**3GPP TSG-RAN WG4 Meeting # 95-e R4-200xxxx**

**Electronic Meeting, 25 May– 5 June, 2020**

**Agenda item:** 6.16.1.3 /6.16.1.4

**Source:** Moderator (OPPO)

**Title:** Email discussion summary for [95e][226]NR\_CSIRS\_L3meas\_RRM\_2

**Document for:** Information

# Introduction

*Briefly introduce background, the scope of this email discussion and provide some guidelines for email discussion if necessary.*

For measurement capability, 6 sub-topics are identified and to be discussed in this meeting.

* *Sub-topic 1-1: General*
* *Sub-topic 1-2: number of frequency layers to be monitored*
* *Sub-topic 1-3: number of cells to be monitored*
* *Sub-topic 1-4: number of CSI-RS resource/beams to be monitored per layer/MO*
* *Sub-topic 1-5: Buffering and processing capability*
* *Sub-topic 1-6: On CSI-RS resources configurations*

For measurement requirement, 6 sub-topics are identified and to be discussed in this meeting.

* *Sub-topic 2-1: General*
* *Sub-topic 2-2: Measurement delay*
* *Sub-topic 2-3: Scaling factor*
* *Sub-topic 2-4: UE capability to indicate the simultaneous reception of CSI-RS of neighbour cell and SSB of serving cell*
* *Sub-topic 2-5: Scheduling Restriction*

*List of candidate target of email discussion for 1st round and 2nd round*

* *1st round: Discuss and agree on all listed issues for measurement capability and measurement requirement.*
* *2nd round: Discuss and agree on CRs，and provide the WF for both agreements and remaining open issues.*

# Topic #1: Measurement capability

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2006225**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2006225.zip) | CATT | **Proposal 1: CSI-RS based UE measurement capabilities shall specified in terms of:*** **Number of carrier to be monitored**
* **Number of cell to be monitored per frequency layer**
* **Number of CSI-RS resources to be monitored per frequency layer**

**Proposal 2: UE shall be able to measure at least 8 NR frequency layers in total, including SSB frequency layers and CSI-RS frequency layers.****Proposal 3: UE shall be able to measure at least 14 carriers of all RATs in total.****Proposal 4: The requirement of number of cell to be monitored defined for SSB based UE measurement capability can be reused to define the number of cells to be monitored for CSI-RS based UE measurement capabilities.****Proposal 5: For the number of CSI-RS resource, UE shall monitor at least 24 CSI-RS resources per frequency layer.** |
| [**R4-2006552**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2006552.zip) | Intel Corporation | ***Proposal 1:*** ***measurement capability requirement is defined per frequency layer for CSI-RS based measurement.******Proposal 2:*** ***the frequency layer definition for CSI-RS is as follows:***

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| * ***the same SCS and CP type***
* ***the same centre frequency***
* ***the same value of CSI-RS bandwidth***
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***Proposal 3: Considering the flexibility of CSI-RS, more configuration options of CSI-RS than that of SSB can be designed.*** |
| [**R4-2006574**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2006574.zip) | MediaTek inc. | **Proposal 1:** **One MO is one frequency layer. Different MOs are different frequency layers.****Proposal 2: The layers to be monitored based on CSI-RS can only be a subset of the layers to be monitored based on SSB. The minimum # of layers to be measured based on CSI-RS is the same as that for** SSB.**Proposal 3: The cells to be monitored based on CSI-RS can only be a subset of the cells to be monitored based on SSB. The minimum # of cells to be measured based on CSI-RS is the same as that** for**Proposal 4: If the number of remaining CSI-RS resources to be measured with detectable associated SSB in an MO is larger than the UE measurement capability, the UE behavior is undefined.****Proposal 5: Regarding the number of CSI-RS (beams) to be monitored per layer based on L3 CSI-RS, requirements defined the same requirements as those for SSB.****Proposal 6: Since only requirements with associated SSB will be defined, the UE processing capability in a slot per MO should be revised to consider only the CSI-RS resources to be measured with detectable associated SSB.****Proposal 7: The discussion of UE buffering and processing capability is pending on the conclusion of time domain limitation of the CSI-RS per MO in another discussion.** |
| [**R4-2006764**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2006764.zip) | CMCC | ***Observation 1: the associated SSB used for CSI-RS measurement may not be the same as the SSB configured as mobility RS in MO, which will increase the number of frequency layers UE need to measure.*** ***Proposal 1: it is proposed that UE is capable of measuring [8] NR frequency layers including SSB frequency layers configured as mobility RS in MO and associated SSB used for CSI-RS measurement******Proposal 2: For each intra-frequency layer, it is proposed that UE is capable of measuring [8] CSI-RS cell for FR1 and [6] CSI-RS cells for FR2.******Proposal 3: For each inter-frequency layer, it is proposed that UE is capable of measuring [4] CSI-RS cell for both FR1 and FR2.******Proposal 4: For each intra-frequency layer for FR1, the number of CSI-RS resource is proposed to be [32]. For each intra-frequency layer for FR2, the number of CSI-RS resource is proposed to be [42]******Proposal 5: For each inter-frequency layer for FR1, the number of CSI-RS resource is proposed to be [24]. For each inter-frequency layer for FR2, the number of CSI-RS resource is proposed to be [34]*** |
| [**R4-2007100**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2007100.zip) | Nokia, Nokia Shanghai Bell | **Proposal1: Do not introduce additional carrier frequency layers due to CSI-RS based RRM measurements.** **Proposal2: The UE shall be capable of monitoring a total of at least 7 NR carriers excluding NR serving carrier(s).** **Proposal3: For CSI-RS based RRM measurement, the carrier/ frequency layer refers to the center frequency of the CSI-RS resources.****Proposal4: There could be one or multiple MOs per frequency layer when CSI-RS based RRM measurement is configured.** **Proposal5: When *associatedSSB* is configured, the UE is supposed to monitor not only the frequency layer of the CSI-RS resource, but also the frequency layer of the *associatedSSB* which is indicated via *ssbFrequency.*** **Proposal6: If the CSI-RS resources with different center frequencies (i.e. layers) are associated with the same *ssbFrequency*, the layer corresponding to the *ssbFrequency* shall be counted only once to the total number of effective carrier frequency layers.** **Proposal7: For intra-frequency measurements, the number of cells the UE is capable of monitoring should be the same as the number defined for SSB-based measurements i.e. 8 identified cells for FR1 and 6 identified cells for FR2, for each intra-frequency layer. In these cells, the UE may be configured for SSB-based and/or CSI-RS based measurements.****Proposal8: The UE shall be capable of measuring** * **For FR1, at least 14 CSI-RS resources for each intra-frequency layer, if no SSB-based measurement or *associatedSSB* is configured on this layer.**
* **For FR2, at least 24 CSI-RS resources for the single serving carrier and 2 CSI-RS resources for other carriers on the same band, if no SSB-based measurement or *associatedSSB* is configured on this layer.**
* **Otherwise, the capability is shared between SSBs and CSI-RS resources.**

**Proposal9: No additional measurement capability is required in a slot per MO.**  |
| [**R4-2007352**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2007352.zip) | OPPO | **Proposal 1: Measurement capabilities per MO or per layer are the same.****Proposal 2: Support option 1 that UE shall be able to measure at least 7 effective** **NR frequency layers in total excluding NR serving carrier(s), including SSB frequency layers and CSI-RS frequency layers.****Proposal 3: Considering the different buffer and processing for RRM, MO(s) configured for SSB and/or CS-RS mobility measurement should be taken as different NR frequency layers.****Proposal 4: Support shared capability on number of cells for CSI-RS&SSB:*** + **Number of monitored cells is determined by the UE capability based on SSB based measurements.**
	+ **For FR1, at least 8 and 4 identified cells for intra-f and inter-f measurement respectively.**
	+ **For FR2, at least 6 and 4 identified cells for intra-f and inter-f measurement respectively**

**Proposal 5: Support option 3, and requirements defined the same requirements as those for SSB** * + **If network configures more CSI-RS resources in an MO than the UE measurement capability, the UE behaviour is undefined.**
	+ **For FR1, 14 and 7 CSI-RS resources for intra-f and inter-f measurement respectively.**
	+ **For FR2, 24 and 10 CSI-RS resources for intra-f and inter-f measurement respectively and at least 1 CSI-RS resources per identified cell.**

**Proposal 6: For intra-frequency measurements on FR2, the UE shall also be capable of at least 2 SSBs and 2 CSI-RS resources on serving cell for each of the other serving carrier(s) in the same band.** |
| [**R4-2007650**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2007650.zip) | ZTE | ***Proposal 1. UE shall be able to measure at least [7] CSI-RS frequency layers if there is no SSB based measurement is configured.*** ***Proposal 2. The total number of NR frequency layers UE shall be able to monitoring remains unchanged.*** ***Proposal 3. No need to further discuss per MO or per frequency layer.*** ***Proposal 4. Separated UE capability of number of cells and number of CSI-RS resources that the UE shall be capable of performing CSI-RS based measurement for L3 mobility should be specified.******Proposal 5. The same number of cells as for SSB based measurement is used for CSI-RS based measurement.******Proposal 6. The number of CSI-RS resources shall be monitored by UE is specified as in option 2.******Proposal 7. Not to define UE capability to indicate maximum CSI-RS resources in a slot per MO.******Proposal 8. Further study impact of UE capability*** *maxNumberCSI-RS-RRM-RS-SINR* ***to number of beams UE shall be capable of monitoring.*** |
| [**R4-2007864**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2007864.zip) | Huawei, HiSilicon | **Proposal 1: CSI-RS measurement capability requirements are defined on per MO basis, and one CSI-RS frequency layer is identical to one MO with CSI-RS.****Proposal 2: Define separate capabilities for SSB measurement and CSI-RS measurement.****Proposal 3: The number of CSI-RS frequency layers is the number of MOs with CSI-RS.****Proposal 4: The number of SSB frequency layers is the total number of MOs with*** **SSB configured as mobility RS (no matter if CSI-RS is configured as mobility RS)**
* **SSB not configured as mobility RS but CSI-RS configured as mobility RS with associated SSB**

