**3GPP TSG RAN WG1 #107-e R1-2111836**

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

**Agenda Item: 8.2.4**

**Source: Moderator (InterDigital, Inc.)**

**Title: Discussion Summary #1 for Beam Management for new SCSs**

**Document for: Discussion and Decision**

# **Introduction**

In this contribution, we summarize all issues discussed on beam management and timings associated with beam-based operation for new SCSs to support NR from 52.6 GHz to 71 GHz in RAN#107-e.

# **Multiple QCL Assumptions for Multiple PDSCHs/PUSCHs**

## Multiple QCL assumptions based on timeDurationForQCL

### Observations and Proposals from Contributions

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| --- | --- |
| **Company** | **Observations and Proposals from Contributions** |
| [Huawei/HiSi, 1] | **Proposal 5: For the single-TRP multi-PDSCH scheduling scenario when any scheduled PDSCH < *timeDurationForQCL*, multiple QCL assumptions are applied as per Rel-16*** + **This means that the following Rel-16 rule is applied for any PDSCH < *timeDurationForQCL*:**
		- **The UE may assume that the DM-RS ports of a PDSCH of a serving cell are quasi co-located with the RS(s) with respect to the QCL parameter(s) used for PDCCH quasi co-location indication of the CORESET associated with a monitored search space with the lowest *controlResourceSetId* in the latest slot relative to that PDSCH in which one or more CORESETs within the active BWP of the serving cell are monitored by the UE.**
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| [FUTUREWEI, 2] | **Proposal 4: For Case 2 and PDSCH scheduling offset for any scheduled PDSCH < timeDurationForQCL** * **Multiple QCL assumptions are applied as per Rel-16**
	+ **This means that the following Rel-16 rule is applied for any PDSCHs < timeDurationForQCL:**
		- **The UE may assume that the DM-RS ports of a PDSCH of a serving cell are quasi co-located with the RS(s) with respect to the QCL parameter(s) used for PDCCH quasi co-location indication of the CORESET associated with a monitored search space with the lowest controlResourceSetId in the latest slot of the PDSCH in which one or more CORESETs within the active BWP of the serving cell are monitored by the UE.**
	+ **For all PDSCH with scheduling offset ≥ timeDurationForQCL**
		- **Apply single QCL assumption as supported in Case 1-1 and Case 1-2**

**Proposal 5: For Case-2 default single QCL assumption is derived based one of the following options:*** **a configured value of the first scheduled PDSCH slot offset, i.e., a configured choice of the slot containing PDSCH with the smallest scheduling offset, is applied. The default QCL assumption derived for this PDSCH slot, is same as that specified in Rel. 15/16 for single-PDSCH scheduling when the scheduling offset is less than *timeDurationForQCL*.**
* **Modify Rel. 15/16 rule for single-PDSCH scheduling when the scheduling offset is less than *timeDurationForQCL*. The modification only applies the original rule over a pool of CORESETs that are further indicated to be valid for default beam determination.**

**Proposal 6: Any PDSCH whose one or more symbols collide with semi-statically configured UL symbols can be disregarded for the purpose of QCL determination.**  |
| [ZTE/Sanechips, 4] | **Proposal 3: For the single TRP case, for multi-PDSCHs scheduled by a single DCI with a single DCI field ‘Transmission Configuration Indication’ that indicates a single TCI state (if the DCI field is present),** * **Case 2: PDSCH scheduling offset for any scheduled PDSCH < *timeDurationForQCL***
	+ **Case 2-1: For each PDSCH with scheduling offset < *timeDurationForQCL***
		- **Multiple QCL assumptions are applied as per Rel-16**
			* **The UE may assume that the DM-RS ports of a PDSCH of a serving cell are quasi co-located with the RS(s) with respect to the QCL parameter(s) used for PDCCH quasi co-location indication of the CORESET associated with a monitored search space with the lowest controlResourceSetId in the latest slot of the PDSCH in which one or more CORESETs within the active BWP of the serving cell are monitored by the UE.**
	+ **Case 2-2: For each PDSCH with scheduling offset ≥ *timeDurationForQCL***
		- **Apply single QCL assumption as supported in Case 1-1 and Case 1-2**
			* **If *tci-PresentInDCI* is enabled**
				+ **Single QCL assumption based on the indicated codepoint of the single DCI field ‘Transmission Configuration Indication’ is applied for all scheduled PDSCHs**
			* **If *tci-PresentInDCI* is not present**
				+ **Single QCL assumption of the single scheduling DCI scheduled multi-PDSCHs is applied for all scheduled PDSCHs**

**Observation 2: Regardless of S-DCI or multi-DCI based mechanism, multi-TRP can be transparent to multi-PDSCH scheduling (note: the ‘repetitionNumber’ scheme has been excluded).****Proposal 4: QCL acquisition for multi-PDSCH scheduling for multi-TRP can reuse the same method as specified for single-TRP.** |
| [Nokia/NSB, 5] | ***Proposal 1****: For PDSCH scheduling offset scheduled PDSCH* < *timeDurationForQCL** *Apply Rel-16 QCL assumption for each scheduled PDSCH, (i.e. default QCL assumption for PDSCHs less than threshold, following TCI state indicated for PDSCHx equal or larger than threshold.)*
* *Network ensure all PDSCHs by scheduled by single DCI having the same TCI/QCL assumption*

***Proposal 2:*** *In multi-TRP case, support the same principle applied for single TRP QCL assumption for the multiple scheduled PDSCHs per TRP.*  |
| [CATT, 6] | **Observation 3:** **For the case 2, two options could be selected for multi-PDSCH scheduled by single DCI, and they could achieve reception gain in different scenarios. The scenarios benefit to Alt1 could be easily satisfied by gNB scheduling. And considering UE complexity, Alt1 is preferred than Alt2.** **Proposal 4: When some of the scheduled PDSCHs have scheduling offset less than timeDurationForQCL and some have scheduling offset equal to or greater than timeDurationForQCL, “Single QCL assumption is applied for all scheduled PDSCHs” should be supported.** |
| [OPPO, 7] | **Proposal 3: if any PDSCH from the multi-PDSCHs scheduling does not satisfy the timeDurationForQCL threshold, the QCL assumption should follow the R16 default rule, i.e. to check back the TCI codepoints configuration. If all the scheduled PDSCHs are satisfied with the timeDurationForQCL threshold, the QCL assumption should follow the DCI indicated TCI state(s).** |
| [Sony, 8] | **Proposal 3 : For the case of single DCI scheduled multiple PDSCH of single-TRP, when any of the scheduled PDSCHs < timeDurationForQCL, UE applies the same default Rx beam from the 1st PDSCH to the last PDSCH.** |
| [Ericsson, 9] | [Proposal 1 Adopt the following high level principle for both single- and multi-TRP: If any PDSCH scheduled by the same DCI has offset < *timeDurationForQCL*, a single default QCL assumption is applied for all PDSCHs. The default QCL assumption does not vary over the time duration of the scheduled PDSCHs.](#_Toc87008283)[Proposal 2 Adopt the following unified approach for QCL indication for both single and multi-TRP](#_Toc87008284)* For both single- and multi-TRP, if any PDSCH scheduled by the same DCI has offset < timeDurationForQCL, a default QCL assumption is applied for all PDSCHs
* The default QCL assumption for each PDSCH is according to the following, and applies regardless of whether or not *tci-PresentInDCI* is configured in the scheduling DCI:
	+ For single TRP:
		- The UE may assume that the DM-RS ports of each PDSCH of a serving cell are quasi co-located with the RS(s) with respect to the QCL parameter(s) associated with the TCI state corresponding to the lowest codepoint among the TCI codepoints, where the TCI state is the one that is active in the slot corresponding to the first scheduled PDSCH
	+ For single DCI, multi-TRP:
		- The UE may assume that the DM-RS ports of each PDSCH of a serving cell are quasi co-located with the RS(s) with respect to the QCL parameter(s) associated with the TCI state(s) corresponding to the lowest codepoint among the TCI codepoints, where the TCI state(s) are the one(s) that is(are) active in the slot corresponding to the first scheduled PDSCH
	+ For multi DCI, multi-TRP:
		- The UE may assume that the DM-RS ports of each PDSCH associated with a value of *coresetPoolIndex* of a serving cell are quasi co-located with the RS(s) with respect to the QCL parameter(s) associated with the TCI state corresponding to the lowest codepoint among the TCI codepoints, where the TCI state is the one that is active in the slot corresponding to the first scheduled PDSCH associated with the value of *coresetPoolIndex*
* Note: the above assumes that *tci-PresentInDCI* is configured in at least one configured CORESET or at least one configured CORESET in each CORESET pool.

