**3GPP TSG RAN WG1 #108-e R1-220XXXX**

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

Agenda Item: 8.7

Source: Rapporteur (MediaTek)

Title: Collection of RAN1 agreements for UE power saving enhancements for NR (post RAN1 #108-e)

Document for: Information

# Paging Enhancement

This feature is for idle/inactive mode UE power saving enhancement. The following summarize the scope and the RAN1 related agreements.

Please be noticed that:

* There are agreements on evaluation assumptions and observations for the study phase of this feature. Since they are not related to final specification and thus not included in the following table. Yet, they can still be checked in the status reports [1]-[5].
* Decision on physical-layer channel of Paging Early Indication (PEI) is made in RAN #93-e, as RAN Plenary guidance to RAN1. The RAN#93-e agreement is also captured in the following table.
* RAN1 enters maintenance phase for Rel-17 since RAN1 #107-bis-e meeting.

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| 1. Specify enhancements for idle/inactive-mode UE power saving, considering system performance aspects [RAN2, RAN1]
	1. Study and specify paging enhancement(s) to reduce unnecessary UE paging receptions, subject to no impact to legacy UEs [RAN2, RAN1]
* NOTE: RAN1 to check and update, if needed, evaluation methodology in RAN1 #102-e meeting

**Agreements related to the above scope item are as follows:** |
| **RAN1 #103-e meeting**Agreements**:** For NR idle/inactive-mode paging enhancement, paging early indication before paging occasion is supported from RAN1 perspective* FFS: Physical layer design based on DCI, SSS or TRS/CSI-RS
* Send LS to inform RAN2 and kindly ask RAN2 to inform RAN1 if there is anything that RAN1 should take into consideration in the physical layer design for this feature, including any other progress RAN2 has made in this WI which may has RAN1 impact
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| **RAN1 #104-e meeting**Agreement:* Carrying UE subgroups information is considered in physical layer design for paging enhancement

Agreements:For the evaluation and comparison of PEI candidate designs based on PDCCH, TRS/CSI-RS and SSS, the following are assumed:* Behv-A:
	+ PEI indicates UE should monitor a PO if UE’s group/subgroup is paged
	+ UE is not required to monitor a PO if UE does not detect PEI at all PEI occasion(s) for the PO
* Behv-B:
	+ PEI indicates whether or not UE should monitor a PO
	+ UE is required to monitor a PO if UE does not detect PEI at all PEI occasion(s) for the PO
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| **RAN1 #105-e meeting**Agreement:For UE subgroups indication in physical layer, maximum of 8 subgroups per PO is supported.**Conclusion:**To down-select one solution for PEI physical-layer channel/signal in RAN1 #106-e, using below as a starting point:* PDCCH-based PEI
* SSS-based PEI
* TRS/CSI-RS-based PEI

Note: Additional details for each of the above 3 solutions are encouraged for more informed down-selectionNote: further refinement of the above list is possible, e.g., by merging/further splitting, depending on significance of the commonality and/or differencesAgreement:For paging indication to the subgroups in a PO,* For PDCCH-based PEI, subgroups in a PO are indicated by one PEI
	+ One bit in the DCI payload indicating one UE subgroup is supported
		- FFS: Whether code-point based mapping is utilized, and, if so, how to map to the subgroups in a PO
* For SSS-based PEI, subgroups in a PO are indicated by a set of sequence realizations
	+ FFS: Sequence mapping design for supporting up to 8 subgroups per PO
	+ Physical-layer configuration(s) and sequence generation design are subject to no impact to initial access and RRM measurements of legacy UEs
* For TRS/CSI-RS-based PEI, subgroups in a PO can be indicated by the following alternatives
	+ Alt 1:One TRS sequence with orthogonal cover as PEI transmitted in the PEI monitoring occasion where one orthogonal cover of the PEI indicates one subgroup or combination of subgroups
		- FFS: Design details for the orthogonal cover
	+ Alt 2: A set of TRS sequences indicating the subgroups with one selected sequence transmitting in one TRS resource
		- FFS: Sequence mapping design for supporting up to 8 subgroups per PO and combination of subgroups
	+ Alt 3: Multiple TRS/CSI-RS resources FDMed/TDMed /CDMed in the same monitoring occasion where one TRS/CSI-RS resource indicates one subgroup
		- Reuse Rel-15/16 CSI-RS FDM/TDM/CDM patterns for supporting up to 8 subgroups per PO
* Note : It is RAN1 understanding that Physical-layer configuration(s) for paging early indication to the subgroups is subject to the same idle-mode reception bandwidth as CORESET-0 frequency span
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| **RAN1 #106-e meeting**Conclusion* For the evaluation of PEI candidate designs (for which observations made in previous RAN1 meetings), it was implicitly assumed by companies that the following processing can also provide synchronization:
	+ Processing of SSB(s) of each DRX cycle for serving-cell measurement
	+ Detection of multi-symbol SSS PEI (s)when transmitted
	+ Detection of TRS/CSI-RS PEI(s) when transmitted

Note: SSS PEI is assumed to reuse the SSS structure as in legacy SSBConclusionTo down-select one solution for PEI physical-layer channel/signal in RAN1 #106-e,* PDCCH-based PEI
* SSS-based PEI
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| **RAN #93-e meeting**Conclusion* Support PDCCH-based PEI as the only option

•       Only essential function for PEI is support•     New DCI format•     Higher layer configuration, including SS•     Details of the procedures of PEI monitoring, and identification of MOs before PO•     Only Behv-A (per RAN1#104e agreement) is supported •     If TRS availability indication is agreed to be supported in both paging DCI and the DCI format for PEI, same mechanism/principle for TRS availability indication is adopted for the two DCI formats•     Supporting TRS availability indication in DCI format for PEI shall not delay the completion of essential functionality of PEI |
| **RAN1 #106-bis-e Meeting**AgreementFor NR Rel-17, paging indications to UE subgroups are carried only in PEI.Agreement For PEI, a new DCI format is supported to include at least paging indications to UE group(s)/subgroups of the associated PO(s)* One bit in the DCI payload indicating one UE subgroup of a PO or one UE group/PO
* The maximum number of total bits for paging indication field in PEI DCI format is x
	+ One PEI can be configured to indicate up to 4 PO(s) in a PF
		- FFS whether to supporting map PEI to 3 POs in a PF
	+ FFS: 1 PEI for POs across multiple PFs
	+ FFS: value of x

Agreement A PEI occasion (PEI-O) is a set of *S* consecutive PDCCH monitoring occasions when *nrofPDCCH-MonitoringOccasionPerSSB-InPO* is not configured* *S* is the number of actual transmitted SSBs determined according to *ssb-PositionsInBurst* in SIB1
* The *K*-th PDCCH monitoring occasion for PEI in the PEI-O has the same QCL assumption as that of the *K*-th PDCCH monitoring occasion for paging in the PO.
	+ Note: QCL reference is SSB
* FFS: Determination of the PEI-O location
* FFS: Support of unlicensed spectrum operation with *nrofPDCCH-MonitoringOccasionPerSSB-InPO* configured

Agreement CORESET # 0 or *commonControlResourceSet* in SIB1 can be used for PEI* Note: The number of CORESETs configured for a UE follows the requirement of UE feature 3-1

 Agreement Support configuration of a dedicated search space (‘peiSearchSpace’) for PEI* FFS: Configuration details and whether and how to reuse legacy search space sets, including *pagingSearchSpace* and *searchSpaceSetZero*

AgreementDetermination of PEI-O location for a target PO is based on one of the following alternatives:* Alt 1: The first PDCCH monitoring occasion of the PEI-O is provided w.r.t. the start of a reference frame determined by a frame-level offset to the PF of the target PO
	+ FFS: The unit and the range of the frame-level offset
	+ FFS: The unit and the range of the configuration for the first PDCCH monitoring occasion (e.g., to be the same as those of *firstPDCCH-MonitoringOccasionOfPO*)
* Alt 2: The first PDCCH monitoring occasion of the PEI-O is provided w.r.t. the *L*-th SS burst before the first PDCCH monitoring occasion of the target PO.
	+ FFS: the case that a SSB burst overlaps in time with the target PO
	+ FFS: *L* = 1, 2 or 3
	+ FFS: Reference the “start” or “end” of the *L*-th SS burst
	+ FFS: The unit and the range of the configuration for the first PDCCH monitoring occasion
* Alt 3: The first PDCCH monitoring occasion of the PEI-O is provided by a time offset w.r.t. a reference time for the target PO.
	+ FFS: The exact definition of the reference time, e.g. the first MO of the target PO, the first MO of the first PO indicated by the PEI, the start of the PF for the target PO
	+ FFS: The unit and the range of the time offset
* FFS: Whether any SS burst or TRS burst is needed between PEI-O and PO
* Configuration for one PEI indicating multiple POs within a PF should be taken into consideration in the determination of PEI occasion

Decide one of the above alternatives or a single merged solution based on the alternatives in RAN1#107-e meeting.FFS: Extension for the case one PEI indicates multiple POs across multiple PFs, if supported |
| **RAN1 #107-e meeting****Agreement**For unlicensed operation,A PEI-O is a set of 'S\*X ' consecutive PDCCH monitoring occasions where 'S' is the number of actual transmitted SSBs determined according to *ssb-PositionsInBurst* in *SIB1* and X is the *nrofPDCCH-MonitoringOccasionPerSSB-InPO* if configured or is equal to 1 otherwise. The [x\*S+K]th PDCCH monitoring occasion for PEI in the PEI-O corresponds to the Kth transmitted SSB, where x=0,1,…,X-1, K=1,2,…,S.* If X > 1, when the UE detects a PEI within its PEI-O, the UE is not required to monitor the subsequent monitoring occasion(s) associated with the same PEI-O

Note: The QCL reference is SSB**Agreement**Support mapping one PEI to *POnumPerPEI* PO(s) in one or multiple PF(s)        *POnumPerPEI* is a factor of  (total PO number in a paging cycle) and configurable via SIB for the cell with the value range of {1, 2, 4, 8}* The Maximum number of PF associated with one PEI is up to 2

        Note: Maximum number of paging indication bits in DCI format 2\_7 can be kept the same for any configuration of *POnumPerPEI*, e.g., by applying a smaller *subgroupsNumPerPO* and a larger *POnumPerPEI.*        Note: Larger value of *POnumPerPEI* can reduce the average PEI overhead per PO, but there can also cause potentially larger paging latency and larger UE power consumption due to longer UE wake-up time before PO monitoring, which can be significant with large value of (*T/N*).**Agreement**Confirm the following working assumption:**Working Assumption*** The paging indication field of PEI DCI format comprises of *POnumPerPEI* segment(s) of *K* bit
	+ *K* = 1, if  is absent or set to 0 or 1,

* + *K* = , if  is configured.