**Proposal 5: If SSB related parameters are same in multiple MOs, the multiple MOs can be counted as one SSB layer in capability.** **Proposal 6: The capability in number of frequency layers are defined as** * **SSB intra-frequency layer: 1 per serving cell**
* **CSI-RS intra-frequency layer: 1 per serving cell**
* **SSB inter-frequency layers: 7**
* **CSI-RS inter-frequency layers: 7**
* **Total inter-frequency layers including SSB and CSI-RS: 7**
* **Total inter-frequency and inter-RAT layers: 13**

**Proposal 7: Re-use the SSB requirements for CSI-RS on number of cells UE shall monitor per frequency layer. UE measures the same set of cells for CSI-RS and its associated SSB.****Proposal 8: UE shall monitor at least 32/24 CSI-RS resources for each intra/inter-frequency CSI-RS layer.****Proposal 9: For an FR2 band, UE measures CSI-RS from neighbour cells on one single intra-frequency layer.****Proposal 10: The total number of CSI resources that UE can monitor per slot is indicated by existing capability maxNumberCSI-RS-RRM-RS-SINR.** **Proposal 11:** CSI-RS requirements apply provided that CSI-RS resources in any two consecutive slots are separated by at least 7 symbols.**Proposal 12: RAN4 to discuss the requirements when number of configured CSI-RS resources per slot exceeds the indicated UE capability.*** **Option 1: measurement period is extended**
* **Option 2: other**
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| [**R4-2007867**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2007867.zip) | Huawei, HiSilicon | **Proposal 1: Introduce the concept of CMTC in Rel-16, and UE is only required to measure CSI-RS resources within the CMTC window.****Proposal 2: 1 CMTC periodicity can be configured per CSI-RS frequency layer, and the candidate values are {10, 20, 40}ms.****Proposal 3: 1 CMTC duration can be configured per CSI-RS frequency layer, and the candidate values are {1, 2, 3, 4, 5}ms.****Proposal 4: RAN4 does not define restrictions on number of CSI-RS resources periodicities per MO.** |
| [**R4-2008237**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2008237.zip) | Qualcomm CDMA Technologies | **Proposal1: CSI-RS measurement capabilities can be specified per frequency layer. And option 1b is supported.** **Proposal1.1: Regardless of SSB or CSI-RS, total number of NR inter-frequency layers shall be the same. At least 7 effective NR carrier frequency layers shall be measured for UE. Option 1 is supported.****Proposal1.2: Option1 is supported and number of monitored cells is shared for CSI-RS and SSB per frequency layer.** **Proposal1.3: the number of neighbor CSI-RS beams can be equal or more than that of the SSB. As a baseline, following numbers of monitored CSI-RS beams are considered.*** **For FR1, 16 and 8 CSI-RS resources for intra-f and inter-f measurements, respectively.**
* **For FR2, 24 and 16 CSI-RS resources for intra-f and inter-f measurements, respectively.**

**Proposal 1.4: The total number of CSI resources that UE can monitor per slot should come from the UE capability maxNumberCSI-RS-RRM-RS-SINR. And the capability is reserved for RRM purpose.****Proposal 1.5: Given that maxNumberCSI-RS-RRM-RS-SINR shall reflect the UE’s capability in the back2back slot processing, it is not necessary to define new UE capability on the minimum separation between two slots with CSI-RS resources.****Proposal2: Consider the existing mechanisms of time configuration via slotConfig and SMTC for measuring the intra-frequency and inter-frequency CSI-RS resources.** **Proposal2.1: Send a LS to RAN1/2 for clarity on measurement timing configuration for inter-frequency measurements via SMTC based gap or, gaps independent of SMTC.**  |
| [**R4-2006216**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2006216.zip) | Apple | Measurement capability* + Measurement capability per MO or per frequency layer

**Proposal 2: Limit one MO per frequency layer so that the measurement per MO or per frequency layer are equivalent.** * + Number of frequency layers to be monitored

**Proposal 3: Existing requirements do not change, i.e. The total number of carrier UE shall be capable of monitoring at least 13 effective carrier frequency layers****Proposal 4: UE shall be able to measure at least 7 NR frequency layers in total, including SSB frequency layers and CSI-RS frequency layers.*** + Number of cells to be monitored

**Proposal 5: Shared capability for CSI-RS&SSB*** + Number of CSI-RS resource/beams to be monitored

**Proposal 6: For FR1, 14 and 7 CSI-RS resources for intra-f and inter-f, respectively. For FR2, 24 and 10 CSI-RS resources for intra- and inter-frequency, respectively and at least 1 CSI-RS resources per cell.*** + UE capability to indicate maximum CSI-RS resources in a slot per MO

**Proposal 7: The total number of CSI resources that UE can monitor per slot should come from the UE capability maxNumberCSI-RS-RRM-RS-SINR.****Proposal 8: Introduce CSI-RS Measurement Timing Configuration (CMTC).*** **All CSI-RS resources for L3 meaurement should be configured within CMTC window**
* **CMTC window duration: considering CSI-RS periodicity is up to 40ms, the CMTC window should be less than 5ms.**
* **Up to 2 CMTC periodicities can be configured per CSI-RS intra-frequency layer**
* **Up to 1 CMTC periodicity can be configured per CSI-RS inter-frequency layer**

**Proposal 9: Further restriction on CSI-RS MO configuration for mobility in Rel-16 include*** **A fixed channel bandwidth per MO should be configured**
* **Up to 2 CSI-RS resources periodicities can be configured per intra-frequency MO**
* **Up to 1 CSI-RS resource periodicity can be configured per inter-frequency MO**
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## Open issues summary

*Before e-Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub-topic 1-1: General

*Sub-topic description:*

In last meeting RAN4 has agreed requirements shall be defined when CSI-RS is configured with an associated SSB. No requirements in Rel-16 for the case associated SSB is not configured for CSI-RS.

* Measurement capabilities per MO or per layer
	+ Option 1: per frequency layer
		- Option 1a (CATT, Nokia): a frequency layer is identical to an MO
		- Option 1b (ZTE, Apple): One or multiple MOs can be one frequency layer.
	+ Option 2: per MO
		- A frequency layer is identical to an MO
	+ Option 3: Measurement capabilities per MO or per layer are the same, since single MO is configured per frequency layer,
		- CSI-RS resources in the same MO should have the same center frequency, SCS and CP type.

*Open issues and candidate options before e-meeting:*

#### **Issue 1-1-1: Alignment on Measurement capabilities per MO or per layer**

* Proposals
	+ Option 1: CSI-RS measurement capability requirements are defined on per layer.
		- One or multiple MOs can be corresponding to one frequency layer.
	+ Option 2: CSI-RS measurement capability requirements are defined on per MO basis.
		- One CSI-RS frequency layer is identical to one MO with CSI-RS. Different MOs are different frequency layers.
	+ Option 3: No need to further discuss per MO or per frequency layer.
* Recommended WF
	+ Based on the definition of CSI-RS frequency layer, measurement capabilities per MO or per layer are the same. Capability requirement is defined per layer.
		- the frequency layer definition for CSI-RS is as follows:
			* the same SCS and CP type
			* the same centre frequency
			* the same value of CSI-RS bandwidth

#### **Comments on Sub-topic 1-1: General**

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| **Issue 1-1-1: Alignment on Measurement capabilities per MO or per layer** |
| **Company** | **Comments** |
| vivo | If per MO and per layer is the same, that means only one MO is allowed for each frequency layer. If per MO and per layer is not the same, i.e. more than one MO is allowed for each frequency layer, per MO basis is a better choice for us. |
| MTK | Support Option 2.This is the discussion on whether to allow multiple MOs for the same frequency layer. We understand the concern from infra vendors that single MO provides only 92 CSI-RS configurations which may not be sufficient if 32 CSI-RS resources are configured per cell. For an example, to configure all CSI-RS of 7 cells, we need 224 CSI-RS which requires 3 MOs. But we want to check if this is a real consideration in deployment because 224 CSI-RS implies a very high RS overhead as well as significant scheduling restriction (e.g., in FR2) on top of what we already have for SSB. It seems to us to disadvantage of this high overhead would outweigh the benefit of introducing CSI-RS for L3 mobility. |

### Sub-topic 1-2: number of frequency layers to be monitored

*Sub-topic description*

* Agreement: The total number of carrier UE shall be capable of monitoring at least 13 effective carrier frequency layers
* CSI-RS based NR inter-frequency layers
	+ Option 1 (MediaTek, OPPO, Qualcomm, CATT, Apple, Huawei):
		- UE shall be able to measure at least 7 NR frequency layers in total, including SSB frequency layers and CSI-RS frequency layers.
	+ Option 2 (CMCC):
		- UE shall be able to measure at least [3] CSI-RS frequency layers.
		- UE shall be able to measure at least 8 NR frequency layers in total, including SSB frequency layers and CSI-RS frequency layers.
	+ Option 3 (ZTE):
		- UE shall be able to measure at least [7] CSI-RS frequency layers

*Open issues and candidate options before e-meeting:*

#### **Issue 1-2-1: number of frequency layers to be monitored**

* Proposals
	+ UE shall be able to measure at least [X1] CSI-RS inter-frequency layers if there is no SSB based measurement is configured. At least [X2] NR inter-frequency layers in total including CSI-RS and SSB frequency layers
		- Option 1: X1=X2= 7
		- Option 1a: X1= 0, X2=7 (MediaTek)
		- Option 2: X1=X2= 8 (CMCC, CATT)
* Recommended WF
	+ UE shall be able to measure at least [X1] CSI-RS inter-frequency layers if there is no SSB based measurement is configured. At least [X2] NR inter-frequency layers in total including CSI-RS and SSB frequency layers.
		- FFS on X1 and X2
	+ In summary, number of frequency layers to be monitored
		- SSB intra-frequency layer: 1 per serving cell
		- CSI-RS intra-frequency layer: 1 per serving cell
		- SSB inter-frequency layers: 7
		- CSI-RS inter-frequency layers: 7
		- Total inter-frequency layers including SSB and CSI-RS: 7
		- Total inter-frequency and inter-RAT layers: 13