[Proposal 3 QCL indication for cross-carrier scheduling](#_Toc87008285)* For cross-carrier multi-PDSCH scheduling for single-TRP operation, the following is supported:
	+ If the UE is not configured with *enableDefaultBeamForCCS*
		- The UE expects that the PDSCH scheduling offset for all scheduled PDSCHs ≥ *timeDurationForQCL*
	+ If the UE is configured with *enableDefaultBeamForCCS*
		- A default QCL assumption for single-PDSCH scheduling is applied for all scheduled PDSCHs when either or both of the following apply:
			* The PDSCH scheduling offset for any scheduled PDSCH < *timeDurationForQCL*
			* The TCI field is absent from the scheduling DCI
		- The default QCL assumption corresponds to the activated TCI state with the lowest ID applicable to the scheduled PDSCH in the active BWP of the scheduled cell where the activated TCI state is the one that is active in the slot corresponding to the first scheduled PDSCH.
* FFS: Details for multi-TRP operation
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| [Intel, 10] | **Proposal 4:** For Case 2 when PDSCH scheduling offset is less than *timeDuraionForQCL*, the UE should apply the default QCL assumption, which corresponds to one of the semi-statically configured PDSCH TCI states for the UE, to all scheduled PDSCH transmissions, i.e., single QCL assumption.**Proposal 5:** The default QCL assumption for multi-PDSCH transmission in Case 2, is the QCL parameter(s) (one per TRP in case of multi-TRP) associated with TCI state(s) corresponding to the lowest codepoint among the TCI codepoints containing activated TCI states. |
| [Lenovo/MotM, 12] | ***Observation 1: For NR operation between 52.6 GHz and 71 GHz, the new indicated common TCI state may not be applicable for the scheduled PDSCHs even the PDSCHs are received after the application time when the UE cannot switch it RX beams to the new indicated common TCI state between two continuous PDSCH transmissions*** ***Proposal 1: For NR operation between 52.6 GHz and 71 GHz with high subcarrier spacing values such as 480kHz and 960kHz, specify enhancements to support multiple default beams association for multiple PDSCHs scheduled by single DCI:**** ***PDCCH CORESET can be associated with multiple QCL assumptions (beams) that can be used to determine multiple default beams based on lowest CORESET ID***
* ***Duration/applicability for each of the default beams can also be associated to allow UE to determine when to switch from one default beam to another during the duration of multiple PDSCH transmission***

***Proposal 2: For NR operation between 52.6 GHz and 71 GHz with high subcarrier spacing values such as 480kHz and 960kHz, if a UE is going to transmit a set of consecutive PUSCH transmissions including both dynamically scheduled PUSCH transmissions and CG-PUSCH transmissions, the UE can select the latest indicated UL Tx beam to transmit the consecutive UL CG and DG transmissions*** |
| [NEC, 13] | ***Proposal 1: For case 2 PDSCH scheduling offset for any scheduled PDSCH < timeDurationForQCL, the current Rel-16 behavior can be directly extended to multiple-PDSCH scheduling, and Alt 2 multiple QCL assumption can be supported for multiple-PDSCH transmission.*** |
| [Samsung, 14] | **Proposal 4: Support Alt-2 of Case 2 (multi QCL assumptions) and propose following:****For Case 2 and PDSCH scheduling offset for any scheduled PDSCH < timeDurationForQCL*** **Multiple QCL assumptions are applied as per Rel-16 (Alt-2 of Case 2)**
* **This means that the following Rel-16 rule is applied**
	+ **PDSCH scheduling offset for all PDSCHs < *timeDurationForQCL***
		- **The UE may assume that the DM-RS ports of a PDSCH of a serving cell are quasi co-located with the RS(s) with respect to the QCL parameter(s) used for PDCCH quasi co-location indication of the CORESET associated with a monitored search space with the lowest controlResourceSetId in the latest slot of the PDSCH in which one or more CORESETs within the active BWP of the serving cell are monitored by the UE.**
	+ **PDSCH scheduling offset for all PDSCHs ≥ *timeDurationForQCL***
		- **Follow TCI/QCL assumption indication rule in Case 1**

**Proposal 5: If beam switching gap is required, use indicated QCL assumption when an enough gap for beam switching is provided, otherwise keep default QCL assumption.** |
| [InterDigital, 15] | ***Observation 3:*** *More performance gain can be achieved by using an optimized beam indicated by a TCI state field in DCI rather than using a default beam.****Proposal 2:*** *Support multiple QCL assumptions (Alt 2) when PDSCH scheduling offset for any PDSCH < timeDurationForQCL (Case 2).****Observation 4:*** *When multiple PDSCHs are scheduled by a single DCI,**suitable slot level or symbol level gaps between the scheduled PDSCHs could be used to switch the QCL assumption in between reception of the first and the last scheduled PDSCHs.* |
| [Apple, 16] | **Proposal 2: Support a mechanism to allow a single QCL assumption at least for multi-PDSCH scheduled by a single DCI that have** **scheduling offset less than timeDurationForQCL.** **Proposal 3: A UE skips PDCCH monitoring for MOs within the multi-PDSCH duration that have scheduling offset less than *timeDurationForQCL,* if they have different QCL assumptions with the overlapped PDSCH.**  |
| [Convida, 17] | ***Proposal 1: Alt-2 (i.e. multiple QCL assumptions are applied) is preferred when the scheduling offset shorter than timeDurationForQCL for single DCI scheduling multi-PDSCH with single TRP.*** |
| [LGE, 18] | **Proposal #3: If PDSCH scheduling offset for any of PDSCHs scheduled by a single DCI is less than *timeDurationForQCL* (i.e., Case 2), the single QCL assumption is applied for all scheduled PDSCHs and is determined based on the lowest index CORESET in the latest slot from the first valid PDSCH (which is not collided with semi-static UL symbols). UE does not expect that different QCL assumption is applied for any of the scheduled PDSCHs.****Proposal #4: In order to determine Case 1 (i.e., PDSCH scheduling offset for all PDSCHs ≥ *timeDurationForQCL*) or Case 2 (PDSCH scheduling offset for any scheduled PDSCH < *timeDurationForQCL*), only valid PDSCHs are taken into account and PDSCHs skipped due to collision with semi-static UL symbols are excluded.** |
| [NTT Docomo, 19] | Proposal 3: For multi-PDSCH scheduled by single DCI for single TRP case, for the case that PDSCH scheduling offset for any scheduled PDSCH < timeDurationForQCL* **For any PDSCH<timeDurationQCL,**
	+ **UE assumes that the DM-RS ports of a PDSCH(s) of a serving cell are quasi co-located with the RS(s) with respect to the QCL parameter(s) used for PDCCH quasi co-location indication of the CORESET associated with a monitored search space with the lowest controlResourceSetId in the latest slot prior to the PDSCH in which one or more CORESETs within the active BWP of the serving cell are monitored by the UE.**
* **For any PDSCH>=timeDurationQCL,**
	+ **the rule for case 1 will be applied.**
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| [Qualcomm, 20] | **Proposal 2: Support dedicated configuration of a single default PDSCH beam for better optimization flexibility*.**** **gNB can dynamically update the default PDSCH beam via MAC-CE.**

