3GPP TSG-RAN WG1 Meeting #94 **Tdoc R1-1809864**
Gothenburg, August 20th - 24th 2018

Agenda: **7.1.2.3**

Source: **Ericsson**

Title: **Feature lead summary for beam management - Thursday**

Document for: **Discussion, Decision**

1 Introduction

In this document, the input on beam management (part of AI 7.1.2.3) is summarized.

2 Issues

2.1 Aperiodic CSI-RS

For aperiodic CSI-RS involving a QCL TypeD indication, there is an associated UE capability (2-28) that specifies how long it takes for the UE to apply the new QCL assumption. So far, there has not been any agreement what QCL assumption the UE would make if the ap-CSI-RS was scheduled with a shorter delay than the UE capability states.

There are two alternatives:

Alternative 1: For FR2, the NW may schedule an ap-CSI-RS with a shorter delay than a threshold, and the UE applies a default QCL assumption. This does not apply to A-TRS.

Alternative 2: For FR2, the NW shall not schedule an ap-CSI-RS with a shorter delay than a threshold.

The options were discussed. There is no clear majority for any of the options:

Alt1: HW, ZTE, Ericsson, QC, Sony, Vivo

Object: LGE, Samsung [CSI-RS for BM]

Alt2: LGE, Oppo, Samsung, MTek, DCM, Nokia, CATT

Obj: ZTE, HW, Ericsson

The options were discussed with the addition that alt 1 is restricted to CSI for CSI for CSI acquisition. The views are rather similar:

Alt1: HW, ZTE, Ericsson, QC, Sony, Vivo

Object: LGE

Alt2: LGE, Oppo, Samsung, MTek, DCM, Nokia, CATT

Obj: ZTE, HW, Ericsson

The alternatives were also discussed, where alt 1 was restricted so that all the symbols in the scheduled CSI-RS resources were either before or after the threshold, but without any conclusion.

2.2 Cross-carrier scheduling with TCI in DCI

Scheduling when TCI is present in DCI was discussed. The following offline agreement was reached:

Offline agreement: When TCIpresentinDCI is enabled, the TCI field in DCI in the scheduling CC points to the activated TCI states in the scheduled CC/BWP.

2.3 TCI state during MAC CE update

If the candidate TCI states for PDSCH are updated between the time when the PDCCH is sent, and the corresponding PDSCH is received, it is unclear which TCI states the UE would use. The following off-line agreement was reached.

Offline agreement: The indicated TCI should be based on the candidate TCI states in the slot with the scheduled PDSCH.

2.4 Spatial relation for PUSCH scheduled by DCI format 0_0

RAN1 has agreed that the spatial relation for PUSCH scheduled by DCI format 0_0 follows the spatial relation for PUCCH. It has also been identified that PUSCH may be scheduled using DCI format 0_0 in a cell without PUCCH, in which case this is not possible.

Two alternatives are proposed and discussed offline:

Alternative 1: The spatial relation of PUSCH is derived from the spatial relation of PUCCH on another cell. The UE is expected to be configured with at least one PUCCH resource with spatial relation info per band in FR2

Alternative 2: PUSCH cannot be scheduled by DCI format 0_0 on a cell without configured PUCCH resource on the same cell with spatial relation info in FR2.

Alt 1: ZTE, QC, DCM, Ericsson,

Alt 2: Vivo, HW, CATT, ASUS, LG, Oppo, Intel, MTEK, QC, Sony

2.5 Remove implementation details for group-based reporting

Two companies identified that one section includes implementation details and suggest removing those. It was also suggested to remove brackets in the same paragraph.

Proposal 1 Agree to the following TP.

5.2.1.4.2 Report Quantity Configurations

<Unrelated part omitted>

If the UE is configured with a *CSI-ReportConfig* with the higher layer parameter *reportQuantity* set to 'cri-RSRP' or 'ssb-Index-RSRP'

- if the UE is configured with the higher layer parameter *groupBasedBeamReporting* set to 'disabled', the UE is not required to update measurements for more than 64 [CSI-RS and or SSB] resources, and the UE shall report in a single report *nrofReportedRS* (higher layer configured) different [CRI or SSBRI (SSB Resource Indicator)] for each report setting.
- if the UE is configured with the higher layer parameter *groupBasedBeamReporting* set to 'enabled', the UE is not required to update measurements for more than 64 CSI-RS and or SSB resources, and the UE shall report in a single reporting instance two different CRI or SSBRI for each report setting, where CSI-RS and/or SSB resources can be received simultaneously by the UE.

2.6 Meaning of UE feature maxNumberRxTxBeamSwitchDL

According to RAN1 agreements and TS 38.331, UE capability reporting has one parameter called '*maxNumberRxTxBeamSwitchDL*'. The possible values are {4, 7, 14} at all SCS. By reporting this capability, UE informs gNB about the supported 'maximum number of Tx + Rx beam changes a UE can conduct during a slot across the whole band CC'. How does gNB interpret this UE capability reporting is unclear. It is suggested to capture this agreement in TS38.214 as follows.

Proposal 2 Agree to the following TP.

---Start of Text Proposal TS38.214 Section 5.1.5---

< Unchanged parts are omitted >

UE is not expected to be configured with a number of changes of spatial domain filter within a slot that is larger than the UE capability reported in *maxNumberRxTxBeamSwitchDL*,

< Unchanged parts are omitted >

---End of Text Proposal TS8.214 Section 5.1.5---

2.7 Inconsistency on *CSI-ResourceConfig* definition

One company observed that there is a discrepancy between 38.214 and 38.331 regarding the definition of CSI-ResourceConfig.

Proposal 3 Agree to the following TP.

>>> Text Proposal for 38.214 Section 5.2.1.2 >>>

Each CSI Resource Setting *CSI-ResourceConfig* contains a configuration of a list of S≥1 CSI Resource Sets (given by higher layer parameter *csi-RS-ResourceSetList*), where the list is comprised of references to either or both of NZP CSI-RS resource set(s) and SS/PBCH block set(s) or the list is comprised of references to CSI-IM resource set(s). ~~with each CSI Resource Set consisting of CSI-RS resources (comprised of either NZP CSI-RS or CSI-IM) and SS/PBCH Block resources used for L1-RSRP computation.~~ Each CSI Resource Setting is located in the DL BWP identified by the higher layer parameter *bwp-Id*, and all CSI Resource Settings linked to a CSI Report Setting have the same DL BWP.

>>> End Text Proposal >>>

2.8 Increase the maximum number of TCI states

Currently, maximum number of TCI state is 64 and it is decided to support dynamic indication of 64 beams.

At that time, dynamic beam indication of 64 beams were possible since there was no restriction on the TCI-State configurations.

However, further restrictions on the configuration of TCI states are agreed in Busan meeting and we can't share TCI-States between TRS and other RS/channels.

For example,

TRS

For a periodic CSI-RS resource in a *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *trs-Info*, the UE shall expect that a TCI-State indicates one of the following quasi-colocation type(s)

- 'QCL-TypeC' with an SS/PBCH block and, when applicable,'QCL-TypeD' with a CSI-RS resource in an *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *repetition*, or

PDCCH

For the DM-RS of PDCCH, the UE shall expect that a *TCI-State* indicates one of the following quasi co-location type(s):

- 'QCL-TypeA' with a CSI-RS resource in a *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *trs-Info* and, when applicable, 'QCL-TypeD' with a CSI-RS resource in an *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *repetition*, or
- 'QCL-TypeA' with a CSI-RS resource in a *NZP-CSI-RS-ResourceSet* configured without higher layer parameter trs-Info and without higher layer parameter *repetition*, when 'QCL-TypeD' is not applicable.
- 'QCL-TypeA' with a CSI-RS resource in a *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *trs-*
- 'QCL-TypeC' with an SS/PBCH block and, when applicable, 'QCL-TypeD' with the same SS/PBCH block, or
- *Info* and, when applicable, 'QCL-TypeD' with the same CSI-RS resource, or

Note that our intention is not to change on the number of activated TCI states and there will be no change but additional RRC configurations.

