**3GPP TSG RAN WG1 #106-e**  **R1-21XXXX**

**e-Meeting, Oct 11th – 19th, 2021**

**Agenda Item:** 8.7.1.2

**Source:** Moderator (Samsung)

**Title:**  First Round Discussion for TRS/CSI-RS occasion(s) for idle/inactive UEs

**Document for:** Discussion/Decision

# Introduction

This document provides moderator summary of contributions [1-24] submitted to agenda item 8.7.1.2 for RAN1#1-6bis-e meeting. The remaining issues for supporting TRS/CSI-RS occasion(s) for idle/inactive UEs can be divided into three parts as summarized in Section 2 to 4, including:

* Availability indication
	+ 2.1: L1 based signaling methods
	+ 2.2: Indication content for L1 based availability indication
	+ 2.3: Valid duration for L1 based availability indication
	+ 2.4: SIB based availability indication
* Higher layer configurations
	+ 3.1: Configuration structure
	+ 3.2: Other configuration parameter
	+ 3.3: Configuration overhead reduction
* Others
	+ 4.1: Impact to existing physical layer signals/channels

Per chairman’s instruction, this document will be used for the following discussion:

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| --- |
| [106bis-e-NR-R17-PowSav-02] Email discussion regarding TRS/CSI-RS occasions for idle/inactive UEs – Qiongjie (Samsung)* 1st check point: October 14
* Final check point: October 19
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For the first round discussion, companies are invited to provide views for possible proposals or questions tagged ‘**[1RD]**’ before 10/12 UTC 06:00**.**

The issues in this document are color coded with High Priority or Medium Priority.

# Availability Indication

## 2.1 L1 based signaling methods

In RAN1#105-e meeting, the following working assumption was made to support both paging DCI and PDCCH based PEI based signaling for availability indication of TRS/CSI-RS occasion(s) to idle/inactive UEs.

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| --- |
| **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
 |

In contributions [1-24], proposals related to L1 based signalling methods are summarized in table below:

|  |  |
| --- | --- |
| Huawei, HiSilicon | **Proposal 1: Confirm the whole working assumption, i.e.**** 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.****o FFS how to enable/disable L1 based availability indication configurable by SIB****Proposal 11: The L1 based availability indication for a TRS resource is enabled/disabled implicitly by the presence/absence of the configuration of the TRS resource in SIB.** |
| TCL  | **Observation 1: Using PEI based availability indication of TRS/CSI-RS occasion to the idle/inactive UE is more beneficial in terms of power saving when a UE or a group of UEs are paging in non- contiguous way in successive POs.****Observation 2: Using paging PDCCH based availability indication of TRS/CSI-RS occasion is more beneficial in terms of power saving perspective when a UE or a group of UEs is paging in contiguous way in successive POs.****Proposal 1: Confirm the following 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.** |
| ZTE, Sanechips | **Proposal 1: Confirm the following 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.** |
| Spreadtrum | **Proposal 1: Confirm the working assumption that “Support paging PDCCH based availability indication of TRS/CSI-RS occasions for idle/inactive UEs”.****Proposal 2: Confirm the working assumption that “Support PEI based availability indication of TRS/CSI-RS occasions for idle/inactive UEs”.** |
| Vivo | **Proposal 4: Mechanisms for L1 indication in PEI PDCCH should reuse the same logic as that for paging PDCCH to avoid duplicated work.** |
| OPPO | **Proposal 5: Implicit method to enable/disable L1 based availability indication shall be supported.****- Presence of the configuration of TRS/CSI-RS occasions or the grouping of TRS/CSI-RS occasions can implicitly indicate that L1 based availability indication is enabled** |
| CATT | **Proposal 8: Paging DCI based availability indication should be supported at least for the case when PEI is not configured.****Observation 5: PEI based availability indication has a negligible UE power saving gain over that of paging DCI.****Proposal 10: An 1-bit explicit indication of enable/disable L1 signaling for TRS/CSI-RS availability indication can be configured together with TRS/CSI-RS resource configuration in SIB-X.**  |
| CMCC | **Proposal 1. Support both paging PDCCH based and PEI based availability indication of TRS/CSI-RS occasions for idle/inactive UEs.****• If PEI is configured by SIB, the availability indication is carried in PEI, else, the availability indication is carried in paging PDCCH.****Proposal 2. Don’t allow indicating the availability of TRS/CSI-RS only in paging PDCCH without short message and/or scheduling information.** |
| Samsung | **Observation 1: The performance of PEI based signalling and paging PDCCH based signalling is small if gNB doesn’t expect to transmit the availability indication frequently.** **Observation 2: The detection reliability of PDCCH based PEI will be degraded due to increased payload size if the PDCCH based PEI is used for providing availability indication of TRS/CSI-RS occasions for idle/inactive UEs.** **Observation 3: Similar as SI modification or ETWS notification, availability indication of TRS/CSI-RS occasions is another type of cell-specific information monitored by idle/inactive UEs. Same L1 based singling method should be considered to keep the consistent UE implementation with low complexity.****Proposal 1: Confirm the WA to support paging PDCCH based availability indication of TRS/CSI-RS occasions for idle/inactive UEs.****Proposal 2: Do not confirm WA to support PEI based availability indication of TRS/CSI-RS occasions for idle/inactive UEs.** |
| MediaTek | **Observation 1: In RAN #93-e, PDCCH-based PEI was agreed. To facilitate the progress, it also agreed that the same mechanism/principle for TRS availability indication for both paging PDCCH and PDCCH-based PEI is adopted. Therefore, there is no need to prioritize the discussion of paging PDCCH-based signalling. The working assumption in RAN1 #105-e should be confirmed as a whole package.****Proposal 1: Confirm the following working assumption for TRS/CSI-RS availability information:****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** |
| Intel | **Proposal 1: Prioritize paging PDCCH based availability indication signaling design.****Observation 1: TRS availability indication is not an essentially functionality of the PEI.****Proposal 6: Similar design mechanism/principle for PEI (if agreed) and paging DCIs for TRS availability indication includes adopting a similar applicable validity duration, reference starting point, bitmap/codepoint mapping to TRS resources/resource sets etc.** |
| DOCOMO | **Proposal 2: Only paging DCI and/or paging early indication should be adopted to indicate the availability of TRS/CSI-RS for idle/inactive mode UE.** |
| Sony | **Observation 1: The usage of TRS/CSI-RS for idle/inactive UEs and paging enhancements are two different features in rel-17. Depending on the progress of the WI, each of the features can be a mandatory or optional feature.****Proposal 1: Confirm the working assumption on supporting paging PDCCH based availability indication of TRS/CSI-RS occasions for idle/inactive UEs.****Proposal 2: The availability indication can be explicitly informed using one or more of the reserved bits in paging DCI.** |
| Panasonic | **Proposal 1: Confirm the working assumption to support both PEI and paging based signaling for TRS/CSI-RS availability indication.** |
| InterDigital | **Proposal 1: Confirm the following working assumption:****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** |
| LG | **Observation 1: Both paging DCI and PEI can afford the information on availability indication of TRS/CSI-RS at the configured occasion(s) to the idle/inactive UEs.****Observation 2: The availability indication over PEI is beneficial from UE power saving and NW overhead perspective when PEI is supported.****Observation 3: If the availability indication over PEI is not supported,** **o UE that monitors a PEI consumes the power due to the PO monitoring when PEI is transmitted** **o NW overhead will be increased if gNB transmit PEI even if there is no paging message****Proposal 1: Confirm the working assumption regarding L1 based availability indication.** **o Support paging PDCCH based availability indication of TRS/CSI-RS occasions for idle/inactive UEs.****o Support PEI based availability indication of TRS/CSI-RS occasions for idle/inactive UEs at least if PDCCH-based PEI is down-selected.****• FFS how to enable/disable L1 based availability indication configurable by SIB.** |
| Qualcomm | **Proposal 1: For Rel-17 L1 TRS availability indication signaling design**** Support paging PDCCH based TRS availability indication**** If PEI based TRS availability indication is agreed, it should assume there are UEs not supporting PEI****o Note: The design that only uses paging PDCCH based TRS availability indication when PEI is not configured does not work for UEs that do not support PEI****Observation 1: Based on the RAN #93 conclusion on Rel-17 power saving enhancements, if TRS availability indication is agreed to be supported in both paging DCI and the DCI format for PEI**** No joint indication based on the two DCI formats is supported**** TRS resource granularity (i.e., one bit per resource, per set of resources, per group of resource sets etc.) should be the same for the two DCI formats**** Number of information bits used for TRS availability indication should be the same for the two DCI formats.****Observation 2: Allowing PEI and paging PDCCH to carry different availability information (i.e., bitmap values) forces the UE that supports PEI to also decode the paging PDCCH.****Proposal 2: PEI and paging PDCCH carry the same availability information (i.e., bitmap values) before the TRS availability indication in both signaling take effect. The two DCI formats should take effect at the same time.****Observation 3: The method that L1 based availability indication of TRS/CSI-RS occasions for idle/inactive UEs can be enable/disabled based on presence/absence of the configuration of TRS/CSI-RS occasions implies that L1 based availability indication is always enabled for configured TRS occasions.****Proposal 3: If RAN1 discusses whether and how the enabling/disabling of L1 TRS availability mechanism is supported, it should be discussed under the condition that some TRS occasions are configured by SIB. When L1 availability indication is disabled**** If SIB based availability indication is supported, whether TRS is present at the configured occasions is indicated by SIB**** If SIB based availability indication is not supported, UE assumes a configured TRS is present.** |
| Nokia | **Observation: Monitoring PEI is not mandatory to the UE, and UE could choose to monitor paging DCI directly instead, thus if L1 availabilty indication is configured, it should be provided in both PEI and in paging DCI.****Proposal: Confirm the working assumption:** **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** |

According to the above proposals, there are two remaining issues related to L1 based signalling methods for availability indication of TRS/CSI-RS occasion(s) to idle/inactive UEs:

* Issue 1-1: WA to support paging PDCCH based and PEI based availability indication
* Issue 1-2: FFS how to enable/disable L1 based availability indication configurable by SIB

### 2.1.1 <1st round discussion>

**Issue 1-1: WA to support paging PDCCH based and PEI based availability indication**

Companies’ views are summarized in table below.

|  |  |  |
| --- | --- | --- |
|  | **Descriptions** | **Support by** |
| Alt-1 | Confirm the entire working assumption to support both PEI and paging based signaling | Huawei, HiSilicon, TCL, ZTE, Sanechips, Spreadtrum, CMCC, MediaTek, DOCOMO, Panasonic, InterDigital, LG, Nokia (13) |
| Alt-2 | Confirm only paging PDCCH based availability indication.  | CATT, Samsung, Sony (3) |
| Alt-3 | Same design mechanism/principle for paging PDCCH based availability indication if both supported* To reduce duplicated work
 | Vivo, Intel, Qualcomm, Nokia, (4) |

For Alt1, 13 companies support to confirm the entire WA.

For Alt2, 3 companies support to confirm only paging PDCCH based indication due to the following concerns:

* + PEI based availability indication has a negligible UE power saving gain over that of paging DCI,
	+ The detection reliability of PDCCH based PEI will be degraded due to increased payload size if the PDCCH based PEI is used for providing availability indication of TRS/CSI-RS occasions for idle/inactive UEs;
	+ Same L1 based singling method should be considered for SI modification or ETWS notification, and availability of TRS/CSI-RS occasions

For Alt3, 4 companies proposed same design mechanism/principle or restrictions to support both paging PDCCH based and PEI based availability indication, including

* 1) Availability indication should be carried in both paging PDCCH and PEI if configured in case some UEs not supporting PEI.
	+ If PEI based TRS availability indication is agreed, it should assume there are UEs not supporting PEI [QC].
	+ Monitoring PEI is not mandatory to the UE, and UE could choose to monitor paging DCI directly instead, thus if L1 availability indication is configured, it should be provided in both PEI and in paging DCI [Nokia].
* 2) bitmap/codepoint mapping to TRS resources/resource sets etc [Intel, QC]
* 3) validity duration, reference starting point [Intel, QC]
	+ The two DCI formats should take effect at the same time [QC].