**Proposal 3: In case of PDSCH scheduling offset for any scheduled PDSCH with offset < *timeDurationForQCL*, UE applies the single default PDSCH beam to remaining scheduled PDSCH with offset > *timeDurationForQCL*.** * **This is regardless of whether the indicated TCI state is same as the single default PDSCH beam or not.**

**Proposal 4: In case of mDCI mTRP for any scheduled PDSCH with offset < *timeDurationForQCL*, support a single default PDSCH beam applied to all PDSCHs scheduled by a DCI associated with a CORESET for a given *CORESETPoolIndex*.*** **gNB can dynamically update the single default PDSCH beam per *CORESETPoolIndex* via MAC-CE.**

**Proposal 5: In case of sDCI mTRP for any scheduled PDSCH with offset < *timeDurationForQCL*, support the two default PDSCH beams defined in R16 to be applied to all PDSCHs scheduled by a DCI.****Proposal 6: Support new RRC parameter to indicate UE to follow either the R17 enhanced PDSCH default beam & QCL rule for multi-PDSCH scheduling or the corresponding R15/16 rule.*** **The RRC parameter can be introduced separately for sTRP, sDCI mTRP, and mDCI mTRP.**
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| [MediaTek, 21] | **Proposal 2: For the reception of multi-PDSCHs scheduled by a single DCI within the duration specified by timeDurationForQCL, current Rel-15/16 default beam assumption for single TRP and multi-TRP scenarios should be applied accordingly.*** **Single-TRP:**
	+ **The default beam follows the TCI state corresponding to the lowest *controlResourceSetId* in the latest slot in which one or more CORESETs are monitored by the UE**
* **S-DCI M-TRP:**
	+ **The default beams follow the TCI states corresponding to the lowest codepoint among the TCI codepoints containing two different TCI states based on the activated TCI states in the slot with the first PDSCH transmission occasion.**
* **M-DCI M-TRP:**
	+ **The default beam for the PDSCH associated with a value of *coresetPoolIndex* follows the TCI state corresponding to the lowest *controlResourceSetId* among CORESETs, which are configured with the same value of *coresetPoolIndex* as the PDCCH scheduling that PDSCH, in the latest slot in which one or more CORESETs associated with the same value of *coresetPoolIndex* as the PDCCH scheduling that PDSCH are monitored by the UE.**
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### Summary of views

In RAN1#106-e, the following agreements on QCL assumptions of PDSCH for single TRP are agreed.

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| Agreement:For the single TRP case, for multi-PDSCHs scheduled by a single DCI with a single DCI field ‘Transmission Configuration Indication’ that indicates a single TCI state (if the DCI field is present), * Case 1: PDSCH scheduling offset for all PDSCHs ≥ *timeDurationForQCL*
	+ Case 1-1: *tci-PresentInDCI* enabled
		- Single QCL assumption based on the indicated codepoint of the single DCI field ‘Transmission Configuration Indication’ is applied for all scheduled PDSCHs
	+ Case 1-2: *tci-PresentInDCI* not present
		- Single QCL assumption of the single scheduling DCI scheduled multi-PDSCHs is applied for all scheduled PDSCHs
* Case 2: PDSCH scheduling offset for any scheduled PDSCH < *timeDurationForQCL*
	+ Down select one of the following alternatives
		- Alt 1: Single QCL assumption is applied for all scheduled PDSCHs
			* FFS: Details of single QCL assumption
		- Alt 2: multiple QCL assumptions are applied
			* FFS: Details of multiple QCL assumptions
* FFS: When some of PDSCHs are collided with semi-static UL symbols and then skipped
* FFS: The multi-TRP case
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Based on the above agreement, the following companies’ views are observed.

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| **#** | **Issue** | **Companies’ views** |
| 1.1 | Whether to support single QCL assumption or multiple QCL assumptions for Case 2 | **Single QCL assumption (Alt 1):** CATT, Sony, Ericsson (before timeDurationForQCL), Intel, Apple, LGE, Qualcomm* [CATT]: When some of the scheduled PDSCHs have scheduling offset less than timeDurationForQCL and some have scheduling offset equal to or greater than timeDurationForQCL, “Single QCL assumption is applied for all scheduled PDSCHs” should be supported.
* [Sony]: For the case of single DCI scheduled multiple PDSCH of single-TRP, when any of the scheduled PDSCHs < timeDurationForQCL, UE applies the same default Rx beam from the 1st PDSCH to the last PDSCH.
* [Intel]: The default QCL assumption for multi-PDSCH transmission in Case 2, is the QCL parameter(s) (one per TRP in case of multi-TRP) associated with TCI state(s) corresponding to the lowest codepoint among the TCI codepoints containing activated TCI states.

**Details of single QCL assumption:** * 1st PDSCH: Sony
* Lowest codepoint of TCI: Ericsson, Intel,
* Skips PDCCH monitoring/no CORESET configuration: Apple, LGE
* MAC CE: Qualcomm

**Multiple QCL assumption (Alt 2):** Huawei/HiSi, Futurewei, ZTE/Sanechips, Nokia/NSB, OPPO, Lenovo/MotM, NEC, Samsung, InterDigital, Convida, NTT Docomo, MediaTek* [Huawei/HiSi]: For the single-TRP multi-PDSCH scheduling scenario when any scheduled PDSCH < timeDurationForQCL, multiple QCL assumptions are applied as per Rel-16
* [ZTE/Sanechips]: Multiple QCL assumptions are applied as per Rel-16
* [Samsung]: Multiple QCL assumptions are applied as per Rel-16 (Alt-2 of Case 2)
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### 1st round discussion

#### Observation 1

The moderator observed majority support on multiple QCL assumption (16 companies) while few companies (7 companies) are still supporting single QCL assumption. In addition, while the companies supporting multiple QCL assumption propose a unified solution based on Rel-16 (a TCI state of a CORESET with a lowest CORESET ID in a latest slot), the companies supporting single QCL assumption propose various solutions (i.e., based on lowest TCI codepoint, MAC CE indication or a TCI state of 1st PDSCH). Given the situation, the moderator provides Proposal 1. Please note that details for any PDSCHs ≥ timeDurationForQCL are added based on the Proposal 5j of the FL summary in RAN1#106bis-e.

