based indication would be default.
	+ If PEI based availability indication is agreed/supported, a separate FG can be created such as FG 29-2A where FG 29-2 can be prerequisite.

**Observation 3: If PEI based availability indication is agreed/supported, a separate FG can be created such as FG 29-2A where FG 29-2 can be prerequisite.** |
| [9] | ZTE, Sanechips | Similar to feature group 29-1, the feature group 29-2 is also optional without UE capability signalling.1. The feature group 29-2 of TRS resources for idle/inactive UEs should be optional without UE capability signalling.
 |
| [10] | Apple |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 29. NR\_UE\_pow\_sav\_enh | 29-2 | TRS resources for idle/inactive UEs | TRS occasions for idle/inactive UEs 1. Support receiving TRS configuration being indicated to idle/inactive UEs from a new SIB2. Support receiving L1 indication for TRS availability |  | N |  | Lost of power saving gain on AGC, time/frequency tracking in idle/inactive mode | Per UE | N | N | N |  | Optional without capability signalling |

 |
| [11] | Ericsson | Below are some of the main changes proposed for the FGs (using track changes in below table). * For FGs 29-1 (PEI) and 29-2 (TRS occasions), allow optional UE capability signalling as it is useful for NW to know when to turn on these features. Alternatively, the last column can be left blank and discussed later.
* The ‘consequence if feature is not supported by the UE’ should be left empty’ and making generalized statements about deployments, etc should be avoided. It is clear that all features being developed in the WI are for UE power savings.
* For FG(29-3), component 3) should be added as per the WA from RAN1#106-e.

**Proposal 1: Update the UE feature list for UEPS as shown in below Table.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 29. NR\_UE\_pow\_sav\_enh | 29-1 | Paging enhancement   | 1. Support paging early indication2. Support UE subgroup indication |  |  |  |  | Per UE | N | N | N |  | Optional with capability signalling |
|  29. NR\_UE\_pow\_sav\_enh | 29-2 | TRS occasions for idle/inactive UEs | TRS occasions for idle/inactive UEs 1. Support reading TRS configuration from SIB2. Support receiving L1 indication for TRS availability |  |  |  |  | Per UE | N | N | N |  | Optional with capability signalling |
|  29. NR\_UE\_pow\_sav\_enh | 29-3 | PDCCH monitoring adaptation within an active BWP | 1. Support of PDCCH monitoring adaptation behaviour 1/1A
2. Support of PDCCH monitoring adaptation behaviour 2/2A/[2B]
3. Support of PDCCH monitoring adaptation behaviour 1/1A/2/2A
 |  |  |  |  | Per UE | N | N | N | FFS: Support of PDCCH monitoring adaptation behaviour 1/1A/2/2A/2B | Optional |

 |
| [12] | Qualcomm | For FG 29, the differentiation between licensed and unlicensed bands is necessary. It is not because there are significant implementation challenges specifically in the unlicensed band or vice versa, but because it is unlikely that deployment schedules of NR in licensed and unlicensed bands are the same. Note that NR has already been deployed worldwide in licensed bands, while the deployment for unlicensed bands has not been started. If the feature is based on per-UE signaling, in order to introduce the UE power saving feature for either licensed or unlicensed band first, it requires IODT for both licensed and unlicensed bands, and thus the introduction of the feature would be delayed. However, 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. The same argument also applies to the NTN band. Among the types of signaling, “Per Band” should be used to support the licensed-unlicensed differentiation. Otherwise, if a signaling type other than “Per Band” is used, the differentiation between licensed and unlicensed should separately be enabled with the feature.Proposal 1: Unless otherwise stated, the type for the UE power saving feature should be at least per band (or preferreably a type with finer granularity), given the potential UE testing differentiation among licensed, unlicensed, and NTN band. |
| [13] | Nokia, Nokia Shanghai Bell | * **29-2:**
	+ Simplify ”Consequence if…” as current text is not appropriate for specifications. E.g. “UE does not support TRS occasions for idle/inactive UEs”
	+ Optional with capability signalling. Similar reasons as for 29-1.
 |

## **Discussion**

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

* **Companies are encouraged to provide views on whether to separate the capability for receiving L1 indication for TRS availability (i.e., component 2 in FG 29-2) as another FG**

|  |  |
| --- | --- |
| Company | Comment |
| MTK | We are fine to either keep the original form (only 1 feature) or separate the capability for receiving L1 indication for TRS availability (i.e., component 2 in FG 29-2) as another FG. If the capability for receiving L1 indication is separated, then the SIB reading capability (i.e., component 2 in FG 29-2) should be its prerequisite. |
| Vivo | Support of receiving L1 indication for TRS availability also requires UE to read corresponding configurations from system information. Hence it seems UE supporting component (2) would be very easy to support component (1) if no new mechanism for system information change for idle/inactive TRS from SIB is introduced. On the other hand, only supporting component (1) is also useful, e.g., the TRS configurations does not change quite very frequently. Component (2) is useful only if the TRS configurations change quite very frequently. Hence separating these two components in different UE feature is more appropriated. Suggest to modified as follows,