Similar as in last meeting, there are some objections to confirm the entire WA. For the sake of progress, we can discuss the common design principle and clarify specification efforts to support both of them as WA. The following proposal is drafted based on companies’ views about Alt-3.

|  |
| --- |
| **[1RD] Proposal 1-1 (v0)**If both paging PDCCH based and PEI based are supported as L1 based signaling methods for the availability indication of TRS/CSI-RS occasions for idle/inactive UEs:* support the same design mechanism/principle for the two L1 based signaling methods, including
	+ same DCI field design, i.e. bitmap/codepoint mapping to TRS resources/resource sets
	+ same valid time duration, including reference point and the time duration.
	+ enable/disable at the same time based on the same method (if supported)
* if L1 availability indication is enabled, it should be provided in both PEI (if configured) and in paging DCI
	+ Note: assume there are UEs not supporting PEI
 |

Please provide your views about **Proposal 1-1(v0).** Y or N? Any suggestions or modifications?

|  |  |  |
| --- | --- | --- |
| **Company** | **Support** **(Y/N)** | **Comments**  |
| OPPO | Y | Fine with the proposal |
| Nordic  | Y, but  | We believe that mapping to bitmap codepoints could be different in Pei and Paging DCI, similarly as dormancy can be configured differently outside and inside active time. |
| Qualcomm | Y | In addition to the proposal, values of the indication fields in the two PDCCH should be the same. For example, a UE is paged in the PEI will further paging PDCCH. Then the UE will read the TRS indication from both DCI formats. In this case, the bitmap/codepoint has to be identical in the two DCI formats. |
| Sharp | Y |  |
| LG |  | We would like to suggest following modifications: * For the 1st sub-bullet in the 1st bullet, we are fine with the intention of the “same DCI field design” but would like to clarify that the number of bits for the DCI filed can be differently configured.
* For the 2nd sub-bullet in the 1st bullet, we have not discussed enough yet for the valid duration and its reference point. So we think it is it is too early to make decision. (at least issues in the section 2.3 shall be discussed first)
* For the 3rd sub-bullet in the 1st bullet, this bullet seems not necessary if disabling signaling is not supported.
* For the 2nd bullet, although we are not sure we need such a restriction or not, but we are ok with following majority view.

**[1RD] Proposal 1-1 (v0) - LG**If both paging PDCCH based and PEI based are supported as L1 based signaling methods for the availability indication of TRS/CSI-RS occasions for idle/inactive UEs:* support the same design mechanism/principle for the two L1 based signaling methods, including
	+ same DCI field design, i.e. bitmap/codepoint mapping to TRS resources/resource sets
		- the size of the DCI field can be different
	+ ~~same valid time duration, including reference point and the time duration.~~
	+ ~~enable/disable at the same time based on the same method (if supported)~~
* if L1 availability indication is enabled, it should be provided in both PEI (if configured) and in paging DCI

Note: assume there are UEs not supporting PEI |
| ZTE, Sanechips | Yes with the main bullet and the first sub-bullet | We also agree that we need to move forward. We are okay with the main bullet and first sub-bullet. Our comments on the other bullets are as below:(1)As to the following sub-bullet, does it imply the indication content of these two L1 signaling should be the same, or does it just restrict the definition of the valid time duration (if it is supported)?* + same valid time duration, including reference point and the time duration.

(2) According to our understanding, it seems the last two bullets require NW to configure these two L1 based signaling at the same time. We think this kind of restriction is not needed. NW needs the flexibility to separate configure either of them, or both. We suggest to update as below.* + enable/disable at the same time based on the same method (if supported)
		- The enabler/disabler can be different
* ~~if L1 availability indication is enabled, it should be provided in both PEI (if configured) and in paging DCI~~
 |
| Xiaomi | YBut not quite support the second bullet | For the second bullet “if L1 availability indication is enabled, it should be provided in both PEI (if configured) and in paging DCI”. we think it is more flexible to let gNB configure separately whether TRS indication in present in PEI or paging DCI. and from our opinion, if TRS indication is in paging DCI, there seems no need for TRS indication in PEI, since no matter how UE has to monitor paging DCI. Anyway, it is up to gNB configuration,and gNB should be able to configure them separately |
| CATT | Yes | We are generally OK with the principle to have same design of bits for PEI and paging DCI. However, the configuration of TRS availability in either PEI or paging DCI should be included in SIB. We have strong concern if TRS availability is configured on both PEI and paging DCI.  |
| Samsung | Y | In general, we don’t support PEI based availability indication due to the limited gain and impact to PEI detection performance. We can make compromise only if there are no additional spec efforts to support it in addition to paging PDCCH.  |

**Issue 1-2: FFS how to enable/disable L1 based availability indication configurable by SIB**

Three alternatives were proposed for enabling/disabling L1 based availability indication.

|  |  |  |
| --- | --- | --- |
|  | **Alternatives** | **Support by** |
| Alt-1 | enabled/disabled implicitly by the presence/absence of the configuration of the TRS resource in SIB. | Huawei, HiSilicon, OPPO |
| Alt-2 | 1-bit explicit indication of enable/disable L1 signaling for TRS/CSI-RS availability indication can be configured together with TRS/CSI-RS resource configuration in SIB-X.  | CATT |
| Alt-3 | If SIB based availability indication is supported, whether TRS is present at the configured occasions is indicated by SIBIf SIB based availability indication is not supported, UE assumes a configured TRS is present. | Qualcomm |

The potential solution for this issue also depends on whether or not SIB-based availability indication is supported. So, the following proposal is drafted with the intention to discuss the solutions for the two cases separately.

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| --- |
| **[1RD] Proposal 1-2 (v0)**If SIB based availability indication is not supported, support enable/disable L1 based availability indication based on presence/absence of the configuration of TRS/CSI-RS occasions. If SIB based availability indication is supported, support enable/disable L1 based availability indication based on one of the following alternatives:* Alt1: 1-bit explicit indication of enable/disable L1 signaling for TRS/CSI-RS availability indication configured together with TRS/CSI-RS resource configuration in SIB-X.
* Other alternatives are not precluded
 |

Please provide your views about **Proposal 1-2(v0).** Y or N? Any suggestions or modifications?

|  |  |  |
| --- | --- | --- |
| **Company** | **Support** **(Y/N)** | **Comments**  |
| OPPO | Y |  |
| Nordic | N | No need to complicate design, support only L1 based availability indication |
| Qualcomm | Y | Do we need to consider the case that SIB based availability indication is not supported and L1 based availability indication is not configured? |
| ZTE, Sanechips |  | We think Proposal 1-2(v0) should be discussed together with Proposal 4 (v0), i.e., we think to first discuss whether SIB based solution is supported or not.In our understanding, if gNB would like to disable L1 based availability indication, it doesn’t need to configure the TRS/CSI-RS resource or can reconfigure the TRS occasion by SI update for RRC\_Idle/Inactive UE. There is no need to introduce an explicit indication in SIB for availability indication. |
| CATT | Y | We need to have enable/disable of L1 based signaling  |
| Samsung | Y |  |

## 2.2 Indication content for L1 based availability indication

The following agreements have been made regarding the indication content for L1 based availability indication:

|  |
| --- |
| From RAN1#105-e: 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

From RAN1#106-e: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. |

In contributions [1-24], proposals related to indication content for L1 based availability indication are summarized in table below:

|  |  |
| --- | --- |
| Huawei, HiSilicon | **Proposal 7: Bitmap is the baseline for availability indication, where each bit indicates a RS or a group of RS.****Proposal 8: Support Alt2 that L1 availability indication, including both paging DCI and PEI DCI, 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.****Proposal 9: Support to indicate the availability of assistance TRS occasion(s) per beam direction(s) by a bitmap, where each bit corresponds to the assistance TRS(s) that are QCLed with the same associated SSB index or the same set of SSB indexes.****Proposal 10: Support paging PDCCH/PEI to indicate part of the configured resources, which is confined in the validity window, to reduce L1 signaling overhead.** **- The association between the RS resources and paging PDCCH/PEI can be pre-determined by TRS occasion and paging configurations.** |
| TCL | **Proposal 2: Consider an indication cycle of N paging occasions, where an indication is transmitted in the first paging occasion to inform the availability of TRS/CSI-RS for N paging occasions.****Proposal 3: Availability of a set/group of multiple TRS/CSI-RS can be indicated in a paging cycle to the UE or group of UE for the next paging cycle, which may reduce the availability indication overhead of L1 signaling.** |
| ZTE, Sanechips | **Proposal 3: For the L1 availability indication, the following Alt 2is preferred.**** 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****Proposal 4: The number of bits of the bitmap for TRS availability indication is configurable.****Proposal 5: The TRS/CSI-RS occasion(s) for different beam direction should be further grouped to reduce the L1 signaling overhead.** |
| Spreadtrum | **Proposal 4: Availability/unavailability information using bitmap, where each bit is associated with at least one resource/configuration or a set/group of resources, should be supported.** |
| Vivo | **Proposal 1: L1 availability indication at an occasion can provide availability/unavailability information for RS resources with different QCL properties.****- Each L1 indication should provide availability/unavailability of all TRS resources configured with L1 availability indication.****Proposal 2: Availability/unavailability information is indicated using a bitmap, where each bit is associated with at least one TRS resource set based on SIB configuration.****Proposal 3: The availability/unavailability information can be indicated in the 6 reserved bits in paging DCI.** |
| OPPO | **Proposal 1: Availability/unavailability information is for all configured RS resources using a bitmap.****- each bit is associated with one resource or a set/group of resources****Proposal 6: 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.** |
| CATT | **Proposal 9: The availability indication should be one bit or one code point to indicate all TRS/CSI-RS resources within a cell. UE could not assume any TRS/CSI-RS resource if the availability indication is only indicated the selected TRS/CSI-RS resources within a cell.** |
| CMCC | **Proposal 5. Support 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.****Proposal 6. Support using a bitmap to indicate the availability/unavailability information for configured RS resources** |
| Xiaomi | **Proposal 2: 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) should be supported.****Proposal 6: Bitmap for RS resource sets configuration should be supported and no need to define the number of consecutive slots with applicable values of 1.** |
| Samsung | **Proposal 4: For availability indication provided by paging PDCCH, support availability/unavailability information for configured RS resources using a bitmap, where each bit is associated with at least a set/group of resources.****Observation 5: To support L1 based availability indication in beam-selective manner, UE has to decode all paging PDCCCH monitoring occasions in order to get the complete availability information for TRS resources in all beam directions.** |
| MediaTek | **Proposal 3: For L1-based TRS/CSI-RS availability indication, Alt 1 is supported for signalling overhead reduction.****• Alt1: L1 at an occasion provides availability/unavailability information only for RS resources with the same QCL reference as the L1 availability indication occasion.** |
| Intel | **Proposal 4: Support availability/unavailability information for configured RS resources using a bitmap****• Up to 6 bits in reserved bit field can be used in paging DCI for the indication.****Proposal 5: Regarding QCL reference and L1 indication, we propose the following:****• QCL information can be configured per RS resource set or per configuration****• Each RS resource set is configured to be QCLed with one SSB index, and a bit/codepoint in a L1 availability indication provides availability/unavailability information for a RS resource set.****• 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** |
| DOCOMO | **Observation 1: It would be beneficial that TRS/CSI-RS for idle/inactive mode UE is located in front of PO.****Observation 2: Depending on the availability indication method, the UE doesn’t necessarily have to be notified of the availability of all configured TRSs.****Proposal 3: TRS availability indication of DCI field for PEI and Paging DCI should be notified about some or all availabilities of all configured TRS resource(s).** |
| Sony | **Proposal 4: For the information provided by a physical layer availability indication of TRS/CSI-RS at the configured occasion(s) to the idle/inactive UEs, use a bitmap / codepoint to indicate availability/unavailability information for all or some of configured RS resources.****Proposal 5: 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** |
| Panasonic | **Proposal 1: Regarding association between TRS availability indication occasion and the QCLed TRS resource, Alt2 is adopted and the indication should not be limited by Alt1.****Proposal 2: The total number of TRS resources included in the L1 availability indication in each occasion should be limited by a maximum value. FFS on how a subset is decided in case the SIB configured TRS resource is more than the maximum value.****Proposal 3: Depending on the maximum number of TRS configurations supported by L1 availability indication, to decide whether to use bitmap or codepoint.** |
| Lenovo | **Proposal 4: For L1 based signalling for the availability indication of TRS/CSI-RS at the configured occasion(s),****• Support 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).****• PEI transmitted in a current DRX cycle can indicate TRS availability/unavailability information of configured TRS occasions within the current DRX cycle.****• Paging DCI of a current DRX cycle can include TRS availability information for a following DRX cycle.** |
| InterDigitial | **Proposal 3: Availability is indicated using a bitmap where each bit associated to a group of (including one) resources.****Proposal 4: 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.** |
| LG | **Proposal 2: Support Alt 2 for the paging DCI based TRS availability indication, and support Alt 1 for the PEI based TRS availability indication, where** **o 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****o 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** |
| Sharp | **Proposal 3: Support Alt1 to provide availability/unavailability indication for RS resources** |
| Apple | **Proposal 2: When the availability indication is carried in a DCI, it can be configured whether the DCI carries the availability information for all the TRS configurations or only the TRS configuration(s) that correspond to the same beam as the DCI.****Proposal 3: When the availability indication is carried in a DCI, a bitmap is used to carry the availability indication, with one bit per indicated TRS configuration.** |
| Ericsson | **Proposal 3 For L1-based TRS availability indication via Paging DCI, the bitfield within the paging DCI is explicitly configured using a start and length field (Details FFS) with maximum 6 bits in the DCI.****Proposal 4 For L1-based TRS availability indication via Paging DCI, a bitmap-based approach is used to indicate TRS availability of different resources/set of resources and/or for different validity timer values.** 1. **The number of resource sets per availability indication can be up to [64].**