To solve this, it is proposed that

Proposal 4 Increase the maximum number of TCI states to 128.

3 Summary of input

3.1 CORESET #0

One issue that has been discussed during a few meetings is if CORESET#0 can be configured with TCI states, and if there are any limitations in the configuration. In the contributions, there seems to be consensus that it should be possible to configure CORESET#0 with TCI states. The remaining issue is if the configuration should be associated with any restrictions.

There are two alternatives:

Alternative 1: TCI states can be freely configured for CORESET#0

- TCI state(s) can be UE-specifically configured and activated subsequently for CORESET #0. [5]
- TCI states can be configured and activated for CORESET #0. [15]
- NR supports CORESET#0 to be configured with TCI state(s) if it is re-configured via RRC signaling. [11]
- If RAN1 decides to ask RAN2 for changes in RAN2 specification, RAN1 shall recommend Alt 1', otherwise RAN1 shall adopt Alternative 3 or 3' [17] [19]

Alternative 2: Only SSBs can be configured in TCI states for CORESET#0

- UE does not expect RS other than SSB configured in TCI state TCI-StatesPDCCH for re-configuration of CORESET #0. [3]
- For CORESET 0, it is up to gNB whether to configure TCI state or not, and only the TCI state including SSB index can be configured. [8]
- For unicast by CORESET#0, re-use the MAC CE message "TCI state indication for UE-specific PDCCH MAC CE" to indicate the CORESET#0 and the index of selected SS/PBCH block. [9]
- TCI state is configured for CORESET #0 where the QCL reference is only an SSB. Once TCI state is configured for CORESET #0, the UE follows QCL assumption based on the TCI state configuration for both broadcast PDCCH and unicast PDCCH in the search space set(s) associated with the CORESET #0. [10]
- During beam failure recovery, UE indicates gNB the new SSB/CORESET0/SS0 for non-broadcast PDSCH. [18]
- In absence of beam failure, gNB indicates UE the new SSB/CORESET0/SS0 for non-broadcast PDSCH by UE-specific PDCCH MAC CE with one CORESET ID reserved for CORESET 0. [18]

Alternative 3: re-use the MAC CE message for PDCCH beam indication to indicate one SSB index for CORESET#0

As all the input contributions indicated that CORESET#0 can be configured with TCI states, it is proposed that

Proposal 5 (Modified) Based on the discussion in the joint offline session, CORESET#0 cannot be configured with TCI states.

(Comments to previous proposal)

Company	Comment
Vivo	Alt. 2. Search space #0 is used for uni-cast data transmission. SSB indication is needed for UE to find SS#0
OPPO	Support
Intel	We think Proposal 1 and 2 should be discussed together. Only RS QCLed with SSB can be used for CORESET 0 beam indication to keep our previous agreement that TCI indication is per CORESET instead of per SS.

Ericsson	Support
CATT	Support Alt-2
Qualcomm	Support Alt. 3., which preserves same definition for SS0/CORESET0 as initial access and no RRC impact
Nokia	Support the proposal.
Sony	Support. We suggest to handle this issue in steps. First we dicuss whether or not TCI state can be configured and activated for CORESET #0. Second, if TCI state configured and activated for CORESET #0, then we discuss whether there is limitation on the RS in TCI state, if applicable.
LGE	This issue is highly correlated with control channel AI, so that it should be jointly discussed and resolved.
MediaTek	We agree with Intel that Proposal 1 and Proposal 2 should be discussed together. A high-level agreement as Proposal 1 seems not enough at this stage. We also believe that, if CORESET-0 is to be configured with TCI state, restricting it to SSB is crucial from UE complexity perspective.
HW/HiSi	Ok
ZTE	Support
Samsung	We propose to use MAC-CE message to indicate one SSB index for CORESET#0, which does not have RRC impact. In contrast, Alt1 and Alt2 have RRC impact.

OPPO	Either of the following configuration are ok for us: ● TCI state can be configured with SSB or CSI-RS resoruce ● TCI state can be only configured with SSB
Samsung	Propose to use MAC-CE message to indicate one SSB index for CORESET#0.
ZTE	Support "TCI state can be configured with SSB or CSI-RS resource" We do not see any necessity of restricting only SSB as reference RS w.r.t spatial parameter for CORESET#0. Last meeting, we have clear agreement that SSB is assumed as reference RS w.r.t spatial parameter before TRS configuration, but it's not available after that. Therefore, when TCI state is configured with CSI-RS resource, the spatial QCL assumption between **active** SSB/CORESET0/SS0 and the configured CSI-RS is ensured by NW, where "active" means that the SSB/CORESET0/SS0 contains real PDCCH transmission. Agreement For the DM-RS of PDCCH, the UE should only expect the following three configurations of the higher layer parameter *TCI-State* while the fourth configuration is valid as default, before TRS is configured:

Valid TCI state Configuration	**DL RS 1**	***qcl-Type1***	**DL RS 2 (if configured)**	***qcl-Type2* (if configured)**
1	TRS	QCL-TypeA	TRS	QCL-TypeD
2	TRS	QCL-TypeA	CSI-RS (BM)	QCL-TypeD
3**	CSI-RS (CSI)	QCL-TypeA		
4*	SS/PBCH Block*	QCL-TypeA	SS/PBCH Block*	QCL-TypeD

**Note: Only when QCL-typeD is not applicable agreement what QCL assumption the UE would make if the ap-CSI-RS was scheduled with a shorter delay than the UE capability states.

There are two alternatives:

Alternative 1: For FR2, the NW may schedule an ap-CSI-RS with a shorter delay than a threshold , and the UE applies a default QCL assumption. This does not apply to A-TRS.

- If the time offset between reception of the DL DCI and the first symbol of the corresponding CSI-RS is less than the threshold Threshold-Sched-Offset, UE assumes that the spatial Rx parameter of AP-CSI-RS is overridden by the spatial QCL assumption for PDSCH reception but the other QCL parameters of AP-CSI-RS is still indicated by its associated aperiodic triggering state. [2]
- The default TCI state for a UE to receive aperiodic CSI-RS is the DMRS of PDSCH in the same slot when the triggered aperiodic CSI-RS is transmitted. [5]
- When the scheduling delay for aperiodic CSI-RS is smaller than the minimum scheduling delay of the UE, the UE may obtain QCL assumptions for an aperiodic CSI-RS transmitted in the PDSCH region from a default TCI state, where the default TCI state corresponds to the TCI state used for PDSCH QCL indication in the slot where the measurement is performed. [15]
- For non cross-carrier triggering, if time offset between the reception of scheduling DCI and the first symbol of scheduled A-CSI-RS is less than the corresponding beam switch threshold, default QCL assumption of A-CSI-RS follows that for PDSCH reception. [18]
- For CSI-RS resource set configured with repetition set to 'ON', the UE does not expect trigger time offset to be less than Threshold-Sched-Offset. For CSI-RS resource set configured with repetition set to 'OFF', or for a CSI-RS resource set configured without repetition and without trs-Info, the default QCL assumption for a UE to receive aperiodic CSI-RS is the same as that used for DMRS of PDSCH in the same slot when the triggered aperiodic CSI-RS is transmitted. [12]
    - o A slot where periodic and/or semi-persistent CSI-RS resource transmitted in the same slot as PDSCH with different TCI states between NZP-CSI-RS resource and PDSCH DMRS should not be handled as a valid downlink slot.