* + UE identifies its paging indication bit as follows:
		- Let  denote the relative PO index, with starting value of 0, among the POs associated with the PEI

* + - * , where  are as defined in clause 7 of TS 38.304

* + - when *K* = 1 ~~and UE is not provided a subgroup index~~

* + - when UE is provided a subgroup index

* + - UE checks the corresponding paging indication from -th bit of the paging indication field where the starting bit index is 0

* If the corresponding paging indication value is set to ‘1’, it indicates the UE to monitor the PO
* If the corresponding paging indication value is set to ‘0’, it indicates the UE is not required to monitor the PO

**Agreement**For PEI DCI format, defined as DCI format 2\_7,* Total number of bits for paging indication filed is *POnumPerPEI*, if  is absent or set to 0 or 1, and the number is , if  is configured.

* + For Rel-17, UE does not expect paging indication filed size is larger than the DCI payload size
* Whether and how TRS availability indication field is included is up to Agenda Item 8.7.1.2
* Support configurable DCI payload size which should be no larger than payload size of paging DCI
	+ Unused bits, when applicable, are regarded as reserved bits
	+ Note: A smaller payload size is beneficial for PEI detection performance

**Agreement*** Determination of PEI-O location for UE’s PO is based on deciding a reference point and an offset from the reference point to the start of the first PDCCH MO of the PEI-O.

o   The reference point is the start of a reference frame determined by a frame-level offset from the start of the first PF of the PF(s) associated with the PEI-O and configured via SIB for the cell.* + - FFS: The range of the frame-level offset

o   There is a symbol-level offset from the reference point to the start of the first PDCCH MO of PEI-O, provided by *firstPDCCH-MonitoringOccasionOfPEI-O* and configured via SIB for the cell.* + - FFS: The range of the symbol-level offset
* Note: When PEI-O is placed close to or overlapped with an earlier SS burst before its associated POs, the total UE wake-up time can be reduced for better power saving gain. Network can configure the PEI-O location accounting the power saving benefit and potential impact on gNB flexibility.

**Agreement**The CCE aggregation levels and maximum number of PDCCH candidates per CCE aggregation level for PEI PDCCH monitoring occasion are given as the following table. Actual aggregation levels and PDCCH candidates are provided by ‘peiSearchSpace’ configuration in SIB.

|  |  |
| --- | --- |
| **CE Aggregation Level** | **Number of Candidates** |
| 4 | 4 |
| 8 | 2 |
| 16 | 1 |

**Agreement***‘peiSearchSpace’* can be configured to one of up to 4 common SS sets configured by commonSearchSpaceList with *SearchSpaceId*> 0 |
| **RAN1 #107-bis-e Meeting****Agreement****A new PEI-RNTI is supported for DCI format 2\_7.** **The following text proposals are adopted:**

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| **TS 38.213 section 10.1:****<**Unchanged text is omitted>- a Type2A-PDCCH CSS set configured by *peiSearchSpace* in *DownlinkConfigCommonSIB* for a DCI format 2\_7 with CRC scrambled by a PEI-RNTI on the primary cell of the MCG**<**Unchanged text is omitted> |
| **TS 38.213 section 10.4B:****<**Unchanged text is omitted>A UE in RRC\_IDLE state or RRC\_INACTIVE state can be provided by *TRS-ResourceSetConfig* a set of TRS occasions [6, TS 38.214]. If *TRS-ResourceSetConfig* is provided, a DCI format 2\_7 with CRC scrambled by PEI-RNTI or a DCI format 1\_0 with CRC scrambled by P-RNTI includes a TRS availability indication field [4, TS 38.212] that provides a bitmap to groups of TRS resource sets where the configuration of each TRS resource set includes an association to a bit of the bitmap. **<**Unchanged text is omitted> |

**Agreement****For whether and how to accommodate PEI-O location determination for the case *POnumPerPEI* is smaller than *Ns*, decide one of the following alternatives*** **Alt-2: It is supported, and UE applies the single value in *PEI-F\_offset* for the frame-level offset and the** $(floor\left(i\_{s}/POnumPerPEI\right)+1) $**-th value out of** $\left(N\_{s}/POnumPerPEI\right)$ **configured values in *firstPDCCH-MonitoringOccasionOfPEI-O*****for the symbol-level offset**

**Note: The number of PO mapping to one PEI should be multiple of *Ns when POnumPerPEI* is larger than *Ns*****Agreement****For PEI-O location determination:*** **Range of *PEI-F\_offset*, in unit of frame, is** $\left\{0, 1,2, …, 16\right\}$
* **Range of *firstPDCCH-MonitoringOccasionOfPEI-O*, in unit of symbol, is decided as one of the following alternatives:**
	+ **Alt-1: The same value range as *firstPDCCH-MonitoringOccasionOfPO***

**Agreement****For the value PEI-RNTI, decide one of the following:*** **Alt-1: PEI-RNTI is of fixed value, and value design is up to RAN2.**

**Conclusion****For a UE supporting R17 paging enhancement feature, it is up to UE implementation whether the UE monitors the MO(s) for a PEI.*** **If UE decides to not to monitor PEI, it has to monitor UE’s PO as defined in 38.304.**
* **Note: No specification impact**

**Agreement*** **The PDCCH monitoring occasions defined by *peiSearchSpace* colliding with UL symbols are omitted from the determination of the PEI monitoring occasions. The PDCCH monitoring occasions for PEI which do not overlap with UL symbols (determined according to *tdd-UL-DL-ConfigurationCommon*) are sequentially numbered from zero starting from the first PDCCH monitoring occasion for PEI in the PEI-O.**

**Agreement****The transmission power of PEI is based on the same determination method as paging PDCCH, and the following TP is adopted.**

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| .............................................................. Text Proposal for 38.213..............................................................................4.1          Cell searchCell search is the procedure for a UE to acquire time and frequency synchronization with a cell and to detect the physical layer Cell ID of the cell.A UE receives the following synchronization signals (SS) in order to perform cell search: the primary synchronization signal (PSS) and secondary synchronization signal (SSS) as defined in [4, TS 38.211]. A UE assumes that reception occasions of a physical broadcast channel (PBCH), PSS, and SSS are in consecutive symbols, as defined in [4, TS 38.211], and form a SS/PBCH block. The UE assumes that SSS, PBCH DM-RS, and PBCH data have same EPRE. The UE may assume that the ratio of PSS EPRE to SSS EPRE in a SS/PBCH block is either 0 dB or 3 dB. If the UE has not been provided dedicated higher layer parameters, the UE may assume that the ratio of PDCCH DMRS EPRE to SSS EPRE is within -8 dB and 8 dB when the UE monitors PDCCHs for a DCI format 1\_0 with CRC scrambled by SI-RNTI, P-RNTI, or RA-RNTI, and DCI format 2\_7 with CRC scrambled by PEI-RNTI................................................................ Text Proposal for 38.213.................................................................................. |

**Agreement****UE expects at most one PEI outcome from each PDCCH monitoring occasion of PEI-O, and the following text proposal is adopted.**

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| **Section 10.1 of TS 38. 213**\*\*\* Unchanged text is omitted \*\*\*If a UE is provided-     one or more search space sets by corresponding one or more of*searchSpaceZero, searchSpaceSIB1*, *searchSpaceOtherSystemInformation*,*pagingSearchSpace*,*peiSearchSpace, ra-SearchSpace*, or a CSS set by*PDCCH-Config*, and -     a SI-RNTI, a P-RNTI, a PEI-RNTI, a RA-RNTI, a MsgB-RNTI, a SFI-RNTI, an INT-RNTI, a TPC-PUSCH-RNTI, a TPC-PUCCH-RNTI, or a TPC-SRS-RNTIthen, for a RNTI from any of these RNTIs, the UE does not expect to process information from more than one DCI format with CRC scrambled with the RNTI per slot.\*\*\* Unchanged text is omitted \*\*\* |

**Agreement****If one PEI-O is associated with POs of 2 PFs,*** **The two PFs are consecutive PFs configured in SIB**
	+ **FFS: two PFs are consecutive PFs within the same paging cycle**
* **Note: As an example, SFN of the first PF of the PF(s) associated with the PEI-O can be obtained by: (SFN of UE’s PF) -** $\left⌊i\_{PO}/N\_{s}\right⌋⋅T/N$

**Agreement*** **LS to RAN2 for sharing agreements with potential RAN2 specification impacts**
	+ **~~Draft LS in~~** [**~~R1-2200788~~**](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_107b-e/Inbox/R1-2200788.zip)

**Conclusion*** **For Rel-17, inclusion of SI change indication or ETWS/CMAS notification in DCI format 2\_7 is not supported.**

**Conclusion** **For Rel-17 DCI format 2\_7,** * **Explicit starting position configuration for paging indication field or TRS availability indication field is not supported.**
	+ **Paging indication field starts from the first bit, and TRS availability indication field starts from the next bit after the end of the paging indication field**
* **UE does not expect the total size of paging indication filed and TRS availability indication field is larger than the DCI payload size**

**Working assumption*** *SearchSpaceId = 0* can be configured for*peiSearchSpace* for the case of CORESET multiplexing pattern **2 or** 3

**Agreement*** Draft LS R1-2200788 is endorsed in principle
* Include above working assumption in the LS on paging enhancement to RAN2

**Agreement*** Final LS R1-2200800 is endorsed.
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| **RAN1 #108-e meeting**ConclusionFor Rel-17, the following for paging early indication design are not supported:* Multipe PEI-Os for one PO
* UE assistance information for preferred offset between PEI-O and PO
* Different PEI configurations for different devices types

AgreementThe following TP for 38.202-h00, subclause 6 to reflect reception type with PEI-RNTI is endorsed.<Begin TP for 38.202-h00, subclause 6.2>**Table 6.2-1: Downlink "Reception Types"**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **"Reception Type"** | **Physical Channel(s)** | **MonitoredRNTI** | **AssociatedTransport Channel** | **Comment** |
| <unchanged rows omitted for brevity> |
| P | PDCCH | CI-RNTI | N/A |   |
| Q | PDCCH | PEI-RNTI | N/A | **Note1** |

 **Table 6.2-2: Downlink "Reception Type" combinations**

|  |  |
| --- | --- |
| **Supported Combinations** | **Comment** |
| **PCell** | **PSCell** | **SCell** |
| 1. RRC\_IDLE |
| A + (B and/or **(**C1**or Q)** and/or D0) + F0 |   |   | Note 1 |
| 2. RRC\_INACTIVE |
| A + (B and/or **(**C1**or Q)**  and/or D0) + F0 |   |   | Note 1 |
| < unchanged rows omitted for brevity> |

<End TP for 38.202-h00, subclause 6.2>Agreement For the alignment with the following RAN2#116bis-e agreements,

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|     **Both *subgroupNumPerPO* and Nsg-UEID range from 1 to 8.**    **If network supports PEI but not subgrouping, the whole*SubgroupConfig-r17* is absent. The parameter *subgroupsNumPerPO* is mandatory present if *subgroupConfig-r17* is configured.** |