**Proposal 5 For L1-based TRS availability indication via Paging DCI, support beam selective TRS availability indication, i.e., if UE detects Paging DCI in a beam X, the availability bitfield in the Paging DCI is associated to a group of beams corresponding to beam X.** **a. Grouping is configured via higher layers (Details FFS)** |
| Qualcomm | **Proposal 4: Use bitmap to indicate the availability of configured TRS resources in the DCI format for L1 TRS availability indication.****Proposal 5: If not all configured TRS resources can be indicated by the L1 availability indication signaling, network configures which resources are indicated by the L1 signaling. For the remaining TRS resources** ** If SIB based availability indication is supported, whether TRS is present at the configured occasions is indicated by SIB**** If SIB based availability indication is not supported, UE assumes the TRS is always present at the configured occasions****Observation 4: If a L1 availability indication at an occasion provides availability and unavailability information only for RS resources with the same QCL reference as the L1 availability indication occasion, the UE needs to first receive the TRS availability for beams not currently tracked before it can receive TRS resources on these beams for beam management and tracking loop update.****Proposal 6: Do not restrict L1 availability indication at an occasion to provide availability and unavailability information only for RS resources with the same QCL reference as the L1 availability indication occasion.** |
| Nordic | **Proposal-2: A gNB may configure X codepoints, up to [8], each codepoint indicating validity/invalidity for a subset of all configured iTRS resource sets.** **• DCI field is present in PEI PDCCH (if configured), otherwise in Paging DCI.** **• L1 availability indication at a monitoring occasion provides availability/unavailability information for RS resources, of the subset of iTRS resource set(s), having the same QCL reference as the monitoring occasion.** |
| Nokia | **Observation: For L1 availability indication in paging DCI, QCL source of the physical layer indication should not always restrict to which TRS resources/sets the availability indication applies.****Observation: For L1 availability indication in PEI, QCL source of the physical layer indication could be used to determine to which TRS resources/sets the availability indication applies.****Observation: Different methods to interpret the availability indication information could be considered for paging DCI and PEI.****Proposal: For indicating the availability indication in paging DCI via the [6] bits, use network configurable grouping to establish mapping between indication and active TRS resources/sets. For PEI, consider using QCL relation of PEI (based on monitoring occasion) with 1 bit availability indication and 1 bit to identify the possible QCL sources (in case of Type2-PDCCH CSS is sharing Type0-PDCCH CSS).****Observation: Network configurable grouping of TRS resource sets can be considered to limit the size of the physical layer availability indication.** |

According to the above proposals, there are two remaining issues related to indication content for L1 based availability indication of TRS/CSI-RS occasion(s) to idle/inactive UEs:

* Issue 2-1: Down-selection from Alt1 and Alt2 for multi-beam transmission
* Issue 2-2: DCI field design to provide availability/unavailability information
	+ Mapping between codepoint/bitmap and TRS resources or resources sets.
	+ Whether and how to reduce L1 signalling overhead,
		- E.g. whether availability/unavailability information is for all or some of configured RS resources
		- E.g. maximum number of configured RS resources per physical layer availability indication

### 2.2.1 <1st round discussion>

**Issue 2-1: Down-selection from Alt1 and Alt2 for multi-beam transmission**

Companies’ views are summarized in table below.

|  |  |  |
| --- | --- | --- |
|  | **Descriptions** | **Support by** |
| Alt-1 | 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. | OPPO, MediaTek, LG(for PEI based), Sharp, Ericsson, Nordic (6) |
| Alt-2 | 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 | Huawei, HiSilicon, ZTE, Sanechips, Vivo, CMCC, Xiaomi, Intel, Sony, Panasonic, Lenovo, LG(for paging DCI based), Qualcomm (13) |
| Alt-3 |  Both Alt1, and Alt2, configurable by SIB | Apple (1) |

**Issue 2-2: DCI field design to provide availability/unavailability information**

Companies’ views are summarized in table below.

|  |  |  |
| --- | --- | --- |
|  | **Descriptions** | **Support by** |
| Alt-1 | using bitmap, where each bit is associated with at least one resource/configuration or a set/group of resources | Huawei, HiSilicon, Spreadtrum, vivo, OPPO, CMCC, Samsung, Intel, Sony, InterDigitial, Apple, Ericsson, Qualcomm (13) |
| Alt-2 | Using codepoint,  | Nordic |
| Alt-3 | Depending on the maximum number of TRS configurations supported by L1 availability indication, to decide whether to use bitmap or codepoint. | Panasonic |

The majority (13 companies) support using bitmap for the DCI field design. Also, there are proposals to complete the details using a bitmap, including

* D1: whether and how to bundle TRS resources to be indicated per bit,
* D2: determine the bitmap size/location, and
* D3: for all or some of configured RS resources

D1: Whether and how to bundle TRS resources to be indicated per bit:

|  |  |  |
| --- | --- | --- |
|  | **Descriptions** | **Support by** |
| Alt-1  | Per beam direction, where* Each RS resource set is configured to be QCLed with one SSB index, and
* a bit in a L1 availability indication provides availability/unavailability information for a RS resource set.
 | Huawei, HiSilicon,, Intel |
| Alt-2 | The TRS/CSI-RS occasion(s) for different beam direction should be further grouped to reduce the L1 signaling overhead. | ZTE, Sanechips |

D2: Determination of the bitmap size/location

|  |  |  |
| --- | --- | --- |
|  | **Descriptions** | **Support by** |
| Alt-1  | Configurable,e.g. implicitly based on number of TRS configurations or TRS resource sets | ZTE, Sanechips |
| Alt-2 | [Up to] 6 bits | Vivo, Intel, Ericsson, Nokia |
| All-3 | Explicit configure a start and length  | Ericsson |
| Alt-4 | 1 bit to indicate all TRS/CSI-RS resources within a cell | CATT |

D3: Whether the availability/unavailability information per transmission is for all or some of configured RS resources.

* Per transmission includes multi-beam operation or beam selective manner. Whether the transmission is in beam selective manner is not a discussion point here.

|  |  |  |
| --- | --- | --- |
|  | **Descriptions** | **Support by** |
| Alt-1  | For all configured TRS resources can be indicated by L1 availability indication | Vivo, OPPO, Samsung, Nokia |
| Alt-2 | For part of configured TRS resources based on pre-determined association between TRS occasion and paging configurations.* e.g. Paging DCI of a current DRX cycle can include TRS availability information for a following DRX cycle. [Lenovo, TCL]
* E.g. PEI transmitted in a current DRX cycle can indicate TRS availability/unavailability information of configured TRS occasions within the current DRX cycle [TCL]
* Depending on the availability indication method, the UE doesn’t necessarily have to be notified of the availability of all configured TRSs. [DOCOMO]
 | Huawei, HiSilicon , Lenovo, TCL, DOCOMO |

There is no consensus on whether to support beam-selective manner for the L1 based availability indication yet (i.e. Alt1(6) vs Alt2(13)). But the majority support to use bitmap for the DCI field design.

So the following proposal is draft for 1st round discussion on the details for both cases by using bitmap. The intention is to sync the views about how each alternative works and corresponding remaining spec efforts first. We can also do down-select in later discussion in this meeting if possible.

|  |
| --- |
| **[1RD] Proposal 2 (v0)**For L1 based 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. where each bit indicates whether or not associated TRS resource(s) are available. * If Alt1 is supported, i.e. 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.
	+ a RS resources set is configured to be QCLed with one SSB index,
	+ each bit from a L1 availability indication occasion is associated with a subset of RS resource(s) from a RS resources set with the same QCL reference as the L1 availability indication occasion
	+ FFS how to determine subset of RS resources
* If Alt2 is supported, i.e. 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
	+ each bit is associated with at least a RS resources set
	+ FFS how a RS resources set is configured, e.g. per SSB index
	+ FFS whether and how to group part or all configured RS resource sets to reduce L1 signaling overhead
* Bitmap size is up to [6] bits,
	+ FFS start and length of bitmap, e.g. explicitly/implicitly configured
 |

Please provide your views about **Proposal 2 (v0).** Y or N? Any suggestions or modifications? Companies are also encouraged to show preference between Alt1 or Alt2 for down-selection in this meeting.

|  |  |  |
| --- | --- | --- |
| **Company** | **Support** **(Y/N)** | **Comments**  |
| OPPO |  | For alt1, RS resources has the same QCL reference as the L1 availability indication occasion, so the 1st sub-bullet is not needed.  |
| Nordic  | Y | Alt 1 is low overhead, and we believe that beam management is unnecessary optimization. Even if multi-beam indication could be covered by Alt 2, it would not solve the change of cell. Finally, compromise could be that Alt 1 is used in PEI and Alt2 in Paging DCI |
| Qualcomm | Y | Alt 2 should be the design because a UE needs to first receive reference signals to get the tracking loops updated before it can receive either PEI or paging PDCCH, but not the other way round. Having said that, Alt 1 is against the purpose of using TRS for tracking loop update before it can receive paging PDCCH and also PEI PDCCH. For alt 2, the RS resource set should not be associated with the SSB index. This is because typically network needs not to transmit multiple TRSs on the same beam (here we assume that TRS resources within consecutive one or two slots can be configured as one TRS).  |
| Sharp | Y | Support alt1 with lower overhead |
| LG | Yes with modification | We are fine with using a bitmap for the L1 availability indication. Alt 1 is beneficial for PEI in DCI overhead perspective. Meanwhile Alt 2 will be needed for paging PDCCH. Regarding “subset of RS resource(s)” in the 2nd and 3rd sub-bullet in the first bullet, we would like to clarify that it can be determined by the valid time duration if predefined/configured window is supported.Regarding the 3rd bullet, it seems like that using reserved bits in the short message field in the paging PDCCH is not intended in this proposal. Although our preference is to use short message field for conveying more information, we are fine with the current proposal if it is the majority view. Anyway, it would be better to clarify that up to [6] reserved bits in the paging DCI can be used, and the size of the DCI field in the PEI can be configured differently.  |
| ZTE, Sanechips |  | We agree with Mr chairman’ online suggestion that it is better to down-select between Alt1 and Alt2 to avoid paralleled discussion. Moreover, we think mobility is an essential issue. On the contrary, as RRC idle/inactive state UE doesn’t report mobility/beam information, more considerations should be paid to the mobility issue.Compared with Alt2, Alt1 requires more detection time to obtain the whole availability/unavailability information for all the TRS resources, which is more power consuming, especially considering that the best reception beam is not constant due to UE mobility, unexpected beam blocking, etc.For Alt2, as the DCI size is limited for both paging DCI and PEI, it is unreasonable to assume either of them can separately carry availability/unavailability information for each RS resource with a dedicated QCL information. Hence, grouping RS resource is needed to make sure that the availability/unavailability information can be indicated by L1 signaling with limited bit size, for example [6] in the third bullet. Hence, we suggest to revise Alt2 as following* + Alt2-1: each bit is associated with at least a RS resources set
	+ Alt2-2: each bit is associated with at least a group of RS resource sets
		- FFS how to group part or all configured RS resource sets to reduce L1 signaling overhead
	+ FFS how a RS resources set is configured, e.g. per SSB index
	+ ~~FFS whether and how to group part or all configured RS resource sets to reduce L1 signaling overhead~~