Alternative 2: For FR2, the NW shall not schedule an ap-CSI-RS with a shorter delay than a threshold

- For aperiodic CSI-RS configured with QCL Type-D, UE shall expect its scheduling offset is above threshold UE reported. [8]
- For CSI-RS resource set configured with repetition set to 'ON', the UE does not expect scheduling time offset to be less than Threshold-Sched-Offset. [17]
- For CSI-RS resource set configured with repetition set to 'OFF', the UE does not expect scheduling time offset to be less than Threshold-Sched-Offset. [17]

Proposal 7 Further discuss the above alternatives offline.

Company	Comment
OPPO	Support Alt2.
Intel	Support Alt2. For aperiodic TRS, it follows this way.
ZTE	Support Alt1. When TCI_PresentInDCI is disabled or there exists PDSCH transmission with scheduling offset < threshold, with the gNB can trigger one AP-CSI-RS for CSI acquisition with one shorter delay than threshold for low latency, like in FR1 or LTE. We cannot see any benefits from restricting CSI-RS scheduling offset. For CSI-RS resource set configured with repetition set to "off" and the scheduling offset is low than the threshold, UE behavior is still very clear, i.e., according to the default PDSCH beam, UE should keep its Rx beam and measuring differnt TX beams from gNB. For "on", UE cannot make any Rx beam training, but at least once beam measurement on default beam can be achieved.

	Therefore, we do NOT see any necessity of restricting the AP-CSI-RS scheduling offset.
HW/HiSi	As agreed/captured in the consequence part, 2-28 is a recommendation only. Default behavior should be defined and support to have more offline on this.
MediaTek	Support Alte 2. At least for CSI-RS-BM, it is not clear to us how to apply a default beam since their QCL Type-D is configured in RRC. Before the latency, UE cannot decide spatial QCL assumption. In addition, before the latency, UE cannot tell if an AP CSI-RS is for CSI acquisition or for BM.
Samsung	Alt 2
Ericsson	Alt 1
CATT	Alt-2 is fine. We don't see the system is broken.
Qualcomm	Alt
Nokia	Support Alt 2. Related to CSI-RS for beam management, both repetition set to 'On' and 'OFF', it's important that the CSI-RS resource has "correct" QCL
Sony	Support
LGE	Support Alt2, without spec impact

Company	Comment
Intel	Support Alt2. Alt1 could not work for inter-band CA case, e.g. Pcell in FR1 and Scell in FR2.
OPPO	Alt2
vivo	Alt2
ZTE	Support Alt1. For the case raised by Intel, gNB can configure PUCCH for the Scell in FR2 directly and using the previous agreement "the spatial relation for PUSCH scheduled by DCI format 0_0 follows the spatial relation for the configured PUCCH". The Alt-1 is to handle the case of Pcell and Scell both in FR2 but Scell without any PUCCH configuration, similar to LTE design.
Qualcomm	[illegible] single beam intra-band CA assumption, support Alt. 1
Nokia	Support Alt1. Similar view as ZTE.
LGE	Alt-2
MediaTek	Alt 2. Currently for Scell, there is no PUCCH. The same rule as for Pcell cannot be applied directly.
HW/HiSi	Alt-2

- o In case of cross-carrier scheduling, UE expects that the scheduling cell can provide spatial QCL assumption from corresponding CORESET configuration.

Some companies discuss which CORESETs the UE should use when deriving the default QCL assumption:

- For PDSCH QCL determination, the CORESET-BFR should be excluded if the scheduling offset is below a threshold. [8]
- Support considering CORESET 0 in determining lowest CORESET ID for default PDSCH QCL. [18]
- CORESET for PDCCH scheduling beam failure recovery response should not be used to determine the default PDSCH TCI. [18]

The following proposal is also related to how the UE derives the default QCL assumption:

- With regard to default PDSCH QCL assumption, UE shall expect that at least one CORESET with TCI state configured in active BWP. [8]

Proposal 9 Further discuss the above alternatives offline.

Company	Comment
Intel	Although there are different proposals for different aspects, we suggest we can try to make a conclusion on default PDSCH beam assumption when there is no valid TCI configuration in a CORESET. This seems to be an essential issue.
ZTE	Share the same view as Intel that is an essential issue. In addition, we should keep in mind that the default PDSCH beam should be the same across all potential scheduled CCs in FR2 for simultaneous reception.
vivo	Similar view as Intel.
HW/HiSi	To facilitate further discussions, suggest feature lead to categorize use cases and also possible solutions for each scenario.
MediaTek	Similar view as Intel. This is an essential issue. The solution should consider the case of LF+HF case.
Nokia	Similar view as ZTE.
Qualcomm	First, we need to agree single beam is always assumed for intra-band CA. Second, clarify if alternatives for cross-carrier default QCL are for intra-band CA or not.
CATT	Agree with Intel. The case where an active BWP doesn't have any configured CORESETs need to be resolved first, e.g. not supporting scheduling offset smaller than the threshold.
Ericsson	Agree with Intel: this is essential and we should strive for a complete solution.

Yet another option is that the UE simply applies the TCI state of the scheduled CORESET. This would then mean that the NW would have to define TCI states with QCL Type D for a CORESET in FR1. It is our understanding that the signalling supports this.

It is the understanding of the moderator that the first decision to make is if the cross-carrier scheduling without indication in DCI is allowed or not. In the contributions, no company proposed to forbid this possibility. Instead, there were different proposals on how to derive the default QCL assumption.

Summing up, there are the following options for the case when tci-PresentInDCI is not 'enabled', or the scheduling delay is below the threshold:

Alt 1: cross-carrier scheduling is not allowed

Alt 2: the UE derives the default TCI state based on the CORESET in the target, and at least one CORESET must be configured in the target

Alt 3: the UE derives the default TCI state based on the CORESET for the CC with lowest CC Id

Alt 4: the UE derives the default TCI state based on the CORESET for the scheduling CC

Proposal 10 Further discuss the above alternatives offline

Company	Comment
CATT	Alt-1: Cross-carrier scheduling is <u>allowed</u> when TCI is in DCI and scheduling offset larger than threshold. In our undersranding, all alterantives impose some system restriction here or there and it is a matter whethere the restriction is critical or can be simply bypassed by other NR functionalities readily availlabe to gNB scheduling. To us the restriction of alt-1 is scheduling delay but we believe this can be easily resolved by scheduling PDSCH in another CC where scheduling delay smaller than the offset is allowed (e.g. in the scheduling CC, using same-carrier scheduling). Alt-2 mandates CORESET configuration in all CC and not preferable. Alt.3/4 mandates type-D configuration in all CC (even in FR1) and not preferrable either.

For both the cases when *tci-PresentInDCI* is set to 'enabled' and *tci-PresentInDCI* is not configured, if t_{offset} the offset between the reception of the DL DCI and the corresponding PDSCH is less than the threshold *Threshold-Sched-Offset*, the UE may assume that the DM-RS ports of PDSCH of a serving cell are quasi co-located with the RS(s) in the TCI state with respect to the QCL parameter(s) used for PDCCH quasi co-location indication of the lowest *CORESET-ID* in the latest slot in which one or more CORESETs with search space(s) the UE is monitoring within the active BWP of the serving cell are configured for the UE. If none of configured TCI states contains 'QCL-TypeD', the UE shall obtain the other QCL assumptions from the indicated TCI states for its scheduled PDSCH irrespective of the time offset between the reception of the DL DCI and the corresponding PDSCH.

3.4.1 In transition periods

Several companies discuss the QCL assumptions the UE can make during transition periods, e.g., between RRC reconfiguration and MAC CE activation.