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Features | Index | Feature group | Components | Prerequisite feature groups |
|  29. NR\_UE\_pow\_sav\_enh | 29-2-1 | TRS resources for idle/inactive UEs | 1. Support reading TRS configuration from SIB for idle/inactive TRS |  |
| 29. NR\_UE\_pow\_sav\_enh | 29-2-2 | TRS resources for idle/inactive UEs | 1. Support receving L1 indication for TRS availability for idle/inactive TRS | 29-2-1 |

 |
| ZTE, Sanechips | We think there is no need to separate these two features. According to the highlights in the following agreements, UE assumes the TRS is not present if NW does not indication it is available, if UE does not support to receive the L1 signaling with TRS availability information, the TRS UE read from SIB cannot be assumed to be available for sync. In this sense, there is no need to read TRS configuration from SIB. Agreements:For a cell with TRS/CSI-RS occasions configured for IDLE/Inactive UEs, IDLE/Inactive UE’s assumption on the availability of TRS/CSI-RS at the configured occasion(s) is informed to the idle/inactive UE based on explicit indication.* FFS details (e.g., the signalling, detailed information for the TRS/CSI-RS, etc.)
* There is no intended blind detection of the presence/absence of TRS/CSI-RS at the UE side in this feature. That is, the UE assumes TRS/CSI-RS is not present if the network does not indicate it is available (or indicates it is unavailable).
 |
| Nordic | It depends on progress in 8.7.1.2. so far validation by SIBx has not been agreed, in our understanding  |
| Nokia, NSB | No need for a separate capability. |

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

* **Companies are encouraged to provide views on whether to separate the capability for receiving PEI based indication for TRS availability as another FG**

|  |  |
| --- | --- |
| Company | Comment |
| MTK | We prefer to NOT separate since it is just information parsing after decoding the DCI. However, we are open to further discuss if majority of companies think the other way. |
| Vivo | Yes, we support |
| ZTE, Sanechips | We agree with MTK that there is no need for this separate definition. UE will detect PEI for power saving if it supports PEI, there is almost no additional complexity. |
| Nordic  | No need, UE should support PEI based indication of TRS if supports PEI and supports TRS |
| Nokia, NSB | No need for a separate capability. |

**Medium priority question 3-3:**

* **Companies are encouraged to provide views on whether capability signaling is necessary for FG 29-2, i.e, whether to support as optional with capability signaling or optional without capability signaling**

|  |  |
| --- | --- |
| Company | Comment |
| MTK | Having read companies’ views, we think there should be some way for UE to report to gNB whether it supports this feature. As mentioned by Huawei, this can be achieved by using NAS signaling to inform the core network, or using RRC signaling to inform the gNB, e.g. when the UE firstly does the registration procedure to the network. We are not sure how this kind of notification (different from normal connected mode capability report) should be named. We are open to hear more views or consult RAN2. |
| Vivo | Report the capability to gNB is benificial |
| ZTE, Sanechips | Okay to be decided by RAN2. |
| Nordic  | Network should know whether there are some UEs benefiting from Idle TRS. |
| Nokia, NSB | Signaling is needed, as CN needs to know if there are UEs supporting the feature. |

**Medium priority question 3-4:**

* **Companies are encouraged to provide views on whether the type of FG 29-2 should be per UE or per band**

|  |  |
| --- | --- |
| Company | Comment |
| MTK | Having read QC’s concern on licensed/unlicensed band differentiation, we think it’s reasonable to use “per band”. |
| Vivo | Per UE is preferred |
| ZTE, Sanechips | We think per-UE is better. If there is concerns from other companies, a similar note as Rel-16 PS power saving feature can be added (which is copied as below).“When this field is reported, either of *sharedSpectrumChAccess-r16* or *non-SharedSpectrumChAccess-r16* shall be reported, at least.” |
| Nordic  | Per band |
| Nokia, NSB | Per UE. Licensed/unlicensed differentiation has been solved in Rel-16 already, we do not understand why companies bring this up again. |