#### Proposal 1

For Case 2 and PDSCH scheduling offset for any scheduled PDSCH < timeDurationForQCL

* Multiple QCL assumptions are applied as per Rel-16
	+ The following Rel-16 rule is applied for any PDSCHs < timeDurationForQCL:
		- The UE may assume that the DM-RS ports of a PDSCH of a serving cell are quasi co-located with the RS(s) with respect to the QCL parameter(s) used for PDCCH quasi co-location indication of the CORESET associated with a monitored search space with the lowest controlResourceSetId in the latest slot of the PDSCH in which one or more CORESETs within the active BWP of the serving cell are monitored by the UE.
	+ The following Rel-16 rule is applied for any PDSCHs ≥ timeDurationForQCL:
		- *tci-PresentInDCI* enabled
			* Single QCL assumption based on the indicated codepoint of the single DCI field ‘Transmission Configuration Indication’ is applied for the scheduled PDSCHs ≥ timeDurationForQCL
		- *tci-PresentInDCI* not present
			* Single QCL assumption of the single scheduling DCI scheduled multi-PDSCHs is applied for the scheduled PDSCHs ≥ timeDurationForQCL

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| **Company** | **Input** |
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#### 1st round discussion summary

TBU

## Multiple TCI states/SRIs for multiple PDSCHs/PUSCHs with multi-TRPs

### Observations and Proposals from Contributions

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| **Company** | **Observations and Proposals from Contributions** |
| [vivo, 3] | *Proposal 2: For multi-PDSCHs scheduling, these schemes including ‘SDM’, ‘FDMSchemeA’, ‘FDMSchemeB’, ’TDMSchemeA’ and ‘repetitionNumber-R16’ can be configured.**Proposal 3: study which patterns in figure 1 are supported in case of joint configuration of multi-PDSCHs scheduling and scheme ‘repetitionNumber-R16’.* |
| [CATT, 6] | **Proposal 6: The multi-PUSCH scheduling by the same DCI should be grouped when the number of scheduling PUSCH is more than two.** |
| [OPPO, 7] | **Proposal 1: for FDM, wideband-wise or RBG-wise resource splitting between two TRPs are applied to each of the multi-scheduled PDSCHs.****Proposal 2: Reusing the offset from the last scheduled PDSCH from the first TRP to determine the first scheduled PDSCH from the second TRP.** |
| [Sony, 8] | **Proposal 2 : For single-DCI scheduled multi-PUSCH for multi-TRP, support up to 2 SRIs and each SRI is pointed to each TRP.** |
| [LGE, 18] | **Proposal #5: It should be clarified whether UE can be configured with *repetitionNumber* in DCI format 1\_2 or not, for a serving cell configured with *pdsch-TimeDomainResourceAllocationListForMulti PDSCH*.****Proposal #6: It should be discussed how to guarantee *StartingSymbolOffsetK* symbols between the last symbol of the second PDSCH occasion of TB#1 and the first symbol of the first PDSCH occasion of TB#2, in order to support TDM scheme A for multi-PDSCH scheduling for multi-TRPs.** |

### Summary of views

In RAN1#106bis-e, the following supports of multiple TCI states for multi-TRP are agreed.

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| Agreement:The working assumption in RAN1#106-e is confirmed with the following update:For multi-PDSCH scheduling for multi-TRPs, support a single DCI field ‘Transmission Configuration Indication’ as in Rel-16 TCI state indication mechanism for multi-TRPs* The single DCI field ‘Transmission Configuration Indication’ indicates one or two TCI states associated with a code point for single DCI based multi-TRP mechanism
	+ When two TCI states are indicated, reuse Rel-16 association rules to apply the two TCI states for each PDSCH scheduled by a multi-PDSCH scheduling DCI
* The single DCI field ‘Transmission Configuration Indication’ indicates only one TCI state associated with a code point for multi-DCI based multi-TRP mechanism
* Reuse Rel-16 RRC configuration and MAC CE activation/deactivation methods for the one or two TCI states
* ~~FFS: Details of multiple TCI state association with multiple PDSCHs~~
* Within the TDRA table for multi-PDSCH scheduling, the UE does not expect to be configured with the higher layer parameter repetitionNumber
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Based on the above agreement, the following companies’ views are observed.

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| **#** | **Issue** | **Companies’ views** |
| 2.1 | Support of multi-PDSCHs with multi-TRP | Wideband-wise or RBG-wise resource splitting for FDM: OppoReuse of the offset of the last scheduled PDSCH from the first TRP to the first scheduled PDSCH of the second TRP: OppoWhether UE can be configured with repetitionNumber in DCI format 1\_2 or not: LGEHow to guarantee StartingSymbolOffsetK symbols between the last symbol of the second PDSCH occasion and the first symbol of the first PDSCH occasion: LGE |
| 2.2 | Support of multi-PUSCHs with multi-TRP | Support of multiple groups of PUSCHs and multiple SRIs: CATT, Sony |

### 1st round discussion

#### Observation 2

The moderator observed that few companies indicated necessity of further clarifications of multi-PDSCH operation. In addition, few companies indicated their preference to support specification enhancement for multi-PUSCHs with multi-TRP. Companies are asked to answer the following questions.

**Q1. Do you think that additional clarification is needed for multi-PDSCHs by a single DCI with multi-TRP (e.g., the offset between the last scheduled PDSCH of the first TRP and the first scheduled PDSCH of the second TRP)? If so, what would be the required clarification?**

**Q2. Do you think that enhancement of multi-PUSCHs by a single DCI is needed (e.g., supporting multiple groups/SRIs)? If so, what would be the required enhancement?**

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| **Company** | **Input** |
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#### Proposal 2

TBU

#### 1st round discussion summary

TBU

# **Parameters Associated with Beam-based Operation**

## maxNumberRxTxBeamSwitchDL

### Observations and Proposals from Contributions

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| **Company** | **Observations and Proposals from Contributions** |
| [Huawei/HiSi, 1] | **Proposal 1: UL-DL or DL-UL w/o spatial domain filter change should be counted as a beam switch in *maxNumberRxTxBeamSwitchDL*.****Proposal 4: A UE can drop the low priority signal(s)/channel(s) in a slot when additional beam switch is required and the number of beam switches has already reached *maxNumberRxTxBeamSwitchDL*.** |
| [FUTUREWEI, 2] | **Proposal 3: UE is expected to prioritize reception based on a priority ranking and is expected to receive those symbols in a slot (using their corresponding beams) that are associated with signals (or channels) whose priorities are in the top maxNumberRxTxBeamSwitchDL highest priorities among signals of all symbols in that slot.** * **Reuse Rel.15/16 priority ranking**
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| [MediaTek, 21] | **Proposal 1: For maxNumberRxTxBeamSwitchDL, the feasibility of candidate value {7} for 480kHz and candidate values {4,7} for 960kHz should be further discussed after the RAN4 decision on the beam switching** **time for 480kHz and 960kHz.** |

### Summary of views

In RAN1#106bis-e, the following agreements on maxNumberRxTxBeamSwitchDL are agreed.

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| Agreement:For maxNumberRxTxBeamSwitchDL, support 1, 4 and 7 as candidate values for 960 kHz in addition to the agreed candidate value 2.* Note: this is Alt-1 from the RAN1#106 agreement.
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Based on the above agreement, the following companies’ views are observed.