- The UE can assume the TCI state of CORESET #0 (if configured) as default TCI state between RRC configuration and MAC-CE activation. [3]
- Between RRC reconfiguration and MAC-CE activation, the UE may assume that PDSCH is spatially QCL-ed with CORESET #0. [3]
- Between RRC re-configuration and subsequent MAC CE activation, a UE refers to the SS/PBCH resource determined during random access or the most recent DL RS activated by MAC CE in existing CORESETs whichever is more recent for the default TCI state of PDCCH. [5]
- For RRC reconfiguration and activation of TCI-states PDCCH: [6]

- o For an RRC reconfiguration where there is an associated (subsequent) RACH procedure, the UE assumes that PDCCH is QCL with the SSB/CSI-RS identified during the RACH procedure, until MAC-CE activation of a TCI state from the RRC configured states.
  - o For an RRC reconfiguration where there is not an associated RACH procedure, the UE continues to assume the most recent MAC-CE indicated TCI state for PDCCH in the CORESET, until MAC-CE activation of a TCI state from the RRC configured states.
- During the period between the RRC re-configuration of TCI-statesPDCCH with multiple TCI states and MAC-CE activation, the UE shall assume the TCI state activated in the most recent MAC-CE activation. [9]
- After an RRC re-configuration of TCI-StatesPDCCH for a CORESET (at least one that is not CORESET#0 or CORESET BFR) and prior to MAC-CE activation of a TCI state for that COREST, the UE makes the following assumption: [14]
  - o For an RRC reconfiguration where there is an associated (subsequent) RACH procedure, the UE assumes that PDCCH is QCL with the SSB/CSI-RS identified during the RACH procedure
  - o For an RRC reconfiguration where there is not an associated RACH procedure, the UE assumes that PDCCH is QCL with a TCI state which is provided by the lowest ID of TCI-StatesPDCCH for the CORESET
- Between reconfiguration of TCI-StatesPDCCH and subsequent MAC-CE activation [16]
  - o if the latest activated TCI state for the CORESET is not removed out of TCI-StatesPDCCH by reconfiguration, UE assumes that the CORESET is monitored via the latest activated TCI state;
  - o otherwise, UE assumes that the CORESET is monitored via the TCI state with the lowest TCI state ID among the reconfigured TCI-StatesPDCCH.
- Between reconfiguration of TCI states for PDSCH and subsequent MAC-CE activation, [16]
  - o if any of TCI state among the latest activated subset of TCI states for PDSCH is not removed out of TCI states by reconfiguration, codepoints in TCI field in scheduling DL DCL can be mapped to the latest activated subset of TCI states for PDSCH;
  - o otherwise, UE assumes that PDSCH is received via the same TCI state for receiving the scheduling CORESET.
- Assume implicit TCI-State for PDCCH and PDSCH based on the associated downlink RS (SS/PBCH block) with selected PRACH preamble before and after RRC configuration until first MAC-CE activation command. [17]
- After first RRC configuration and activation it’s considered that between RRC re-configuration and activation the used TCI state for a CORESET is given by the RS for the most recently activated TCI state from the list TCI-StatesPDCCH for the CORESET. [17]
- The TCI field in DCI shall should correspond to TCI states selected in the most recent MAC-CE after RRC reconfiguration until new MAC-CE is received. [17]
- Existing TCI state is used as PDCCH default TCI between RRC reconfig and MAC-CE activation. [18]

OPPO	Support

This issue has been discussed during several meetings. The same alternatives are still on the table, and there has been little progress: the likelihood of reaching consensus is small. Without any additional agreements, this will be up to UE implementation. It is the view of the moderator that there is little point to discuss this on-line or in official offline sessions without additional offline alignment.

Intel	Support this proposal. No definition when RRC reconfiguration is done.

Proposal 11 The QCL assumptions during transition periods are up to UE implementation.

Company	Comment

ZTE	Not support. This is one negative proposal, and there exists the risk of link failure due to misalignement for default DL beams between gNB and UE sides.
HW/HiSi	With minimum UE capability in Rel-15, RRC reconfiguration of TCI states seems difficult to avoid even for intra-cell mobility in FR2. As MAC-CE may not follow RRC message immediately, to minimize the ambiguilty periods, suggest considering applying the lowest entry of RRC configured TCI states as default beam for CORESET monitoring before MAC-CE activation (similar to what was agreed for the case when scheduling offset is smaller than *Threshold-Sched-Offset*).
Sony	Support
Nokia	If this is up to UE implementation, there is a risk for beam misalignment between gNB and UE. Thus, we think it's safer to define the behavior: use previous activated TCI state until new MAC-CE is received and acknowledged.
CATT	Leaving to UE implementation is acceptable.
Samsung	We lean to specify it clearly to avoid misalignment. Same view as Nokia, using previously activated TCI state is a natural choice.

3.5 Default spatial relations:

Several companies discuss the spatial relations the UE would use during transition periods, e.g., between RRC reconfiguration and MAC CE activation.

- Before RRC configuration, the UL transmission beam is derived from initial access procedure, i.e. the UE assumes PUSCH are spatially QCL-ed with Msg3. [3]
- The UE can assume the first element of PUCCH-SpatialRelationInfo as default spatial relation to provide the PUCCH QCL between RRC configuration and MAC-CE activation. [3]
- After an RRC re-configuration of PUCCH-SpatialRelationInfo or a beam failure recovery/RLF/handover, and prior to MAC-CE activation of one of the spatial relations in PUCCH-SpatialRelationInfo, UE assumes a default spatial relation for PUCCH transmission by: [4]
    - o If there is an accompanying PRACH transmission, follow the spatial relation for PRACH or msg 3 transmission.
    - o If this is no accompanying PRACH transmission, follow the most recent MAC-CE indicated spatial relation for the PUCCH resources.
- Between RRC re-configuration and subsequent MAC CE activation, a UE may refer to the SS/PBCH block resource determined during random access or the most recent spatial relation activated by MAC CE whichever is more recent as the default spatial transmission filter for PUCCH. [5]
- Prior to UE dedicated configuration, a UE reuses the spatial relation of Msg.3 PUSCH for other PUSCH transmissions. [5]
- PUCCH is spatially QCL-ed with the latest activated PUCCH beam. [6]
- Spatial beam for Msg3 retransmission scheduled by DCI 0_0 is undefined. [6]
- During the period between the RRC configuration of PUCCH-SpatialRelationInfo with multiple RSs and MAC-CE activation, the UE shall apply the Tx beam as follows: [9]
    - o The Tx beam used to transmit msg3 in RACH for the PUCCH for the case of RRC initial configuration
    - o The most recently activated Tx beam for the case of RRC re-configuration.
- The spatial relation for PUCCH resources before and between RRC re-configuration and subsequent MAC-CE activation is left up to UE implementation. [13]

- After an RRC re-configuration of PUCCH-SpatialRelationInfo and prior to MAC-CE activation, the UE makes the following assumption: [14]
    - o For an RRC reconfiguration where there is an associated (subsequent) RACH procedure, the UE assumes that PUCCH is QCL with the Msg. 3 PUSCH during the RACH procedure
    - o For an RRC reconfiguration where there is not an associated RACH procedure, the UE assumes that PUCCH is QCL with the lowest ID of PUCCH-SpatialRelationInfo
- Default spatial relation between RRC reconfiguration and subsequent MAC-CE activation is provided by the most recently activated one for PUCCH. [17]
- After RACH procedure, until RRC configuration and MAC-CE activation allows default PUSCH beams to be based on PUCCH resources, the beams identified during RACH procedure serve as default. These are the beam of SSB identified by the UE for DL, and the beam of the PRACH or msg3 transmission that led to completion of RACH procedure for UL. [18]
- Existing spatial relation is used as PUCCH default spatial relation between RRC reconfig and MAC-CE activation, if there is more than one spatial relation in PUCCH-SpatialRelationInfo and UE supports MAC-CE based activation. [18]
- Newly configured additional PUCCH remains inactive till MAC-CE activation. [18]
- Specify the UE behavior before the dedicated configuration of PUCCH resource [11]

This issue has been discussed during several meetings. The same alternatives are still on the table, and there has been little progress: the likelihood of reaching consensus is small. Without any additional agreements, this will be up to UE implementation. It is the view of the moderator that there is little point to discuss this on-line or in official offline sessions without additional offline alignment.