**Low priority question 3-5:**

* **Companies are encouraged to provide views on whether/how to revise the sentence in “Consequence if the feature is not supported by the UE”, e.g.,**
	+ **Lose of power saving gain on AGC, time/frequency tracking in idle/inactive mode from potential TRS occasions**
	+ **UE does not support TRS occasions for idle/inactive UEs**

|  |  |
| --- | --- |
| Company | Comment |
| MTK | We support current revised moderator proposal |
| Nokia, NSB | Support 2nd option, i.e. “UE does not support TRS occasions for idle/inactive UEs” |
|  |  |

**Low priority question 3-6:**

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

|  |  |
| --- | --- |
| Company | Comment |
| MTK | We support Samsung’s proposal:* **Add “to support at least AGC, time/frequency tracking using available TRS resources in configured occasions” as the component.**
 |
|  |  |
|  |  |

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

In [1], FG 29-3 is captured as below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 | 29-3 | PDCCH monitoring adaptation within an active BWP | 1. Support of PDCCH monitoring adaptation behaviour 1/1A
2. Support of PDCCH monitoring adaptation behaviour 2/2A/[2B]
 |  | Y |  | PDCCH monitoring adaptation within an active BWP is not supported  | Per UE | N | N | N | FFS: Support of PDCCH monitoring adaptation behaviour 1/1A/2/2A/2B | Optional |

Following feedbacks are provided in contributions for the RAN1#106bis-e meeting.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| [2] | vivo | It is agreed in RAN1#106 that,

|  |
| --- |
| Agreement * UE behavior after receiving PDCCH indication of monitoring adaptation can be one of the followings,
	+ - Working Assumption: Beh 1: PDCCH skipping is not activated
		- Beh 1A: PDCCH skipping means stopping PDCCH monitoring for a duration X
			* FFS the possible values for X
			* FFS: Whether and how to support more than one skipping duration(s)
			* FFS: whether to continue monitoring PDCCH scrambled by C-RNTI for Type 0/1/1A/2 CSS or not
		- Beh 2: stop monitoring SS sets associated with SSSG#1 and SSSG#2 (if confirmed) and monitoring  of SS sets associated to SSSG#0 (legacy behaviour)
		- Beh 2A: stop monitoring SS sets associated with SSSG#0 and SSSG#2 (if confirmed)  and monitoring  of SS sets associated to SSSG#1 (legacy behaviour)
		- Working Assumption: Beh 2B(if confirmed): stop monitoring SS sets associated with SSSG#0 and SSSG#1 and monitoring  of SS sets associated to SSSG#2 (if confirmed)
* Note: The number of supported SSSG is left to UE feature discussion.
* FFS: UE capability of supported UE behaviors
* Indication of Beh 1A when SSSG(s) are not configured is supported.
* Working assumption: Indication of Beh 1A for current SSSG when two SSSG(s) are configured is supported
* FFS: Indication of Beh 1A when three SSSG(s) (if supported) are configured
* Y bits is configured for scheduling DCIs (i.e., DCI format 1-1/0-1/1-2/0-2) indicating PDCCH schedules data and also PDCCH monitoring adaptation
	+ - FFS how the UE behavior(s) defined above mapping to Y bits

§  Note: at most Y = 2* Working Assumption at most 3 SSSGs is supported to be configured.
	+ - FFS: whether or how SSSG can be configured to be monitored conditionally (e.g., depending on HARQ NACK or RTT/ReTx timers)
		- FFS: whether or how non-default SSSG to another non-default SSSG
* FFS details of timer(s) for switching between SSSG(s)
	+ - UE fallbacks to default SSSG (i.e., SSSG#0) after timer expiration.
		- R16 timer for SSSG switching and the corresponding behavior is as baseline
* FFS whether the timer(s) is configured per SSSG, per BWP or other approaches.
* FFS whether the skipping duration(s) is configured per SSSG, per BWP, or other approaches.
* FFS PDCCH monitoring adaptation indicated by non-scheduling DCI
* PDCCH based monitoring adaptation is applied to USS and type-3 CSS.
 |

According to this further discussion on supported UE behaviours and number of supported SSSG need to be addressed. In [3], the corresponding UE capability and PDCCH adaptation mode is discussed.* **number of supported SSSG**

The motivation to support more than 3 SSSG has been discussed and added as an working assumption. Considering specification effort for supporting more than 2 SSSGs and different understanding of urgency, it would be natural to have a sperate capability indication for UE supporting more than 2 SSSGs. Hence support of 2/2 and [2B] should be separated.* **supported UE behaviors**