* Adopt following TP to TS38.213 Section 10.4:

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| TS38.213v17.0.0]10.4  A PDCCH monitoring for early indication of pagingA UE can be provided the following for detection of a DCI format 2\_7 in RRC\_IDLE state or in RRC\_INACTIVE state [12, TS 38.331]-     a search space set, by *peiSearchSpace*, to monitor PDCCH for detection of DCI format 2\_7 according to a Type2A-PDCCH CSS set as described in clause 10.1-     a number of frames, by *PEI-F\_offset*, from the start of a first paging frame of paging frames associated with a number of PDCCH monitoring occasions for DCI format 2\_7 [17, TS 38.304] to the start of a frame-     a number of symbols, by *firstPDCCH-MonitoringOccasionOfPEI-O*, from the start of the frame to the start of the first PDCCH monitoring occasion for DCI format 2\_7-     a size, by *payloadSizeDCI\_format2\_7*-     a number of subgroups per paging occasion, , by *subgroupsNumPerPO*-     a number of paging occasions associated with the number of PDCCH monitoring occasions for DCI format 2\_7, , by *PONumPerPEI*A paging indication field of DCI format 2\_7 includes  segments of  bits, where  if  and  if is not ~~provided~~configured~~or~~. For a subgroup index , , a UE determines a value for the  bit in the paging indication field, where  is a paging occasion index, and , , ,  and  are defined in [17, TS 38.304]. When the value is '1', the UE monitors a paging occasion determined according to [17, TS 38.304]; otherwise, the UE is not required to monitor the paging occasion. |

* Adopt following TP to TS38.212 Section 7.3.1.3.8:

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| [TS38.212v17.0.0]7.3.1.3.8           Format 2\_7DCI format 2\_7 is used for notifying the paging early indication and TRS availability indication for one or more UEs. The following information is transmitted by means of the DCI format 2\_7 with CRC scrambled by PEI-RNTI:-     Paging indication field –  bit(s), where-      is the number of paging occasions configured by higher layer parameter *PONumPerPEI* as defined in Clause 10.4A in [5, TS 38.213];-     is the number of sub-groups of a paging occasion configured by higher layer parameter*subgroupsNumPerPO*, if *subgroupsNumPerPO* is configured~~and not set to 0~~; otherwise  is set to 1.-     Each bit in the field indicates one UE subgroup of a paging occasion if *subgroupsNumPerPO*~~subgroupsNumPerPO~~ is configured~~and not set to 0~~; otherwise each bit in the field indicates the UE group of a paging occasion.-     TRS availability indication – 1, 2, 3, 4, 5, or 6 bits if *TRS-ResourceSetConfig*is configured; 0 bits otherwise.The size of DCI format 2\_7 is indicated by the higher layer parameter *payloadSizeDCI\_format2\_7*, according to Clause 10.4A of [5, TS 38.213]. If the number of information bits in format 2\_7 is less than the size of format 2\_7, the remaining bits are reserved. |

AgreementAdopt the following TP to Section 10 of TS 38.213

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| **10        UE procedure for receiving control information**\*\*\* Unchanged text is omitted \*\*\*If the UE is configured with a SCG, the UE shall apply the procedures described in this clause for both MCG and SCG except for PDCCH monitoring in Type0/0A/2/2A-PDCCH CSS sets where the UE is not required to apply the procedures in this clause for the SCG-  When the procedures are applied for MCG, the terms 'secondary cell', 'secondary cells' , 'serving cell', 'serving cells' in this clause refer to secondary cell, secondary cells, serving cell, serving cells belonging to the MCG respectively.-  When the procedures are applied for SCG, the terms 'secondary cell', 'secondary cells', 'serving cell', 'serving cells' in this clause refer to secondary cell, secondary cells (not including PSCell), serving cell, serving cells belonging to the SCG respectively. The term 'primary cell' in this clause refers to the PSCell of the SCG.\*\*\* Unchanged text is omitted \*\*\* |

ConclusionSFN of the first PF of the PF(s) associated with the PEI-O is provided by (SFN of UE’s PF) - Agreement* Confirm the following working assumption:

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| **Working assumption***SearchSpaceId = 0* can be configured for *peiSearchSpace* for the case of CORESET multiplexing pattern 2 or 3 |

* When *SearchSpaceId* = 0 is configured for *peiSearchSpace*, subject to SS/PBCH block and CORESET multiplexing pattern 2 or 3, the PDCCH monitoring occasions for PEI-O are same as for RMSI as defined in clause 13 in TS 38.213.
* UE determines first PDCCH MO for PEI-O based on *PEI-F\_offset* and *firstPDCCH-MonitoringOccasionOfPEI-O*, as previously agreed for the case with *SearchSpaceId* > 0.
	+ Note: UE expects the first PDCCH MO for PEI-O determined from *PEI-F\_offset* and *firstPDCCH-MonitoringOccasionOfPEI-O* is aligned with the MOs for RMSI as defined in clause 13 in TS 38.213.
 |

# TRS/CSI-RS occasion(s) for idle/inactive UEs

This feature is for idle/inactive mode UE power saving enhancement. The following summarize the scope and the RAN1 related agreements. It is noticed that this scope item goes work phase directly.

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| 1. Specify enhancements for idle/inactive-mode UE power saving, considering system performance aspects [RAN2, RAN1]
	1. Specify means to provide potential TRS/CSI-RS occasion(s) available in connected mode to idle/inactive-mode UEs, minimizing system overhead impact [RAN1]
* NOTE: Always-on TRS/CSI-RS transmission by gNodeB is not required

**Agreements related to the above scope item are as follows:** |
| **RAN1 #102-e Meeting**Agreements:* New types/patterns of TRS/CSI-RS are not introduced specifically for idle/inactive mode UE.

Agreements:The TRS/CSI-RS occasion(s) that may be for connected mode UEs can be shared to idle/inactive mode UEs. -  Note: It is understood that gNB can potentially share the occasions to idle/inactive (which would just mean it up to NW whether to share or not share).-  Note: It is understood that TRS/CSI-RS in the TRS/CSI-RS occasion(s) may or may not be transmitted.-  Note: Always-on TRS/CSI-RS transmission by gNodeB is not required-  At least TRS/CSI-RS occasion(s) corresponding to periodic TRS is supported - FFS for other RS types-  FFS: Whether UE blind detection is required or not.Agreements:Idle/inactive UE may use the TRS/CSI-RS occasion(s) that are shared to it for functionalities such as: -           AGC, time/frequency tracking-           FFS: RRM measurement for serving cell, RRM measurement for neighbor cell, paging reception indication**Observation:**It is up to gNB implementation whether or not to transmit a TRS/CSI-RS to idle/inactive UEs even when the TRS/CSI-RS is not needed by connected UEs (e.g., when there is a connected mode UE in a cell but the UE is no longer using the TRS/CSI-RS, or when there is no longer connected mode UE in a cell, etc.)Agreements:The configuration of TRS/CSI-RS occasion(s) for idle/inactive mode UE(s) is provided by higher layer signalling-           FFS higher layer signalling candidates (e.g., SIB, dedicated RRC, RRC release message, etc.)-           FFS for other signalling candidates (e.g., pre-configuration, etc.)-           FFS for detailed configuration parameters (e.g., whether and how to reduce the signalling overhead for configuration, etc.)Agreements:Further study whether and how to inform the availability of TRS/CSI-RS to idle/inactive mode UE (implicitly or explicitly).- Note: Availability corresponds to the information for whether TRS/CSI-RS is actually transmitted or not. |
| **RAN1 #103-e Meeting**Agreements:* Functionality of RRM measurement for neighbour cell is not supported for TRS/CSI-RS for idle/inactive UE(s).

**Agreements:*** SIB signalling provides the configuration of TRS/CSI-RS occasion(s) for idle/inactive UE(s).
	+ Up to RAN2 to decide which SIB is to be used.
	+ Whether or not to additionally support other high-layer signalling methods (e.g., dedicated RRC, RRC release message, etc.) is up to RAN2

Send an LS to RAN2 informing the above agreements, and* To further add that RAN1 is working on the detailed physical layer design

Draft LS is endorsed, with final LS in [R1-2009791](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_103%5CDocs%5CR1-2009791.zip). 🡪 R1-2009848Agreements:* Aperiodic TRS and semi-persistent/aperiodic CSI-RS are not used as TRS/CSI-RS occasion(s) for idle/inactive UEs.

Agreements:- Target sending an LS to RAN2 and RAN4 to ask whether it is feasible to allow a UE to use the potential TRS/CSI-RS occasion to enhance the SSB based IDLE/Inactive mode evaluations of the serving cell. (to also include agreements from last meeting)\* Further discussion whether any additional information needs to be included in the LS or not, including potential re-wording of the leading sentenceAgreements:* Discuss further based on the following alternatives and down-select at RAN1#104-e:
	+ Alt 1: The availability of TRS/CSI-RS at the configured occasion(s) is NOT informed to the UE.
	+ Alt 2: The availability of TRS/CSI-RS at the configured occasion(s) is informed to the UE.
	+ Alt 3. The conditional availability of TRS/CSI-RS at the configured occasion(s) is informed to the UE.
		- The condition can be, e.g., existence of paging.
	+ Alt 4. Combination of the above alternatives.
	+ FFS for details
	+ FFS for UE behavior when the availability is not informed.
	+ Other techniques are not precluded.
	+ Companies encourage to provide sufficient information for the proposal, e.g.,
		- how to achieve power saving gain
		- how to minimize impact on NW

how to minimize extra UE implementation complexity* + - feasibility check on sharing the TRS/CSI-RS between connected UEs and idle/inactive UEs
	+ Proposals should be consistent with the WID objective.

**Conclusion:*** TRS/CSI-RS based PEI is discussed in AI 8.7.1.1.
* PEI functionality is not further discussed under AI 8.7.1.2.
* Note: This does not prevent to potentially use PEI to carry the indication for TRS/CSI-RS presence.
 |
| **RAN1 #104-e Meeting**Agreements:Configuration of TRS/CSI-RS occasion(s) for idle/inactive Ues include at least:* powerControlOffsetSS,
* scramblingID
* firstOFDMSymbolInTimeDomain,
* startingRB.
* nrofRBs,
* FFS other parameters
* FFS applicable values

Agreements:The SCS configuration of TRS/CSI-RS occasion(s) for idle/inactive UEs can be discussed and down-selected from following alternatives at RAN1#104b-e:* Alt1: same as initial BWP
* Alt2: configurable parameter

Agreements:Multiple RS resources can be configured for TRS/CSI-RS occasion(s) for idle/inactive UEs. * FFS details (including whether or not to restrict the RS to be TRS only)

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).