#### **Issue 1-2-2: SSB frequency layers to be monitored**

* Proposals
	+ Option 1(Huawei):
		- The number of SSB frequency layers is the total number of MOs with
		- SSB configured as mobility RS (no matter if CSI-RS is configured as mobility RS)
		- SSB not configured as mobility RS but CSI-RS configured as mobility RS with associated SSB
		- If SSB related parameters are same in multiple MOs, the multiple MOs can be counted as one SSB layer in capability.
	+ Option 2(Nokia):
		- When associatedSSB is configured, the UE is supposed to monitor not only the frequency layer of the CSI-RS resource, but also the frequency layer of the associatedSSB which is indicated via ssbFrequency.
		- If the CSI-RS resources with different center frequencies (i.e. layers) are associated with the same ssbFrequency, the layer corresponding to the ssbFrequency shall be counted only once to the total number of effective carrier frequency layers.
* Recommended WF
	+ FFS

#### **Comments on Sub-topic 1-2: number of frequency layers to be monitored**

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| **Issue 1-2-1: number of frequency layers to be monitored** |
| **Company** | **Comments** |
| vivo | We support option 1 and fine with the recommended WF.Moreover, we suggest that if both “ssb-ConfigMobility” and “ssb-ConfigMobility” are configured in the same inter-frequncy MO, SSB-based measurement and CSI-RS based measurement are treated as two separate layers. |
| MTK | Option 2Firstly, we need to clarify whether RAN4 allows a MO with only CSI-RS configurations without SSB configuration. In our view, this is infeasible for CSI-RS with associated SSB. UE has to detect the SSB first before performing measurement on CSI-RS. Without SSB-related information, UE cannot start to detect the SSB and therefore cannot perform CSI-RS measurement. So X1 should be 0. In other words, we should empathize in the spec that the layers that UE performs CSI-RS based measurements should only be a sub set of layers that UE performs SSB-based measurements.Regarding X2, 7 is OK to us. |

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| **Issue 1-2-2: SSB frequency layers to be monitored** |
| **Company** | **Comments** |
| vivo | We support option 1 and see it is also compatible with option 2. |
| MTK | For Option 1, we have concern on the 3rd condition of Option 1. SSB should be also configured in the same MO so that UE can detect SSB first before measuring CSI-RS. For the other conditions, we are fine.For Option 2, we are OK with the 1st bullet, while the 2nd bullet is pending on the conclusion of Issue 1-1. |

### Sub-topic 1-3: number of cells to be monitored

*Sub-topic description*

* Option 1 (MediaTek, OPPO, Qualcomm, Nokia): Shared capability for CSI-RS&SSB
	+ Number of monitored cells is determined by the UE capability based on SSB based measurements.
* Option 2 (Huawei, CATT, CMCC):  Separated capability for CSI-RS
	+ Option 2a (Huawei):
		- Re-use the SSB requirements for CSI-RS on number of cells UE shall monitor per layer.
	+ Option 2b (CMCC):
		- For each intra-frequency layer, UE is capable of measuring [8] CSI-RS cell;
		- For each inter-frequency layer, UE is capable of measuring [4] CSI-RS cell.
* Option 3 (ZTE): Capabilities for CSI-RS only and CSI-RS&SSB
	+ UE shall be capable of performing CSI-RS based measurements for at least [8] identified cells in FR1 for intra frequency measurement and at least [4] identified cells in FR1 for inter frequency measurement, at least [6] identified cells in FR2 for intra frequency measurement and at least [4] identified cells in FR2 for inter frequency measurement.
	+ UE shall be capable of performing SSB and CSI-RS based measurements for at least [12] identified cells in FR1 for intra frequency measurement and at least [6] identified cells in FR1 for inter frequency measurement.
	+ UE shall be capable of performing CSI-RS based measurements for at least [9] identified cells in FR2 for intra frequency measurement and at least [6] identified cells in FR2 for inter frequency measurement.

*Open issues and candidate options before e-meeting:*

#### **Issue 1-3-1: number of cells to be monitored per layer**

* Proposals
	+ Option 1: Support shared capability for CSI-RS&SSB((MediaTek, OPPO, Qualcomm, Nokia)
		- Number of monitored cells is determined by the UE capability based on SSB based measurements.
			* For each intra-frequency layer, UE is capable of measuring [8] identified cell for FR1 and [6] identified cells for FR2.
			* For each inter-frequency layer, UE is capable of measuring [4] identified cell for both FR1 and FR2.
	+ Option 2: Separated capability for CSI-RS and SSB (CMCC, ZTE, CATT, Huawei )
		- For each intra-frequency layer, UE is capable of measuring [8] CSI-RS cell for FR1 and [6] CSI-RS cells for FR2.
		- For each inter-frequency layer, UE is capable of measuring [4] CSI-RS cell for both FR1 and FR2
* Recommended WF
	+ Decide whether to define shared capability or separated capability for monitored cells for CSI-RS and SSB based measurement
	+ For either option 1 or 2, the majority view on the number of identified cells is reusing the values for SSB.
		- Each intra-frequency layer：8 for FR1, 6 for FR2
		- Each inter-frequency layer：4 for FR1, 4 for FR2

#### **Comments on Sub-topic 1-3: number of cells to be monitored**

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| **Issue 1-3-1: number of cells to be monitored per layer** |
| **Company** | **Comments** |
| vivo | For intra-frequency layer, if frequency layer definition follows WF in 1-1-1, shared capability is a better choice for CSI-RS based RRM.For inter-frequency layer, in one MO where both “ssb-ConfigMobility” and “csi-rs-ResourceConfigMobility” are configured, SSB and CSI-RS should be treated as 2 different frequency layers. If such proposal can be adopted, we support separate capability on these layers. If they are not treated as different frequency layer, maybe shared capability is better for this case.If only one of “ssb-ConfigMobility” and “csi-rs-ResourceConfigMobility” is configured, we support separate capability on each MO. |
| MTK | Support Option 1 with the additional note that the cells that UE monitors based on CSI-RS is only a sub set of cells that UE monitors based on SSB.  |

### Sub-topic 1-4: number of CSI-RS resource/beams to be monitored per layer/MO

*Sub-topic description*

* Option 1(CATT, Huawei): UE shall monitor at least 32 CSI-RS resources per frequency layer
* Option 2(ZTE): Define different UE capability for different scenarios, and number of CSI-RS resources shall be monitored by UE,
	+ [24] CSI-RS resources for intra frequency measurements in FR1
	+ [48] CSI-RS resources for intra frequency measurements in FR2,
	+ [16] CSI-RS resources for inter frequency measurements in FR1,
	+ [24] CSI-RS resources for inter frequency measurements in FR2.
* Option 3 (MTK,OPPO, Apple): Requirements defined the same requirements as those for SSB
	+ If network configures more CSI-RS resources in an MO than the UE measurement capability, the UE behavior is undefined.
	+ For FR1, 14 and 7 CSI-RS resources for intra-f and inter-f, respectively.
	+ For FR2, 24 and 10 CSI-RS resources for intra- and inter-frequency, respectively and at least 1 CSI-RS resources per cell.
* Option 4 (CMCC, Huawei)：
	+ For each intra-frequency layer, the number of CSI-RS resource is proposed to be [32].
	+ For each inter-frequency layer, the number of CSI-RS resource is proposed to be [24].
* Do not preclude other options (Qualcomm)

*Open issues and candidate options before e-meeting:*

#### **Issue 1-4-1: number of CSI-RS resource/beams to be monitored for each intra-f and inter-f layer**

* Proposals
	+ CSI-RS resources for each intra frequency layer in FR1
		- Option 1: 14 (MTK, OPPO, Apple, Nokia)
		- Option 2: 16 (Qualcomm)
		- Option 3: 24 (ZTE, CATT)
		- Option 4: 32 (CMCC, Huawei)
	+ CSI-RS resources for each intra frequency layer in FR2
		- Option 1: 24 (MTK, OPPO, Apple, Nokia, Huawei, Qualcomm, CATT)
		- Option 2: 42 (CMCC)
		- Option 3: 48 (ZTE)
		- Option 4: 32 (Huawei)
	+ CSI-RS resources for each inter frequency layer in FR1
		- Option 1: 7 (MTK, OPPO, Apple)
		- Option 2: 16 (ZTE, Qualcomm)
	+ Option 3: 24 (CMCC, CATT, Huawei)CSI-RS resources for each inter frequency layer in FR2
		- Option 1: 10 (MTK, OPPO, Apple)
		- Option 2: 16 (Qualcomm)
		- Option 3: 24 (ZTE, Huawei, CATT)
		- Option 4: 34 (CMCC)
* Recommended WF
* Define number of CSI-RS resource/beams to be monitored for each intra-f and inter-f layer based on majority views, leaving the values in [] as TBD.
	+ - [14] CSI-RS resources for intra frequency measurements in FR1
		- [24] CSI-RS resources for intra frequency measurements in FR2,
		- [7] CSI-RS resources for inter frequency measurements in FR1,
		- [10/ 24] CSI-RS resources for inter frequency measurements in FR2.
* Discuss whether and how the capability can be shared between SSBs and CSI-RS resources.