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| **#** | **Issue** | **Companies’ views** |
| 3.1 | UE prioritization within maxNumberRxTxBeamSwitchDL | * **Support:** Huawei/HiSi, Futurewei
	+ [Huawei/HiSi]: To solve the issue, based on the predefined priority levels, a low capability UE can drop the low priority signal(s)/channel(s) in a slot when additional beam switch is required and the number of beam switches has already reached maxNumberRxTxBeamSwitchDL.
	+ [Futurewei]: As remarked earlier, relying on gNB scheduling alone to avoid such scenario may become limited by the worst-case. For UE behavior the priority ranking from Rel.15/16 can again be used which is to prioritize PDCCH over PDSCH and a PDCCH in CORESET of lower ID over other PDCCH.
 |
| 3.2 | Count UL-DL or DL-UL without spatial domain filter change as a beam switch for maxNumberRxTxBeamSwitchDL | * **Support:** Huawei/HiSi
	+ [Huawei/HiSi]: In our opinion, as Tx/Rx (or Rx/Tx) conversion causes additional time cost, UL-DL or DL-UL should be counted even without spatial domain filter change.
 |
| 3.3 | Feasibility {7} for 480 kHz and {4, 7} for 960 kHz as candidate values of maxNumberRxTxBeamSwitchDL | * **Support:** MediaTek
	+ [MediaTek]: In the latest discussion, RAN4 further agreed on the RX-TX beam switching time for 480kHz and 960kHz to be the same 7.015us as the RX-TX beam switching for 120kHz. Based on the agreed beam switching time, it is around 3 symbols for 480kHz and 6 symbols for 960kHz, which restrict the maximum number of beam switching time within a slot of 480kHz and 960kHz to be at most 4 and 2, respectively. Although LS from RAN4 has not been received by RAN1, further discussion on the agreed candidate values of maxNumberRxTxBeamSwitchDL for 480kHz and 960kHz is necessary.
 |

### 1st round discussion

#### Observation 3

The moderator observed that few companies indicated that UE prioritization mechanism is needed to limit number of beam switching within maxNumberRxTxBeamSwitchDL. Also, one company preferred to count UL/DL and DL/UL switching within a same beam as a beam change. In addition, one company to further discuss the agreed candidate values for {7} for 480 kHz and {4, 7} for 960 kHz. Based on the observation, companies are asked to answer the following questions.

**Q1. Do you think that UE prioritization of signals/channels is needed to secure UE beam switching rather than resolving the issue by gNB implementation?**

**Q2. Do you think that UL/DL and DL/UL switching within a same beam should be counted as a beam change for maxNumberRxTxBeamSwitchDL?**

**Q3. Do you agree to hold the discussion of candidate values {4} for 480 kHz and {4, 7} for 960 kHz until RAN4 LS?**

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| **Company** | **Input** |
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#### Proposal 3

TBU

#### 1st round discussion summary

TBU

## A minimum guard period Y between two SRS resources of an SRS resource set for antenna switching

### Observations and Proposals from Contributions

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| --- | --- |
| **Company** | **Observations and Proposals from Contributions** |
| [Huawei/HiSi, 1] | **Proposal 2: Wait for RAN4 feedback on the switching time requirement before determining the value of Y for 480 kHz and 960 kHz.** |
| [ZTE/Sanechips, 4] | **Proposal 1: For minimum guard period Y, a same scaled value from 120 kHz can be defined for 480 kHz and 960 kHz e.g. 4 symbols, which can be confirmed after RAN4 feedback the switching time requirement.** |
| [Nokia/NSB, 5] | ***Proposal 3:*** *Support following value of minimum guard period Y between two SRS resources of an SRS resource set for antenna switching for 480 kHz and 960 kHz** *Y=3 for 480kHz, Y=5 for 960kHz*
 |
| [CATT, 6] | **Proposal 3: For SCS 480/960 kHz, the values of Y should be different with SCS 120 kHz, which is 8 and 16.**  |
| [Intel, 10] | **Proposal 2:** The minimal guard period between SRS resources for antenna switching for SCS 480 kHz and 960 kHz is Y=2.**Proposal 3:** Depending on the availability of RAN4 feedback on antenna switching time requirements for a UE, introduce an optional UE capability for guard period of SRS antenna switching. When this capability is not reported, the minimal value of Y=2 is assumed for the guard period for antenna switching between SRS resources with SCS 480 kHz and 960 kHz. Otherwise, the value indicated in the capability signalling is used. |
| [Samsung, 14] | **Proposal 1: Support values of Y dependent on RAN4 feedback on the switching time requirement** |
| [InterDigital, 15] | ***Observation 1:*** *The simple extrapolation of the number of symbols required for antenna switching gap with SRS resource set transition will lead to 8 and 16 blanked symbols respectively for 480 and 960KHz SCS if we use the absolute time duration for low SCSs.****Observation 2:*** *Supporting low values of antenna switching gap would bring efficient NR operation in 52-71GHz.* ***Proposal 1:*** *Introduce a UE capability signaling to indicate one of [2, 8] for 480 kHz and [2, 16] for 960 kHz*, where 8 and 16 are mandatory values for 480 kHz and 960 kHz, respectively. |
| [Apple, 16] | **Proposal 1: The minimum guard period between two SRS resources of an SRS resource set for antenna switching are defined as ‘8’ symbols and ‘16’ symbols for 480kHz and 960kHz SCS, respectively.**   |

### Summary of views

In RAN1#106bis-e, the following agreements on a minimum guard period Y are agreed.

|  |
| --- |
| Agreement:Like in Rel-15, a minimum guard period Y between two SRS resources of an SRS resource set for antenna switching is supported for 480 kHz and 960 kHz* FFS: Whether to define different values of Y for 480 kHz and 960 kHz or not
* FFS: Values of Y dependent on RAN4 feedback on the switching time requirement
 |

Based on the above agreement, the following companies’ views are observed.

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| **#** | **Issue** | **Companies’ views** |
| 4.1 | Values of a minimum guard period Y between two SRS resources of an SRS resource set for antenna switching | * **Hold the discussion until RAN4 feedback:** Huawei/HiSi, Samsung
* **2 symbols for both 480 kHz and 960 kHz:** Intel (with UE capability)
* **4 symbols for both 480 kHz and 960 kHz:** ZTE/Sanechips
* **3 symbols for 480 kHz and 5 symbols for 960 kHz:** Nokia/NSB
* **Scaled values based on the value for 120 kHz (8 symbols for 480 kHz and 16 symbols for 960 kHz):** CATT, Apple
* **UE capability (2/8 for 480kHz and 2/16 for 960 kHz):** InterDigital
 |

### 1st round discussion

#### Observation 4

No clear majority view is observed by the moderator. Given the situation, the moderator suggests holding the discussion until RAN4 feedback.

**Q1. Do you agree with the moderator’s suggestion that holding the discussion until RAN4 feedback?**

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| **Company** | **Input** |
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#### Proposal 4

TBU

#### 1st round discussion summary

TBU

## Beam switching gap and scheduling restrictions for higher SCSs

### Observations and Proposals from Contributions

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| **Company** | **Observations and Proposals from Contributions** |
| [Huawei/HiSi, 1] | **Proposal 3: Regarding beam switch time, support the following*** **Support a UE capability signaling for beam switch time.**
* **UE is not expected to be scheduled/configured with a signal/channel on one symbol before to and one symbol after of another signal/channel if the signals/channels have two different QCL-D assumptions and the indicated beam switch time of UE is larger than X =[60] ns for 960 kHz or X=[120] ns for 480 kHz SCS.**
 |
| [FUTUREWEI, 2] | **Proposal 1 Regarding beam switch time, support the following*** + **Support a UE capability signalling for beam switch time.**
	+ **UE is not expected to receive adjacent symbols with different QCL-D assumptions when the indicated beam switch time of UE is larger than threshold X ns.**
		- **Threshold X depends on the CP time of the operating SCS (X =[60] ns for 960 kHz and X=[120] ns for 480 kHz SCS).**