**Conclusion**From RAN1 perspective, there is no consensus on supporting RRM measurement for serving cell functionality for TRS/CSI-RS occasion(s) for idles/inactive UEs.Agreements:The configuration of the frequency location of TRS/CSI-RS occasion(s) for idle/inactive UEs are discussed and down-selected from following alternatives at RAN1#104bis-e:* Alt-1: within initial DL BWP
* Alt-2: is not restricted by initial BWP
	+ IDLE/INACTIVE mode UE is not expected to receive TRS/CSI-RS outside the initial DL BWP.

Agreements:To study QCL information of TRS/CSI-RS occasion(s) for idle/inactive UEs from following alternatives: * Alt-1: From higher layer configuration, e.g. qcl-InfoPeriodicCSI-RS
* Alt-2: QCL assumptions associated with transmitted SSBs implicitly, e.g. similar to PDCCH monitoring in PO
* FFS details
* Other alternatives are not precluded

**Conclusion:**Decide at RAN1#104b-e, whether or not to support periodic CSI-RS in addition to periodic TRS for TRS/CSI-RS occasion(s) for idle/inactive UEs. |
| **RAN1 #104-bis-e Meeting**Agreement:SCS of TRS/CSI-RS occasion(s) for idle/inactive UEs is same as SCS of CORESET#0.Agreement:Support higher layer configuration of the QCL information of TRS/CSI-RS occasion(s) for idle/inactive UEs.* FFS details of the QCL information, e.g. associated SSB index

Agreement:IDLE/INACTIVE mode UE is not expected to receive TRS/CSI-RS outside the initial DL BWP.* Configuration of the frequency location of TRS/CSI-RS occasion(s) for idle/inactive UEs is not restricted by initial BWP.

Working assumption:Support at least L1 based signaling for the availability indication of TRS/CSI-RS at the configured occasion(s) to the idle/inactive UEs.* FFS details, including paging DCI and/or PEI for L1 based signaling
* FFS SIB-based signaling/configuration
	+ **Note:** It is RAN1 understanding that existing SI update procedure is used for SIB based signaling

Agreement:**Configuration for TRS/CSI-RS occasion(s) for idle/inactive UEs is based on periodic TRS only, including following limitations*** **Configuration parameters that are necessary to provide configuration of periodic TRS for idle/inactive UEs**
* **Applicable values that are necessary to provide configuration of periodic TRS for idle/inactive UEs**
* **If the configuration is provided, idle/inactive UEs can always implicitly assume that trs-info is configured.**
	+ **The parameter trs-info does not need to be provided in the configuration**

Agreement:For the information provided by a physical layer availability indication of TRS/CSI-RS at the configured occasion(s) to the idle/inactive UEs, one or more alternatives from the following can be supported:* Alt1: Availability/unavailability information for all or some of configured RS resources using a bitmap or codepoint
* e.g. using bitmap, where each bit ~~from a bitmap or a codepoint~~ is associated with at least one resource~~/configuration~~ or a set/group of resources
* e.g. a codepoint to indicate a state of availability/unavailability for all or some of configured RS resources
* Alt2: value or codepoint to indicate one or more resource/configuration indices that correspond to the available RS resources
* FFS whether and how to indicate the ‘availability’ in beam selective manner.
* Other alternatives are not precluded

 |
| **RAN1 #105-e Meeting**Agreement:Confirm the following working assumption:Support at least L1 based signaling for the availability indication of TRS/CSI-RS at the configured occasion(s) to the idle/inactive UEs.* FFS details, including paging DCI and/or PEI for L1 based signaling
* FFS SIB-based signaling/configuration
	+ Note: It is RAN1 understanding that existing SI update procedure is used for SIB based signalling

 Agreement:**For the information provided by a physical layer availability indication of TRS/CSI-RS at the configured occasion(s) to the idle/inactive UEs, support availability/unavailability information for configured RS resources using a bitmap or codepoint*** **e.g. using bitmap, where each bit is associated with at least one resource/configuration or a set/group of resources**
* **e.g. a codepoint to indicate a state of availability/unavailability for all or some of configured RS resources**
* **FFS** **maximum number of** **configured RS resources per physical layer availability indication to support.**
* **FFS whether availability/unavailability information is for all or some of configured RS resources**

 Agreement:**Support applicable values for the following configuration parameters as below.*** **powerControlOffsetSS:** **{-3, 0, 3, 6}dB**
* **scramblingID:** **0 to 1023**
* **firstOFDMSymbolInTimeDomain:** **0 to 9**
	+ **firstOFDMSymbolInTimeDomain indicates first symbol in a slot, a second symbol in the same slot can be derived implicitly with symbol index as firstOFDMSymbolInTimeDomain+4**
* **startingRB:** **0 to 274**
* **nrofRBs:** **24 to 276**

  Agreement:The QCL information of TRS/CSI-RS occasion(s) for idle/inactive UEs is indicated as a SSB index in range of 0 to 63.* FFS: how the QCL information can be configured, e.g. per RS resource set or per configuration
* FFS: QCL type, which is predetermined

**Working assumption:****Support paging PDCCH based availability indication of TRS/CSI-RS occasions for idle/inactive UEs.****Support PEI based availability indication of TRS/CSI-RS occasions for idle/inactive UEs at least if PDCCH-based PEI is down-selected.*** **FFS ~~whether and~~ how to enable/disable L1 based availability indication configurable by SIB**

Agreement:Configuration of TRS/CSI-RS occasion(s) for idle/inactive UEs include:* periodicityAndOffset {10, 20, 40, 80} ms
* frequencyDomainAllocation for row1 with applicable values from {0, 1, 2, 3} to indicate the offset of the first RE to RE#0 in a RB
* FFS Configuration index
	+ details,
		- E.g. Per resource or resource set or group of resource sets
		- E.g. explicit or implicit indication based on QCL source

Agreement:Further study supporting SIB based signaling for availability information of TRS/CSI-RS occasions for idle/inactive UEs at least based on the presence/absence of the configuration of the TRS/CSI-RS occasion in SIB\_X in case L1 based availability indication is not configured.* FFS whether and how SIB based signaling and L1 based signaling can be configured simultaneously
 |
| **RAN1 #106-e Meeting**AgreementSupport at least one of the following alternatives* Alt1: L1 availability indication at an occasion provides availability/unavailability information only for RS resources with the same QCL reference as the L1 availability indication occasion.
* Alt2: L1 availability indication at an occasion can provide availability/unavailability information for RS resources with QCL references not confined to be the same as for the L1 availability indication occasion

Note:  The occasion mentioned above refers to a signal/channel monitoring occasion (e.g. a paging PDCCH or PEI monitoring occasion) to provide the L1 availability indication. Note: a RS resource is a RS from configured TRS/CSI-RS occasion(s) for idle/inactive UEs., where the configuration for TRS/CSI-RS occasion(s) for idle/inactive UEs is based on periodic TRS only.AgreementL1 based availability indication of TRS/CSI-RS at the configured occasion(s) to the idle/inactive UEs is valid for a time duration starting from a reference point, where* the time duration can be determined based on at least one from the following (to be down-selected):
	+ Alt-1: configured by higher layer
	+ Alt-2: a predefined/configured window
	+ Alt-3: value indicated by the availability indication, where the value is one of multiple configured time duration(s)
	+ Alt-4: until when the UE receives another availability indication
	+ A combination of alternatives or other alternatives is not precluded.
* the reference point can be determined as at least one from the following (to be down-selected):
	+ Alt-1: start of next PO or DRX cycle
	+ Alt-2: time location where UE receives the indication
		- Note: the time location is subject to application delay if agreed
	+ Alt-3: start of current PO or DRX cycle where UE receive the indication
	+ Alt-4: a time location which is configured by higher layer
	+ A combination of alternatives or other alternatives is not precluded.

**Agreement**For a RS resource configured for TRS/CSI-RS occasion(s) for idle/inactive UEs, a quasi co-location type can be determined as* + ‘typeC’ with an SS/PBCH block and, when applicable, ‘typeD’ with the same SS/PBCH block
 |
| **RAN1 #106-bis-e Meeting**ConclusionNo consensus to support SIB based signaling for availability information of TRS/CSI-RS occasions for idle/inactive UEsWorking AssumptionIf TRS resource is configured in SIB, L1 based availability indication is always enabled based on the configuration. **Agreement**For L1 based availability indication of TRS/CSI-RS at the configured occasion(s) to the idle/inactive UEs, support availabilityinformation for configured RS resources using a bitmap. where each bit indicates whether associated TRS resource(s) are available.* support L1 availability indication at an occasion can provide availability information RS resources with QCL references not confined to be the same as for the L1 availability indication occasion
	+ FFS associated TRS resource(s) per bit, e.g. a bit is associated with a TRS resource set
	+ Bitmap size is up to X bits
		- X = [6] for paging PDCCH based L1 availability indication.
		- FFS X for PEI DCI based L1 availability indication
		- FFS details about how to configure the DCI field: e.g. start and length of bitmap (e.g. explicitly/implicitly configured)
* for paging PDCCH based L1 availability indication, support L1 availability indication at an occasion can provide availability information for all configured RS resources
	+ FFS whether this needs to be supported regardless of the number of beams or for some configured RS resources
* FFS: PEI DCI provides L1 availability indication information only for RS resources with QCL references to be the same as for the L1 availability indication occasion
* FFS: indication of unavailability

**Agreement**At least for paging PDCCH based L1 availability indication of TRS/CSI-RS at the configured occasion(s) to the idle/inactive UEs, the L1 availability indication is valid for a time duration starting from a reference point, where* the time duration is a validity duration configured by higher layer,
	+ FFS applicable values, e.g. # of DRX cycles, or multiple of default paging cycle duration (i.e. modification period)
	+ FFS UE doesn’t expect inconsistent L1 based indication during the time duration
* the reference point for start of the validity duration is one of the following alternatives:
	+ Alt1: SFN of the first PF from the next DRX cycle
	+ Alt2: SFN of the first PF from the current DRX cycle where UE receives the indication
	+ Alt3: based on SFN configured by higher layer, i.e. modification period configured as multiple of default paging cycle duration
	+ Alt4: start of the PF for the PO where UE receives the indication
	+ Note: the DRX cycle in Alt1 and Alt2 is the default paging cycle broadcast in SIB
	+ Note: The SFN for the first PF is ~~for (UE mod N) = 0, and can be~~ calculated by (SFN + PF\_offset) mod T = 0
* the time duration can be optionally configured by gNB
	+ when the time duration is not configured, one of the following alternatives can be considered:
		- Alt1: the availability indication is valid until when the UE receives another availability indication.
		- Alt2: the availability indication is valid until L1 availability indication is changed by network
		- Alt3: default time duration e.g. default paging cycle
* FFS whether and how to handle the miss detection issue of L1 signaling