Proposal 12 The spatial relations during transition periods are up to UE implementation.

Company	Comment
Intel	Support this proposal. No definition when RRC reconfiguration is done.
OPPO	Support
ZTE	Not support. This is one negative proposal, and there exists the risk of link failure due to misalignement for default DL beams between gNB and UE sides.
HW/HiSi	Similar to previous section. Suggest to minimize the ambiguity periods by introducing default behavior.
Sony	Support
Nokia	If up to UE implementation, there is a risk for beam misalignment between gNB and UE. Thus, we think it's safer to define the behavior: use previous activated TCI state until new MAC-CE is received and acknowledged.
CATT	Lean to define it clearly.
Samsung	Same to Nokia's view, using previous activated SpatialRelation until new MAC-CE is a natural choice.
MTI	Support After an RRC re-configuration, UE has an opportunity to refine PUCCH beam by using PUCCH-SpatialRelationInfo. There is a chance that only one candidate beam is configured in PUCCH-SpatialRelationInfo, and UE can apply this beam directly to transmit HARQ and RRC re-configuration complete before MAC-CE activates this. This could happen if the spatial relation is up to UE implementation

3.6 Slot aggregation

A few companies discuss the QCL assumptions for multi-slot PDSCH and the scheduling delay. Two companies provide suggestions on how to define the scheduled delay:

IPR2025-01190
Hannibal Exhibit 2008, Page 14 of 26

Alternative 1: The delay is defined as the time between the last symbol of PDCCH and the first symbol of PDSCH *in the first scheduled slot.*

- For multi-slot PDSCH, the TCI state is determined based on the scheduling offset for the first PDSCH slot instead of the scheduling offset for each PDSCH slot. [8]

Alternative 2: The delay is defined as the time between the last symbol of PDCCH and the first symbol of PDSCH *in each scheduled slot.*

- Time offset toffset is defined as the time duration from the end of last symbol of PDCCH carrying the scheduling DL DCI to the beginning of the first symbol of corresponding PDSCH in each of the scheduled slots. [2]

A few companies propose to introduce restrictions for the scheduled delay for multi-slot PDSCH:

- For PDSCH based slot aggregation, the time offset between the last symbol of PDCCH and the first symbol of PDSCH in the first scheduled slot should be no less than Threshold-Sched-Offset. [18]
- For a UE configured with TCI states containing QCL-TypeD, the time offset between the reception of the DL DCI and the corresponding multi-slot PDSCH should be equal to or greater than the threshold Threshold-Sched-Offset. [11]

One company discusses PUSCH with slot aggregation:

- For PUSCH with slot aggregation, all slots share the same spatial relation info in Rel-15. PUSCH beam determination is independent of whether PUSCH carries UCI, SCH data, or both. [18]

Proposal 13 Further discuss the above alternatives offline.

Company	Comment
Intel	We think first we should make sure that the beam for each slot is the same to avoid MCS mismatch issue. Then we can down-select the following ways: 1) PDSCH beam is based on the scheduling offset of the first slot 2) Scheduling offset of the first slot should be no less than UE reported threshold
vivo	Fine with the proposal that all the scheduled slots follow the QCL of the first slot.
ZTE	Support Alt2, for obtaining diversity gain, like precoding cycling. Also, it aligns with UE buffering behavoir according to default beam assumptions which can vary [illegible]
HW/HiSi	[illegible]
MediaTek	Share the same understanding as HW/HiSi that Alt 1 is captured, but we are fine [illegible]
Qualcomm	Support using 1st PDSCH to define beam switch latency for slot aggregation, and restrict the latency to be always greater than threshold
Nokia	[illegible] to avoid ambiguity
CATT	Prefer to use the offset of the 1st slot to determine the spatial QCL of the entire PDSCH assignment. Prefer to allow scheduling offset smaller than threshold, i.e. for delay-sensitive services.
Samsung	It looks like only the UE is only able to implement any one of the following two options: Option 1: per-slot QCL assumption. Option 2: Scheduling offset of 1st slot is >= the threshold.

	In our view, using the offset of 1st slot to determine the QCL-type D for multi-slot PDSCH is not doable at the UE side. Here is the reason: considering threshold = 2 slots. One DCI in slot n schedules one multi-slot PDSCH starting from slot n. The PDSCH part in slot n and n+1 are both < the threshold. For the PDSCH part in slot n and n+1, the UE will applies the default QCL based on the lowest CORESET ID in recent slot, which could be different for PDSCH part in slot n and n+1.

3.7 Cross-carrier scheduling:

A few companies discuss cross-carrier scheduling issues not only related to default QCL relation:

- In case of cross-carrier scheduling, the TCI indication refers to TCI states on the target CC [1]
- To solve the issue of TCI field absence for cross carrier scheduling, down-select the following alternatives for determining TCI state for PDSCH: [16]
  - Alternative 1: a DL DCI, scheduling a PDSCH of another cell serving cell, always comprises TCI field.
  - Alternative 2: The TCI states applied for CORESETs in the scheduling serving cell are also associated with index of reference signal(s) transmitted in the scheduled serving cells.
  - Alternative 3: UE assumes PDSCH in scheduled serving cell is always received via one TCI state in activated subset of TCI state for receiving PDSCH in scheduled serving cell, e.g. codepoint 0 in TCI field.
- If the scheduling DL DCI is scheduled on another serving cell and the scheduling delay is less than the threshold Threshold-Sched-Offset, down-select the following alternatives for determining TCI state for PDSCH: [16]
  - Alternative 1: UE assumes the PDSCH is received via one TCI state in activated subset of TCI states for receiving PDSCH in scheduled serving cell, e.g. codepoint 0 in TCI field.
  - Alternative 2: The TCI states applied for CORESETs in the scheduling serving cell are also associated with index of reference signal transmitted in the scheduled serving cells.
- When PDSCH and its scheduling PDCCH are in the different CCs, [2]
  - If TCI field is not present in DCI, UE obtains the QCL assumptions other than QCL-TypeD from the first one of M TCI-States configured for the active BWP in which the PDSCH is scheduled.
  - If TCI field is present in DCI and the time offset between the reception of the DL DCI and the corresponding PDSCH is smaller than a threshold Threshold-Sched-Offset, UE obtains the QCL assumptions other than QCL-TypeD from the indicated TCI state in DCI for the PDSCH.

Proposal 14 Further discuss the above alternatives offline.

Company	Comment
Intel	It seems our proposal is not captured. We pasted it below: For cross-carrier scheduling, if TCI is not present in DCI, UE can use the default PDSCH QCL assumption to receive the scheduled PDSCH regardless of the scheduling offset, and the default PDSCH QCL assumption is based on the TCI state for CORESET in the latest slot with the lowest ID if multiple CORESETs are configured. *Feature lead comment: this is under „Default QCL“*
vivo	Our proposal are also not captured. Several comments 1. Agree with intel's proposal.