**Proposal 2: Analogous to the overlapping PDCCH/PDSCH and PDCCH/PDCCH with different QCL-TypeD situation in FR2-1, in FR2-2 a precedence relation is necessary for UEs incapable of adjacent symbol reception with beam switching.*** **Adopt precedence relations based on Rel. 15/16.**
 |
| [ZTE/Sanechips, 4] | **Observation 1: Rel-15/16 NR specifications have enough flexibility to support beam switching for non-SSB channels/signals with new SCSs 480 kHz and 960 kHz, even if the lengths of CP are not enough for beam switching.****Proposal 2: We agree to introduce a UE capability for the UE reporting the beam switching time it can support before RAN4 makes a final conclusion on beam switching time.** |
| [CATT, 6] | **Observation 4: In order to guarantee the reception performance of PDSCH, the additional beam switching gap need to be reserved before the PDSCH.****Proposal 5: When the additional beam switching gap is introduced, QCL assumption needs to be investigated.** |
| [Ericsson, 9] | [Proposal 4 To allow efficient configuration of reference signal resource sets for beam management for 480/960 kHz SCS, RAN1 should further discuss the introduction of some form of UE capability signalling that can provide the network with knowledge related to the UE beam switch time.](#_Toc87008286) |
| [Intel, 10] | **Proposal 1:** Support UE capability signaling for beam switching time. The signaling may indicate a UE needs at least 1 symbol gap for both 480 kHz and 960 kHz. |
| [Samsung, 14] | **Proposal 2: Reserve one symbol for beam switching gap when using 480 kHz and 960 kHz SCSs.****Proposal 3: Support UE capability signalling for beam switching time except for SSB, which has already been addressed in A.I. 8.2.1** |
| [LGE, 18] | **Proposal #1: At least for 960 kHz, introduce new UE capability signaling for beam switching time considering at least the following case, and UE does not expect to receive adjacent DL signals/channels with a symbol-level gap which is no less than the indicated beam switching time.*** **Beam switching time between DL signals/channels (e.g., PDCCH/PDSCH/CSI-RS) with different QCL Type-D source RSs**

**Proposal #2: At least for 960 kHz, introduce new UE capability signaling for beam switching time considering at least the following cases, and UE does not expect to transmit adjacent UL signals/channels with a symbol-level gap which is no less than the indicated beam switching time.*** **Beam switching time between UL signals/channels (e.g., PUCCH/PUSCH/SRS) with different spatial relation RSs**
* **Beam switching time between SRS resources (e.g., BM SRS) without configured spatial relation RSs**
 |
| [NTT Docomo, 19] | **Proposal 1: Support UE capability signaling for following cases.*** **Beam switching time between DL signals/channels with different QCL Type-D source RSs**
	+ **The required guard period for beam switching time should follow RAN4 feedback.**
	+ **The UE does not expect to receive adjacent DL signals/channels within the indicated beam switching time.**
	+ **The beam switching time is supported for PDSCHs/PDCCHs/CSI-RSs.**
* **Beam switching time between UL signals/channels with different spatial relation RSs**
	+ **The required guard period for beam switching time should follow RAN4 feedback.**
	+ **The UE does not expect to transmit adjacent UL signals/channels within the indicated beam switching time.**
	+ **The beam switching time is supported for PUSCHs/PUCCHs/SRSs.**
 |
| [Qualcomm, 20] | **Proposal 1: Support UE capability for the beam switch time gap, such that UE is NOT expected to be scheduled/configured with a signal within the beam switch action time before and after another signal if the two signals correspond to one of the following cases.*** **Case 1:**
	+ **Any two signal that have different specified QCL-TypeD assumptions**
* **Case 2:**
	+ **One signal has specified QCL-TypeD assumption, while the other is SSB or CSI-RS without specified QCL-TypeD assumption**
* **Case 3:**
	+ **The two signals are two CSI-RS resources without specified QCL-TypeD assumption**
* **Case 4:**
	+ **The two signals are two CSI-RS resources with same specified QCL-TypeD assumption in a resource set with higher layer parameter *Repetition* set to ‘ON’**
* **Case 5:**
	+ **Any two signals that have different specified spatial relations**
* **Case 6:**
	+ **One signal has specified spatial relation assumption, while the other is SRS without specified spatial relation**
* **Case 7:**
	+ **The two signals are two SRS resources without specified spatial relation**
* **Note:**
	+ **The above “specified” means the beam indication is either explicitly provided by gNB or implicitly determined by spec****.**
 |

### Summary of views

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| **#** | **Issue** | **Companies’ views** |
| 5.1 | Introduction of explicit beam switching gap or scheduling restriction | **Beam switching gap:** CATT, Samsung* [Samsung]: Reserve one symbol for beam switching gap when using 480 kHz and 960 kHz SCSs.

**Scheduling restriction:** Huawei/HiSi, Futurewei, LGE (at least for 960 kHz), NTT Docomo, Qualcomm* [Futurewei]: Analogous to the overlapping PDCCH/PDSCH and PDCCH/PDCCH with different QCL-TypeD situation in FR2-1, in FR2-2 a precedence relation is necessary for UEs incapable of adjacent symbol reception with beam switching.
* [LGE]: At least for 960 kHz, introduce new UE capability signaling for beam switching time considering at least the following case, and UE does not expect to receive adjacent DL signals/channels with a symbol-level gap which is no less than the indicated beam switching time.

**No:** ZTE/Sanechips* [ZTE/Sanechips] Rel-15/16 NR specifications have enough flexibility to support beam switchingfor non-SSB channels/signals even if the lengths of CP are not enough for beam switching
 |
| 5.2 | Introduction of UE capability reporting on UE beam switching time | **Yes:** Huawei/HiSi, Futurewei, ZTE/Sanechips, Intel, Samsung, LGE, NTT Docomo, Qualcomm* [Ericsson] To allow efficient configuration of reference signal resource sets for beam management for 480/960 kHz SCS, RAN1 should further discuss the introduction of some form of UE capability signalling that can provide the network with knowledge related to the UE beam switch time (on the order of 10s of ns, rather than 10s of symbols).

**Further discuss:** Ericsson* [Ericsson]: To allow efficient configuration of reference signal resource sets for beam management for 480/960 kHz SCS, RAN1 should further discuss the introduction of some form of UE capability signalling that can provide the network with knowledge related to the UE beam switch time.
 |

### 1st round discussion

#### Observation 5

The moderator observed that majority companies support introduction of UE capability reporting on beam UE beam switching time. Companies are asked to provide their views on Proposal 5a and Proposal 5b (based on Proposal 4b and Proposal 4e from the summary of RAN1#106-bis).