As to the location of the bit field in L1 signaling, we think the start / length of bitmap may not be needed for PEI, which can be also implicitly indicated as Scell dormancy indication in DCI format 2-6. For paging DCI, the location depends on how to interpret the legacy information field, implicit indication is sufficient.  |
| Xiaomi | Y | Support the proposal. but more prefer to do down selection in this meeting since the very limited time budget. we prefer Alt 2 for its more convenient for UE moving among different beams within the cell. |
| CATT |  | We don’t think Alt 1 would provide any power saving since UE does not know which beam (SSB) it is covered when it wakes up from deep sleep. If UE only knows the availability information of the beam it is under covered, UE could not assume any TRS availability and have to wake up early, which has the results of no power saving gain from TRS for IDLE/Inactive UEs.We also don’t see the TRS availability indication would be different among beam since UE would only assume the TRS availability of all beams are the same within a cell to get the power saving gain.  |
| Samsung | Y, Alt2 | For Alt1, gNB can’t make sure the availability status for RS resource per QCL are same because the TRS resources are shared from connected mode, which is not configured per QCL. So further availability indication within a RS resource set is needed if more than one TRS resources per TRS resource set is configured. In this sense, we are not sure if Alt1 can reduce L1 signaling overhead. For Alt2, we think it can reuse legacy CSI-RS resource set configuration to reduce L1 signaling overhead. A bit can be associated with more than one TRS resource sets. We don’t see need to configure TRS resource set per QCL for Alt2. In general, we prefer Alt2 over Alt1. Because UE can’t get complete availability information in all beam directions based on Alt1, which can reduce UE power saving gain.  |

## 2.3 Valid duration for L1 based availability indication

The following agreement has been made for determining the valid duration for L1 based availability indication:

|  |
| --- |
| From RAN1#106-e: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.
 |

In contributions [1-24], the following proposals were made to address the remaining issues for determining the valid duration for L1 based availability indication of TRS/CSI-RS occasion(s) to idle/inactive UEs:

|  |  |
| --- | --- |
| Huawei, HiSilicon | **Proposal 2: Support to indicate the availability of assistance TRS in a window before the PO for both paging DCI based availability indication and PEI based availability indication:****- The reference time of the window is defined by a configured offset relative to the start of PO.****Proposal 3: An indication period is introduced during which the availability of assistance TRS(s) is assumed to be the same.****Proposal 4: Indication period is several default paging cycle length, which is common to all UEs and can avoid different understanding among UEs paged on the same PO.****Proposal 5: The length of the indication period can be configured to one default paging cycle or configured as N default paging cycles.****Proposal 6: Validity time window and indication period are supported to work together.****Observation 1: Including the validity time in the availability indication provides no obvious benefit and increases the signaling overhead.** |
| TCL | **Observation 3: The validity time’s duration and reference point of paging PDCCH based TRS availability indication is different from PEI based TRS availability indication.****Observation 4: When TRS availability indication is used for one paging cycle the validity time’s effective duration is based on the duration of one paging cycle.****Observation 5: When TRS availability indication is used for N paging cycle the validity time’s effective duration is based on the duration of N paging cycle point.****Proposal 4: Support Alt1 and Alt2 or a combination of Alt1 and Alt2 i.e. a predefined window configured by higher layers, for validity time’s effective duration.** **Proposal 5: Support Alt2 i.e., the time location where UE receives the indication, for validity time’s reference point.****Observation 6: The switching status of TRS/CSI-RS in the network from ON to OFF before and after the availability indication is being transmitted, may affect the validity time’s duration.** **Proposal 6: In the design of validity time’s duration, consider the switching status of TRS/CSI-RS in the network from ON to OFF before and after the availability indication is being transmitted.** |
| ZTE, Sanechips | **Proposal 6: For the valid time duration of TRS resources, the Alt-4 (i.e., until when the UE receives another availability indication) is preferred.** |
| Spreadtrum | **Proposal 5: Select Alt-1 or Alt-2 for the time duration of the validity time.** |
| Vivo | **Observation 1: UE can take more advantage of transmitted TRS, if TRS availability is provided without limited by validity time.****Proposal 5: TRS without validity time limitation, i.e., Alt-4, should be supported.****Proposal 6: To strive for a balance between UE power saving and indication overhead, a merged solution with and without validity time limitation can be considered.****- NW configured validity time durations can be selected in {N1, N2, … Nx, Null}; where Nx means number of paging cycles.****- For validity time length configured as ‘NULL’, if UE detects L1 signaling indicate TRS available, UE does not change the assumption of TRS availability unless receiving new L1 signaling indicate TRS unavailable.****Proposal 7: The L1 availability indication takes effect once it is received.** |
| OPPO | **Proposal 2: DCI in previous paging cycle can be used to indicate whether there is RS for the current paging cycle or Paging DCI in previous PO can be used to indicate whether there is RS for current PO.****Proposal 3: Alt-2 (a predefined/configured window) or alt-1(a time duration configured by higher layer) can be used as the valid time duration for the L1 based availability indication****Proposal 4: Alt-1(start of next PO or DRX cycle) can be considered as the reference point to determine the valid time duration.** |
| CATT | **Proposal 6: UE should assume an availability indication is always valid before receiving new availability indication.****Proposal 7: Reference point of validity time duration should be after the current PO which L1-based signaling indicating availability of TRS/CSI-RS is detected and before at the starting point of the next PO or DRX cycle for both paging DCI and PEI based availability indication.** |
| CMCC | **Proposal 7. For PEI based availability indication:****• the validity time duration is a predefined window before the associated PO;****• the reference point is the time location where UE receives the indication.****Proposal 8. For paging PDCCH based availability indication:****• the validity time duration is a value configured by higher layer;****• the reference point is the time location where UE receives the indication.** |
| Xiaomi | **Proposal 3: Supporting a predefined/configured window in which there is no TRS being transmitted.** |
| Samsung | **Observation 6: Validity time for L1 based availability indication is beneficial for reducing signalling overhead and improving signalling flexibility on gNB.** **Proposal 5: L1 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 configured by higher layer, and****• the reference point can be start of next PO or DRX cycle** |
| MediaTek | **Observation 2: The design of the validity time is relevant to the signalling method. For example, if PEI is used to signal the availability indication, then it is natural that the indication is valid before a PO to reflect the immediate information. However, if SIB or paging DCI is used, then the explicitly indicated validity time, e.g., next N paging cycles, by higher layer configuration can be considered.****Proposal 4: Further study the following alternatives for the validity time duration of TRS/CSI-RS availability indication at the configured occasion(s) to idle/inactive UEs.**** Alt 1: Configured by higher layer (e.g. SIB-based and paging DCI based signalling)**** Alt 2: A window before a PO (e.g. PEI-based signalling)****Proposal 5: Support the following alternative for the reference point of the validity time duration.**** Alt-2: time location where UE receives the indication****o Subject to [5] msec application delay** |
| Intel | **Proposal 2: Support the following for time duration and reference point for TRS availability indication****o Time duration: Alt-1: configured by higher layer****o Reference point: Alt-1: start of next PO or DRX cycle** |
| DOCOMO | **Proposal 1: The validity timer of the availability of TRS/CSI-RS should be supported.** **• When the availability is informed e.g., by paging PDCCH, the timer (re)starts, and then after the timer expires, i.e., the availability indication has not been received for the timer period, the UE assumes no TRS/CSI-RS can be obtained.****• The time period can be configured, e.g., via SIB.** |
| Sony | **Proposal 3: Support L1 based availability indicating the applied validity time of TRS/CSI-RS transmission. Higher layers can provide the configuration of multiple validity time value(s).**  |
| Panasonic | **Proposal 4: Validity period for L1 TRS availability/unavailability indication is defined as follows:****- For the case of switching from unavailable to available**** The starting reference point is start of current or next PO.**** The time duration is configured by higher layer. If more than one values are configured, L1 indication selects one of them.****- For the case of switching from available to unavailable**** The starting reference point is the time location decided by where UE receives the L1 indication, which is subject to application delay.**** The time duration is absent by default. UE shall assume the TRS is not available until it receives another indication.** |
| Lenovo | **Proposal 5: gNB can configure a validity time interval for a TRS configuration. Upon expiry of the validity time, UE assumes that previous TRS configuration is unavailable.** |
| InterDigital | **Proposal 5: Validity time of the availability indication is configured by higher layers.****Proposal 6: The reference point of the validity time can be determined from the time location where UE receives the indication.** |
| LG | **Proposal 3: L1 based availability indication of TRS/CSI-RS at the configured occasion(s) to the idle/inactive UEs is valid for a time duration which can be determined as follows:****o For paging PDCCH based availability indication, UE can assume the actual TRS/CSI-RS transmission for N modification period, where the value N is indicated by the availability indication and is one of multiple configured values via higher layer.****o For PEI based availability indication, UE can assume TRS/CSI-RS transmission from the reference point to the associated PO(s)****Proposal 4: L1 based availability indication of TRS/CSI-RS at the configured occasion(s) to the idle/inactive UEs is valid from a reference point.** |
| Apple | **Proposal 4: For PEI based availability indication of TRS occasions, the availability indication is valid until the end of the current PO, starting from when the UE receives the indication.****Proposal 5: For paging PDCCH based availability indication of TRS occasions, the duration for which the availability indication remains valid is configurable, with one of the values being infinity. It should be valid at least until the end of the next PO.** |
| Ericsson | **Observation 1: L1 based availability signaling with a validity time in terms of a number of default paging cycles has a relatively low additional NW overhead and does not entail additional UE power consumption to obtain the availability information.****Proposal 1 Support L1-based TRS availability indication with associated validity time via a bitfield in Paging DCI. The reference point is selected from the start of the PF/SFN/DRX cycle where the UE receives the indication.****Proposal 2 For L1-based TRS availability indication via Paging DCI, higher layers can configure multiple validity time value(s) and the applied validity time value is indicated via Paging DCI. The validity timer can be in terms of a multiple of default paging cycles, e.g., [1,..,40].** |
| Qualcomm | **Proposal 7: The L1 based availability indication of TRS/CSI-RS at the configured occasion(s) to the idle/inactive UEs is valid until when the UE receives another availability indication.****Proposal 8: Reference point of the L1 based availability indication of TRS/CSI-RS is determined by the monitoring occasion of the paging PDCCH that carries the indication. This applies to the PEI based L1 based availability indication received before the paging PDCCH too.** |
| Nordic | **Proposal-1: Down-select Alt-1 for both time duration and reference point.** |
| Nokia | **Observation: On/off type of availability indication would increase network overhead and may imply need for the UE to validate the TRS presence.****Observation: Configuring additional time window, on top of the TRS resource configuration, does not seem to provide any meaningful benefit, and would restrict the TRS resource configurations.****Observation: It does not seem necessary to consider Alt-4 or Alt-2 from last meeting agreement.****Observation: Assuming that L1 availability indication implies availability/presence of the TRS occasion only for a configurable time duration (validity timer) would ensure that UE and network have common assumption on the availability.****Proposal: Support L1 availability indication that indicates the availability for a validity timer duration, where the validity timer is configurable by higher layers. After the timer has expired, UE should assume that the TRS are no longer available.****Observation: Supporting indication/selection of multiple different validity timer values does not appear as essential and can be down prioritized for the time being.****Proposal: Consider immediate availability of the TRS based on received L1 availability indication.****Observation: Validity timer end can be UE (i.e. PO) specific, and network can ensure that TRS are available till timer expires.****Observation: It does not appear to be necessary to determine the application delay for the L1 availability indication as the use of the TRS occasions is subject to UE implementation choice.** |

According to the above proposals, the remaining issue is to down-select alternatives in agreement from last meeting about how to support valid duration and reference point for L1 based availability indication (paging/PEI DCI).

### 2.3.1<1st round discussion>

For time duration, companies’ views are summarized in table below.

|  |  |  |
| --- | --- | --- |
|  | **Alternatives** | **Support by** |
| Alt-1 | configured by higher layer | -TCL, Spreadtrum, OPPO, Samsung, Intel, DOCOMO, Sony, Lenovo, InterDigital, Nordic, Nokia**-for paging DCI only:** CMCC, MediaTek, Apple**(14)** |
| Alt-2 | a predefined/configured window- | Huawei, HiSilicon, TCL, Spreadtrum, OPPO, -**For PEI only:** CMCC, MediaTek, LG, apple**(9)** |
| Alt-3 | value indicated by the availability indication, where the value is one of multiple configured time duration(s) | Panasonic, LG (paging DCI), Ericsson**(3)** |
| Alt-4 | until when the UE receives another availability indication | ZTE, Sanechips, Vivo, CATT, Qualcomm**(5)** |

For time duration, the majority support Alt-1 at least for paging PDCCH based availability indication.