	2. Regarding the case PDCCH and PDSCH having different numerology, *schd_offset* is determined based on the numerology of PDSCH; *Feature lead comment: this is mentioned under „Timing related“*
ZTE	It seems our proposal is not captured. We pasted it below: *When PDSCH and its scheduling PDCCH are in the different CCs,* - *If TCI field is not present in DCI, UE obtains the QCL assumptions other than QCL-TypeD from the first one of M TCI-States configured for the active BWP in which the PDSCH is scheduled.* *If TCI field is present in DCI and the time offset between the reception of the DL DCI and the corresponding PDSCH is smaller than a threshold Threshold-Sched-Offset, UE obtains the QCL assumptions other than QCL-TypeD from the indicated TCI state in DCI for the PDSCH.* *Feature lead comment: included above*
HW/HiSi	We can first discuss whether to allow cross-carrier scheduling with DCI(s) without TCI field.
MediaTek	Our proposal is not captured. We copy it below: In case of cross-carrier scheduling, UE expects that the scheduling cell can provide spatial QCL assumption from corresponding CORESET configuration. *Feature lead comment: now captured under „Default QCL“*
Nokia	We prefer solution where default PDSCH QCL assumption is derived from the TCI states activated for receiving PDSCH in scheduled serving cell.
Qualcomm	Clarify if it is for single beam intra-band CA or not

Clearly, there are open issues also for the normal cross-carrier scheduling case where the TCI is present in DCI, and when the scheduling threshold is above the threshold. The main issue seems to be if the TCI states are

Alt 1: the TCI states of the PDSCH in the *scheduling* CC

Alt 2: the TCI states of the PDSCH in the *scheduled* CC.

Proposal 15 Further discuss the above alternatives offline.

Company	Comment
Vivo	Alt 2
[illegible]	[illegible]

Offline agreement: ~~When TCIpresentinDCI is enabled, the TCI field in DCI in the scheduling CC points to the~~ activated TCI states in the scheduled CC/BWP.

3.8 Timing related:

A few companies discuss clarifications on timing:

1. In case of CBG-based PDSCH, the Ack for determining MAC-CE activation time refers to the last Ack for all CBGs, regardless which CBGs carry MAC-CE bits. [18]
2. For cross carrier scheduled PDSCH, the scheduling offset threshold (timeDurationForQCL) is determined according to numerology of the scheduled PDSCH carrier. [3]

IPR2025-01190
Hannibal Exhibit 2008, Page 17 of 26

3. The indicated TCI should be based on the candidate TCI states in slot with scheduling PDCCH instead of the slot with scheduled PDSCH. [8]

Issue 1. has been discussed also in the CSI reporting, and a proposal is being developed there. There is no need to discuss that here.

On issue 3, we have the following offline agreement:

Offline agreement: The indicated TCI should be based on the candidate TCI states in the slot with the scheduled PDSCH.

Company	Comment
Intel	Support the 1st and 3rd bullet. But for the first bullet, we do not see spec impact. For the 2rd bullet, we feel it is better to be based on the minimal SCS between scheduling and scheduled carriers.
vivo	Support all the three proposals.
ZTE	Need further offline discussion due to the above issue should be assumed as general one and not only for BM for the perspective of spec. We are not sure whether the above issues are discussed on BM session is appropriate or not, e.g. the 2nd one depends on how the scheduling offset is interpreted in control session.
HW/HiSi	For the 1st point, current spec is clear enough and no change is needed. To be specific, the original wording of 'HARQ-ACK corresponding to the PDSCH carrying the activation command' already covered both CBG-based and TB-based transmission (i.e., HARQ-ACK for the whole PDSCH).
Qualcomm	TP for 1st bullet can be found in [18] and also copied below. If not clarified, ACK timing given CBG based transmission may have the following two understandings: (1) Ack of all CBGs containing the MAC-CE bits, or (2) Ack of all CBGs, regardless of which of them carry MAC-CE bits . --- Start of text proposal to Section 5.1.4.2 in TS 38.214 --- - when the HARQ-ACK corresponding to corresponding to all code block groups of the PDSCH carrying the activation command [10, TS 38.321] for ZP CSI-RS resource(s) transmitted in slot n, the corresponding action in [10, TS 38.321] and the UE assumption on the PDSCH RE mapping corresponding to the activated ZP CSI-RS resource(s) shall be applied starting from slot n+〖3N〗_slot^(subframe,μ)+1. - when the HARQ-ACK corresponding to all code block groups of the PDSCH carrying the deactivation command [10, TS 38.321] for activated ZP CSI-RS resource(s) in slot n, the corresponding action in [10, TS 38.321] and the UE assumption on cessation of the PDSCH RE mapping corresponding to the de-activated ZP CSI-RS resource(s) shall be applied starting from slot n+〖3N〗_slot^(subframe,μ)+1. --- End of text proposal ---
Sharp	Support 1st and 3rd proposals
Samsung	Fine with 1 and 3
CATT	Fine with 1st and 3rd bullet. 2nd bullet needs to be discussed in control session.

3.9 Reporting

Some companies discuss issues related to the joint reporting of SSBs and CSI-RS:

- One CSI-RS resource for BM and one SS/PBCH resource block can be configured as being quasi co-located with 'QCL-Type A' and 'QCL-TypeD'. [2]
- For UEs supporting independent and joint L1-RSRP reporting, it is up to UE to report either independent or joint L1-RSRP to gNB, therefore it should not be a mandatory feature. [5]
- For joint SSB and CSI-RS reporting, no additional agreements are needed. The reporting can be configured via the existing CSI framework already. [13]

Proposal 16 Further discuss the above alternatives offline.

Company	Comment
ZTE	Support the first bullet: 'One CSI-RS resource for BM and one SS/PBCH resource block can be configured as being quasi co-located with 'QCL-Type A' and 'QCL-TypeD'. It is because that in TS 38.214, when L1-RSRP computation is determined by both CSI-RS and SS/PBCH, these CSI-RS resources and SS/PBCH block resources should be resource-wise QCLed w.r.t. 'QCL-TypeA' and 'QCL-TypeD'. But, according to the following framework of configurable QCL types between CSI-RS for beam management and SS/PBCH in TS 38.214, one CSI-RS resource for BM only can be RRC configured the QCL type of 'QCL-Type C' and 'QCL-TypeD' with one SS/PBCH, rather than 'QCL-Type A' and 'QCL-TypeD'. Therefore, one more QCL-Type candidate pair of 'QCL-Type A' and 'QCL-TypeD' between CSI-RS for beam management and SS/PBCH should be complemented accordingly.
HW/HiSi	No additional agreement needed for Rel-15.
Sony	We think Bullet 1 and 2 are not mutually exclusive and we slightly support the 2nd bullet.
Nokia	Support the 3rd bullet. For clarity of specification, addtion to section 5.1.6.1.2 needs to added for defining joint L1-RSRP computation.
MTI	Support the 3rd bullet, Agree with Nokia and HW/HiSi.

One company proposes to modify the L1-RSRP reporting:

- For differential L1-RSRP based reporting, consider a 7-bit non-uniform quantization table to quantize the largest measured value of L1-RSRP. [13]

3.10 SRS:

One company proposes modifications on SRS:

- For SRS resource set used for beam management, UE shall expect the SRS resources in a set should be configured with the same time domain behavior. [8]

This was agreed in the SRS session.

To the moderator, this proposal is of an editorial nature. Hence, it is proposed that

Proposal 17 Agree to the above proposal.

Company	Comment
Intel	Support.

OPPO	Support
Vivo	Support
ZTE	Support
HW/HiSi	Ok
LGE	OK
Sony	Support
Nokia	Support
CATT	Support
Samsung	OK

Two companies discuss configuration of an SRS resource set with SRS-SetUse = “BeamManagement”.