#### **Issue 1-4-2: number of CSI-RS resource/beams to be monitored for FR2 intra-f layer**

* Proposals
	+ Option 1: For an FR2 band, UE measures CSI-RS from neighbour cells on one single intra-frequency layer.
	+ Option 2: For intra-frequency measurements on FR2, the UE shall also be capable of at least 2 SSBs and 2 CSI-RS resources on serving cell for each of the other serving carrier(s) in the same band.
* Recommended WF
	+ Option 2

#### **Comments on Sub-topic 1-4: number of CSI-RS resource/beams to be monitored per layer/MO**

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| **Issue 1-4-1: number of CSI-RS resource/beams to be monitored for each intra-f and inter-f layer** |
| **Company** | **Comments** |
| vivo | We suggest to differentiate beams for associated SSB and beams for CSI-RS. Since beams for CSI-RS should be finer beams, we are fine to support more beams of CSI-RS, if the beams of associated SSB is limited to be the same as or less than SSB-based requirement, and measurement accuracy is derived based on the timing of associated SSB for inter frequency. |
| MTK | Support Option 1. As we explained several times in previous meetings, finer beamwidth does not guarantee better robustness in mobility performance. We wonder how more CSI-RS beams from gNB is going to maintain the same mobility robustness as SSB-based measurement. More and finer CSI-RS beams means the coverage of each CSI-RS beam becomes narrower than a SSB beam. This is going to increase the chance of handover failure because the best CSI-RS beam reported by UE could be highly likely not a suitable beam to that UE after handover.  |

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| **Issue 1-4-2: number of CSI-RS resource/beams to be monitored for FR2 intra-f layer** |
| **Company** | **Comments** |
| vivo | On option 1, we support the view.On option 2, we are fine with the proposal. |
| MTK | We are OK to both Option 1 and Option 2. They can be combined in to 2 proposal. |

### Sub-topic 1-5: Buffering and processing capability

#### **Issue 1-5-1: UE capability to indicate maximum number of CSI-RS resources in a slot per MO**

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| **WF on UE capability to indicate maximum CSI-RS resources in a slot per MO*** Option 1(Huawei, MTK, OPPO): Introduce UE capability to indicate the maximum number of CSI-RS resources per MO in a slot.
* Option 2 (ZTE): Not to define UE capability to indicate maximum CSI-RS resources in a slot per MO.
* Option 3(Qualcomm, Apple, Huawei): The total number of CSI resources that UE can monitor per slot should come from the UE capability maxNumberCSI-RS-RRM-RS-SINR.
	+ FFS how to split up
 |

* Proposals
	+ Option 1 (MTK): Since only requirements with associated SSB will be defined, the UE processing capability in a slot per MO should be revised to consider only the CSI-RS resources to be measured with detectable associated SSB.
	+ Option 2 (Huawei, Qualcomm, Apple): The total number of CSI resources that UE can monitor per slot is indicated by existing capability *maxNumberCSI-RS-RRM-RS-SINR.*
	+ Option 3 (ZTE, Nokia): Not to define UE capability to indicate maximum CSI-RS resources in a slot per MO.
	+ Recommended WF
	+ Discuss and decide whether to define UE capability.
		- If option 3 is agreed, no more discussion.
		- If option 1 or 2 is agreed, UE capability is introduced. Discuss how to reuse or revise the existing capability.

#### **Issue 1-5-2:** the requirements when number of configured CSI-RS resources per slot exceeds the indicated UE capability.

* + Option 1: measurement period is extended
	+ Option 2: other
	+ Recommended WF
	+ FFS.

#### **Issue 1-5-3: whether to introduce minimum separation between two slots with CSI-RS resources**

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| * Option 1: Introduce UE capability on the minimum separation between two slots with CSI-RS resources.
* Option 2: Not to introduce UE capability on the minimum separation between two slots with CSI-RS resources.
 |

* Proposals
	+ Option 1: Yes
		- Introduce UE capability on the minimum separation between two slots with CSI-RS resources.
	+ Option2: No
		- Not to define UE capability on the minimum separation between two slots with CSI-RS resources.
	+ Option 3: FFS
		- Pending on the conclusion of time domain limitation of the CSI-RS per MO in another discussion.
* Recommended WF
	+ FFS

#### **Issue 1-5-4: Minimum separation between two slots with CSI-RS resources**

* Proposals
	+ Option 1: CSI-RS requirements apply provided that CSI-RS resources in any two consecutive slots are separated by at least 7 symbols.
* Recommended WF
	+ If issue 1-5-3 is yes, further discuss the requirement for separation.

#### **Comments on Sub-topic 1-5: Buffering and processing capability**

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| **Issue 1-5-1: UE capability to indicate maximum number of CSI-RS resources in a slot per MO** |
| **Company** | **Comments** |
| vivo | We support option 2. |
| MTK | Option 1 is just an update of the wording based on the agreement to define requirements for associated SSB only.Regarding Option 2, how to interpret this capability in RAN4 needs some further discussion. Note that this capability considers all frequency layers.

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| ***maxNumberCSI-RS-RRM-RS-SINR***Defines the maximum number of CSI-RS resources for RRM and RS-SINR measurement across all measurement frequencies per slot. If UE supports any of *csi-RSRP-AndRSRQ-MeasWithSSB*, *csi-RSRP-AndRSRQ-MeasWithoutSSB*, and *csi-SINR-Meas*, UE shall report this capability. |

However, for inter-frequency measurement, UE is only required to perform measurement on one single frequency layer at a time. For intra-frequency layer, RAN4 may introduce CSSF to address the searcher constraint when performing measurements on multiple layers at the same time. RAN4 should first clarify how to interpret this capability. |

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| **Issue 1-5-2:** the requirements when number of configured CSI-RS resources per slot exceeds the indicated UE |
| **Company** | **Comments** |
| vivo | We prefer no requirement if number of CSI-RS exceeds UE capability. |
| MTK | Same view as vivo. |

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| **Issue 1-5-3: whether to introduce minimum separation between two slots with CSI-RS resources** |
| **Company** | **Comments** |
| vivo | We think option 3 reflects current situation. |
| MTK | Support Option 3. If there is a clear time domain limitation of CSI-RS per MO (or per frequency layer), perhaps there is no need to discuss slot separation anymore. |

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| **Issue 1-5-4: Minimum separation between two slots with CSI-RS resources** |
| **Company** | **Comments** |
| XXX |  |

### Sub-topic 1-6: On CSI-RS resources configurations

In last meeting, RAN4 agreed to introduce restrictions about time-domain scheduling for CSI-RS resources. Whether and how to introduce CMTC are to be discussed in this meeting in WF. The parameters including at least CMTC window length and periodicity should also be further discussed in this meeting.

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| * FFS the maximum number of CSI-RS resources periodicities configured per intra-frequency and inter-frequency MO
* FFS how to introduce CMTC
	+ Option 1:Introduce CSI-RS Measurement Timing Configuration
		- All CSI-RS resources for L3 meaurement should be configured within CMTC window
		- CMTC window duration: considering CSI-RS periodicity is up to [40]ms, the CMTC window should be less than [5] ms.
		- Up to [2] CMTC periodicities can be configured per CSI-RS intra-frequency layer
		- Up to [1] CMTC periodicity can be configured per CSI-RS inter-frequency layer
* FFS whether to introduce CMTC in Rel-16
 |

#### **Issue 1-6-1: Whether to introduce restriction on CSI-RS MO configuration**

* Proposals
	+ Option 1 (Apple):
		- Further restriction on CSI-RS MO configuration for mobility in Rel-16 include
			* A fixed channel bandwidth per MO should be configured
			* Up to 2 CSI-RS resources periodicities can be configured per intra-frequency MO
			* Up to 1 CSI-RS resource periodicity can be configured per inter-frequency MO
	+ Option 2 (Huawei):
		- RAN4 does not define restrictions on number of CSI-RS resources periodicities per MO.
	+ Option 3 (Intel):
		- Considering the flexibility of CSI-RS, more configuration options of CSI-RS than that of SSB can be designed.
	+ Option 4: Up to RAN2.
* Recommended WF
	+ FFS

#### **Issue 1-6-2: How to introduce time-domain restriction on CSI-RS resources configuration**

* Proposals
	+ Option 1: (Apple):
		- Introduce CSI-RS Measurement Timing Configuration (CMTC).
			* All CSI-RS resources for L3 meaurement should be configured within CMTC window
			* CMTC window duration: considering CSI-RS periodicity is up to 40ms, the CMTC window should be less than 5ms.
			* Up to 2 CMTC periodicities can be configured per CSI-RS intra-frequency layer
			* Up to 1 CMTC periodicity can be configured per CSI-RS inter-frequency layer
	+ Option 2 (Huawei):
		- Introduce the concept of CMTC in Rel-16
			* UE is only required to measure CSI-RS resources within the CMTC window.
			* 1 CMTC periodicity can be configured per CSI-RS frequency layer, and the candidate values are {10, 20, 40}ms.
			* 1 CMTC duration can be configured per CSI-RS frequency layer, and the candidate values are {1, 2, 3, 4, 5}ms.
	+ Option 3 (Qualcomm):
		- Consider the existing mechanisms of time configuration via slotConfig and SMTC for measuring the intra-frequency and inter-frequency CSI-RS resources.
		- Send a LS to RAN1/2 for clarity on measurement timing configuration for inter-frequency measurements via SMTC based gap or, gaps independent of SMTC.
	+ Option 4 (Nokia):
		- It is up to RAN2 to discuss whether CSI-RS based measurement window is required or not.
	+ Option 5 (MediaTek)
		- Limit CSI-RS resources to be confined in the SMTC duration of the same MO.
* Recommended WF
	+ Decide whether to introduce CMTC or how to confine in SMTC in Rel-16
		- FFS on parameters (based on Option 1 or Option 2)
	+ If agreed on measurement timing configuration, send LS to RAN1/2 in this meeting

#### **Comments on Sub-topic 1-6: On CSI-RS resources configurations**

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| **Issue 1-6-1: Whether to introduce restriction on CSI-RS MO configuration** |
| **Company** | **Comments** |
| vivo | One periodicity that is equal to the SMTC periodicity would be enough for R16. |
| MTK | Yes.A time domain limitation is essential to identify the relation to measurement gap, e.g., fully overlapped, partial overlapped or fully non-overlapped. Without this relation clarified, it is very difficult to progress on the CSSF requirements. If there is no time to introduce new signaling, then we suggest to limit CSI-RS in existing SMTC duration. |

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| **Issue 1-6-2: How to introduce time-domain restrictino on CSI-RS resources configuration** |
| **Company** | **Comments** |
| vivo | We think option 5 is a better way to move forward in R16. For UE performing CSI-RS measurement, UE may need first to obtain timing based on the associated SSB, and it is better to measure CSI-RS right after the timing is obtained.Note that in previous version of 38.215 CSI-RS is already confined in SMTC but got removed in later version. We think such confinement is feasible, although not optimal. Enhancement can be done in later release. |
| MTK | Support Option 5.It may be difficult for RAN4 to agree on a new signaling in this meeting. Also some companies have views that this signaling should be discussed in either RAN1 or RAN2. However, this time domain limitation is very important for RAN4 to reduce the spec workload as well as to progress the discussion on CSSF. Therefore, limiting CSI-RS in SMTC could be considered as a compromise for the time being. |

## Companies views’ collection for 1st round

### Open issues

Moderator: please comment directly in the tables under the text of corresponding issues in clause 1.2.