#### Proposal 5a

Support UE capability signaling for following cases:

* Beam switching time between DL signals/channels with different QCL Type-D source RSs
	+ The UE does not expect to receive adjacent DL signals/channels within the indicated beam switching time
	+ FFS: Which DL signals/channels should be supported
	+ FFS: Whether apply the same beam switching time between CSI-RS resources without QCL Type-D source RS or between DL signals/channels with same QCL Type-D source RS
* Beam switching time between UL signals/channels with different spatial relation RSs
	+ The UE does not expect to transmit adjacent UL signals/channels within the indicated beam switching time
	+ FFS: Which UL signals/channels should be supported

#### Proposal 5b

* Regarding beam switch time, support the following
	+ Support a UE capability signaling for beam switch time.
	+ Within each slot, UE is not expected to be scheduled/configured with a signal/channel on one symbol before to and one symbol after of another signal/channel if the signals/channels have two different QCL-D assumptions and the indicated beam switch time of UE is larger than X ns.
		- FFS: Value of X and whether it depends on the CP time of the operating SCS (eg X =[60] ns for 960 kHz and X=[120] ns for 480 kHz SCS).
		- FFS: Whether apply the same beam switching time between CSI-RS resources without QCL Type-D source RS or between DL signals/channels with same QCL Type-D source RS

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| **Company** | **Input** |
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#### 1st round discussion summary

TBU

# **Beam Management for Shared Spectrum Operation**

## Observations and Proposals from Contributions

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| **Company** | **Observations and Proposals from Contributions** |
| [Huawei/HiSi, 1] | **Proposal 7: In order to mitigate the impact of LBT failure in BFD procedure, support transmitting complementary aperiodic CSI-RS when LBT failure occurs on periodic BFD-RS.** |
| [FUTUREWEI, 2] | **Proposal 7: Utilize aperiodic CSI-RS transmission to address impact of LBT failure on periodic RS transmissions intended to support beam failure recovery.** **Proposal 8: Consider support for low latency beam (QCL-TypeD) switch of periodic RS transmissions after persistent or sustained LBT failure.**  |
| [ZTE/Sanechips, 4] | **Proposal 5:****Study and evaluate the impact of LBT and the limitation of COT length on the procedure of beam failure detection.** |
| [Nokia/NSB, 5] | ***Observation 1****: For P-TRS transmissions in the cell, it would be beneficial to have a mechanism to be able to transmit P-TRSs dropped due to LBT failure.****Proposal 4:*** *Consider solutions to provide robustness for TRS transmission due to LBT failures, for instance:** *A beam specific (SSB specific) aperiodic TRS transmission that could be triggered for one or multiple UEs at a time to “patch” non-transmitted P-TRS using certain beam (certain SSB as QCL-TypeD source)*
* *Multiple transmission opportunities for the P-TRS within a time period*

***Observation 2:*** *More transmission opportunities for the BFD-RS against LBT failures can be supported by the same mechanism used for peridic CSI-RS such as TRS.****Proposal 5:*** *In case of directional LBT (if applied), consider impacts on beam management in the COT, e.g.* * *impact on validity of the configured DL RSs for L1-RSRP measurement and reporting and*
* *impact on beam switching application time within the COT (e.g. the case when the new beam is or is not QCLed with the LBT beam of the COT).*

***Proposal 6:*** *If multi-slot CSI-RS is supported, use slot offset (by reusing the parameter CSI-ResourcePeriodicityAndOffset currently applicable only for periodic and semi-persistent resource) parameter for the aperiodic CSI-RS resource where the offset would be calculated from the slot where the first CSI-RS resource of the same set is allocated.*  |
| [CATT, 6] | **Observation 1: When UE cannot measure the periodic CSI-RS at the scheduled transmission instance for beam management due to LBT failure, gNB could transmit aperiodic CSI-RS as the alternative measurement.** **Proposal 1:** **Aperiodic CSI-RS could be used as the alternative solution of missed L1 RSRP measurement of periodic CSI-RS due to LBT failure with minimized specification impact.**  |
| [Sony, 8] | 1. **: Support aperiodic CSI-RS for beam failure detection (BFD) and candidate beam determination (CBD) at least for unlicensed band operation.**
2. : **Study and specify if needed single DCI scheduled multiple aperiodic CSI-RS and/or aperiodic SRS across multiple slots.**
 |
| [Ericsson, 9] | [Proposal 5 Enhancement of existing BFD procedures by introduction of ap-CSI-RS is not needed for operation in shared spectrum. The existing BFI counter and timer can be adjusted to compensate for occasional LBT failure causing a missing instance (period) of a periodic BFD RS (SS/PBCH block and/or p-CSI-RS).](#_Toc87008287) |
| [Intel, 10] | **Proposal 6:** No special handling of periodic RS transmissions is needed to address interruptions due to LBT failure as well as no special means are needed to distinguish between LBT failures and beam failures. |
| [Xiaomi, 11] | ***Observation 1: There may be performance loss caused by non-transmitted periodic CSI-RS for beam measurement because gNB cannot get the latest beam measurement results especially for high speed UE.******Proposal 4: Aperiodic RS transmission can be triggered to patch a non-transmitted periodic CSI-RS.******Observation 2: The existing BFD mechanism may not work well if the periodic CSI-RS for BFD cannot transmitted because of LBT failure.******Proposal 6: The beam failure detection procedure should be enhanced if triggering aperiodic CSI-RS to complement the non-transmitted BFD-RS is supported.******Observation 3: The beam switching in the same COT will be influenced by the LBT mechanism.*** |
| [Lenovo/MotM, 12] | ***Proposal 3: For NR operation in unlicensed bands between 52.6 GHz and 71 GHz, the following potential enhancements related to periodic transmissions of RS such as P-TRS should be specified to deal with LBT failure:**** ***Termination of periodic RS transmission on beams where consecutive LBT failures are encountered***
* ***Dynamic switching of the QCL assumption (beams) for periodic RS transmission where consecutive LBT failures are encountered, where:***
	+ ***Multiple QCL assumptions (multiple beams) can be configured to the RS resource and beam switch can be triggered once the continuous number of LBT failures reach a certain threshold value***
 |
| [NEC, 13] | ***Proposal 2:*** ***A gap for beam switching or directional LBT should be introduced for multiple QCL assumption in multiple-PDSCH scheduling.******Proposal 3: UE should apply the QCL assumption(s) of the smallest CORESET ID that LBT succeed in the latest slot for each PDSCH when some or all of the scheduled PDSCHs of the multiple PDSCH have scheduling offset less than timeDurationForQCL for shared spectrum.******Proposal 4:*** ***If the indicated beam in the DCI scheduling the PDSCH is QCLed with the directional LBT beam for the DCI, then no additional LBT is needed for the PDSCHs have scheduling offset equal to or greater than timeDurationForQCL in shared spectrum.*** |
| [Samsung, 14] | **Proposal 6: Support multi-slot aperiodic CSI-RS/SRS scheduled by a single DCI for beam management in 60 GHz unlicensed band.****Proposal 7: Further investigate the issue on the uncertainty of RS transmission due to LBT for 60 GHz unlicensed band.** |
| [InterDigital, 15] | ***Observation 5:*** *Absence of periodic/semi-persistent RSs may impact on performance of fine time/frequency tracking, beam failure recovery and beam/CSI reporting.****Proposal 3:*** *Introduce an enhanced mechanism to patch non-transmitted periodic/semi-persistent RSs due to LBT failures.****Proposal 4:*** *Support RS transmission based on candidate RSs when LBT fails for periodic/semi-persistent RSs.****Proposal 5:*** *Support RS pre-emption based on gNB indication to achieve accurate fine time/frequency tracking, beam failure recovery and beam/CSI.* |
| [Apple, 16] | ***Proposal 2: Enhancement of beam operation for unlicensed bands should be investigated to mitigate interference and optimize system performance due to hidden node for NR from 52.6 GHz to 71 GHz****.* |
| [LGE, 18] | **Proposal #7: The following aspects can be considered to enhance beam management operation when channel access scheme is used for unlicensed spectrum.*** + **How to provide more opportunities of CSI-RS or SRS transmission considering LBT failure**
	+ **How to enhance beam failure procedure considering not transmitted BFD-RS due to LBT failure**
 |
| [MediaTek, 21] | **Proposal 3: For multi-PDSCH scheduling, all the scheduled PDSCHs from a single DCI are either received within *timeDurationForQCL* or the time offset between the reception of the DCI and each scheduled PDSCH is equal to or greater than a threshold *timeDurationForQCL*.****Proposal 4: No further discussion on beam management enhancements for LBT failure handling in Rel-17.** |