- In one SRS resource set configured with higher layer parameter SRS-SetUse = “BeamManagement”, if one SRS resource is not configured with higher layer parameter spatialRelationInfo, the UE shall transmit it with a spatial domain transmission filter that is different from the spatial domain transmission filter used on transmission of any other SRS resources in the same set. [9]
- For UE without beam correspondence. For an SRS resource set configured with SRS-SetUse = ‘beamManagement’. The UE shall expect that either all or only one of the SRS resources within the SRS resource set are configured with the higher layer parameter spatialRelationInfo [18]
  - In case of only one SRS resource is configured with spatialRelationInfo, UE shall transmit other resources by spatial filters whose directions are within a maximum angular spread around that of the resource with spatialRelationInfo configured, and the maximum angular spread is determined in RAN4

The two latter proposals are contradictory. It is the understanding of the moderator that if nothing is agreed, an SRS resource set with SRS-SetUse = “BeamManagement” may contain SRS resources with and with spatial relations configured, and the choice of the spatial transmission filter for an SRS resource without a configured spatial relation will be up to the UE.

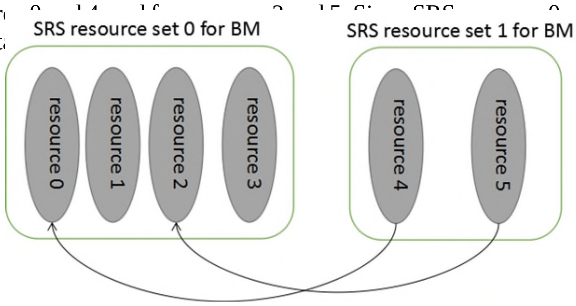
[Adding one more missing part from ZTE]: When the higher layer parameter SRS-SetUse is set to 'BeamManagement' for some SRS resource sets within one BWP, if all resources in all of these SRS resource sets are configured either with spatialRelationInfo or without spatialRelationInfo, and have the same time domain behavior, the SRS resources in different SRS resource sets among these resource sets can be transmitted simultaneously. To be more specific, we have the following TP

[Adding one more missing part from LG]: We embedded our missing part of proposals in the following TP provided by ZTE since those issues are correlated:

TP: *The text in the paragraph on the UE sounding procedure in {38.214：　6.2.1　　UE sounding procedure }*

The UE can be configured with one or more Sounding Reference Symbol (SRS) resource sets as configured by the higher layer parameter SRS-ResourceSet. For each SRS resource set, a UE may be configured with $K \geq 1$ SRS resources (higher later parameter SRS-Resource), where the maximum value of K is indicated by [SRS_capability [13, 38.306]]. The SRS resource set applicability is configured by the higher layer parameter SRS-SetUse. When the higher layer parameter SRS-SetUse is set to 'BeamManagement', only one SRS resource in each of multiple SRS sets can be transmitted at a given time instant. When the higher layer parameter *SRS-SetUse* is set to 'BeamManagement', the SRS resources in different SRS resource sets within the same BWP can be transmitted simultaneously if these SRS resources have the same time domain behavior and if all or none of these SRS resources are configured with the higher layer parameter *spatialRelationInfo*. When the higher layer parameter *SRS-SetUse* is set to ‘BeamManagement’ for a configured SRS resource set and none of the SRS resources within the set are configured with higher layer parameter *SRS-SpatialRelationInfo*, UE shall apply a spatial domain transmission filter for the (i+1)-th SRS resource different from that for the i-th SRS resource configured within the set. **Proposal 18　　Further discuss the above alternatives offline.**

IPR2025-01190
Hannibal Exhibit 2008, Page 20 of 26

Company	Comment
ZTE	The rule of grouping SRS resources seems not to be correct while considering the following cases. - **Case 1:** For those SRS resource sets for BM, SRS resources in one set is configured without *spatialRelationInfo*, and SRS resources in another set is configured with *spatialRelationInfo*. As shown in Figure 2.4-1, SRS resource 0, 1,2,3 in the SRS resource set 0 are configured without *spatialRelationInfo* for initial BM and SRS resource 4, 5 are configured with *spatialRelationInfo* for further beam measurement. RS included in *spatialRelationInfo* of SRS resource 4 is actually SRS resource 0, and RS included in *spatialRelationInfo* of SRS resource 5 is actually SRS resource 2. In other words, the same beam are used for SRS resour... 2 cannot be transmitted simult... aneously either.  **Figure 1** SRS for beam management - Case 2: For those SRS resource sets for BM have different time domain behavior. For instance, two SRS resource sets are configured for initial BM, and SRS resource set 0 and set 1 are periodic and aperiodic respectively. Since some resources in set 1 may have the same beam with some resources in set 0, the rule is also not correct in this case. In addition, all SRS resource sets mentioned here should be limited within one CC or BWP since SRS resources across CCs may be the same beam. For SRS resource sets in different BWP, the rule seems not satisfied either.
HW/HiSi	Similar view as ZTE that this is an issue
MediaTek	This proposal seems more suitable for Rel-16/17.
LGE	... between it can wait till Rel-16. In the above TP, we embedded our missing CR text proposal as well, since those issues are correlated. In the last meeting, SRS initial beam sweeping issues for UL BM had been intensively discussed, in terms of how to properly capture the following agreements made in RAN1#90bis as a part (Slide 3) of the WF R1-1719059: **<u>Agreements (R1-1719059, Slide 3):</u>** • For UL beam management, – NR supports gNB configuration of transmitting SRS with same Tx beam across multiple symbols via either of followings • configuring one SRS resource spanning multiple symbols • configuring UE to apply the same Tx beam across the SRS resources in a SRS resource set. – UE can apply different Tx beams to different SRS resources if it is not configured to apply the same Tx beam across SRS resources in a SRS resource set, where the beams can be determined either (1) via a gNB-transparent way, or (2) via gNB indication.

IPR2025-01190
Hannibal Exhibit 2008, Page 21 of 26

	Here, "(1) via a gNB-transparent way" can corresponds to the case where a SRS resource set for BM is configured without *spatialRelationInfo* for all the SRS resources within the set. This agreed option is essential for UEs when UE beam correspondence does not hold (which is informed to gNB via UE capability signaling, according to the agreements on UE feature list). Even for UEs satisfying UE beam correspondence, this option is beneficial to the gNB side as well, in that gNB can significantly save DL resource overhead regarding DL BM since this UE-side SRS Tx beam sweeping can provide best DL gNB Tx beam determinations after measuring such beam-swept SRS resources at gNB using gNB beam correspondence. Therefore, ensuring UE-side SRS Tx beam sweeping behaviors for these purposes is important to the intended gNB implementation, and we provide the above text proposal.
Sony	Agree with HW and MTK that this issue can be discussed in the upcoming Rel.16
Nokia	Same view as Huawei.
Qualcomm	Tx beam for SRS resource without spatial relation should follow gNB's guidence to avoid interference
CATT	Fine to leave it to future releases.

One company proposes a clarification of 'active BWP':

- Clarify 'active BWP' for SRS resource transmission including the resources corresponding to the parameters SRS-SpatialRelationInfo and associatedCSI-RS. [12]

**Proposal 19	Further discuss offline.**

Company	Comment

One company propose a restriction on the number of ports for SRS resources with SRS-SetUse="BeamManagement":

- for SRS for beam management, UE shall expect that the number of antenna ports is up to 2. [8]

**Proposal 20	Further discuss offline.**

Company	Comment
Intel	We feel this is straight-forward as CSI-RS for BM includes up to 2 ports, it is unreasonable to support 4 port SRS for BM. Anyway, we would like to see other companies' view.
HW/HiSi	Don't see the need of have such restriction.
Ericsson	[illegible]

One company proposes a clarification:

- The UE shall transmit SRS with the same spatial domain transmission filter across the OFDM symbols occupied by an SRS resource. [11]

It is the understanding of the moderator that this is already captured in the specification, as the spatial relation is configured per SRS resource.