Considering the different mechanisms/usage to support PDCCH monitoring adaptation, it is natural to sperate 1/1A and 2/2A/[2B]. And it is in RAN1#106-E that indication of Beh 1A for current SSSG when two SSSG(s) are configured is WA. Considering this, another UE capability can be considered to indicate the network.***Proposal 3:*** * ***Update the descriptions of 29-3 as follows,***

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Features | Index | Feature group | Components | Prerequisite feature groups |
| 29. NR\_UE\_pow\_sav\_enh | 29-3-1 | PDCCH monitoring adaptation within an active BWP | Support of PDCCH monitoring adaptation behaviour 1/1A |  |
| 29. NR\_UE\_pow\_sav\_enh | 29-3-2 | PDCCH monitoring adaptation within an active BWP | Support of PDCCH monitoring adaptation behaviour 2/2A |  |
| 29. NR\_UE\_pow\_sav\_enh | 29-3-3 | PDCCH monitoring adaptation within an active BWP | Support of PDCCH monitoring adaptation behaviour [2B] | 29-3-2 |
| 29. NR\_UE\_pow\_sav\_enh | [29-3-4] | [PDCCH monitoring adaptation within an active BWP] | [Support of PDCCH monitoring adaptation behaviour 1/1A/2/2A] | [29-3-1, 29-3-2] |

 |
| [3] | Huawei, HiSilicon | **Feature 29-3**1. According to the agreements made in RAN1#106 as following, it is FFS to discuss UE capability of supported UE behaviors. In our view, the feature should be at least split to two separate UE features. One is for PDCCH skipping capability and the other one is for SSSG switching.

|  |
| --- |
| Package 1* UE behavior after receiving PDCCH indication of monitoring adaptation can be one of the followings,
	+ Working Assumption: Beh 1: PDCCH skipping is not activated
	+ Beh 1A: PDCCH skipping means stopping PDCCH monitoring for a duration X
		- FFS the possible values for X
		- FFS: Whether and how to support more than one skipping duration(s)
		- FFS: whether to continue monitoring PDCCH scrambled by C-RNTI for Type 0/1/1A/2 CSS or not
	+ Beh 2: stop monitoring SS sets associated with SSSG#1 and SSSG#2 (if confirmed) and monitoring  of SS sets associated to SSSG#0 (legacy behaviour)
	+ Beh 2A: stop monitoring SS sets associated with SSSG#0 and SSSG#2 (if confirmed)  and monitoring  of SS sets associated to SSSG#1 (legacy behaviour)
	+ Working Assumption: Beh 2B(if confirmed): stop monitoring SS sets associated with SSSG#0 and SSSG#1 and monitoring  of SS sets associated to SSSG#2 (if confirmed)
* Note: The number of supported SSSG is left to UE feature discussion.
* FFS: UE capability of supported UE behaviors
* Indication of Beh 1A when SSSG(s) are not configured is supported.
* Working assumption: Indication of Beh 1A for current SSSG when two SSSG(s) are configured is supported
* FFS: Indication of Beh 1A when three SSSG(s) (if supported) are configured
* Y bits is configured for scheduling DCIs (i.e., DCI format 1-1/0-1/1-2/0-2) indicating PDCCH schedules data and also PDCCH monitoring adaptation
	+ FFS how the UE behavior(s) defined above mapping to Y bits
		- Note: at most Y = 2
* Working Assumption at most 3 SSSGs is supported to be configured.
	+ FFS: whether or how SSSG can be configured to be monitored conditionally (e.g., depending on HARQ NACK or RTT/ReTx timers)
	+ FFS: whether or how non-default SSSG to another non-default SSSG
* FFS details of timer(s) for switching between SSSG(s)
	+ UE fallbacks to default SSSG (i.e., SSSG#0) after timer expiration.
	+ R16 timer for SSSG switching and the corresponding behavior is as baseline
* FFS whether the timer(s) is configured per SSSG, ~~or~~per BWP or other approaches.
* FFS whether the skipping duration(s) is configured per SSSG, per BWP, or other approaches.
* FFS PDCCH monitoring adaptation indicated by non-scheduling DCI
* PDCCH based monitoring adaptation is ~~limited~~applied to USS and type-3 CSS.
 |

Therefore, for feature 29-3, we have the following proposal:***Proposal 3: At least split feature 29-3 to two separate UE features: One is for PDCCH skipping capability and the other one is for SSSG switching.***