## Summary of views

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| **#** | **Issue** | **Companies’ views** |
| 6.1 | Whether to enhance RS transmissions to deal with LBT failure | **Yes:** Huawei/HiSi, Spreadtrum, InterDigital, Sony, Futurewei, Nokia/NSB, LGE, NTT Docomo, Xiaomi* [InterDigital]: Support RS pre-emption based on gNB indication to achieve accurate fine time/frequency tracking, beam failure recovery and beam/CSI.
* [Lenovo/MotM]: For NR operation in unlicensed bands between 52.6 GHz and 71 GHz, the following potential enhancements related to periodic transmissions of RS such as P-TRS should be specified to deal with LBT failure:
	+ Termination of periodic RS transmission on beams where consecutive LBT failures are encountered
	+ Dynamic switching of the QCL assumption (beams) for periodic RS transmission where consecutive LBT failures are encountered, where:
		- Multiple QCL assumptions (multiple beams) can be configured to the RS resource and beam switch can be triggered once the continuous number of LBT failures reach a certain threshold value

**Need further study/hold the discussion:** Samsung, ZTE/Sanechips, OPPO* [Samsung]: Further investigate the issue on the uncertainty of RS transmission due to LBT for 60 GHz unlicensed band.
* [ZTE/Sanechips]: Study and evaluate the impact of LBT and the limitation of COT length on the procedure of beam failure detection.

**No:** CATT, Ericsson, Intel* [CATT]: Aperiodic CSI-RS could be used as the alternative solution of missed L1 RSRP measurement of periodic CSI-RS due to LBT failure with little specification change.
* [Ericsson]: Enhancement of existing BFD procedures by introduction of ap-CSI-RS is not needed for operation in shared spectrum. The existing BFI counter and timer can be adjusted to compensate for occasional LBT failure causing a missing instance (period) of a periodic BFD RS (SS/PBCH block and/or p-CSI-RS).
* [Intel]: No special handling of periodic RS transmissions is needed to address interruptions due to LBT failure as well as no special means are needed to distinguish between LBT failures and beam failures
 |
| 6.2 | Multi-slot aperiodic RS | **Yes:** Samsung, Nokia/NSB, LGE, Xiaomi* [Samsung]: Support multi-slot aperiodic CSI-RS/SRS scheduled by a single DCI for beam management in 60 GHz unlicensed band.
* [LGE]: How to provide more opportunities of CSI-RS or SRS transmission considering LBT failure
 |
| 6.3 | Other enhancements related to beam failure recovery | **Symbol window for decoding PDCCH in recoverySearhSpaceId*** [Ericsson]: For the new beam identification (NBI) procedure, the 28 symbol window for decoding PDCCH in recoverySearchSpaceId may need to be revisited for the case that a serving cell is configured with 480 or 960 kHz SCS.
* [NTT Docomo]: whether to introduce a new time gap to apply new beam configuration after receiving BFR response from gNB

**Partial BFR*** [Qualcomm]: Support partial BFR for single TRP.

**Increased number of candidate beams*** [NTT Docomo]: whether to increase the number of candidate beams included in set
 |

## 1st round discussion

### Observation 6

The moderator observed no proposal supported by majority companies in this topic. Moreover, companies supporting periodic RS enhancement indicated different preferences on detailed enhancements (e.g., use of aperiodic RS for BFR, periodic TRS enhancement and etc.). In addition, the moderator observed that companies’ views are very stable during recent few meetings and expect no further changes. Given the situation, the moderator believes that it would be better to conclude as no RS enhancement.

### Proposal 6

Conclusion

* No periodic RS enhancement is supported for Rel-17 NR 52-71.

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| **Company** | **Input** |
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### 1st round discussion summary

TBU

# **Others**

## Observations and Proposals from Contributions

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| **Company** | **Observations and Proposals from Contributions** |
| [CATT, 6] | **Proposal 2: The beam management frame work should be reused for NR operation in 52.6-71 GHz.** **Proposal 7: In initial access, the beam adaptation for Msg3 and Msg4 transmission can be adapted based on the beam measurement report from UE.** |
| [Sony, 8] | **Proposal 5 : Beam alignment during initial access procedure should be considered for NR above 52.6 GHz.** |
| [Ericsson, 9] | [Proposal 6 Enhancement of the number of explicitly configured RSs for BFD (SS/PBCH blocks and/or p-CSI-RS) is not needed.](#_Toc87008288)[Proposal 7 For the new beam identification (NBI) procedure, the 28 symbol window for decoding PDCCH in *recoverySearchSpaceId* may need to be revisited for the case that a serving cell is configured with 480 or 960 kHz SCS.](#_Toc87008289) |
| [Xiaomi, 11] | ***Proposal 5: To support more beams, the maximal number of reference singles in one CSI-RS resource set should be increased. Or, multiple aperiodic CSI-RS resource sets associated with one aperiodic trigger state should be allowed to be used for beam measurement.*** |
| [Lenovo/MotM, 12] | ***Proposal 4: For NR operation between 52.6 GHz and 71 GHz, Rel-17 common TCI state indication should be supported for multi-PDSCH scheduling******Proposal 5: For NR operation between 52.6 GHz and 71 GHz, how to determine the applied TCI state for the multiple PDSCH in continuous slots when the indicated common TCI state is changed but the UE cannot switch it RX beam within the CP should be further discussed******Proposal 6: For NR operation between 52.6 GHz and 71 GHz, when multiple PDSCHs with different TBs are scheduled by the DCI indicating a common TCI******state, the ACK/NACK of any one scheduled PDSCH can be used as the ACK for the DCI*** |
| [NTT Docomo, 19] | Proposal 2: For beam failure detection/recovery procedure in NR 52.6-71GHz, discuss whether to introduce a new time gap to apply new beam configuration after receiving BFR response from gNB. |
| [Qualcomm, 20] | **Proposal 7: Support partial BFR for single TRP.****Proposal 8: Support UE report of recommended SSB in Msg3/A in initial access.****Proposal 9: Support dynamic beam update of periodic channel/RS.****Proposal 10: Investigate sub-band based beam report.****Proposal 11: The contents of configured TCI states can be dynamically updated*.**** **The contents may include any QCL source RS ID, e.g. both TypeA/D RS IDs, and corresponding BWP/CC ID.**
 |

## Summary of views

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| **#** | **Issue** | **Companies’ views** |
| 7.1 | Beam reporting/alignment during initial access procedure | **Yes:** Sony, CATT, Qualcomm**No:** |
| 7.2 | Dynamic beam update | **Yes:** Lenovo/MotM, Qualcomm, NTT Docomo**No:** |
| 7.3 | Increase the number of configured CSI-RS resources | **Yes:** NTT Docomo, Xiaomi |
| 7.4 | Considering Rel-17 feMIMO unified TCI framework for multi-PDSCH/PUSCH scheduling | **Yes:**Lenovo/MotM**No:** |
| 7.5 | Enhancement on 28 symbol window for decoding PDCCH for the NBI procedure of BFR | **Yes:** Ericsson, NTT Docomo**No:** |
| 7.6 | Partial BFR | **Yes:** Qualcomm**No:** |

## 1st round discussion

### Observation 7

The moderator observed no proposal supported by majority companies. Please provide your views on the above proposals in the summary.

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| --- | --- |
| **Company** | **Input** |
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### Proposal 7

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### 1st round discussion summary

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