* Sub-topic 1-1: General
* Sub-topic 1-2: number of frequency layers to be monitored
* Sub-topic 1-3: number of cells to be monitored
* Sub-topic 1-4: number of CSI-RS resource/beams to be monitored per layer/MO
* Sub-topic 1-5: Buffering and processing capability
* Sub-topic 1-6: On CSI-RS resources configurations

### CRs/TPs comments collection

*Major close-to-finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

Moderator: How to handle and split CRs will be covered in 1st round summary of email thread [225]. No discussion is expected here.

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| --- | --- |
| **CR/TP number** | **Comments collection** |
| [**R4-2006227**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2006227.zip)**(CATT)** | Company A |
| Company B |
|  |
| [**R4-2006766**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2006766.zip)**(CMCC)** | Company A |
|  | Company B |
|  |  |
| [**R4-2007353**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2007353.zip)**(OPPO)** | Company A |
|  | Company B |
|  |  |
| [**R4-2007354**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2007354.zip)**(OPPO)** | Company A |
|  | Company B |
|  |  |
| [**R4-2007355**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2007355.zip)**(OPPO)** | Company A |
|  | Company B |
|  |  |
| [**R4-2007865**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2007865.zip)**(HW)** | Company A |
|  | Company B |
|  |  |
| [**R4-2007866**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2007866.zip)**(HW)** | Company A |
|  | Company B |
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## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary**  |
| **Sub-topic#1** | *Tentative agreements:**Candidate options:**Recommendations for 2nd round:* |

*Recommendations on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| #1 |  |  |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provides recommendation on CRs/TPs Status update*

|  |  |
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| **CR/TP number** | **CRs/TPs Status update recommendation**  |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
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| **CR/TP/LS/WF number** | **T-doc Status update recommendation**  |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #2: Measurement requirements for CSI-RS intra-frequency and inter-frequency measurements

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2006226**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2006226.zip) | CATT | **Proposal 1: For CSI-RS based measurement requirement, the following scenarios are prioritized to be defined in Rel-16:** * **Intra-frequency measurement without gap**
* **Inter-frequency measurement with gap**

**Proposal 2: If associated SSB is configured for CSI-RS resources, the CSI-RS identification time can be expressed as follows:****T CSI-RS\_identify\_intra\_without\_index = (TPSS/SSS\_sync\_intra + T CSI-RS\_measurement\_period\_intra) ms****T CSI-RS\_identify\_intra\_with\_index = (TPSS/SSS\_sync\_intra + T CSI-RS\_measurement\_period\_intra + TSSB\_time\_index\_intra) ms****Proposal 3: The scaling factor due to Rx beam sweeping for CSI-RS measurement is defined as 8 in FR2.****Proposal 4: It is proposed to introduce the UE capability to indicate the simultaneous reception of CSI-RS of neighbour cell and SSB of serving cell.****Proposal 5: the scheduling restriction for CSI-RS based measurement shall be introduced for the following cases:**1. **Mix-numerology between data/SSB of serving cell and CSI-RS of neighbour cell**
2. **RX beam sweeping in FR2**
3. **Collision between UL transmission and DL measurement for TDD carrier**

**Proposal 6: If additional dedicated searcher is assumed for CSI-RS measurement, no impact on existing CSSF defined for SSB based measurement specified in 38.133. Otherwise, the CSSFs for FR1/FR2 SCC shall be updated by considering the CSI-RS based intra-frequency and inter-frequency measurement without gap and within gap respectively.** |
| [**R4-2006575**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2006575.zip) | MediaTek inc. | **Observation 1: The introducing of the CSI-RS based requirement may have impact to existing SSB-based requirement.****Observation 2: The purpose of PBCH decoding is to acquire the frame and slot timing of the target cell.****Proposal 1: RAN4 to first conclude the time-domain limitation before discussing CSSF requirement.****Proposal 2: All CSI-RS in the same MO should follow the same time-domain relation with gap, e.g., either fully overlapped with gap, partially overlapped with gap or fully non-overlapped with gap.****Proposal 3: The easiest way to minimize the impact to existing SSB-based measurement requirement is to limit CSI-RS resources to be confined in the SMTC duration of the same MO.****Proposal 4: For PBCH, 5 samples are needed to guarantee >90% detection rate at SNR -6dB. If UE already detects the SSB of the target cell and deriveSSB-IndexFromCell is indicated, then UE may skip PBCH decoding.****Proposal 5: For inter-frequency CSI-RS measurement, at least additional [3] AGC samples are needed.****Proposal 6: All inter-frequency measurements are gap-assisted.****Proposal 7: Given the agreement in R4-2005355, all intra-frequency measurements are gapless.****Proposal 8: RAN4 should only introduce UE capability for simultaneous reception of CSI-RS of neighbour cell and SSB of serving cell with different numerology if this scenario is confirmed to be important. Otherwise, RAN4 should leave it with no requirement.****Proposal 9: The FFT window timing always follows the serving cell timing for intra frequency measurement and is up to UE implementation for inter frequency measurement.****Proposal 10: The scheduling restriction on the additional OFDM symbols before and after CSI-RS are not needed.** |
| [**R4-2006765**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2006765.zip) | CMCC | ***Proposal 1: for the case that cell search via SSB and PBCH decoding are needed, the time period for PSS/SSS detection and time period for time index detection (the terminology may need to be updated to apply to PBCH decoding) specified for SSB based mobility can be reused.******Proposal 2: for intra-frequency measurement, the measurement delay is proposed to be 3 samples.******Proposal 3: for inter-frequency measurement, the measurement delay is proposed to be 6 samples.*** |
| [**R4-2006841**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2006841.zip) | LG Electronics Inc. | * ***Proposal 1***: Tight synchronization level between serving and neighbour cell should be considered to utilize CSI-RS L3 measurement.
* ***Proposal 2***: Tight synchronization level less than CP length is needed to support different SCS value.
* ***Proposal 3***: Re-use the principle of SSB based L3-measurement for scaling factor N which could be up to 8.
* ***Proposal 4:*** Define scheduling restriction on one data symbol before and after CSI-RS symbol to be measured.
* ***Proposal 5:*** Do not define scheduling restriction if the timing difference between serving and neighbor cell including cell phase synchronization is guaranteed to be less then CP length
* ***Proposal 6:*** Network should configure L1 measurement resource to avoid collision with CSI-RS L3 measurement resource of neighbour cell.
 |
| [**R4-2006951**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2006951.zip) | NTT DOCOMO, INC. | **Observation 1: According to the definition of cell phase synchronization accuracy, the difference of frame start timing between two intra-frequency cells can be allowed if its value is less than 3us.****Observation 2: MRTD requirement for intra-band CA is 3us.****Observation 3: If deriveSSB-IndexFromCell is indicated, UE assumes that the neighbour cell is synchronous with the serving cell and the serving cell timing can be derived from the index of the SSB transmitted by the neighbour cell.****Observation 4: In the case of SSB based intra-frequency measurement, scheduling restriction is applied to 1 data symbol before and after SSB symbols.****Proposal 1: The timing error between the serving cell and the neighbor cell should be less than 3us.****Proposal 2: Select either two options about synchronization assumption for both of the cases of with/without associated SSB. (option 2 and 3 for the case without associated SSB and option 3 and 4 for the case with associated SSB)*** + **the timing error is less than [X]us, where X is 3~4us**
	+ **MRTD value for intra-band CA can be reused.**

**Proposal 3: PBCH decoding on target cell is not necessary regardless of associatedSSB when deriveSSB-IndexFromCell is indicated.****Proposal 4: To align with the case of SSB, select option 2:*** **Option 2 : The scheduling restriction on the additional OFDM symbols before and after SSB is not needed.**
 |
| [**R4-2007101**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2007101.zip) | Nokia, Nokia Shanghai Bell | **Proposal1: Gaps are not needed for intra-frequency CSI-RS based measurement.** **Proposal2: It is up to RAN2 to discuss whether CSI-RS based measurement window is required or not.** **Proposal3: The CSI-RS based RRM measurement is at least restricted by DRX configuration in time domain.** **Proposal4: The CSI-RS based intra-frequency cell identification comprises SSB-based cell identification and CSI-RS based measurements, where SSB-based cell identification is the same as the intra-frequency cell identification for SSB-based measurement.****Proposal5: Within the CSI-RS based intra-frequency cell identification, the time period to detect the *associatedSSB* can reuse Tidentify\_intra\_with\_index as defined in [3].****Proposal6: The CSI-RS based measurement period for intra-frequency measurement is defined based on 3 samples for {D=3 & 48PRB} and {D=1 & 96PRB} given SNR = -6dB.**  |
| [**R4-2007356**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2007356.zip) | OPPO | ***Proposal 1: No requirements is specified for CSI-RS L3 measurement when associatedSSB is not configured.******Proposal 2: No requirement is defined for the case the MO doesn’t include the serving CSI-RS resource regardless of CSI-RS resource associated SSB configured or not.******Proposal 3:******For intra-frequency CSI-RS based measurements, UE can perform intra-frequency CSI-RS based measurements without measurement gaps if*** * ***CSI-RS resource is completely contained in the active BWP of the UE.***

***Proposal 4: For inter-frequency CSI-RS based measurements, UE will need GAPs if**** ***SCS of CSI-RS is different from active BWP if UE is not capable of mixed numerology, and/or***
* ***CSI-RS resource is not fully confined within the active BWP, and/or***
* ***CP of cells to be measured is different from that of active BWP***