**Agreement**Configuration of TRS/CSI-RS occasion(s) for idle/inactive UEs include a list of one or more TRS resource sets, where:        a TRS resource set can be configured to includeo   a set of TRS resources up to two consecutive slots,  Note: a TRS resource is same as Rel-15/16, i.e. a CSI-RS in a symbol.o   at least common configuration parameters:  a QCL reference  firstOFDMSymbolInTimeDomain,  ‘frequencyDomainAllocation for row1’, ‘startingRB’ ,‘nrofRBs’,’powerControlOffsetSS’, periodicityAndOffset’  FFS        scramblingID,        a TRS resource set ID, number of slots {1, 2} or number of symbols {2, 4} if supported        Note: the ‘TRS resource set’ configuration is not (necessarily) identical to ‘NZP-CSI-RS-ResourceSet’ configuration for TRSin R15/16. |
| **RAN1 #107-e Meeting****Agreement**For the maximum number of TRS resource sets configured by higher layer, X,* X = 64
* FFS: the number of configured TRS resource sets is not larger than the number of actual transmitted SSBs determined according to ssb-PositionsInBurst in SIB1

**Agreement**For L1 availability indication using a bitmap, the following is supported:* Number of bits in the bitmap, N, is up to 6 bits
* a bit is associated with a group of TRS resource sets. The associated TRS resource sets for each bit can be based on
	+ explicit configuration of TRS resource set group, where
		- each TRS resource set is configured with a ID i, with value from {0, …, N-1}, for the association with an indication bit in TRS availability indication field.
		- the ith bit maps to all the TRS resource set(s) associated with ID *i*.
* start of the bitmap is the first bit of the reserved bits in paging PDCCH
* Note: It is left to RAN2 decision on whether explicit parameter is used for N or it can be implicitly determined by the TRS resource set configurations.

**Agreement**The reference point for start of the validity duration is SFN of the first PF from the current default DRX cycle where UE receives the availability indication* FFS: Whether the availability indication is transmitted [only once] during the validity duration

**Note: Qualcomm and Huawei have concern on Alt a****Agreement**For the validity duration configured by higher layer at least for paging PDCCH based L1 availability indication, support* time unit is one default paging cycle,
* applicable values: {1, 2, 4, 8, 16, 32, [64], [128], [256],[512]}

When the validity duration is not configured, UE assumes a default time duration to be 2 default paging cycle(s):**Agreement**Confirm the following working assumptionWorking Assumption* Support paging PDCCH based availability indication of TRS/CSI-RS occasions for idle/inactive UEs.
* Support PEI based availability indication of TRS/CSI-RS occasions for idle/inactive UEs at least if PDCCH-based PEI is down-selected.
 |
| **RAN1 #107-bis-e Meeting****Agreement**Support a configuration parameter for the number of, X, TRS resources for a TRS resource set at least for FR2* Applicable values for X: {2, 4}
* For FR1, X is based on configuration parameter with applicable value {2, 4}

Note: Configuration follows restriction specified in sub-clause 5.1.6.1.1 in TS38.214 for connected mode TRS**Agreement**One or more scrambling IDs is configured for a TRS resource set.* If a single scrambling ID is configured, it applies to all the TRS resources.
* Otherwise, each TRS resource is provided with a scrambling ID.

**Agreement**The applicable values:{64, 128, 256, 512} are supported for the validity duration configured by higher layer, * Note: If UE is provided a configuration of validity duration longer than 10.24s, and the UE does not support eDRX, it is up to UE implementation whether to assume the validity duration length is no larger than 10.24s

**Agreement**UE can receive L1 based signaling for TRS availability indication before the expiration/end of validity duration associated with previous L1 based signaling for TRS availability indication * For each bit indicated as ‘1’ in the availability indication field of the current L1 based signaling ~~TRS availability indication~~, the UE assumes the corresponding TRS resource set(s) are available from the reference point until the end of the validity duration associated with the current L1 based signaling ~~indication~~.
* For each bit indicated as ‘0’ in the availability indication field of the current L1 based signaling, the UE keeps the existing ~~current~~ assumption on the availability or unavailability of the corresponding TRS resource set(s).

Note: the validity duration for different group of TRS resources sets correspond to different bits in the availability indication field can be different and are maintained independently. Note: CATT has concern on the power saving gain based on this agreement.**Agreement**Confirm the following working assumptionWorking AssumptionIf TRS resource is configured in SIB, L1 based availability indication is always enabled based on the configuration. **Agreement**The parameter of *periodicityAndOffset* is used to determine the location of the first slot of TRS resource set.**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-RNTINote: Huawei, MTK and ZTE have concern on the agreement. |
| **RAN1 #108-e Meeting****Agreement**The following TP to TS 38.213 is endorsed

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| 10.4B   Indication of TRS resourcesA UE in RRC\_IDLE state or RRC\_INACTIVE state can be provided by *TRS-ResourceSetConfig* a set of TRS occasions [6, TS 38.214]. If *TRS-ResourceSetConfig* is provided, a DCI format 2\_7 if configured ~~or~~and a DCI format 1\_0 with CRC scrambled by P-RNTI includes ~~a~~ the TRS availability indication field [4, TS 38.212] that provides a bitmap to groups of TRS resource sets where the configuration of each TRS resource set includes an association to a bit of the bitmap. The UE can be additionally provided a multiple, by *validityDuration*, for a number of frames provided by*defaultPagingCycle* for TRS resource sets with indicated presence; if*validityDuration* is not provided, the multiple is equal to 2.A value of '1' for a bit of the bitmap indicates presence of associated TRS resource sets for the multiple of the number of frames, starting from a SFN determined from [17, TS 38.304] that corresponds to the frame that includes a PDCCH providing the DCI format 2\_7, or the DCI format 1\_0 with CRC scrambled by P-RNTI, with the TRS availability indication fieldindicating the TRS resource sets, where  is provided by *defaultPagingCycle*. A value of '0' for a bit of the bitmap ~~is ignored by the UE~~indicates that the UE keeps existing assumption of the availability or unavailability of associated TRS resource sets. A UE can receive first and second PDCCHs that provide DCI format 2\_7 or DCI format 1\_0 with CRC scrambled by P-RNTI that indicate presence of TRS resource sets for the multiple of the number of frames, where the second PDCCH reception after the first PDCCH reception by a time that is smaller than themultiple of the number of frames.\*\*\* Unchanged text is omitted \*\*\* |

**Agreement**The following TP to TS 38.214 is endorsed

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| 5.1.6.1.1              CSI-RS for tracking<omitted text>Each NZP CSI-RS resource, defined in Clause 7.4.1.5.3 of [4, TS 38.211], is configured by the higher layer parameter *TRS-ResourceSet* with the following restrictions for a UE in RRC\_IDLE or RRC\_INACTIVE:-    the number of periodic NZP CSI-RS resources configured by a *TRS-ResourceSet* is given by *numberOfresources*-    the time-domain locations of the two CSI-RS resources in a slot, or of the four CSI-RS resources in two consecutive slots (which are the same across two consecutive slots), is one of-     , , or for frequency range 1 and frequency range 2,-     , , , , ,  or  for frequency range 2.-     where the first symbol location in a slot is indicated by *firstOFDMSymbolInTimeDomain*in the *TRS-ResourceSet* and the second symbol location in a slot is*firstOFDMSymbolInTimeDomain +*4-    a single port CSI-RS resource with density  given by Table 7.4.1.5.3-1 from [4, TS 38.211]*.*-    the bandwidth and the frequency location of the NZP CSI-RS resource, is given by the higher layer parameter *nrofRBs*, *startingRB* and *frequencyDomainAllocation* in a *TRS-ResourceSet* and applies to all resources in a *TRS-ResourceSet*. ~~The frequencyDomainAllocation configuration is~~Bandwidth, *nrofRBs*, and the initial CRB index, *startingRB*, of the NZP CSI-RS resource configured by *TRS-ResourceSet* are not restricted by initial DL BWP.-    UE is not required to receive TRS occasions outside the initial DL BWP.-    the periodicity for periodic NZP CSI-RS resources, is given by the higher layer parameter*periodicityAndOffset*configured b*y* a *TRS-ResourceSet*, is one of slots where 10, 20, 40, or 80 and where µ is defined in Clause 4.3 of [4, TS 38.211], applies to all resources in a *TRS-ResourceSet*. The slot offset given by the higher layer parameter *periodicityAndOffset*configured b*y* a *TRS-ResourceSet* provides the location of the first slot containing the periodic NZP CSI-RS resources configured by b*y* a *TRS-ResourceSet.*-    the UE does not expect the *TRS-ResourceSet* to be configured with the periodicity of  slots if the bandwidth of NZP CSI-RS resource is larger than 52 resource blocks.-    the UE may assume the sub-carrier spacing of the NZP CSI-RS resources configured by*TRS-ResourceSet* to be same as the sub-carrier spacing of the initial DL BWP.-    *powerControlOffsetSS*given bya *TRS-ResourceSet* applies to all resources in a *TRS-ResourceSet*.-    the QCL information for periodic NZP CSI-RS resources, is given by the higher layer parameter *ssb-Index* configured by a *TRS-ResourceSet*, is a SS/PBCH block, applies to all resources in a *TRS-ResourceSet*.-     One or more *scramblingIDs* where if a single *scramblingID* is configured, it applies to all NZP-CSI-RS resources in the resource set, otherwise, each NZP-CSI-RS resource is provided with a *scramblingID*.-    the UE may assume the following quasi co-location type(s):-     'typeC' with an SS/PBCH block and, when applicable, 'typeD' with the same SS/PBCH block.For each *TRS-ResourceSet* the index of the associated bit in TRS availability indication field [5, TS 38.212], is given by the higher layer parameter *indBitID*.<omitted text> |

**Conclusion**No consensus to support * PEI DCI provides L1 availability indication information only for RS resources with QCL references to be the same as for the L1 availability indication occasion

**Conclusion**A UE can receive different TRS availability indication content from PEI and associated paging PDCCH.* Note: It is up to UE implementation whether UE receives both PEI and the associated paging PDCCH to receive TRS availability indication

**Conclusion**No consensus to support* For PEI based availability indication, the reference time of the start of validity duration follows the reference time for associated monitoring occasion for the paging DCI.