For reference point, companies’ views are summarized in table below.

|  |  |  |
| --- | --- | --- |
|  | **Alternatives** | **Support by** |
| Alt-1 | start of next PO or DRX cycle | OPPO, Samsung, Intel, Panasonic (unavailable to available), Nordic**(5)** |
| Alt-2 | time location where UE receives the indication  | TCL, Vivo, CMCC, MediaTek, Panasonic(available to unavailable), InterDigital, Apple (for PEI), Qualcomm, Nokia**(9)** |
| Alt-3 | start of current PO or DRX cycle/PF/SFN where UE receive the indication. | Panasonic (unavailable to available), Ericsson**(2)** |
| Alt-4 | a time location which is configured by higher layer | Huawei, HiSilicon* The reference time of the window is defined by a configured offset relative to the start of PO.

**(2)** |
| Others | Reference point of validity time duration should be after the current PO which L1-based signaling indicating availability of TRS/CSI-RS is detected and before at the starting point of the next PO or DRX cycle for both paging DCI and PEI based availability indication. | CATT |

For reference point, the majority support Alt-2, so that UE can assume immediate availabilitywhen UE receives the indication. However, the time duration is configured per cell, while the PO will be different per UE groups. In order to keep consistent validity timer on gNB side, a cell-specific reference point is needed to match with Alt1 for time duration.

The following proposal is drafted based on majority view, considering

* Prioritize paging PDCCH based availability indication
* merge Alt1 and Alt4 for time duration, and
* merge Alt 2 and Alt 3 for reference point.
* For PEI based availability indication, whether or not new mechanism is needed can be FFS or deprioritized.

|  |
| --- |
| **[1RD] Proposal 3 (v0)**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 configured by higher layer,
	+ one applicable value is ‘infinity’, i.e. the availability indication is valid until when the UE receives another availability indication
	+ FFS other applicable values, e.g. # of DRX cycles
* the reference point is start of DRX cycle where UE receive the indication
	+ Note: start of DRX cycle is determined based on DRX cycle and PF\_offset, and common to all UEs
	+ Note: UE can apply the availability indication immediately at the time location where UE receives the indication.
 |

Please provide your views about **Proposal 3 (v0).** Y or N? Any suggestions or modifications?

|  |  |  |
| --- | --- | --- |
| **Company** | **Support** **(Y/N)** | **Comments**  |
| OPPO | N | 1. The second bullet doesn’t reflect the majority view.
2. The 1st sub-bullet under the 1st bullet shall be removed. If the UE unfortunately fail to receive the L1 signaling, it will fail to use the RS for long time
 |
| Nordic | N | Indication should be consistent, such as e.g. SFI, new indication does not override previous. Reference point should be start of next/sub-sequent DRX cycle. |
| Qualcomm | Partially Y | For the first time duration, we do not think even the network can predict for how long the TRS remains valid or not. For the sake of progress, we can live with it, but it does not mean network should configure anything other than “infinity”.For the second bullet, we think the intent is that the indication takes effect from the beginning of the next DRX cycle. If so, it is better to just say that “the start point is start of the next DRX cycle after the DRX cycle where UE receive the indication”. The DRX cycle level time granularity can guarantee that TRS availability indication received in the same DRX cycle all have the same bitmap/codepoint values. As mentioned in our reply to proposal 1-1, this requirement is necessary to have the consistency of TRS indication. Based on this, the second note of second bullet should be “Note: UE can apply the availability indication at the start of the next DRX cycle after the DRX cycle where UE receives the indication.” |
| Sharp | N | Regarding the time duration configuration, if ‘infinity” is supported, it means UE will need to monitor every indication occasion which will reduce the power saving gain |
| LG | N | **Regarding time duration*** Our best preference is to allow indicating time duration via L1 signaling, but also OK with Alt 1 for paging PDCCH case for the progress. (i.e. a value is configured by higher layer)
* However, we have concern on indicating ‘infinity’ value via L1 signaling. We should consider the case when UE misses the L1 signaling. When UE missies enabling indication, UE may not take advantage from the actual TRS transmission but it does not harm the UE behavior. However, if UE misses the disabling indication, UE will perform T/F synchronization with the noise, which shall be avoided. From this perspective, we do not prefer Alt 4.
* Regarding applicable values, we prefer to consider the ‘modification period’, which is a multiple of default paging cycle and a common to all UEs.

**Regarding the reference time*** Reference point would be used not only to indicating the starting occasion for the TRS transmission but also to determine the ending occasion where UE stops to expect TRS transmission. Thus, if the use of ‘DRX cycle’ to determine a reference point, between UEs with different POs will have different understanding on the actual TRS transmission duration. Instead, we would like to suggest to use the ‘modification period boundary before the UE receive the indication’ or ‘start of the modification period where UE receive the indication’ which is a common value to all UEs.
* Moreover, if the PEI based availability indication is introduced, it would be worth to consider same method/principle for both L1 signaling. As we discussed so far, the TRS for idle/inactive UEs would be useful for paging procedure, and if PEI can be used for the availability indication, it seems obvious that using indicated TRS for the PO where associated with the PEI is preferred. However, it seems like the ‘DRX cycle’ means that PF would be used as a reference point for the availability indication. If so, UE that detects the PEI cannot use the indicated TRS for the upcoming PO. Meanwhile, if the ‘modification period’ is used for the reference point, both PEI and paging PDCCH can have same method/principle for the reference point while guaranteeing the benefits from the availability indication on the PEI.

In this points of view, we would like to suggest following update: **[1RD] Proposal 3 (v0) - LG**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 configured by higher layer,
	+ ~~one applicable value is ‘infinity’, i.e. the availability indication is valid until when the UE receives another availability indication~~
	+ FFS other applicable values, e.g. # of DRX cycles, modification period
* the reference point is start of modification period ~~DRX cycle~~ where UE receive the indication
	+ ~~Note: start of DRX cycle is determined based on DRX cycle and PF\_offset, and common to all UEs~~
	+ Note: UE can apply the availability indication immediately at the time location where UE receives the indication.
 |
| ZTE, Sanechips | N | (1) As we analyzed in our contribution, with Alt1, if NW continues to indicate the availability information via L1 signaling during the valid time duration indicated by the previous L1 indication, the actual valid time duration will be extended (the TRS will be valid in the next valid time duration starting from the L1 signaling), which would make the TRS as “always-on”. Meanwhile, if NW doesn’t continue to transmit the availability indication during the valid time duration, the UEs that newly access the cell cannot use TRS for sync.(2) As it was commented by other company before, the valid time for SIB is several hours at most. And adding a value of ‘infinity’ makes the UEs newly accessing the cell can use the TRS for power saving. And if ‘infinity’ implies that “the availability indication is valid until when the UE receives another availability indication”, it seems “valid time duration” is not needed.(3)Hence, our understanding is that L1 based signaling availability/un availability already provides enough flexibility. If the valid time duration is deemed as essential by the group, a better solution is to define a window, which works as a mask and the TRS resources are only available during the window. But this window should be common to all the UEs, instead of any particular UEs, as the TRS are originally configured for connected UEs.  |
| Xiaomi | Partially Y | For the first bullet, support “the time duration is configured by higher layer”, but doubt whether there’s a need for ‘infinity’, since if UE miss detect the next TRS indication, UE will have wrong assumption for how to do synchronization/tracking.For the second bullet, we can not agree, since different UE may possiblely have different DRX cycle (as specified in TS 38.304,” *DRX cycle of the UE (T is determined by the shortest of the UE specific DRX value(s), if configured by RRC and/or upper layers, and a default DRX value broadcast in system information. In RRC\_IDLE state, if UE specific DRX is not configured by upper layers, the default value is applied)*.”), so the start of DRX cycle determined based on DRX cycle and PF\_offset, is not common to all UEs |
| CATT | N | To achieve the power saving gain, the TRS availability indication should be known by UE before UE wakeup at the next PO. The TRS availability indication could not apply to current PO since it provides no power saving gain. Thus, the reference point should be before the start of the next PO. We had shown that the power saving gain degrades dramatically if the validity is not persistently through long period of time.  |
| Samsung  | Y | For time duration, it can be clarified that UE doesn’t expect to receive or monitor L1 based availability indication during the time duration to address the concern (1) from ZTE. For reference time, we are fine with either start of current DRX cycle or next DRX cycle. In our view, both works. If it’s start of current DRX cycle, UEs will set the validity timer with different initial values according to the time offset between PO and start of current DRX cycle. If we consider start of next DR cycle, UEs from different POs may set the timer with same initial value, but all UEs has to wait and start the timer at the beginning of next DRX cycle.  |

## 2.4 SIB based availability indication

The following agreement has been made for SIB based availability indication:

|  |
| --- |
| From RAN1#105-e: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 |

In contributions [1] - [24], the following proposals were made to address the remaining issues for SIB based availability indication of TRS/CSI-RS occasion(s) to idle/inactive UEs:

|  |  |
| --- | --- |
| Huawei, HiSilicon | **Proposal 12: No SIB based availability indication is supported for availability indication of TRS/CSI-RS occasions for idle/inactive UEs.** |
| TCL | **Proposal 7: Support SIB based signaling for availability indication of TRS/CSI-RS occasions to the idle/inactive UEs.****Proposal 8: SIB based singling and L1 based signaling can be configured simultaneously through SIB\_X or Pre-Configuration.****Proposal 9: Consider a NewBitField of size one bit in the SIB\_X to enable/disable SIB based or L1 based signaling of TRS/CSI-RS availability indication** |
| ZTE | **Proposal 2: The SIB-based signaling for indication of TRS occasion availability is not needed if L1-based signaling indication is configured.** |
| Spreadtrum | **Proposal 3: SIB based signaling and L1 based availability indication of TRS/CSI-RS can be configured simultaneously.** |
| Vivo | **Proposal 8: SIB based TRS avsilsbility update can be supported by reusing existing SI update mechanism.****Proposal 9: NW can configure a subset of TRS with SIB based availability indication, and the remaining TRS resource with L1 based availability indication in the TRS resource allocation.****- For TRS resource configured with L1 availability signalling, UE follows the indication provided in the paging/PEI PDCCH.** |
| OPPO | **Observation 1: SIB-based indication has the following drawbacks: 1) additional power consumption 2) restriction of the flexibility of using TRS send for connected UEs.** |
| CATT | **Observation 4: Compared with L1 signaling, SIB based availability indication of TRS/CSI-RS at a given cell for IDLE/Inactive mode UE can provide affirmative TRS/CSI-RS resource availability to achieve UE power saving gain and no additional signaling overhead.****Proposal 5: The availability of TRS/CSI-RS at a given cell should be indicated to the UE by SIB-based signaling, which is indicated by the presence/absence of SIB-X.** |
| CMCC | **Proposal 3. Support SIB based signaling for availability information of TRS/CSI-RS occasions for idle/inactive UEs in semi-static manner when L1 based availability indication is not configured.****Proposal 4. SIB based signaling provides availability indication for a default assumption of the availability information for all configured TRS/CSI-RS occasions, and L1 based signaling provide updates relatively to the default assumption.** |
| Xiaomi | **Proposal 4: Prioritize finalizing the details of L1 signalling than SIB based availability indication.** |
| Samsung | **Observation 4: SIB-based singling can be used to provide static availability information and won’t increase UE power consumption.****Proposal 3: Support SIB based signaling for availability information of TRS/CSI-RS occasions for idle/inactive UEs when L1 based availability indication is not configured.** |
| MediaTek | **Proposal 2: Support SIB-based signalling for TRS/CSI-RS availability information only when L1-based availability indication is not configured, i.e., SIB-based and L1-based availability indication cannot be configured simultaneously.** |
| Intel | **Proposal 3: Support SIB based signaling for availability indication of TRS/CSI-RS occasions for idle/inactive UEs in case L1 based availability indication is not configured.** |
| DOCOMO | **Proposal 2: Only paging DCI and/or paging early indication should be adopted to indicate the availability of TRS/CSI-RS for idle/inactive mode UE.** |
| Lenovo | **Proposal 6: Support a TRS transmission mode that UE may assume that TRS are present on all configured TRS occasions, in order to reduce DCI signalling overhead.**  |
| InterDigital | **Proposal 2: SIB-based signaling of availability indication is not supported.** |
| Apple | **Proposal 6: Support SIB-based availability indication of the TRS occasion(s). Do not support simultaneous configuration of SIB-based signaling and L1 signaling for availability indication.****Proposal 7: When a TRS configuration is indicated as available, the idle/inactive UEs assumes that only a certain number of TRS occasion(s) before a PO is available.** |
| Ericsson | **Observation 2 SIB based TRS availability signaling leads to:** **• Unnecessary increasing the NW power consumption (e.g. by 40 to 80%)****• Frequent SI update signaling increasing NW overhead****• Increasing power consumption for all UEs, particularly legacy UEs****• Always-ON TRS transmissions** |
| Qualcomm | **Proposal 9: Support SIB based signaling for availability information of TRS/CSI-RS occasions for idle/inactive UEs when L1 based availability indication is not configured** ** All configured TRS resources are available** ** Note: If L1 based availability indication is configured, it should be transmitted. I.e., there is no additional configuration to indicate that the configured L1 based availability indication is not enabled.** |
| Nokia | **Observation: Indication of the availability via changing SI content results in long latency and high overhead.****Observation: SI based availability information can benefit the UE power saving opportunities especially when paging probability is low.****Proposal: Support providing availability information in SI when physical layer presence/availability indication is not configured.** **Observation: Providing static availability configuration in SI, for example in form of time table of the availability of the TRS occasions, would enable dynamic TRS presence without separate physical layer indication or SI change.** **Proposal: Support providing availability information in system information, e.g. in a form of a time table.** |