3.11 Editorial

Several companies have discovered inconsistencies or unclarities in the specification:

- To 38.214, 5.1.5, regarding scheduling offsets. [3], [7]
- To 38.214, 6.1.2, regarding SRS transmission when setUse='beam management' [7]
- To 38.214, 5.2.1.4.2, regarding group-based reporting [8], [11]
- To 38.214, 5.2.1.4.2: Fix the discrepancy the cases i) TCI-PresentInDCI set as 'Disabled' and ii) the case TCI-PresentInDCI set as 'Disabled' and the offset is less than a threshold [11]
- To 38.214, 5.2.1.4.2: Remove the brackets and with minor modification to complete the specification [11]
- To 38.214, 5.2.1.2: Align text in Section 5.2.1.2 of 38.214 to be consistent with 38.331 with respect to the definition of CSI-ResourceConfig. [15]
- To 38.214, 5.1.5: UE is not expected to be configured with a number of changes of spatial domain filter within a slot that is larger than the UE capability reported in maxNumberRxTxBeamSwitchDL, [1]
- To 38.214, 5.1.6.1.1: Threshold-Sched-Offset~~ThresholdSched-Offset~~

Proposal 21 Agree to the above proposals.

~~Company~~	~~Comment~~

3.12 UE features

Several companies discuss issues related to UE features:

- Feature group 2-20 should be optional or the decision should be deferred until RAN4 completes its work. [4]
- Alternative 1 should be adopted for feature group 2-28. [4]
- Agree to SP CSI-RS as a mandatory with capability signaling which shall be set to '1'. [9]
- Component 2 of UE capability 2-4 is removed and 64 configured TCI states is mandatory. Add a note saying that the UE is only required to track activated TCI states. [15]
- Component 4 and component 5 of UE capability 2-51 are removed. [15]
- For UE with min. capability on active TCI state, active PDSCH TCI state follows the one selected by MAC-CE. [18]
  - o gNB shall ensure selected PDSCH TCI state is 1 of 2 active CORESET TCI states, and selected TCI state overwrites that determined by existing rules if conflict happens.
- Minimum UE capability on active TCI states also implies minimum UE capability on active UL beams, including 1 spatial relation for both PUCCH and PUSCH transmission, and 1 spatial relation for PUCCH transmission. [18]
  - o For UEs with beam correspondence: (1) gNB shall ensure the 2 spatial relations sharing same spatial source RSs as the 2 active TCI states; (2) Same spatial filter for receiving

PDSCH is applied to PUSCH, and overwrites that determined by existing rules if conflict happens.

- In Alt.2 for UE capability on A-CSI-RS beam switch timing, clarify that the first value is applied when CSI-RS resource set is configured with repetition OFF, and the second value is applied otherwise. [18]
- To support UE reporting its capability of 1 active TCI state, when only 1 TCI state for PDSCH is indicated by MAC CE, UE shall use this TCI state to derive PDSCH QCL information regardless whether TCI is present in DCI or whether scheduling offset is below threshold. [8]
- The large minimum time between the DCI triggering of AP-CSI-RS and aperiodic CSI-RS transmission for activating idle antenna panel, e.g., 336 symbols, should be introduced into the candidate values for UE capability, and also the corresponding values should be introduced as additional candidates of RRC configured offset for triggering AP-CSI-RS accordingly. [2]

It is the view of the moderator that these issues are better discussed in the UE feature sessions.

3.13 Signalling optimizations

A few companies discuss improvements to the signalling, especially regarding spatial relations:

- For PUCCH spatial relation information, no need to revert the agreements. A list size of 8 for PUCCH-SpatialRelationInfo is sufficient. [13]
- Support max number of spatialRelationInfos to be 64 for uplink signals and channels. [17]
- For MAC-CE signalling of PUCCH spatial relations, send a LS to RAN2 for a group-based signalling mechanism. [13]
- Support common spatial relation info configuration (RRC) and MAC activation command across all the PUCCH resource sets for PUCCH. [17]
- For PUSCH scheduled by DCI format 0_1 without SRI and with no triggering of SRS resource, the UE shall use a spatial relation corresponding to the spatial relation used by the PUCCH resource with the lowest ID configured in the active UL BWP. [17]
- For PUSCH scheduled by DCI format 0_1, if the UE is configured with single SRS resource, then it shall use a default spatial relation corresponding to the spatial relation, if applicable, used by the PUCCH resource with the lowest ID configured in the active UL BWP. [5]
- It is the view of the moderator that it is too late to introduce this in Rel-15, and that this is explicitly mentioned in the Rel-16 WID. Hence,

Proposal 22 Do not change the signalling regarding spatial relations for PUCCH/PUSCH in Rel-15.

Company	Comment on this proposal
Intel	Support
OPPO	Support
vivo	Support
ZTE	These features are good to have, but not essential in Rel-15.
MediaTek	Support
LGE	Support
MTI	Support

One company suggests that the spatial QCL source/spatial relation of several signals can be derived from the CORESET.

IPR2025-01190
Hannibal Exhibit 2008, Page 24 of 26

- Support determining spatial QCL source for e.g. CSI-RS for CSI acquisition, CSI for RLM, PUCCH and SRS for codebook/non-codebook from the activated TCI state of the lowest CORESET-ID in the latest slot when TCI state (downlink) or spatial relation info (uplink) is not explicitly configured for the resource. [17]

Proposal 23 Do not introduce CORESET as a QCL source for CSI-RS, or as a spatial relation for PUCCH and SRS.

Company	Comment
Intel	Support this proposal
OPPO	Support
ZTE	Support
Sony	Support

3.14 Other AIs:

Some proposals are better discussed in other AIs:

AI 7.1.2.5 (Simultaneous reception in FR2)

- The UE is not expected to be configured with NZP-CSI-RS-ResourceSet with the higher layer parameter repetition set to 'on' over the symbols during which UE is also configured to monitor the CORESET. [1]
- In FR2, for PHY simultaneous reception combinations which are permitted in single CC, Rel-15 follows the same rules with respect to simultaneous reception of PHY channels and RS for the case of different CCs as to the case of single CC. [18]

AI 7.1.2.4 (Reference signals and QCL)

- Introduce the support of SP-TRS [18]
  - o SP-TRS should be allowed to serve as QCL-type A and D sources

3.15 Other issues

Additional topics were brought up by some companies:

- For PDCCH, if a TCI-State is configured with a reference to an RS associated with 'QCL-TypeD', that RS can be an SSB or periodic CSI-RS. [3]
- Discuss support of local beam sweeping without RAN2 impact. [6]
- For CORESET-BFR, UE shall not expect TCI state should be configured. [8]
- Not to adopt TCI framework for PUSCH beam indication in Rel-15. [18]
- When CORESET 0 is in active BWP, it should be considered for monitoring PDCCH in BFD. [18]
- Implicit configuration of RLM/BFD RS is not allowed for UE signaling no support of CSI-RS based RLM. [18]
- Support a configuration of SP-CSI-RS as a souce of QCL Type-D for periodic TRS.

4 References

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[3] R1-1808221, Remaining issues on beam management, vivo, RAN1 #94, Gothenburg, August 2018

[4] R1-1808264, Remaining issues for beam management and beam failure recovery, MediaTek Inc., RAN1 #94, Gothenburg, August 2018

[5] R1-1808330, Remaining issues on beam management and beam failure recovery, Sony, RAN1 #94, Gothenburg, August 2018

[6] R1-1808375, Issues on beam management, CATT, RAN1 #94, Gothenburg, August 2018

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[18] R1-1809711, Maintenance for beam management, Qualcomm Incorporated, RAN1 #94, Gothenburg, August 2018

[19] R1-1808952, On remaining details of DL control, Nokia, Nokia Shanghai Bell, RAN1 #94, Gothenburg, August 2018