**Agreement**Down-select one of the TPs to clarify the current default DRX cycle used for determining the reference point for start of validity duration for an availability indication * Alt1: Adopt TP#1
* Alt2: Adopt TP#2
* Note: TRS availability indication transmitted in all PDCCH monitoring occasions of the same PEI-O or PO is same.
* Note: Reference point for TRS availability indication in a given DCI is identical for all UEs regardless of UE specific DRX value.

|  |
| --- |
| ============================= start of TP#1==========================================10.4B Indication of TRS resources<Unchanged text omitted>A value of '1' for a bit of the bitmap indicates presence of associated TRS resource sets for the multiple of the number of frames, starting from a SFN determined from $\left(SFN+PF\\_offset\right)modT=0$ [17, TS 38.304] that corresponds to the frame within the DRX cycle that includes ~~a~~ the PDCCH providing the DCI format 2\_7, or the DCI format 1\_0 with CRC scrambled by P-RNTI, with the TRS availability indication field indicating the TRS resource sets, where $T$ is provided by *defaultPagingCycle*. A value of '0' for a bit of the bitmap is ignored by the UE. A UE can receive first and second PDCCHs that provide DCI format 2\_7 or DCI format 1\_0 with CRC scrambled by P-RNTI that indicate presence of TRS resource sets for the multiple of the number of frames, where the second PDCCH reception after the first PDCCH reception by a time that is smaller than the multiple of the number of frames. <Unchanged text omitted>============================= end of TP#1======================================================================= start of TP#2==========================================10.4B Indication of TRS resources<Unchanged text omitted>A value of '1' for a bit of the bitmap indicates presence of associated TRS resource sets for the multiple of the number of frames, starting from a SFN determined from $\left(SFN+PF\\_offset\right)modT=0$ [17, TS 38.304] that corresponds to the frame of the DRX cycle associated with the first PDCCH MO of the PEI-O or PO that includes ~~a~~ the PDCCH providing the DCI format 2\_7, or the DCI format 1\_0 with CRC scrambled by P-RNTI, with the TRS availability indication field indicating the TRS resource sets, where $T$ is provided by *defaultPagingCycle*. A value of '0' for a bit of the bitmap is ignored by the UE. A UE can receive first and second PDCCHs that provide DCI format 2\_7 or DCI format 1\_0 with CRC scrambled by P-RNTI that indicate presence of TRS resource sets for the multiple of the number of frames, where the second PDCCH reception after the first PDCCH reception by a time that is smaller than the multiple of the number of frames. <Unchanged text omitted>============================= end of TP#2========================================== |

Agreement*TRS-ResourceSetConfig* IE is not accounted in determination of available resource elements for PDSCH. |

# Extension(s) to Rel-16 DCI-based power saving adaptation during DRX Active Time

This feature is for connected-mode power saving enhancement. The following summarize the scope and the RAN1 related agreements.

Please be noticed that there are agreements on evaluation assumptions and observations for the study phase of this feature. Since they are not related to final specification and thus not included in the following table. Yet, they can still be checked in the status reports [1]-[5].

|  |
| --- |
| 1. Study and specify, if agreed, enhancements on power saving techniques for connected-mode UE, subject to minimized system performance impact [RAN1, RAN4]
	1. Study and specify, if agreed, extension(s) to Rel-16 DCI-based power saving adaptation during DRX Active Time for an active BWP, including PDCCH monitoring reduction when C-DRX is configured [RAN1]
* NOTE: Rel-15 and Rel-16 available power saving solutions should be supported by the UE and included in the evaluation. RAN1 will ask the confirmation from RAN2 that Rel-15 and Rel-16 available power saving solutions are properly utilized.

**Agreements related to the above scope item are as follows:** |
| **RAN1 #103-e Meeting**Agreements:* **Specify at least one of the following options for Rel-17 dynamic PDCCH adaptation ~~in time-domain~~ for active time,**
	+ **Option 1: Search space set group switching,e.g., ~~potential adjustments/enhancements for~~including explicit and implicit search spaceset group switching ~~specified in R16 for NR-U~~**
	+ **Option 2: PDCCH skipping for a certain duration / DRX cycle**
* **FFS: which option(s)~~(e.g. taking into account additional gain of option 1 over option 2, or vice-versa)~~**
* **Candidate DCI formats for dynamic PDCCH adaptation include DCI formats 1\_1(including scheduling and non-scheduling DCI), 0\_1, 1\_2, 0\_2, 2\_0, 2\_6.**
* **Note:**
	+ **Companies are encouraged to provide analysis on specification impact,** **power saving benefit and system impact (e.g., packet latency, system overhead)**
* **FFS: other schemes are not precluded for further study**
 |
| **RAN1 #104-e Meeting**Agreements:* Strive for a common design for DCI based PDCCH monitoring adaptation in active time for an active BWP to support functionalities inclusive of both SSSG switching and PDCCH skipping for a duration.
	+ Details FFS

Agreements:* Further study whether and how to minimize the impact to data scheduling for new transmissions and retransmissions.
	+ FFS details
* Further study the application delay for PDCCH adaptation indication

Agreements:* For DCI based PDCCH skipping in active time for an active BWP (if supported), the following can be further considered,
	+ Explicit indication of PDCCH adaptation
		- Scheduling DCI
			* Format 1\_1
			* Format 0\_1
			* Format 0\_2/1\_2
		- Non-scheduling DCI
			* Format 2\_6 in active time
			* Format 2\_0
			* Format 1\_1 (SCell dormancy case 2)
		- additional indication mechanism
			* By reusing Rel-16 SCell dormancy indication when CA is configured, FFS details
			* By reusing Rel-16 cross-slot scheduling indication when R16 cross-slot scheduling is configured, FFS details
	+ DCI dynamically indicates a duration/periodic interval for skipping
		- FFS: how to indicate the duration/period interval, e.g., number of slots or skipping current DRX
	+ PDCCH skipping for a duration indicated by minimum scheduling offset
	+ Others are not precluded

Agreements* For DCI based SSSG switching in active time for an active BWP (if supported), the following can be further considered,
	+ Explicit indication of PDCCH adaptation
		- Scheduling DCI based
			* Format 1\_1,
			* Format 0\_1,
			* Format 0\_2/1\_2
			* ~~Format 1\_0~~
		- Non-scheduling DCI
			* Format 2\_6 in active time
			* Format 2\_0
			* ~~Format 1\_0~~
			* Format 1\_1 (SCell dormancy case 2)
		- additional indication mechanism
			* By reusing Rel-16 SCell dormancy indication when CA is configured, FFS details
			* By associating Rel-16 cross-slot scheduling indication when R16 cross-slot scheduling is configured, FFS details
		- DCI dynamically indicates a duration for the switched SSSG, UE switch back to previous/default SSSG after duration ends
	+ Timer-based SSSG switching, including RRC configured a timer, UE switch back after timer expired.
	+ SSSG activation/deactivation
	+ FFS: Implicit SSSG switching
		- SSSG switching triggered by SR
		- SSSG switching triggered by RACH
		- Default SSSG that a UE monitors when coming out of DRX to monitor an ON duration.
* FFS: whether/how to support SSSG switching for multiple groups of cell(s).
* FFS: whether/how to support SSSG switching in active time with DCP outside active time
* FFS: whether / how to support more than 2 SSSGs,
	+ FFS: number of SSSGs
* FFS: a search space set group to emulate PDCCH skipping
* Others are not precluded

Agreements:* The following alternatives can be considered for DCI based PDCCH monitoring adaptation in active time for an active BWP for power saving
	+ Alt 1: Enhancement of Rel-16 SSSG switching to support PDCCH monitoring adaptation including skipping for a duration
	+ Alt 2a: Enhancement of DCI(s) utilized for Rel-16 power saving adaptation for supporting both skipping PDCCH monitoring for a duration and SSSG switching
	+ ~~Alt 2b: Enhancement of DCI(s) utilized for Rel-16 power saving adaptation for supporting both skipping PDCCH monitoring for a duration and PDCCH monitoring periodicity adaptation~~
	+ Others not precluded
 |
| **RAN1 #105-e Meeting**Agreement:* PDCCH schedules data and also indicates PDCCH monitoring adaptation by SSSG switching and PDCCH skipping for a duration is supported.
	+ At least DCI format(s) 1-1, 0-1, 1-2 and 0-2 can be used for the indication(s)

Agreement:* ~~At least~~ one of  Alt 1 and Alt 2 is supported, to be decided in RAN1#106,
* Alt 1: Supporting SSSG  switching to emulate PDCCH skipping functionality,
	+ Alt 1-1: by an ‘empty’ SSSG which no SS set(s) is configured for the ‘empty’ SSSG, UE does not monitoring PDCCH on the ‘empty’  SSSG,
	+ Alt1-2: by a ‘dormant SSSG’ which may have associated SS sets, and monitored conditionally (e.g., depending on HARQ NACK or RTT/ReTx timers)
* Alt 2: PDCCH schedules data and also indicates PDCCH monitoring adaptation by PDCCH skipping for a duration is supported.
	+ FFS details, including
		- e.g., joint / separate indication of SSSG switching and PDCCH skipping
		- Determination of the duration(s) for PDCCH skipping, e.g.,
			* by RRC signaling,
			* by DCI indication
			* Implicitly, to the end of C-DRX active time

Agreement:At least SSSG#0 and SSSG#1 switching is supported for Rel-17 SSSG switching indicated by PDCCH scheduling data and/or timer.* FFS: support of more than 2 SSSGs
 |
| **RAN1 #106-e Meeting**Agreement* At most 2 bit indication in self-scheduling DCIs (i.e., DCI format 1-1/0-1/1-2/0-2) can be specified for triggering the PDCCH monitoring adaptation in a single cell
	+ FFS: the bit size of the indication is configurable
	+ FFS: bit mapping to the PDCCH monitoring behaviour
	+ FFS: details of indication of multiple cells case

AgreementSelect either package 1 or package 2Package 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. Package 2 (Alt 1 and Alt 2)* If alt 1 is supported,
	+ supporting SSSG  switching to emulate PDCCH skipping functionality by an ‘empty’ SSSG (i.e. Alt 1-1)or ‘dormant’ SSSG(i.e. Alt 1-2)
		- Y bits is configured for scheduling DCIs (i.e., DCI format 1-1/0-1/1-2/0-2) indicating SSSG index.
			* FFS dynamic indication of ~~initial~~ timer value(s)
			* FFS details
		- At most [3] SSSGs is supported to be configured.
			* Note: including‘empty’ SSSG or ‘dormant’ SSSG
		- ~~FFS support of single timer to switch to default SSSG#0  or support of multiple timers between SSSGs~~
		- FFS whether one or more of the following timer(s) is supported for switching between
			* Option 1: Non-default SSSG to default SSSG (i.e., SSSG#0)
			* Option 2: Non-default SSSG to another non-default SSSG
			* Option 3: Default SSSG (i.e., SSSG#0) to non-default SSSG(s)
		- FFS: down selection between ‘empty’ SSSG (i.e. Alt 1-1)or ‘dormant’ SSSG(i.e. Alt 1-2)
		- ~~FFS: whether ‘empty’ SSSG and ‘dormant’ SSSG, can be looked as a skipping duration and whether to introduce a SSSG state.~~
		- FFS: whether the timer is configured per SSSG, per BWP, or other approaches.
		- ~~FFS: whether multiple timer duration(s) can be configured by RRC, and DCI dynamically indicates a timer duration~~
		- ~~FFS: do we need to define default SSSGs and for what purpose?~~
		- Note: description of ‘empty’ SSSG and ‘dormant’ SSSG has been provided in RAN1#105-E
* If alt 2 is supported,
	+ PDCCH schedules data and also indicates PDCCH monitoring adaptation by PDCCH skipping for a duration is supported.
		- Y bits is configured for scheduling DCIs (i.e., DCI format 1-1/0-1/1-2/0-2) indicating PDCCH monitoring adaptation ~~(including  SSSG index, and/or PDCCH skipping duration(s))~~
			* ~~Alt 2-1:~~
				+ FFS: Determination of the duration for PDCCH skipping, e.g.,

One skipping duration configured by RRC signaling,Multiple candidate values of skipping duration configured by RRC signaling and use DCI to dynamically indicate one of the configured skipping durationby specification* + - * + FFS: possible value(s) of the duration
				+ FFS: joint or separate indication with SSSG switching
			* ~~Alt 2-3:~~
				+ FFS: whether introduce SSS/SSSG specific skipping indication via e.g. bitmap, codepoint, joint indication with a minimum scheduling offset value
		- FFS: whether the skipping duration is configured per SSSG, per BWP, or other approaches.
		- FFS: PDCCH skipping indicated by non-scheduling DCI
		- FFS: interaction with SSSG switching (when configured), e.g. impact to skipping when SSSG timer expires, which SSSG after PDCCH skipping is monitored, etc.