***Proposal 5: If a new capability for UE supporting different SCS in source and target cells is defined in Rel-16 NR mobility measurement, reuse it for CSI-RS L3 measurement.******Proposal 6: If UE already detects the SSB of the target cell and deriveSSB-IndexFromCell is indicated, PBCH decoding can be skipped.******Proposal 7: Support to introduce CMTC for restriction on time-domain for CSI-RS resource.******Proposal 8: Reuse values of SSB samples for intra-frequency and inter-frequency CSI-RS L3 measurements.******Proposal 9: When UE performs CSI-RS intra-frequency measurements in a FR1 TDD band, UE is not expected to transmit and receive on 2 data OFDM symbols impacted by CSI-RS resource symbol to be measured.******Proposal 10: If UE is not able to support mixed numerology of data and CSI-RS L3 mobility, the following scheduling restrictions apply due to intra-frequency CSI-RS based L3 measurement:**** + - ***if the associatedSSB is configured, UE is not expected to transmit or receive on 2 data OFDM symbols impacted by CSI-RS resource symbol to be measured.***
		- ***if the associatedSSB is not configured, no requirements apply.***
 |
| [**R4-2007736**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2007736.zip) | Huawei, Hisilicon | ***Proposal 1: No requirements are specified if associatedSSB is not configured for CSI-RS.******Proposal 2: For intra-frequency CSI-RS measurement******-For FR1 FDD, UE needs to perform PSS/SSS detection, PBCH decoding and intra-frequency CSI-RS measurement.******-For FR1 TDD or FR2, UE needs to perform PSS/SSS detection and the intra-frequency CSI-RS measurement.******For inter-frequency CSI-RS measurement******-For FR1 FDD, UE needs to perform PSS/SSS detection, DMRS matching and PBCH decoding and inter-frequency CSI-RS measurement.******-For FR1 TDD and FR2, UE shall perform PSS/SSS detection, PBCH decoding and inter-frequency CSI-RS measurement.******Proposal 3: AGC adjustment time shall be considered when UE needs to retune RF to an inter-frequency layer to perform measurement.******Proposal 4: The agreement ‘If the CSI-RS is QCL-ed to the associated SSB, no Rx sweeping is needed only after SSB has been detected’ shall be carefully analysed, especially in the case that the multiple CSI-RS resources from different cells are transmitted in the same OFDM symbols in one MO, and the CSI-RS resources are QCL-ed with different associated SSB.******Proposal 5: If a UE is configured with both CSI-RS-Resource-Mobility and ssb-ConfigMobility in one MO, the CSSF calculation shall consider SSB MO and CSI-RS MO.******Proposal 6: There is no requirements if associatedSSB is not included in ssb-ToMeasure in SSB-ConfigMobility in the same MO.******Proposal 7: The requirements for CSI-RS based measurement can consider a full set of the following scenarios:**** ***Intra-frequency without gap***
* ***Intra-frequency with gap***
* ***Inter-frequency without gap***
* ***Inter-frequency with gap***

***Proposal 8: The UE will need GAPs for CSI-RS L3 measurements if******• The CSI-RS is not fully confined within the active BWP******• The CP of cells to be measured is different from that of active BWP (60 kHz SCS only)******Proposal 9: The tuning time for CSI-RS based measurements that are outside UE’s active BWP can be defined as a UE capability.******Proposal 10: If UE is not able to support mixed numerology of data and CSI-RS L3 mobility, if the associatedSSB is configured, UE is not expected to transmit or receive on 2 data OFDM symbols impacted by CSI-RS resource symbol to be measured.******Proposal 11: If UE can perform CSI-RS based measurement independently with SSB based measurement, no scheduling restriction shall be configured.******Proposal 12: When UE performs CSI-RS intra-frequency measurements in a TDD band, UE is not expected to transmit and receive on 2 data OFDM symbols impacted by CSI-RS resource symbol to be measured.******Proposal 13: Scheduling restriction shall be considered when UE performs RX beam sweeping.*** |
| [**R4-2008237**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2008237.zip) | Qualcomm CDMA Technologies | **Proposal4: If CSI-RS configured with associated SSB but not QCL-ed to the associated SSB, the UE Rx sweeping scaling factor N=2 or 4.****Proposal4.1: in view of the cost and Rel-16 timeline, we propose Rel-16 doesnot define requirements for this scenario when associated SSB is not QCLed with CSI-RS. (part of our proposal 3)**Observation3: The tuning time of inter-frequency GAP of CSI-RS measurement shall be longer than the gap switch time for measuring the inter-frequency SSBs. **Proposal5: extra margin needs to be reserved for GAP tune-in time for processing CSI-RS inter-frequency measurements.****Proposal6: L1 measurement resource shall be configured to avoid collision with CSI-RS L3 measurement resource of neighbour cell as stated in Option 2 if UE doesnot support simultaneous SSB and neighbor CSI-RS reception.****Proposal6.1: Define a new UE capability for simultaneous reception of CSI-RS of neighbour cell and SSB of serving cell.****Proposal7: Collision shall be avoided between CSI-RS/PDCCH/PDSCH of the serving cell and CSI-RS L3 measurement resource of neighbour cell.** **Proposal8: As a further restriction for TDD, it is reasonable that UE shall not transmit during reception of the neighbor cell CSI-RS due to UL/DL collision caused by measuring neighbor CSI-RS.**  |

## Open issues summary

*Before e-Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

|  |
| --- |
| **WF on measurement requirements for Case 1 if associatedSSB is not configured for CSI-RS*** + Option 1 (MTK, Apple, Intel, Huawei, Qualcomm, Nokia, OPPO, CATT, ZTE):
		- No requirements in Rel-16.
	+ Option 2 (DOCOMO, CMCC):
		- the requirement needs at least consider the CSI-RS measurement time, if associatedSSB is not configured, assuming UE shall base the timing on its serving cell (indicated by refServCellIndex or PCell)

**WF on measurement requirements for Case 2 if associatedSSB is configured for CSI-RS*** Agreements: CSI-RS based cell identification can consider
	+ 1) Cell search via SSB, 2) PBCH decoding and 3) CSI-RS measurement.
	+ If configured SSB fails to be detected, requirement should not be defined.
* FFS: If UE already detects the SSB of the target cell and deriveSSB-IndexFromCell is indicated, PBCH decoding can be skipped.
* FFS: the working assumption of single FFT window and whether to define a capability.
* FFS the requirements for the cases
	+ If the MO includes the serving CSI-RS resource with associated SSB
	+ if the MO doesn’t include the serving CSI-RS resource and the CSI-RS resource associated SSB is configured
* FFS AGC adjustment time.
* FFS CSSF
* FFS scheduling restriction

**WF on requirements of Measurement Gap**More discussion based on the options as below in next meeting.* Requirements with or w/o gaps
	+ Option 1 : For CSI-RS based measurement requirement, the following scenarios are prioritized to be defined in Rel-16:
		- Intra-frequency measurement without gap
		- Inter-frequency measurement with gap
* The principle for gap-needed or gapless
	+ Option 1: The UE will need GAPs for CSI-RS L3 measurements if
		- The SCS of CSI-RS is different from active BWP [if UE is not capable of mixed numerology]
		- The CSI-RS is not fully confined within the active BWP
		- The CP of cells to be measured is different from that of active BWP (60 kHz SCS only)
	+ FFS : The tuning time for CSI-RS based measurements that are outside UE’s active BWP will be same as that for BWP switch.

**WF on Collision between L1 measurement of serving cell and CSI-RS L3 measurement of neighbour cell*** Option 1(LGE, MTK, OPPO, Apple):
	+ Do not define CSI-RS measurement requirements for the collision case.
* Option 2(LGE, MTK, Qualcomm, OPPO, ZTE, Huawei):
	+ Network should configure L1 measurement resource to avoid collision with CSI-RS L3 measurement resource of neighbour cell.

**Whether to introduce the UE capability to indicate the simultaneous reception of CSI-RS of neighbour cell and SSB of serving cell** * Option 1(OPPO, CATT, MTK, Apple,Huawei, Qualcomm): New UE capability
* Option 2: Reusing SimultaneousRxDataSSB-DiffNumerology
* Option 3(MTK, ZTE): Do not consider the case mix-numerology between data/SSB of serving cell and CSI-RS of neighbour cell

**WF on Scheduling restriction*** Option 1 (Huawei):
	+ If UE is not able to support mixed numerology of data and CSI-RS L3 mobility, the following scheduling restrictions apply due to intra-frequency CSI-RS based L3 measurement:
	+ if the associatedSSB is configured, UE is not expected to transmit or receive on 2 data OFDM symbols impacted by CSI-RS resource symbol to be measured.
	+ if the associatedSSB is not configured, UE is not expected to transmit or receive on the data OFDM symbol impacted by CSI-RS resource symbol to be measured, provided timing difference between the CSI-RS resource and the serving cell should be less than half CP corresponding to the SCS of the CSI-RS.
	+ When UE performs CSI-RS intra-frequency measurements in a TDD band, UE is not expected to transmit and receive on 2 data OFDM symbols impacted by CSI-RS resource symbol to be measured.
	+ Scheduling restriction shall be considered when UE performs RX beam sweeping.
* Option 2 (MediaTek, DOCOMO):
	+ The scheduling restriction on the additional OFDM symbols before and after SSB is not needed.
* Option 3 (LGE, Apple):
	+ Define scheduling restriction on one data symbol before and after CSI-RS symbol to be measured due to Rx beam sweeping.
	+ Do not define scheduling restriction if the timing difference between serving and neighbor cell including cell phase synchronization is guaranteed to be less than CP length
* Do not preclude other options(Qualcomm)
 |

### Sub-topic 2-1: General

*Sub-topic description*

*Open issues and candidate options before e-meeting:*

**Issue 2-1-1: Whether to define requirements related to associated SSB**

* Proposals
	+ Option 1: No requirements shall be defined in Rel-16 for CSI-RS L3 measurement, when
1. associated SSB is not configured
2. associated SSB is not detected even if associated SSB is configured
3. associated SSB is not QCLed with CSI-RS
4. associated SSB is configured and detected but the corresponding target cell timing has a large delta from the UE’s serving cell timing.
5. associated SSB is not included in ssb-ToMeasure in SSB-ConfigMobility in the same MO.
* Recommended WF
	+ Tentative agreement:
		- Collect views on component 1~5 and suggest to agree on at least 1~3 which were already discussed in 1st round

**Issue 2-1-2: Whether to define requirements related to the serving CSI-RS resource and MO configuration**

* Proposals
	+ Option 1: No requirement for the case MO doesn’t include the serving CSI-RS resource.
	+ Option 2: No requirement if serving cell CSI-RS is not available due to missing servingCellMO.
* Recommended WF
	+ Assuming Email thread [225] can cover this issue, no more discussion is needed in this email thread [226].