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 29. NR\_UE\_pow\_sav\_enh | 29-3 | PDCCH Skipping | Support of PDCCH monitoring adaptation behaviour 1/1A |  | Y |  | PDCCH skipping within an active BWP is not supported  | Per UE | N | N | N |  | Optional |
| 29. NR\_UE\_pow\_sav\_enh | 29-3’ | SSSG switching | Support of PDCCH monitoring adaptation behaviour 2/2A |  | Y |  | SSSG switching within an active BWP is not supported  | Per UE | N | N | N | FFS: Support of PDCCH monitoring adaptation behaviour 2/2A/2B | Optional |

 |
| [4] | CATT | The objective of CONNECTED UE power saving with reducing PDCCH monitoring reduction is achieved by dynamic adaptation of PDCCH monitoring interval. It was agreed in RAN1#106-e that up to 2 bits are include in the scheduling DCI format 1\_1, 1\_2, 0\_1, and 0\_2 to indicate PDCCH monitoring adaptation. The UE feature is for UE to support the configured bits of PDCCH monitoring adaptation in the scheduling DCI. It was also agreed in RAN1#105-e that SSSG switching is supported by scheduling DCI. The UE feature for PDCCH monitoring adaptation would also include the indication from scheduling DCI for SSSG switching. **Proposal 4: The UE capability of PDCCH monitoring adaptation for CONNECTED mode UE is to indicate the support of up to 2-bit indication in the scheduling DCI formats 1\_1, 1\_2, 0\_1 and 0\_2 for PDCCH skipping and SSSG switching.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| NR\_UE\_pow\_sav\_enh | 29-3 | PDCCH monitoring adaptation  | Dynamic PDCCH monitoring adaptation1. Support 2-bit in scheduling DCI format 1\_1, 1\_2, 0\_1, and 0\_2 for PDCCH monitoring adaptation
2. Support of PDCCH skipping by scheduling DCI with up to 2-bit indication
3. Support of SSSG switching by scheduling DCI format 1\_1, 1\_2, 0\_1, and 0\_2
 |  | Y |  | UE could not reduce the PDCCH monitoring occasion configured by the given search space.  | Per UE | N | N | N |  | Optional |

 |
| [5] | Samsung | For the consequence, currently wording doesn’t provide useful information. We suggest to capture impact to legacy UE behavior if any. In this case, UE keeps legacy Rel-15/16 PDCCH monitoring behavior if the UE doesn’t support this feature. So it’s better to clarify the default behavior as consequence, i.e. UE monitors PDCCH based on all configured search space sets”.**Proposal 3: For FG 29-3:*** **Capture default UE behavior, i.e. UE monitors all configured search space sets, as consequence.**
 |
| [6] | MediaTek | In RAN1 #106e, RAN1 agrees using Package 1 for connected mode UE power saving enhanements with search space set group (SSSG) switching and PDCCH skipping. In Package 1, using “Beh 2+ Beh 2A +Beh 1A” or “All Beh 2” are both considered to achieve connected mode PDCCH monitoring adaptation, as shown in Fig. 1 below, where a detailed description for Beh 1 series and Beh 2 series are shown in Fig. 2.**Figure 1. Package 1 for UE power saving enhanements agreed in RAN1 #106e****Figure 2. Detailed description for Beh 1 series and Beh 2 series**It can be seen that by using Beh 1 and 1A, the PDCCH skipping behaviour can be realized. By using Beh 2 and 2A, the PDCCH monitoring period adaptation can be realized. By using Beh 2 and 2A and 2B, the PDCCH monitoring period adaptation with the equivalent behavior of PDCCH skipping can be realized.**Observation 1:** * **Using Beh 1 and 1A, the PDCCH skipping behaviour can be realized**
* **Using Beh 2 and 2A, the PDCCH monitoring period adaptation can be realized**
* **Using Beh 2 and 2A and 2B, the PDCCH monitoring period adaptation with the equivalent behavior of PDCCH skipping can be realized**

To allow UE to support a more fine-grained capability report, we have the following proposal:**Proposal 1: For Rel-17 UE feature 29-3, further divide it into 29-3a, 29-3b, and 29-3c where*** **29-3a supports PDCCH monitoring adaptation behaviour 1/1A**
* **29-3b supports PDCCH monitoring adaptation behaviour 2/2A**
* **29-3c supports PDCCH monitoring adaptation behaviour 2/2A/[2B]**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 29. NR\_UE\_pow\_sav\_enh | 29-3a | PDCCH monitoring adaptation within an active BWP | 1. Support of PDCCH monitoring adaptation behaviour 1/1A
 |  | Y |  | PDCCH monitoring adaptation within an active BWP is not supported  | Per UE | N | N | N | FFS: Support of PDCCH monitoring adaptation behaviour 1/1A | Optional |
|  29. NR\_UE\_pow\_sav\_enh | 29-3b | PDCCH monitoring adaptation within an active BWP | Support of PDCCH monitoring adaptation behaviour 2/2A |  | Y |  | PDCCH monitoring adaptation within an active BWP is not supported  | Per UE | N | N | N | FFS: Support of PDCCH monitoring adaptation behaviour 2/2A | Optional |
|  29. NR\_UE\_pow\_sav\_enh | 29-3c | PDCCH monitoring adaptation within an active BWP | Support of PDCCH monitoring adaptation behaviour 2/2A/[2B] |  | Y |  | PDCCH monitoring adaptation within an active BWP is not supported  | Per UE | N | N | N | FFS: Support of PDCCH monitoring adaptation behaviour 2/2A/[2B] | Optional |