Agreement package 1 in above agreement is selected. |
| **RAN1 #106-bis-e Meeting****Agreement****Confirm the four working assumptions(extracted from package 1)**Working assumption(extracted from package 1):Beh 1: PDCCH skipping is not activatedWorking assumption(extracted from package 1):Indication of Beh 1A for current SSSG when two SSSG(s) are configured is supportedWorking assumption(extracted from package 1):At most 3 SSSGs is supported to be configured for PDCCH monitoring adaptation.Working assumption(extracted from package 1):Beh 2B: stop monitoring SS sets associated with SSSG#0 and SSSG#1 and monitoring of SS sets associated to SSSG#2.**Agreement** Scheduling DCIs indicating timer value for a SSSG is not supported.**Agreement**For Beh 1A,* + The UE can be configured to be indicated by DCI a value of X ~~slots~~ (i.e., skipping duration) among multipleRRC configured values by scheduling DCIs indicating PDCCH schedules data
		- The bits for indicating PDCCH monitoring adaptation also indicating skipping duration. Details FFS

**Agreement**The bit mapping of DCI indication PDCCH monitoring adaptation is as follows,* For Case 1 (i.e., PDCCH skipping), the following is supported
	+ 1-bit in scheduling DCI is supported to indicate PDCCH monitoring adaptation UE behaviors if *M*=1
		- ‘0’ is Beh 1 and ‘1’ is Beh 1A
	+ 2-bit in scheduling DCI is supported to indicate PDCCH monitoring adaptation UE behaviors if *M*=2 or 3
		- ‘00’ is Beh 1
		- ‘01’ is Beh 1A with skipping duration 1
		- ‘10’ is Beh 1A with skipping duration 2
		- ‘11’ is Beh 1A with skipping duration 3 if M=3, reserved if M=2
* For Case 2  (i.e., 2 SSSG switching) , the following is supported
	+ 1-bit in scheduling DCI is supported to indicate PDCCH monitoring adaptation UE behaviors
		- ‘0’ is Beh 2 and ‘1’ is Beh 2A
* For Case 3 (i.e., 3 SSSG switching) , the following is supported
	+ 2-bit in scheduling DCI is supported to indicate PDCCH monitoring adaptation UE behaviors
		- ‘00’ is Beh 2
		- ‘01’ is Beh 2A
		- ‘10’ is Beh 2B
		- [‘11’ is reserved]
* For Case 4 (i.e., 2 SSSG switching with PDCCH skipping) , the following is supported
	+ 2-bit in scheduling DCI is supported to indicate PDCCH monitoring adaptation UE behaviors,
		- FFS details bit mapping
* FFS: For Case 5 (i.e., 3 SSSG switching and skipping)
	+ 2-bit in scheduling DCI is supported to indicate PDCCH monitoring adaptation UE behaviors
		- ‘00’ is Beh 2
		- ‘01’ is Beh 2A
		- ‘10’ is Beh 2B
		- ‘11’ is Beh 1A
	+ FFS Timer behavior when Beh 1A is indicated
* Note: The UE can be configured to be indicated by DCI a value of X ~~slots~~ (i.e., skipping duration) among *M* RRC configured values by scheduling DCIs indicating PDCCH schedules data
* FFS whether to restrict Skipping duration to be shorter than SSSG initial timer value
* FFS whether the configuration is same or different for DCI format x\_1 and DCI format x\_2

**Agreement**-         The value of the SSSG switching timer in slots for SSSG#1 and/or SSSG#2 can be configured aso    {[1...20,40,60,80,100]} for 15 kHz SCS,o    {[1...40, 80,100,160,200]} for 30 kHz SCS,o    {[1...80, 160,200,320,400]} for 60kHz SCS,o    {[1...160,320,400,640,800]} for 120kHz SCS **Agreement**-         If the UE monitors PDCCH according to SSSG#1 and the timer expires, the UE starts monitoring PDCCH according to Beh 2.~~-~~If the UE monitors PDCCH according to SSSG#2 and the timer expires,o    Alt 1: the UE monitoring PDCCH according to Beh 2o    Other alternatives are not precluded-         Timer can be optionally configured. **Agreement****Select one of the alternatives from the following:**-         Alt 1: Separate RRC configuration for timer value(s) is supported for switching from SSSG#2 to SSSG#0 and from SSSG#1 to SSSG#0 respectively.-         Alt 2: the timer value(s) for switching from SSSG#2 to SSSG#0 and from SSSG#1 to SSSG#0 is common and configured per cell.-         Alt 3: the timer value(s) for switching from SSSG#2 to SSSG#0 and from SSSG#1 to SSSG#0 is common and configured per BWP. **Agreement**The following application delay for a scheduling DCI based PDCCH monitoring adaptation indication can be considered,-         For PDCCH skipping,o    Option bo    Option fo    Option d for downlink grant and Option c for uplink granto    Option io    Option jo    Note: down-select based on the options in RAN1#107-E-         For SSSG switching,o    Option ao    Option d for downlink grant  and Option c for uplink granto    Option ho    Option bo    Option d for downlink grant and Option g for uplink granto    Note: down-select based on the options in RAN1#107-E-         The Options a – j is defined as follows,o    Option a: the application timelines provided in Table 10.4-1 in TS38.213 for search-space group switching for unlicensed band form is reused.       for SCS configuration , FFS X = 25 or 39      FFS: o    Option b:  the application delay needed for PDCCH processing for Rel-16 minimum application delay for K0min/K2min indication is reused/extended.o    Option c: PDCCH monitoring adaptation command applies after PUSCH transmission if triggered by UL DCIo    Option d: PDCCH monitoring adaptation command applies after HARQ-ACK transmission (or plus some margin for HARQ-ACK decoding).o    Option e: after successfully decoding TB.o    Option f:  Application delay should be “ZERO”  for PDCCH monitoring adaptation. PDCCH monitoring adaptation would be applied after UE receive the additional PDCCH monitoring adaptation control signaling bit(s) in DCIo    Option g:  Application delay(s) are configured via RRC signalingo    Option h:  Application delay applies after drx-RetransmissionTimerUL expireso    Option i: Leave up to implementationo    Option j: UE applies the skipping immediately (e.g. next symbol/slot) after the UE receives the indication in DL assignment. If the UE fails to decode the associated PDSCH and transmits a NACK, skipping is canceled in the slots after the NACK transmission. Option g ( application delay configured via RRC signaling) is used for uplink grant. If RRC signaling is not provided, UE applies the skipping immediately (e.g. next symbol/slot) after the UE receives the indication in UL grant.o    Other options not precluded.-         FFS reference points for the application delay,-         FFS whether the same or different and how application delay for PDCCH monitoring adaptation indicated by DCI and timer expiration-         FFS non-scheduling DCI if supported |
| **RAN1 #107-e Meeting**AgreementThe following agreement in RAN1#106-E is updated as follows,Agreement(extracted from RAN1#106-E)* At most 2 bit indication in self-scheduling DCIs (i.e., DCI format 1-1/0-1/1-2/0-2) can be specified for triggering the PDCCH monitoring adaptation in a single cell
	+ FFS: the bit size of the indication is configurable
	+ FFS: bit mapping to the PDCCH monitoring behaviour
	+ FFS: details of indication of multiple cells case
	+ A new indication field in scheduling DCI is used for indicating PDCCH monitoring adaptation

AgreementConfirm the working assumptions with the following updates (extract from RAN1#106-bis agreements)* The value of the timer in slots for monitoring PDCCH in the active DL BWP of the serving cell before moving to the default search space group is
* {1,2,3,…,20,30, 40, 50, 60, 80, 100} for 15 kHz SCS,
* {1,2,3,…,40, 60, 80, 100, 100,160,200} for 30 kHz SCS,
* {1,2,3,…,80, 120, 160, 200, 240, 320,400} for 60kHz SCS,
* {1,2,3,…,160, 240, 320,400, 480, 640,800} for 120kHz SCS

Agreement* For Case 4 (i.e., 2 SSSG switching with PDCCH skipping) , one of the following is supported
	+ Alt a: 2-bit in scheduling DCI is supported to indicate PDCCH monitoring adaptation UE behaviors
		- If *M* = 1, then
			* ‘00’ is Beh 2
			* ‘01’ is Beh 2A
			* ‘10’ is Beh 1A ~~(stay in current SSSG)~~
			* ~~[~~‘11’ is reserved~~]~~
		- If *M* = 2, then
			* ‘00’ is Beh 2
			* ‘01’ is Beh 2A
			* ‘10’ is Beh 1A for duration T1  ~~(stay in current SSSG)~~
			* ‘11’ is Beh 1A for duration T2 ~~(stay in current SSSG)~~
* Note: for ‘00’ and ‘01’, UE performs Beh 1(i.e., does not perform PDCCH skipping )
* Note: By a single DCI indication, a UE is not expected to simultaneously perform two behaviors of SSSG switching and PDCCH skipping.
* FFS SSSG switching timer behavior, and timer value related to the value of T1/T2