According to the above proposals, the remaining issues related to SIB based availability indication include:

* Whether to support SIB based availability indication, and
* Whether SIB based availability indication can be configured simultaneously with L1 based signaling

### 2.4.1<1st round discussion>

As for whether to support SIB based availability indication, companies’ views are summarized below:

|  |  |
| --- | --- |
|  | **Supported by Companies** |
| Yes | TCL, Spreadtrum, Vivo, CATT, CMCC, Samsung, MediaTek, Intel, Lenovo, InterDigital, Apple, Qualcomm, Nokia **(13)** |
| Availability information to provide: * Alt1: presence/absence of configuration, i.e. all configured TRS resources are available
* QC, Lenovo, CATT
* Alt2: available duration
* Nokia: in a form of a time table.
* Apple: only for a certain number of TRS occasion(s) before PO
 |
| No | Huawei, HiSilicon, DOCOMO, Ericsson, InterDigital , OPPO **(6)** |

As for whether SIB based availability indication can be configured simultaneously with L1 based signaling, companies’ views are summarized below:

|  |  |
| --- | --- |
|  | **Companies** |
| Yes | TCL, Spreadtrum, Vivo **(3)** |
| No | ZTE, CMCC, MediaTek, Intel, Apple, Nokia **(6)** |

The majority (13 companies) support SIB based availability indication, due to the **needs** including

* **1) Avoid unnecessary L1 signaling overhead without additional UE power consumption.** For the use case when the availability information doesn’t change before next time gNB has to reconfigure the TRS resources. The availability information can be provided together with or based on the presence of TRS resources configuration. On UE side, the SI update procedure happens only for reconfiguration of TRS resources occasions. no additional UE power consumption to get the SIB based availability indication. ON NW side, gNB can skip L1 signaling for providing the availability information.
* **2) need for synchronization/AGC for RedCap in dedicated initial DL BWP.** For RedCap UEs, a dedicated initial DL BWP will be supported in Rel-17. There will be no cell-defining SSBs for synchronization/AGC in the dedicated initial DL BWP. In order to receive L1 signal/channel, e.g. paging PDCCH/PDSCH, in the dedicated initial DL BWP, UE needs to know the availability of TRS resources in advance before L1 channel reception.

Additional benefits, including:

* SI based availability information can benefit the UE power saving opportunities especially when paging probability is low [Nokia]

The following proposal is drafted for 1st round discussion, based on the majority view to support SIB based availability indication, considering

* Need at least when L1 based availability indication is not configured.
* In the simplest case, NW can at least indicate the availability based on the presence of the configuration in SIB.
* 2 companies also propose additional availability information, such as time stable, which can be FFS.
* whether and how SIB based signaling and L1 based signaling can be configured simultaneously can be deprioritized due to time limitation. We already have FFS point in previous agreement.

|  |
| --- |
| **[1RD] Proposal 4 (v0)**Support SIB based signaling for availability information of TRS/CSI-RS occasions for idle/inactive UEs when L1 based availability indication is not configured.* All configured TRS resources are available
* FFS whether additional availability information is needed, e.g. a form of a time table
 |

Please comment about **Proposal 4 (v0).** Y or N? If N, please at least provide views about how the two needs as summarized above can be satisfied/resolved. Any suggestions or modifications?

|  |  |  |
| --- | --- | --- |
| **Company** | **Support** **(Y/N)** | **Comments**  |
| OPPO | N | 1. Using SIB duplicates the indication. With L1 signaling, as Paging DCI or PEI(if supported) would anyway be transmitted by the gNB and received by the UE, there is no overhead and power consumption issue for the UE with L1 signaling method.
2. There is still uncertainty for support the additional BWP in RedCap. We propose to decouple the issue with that.
 |
| Nordic  | N |  |
| Qualcomm | Y | Unless L1 based availability indication is always configured and enabled, this probably is probably the simplest design. So we are fine with it.On the “when L1 based availability indication is not configured”, we think it should include the case that L1 based availability indication is configured but not enabled. According to proposal 1-2, this is valid to consider in the discussion. |
| LG |  | We would like to clarify the intention of this proposal. Is that mean there is no SIB based availability indication when L1 based availability indication is configured in a cell? If so, could you elaborate a bit more on why the case where both SIB and L1-based signaling are configured is excluded? Regarding supporting SIB based availability indication, we are open to discuss about this issue, but not prefer to override the availability indication from the SIB by the L1 based signaling. |
| ZTE, Sanechips | No. | We think this proposal should be discussed together with Proposal 1-2 (v0). The SIB indication is unnecessary as we commented in proposal 1-2(v0). Furthermore, because of SI update procedure, it will consume more power of UE and base station. |
| Xiaomi | Slightly prefer No | Since we have determined to specify TRS indication by DCI, we don’t see much need to add another alternative in SIB. |
| CATT | Y | SIB-based signaling is the default method when SIB is present with the TRS configuration information.  |
| Samsung  | Yes |  |

# Higher Layer Configurations

## 3.1 Configuration structure

In [26], RAN2 sent RAN1 an LS to ask for potential structure for a TRS/CSI-RS occasion(s) configuration. So, there is a high priority to determine the configuration structure, such as whether or not to consider common configuration parameters for a set of RS resources, or a group of multiple RS resource sets.

|  |
| --- |
| From RAN1#105-e: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
 |

In RAN#106-e, we discussed the configuration structure of a TRS resources set as summarized in Proposal 4.1-1 (v4) [25].

|  |
| --- |
| **Proposal 4.1-1 (v4)**For RS resources from configured TRS/CSI-RS occasion(s) for idle/inactive UEs, a RS resource set can be configured to include a set of RS resources with one or more common configuration parameters. * FFS the common configuration parameters per RS resource set, e.g. resource set ID (if support), QCL reference, startingRB, nrofRBs, powerControlOffsetSS, number of slots (if support).
* FFS whether allow the possibility for a RS resource in a set to override the common parameter if needed.
* FFS how to indicate availability/unavailability information for RS resources from the configured RS resource set(s) in L1 based availability indication, e.g. bit/codepoint per RS resource, or per RS resource set(s)
* FFS maximum number of RS resources per RS resource set
* FFS maximum number of RS resource set
 |

In contributions [1-24], proposals related to configuration structure are summarized in table below:

|  |  |
| --- | --- |
| Huawei, HiSilicon | **Proposal 13: The QCL information is configured per resource set.****Proposal 14: The configuration of assistance TRS for IDLE/INACTIVE UEs does not include configuration index.** |
| ZTE, Sanechips | **Proposal 7: A default value should be applied if the corresponding parameter is not configured for RRC idle/inactive UE.****Proposal 8: Some parameters, such as startingRB and nrofRBs, can be jointly indicated to reduce signaling overhead.** |
| CATT | **Observation 3: Compared with configuration of TCI state per CSI-RS resource, one TRS resource set can be configured with one TCI state which can reduce unnecessary signaling overhead.****Proposal 3: QCL information configuration of TRS for idle/inactive UE should be configured at least per CSI-RS resource set.****Proposal 4: The following procedure can be used for TRS/CSI-RS occasion(s) configuration:****Step1) Configured parameters of TRS/CSI-RS resource from the resourceMapping and periodicityAndOffset of nzp-CSI-RS-Resource set****Step 2) SIB indicates parameters details, including****- QCL assumption of the configured TRS/CSI-RS resources associated with a SSB;****Step 3) TRS occasion(s) after the SSB is obtained based on the configured TRS/CSI-RS resource grid and periodicity in step1 and step 2** |
| Xiaomi | **Proposal 1: One TRS/CSI-RS resource configuration associated with a couple of SSB indices is possible and should be supported** |
| Samsung | **Proposal 6: Support configuration of a number of a RS resource sets, where each RS resource set include a set of RS resources with a common resource set ID, and each RS resource can have different value for other supported configuration parameters.** |
| DOCOMO | **Proposal 4: The common configuration parameter among RS resource sets, or groups of sets should be supported to reduce the SIB overhead for TRS/CSI-RS for idle/inactive mode UE.** |
| Sony | **Proposal 6: Support providing multiple TRS/CSI-RS configurations to idle/inactive UEs.****Proposal 7: TRS/CSI-RS configuration index is defined for the resource-set of TRS/CSI-RS.** |
| Lenovo | **Proposal 1: Support following methods to reduce the TRS configuration signalling overhead:****• Configure the parameters powerControlOffsetSS, scramblingID, and periodicityAndOffset, respectively, with same values for all TRS resources in a TRS resource set.****• A reference TRS resource has full configuration information. For other TRS resources, a subset of parameters is updated from the full configuration information of the reference TRS resource.****Proposal 2: QCL information for TRS configured for idle/inactive UEs is indicated per TRS resource set.****Proposal 3: A TRS resource set ID explicitly indicates an SSB index as a QCL source of the TRS resource set.** |
| Sharp | **Proposal 1: TRS resources configuration can be compressed by packaging and bundling parameters****Proposal 2: The indication of QCL information of TRS resources can be associated with the configuration order of the resources** |
| Apple | **Proposal 1: A TRS configuration for idle/inactive UEs further includes the number of slots, which indicates 1 or 2 slots for the TRS configuration.****• Further signaling overhead reduction/optimization (e.g. introducing common parameters) can be considered.** |
| Ericsson | **Proposal 6 In cases where there is no SI size limitation issue (e.g. FR1), support reuse of existing periodic TRS configuration(s) for TRS occasion provisioning.****Proposal 7 In cases where resulting SIB size is deemed excessive (e.g. FR2 or FR1 with many beams), support new RRC TRS structure configuration that allows grouping of common parameters within a TRS resource set, and across configured TRS resource sets.****a. Parameters frequencyDomainAllocation, nrofRBs, and startingRB can be common for all resource sets.** |
| Qualcomm | **Observation 5: The number of DCI information bits for L1 TRS availability indication should be also considered as network signaling overhead when common TRS configuration parameters are identified for network signaling overhead reduction.****Proposal 10: For TRS resources at the configured TRS/CSI-RS occasion(s) for idle/inactive UEs, a TRS resource set can be configured to include a set of TRS resources with one or more common configuration parameters**** Common parameters can include RB allocation, periodicity, power offset and number of consecutive slots per TRS occasion** ** QCL reference is not a common parameter**** L1 based availability indication can be based on the same resource set configuration**** Maximum number of TRS resources per TRS resource set is equal to the number of transmitted SSBs in the cell**** Maximum number of TRS resource set can be 2 or 3, including at least one for low density TRS transmission and one for high density TRS transmission**** Configuration of a TRS resource in a TRS set can override the common parameter based on optional configuration parameter IE up to network implementation****Proposal 11: Use the resource set index in the TRS configuration implicitly as the configuration index.** |
| Nokia | **Proposal: The configuration of TRS to the IDLE/INACTIVE mode UEs needs to support independent configuration for each broadcast/SSB beam.****Proposal: When informing TRS occasions for the IDLE/INACTIVE mode UEs, parameters ‘nrofPorts’, ‘cdm-Type’ and ‘density’ in ‘CSI-RS-ResourceMapping’ can be omitted from the configuration and values assumed to be same as defined by specification TS38.214 for CSI-RS configured with ‘trs-info’.****Observation: In case of TRS configuration for IDLE/Inactive mode UEs, ‘row1’, ‘startingRB’ and ‘nrofRBs’ can be assumed to be same for both symbols in a slot.****Observation: In case of TRS configuration for IDLE/Inactive mode, for ‘CSI-ResourcePeriodicityAndOffset’ only one common parameter providing the periodicity and offset is needed for TRS symbols in one slot (or two consecutive slots).****Proposal: Following parameters can be assumed to be same/common for RS resources in a slot for TRS configuration, or could be used to implicitly derive other parameter(s):****- ’row1’, ‘startingRB’ and ‘nrofRBs’ are common/same for both TRS symbols in a slot, thus would be provided only once per slot (RS resource set).****- ‘CSI-ResourcePeriodicityAndOffset’, or similar IE would need to be provided only once for TRS symbols in same slot, or in two consecutive.****Observation: Consider for FR2 if if number of TRS resource sets can be restricted for one per SSB and thereby enabling the resource ID can indicate the QCL-ed SSB index.****Observation: RAN1 could consider the possible parameters that could be common for a group of TRS resources and indicate those to RAN2, who could design the configuration accounting the information.****Observation: Consider if startingRB, numberofRBs and scramblingID could be considered to be common for group of TRS resources. In addition, consider if for FR2 configuration ResourceID could also indicate QCL relation as well.** |