 |
| [7] | Intel | For PDCCH monitoring adaptation FG 29-3, we suggest revising component description as follows:* Support PDCCH monitoring adaptation by scheduling DCI formats, where up to Y bits can be configured in a field
	+ In Note column, we could mention Y can be 1 or 2
	+ Another note can be added as PDCCH based monitoring adaptation is applied to USS and type-3 CSS 2.
* Support of PDCCH monitoring adaptation behaviour [1], 1A, 2, 2A, [2B]
* Support X number of SSSGs
	+ Note column could capture that X can be 1, 2, or 3
* Support Indication of Beh 1A when SSSG(s) are not configured.
* [Support Indication of Beh 1A for current SSSG when two SSSG(s) are configured]
 |
| [8] | DOCOMO | 1. FG 29-3:
* For the Components: In the RAN1 #106-e, there is Working Assumption at most 3 SSSGs is supported to be configured. As the behaviour [2B] is necessary only for configuring 3 SSSGs, behavior 2/2A, i.e., 2 SSSG, and behavior [2B], i.e., 3 SSSG, should be separately indicated as capability indication.
* For the Components: Following note should be added: ‘Support of PDCCH monitoring adaptation behaviour 1/1A’, ‘Support of PDCCH monitoring adaptation behaviour 2/2A’ , ‘Support of PDCCH monitoring adaptation behaviour [2B]’ and combination of behaviors may be separately indicated based on further RAN1 discussion/decision.

|  |  |  |  |
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| **Features** | **Index** | **Feature group** | **Components** |
|  29. NR\_UE\_pow\_sav\_enh | 29-3 | PDCCH monitoring adaptation within an active BWP | (1). Support of PDCCH monitoring adaptation behaviour 1/1A(2). Support of PDCCH monitoring adaptation behaviour 2/2A~~/[2B]~~(3). Support of PDCCH monitoring adaptation behaviour [2B]Note: (1), (2), (3) and combinations of behaviors may be separately indicated based on further RAN1 discussion/decision. |

 |
| [9] | ZTE, Sanechips | In RAN1-#106e meeting, the common design of PDCCH skipping and SSSG switching was agreed. To enable the flexible implementation at both gNB and UE side, separate UE capability signaling for PDCCH skipping and SSSG switching should be supported. And it doesn’t require a dedicated signalling to indicate whether to support both PDCCH skipping and SSSG. Hence, the FFS point in feature group 29-3 can be removed.Furthermore, if the working assumption of Beh-2B is confirmed, supporting 3 SSSGs should also depend on UE capability.1. Add a capability signaling with regarding to whether 3 SSSGs is supported by UE, if the working assumption of Beh-2B is confirmed.

To this end, we suggest to update feature group 29-3 as below1. support of PDCCH skipping;
2. support of search space set group switching
	1. support of 3 search space set groups
3. Update the feature group 29-3 as below
4. support of PDCCH skipping;
5. support of search space set group switching;
	1. support of 3 search space set groups
 |
| [10] | Apple | For FG 29-3, there are 3 types of behaviours:* Behaviour 1/1A (PDCCH skipping)
* Behaviour 2/2A (SSSG switching)
* Behaviour 2B (using empty SSG to emulate PDCCH skipping)

**These 3 types of behaviours are independent, and the support should be separately indicated.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 29. NR\_UE\_pow\_sav\_enh | 29-3 | PDCCH monitoring adaptation within an active BWP | 1. Support of PDCCH monitoring adaptation behaviour 1/1A
2. Support of PDCCH monitoring adaptation behaviour 2/2A
3. [Support of PDCCH monitoring adaptation behaviour 2B]
 |  | Y |  | PDCCH monitoring adaptation within an active BWP is not supported  | Per UE | N | N | N | Component 1: {support, not support}Component 2: {support, not support}[Component 3: {support, not support}]FFS: Support of PDCCH monitoring adaptation behaviour 1/1A/2/2A/2B | Optional with capability signalling |

 |
| [11] | Ericsson | Below are some of the main changes proposed for the FGs (using track changes in below table). * For FGs 29-1 (PEI) and 29-2 (TRS occasions), allow optional UE capability signalling as it is useful for NW to know when to turn on these features. Alternatively, the last column can be left blank and discussed later.
* The ‘consequence if feature is not supported by the UE’ should be left empty’ and making generalized statements about deployments, etc should be avoided. It is clear that all features being developed in the WI are for UE power savings.
* For FG(29-3), component 3) should be added as per the WA from RAN1#106-e.