AgreementIf a UE is provided with a timer value by *searchSpaceSwitchTimer-r17* for PDCCH monitoring on a serving cell and the timer is running, the UE-            resets the timer after a slot of the active DL BWP of the serving cell when the UE detects a DCI format in a PDCCH reception in the sloto    Alt 2a: for the Type3-PDCCH CSS set or the USS set with group index of either 1 or 2o    Alt 2b: for the Type3-PDCCH CSS set or the USS seto    Alt 2c: with CRC scrambled by C-RNTI/CS-RNTI/MCS-C-RNTI-            otherwise, decrease the timer value by one after each slot.-            FFS: When the timer expires in a slotAgreement-            For value X in Beh 1A, candidate skipping values areo    Up to [100ms] length is supported,o    The X is configured and indicated in the unit of slot.o    Working assumption for candidate values for Xo    {1,2,3,…,20,30, 40, 50, 60, 80, 100} for 15 kHz SCS,o    {1,2,3,…,40, 60, 80, 100, 120,160,200} for 30 kHz SCS,o    {1,2,3,…,80, 120, 160, 200, 240, 320,400} for 60kHz SCS,o    {1,2,3,…,160, 240, 320,400, 480, 640,800} for 120kHz SCSo    FFS: Equal to or longer than the applicable minimum scheduling offseto    FFS: additional  symbol level / PDCCH monitoring period level skipping duration |
| **RAN1 #107-bis-e Meeting**AgreementRemove the bracket from following agreement made in RAN1#106bis-EAgreement (extracted from RAN1#106bis-E)* For Case 3 (i.e., 3 SSSG switching) , the following is supported
	+ 2-bit in scheduling DCI is supported to indicate PDCCH monitoring adaptation UE behaviors
		- ‘00’ is Beh 2
		- ‘01’ is Beh 2A
		- ‘10’ is Beh 2B
		- ‘11’ is reserved

AgreementConfirm the following working assumption (extracted from RAN1#107-bis agreements)Agreement* For value X in Beh 1A, candidate skipping values are
	+ Up to [100ms] length is supported,
		- The X is configured and indicated in the unit of slot.
			* Working assumption for candidate values for X
				+ {1,2,3,…,20,30, 40, 50, 60, 80, 100} for 15 kHz SCS,
				+ {1,2,3,…,40, 60, 80, 100, 120,160,200} for 30 kHz SCS,
				+ {1,2,3,…,80, 120, 160, 200, 240, 320,400} for 60kHz SCS,
				+ {1,2,3,…,160, 240, 320,400, 480, 640,800} for 120kHz SCS
	+ FFS: Equal to or longer than the applicable minimum scheduling offset
	+ FFS: additional symbol level / PDCCH monitoring period level skipping duration

Agreement* The initial timer value for switching from SSSG#2 to SSSG#0 and from SSSG#1 to SSSG#0 is common and configured per BWP.
* The *PDCCHSkippingDurationList-r17* is configured per BWP.

Working Assumption* The bit length of the candidate skipping values and SSSG switching initial timer values in slots for 480kHz and 960kHz SCS are assumed to be the same as that for 120KHz SCS

AgreementPDCCH monitoring adaptation is only applied to the individual scheduling cell (including self-scheduling and cross-carrier scheduling)  ConclusionFor Rel-17 PDCCH monitoring adaptation, the case where single DCI indicates monitoring adaptation for multiple cells is not supported.AgreementFor PDCCH monitoring adaptation case 1, support at most M = 3 for PDCCH skipping with 2 bits indication.AgreementThe configuration of PDCCH monitoring adaptation is common for DCI format x-1 and x-2*,* neither Alt 1 nor Alt 2 is agreed,* Alt 1: Support RRC parameter configured for the PDCCH monitoring adaptation indication field presence/absence in DCI format x-2.
* Alt 2:  The configuration of PDCCH monitoring adaptation is common for DCI format x-1 and x-2, except skipping duration for DCI format x-2 (i.e., *PDCCHSkippingDurationList-r17-x-2* for DCI format x-2). The PDCCH monitoring adaptation indication field for DCI format x-2 is dependent on *PDCCHSkippingDurationList-r17-x-2* if configured.

ConclusionNo consensus to introduce non-scheduling DCI based PDCCH monitoring adaptation for Rel-17. |
| **RAN1 #108 -e Meeting**Agreement-             The 480kHz and 960kHz SCS are also supported for Rel-17 PDCCH monitoring adaptation.Agreement* It is up to B52.6GHz to deicide the values for candidate skipping values and SSSG switching initial timer values.

Agreement**Answer 1 for** [**R1-2200884**](file:///C%3A%5C3gpp%5CMeetings%5CTSGR1%5CTSGR1_108-e%5CDocs%5CR1-2200884.zip) **(R2-2201960):**Yes, PDCCH skipping can be applied to C-RNTI(s) and MCS-C-RNTI(s) in at least Type3 PDCCH CSS and USS monitored during RAR/MsgB window for RAR/MsgB reception based on RAN1 agreements till RAN1#107bis-e. Agreement**Answer 2 for** [**R1-2200884**](file:///C%3A%5C3gpp%5CMeetings%5CTSGR1%5CTSGR1_108-e%5CDocs%5CR1-2200884.zip) **(R2-2201960):**RAN1 would discuss and conclude how to capture the above RAN2 agreements in RAN1 specification.o    It is RAN1 understanding PDCCH skipping  is not applied to perform PDCCH monitoring during RAR window/MsgB window/contention resolution timer or when SR is pending.* FFS: If the UE is ~~indicated~~ skipping PDCCH monitoring for a duration and at the first slot after the last OFDM symbol of a positive SR transmission in PUCCH, the UE ~~can~~ stops PDCCH skipping ~~and monitor PDCCH for UL grant~~(i.e., PDCCH skipping is not activated ).

AgreementAnswer 4 for [R1-2200884](file:///C%3A%5C3gpp%5CMeetings%5CTSGR1%5CTSGR1_108-e%5CDocs%5CR1-2200884.zip) (R2-2201960):        It is RAN1’s understanding that transmission of CSI/SRS is not affected by PDCCH skipping i.e. CSI/SRS is still transmitted during the skipping duration.Agreement         It is RAN1 understanding that for DRX operation, * + As DCP is monitored only outside active time, it cannot be missed due to PDCCH skipping as skipping applies only in active time.

Note: RAN1 is discussing whether PDCCH skipping duration can apply to outside active time.Agreement[Draft] LS reply on PDCCH skipping, R1-2202896 is endorsed in principle.AgreementFinal LS reply on PDCCH skipping, R1-2202905 is endorsedAgreementFor DCI format 0\_1, DCI format 0\_2, DCI format 1\_1 and DCI format 1\_2,     * 1 or 2 bits, if *PDCCHSkippingDurationList* is not configured and if *searchSpaceGroupIdList-r17* is configured

-     1 bit if the UE is configured by *searchSpaceGroupIdList-r17* with search space set(s) with group index 0 and search space set(s) with group index 1, and if the UE is not configured by *searchSpaceGroupIdList-r17* with any search space set with group index 2;-     2 bits if the UE is configured by *searchSpaceGroupIdList-r17* with search space set(s) with group index 0, search space set(s) with group index 1 and search space set(s) with group index 2;Note: Same as in existing specifications, specifications allow gNB to configure a search-space set with zero PDCCH candidates. AgreementIf a UE is provided group indexes for a Type3-PDCCH CSS set or a USS set by *searchSpaceGroupIdList-r17* and a timer value by *searchSpaceSwitchTimer-r17* for PDCCH monitoring on a serving cell and the timer is running, the UE* Resets the timer after a slot of the active DL BWP of the serving cell when the UE detects a DCI format in a PDCCH reception in the slot with CRC scrambled by
* Working Assumption: C-RNTI/CS-RNTI/MCS-C-RNTI
* Otherwise, decrease the timer value by one after each slot.
* Note: There is no timer for SSSG switching is running for UE in SSSG#0

 Working Assumption* Upon detecting a scheduling DCI format 1-1/1-2/0-1/0-2 indicating SSSG switching (i.e., Beh 2/2A/2B),
	+ the UE applies SSSG switching on an active BWP of the serving cell at a first slot that is at least *Pswitch* symbols after the last symbol of the PDCCH reception
		- FFS: a minimum applicable scheduling offset is configured in the BWP
	+ Note: *Pswitch* is defined in Table 10.4-1 in TS38.213

 Agreement* Upon detecting a scheduling DCI format 1-1/1-2/0-1/0-2 indicating PDCCH skipping (i.e., Beh 1A), select one of the following schemes
	+ **Alt 1a:** the UE applies Beh 1A on an active BWP of the serving cell at the first slot after the last OFDM symbol of the PDCCH reception
		- FFS: a minimum applicable scheduling offset is configured in the BWP
		- FFS: whether the UE will monitor PDCCH when DRX Retransmission timer is running

Agreement-     When the timer expires, the UE monitors PDCCH on the serving cell according to search space sets with group index 0 in a slot * + no earlier than [application delay] after the slot where timer expires and
	+ if PDCCH skipping is being applied, no earlier than in slot where PDCCH skipping duration expires.

Working assumptions:* When the UE receives DCI format 0\_1 /1\_1/0\_2/1\_2 with a ‘PDCCH monitoring adaptation indication' field in slot *n*, the UE does not expect to receive DCI format  0\_1 /1\_1/0\_2/1\_2 with a ‘PDCCH monitoring adaptation indication’ field indicating change to another SSSG or skipping for the same active BWP of the scheduling cell before slot *n+X* of the scheduling cell, where *X* is the value of the application delay.
* If SSSG timer expires in slot n, the UE does not expect to receive DCI format  0\_1 /1\_1/0\_2/1\_2 with a ‘PDCCH monitoring adaptation indication’ field indicating change to another SSSG or skipping for the same active BWP of the scheduling cell before slot n+X of the scheduling cell, where *X* is the value of the application delay.
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# Reference

1. RP-201701, “Status report for WI UE Power Saving Enhancements for NR”, Rapporteur (MediaTek), RAN #89-e meeting
2. RP-202685, “Status report for WI UE Power Saving Enhancements for NR”, Rapporteur (MediaTek), RAN #90-e meeting
3. RP-210733, “Status report for WI UE Power Saving Enhancements for NR”, Rapporteur (MediaTek), RAN #91-e meeting
4. RP-211452, “Status report for WI UE Power Saving Enhancements for NR”, Rapporteur (MediaTek), RAN #92-e meeting
5. RP-212612, “Status report for WI UE Power Saving Enhancements for NR”, Rapporteur (MediaTek), RAN #93-e meeting
6. RP-213348, “Status report for WI UE Power Saving Enhancements for NR”, Rapporteur (MediaTek), RAN #94-e meeting
7. R1-2110575, “LS on Re-17 LTE and NR higher-layers parameter list”, RAN1, Ericsson,
RAN1#106-bis-e meeting
8. R1-2112977, “LS on updated Rel-17 LTE and NR higher-layers parameter list”, RAN1, Ericsson,
RAN1#107-e meeting
9. R1-2200700, “LS on updated Rel-17 NR higher-layers parameter list”, RAN1, Ericsson,
RAN1#107-bis-e meeting
10. R1-2202542, “LS on updated Rel-17 LTE and NR higher-layers parameter list”, RAN1, Ericsson,
RAN1#108-e meeting