According to the above proposals, the remaining issues related to configuration structure for availability indication of TRS/CSI-RS occasion(s) to idle/inactive UEs include:

* Issue 5-1: whether and how to support a configuration of TRS resource set
	+ e.g. per QCL
* Issue 5-2: configuration structure for all supported parameters in general

### 3.1.1<1st round discussion>

**Issue 5-1: whether and how to support a configuration of TRS resource set**

|  |  |
| --- | --- |
|  | **Supported by Companies** |
| Yes | Huawei, HiSilicon**,**  ZTE, Sanechips, CATT, Samsung, DOCOMO, Sony, Lenovo, Sharp, Apple, Ericsson, Qualcomm, Nokia **(14)** |
| * Alt1: per QCL reference
* Yes: Huawei, HiSilicon, CATT, Lenovo
* No: Qualcomm
* Alt2: resource set ID
* Samsung, Sony, Qualcomm
 |
| No | **(0)** |

There is a consensus to support configuration structure of a TRS resource set for the motivations, including:

* used for L1 based availability indication, i.e. same availability status for RS resources within a TRS resource set, and
* reduce configuration overhead.

The following proposal is drafted for 1st round discussion. Down-selection between Alt1 and Alt2 can be done based on the outcome of the discussion.

|  |
| --- |
| **[1RD] Proposal 5-1 (v0)**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 include
	+ a set of TRS resources,
	+ at least a common configuration parameter:
		- Alt1: a QCL reference,
		- Alt2: TRS resource set ID
 |

Please comment about **Proposal 5-1 (v0).** Y or N? **If Y, please further provide preference between Alt1 and Alt2 if possible.** Any suggestions or modifications?

|  |  |  |
| --- | --- | --- |
| **Company** | **Support** **(Y/N)** | **Comments**  |
| Nordic  | Alt2 |  |
| Qualcomm | Y, Alt2 | For the two alternatives, we support Alt2. Alt1 typically may not work unless network wants to transmit multiple TRSs on the same beam simultaneously. NR TRS is similar to LTE CRS. We do not think it is necessary for network to transmit multiple TRSs on the same beam. |
| Sharp |  | We suppose the “TRS resource set” here is not same as the NZP-CSI-RS-ResourceSet in R15/16, and only is a parameters group for TRS resources. and support alt2 , different TRS resource QCLed with different SSB can share common configurations |
| LG | Y | If I understood correctly, we think both ‘QCL reference’ and ‘TRS resource ID’ can be configured as a common parameter. So they should be ‘options’ not alternatives.* + - Option 1 ~~Alt1~~: a QCL reference,
		- Option 2 ~~Alt2~~: TRS resource set ID
 |
| ZTE, Sanechips |  | The following two alternatives are not exclusive.* Alt1: a QCL reference,
* Alt2: TRS resource set ID
 |
| CATT | Y | QCL and TRS resource set ID need to be configured together.  |
| Samsung | Y, Alt2 | We support Alt2, and we think TRS resource set ID can be implicitly indicated by the order of configured TRS resource set. For QCL reference, it’s needed per TRS resource to follow the R15/16 configuration.  |

**Issue 5-2: Configuration structure for all supported parameters in general**

Companies’ proposals for other common configuration parameters for a TRS resource set or TRS resource sets are summarized as follows:

|  |  |
| --- | --- |
|  | **Companies** |
| powerControlOffsetSS, scramblingID, and periodicityAndOffset | Lenovo |
| frequencyDomainAllocation, nrofRBs, and startingRB | Ericsson (in case SIB size is deemed excessive) |
| RB allocation, periodicity, power offset  | Qualcomm |
| the number of slots (if supported) | Apple, Qualcomm |
| ’row1’, ‘startingRB’ and ‘nrofRBs’, CSI-ResourcePeriodicityAndOffset’ | Nokia |
| Support a TRS resource set in general | DOCOMO, Sharp, Apple |

The following proposal is drafted to collect companies’ views about the configuration structure for each supported configuration parameters.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **[1RD] Proposal 5-2 (v0)**For TRS/CSI-RS occasion(s) configured for idle/inactive UEs:* Support one of the following configuration structure for each configuration parameter:
	+ Alt1: per TRS resource,
	+ Alt2: per TRS resources set,
	+ Alt3: per group of TRS resources sets
* Support configuration structure according to Table below

Table 1: Configuration structure

|  |  |  |
| --- | --- | --- |
| **Index** | **Configuration parameters** | **Configuration structure****(Alt1, Alt2 or Alt3)** |
| 1 | powerControlOffsetSS: {-3, 0, 3, 6}dB | TRS resources set |
| 2 | scramblingID: 0 to 1023 | TRS resources set |
| 3 | firstOFDMSymbolInTimeDomain: 0 to 9 | TRS resources set |
| 4 | startingRB: 0 to 274 | common for all  |
| 5 | nrofRBs: 24 to 276 | common for all |
| 6 | periodicityAndOffset: {10, 20, 40, 80} ms | common for all |
| 7 | 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 | TRS resources set |
| 8 | QCL reference: a SSB index | Mapping to available resources is implicit |
| 9 | Others:* E.g. number of slots if supported
* E.g. ID/configuration index
 |  |

 |

Please provide your views about **Proposal 5-2 (v0),** including input for Table 1: Configuration structure. Any suggestions or modifications?

|  |  |  |
| --- | --- | --- |
| **Company** | **Support** **(Y/N)** | **Comments**  |
| example | Y |

|  |  |
| --- | --- |
| **Index** | **Configuration structure****(Alt1, Alt2 or Alt3)** |
| 1 | Alt1 |
| 2 | Alt1 |
| 3 | Alt1 |
| 4 | Alt1 |
| 5 | Alt1 |
| 6 | … |
| 7 |  |
| 8 |  |
| 9 |  |

 |
| Nordic  |  |

|  |  |
| --- | --- |
| **Index** | **Configuration structure****(Alt1, Alt2 or Alt3)** |
| 1 | TRS resources set |
| 2 | TRS resources set |
| 3 | TRS resources set |
| 4 | common for all  |
| 5 | common for all |
| 6 | TRS resources set |
| 7 | TRS resources set |
| 8 | Mapping to available resources is predefined |
| 9 |  |

 |
| Qualcomm | Y |

|  |  |
| --- | --- |
| **Index** | **Configuration structure****(Alt1, Alt2 or Alt3)** |
| 1 | Alt3 |
| 2 | Alt1 |
| 3 | Alt2 |
| 4 | Alt3 |
| 5 | Alt3 |
| 6 | Alt2 |
| 7 | Alt1 |
| 8 | Alt1 |
| 9 | Alt2 |

 |
| Sharp |  |

|  |  |
| --- | --- |
| **Index** | **Configuration structure****(Alt1, Alt2 or Alt3)** |
| 1 | Alt3 |
| 2 | Alt2 |
| 3 | Alt2 |
| 4 | Alt3 |
| 5 | Alt3 |
| 6 | Alt2 |
| 7 | Alt3 |
| 8 | Alt2 |
| 9 |  |

 |
| ZTE, Sanechips |  |

|  |  |  |
| --- | --- | --- |
| **Index** | **Configuration parameters** | **Configuration structure****(Alt1, Alt2 or Alt3)** |
| 1 | powerControlOffsetSS:  | Alt3 |
| 2 | scramblingID: | Alt1  |
| 3 | firstOFDMSymbolInTimeDomain:  | Alt2 or Alt3 |
| 4 | startingRB:  | Alt3 |
| 5 | nrofRBs:  | Alt3 |
| 6 | periodicityAndOffset:  | Alt2 or Alt3 |
| 7 | frequencyDomainAllocation for row1  | Alt2 or Alt3 |
| 8 | QCL reference: a SSB index | Alt1 |
| 9 | Others:* E.g. number of slots if supported
* E.g. ID/configuration index
 | number of slots: Alt3 |

 |
| CATT |  |

|  |  |
| --- | --- |
| **Index** | **Configuration structure****(Alt1, Alt2 or Alt3)** |
| 1 | TRS resources set |
| 2 | TRS resources set |
| 3 | TRS resources set |
| 4 | common for all  |
| 5 | common for all |
| 6 | TRS resources set |
| 7 | TRS resources set |
| 8 | Mapping to a TRS resources set  |
| 9 |  |

 |
| Samsung | Y |

|  |  |
| --- | --- |
| **Index** | **Configuration structure****(Alt1, Alt2 or Alt3)** |
| 1 | Alt2 |
| 2 | Alt1 |
| 3 | Alt2 |
| 4 | Alt2 |
| 5 | Alt2 |
| 6 | Alt2 |
| 7 | Alt1 |
| 8 | Alt1 |
| 9 |  |

 |
|  |  |  |

## 3.2 Other Configuration parameters

In RAN1#106e, we discussed whether or not to support the number of slots as additional configuration parameter as follows:

|  |
| --- |
| From [25] for RAN1#106e:**Proposal 5.1 (v3)**Configuration of TRS/CSI-RS occasion(s) for idle/inactive UEs supports the time-domain locations of two RS resources in a slot, or of the four RS resources in two consecutive slots * FFS whether need configuration parameter: number of consecutive slots with applicable values of 1 or 2.
 |

In contributions [1-24], proposals related to support other configuration parameters are summarized in table below:

|  |  |
| --- | --- |
| ZTE, Sanechips | **Proposal 9: The number of slot of TRS/CSI-RS occasion(s) is configurable.** |
| Xiaomi | **Proposal 6: Bitmap for RS resource sets configuration should be supported and no need to define the number of consecutive slots with applicable values of 1.** |
| Samsung | **Observation 7: According to the restriction supported in 5.1.6.1.1 of TS 38.214, number of slots configured can be implicated indicated by the number of RS resources per resource set.** |
| Apple | **Proposal 1: A TRS configuration for idle/inactive UEs further includes the number of slots, which indicates 1 or 2 slots for the TRS configuration.****• Further signaling overhead reduction/optimization (e.g. introducing common parameters) can be considered.** |

### 3.2.1<1st round discussion>

Companies’ proposals for whether or not to support additional configuration parameter, i.e. number of slots are summarized as follows:

|  |  |
| --- | --- |
|  | **Supported by Companies** |
| Yes | ZTE, Sanechips, Apple (3) |
| No | Xiaomi, Samsung (2) |

The following question is provided for 1st round discussion. Potential proposal will be draft for further discussion based on the outcome of 1st RD.

|  |
| --- |
| **[1RD] Question 1**:Whether and how to support number of slots as an explicit configuration parameter for TRS/CSI-RS occasion(s) configured to idle/inactive UEs, e.g. per TRS resource set. |

Please provide views for **Question 1**.