**Proposal 1: Update the UE feature list for UEPS as shown in below Table.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 29. NR\_UE\_pow\_sav\_enh | 29-1 | Paging enhancement   | 1. Support paging early indication2. Support UE subgroup indication |  |  |  |  | Per UE | N | N | N |  | Optional with capability signalling |
|  29. NR\_UE\_pow\_sav\_enh | 29-2 | TRS occasions for idle/inactive UEs | TRS occasions for idle/inactive UEs 1. Support reading TRS configuration from SIB2. Support receiving L1 indication for TRS availability |  |  |  |  | Per UE | N | N | N |  | Optional with capability signalling |
|  29. NR\_UE\_pow\_sav\_enh | 29-3 | PDCCH monitoring adaptation within an active BWP | 1. Support of PDCCH monitoring adaptation behaviour 1/1A
2. Support of PDCCH monitoring adaptation behaviour 2/2A/[2B]
3. Support of PDCCH monitoring adaptation behaviour 1/1A/2/2A
 |  |  |  |  | Per UE | N | N | N | FFS: Support of PDCCH monitoring adaptation behaviour 1/1A/2/2A/2B | Optional |

 |
| [12] | Qualcomm | For FG 29, the differentiation between licensed and unlicensed bands is necessary. It is not because there are significant implementation challenges specifically in the unlicensed band or vice versa, but because it is unlikely that deployment schedules of NR in licensed and unlicensed bands are the same. Note that NR has already been deployed worldwide in licensed bands, while the deployment for unlicensed bands has not been started. If the feature is based on per-UE signaling, in order to introduce the UE power saving feature for either licensed or unlicensed band first, it requires IODT for both licensed and unlicensed bands, and thus the introduction of the feature would be delayed. However, 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. The same argument also applies to the NTN band. Among the types of signaling, “Per Band” should be used to support the licensed-unlicensed differentiation. Otherwise, if a signaling type other than “Per Band” is used, the differentiation between licensed and unlicensed should separately be enabled with the feature.Proposal 1: Unless otherwise stated, the type for the UE power saving feature should be at least per band (or preferreably a type with finer granularity), given the potential UE testing differentiation among licensed, unlicensed, and NTN band. |
| [13] | Nokia, Nokia Shanghai Bell | * **29-3:**
	+ Just a note that components cannot be independently enabled/disabled by the signalling, so this needs further discussion once the decisions are in place in the WID.
 |

## **Discussion**

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

* **Companies are encouraged to provide views on whether/how to separate the capabilities of FG 29-3, e.g.,**
	+ **Option 1:**
		- **FG 29-3a: Support of PDCCH monitoring adaptation behaviour 1/1A**
		- **FG 29-3b: Support of PDCCH monitoring adaptation behaviour 2/2A**
		- **FG 29-3c: Support of PDCCH monitoring adaptation behaviour [2B]**
		- **FG 29-3d: Support of PDCCH monitoring adaptation behaviour 1/1A/2/2A**
	+ **Option 2**
		- **FG 29-3a: Support of PDCCH monitoring adaptation behaviour 1/1A**
		- **FG 29-3b: Support of PDCCH monitoring adaptation behaviour 2/2A**
		- **FG 29-3c: Support of PDCCH monitoring adaptation behaviour 2/2A/[2B]**
	+ **Option 3**
		- **Any other FG structures**

|  |  |
| --- | --- |
| Company | Comment |
| MTK | We support Option 2 as explained in our contribution:* **Using Beh 1 and 1A, the PDCCH skipping behaviour can be realized**
* **Using Beh 2 and 2A, the PDCCH monitoring period adaptation can be realized**
* **Using Beh 2 and 2A and 2B, the PDCCH monitoring period adaptation with the equivalent behavior of PDCCH skipping can be realized**
 |
| Vivo | Either Option 1or Option2 is acceptable. The main difference is whether we need an independent capability reporting to a mixed behavior 1/1A/2/2A.For option1, one minor revision is as follows,* + **Option 1:**
		- **FG 29-3a: Support of PDCCH monitoring adaptation behaviour 1/1A**
		- **FG 29-3b: Support of PDCCH monitoring adaptation behaviour 2/2A**
		- **FG 29-3c: Support of PDCCH monitoring adaptation behaviour 2/2A/[2B]**
		- **FG 29-3d: Support of PDCCH monitoring adaptation behaviour 1/1A/2/2A**