**Issue 2-1-3: Conditions for gap-needed or gapless**

* Proposals
	+ Option 1:
		- All inter-frequency measurements are gap-assisted.
		- All intra-frequency measurements are gapless.
	+ Option 2:
		- For intra-frequency CSI-RS based measurements, UE can perform intra-frequency CSI-RS based measurements without measurement gaps if
			* CSI-RS resource is completely contained in the active BWP of the UE.
		- For inter-frequency CSI-RS based measurements, UE will need GAPs if
			* SCS of CSI-RS is different from active BWP if UE is not capable of mixed numerology, and/or
			* CSI-RS resource is not fully confined within the active BWP, and/or
			* CP of cells to be measured is different from that of active BWP
	+ Option 3:
		- The UE will need GAPs for CSI-RS L3 measurements if
			* The CSI-RS is not fully confined within the active BWP
			* The CP of cells to be measured is different from that of active BWP (60 kHz SCS only)
* Recommended WF
	+ Option 2 and 3 are suggested to be merged.

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| **Issue 2-1-1: Whether to define requirements related to associated SSB** |
| **Company** | **Comments** |
| vivo | Regarding to 1), this is the agreement in last meeting.Regarding to 2), this is nature and should be supported.Regarding to 3), in our view no QCL is configured for CSI-RS in the “csi-rs-ResourceConfigMobility” and we are not sure what does this bullet refers to.Regarding to 4), we are fine to discuss that in the performance phase.Regarding to 5), we believe it should have requirement, especially for the case that “ssb-ConfigMobility” is not configured in one MO. |
| MTK | 1. OK
2. OK
3. OK for FR2, but not sure if we also need this in FR1
4. This is the issue to be discussed in performance part
5. OK. Some clarification should be done here.
	* If ssb-ToMeasure is not configured, UE has to detect all SSBs within SMTC duration. In this case, there is no problem to specify requirement.
	* If ssb-ToMeasure is configured, but the bit corresponding to the associated SSB is not toggled, then UE will not even try to detect that SSB. As a result, no CSI-RS requirement should be specified.
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| **Issue 2-1-2: Whether to define requirements for the case MO doesn’t include the serving CSI-RS resource** |
| **Company** | **Comments** |
| MTK | Pending on the discussion in [225] |

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| **Issue 2-1-3: Conditions for gap-needed or gapless** |
| **Company** | **Comments** |
| vivo | We support option 1 for R16. |
| MTK | Support Option 1. Other cases can be left to later releases for enhancement. |

### Sub-topic 2-2: Measurement delay

*Sub-topic description*

*Open issues and candidate options before e-meeting:*

**Issue 2-2-1: Cell identification time**

* Proposals
	+ Option 1:
		- If associated SSB is configured for CSI-RS resources, the CSI-RS intra-frequency cell identification time can be expressed as follows:
* T CSI-RS\_identify\_intra\_without\_index = (TPSS/SSS\_sync\_intra + T CSI-RS\_measurement\_period\_intra) ms
* T CSI-RS\_identify\_intra\_with\_index = (TPSS/SSS\_sync\_intra + T CSI-RS\_measurement\_period\_intra + TSSB\_time\_index\_intra) ms
	+ - The CSI-RS based intra-frequency cell identification comprises SSB-based cell identification and CSI-RS based measurements, where SSB-based cell identification is the same as the intra-frequency cell identification for SSB-based measurement.
		- For the time period for PSS/SSS detection and for time index detection, values for SSB based mobility (TPSS/SSS\_sync\_intra and TSSB\_time\_index\_intra )can be reused for the case that cell search via SSB and PBCH decoding are needed
	+ Option 2:



* Figure 1. Time flow for CSI-RS based cell identification
	+ - For PBCH decoding, 5 samples are needed to guarantee >90% detection rate at SNR -6dB.
		- If UE already detects the SSB of the target cell and deriveSSB-IndexFromCell is indicated, then UE can skip PBCH decoding.
	+ Option 3:
		- For intra-frequency CSI-RS measurement
			* For FR1 FDD, UE needs to perform PSS/SSS detection, PBCH decoding and intra-frequency CSI-RS measurement.
			* For FR1 TDD or FR2, UE needs to perform PSS/SSS detection and the intra-frequency CSI-RS measurement.
		- For inter-frequency CSI-RS measurement
			* For FR1 FDD, UE needs to perform PSS/SSS detection, DMRS matching and PBCH decoding and inter-frequency CSI-RS measurement.
			* For FR1 TDD and FR2, UE shall perform PSS/SSS detection, PBCH decoding and inter-frequency CSI-RS measurement.
		- AGC adjustment time shall be considered when UE needs to retune RF to an inter-frequency layer to perform measurement.
	+ Option 4：
		- PBCH decoding on target cell is not necessary regardless of associatedSSB when deriveSSB-IndexFromCell is indicated.
* Recommended WF
	+ For intra-frequency CSI-RS measurement, Option 1 can be agreed as basic framework of cell identification time for CSI-RS intra-f measurement. And TPSS/SSS\_sync\_intra and TSSB\_time\_index\_intra can be reused.
		- For intra-frequency CSI-RS measurement
			* T CSI-RS\_identify\_intra\_without\_index = (TPSS/SSS\_sync\_intra + T CSI-RS\_measurement\_period\_intra) ms
			* T CSI-RS\_identify\_intra\_with\_index =(TPSS/SSS\_sync\_intra + T CSI-RS\_measurement\_period\_intra + TSSB\_time\_index\_intra) ms
	+ **FFS** intra-frequency CSI-RS measurement.
		- Alt1: the framework for intra-f can be reused
		- Alt2: for inter-frequency CSI-RS measurement (from option 3)
			* For FR1 FDD, UE needs to perform PSS/SSS detection, DMRS matching and PBCH decoding and inter-frequency CSI-RS measurement.
			* For FR1 TDD and FR2, UE shall perform PSS/SSS detection, PBCH decoding and inter-frequency CSI-RS measurement.
	+ For PBCH decoding, Option 2/3/4 are not contradictory with other options, which can be merged as common understanding：
		- If UE already detects the SSB of the target cell and deriveSSB-IndexFromCell is indicated, UE can skip PBCH decoding.

**Issue 2-2-2: CSI-RS measurement period**

* Proposals
	+ Option 1:
		- Reuse SSB samples for intra-frequency and inter-frequency CSI-RS L3 measurements period.
	+ Option 2:
		- For intra-frequency measurement period: 3 samples
		- For inter-frequency measurement period: 6 samples
	+ Option 3:
		- The CSI-RS based measurement period for intra-frequency measurement is defined based on 3 samples for {D=3 & 48PRB} and {D=1 & 96PRB} given SNR = -6dB.
* Recommended WF
	+ Option 1

**Issue 2-2-3: the tuning time for CSI-RS based measurements**

* Proposals
	+ Option 1:
		- The tuning time of inter-frequency GAP of CSI-RS measurement shall be longer than the gap switch time for measuring the inter-frequency SSBs.
		- Extra margin needs to be reserved for GAP tune-in time for processing CSI-RS inter-frequency measurements.
	+ Option 2:
		- The tuning time for CSI-RS based measurements that are outside UE’s active BWP can be defined as a UE capability.
* Recommended WF
	+ Pending on the conclusion of intra and inter-frequency definition.
	+ If agreed on UE capability, an LS to RAN2 should be considered.

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| **Issue 2-2-1: Cell identification time** |
| **Company** | **Comments** |
| vivo | We are fine with the recommend WF. |
| MTK | Option 2, 3 and 4 are fine to us.Regarding Option 1, we are not sure why we need 2 requirements for without index and with index. |

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| **Issue 2-2-2: CSI-RS measurement period** |
| **Company** | **Comments** |
| vivo | We are fine with the recommended WF. |
| MTK | Support Option 1  |

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| **Issue 2-2-3: the tuning time for CSI-RS based measurements** |
| **Company** | **Comments** |
| vivo | For the case CSI-RS is confined in SMTC, the tuning time can be the same as SSB-based requirement. |
| MTK | Option 1 is fine to us. Option 2 is pending on the conclusion of other parallel discussion. For an example, if gap is always assumed, then we can follow the RF re-tuning time of gap |

### Sub-topic 2-3: Scaling Factor

*Sub-topic description*

CSSF and Scaling factor for RX beam sweeping are to be discussed in this section.

*Open issues and candidate options before e-meeting:*

**Issue 2-3-1: Whether dedicated searcher(s) is assumed for CSI-RS based measurement?**

* + Option1: Yes
	+ Option 2: No
* Recommended WF
	+ FFS.

**Issue 2-3-2: CSSF requirements**

* Proposals
	+ Option 1:
		- TBD before concluding the time-domain limitation
		- All CSI-RS in the same MO should follow the same time-domain relation with gap, e.g., either fully overlapped with gap, partially overlapped with gap or fully non-overlapped with gap
	+ Option 2:
		- If additional dedicated searcher is assumed for CSI-RS measurement, no impact on existing CSSF defined for SSB based measurement specified in 38.133.
		- Otherwise, the CSSFs for FR1/FR2 SCC shall be updated by considering the CSI-RS based intra-frequency and inter-frequency measurement without gap and within gap respectively.
	+ Option 3:
		- If a UE is configured with both CSI-RS-Resource-Mobility and ssb-ConfigMobility in one MO, the CSSF calculation shall consider SSB MO and CSI-RS MO.
* Recommended WF
	+ Pending on the conclusion on time-domain restriction.

**Issue 2-3-3: Scaling factor N for RX beam sweeping**

Agreement：If CSI-RS configured with associated SSB but not QCL-ed to the associated SSB, Rx sweeping is needed.