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| Nordic | Explicitly configured |
| Qualcomm | Yes, this can be configured so that configuration of TRS resources within one or two consecutive symbols can share common configuration parameters. |
| Sharp | For FR1, the resources number in a TRS resource set can be deduced based on the *tdd-UL-DL-ConfigurationCommon and first resource’ slot*. for FR2, an one bit can be configured to indicate one or two slots for a resource set |
| LG | No need explicit indication  |
| ZTE, Sanechips | An explicit configuration of slot number is needed. |
| CATT | Explicit configuration |
| Samsung | A TRS resource set can be up to 4 TRS resources across two consecutive slots. In our view, the number of slots can be implicitly determined based on number of configured TRS resource per TRS resource set by following legacy configuration principle.  |

## 3.3 Configuration overhead reduction

In contributions [1-24], the following proposals were made related to configuration structure of a TRS resource set:

|  |  |
| --- | --- |
| Huawei, HiSilicon | **Observation 2: Segmentation of SIB\_X leads to larger delay and more power consumption.****Observation 3: Alt1 (common configuration) can reduce signaling overhead of configuration by configuring the common parameters only once in a resource set instead of configuring them multiple times in multiple resources.****Observation 4: Alt2 (reference configuration) can reduce signaling overhead of configuration by configuring the same parameter in the reference configuration.****Observation 5: Reference configuration can provide the same benefit as the parameter ‘number of consecutive slots’ with more flexibility.****Proposal 15: The following ways can be used to reduce signaling overhead for the TRS resource configuration as the recommendation to RAN2****- Alt1: The common configuration parameter per RS resource set, or group of sets****- Alt2: gNB provides a ‘reference configuration’, and each configured resource can have a ‘delta-configuration’ compared with the reference one** |
| ZTE, Sanechips | **Proposal 7: A default value should be applied if the corresponding parameter is not configured for RRC idle/inactive UE.****Proposal 8: Some parameters, such as startingRB and nrofRBs, can be jointly indicated to reduce signaling overhead.****Proposal 9: The number of slot of TRS/CSI-RS occasion(s) is configurable.** |
| CATT | **Proposal 1: TRS/CRS-RS resource/resource set configuration should meet the requirement of SIB message size limit.****Observation 1: When CSI-RS resources are configured by SI without association with the paging occasion(s), UE might not use the TRS for channel tracking to achieve the UE power saving gain.****Observation 2: gNB could configure the CONNECTED mode UE with the TRS/CSI-RS resource bundled with SSB/paging occasion which is configured for IDLE mode UE.****Proposal 2: TRS/CSI-RS configuration for Idle/Inactive mode should be associated with SSB/paging occasion(s) to achieve good power saving gain with low SIB signaling overhead.**  |
| Xiaomi | **Proposal 5: A predefined window before each PO can be configured for network power saving.** |
| Ericsson  | **Observation 3 To lower the overhead of configuration for TRS occasion provisioning, the applicable values for configuration parameters can be limited to those necessary for periodic TRS only.** **Observation 4 To lower the overhead of configuration for TRS occasion provisioning, common configuration parameters per TRS resource set can be identified.** **Observation 5 To lower the overhead of configuration for TRS occasion provisioning, common configuration parameters across TRS resource sets can be identified.** |
| Nordic | **Observation-1: The overhead per Idle TRS resource is 52bits****Proposal-3: Send LS to RAN2 that includes the above set of agreed parameters and ask whether RAN1 should reduce overhead by making some parameters common to multiple NZP-CSI-RS resources.** |

Configuration overhead is mainly RAN2 work, so it can be deprioritized or discussed after completion of the configuration structure in Section 3.1.

# Others

In addition to the three main topics in Section 2-4, some other issues or design aspects have been discussed by a few companies, and the corresponding proposals are captured below.

|  |  |
| --- | --- |
| Vivo | **Proposal 10: Further clarification is needed on whether and how RRC connected UE would handle the TRS configured for idle/inactive UEs, and following options can be considered.****- Opt-1: Assume the same availability as that defined for idle/inactive UEs.****- Opt-2: Ignores configuration by provided SIB and the availability indication in paging PDCCH.** |
| Samsung | **Proposal 7: Support semi-static rate matching for available TRS resources to idle/inactive UEs.** |
| LG | **Proposal 5: For REs that are configured for a TRS/CSI-RS occasion(s) for idle/inactive UEs and that UEs can assume actual TRS/CSI-RS transmission** * **The UE expect TRS/CSI-RS transmission in the REs which are overlapped with scheduled PDSCH, and the REs are counted but not used in the PDSCH RE mapping.**
 |
| Qualcomm | **Proposal 12: Whether RRC connected UEs can receive the configuration of idle/inactive TRS or use the TRS is up to UE implementation.****Proposal 13: Time gap between L1 TRS availability indication signaling and TRS/CSI-RS is needed at least for the case that an available TRS resource becomes unavailable. This can be discussed under validity time for the L1 indication.** |
| Nordic | **Observation-2: When TRS periodicity is larger than SSB periodicity, UEs with TRS location being far ahead of PF nominal location will have unnecessarily large power consumption.** **Proposal-4: For the case when TRS periodicity is larger than SSB cycle, consider delaying UE’s PF from nominal location to frame after TRS, in order to facilitate power saving.**  |

## 4.1 Impact to existing physical layer signal/channels

### 4.1.1 <1st round discussion>

According to proposals in Section 4, 5 companies (vivo, Samsung, LG, Qualcomm) submitted proposals regarding impact to RRC connected UEs or existing signal/channel, such as:

* how RRC connected UE would handle the TRS configured for idle/inactive UEs, and
* impact to PDSCH, e.g. whether or not to support semi-static rate matching for the available TRS resources.

The following question is provided for 1st round discussion about other remaining issues, Potential proposal will be draft for further discussion based on the outcome of 1st RD.

|  |
| --- |
| **[1RD] Question 2**:Whether to further discuss/study other potential issues, such as* Issue 1: How RRC connected UE would handle the TRS configured for idle/inactive UEs, and
* Issue 2: Impact to PDSCH, e.g. whether or not to support semi-static rate matching for the available TRS resources.
* Others issues are not precluded.
 |

Please provide views for **Question 2,** such as whether or not to discuss, and potential solutions.

|  |  |  |
| --- | --- | --- |
| **Company** | **Issues valid to** **discuss/FFS****(1, 2, or others)** | **Comments**  |
| Nordic |  | Issue 1 is relevantIssue 2 UEs do not rate-match PDSCH in Idle/Inactive/Inactive |
| Qualcomm | None | For issue 1, network should have already configured proper TRS for connected mode UE. So the connected mode UE should find the idle/inactive TRS useful at all. But there is no need to preclude the connected UE to use the iTRS either. This should be up to UE implementation. For issue 2, both the PDSCH and the TRS (which is supposed to be a reused TRS from connected mode UEs) are not new to Rel-17, but only configuring the connected mode UE’s TRS to idle/inactive mode UEs is new. Issue 2 is not new and hence no Rel-17 new design needs to be considered. |
| Sharp |  | Issue1: fineIssue2: semi-static rate matching will cause compatibility problem for legacy UEs, zero-power PDSCH transmission in these TRS REs might be better option |
| LG | 6-1: Need discussion6-2: Necessary  | **Regarding issue 6-1**As we commented in another section, we do not prefer to introduce ‘disabling’ indication. If the ‘disabling indication’ is not supported, it is up to UE whether to use actual TRS transmission indicated via paging PDCCH or PEI. Regarding PDSCH RE mapping issue, it should be noted that gNB has no idea that which PO will be monitored by the connected mode UEs. Thus, unlike other existing CSI-RS/TRS transmission, there might be the ambiguity on actual transmission on TRS for idle/inactive UEs. One possible method to mitigate this problem is to follow existing rule such as semi-static or dynamic rate matching. Otherwise, if there is a TRS occasion(s) where are not configured via dedicated RRC signal for the connected mode UE, RE level puncturing can be considered as described below.**Regarding issue 6-2**As we pointed out in our paper, our concern is handling overlapping between TRS and broadcast PDSCH(e.g. paging PDSCH, PDSCH for SIB, etc.) Unlike the connected mode, UE behavior with regards to the TRS occasions and PDSCHs are not defined yet. Thus legacy UEs will expect PDSCH transmission at all scheduled REs regardless of TRS transmission. However, Rel-17 TRS capable UEs shall aware whether the TRS will be transmitted or not at the REs where actual TRS transmission is indicated. To resolve the ambiguity while guarantees the PDSCH reception for the legacy UEs, RE level puncturing (i.e. REs are used for counting the PDSCH mapping but not used for actual PDSCH transmission if it is used for TRS transmission) should be considered. On the contrary, if the semi-static rate matching is used, the legacy UEs will be affected since they cannot have any prior information on the TRS transmission.  |
| ZTE, Sanechips |  | Okay to discuss issue 1. |
| CATT | None | TRS configuration would be known to UEs regardless it is configured for CONNECTED mode or IDLE/Inactive mode UE. Both issues are not needed with specification since Rel-15 |
| Samsung  | 1, 2 | We are open to discussion both. We think the two issues are relevant. Connected UEs may only be configured with partial of the SIB\_X configured TRS resources. The semi-static rate-matching all SIB\_X configured TRS resources can be supported for connected UEs and idle UEs.  |
|  |  |  |

# Proposals for GTW handling

After discussion round #1- #2, the following proposals are ready for GTW handling on.

|  |
| --- |
|  |

# Conclusion

The following agreements were made in this meeting.

|  |
| --- |
|  |

# References

[1] R1-2108745 Assistance RS occasions for IDLE/inactive mode Huawei, HiSilicon

[2] R1-2108837 TRS/CSI-RS occasions for IDLE/inactive mode TCL Communication Ltd.

[3] R1-2108865 TRS for RRC idle and inactive UEs ZTE, Sanechips

[4] R1-2108917 Discussion on TRS/CSI-RS occasion(s) for idle/inactive UEs Spreadtrum Communications

[5] R1-2108986 TRS/CSI-RS occasion(s) for idle/inactive UEs vivo

[6] R1-2109086 Further discussion on RS occasion for idle/inactive UEs OPPO

[7] R1-2109236 Configuration of TRS/CSI-RS for paging enhancement CATT

[8] R1-2109293 Discussion on TRS/CSI-RS occasion(s) for IDLE/INACTIVE-mode UEs CMCC

[9] R1-2109423 On TRS/CSI-RS configuration and indication for idle/inactive UEs Xiaomi

[10] R1-2109501 Discussion on TRS/CSI-RS occasion(s) for idle/inactive UEs Samsung

[11] R1-2109583 On TRS/CSI-RS occasion(s) for idle/inactive mode UE power saving MediaTek Inc.

[12] R1-2109622 Discussion on periodic TRS occasions in idle/inactive mode Intel Corporation

[13] R1-2109690 Discussion on TRS/CSI-RS occasion for idle/inactive Ues NTT DOCOMO, INC.

[14] R1-2109798 On TRS/CSI-RS occasion(s) for idle/inactive UEs Sony

[15] R1-2109856 Potential enhancements for TRS/CSI-RS occasion(s) for idle/inactive UEs Panasonic

[16] R1-2109945 Provision of TRS/CSI-RS for idle/inactive UEs Lenovo, Motorola Mobility

[17] R1-2109953 Remaining issues on TRS/CSI-RS occasion(s) for idle/inactive UEs InterDigital, Inc.

[18] R1-2109981 Discussion on TRS/CSI-RS occasion(s) for idle/inactive UEs LG Electronics

[19] R1-2109999 Discussion on TRS/CSI-RS occasions for idle/inactive UEs Sharp

[20] R1-2110044 Indication of TRS configurations for idle/inactive-mode UE power saving Apple

[21] R1-2110137 Provisioning TRS occasions to Idle/Inactive UEs Ericsson

[22] R1-2110198 TRS/CSI-RS for idle/inactive UE power saving Qualcomm Incorporated

[23] R1-2110284 On TRS design for idle/inactive UEs Nordic Semiconductor ASA

[24] R1-2110312 On RS information to IDLE/Inactive mode Ues Nokia, Nokia Shanghai Bell

[25] R1-2108515, Final summary for TRS/CSI-RS occasion(s) for idle/inactive UEs, Moderator (Samsung)

[26] R2-2108997, LS on UE Power Saving, 3GPP TSG-RAN WG2 Meeting #115 electronic

# Appendix: Previous Agreements

## RAN1#102-e

|  |
| --- |
| 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

|  |
| --- |
| Agreement:* 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

Agreement:* 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 sentence

Agreements:* 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

|  |
| --- |
| Update on 1/28 email: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#105-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)

Update on 1/31: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: ~~TCI state~~ 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~~
* 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#104b-e

|  |
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| 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 signalling

To further check on 4/19Agreement: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
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## RAN1#105-e

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| 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
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## RAN1#106-e

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| 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
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