For option 2, it should be clarified whether the UE supports adaptation between Beh 1/1A/2/2A? |
| Nordic  | It depends on further progress in 8.7.2, for now keep 3c and 3d in brackets* + - **FG 29-3a: Support of PDCCH monitoring adaptation behaviour 1/1A**
		- **FG 29-3b: Support of PDCCH monitoring adaptation behaviour 2/2A**
		- **[FG 29-3c: Support of PDCCH monitoring adaptation behaviour 2/2A/2B]**
		- **[FG 29-3d: Support of PDCCH monitoring adaptation behaviour 1/1A/2/2A]**

Also it should be clarified that **if UE support 3a and 3b it does not mean UE supports both features at the same time.** |
| Nokia, NSB | In principle Option 2 is ok as working assumption, though the need for 29-3b is not clear. That would lead to an option 3:* + - **FG 29-3a: Support of PDCCH monitoring adaptation behaviour 1/1A**
		- **FG 29-3c: Support of PDCCH monitoring adaptation behaviour 2/2A/[2B]**
 |

**Medium priority question 4-2:**

* **Companies are encouraged to provide views on whether the column for “Mandatory/Optional” in FG 29-3 can be updated to “Optional with capability signaling”**

|  |  |
| --- | --- |
| Company | Comment |
| MTK | We support the moderator proposed update |
| Vivo | Optional with capability signalling |
| ZTE, Sanechips | Support moderator proposal. |
| Nordic  | Yes, optional with capability signalling for all |
| Nokia, NSB | Yes, similar comments as above. |

**Medium priority question 4-3:**

* **Companies are encouraged to provide views on whether the type of FG 29-3 should be per UE or per band**

|  |  |
| --- | --- |
| Company | Comment |
| MTK | Having read QC’s concern on licensed/unlicensed band differentiation, we think it’s reasonable to use “per band”. |
| Vivo | Per UE is preferred |
| ZTE, Sanechips | We think per-UE is better. If there is concerns from other companies, a similar note as Rel-16 PS power saving feature can be added (which is copied as below).“When this field is reported, either of *sharedSpectrumChAccess-r16* or *non-SharedSpectrumChAccess-r16* shall be reported, at least.” |
| Nordic  | Per band  |
| Nokia, NSB | Per UE |

**Low priority question 4-4:**

* **Companies are encouraged to provide views on whether/how to revise the sentence in “Consequence if the feature is not supported by the UE”, e.g.,**
	+ **UE monitors all configured search space sets**

|  |  |
| --- | --- |
| Company | Comment |
| MTK | We are fine with the moderator proposed update |
| Vivo | We are fine |
| ZTE, Sanechips | Support moderator proposal. |

**Low priority question 4-5:**

* **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**

|  |  |
| --- | --- |
| Company | Comment |
| MTK | No further comments |
|  |  |
|  |  |

# **Conclusions**

TBD

# **References**

[1] R1-2108679 Preliminary RAN1 UE features list for Rel-17 NR Moderators (AT&T, NTT DOCOMO, INC.)

[2] R1-2109018 Discussion on UE features for UE power saving enhancements vivo

[3] R1-2109149 Rel-17 UE features for UE power saving enhancements Huawei, HiSilicon

[4] R1-2109206 Discussion on UE feature of UE Power saving enhancements for NR CATT

[5] R1-2109530 UE features for UE power saving enhancements Samsung

[6] R1-2109553 On UE features for UE power saving enhancements MediaTek Inc.

[7] R1-2109648 Discussion on UE features for UE power saving Intel Corporation

[8] R1-2109712 Discussion on Rel-17 UE features for UE power saving NTT DOCOMO, INC.

[9] R1-2109724 Discussion on UE feature for UE power saving enhancements ZTE, Sanechips

[10] R1-2110070 Views on UE features for Rel-17 UE power saving Apple

[11] R1-2110145 UE features for UEPS Ericsson

[12] R1-2110225 UE features for UE power saving enhancements Qualcomm Incorporated

[13] R1-2110270 On UE features for UE power saving enhancements Nokia, Nokia Shanghai Bell