* FFS on the scaling factor N =8.
* Proposals
	+ Option 1: N=2 or 4
	+ Option 2: N=8
	+ Option 3 : Not define requirements when associated SSB is not QCLed with CSI-RS in Rel-16
* Recommended WF
	+ FFS

**Issue 2-3-4: RX beam sweeping when CSI-RS is QCL-ed to the associated SSB**

* Proposals
	+ Option 1: keep the last agreement
		- no Rx sweeping is needed
	+ Option 2: FFS especially in the case that the multiple CSI-RS resources from different cells are transmitted in the same OFDM symbols in one MO, and the CSI-RS resources are QCL-ed with different associated SSB.
* Recommended WF
	+ Option 1

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| **Issue 2-3-1: Whether dedicated searcher(s) is assumed for CSI-RS based measurement** |
| **Company** | **Comments** |
| MTK | Support Option 1.To us, it is very obvious that the engine for measurement is different. However, this does not mean that we can introduce the CSSF for CSI-RS which completely ignoring the SSB CSSF. For inter-frequency layer, UE can still pick one frequency layer at a time for either SSB or CSI-RS (or both) measurement. For intra-frequency layers in FR2, UE still face the Rx beam constraint that UE has to form one single Rx beam direction for the frequencies layers to be measured at the same time. |
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| **Issue 2-3-2: CSSF requirements** |
| **Company** | **Comments** |
| vivo | Agree with the recommended WF. |
| MTK | Agree with the recommended WF |

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| **Issue 2-3-3: Scaling factor N for RX beam sweeping** |
| **Company** | **Comments** |
| vivo | We are not sure what does the QCL here mean.If associated SSB is configured but CSI-RS cannot be detected based on the timing of associated SSB, no requirement is applied.Therefore we prefer option 3. |
| MTK | It seems that this whether to specify the value is pending on the conclusion of **Issue 2-1-1** |

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| **Issue 2-3-4: RX beam sweeping when CSI-RS is QCL-ed to the associated SSB** |
| **Company** | **Comments** |
| vivo | Agree with the recommended WF. |
| MTK | Option 2 is pointing out one key issue to be discussed. If UE needs to measure 2 CSI-RS from 2 cell with 2 different associated and QCL-ed SSBs, respectively. For Cell #1, the best Rx beam to measure the SSB is Rx beam #1, while for Cell #2, the best Rx beam to measure the SSB is Rx beam #2. Now when these 2 CSI-RS comes at the same OFDM symbol, which Rx beam should UE use to perform measurement?  |

### Sub-topic 2-4: UE capability to indicate the simultaneous reception of CSI-RS of neighbour cell and SSB of serving cell

*Sub-topic description*

* The requirements for scheduling restriction are only defined for CSI-RS L3 measurement without gaps
* Identify all possible factors which would cause scheduling restriction in next meeting:
	+ Collision with UL transmission and DL measurement on TDD carrier
	+ The need of Rx beam sweeping in FR2
	+ Mix-numerology between data/SSB of serving cell and CSI-RS of neighbour cell

*Open issues and candidate options before e-meeting:*

**Issue 2-4-1: Whether to introduce UE capability to indicate the simultaneous reception of CSI-RS of neighbour cell and SSB of serving cell**

* Proposals
	+ Option 1: New UE capability
	+ Option 2: Reusing *SimultaneousRxDataSSB-DiffNumerology*
	+ Option 3: If a new capability for UE supporting different SCS in source and target cells is defined in Rel-16 NR mobility measurement, reuse it for CSI-RS L3 measurement.
	+ Option 4: Not needed.
* Recommended WF
	+ According to the majority views, option 2 can be removed firstly.
	+ If agreed to introduce UE capability, LS to RAN2 is needed

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| **Issue 2-4-1: Whether to introduce UE capability to indicate the simultaneous reception of CSI-RS of neighbour cell and SSB of serving cell** |
| **Company** | **Comments** |
| vivo | We prefer option 1. |
| MTK | Support Option 1. It is dangerous to extend other R15/R16 UE capability. However, if this is a scenario that can be avoided by network, we also prefer to have no requirement without any UE capability. |
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### Sub-topic 2-5: Scheduling Restriction

*Sub-topic description*

* The requirements for scheduling restriction are only defined for CSI-RS L3 measurement without gaps
* Identify all possible factors which would cause scheduling restriction in next meeting:
	+ Collision with UL transmission and DL measurement on TDD carrier
	+ The need of Rx beam sweeping in FR2
	+ Mix-numerology between data/SSB of serving cell and CSI-RS of neighbour cell

*Open issues and candidate options before e-meeting:*

**Issue 2-5-1: Scheduling restriction if UE is not able to support mixed numerology of data and CSI-RS L3 mobility**

* Proposals
	+ Option 1: If UE is not able to support mixed numerology of data and CSI-RS L3 mobility, the following scheduling restrictions apply due to intra-frequency CSI-RS based L3 measurement:
		- if the associatedSSB is configured, UE is not expected to transmit or receive on 2 data OFDM symbols impacted by CSI-RS resource symbol to be measured.
		- if the associatedSSB is not configured, no requirements apply.
* Recommended WF
	+ Option 1

**Issue 2-5-2: Scheduling restriction when UE performs CSI-RS intra-frequency measurements in a TDD band**

* Proposals
	+ Option 1:
		- When UE performs CSI-RS intra-frequency measurements in a TDD band, UE is not expected to transmit and receive on 2 data OFDM symbols impacted by CSI-RS resource symbol to be measured.
	+ Option 2:
		- The scheduling restriction on additional OFDM symbols before and after SSB is not needed.
			* Based on the assumption that the FFT window timing always follows the serving cell timing for intra frequency measurement and is up to UE implementation for inter frequency measurement.
* Recommended WF
	+ FFS.

**Issue 2-5-3: Whether to consider scheduling restriction when UE performs RX beam sweeping**

* Proposals
	+ Option 1: yes
		- Option 1a: Define scheduling restriction on one data symbol before and after CSI-RS symbol to be measured due to Rx beam sweeping.
	+ Option 2: No
* Recommended WF
	+ FFS.

**Issue 2-5-4: Collision between L1 measurement of serving cell and CSI-RS L3 measurement of neighbour cell**

* Proposal:
	+ Option 1: Do not define CSI-RS measurement requirements for the collision case.
	+ Option 2: Network should configure L1 measurement resource to avoid collision with CSI-RS L3 measurement resource of neighbour cell.
* Recommended WF
	+ FFS

**Issue 2-5-5: Scheduling restriction if the timing difference between serving and neighbor cell including cell phase synchronization is guaranteed to be less than CP length**

* Proposal:
	+ Option 1: No requirements
* Recommended WF
	+ Option 1
	+ Issues related to synchronization should be discussed in email thread [225]

**Issue 2-5-6: Others for no scheduling restriction**

* Proposal:
	+ Option 1: If UE can perform CSI-RS based measurement independently with SSB based measurement, no scheduling restriction shall be configured.
* Recommended WF
	+ FFS

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| **Issue 2-5-1: Scheduling restriction if UE is not able to support mixed numerology of data and CSI-RS L3 mobility** |
| **Company** | **Comments** |
| vivo | Support the recommended WF. |
| MTK | We do not understand why 2 DL data OFDM symbols needs to be considered here if CSI-RS only occupies 1 DL OFDM symbol. |

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| **Issue 2-5-2: Scheduling restriction when UE performs CSI-RS intra-frequency measurements in a TDD band** |
| **Company** | **Comments** |
| vivo | For intra-frequency measurement, single FFT window is assumed. However, we are also fine to introduce such scheduling restriction, which means UE is allowed to track window of the strongest cell in CSI-RS based RRM requirement.Therefore, we support option 1. |
| MTK | Question for clarification. The additional 1 data OFDM symbol is to address the TA uncertainty, right? |

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| **Issue 2-5-3: Whether to consider scheduling restriction when UE performs RX beam sweeping** |
| **Company** | **Comments** |
| vivo | Fine to option 1 since synchronization assumption may differ due to RX beam sweeping. |
| MTK | Yes. But whether to allow 1 additional OFDM symbol with scheduling restriction needs some further discussion. |

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| **Issue 2-5-4: Collision between L1 measurement of serving cell and CSI-RS L3 measurement of neighbour cell**  |
| **Company** | **Comments** |
| vivo | Fine to option 1. RAN4 do not specify requirement for L1-RSRP if CSI-RS measurement collides with L1-RSRP. |
| MTK | Both Option 1 and Option 2 are fine to us. Note that the collision could be across CCs for intra-band FR2 CA because UE can only for either rough beam or fine beam at a time. |

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| **Issue 2-5-5: Scheduling restriction if the timing difference between serving and neighbor cell including cell phase synchronization is guaranteed to be less than CP length** |
| **Company** | **Comments** |
| MTK | Pending on the conclusion of other discussion |

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| **Issue 2-5-6: Others for no scheduling restriction** |
| **Company** | **Comments** |
| XXXvivo | Fine to option 1. |
| MTK | Option 1 seems to miss some details, e.g., whether the SCS is the same and whether the SSB is to be used for L1 measurements.  |

## Companies views’ collection for 1st round

### Open issues

Moderator: please comment directly in the tables under the text of corresponding issues in clause 2.2.

* Sub-topic 2-1: General
* Sub-topic 2-2: Measurement delay
* Sub-topic 2-3: Scaling Factor
* Sub-topic 2-4: UE capability to indicate the simultaneous reception of CSI-RS of neighbour cell and SSB of serving cell
* Sub-topic 2-5: Scheduling Restriction

### CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

Moderator: How to handle and split CRs will be covered in 1st round summary of email thread [225]. No discussion is expected here.

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| [**R4-2006228**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2006228.zip) | Company A |
| Company B |
|  |
| [**R4-2006229**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2006229.zip) | Company A |
|  | Company B |
|  |  |
| [**R4-2006230**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2006230.zip) | Company A |
|  | Company B |
|  |  |
| [**R4-2007357**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2007357.zip) | Company A |
|  | Company B |
|  |  |
| [**R4-2007358**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2007358.zip) | Company A |
|  | Company B |
|  |  |
| [**R4-2007359**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2007359.zip) | Company A |
|  | Company B |
|  |  |
| [**R4-2007360**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2007360.zip) | Company A |
|  | Company B |
|  |  |
| [**R4-2007739**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2007739.zip) | Company A |
|  | Company B |
|  |  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary**  |
| **Sub-topic#1** | *Tentative agreements:**Candidate options:**Recommendations for 2nd round:* |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| #1 |  |  |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provided recommendation on CRs/TPs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation**  |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation**  |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |