**3GPP TSG-RAN WG4 Meeting #94-e R4-20xxxxx**

**Electronic Meeting, Feb.24th – Mar.6th 2020**

**Agenda item:** 8.16.1 & 8.16.1.1 & 8.16.1.2 & 8.16.1.6

**Source:** CATT

**Title:** Email discussion summary for RAN4#94e\_#65\_NR\_CSIRS\_L3meas\_RRM\_Part\_1

**Document for:** Information

# Introduction

The documents in agenda items 8.16.1.1 & 8.16.1.2 & 8.16.1.6 contain the following 3 main topics:

* Topic #1: CSI-RS measurement configuration (AI 8.16.1.1)
* Topic #2: Intra-frequency and inter-frequency measurement definition (AI 8.16.1.2)
* Topic #3: Others (AI 8.16.1.6)

# Topic #1: CSI-RS measurement configuration (AI 8.16.1.1)

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2000386 | Intel | **Proposal 1:** Define requirement for one configuration with 48PRBs and D = 3. |
| R4-2000462 | MediaTek | **Observation 1:** Larger measurement BW does not always lead to better measurement accuracy requirement because the RF path loss calibration error also increases.  **Proposal 1:** Requirement is defined based on single measurement bandwidth (N=1).  **Proposal 2:** For CSI-RS based L3 measurement, the requirements are specified based on 48 PRBs and density 3. |
| R4-2000582 | CATT | **Observation 1:** It was observed that 5 samples of measurement can achieve the acceptable accuracy requirement when CSI-RS configuration is configured with {PRB=48 and D=1}.  **Observation 2:** It was observed that 3 samples of measurement can achieve the acceptable accuracy requirement when CSI-RS configuration is configured with {PRB=48 and D=3} or {PRB=96 and D=1}.  **Proposal:** 2 set of CSI-RS based measurement requirements shall be defined based on the combination of measurement bandwidth of CSI-RS and CSI-RS resource density, which is expressed in Table 1.  Table 1: TCSI-RS\_measurement\_Period with different configurations   |  |  |  |  | | --- | --- | --- | --- | | Configuration | Measurement bandwidth [RB] | CSI-RS resource Density | TCSI-RS\_measurement\_Period | | 0 | 48 | 1 | 5 samples | | 1 |  | 3 | 3 samples | |
| R4-2000636 | CMCC | ***Proposal 1:*** *it is proposed to define CSI-RS based measurement requirements for two sets of configurations.*  ***Proposal 2:*** *it is proposed to separate requirements based on the number of CSI-RS REs.*  ***Proposal 3:*** *it is proposed to specify CSI-RS based measurement requirements based on 48REs and 192 REs.*   |  |  | | --- | --- | | *The configuration based on which requirements are specified* | *The case that the requirements are applied to* | | *48REs (48 RB, density = 1)* | *the case with number of CSI-RS RE <192, including 24RB with D=3, 48RB with D=1, 96RB with D=1* | | *192REs (192 RB, density = 1)* | *the case with number of CSI-RS RE >=192, including 96RB with D=3, 192RB with D=1, 192RB with D=3, 264RB with D=1, 264RB with D=3* | |
| R4-2000655 | Nokia, Nokia Shanghai Bell | **Proposal1:** 48PRB and Density = 1 is applied for defining the CSI-RS based measurement requirements.  **Proposal2:** Do not define the measurement requirements for 24 PRBs.  **Proposal3:** Define additional CSI-RS measurement requirements for 96 PRBs, 192 PRBs and 264 PRBs.  **Proposal4:** The measurement requirements for wider bandwidth can be defined with one of the options below:   * Option1: Define better accuracy assuming same number of samples. * Option2: Keep accuracy requirements same assuming measuring in WB and samples.   **Proposal5:** The UE may apply the measurement requirement as one of the options, if the configured measurement bandwidth is partially overlapping with the active BWPs:   * Option1: Define reduced accuracy requirements assuming available CSI-RS resources within the active BWP. * Option2: Keep accuracy requirement assuming longer measurement evaluation time (i.e. increased measurement samples). * Option3: Keep same accuracy but UE has to measure more often (if possible - hence if RS is available) |
| R4-2000655 | Nokia, Nokia Shanghai Bell | Simulation results for CSI-RS based measurements. |
| R4-2000655 | NTT DOCOMO, INC. | **Observation:** The number of PRBs for CSI-RS is greatly different compared to that of SSB (127 REs for SSS).  **Proposal 1:** Core requirements for CSI-RS-based L3 measurements should be able to cover various CSI-RS configurations.  **Proposal 2:** For CSI-RS based L3 measurement, two patterns of configuration sets should be adopted as below under the same delay requirement.   * Number of PRBs ≧24, Density = 3 * Number of PRBs ≧96, Density = 1 |
| R4-2000655 | Huawei, HiSilicon | ***Proposal 1:*** *For L3 mobility, RAN4 defines CSI-RS based measurement requirements provided that the bandwidth of CSI-RS is 48 PRBs and the density is 3.*  ***Proposal 2:*** *The CSI-RS based measurement period for L3 mobility can be defined as 5 measurement samples.* |

## Open issues summary

Agreements on CSI-RS configuration agreed in R4-1913749 in RAN4#93 meeting:

* CSI-RS configurations (bandwidth of CSI-RS and density of CSI-RS resource) used to define requirements
* Define requirements at least for 1 set of configurations
  + Option 1: 48PRBs and D = 1
  + Option 2: 48PRBs and D = 3
* FFS whether to define requirements for additional configurations
  + 48PRBs and D = 1
  + 48PRBs and D = 3
  + 96PRBs and D = 1
  + 96PRBs and D = 3

### CSI-RS measurement configuration

*Sub-topic description:*

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

**Issue 1-1: How many set of CSI-RS configuration (bandwidth of CSI-RS and density of CSI-RS resource) are needed to define CSI-RS based measurement requirements?**

* Option 1: 1 set of configuration (Intel, MediaTek, Huawei )
* Option 2: 2 set of configuration (CATT, CMCC, NTT DOCOMO)
* Option 3: Multiple set of configuration (Nokia)
* Recommended WF
  + Need more discussion

**Issue 1-2: If one set of configuration is agreed, what’s the configuration for bandwidth of CSI-RS and density of CSI-RS resource?**

* Option : 48PRBs and D = 3 (Intel, MediaTek, Huawei )

**Issue 1-3: If two sets of configuration is agreed, what’s the configuration for bandwidth of CSI-RS and density of CSI-RS resource?**

* Option 1: (CATT )

|  |  |  |  |
| --- | --- | --- | --- |
| Configuration | Measurement bandwidth [RB] | CSI-RS resource Density | TCSI-RS\_measurement\_Period |
| 0 | 48 | 1 | 5 samples |
| 1 |  | 3 | 3 samples |

* Option 2: Separate requirements based on the number of CSI-RS REs (CMCC)

|  |  |
| --- | --- |
| The configuration based on which requirements are specified | The case that the requirements are applied to |
| 48REs (48 RB, density = 1) | the case with number of CSI-RS RE <192, including 24RB with D=3, 48RB with D=1, 96RB with D=1 |
| 192REs (192 RB, density = 1) | the case with number of CSI-RS RE >=192, including 96RB with D=3, 192RB with D=1, 192RB with D=3, 264RB with D=1, 264RB with D=3 |

* Option 3: (NTT DOCOMO)
  + Two patterns of configuration sets should be adopted as below under the same delay requirement.
    - Number of PRBs ≧24, Density = 3
    - Number of PRBs ≧96, Density = 1
* Recommended WF
  + Need more discussion

**Issue 1-4: If multiple sets of configuration is agreed, what’s the configuration for bandwidth of CSI-RS and density of CSI-RS resource?**

* Option : (Nokia )
  + 48PRB and Density = 1 is applied for defining the CSI-RS based measurement requirements.
  + Define additional CSI-RS measurement requirements for 96 PRBs, 192 PRBs and 264 PRBs.
* Recommended WF
  + Need more discussion

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| CMCC | Issue 1-1:  Considering that better measurement performance is expected when larger BW or density is configured, we still prefer to define 2 sets of requirements.  Issue 1-3:  Our consideration is to sperate the requirements based on the number of CSI-RS REs. But we are open to have discussion on how to separate the requirements.  Sub topic 1-2:  ….  Others: |
| ZTE | Issue 1-1: We support to have 2 set of requirements.  Issue 1-3: We support option 1. This is similar to traditional ways in LTE of defining CSI-RS measurement requirements that different bandwidth/density of CSI-RS resource will lead to different measurement delay. |
| CATT | Issue 1-1: Support to define 2 set of requirements  Different of CSI-RS configuration can have different delay requirement, thus we prefer to have one set of legacy requirement and one set of enhancement requirement. And two set of configuration can also reflect the flexibility of CSI-RS measurement from RRM point of view.  Issue 1-1: support option 1. One is for legacy requirements which 5 measurement samples are needed to define the measurement delay requirement, and the other is for enhancement requirements which 3 measurement are required to define the requirement. |
| Huawei, HiSilicon | Issue 1-1:  We propose option 1 to define 1 set of CSI-RS measurement requirements.  In LTE, CRS bandwidth is same as system bandwidth and can be configured from 6RBs to 100RBs. UE is assumed to perform RSRP measurement on central 6 RBs. The RSRP measurement accuracy requirements are defined based on 6RBs.  Issue 1-2:  We propose to define the CSI-RS measurement requirements with 48RBs and density=3. |
| Nokia, Nokia Shanghai Bell | Issue 1-1: We support to define multiple requirements for different bandwidths.  As the network may configure different measurement bandwidths, the minimum performance is expected from the network per configurable bandwidth. Single requirement is not enough.  Issue 1-4: The requirements could be per configurable bandwidth. Both D=1 and D=3 shall be considered. |
|  |  |

### 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.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | 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:* |

*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*

|  |  |
| --- | --- |
| **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”* |

# Topic #2: Intra-frequency and inter-frequency measurement definition (AI 8.16.1.2)

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2000387 | Intel | **Observation 1:** The definition of positioning frequency layer is defined as:   |  | | --- | | * the same SCS and CP type * the same centre frequency * the same point-A * the same value of DL PRS Bandwidth and Start PRB |   **Proposal 1:** Similar with definition of positioning frequency layer agreed in RAN1, CSI-RS frequency layer can be defined as:   |  | | --- | | * the same SCS and CP type * the same centre frequency * the same value of CSI-RS bandwidth |   **Proposal 2：** The definition of intra-frequency where CSI-RS resource of serving cell is available as follows:   |  | | --- | | * the centre frequency of CSI-RS resources on the target cell configured for measurement is the same as centre frequency of CSI-RS resources on the serving cell configured for measurement, and, * the bandwidth of CSI-RS resources on the target cell configured for measurement is the same as bandwidth of CSI-RS resources on the serving cell configured for measurement, and,   + - the SCS of CSI-RS on serving cell and target cell is the same     - the CP type of CSI-RS on serving cell and target cell is the same |   **Proposal 3：** No requirement will be defined for case 2 in MO configuration. |
| R4-2000463 | MediaTek | **Observation 1:** CSI-RS configuration for mobility can be far more flexible than SSB. A good definition of intra and inter frequency should help reduce the number of scenarios to be address in the spec and reduce UE’s scheduling complexity.  **Observation 2:** SSB-based cell detection is still required for CSI-RS based L3 measurement.  **Observation 3:** The signaling servingCellMO was introduced to avoid UE taking CSI-RS with the same cell ID as its serving cell but in a wrong MO in event evaluation.  **Observation 4:** There is no any UE capability from R15 to further differentiate whether UE is able to handle mix-numerology between CSI-RS and data.  **Observation 5:** The intra-frequency definition has nothing to do with whether the CSI-RS is completely within the DL active BWP or not.  **Proposal 1:** The definition of intra and inter for CSI-RS based L3 measurement should align with SSB as much as possible.  **Proposal 2:** If an MO provides information for both SSB and CSI-RS based measurement, the intra or inter frequency definition for SSB and CSI-RS should be the same.  **Proposal 3:** To avoid contradiction between RAN2 and RAN4 specs, if an MO is indicated as servingCellMO, then it should always be an intra-frequency MO.  **Proposal 4:** UE does not expect the configuration that 2 MOs are configured for the same intra-frequency layer. Network should directly merge the CSI-RS configurations into the same MO.  **Proposal 5:** If there is no strong use case for different SCSs between intra-frequency CSI-RS and DL BWP, RAN4 can add one additional condition that the SCS of intra-frequency CSI-RS resource should have the same SCS as UE’s active DL BWP.  **Proposal 6:** If there is no strong use case for different BWs for CSI-RS resource, RAN4 can add one additional condition that the BW of intra-frequency CSI-RS resource should have be the same as serving cell.  **Proposal 7:** RAN4 to first focus on the requirements of intra-frequency measurement without gap and inter-frequency measurement with gap, and leave the other scenarios for future enhancement.  **Proposal 8:** If an MO configures both SSB and CSI-RS based measurement, then all CSI-RS resources in that MO should cover the SSB in frequency domain.  **Proposal 9:** RAN4 should avoid the case that some of the CSI-RS resources in the MO are intra-frequency and the others are inter-frequency. This has a huge impact to the current CSSF definition and complicates the discussion of UE measurement capability.  **Proposal 10:** Agree on Case 1 to further limit the MO configuration: all CSI-RS resources in the same MO have the same center frequency, BW, SCS, CP type configured.  **Proposal 11:** If an MO configures both SSB and CSI-RS based measurement, then in time domain all CSI-RS resources in that MO should occurs only within the SMTC duration of the same MO.  **Proposal 12:** If CSI-RS of serving cell is not configured, the definition of its intra- and inter-frequency depends on the SSB configured in the same MO if UE is able to measure both SSB and CSI-RS at the same time. Otherwise, there is no requirement. |
| R4-2000583 | CATT | **Observation 1:** From RAN1 perspective, frequency layer for CSI-RS mobility resources is measurement object (MO). And CSI-RS resources in the same MO shall have the same center frequency.  **Proposal 1:** RAN4 will define the RRM requirements for Case 1 and Case 2 MO configuration.  **Proposal 2:** If the CSI-RS resource of serving cell is not available, the MOs configured for CSI-RS based RRM measurement are defined as CSI-RS based inter-frequency measurement.  **Proposal 3:** The definition of intra-frequency measurement and inter-frequency measurement for CSI-RS based RRM measurement shall be defined as follows:   * When CSI-RS resource of serving cell is available   + **CSI-RS based intra-frequency measurement:** a measurement is defined as a CSI-RS based intra-frequency measurement provided that:     - the SCS of CSI-RS on the serving cell and neighbor cell is the same, and     - the CP type of CSI-RS on serving cell and target cell is the same, and       * + It is applied for SCS = 60KHz     - the center frequency of CSI-RS on the serving cell and neighbor cell is the same     - the BW of CSI-RS resources in the same MO is the same   + Otherwise, it can be defined as CSI-RS based inter-frequency measurement. * When CSI-RS resource of serving cell is not available   + the MOs configured for CSI-RS based RRM measurement are defined as CSI-RS based inter-frequency measurement |
| R4-2000584 | CATT | LS on CSI-RS based intra-frequency and inter-frequency Measurement definition |
| R4-2000637 | CMCC | ***Proposal 1:*** *It is proposed to define the CSI-RS based intra-frequency measurement in a similar way as SSB based intra-frequency measurement, and RAN4 can specify measurement requirements for the limited scenarios in Rel-16 to save effort.*  ***Proposal 2:*** *a measurement is defined as CSI-RS based intra-frequency measurement provided that:*   * *the SCS of CSI-RS on the serving cell and target cell is the same* * *the CP type of CSI-RS on serving cell and target cell is the same* * *the centre frequency of CSI-RS on the serving cell and neighbour cell is the same*   ***Proposal 3:*** *it is proposed to specify intra-frequency measurement requirements for the case that all CSI-RS resources in the same MO have the same BW*  ***Proposal 4:*** *for intra-frequency measurement with the case that CSI-RS resources in the same MO have different BW, there are two possible solutions:*   * *Option 1: depending on whether the maximum BW of CSI-RS resource is within active BWP or not, the intra-frequency measurement can be handled as intra-frequency measurement with MG or intra-frequency measurement without MG.* * *Option 2: do not specify RRM requirements in Rel-16*   ***Proposal 5:*** *for CSI-RS based intra-frequency measurement, it is proposed to specify the requirements for both measurement with MG and measurement without MG.*   * Table 1 possible scenarios of CSI-RS based intra-frequency measurement  |  |  |  |  |  | | --- | --- | --- | --- | --- | |  | without associated SSB | with associated SSB | | | | Associated SSB is intra-f w/o MG | Associated SSB is intra-f w/ MG | Associated SSB is inter-f | | Target CSI-RS is fully covered by active BWP | MG is not needed | MG is not needed | MG is needed | | | Target CSI-RS is not fully covered by active BWP | MG is needed | MG is needed | MG is needed | |   ***Proposal 6:*** *for CSI-RS based inter-frequency measurement, it is proposed to specify the requirements for both measurement with MG and measurement without MG.*  Table 2 possible scenarios of CSI-RS based inter-frequency measurement   |  |  |  |  |  | | --- | --- | --- | --- | --- | |  | without associated SSB | with associated SSB | | | | Accociated SSB is intra-f w/o MG | Accociated SSB is intra-f w/ MG | Accociated SSB is inter-f | | Target CSI-RS is fully covered by active BWP | Case 1: SCS is same, MG is not needed  Case 2: SCS is different, whether MG/scheduling restriction is needed or not depends on UE capability | | MG is needed | | | Target CSI-RS is not fully covered by active BWP | MG is needed | MG is needed | MG is needed | |   ***Proposal 7:*** *for inter-frequency measurement with target CSI-RS fully covered by active BWP, but has different SCS with serving CSI-RS resource, if UE is capable of simultaneous reception with different numerologies, MG or scheduling restriction is not necessary.* |
| R4-2000656 | Nokia, Nokia Shanghai Bell | **Observation1:** For SSB based measurements in NR, the UE behaves similarly as long as the SSB is completely contained in the active BWP, irrespective of whether the center frequency is the same or not.  **Proposal1:** The definition of intra-frequency and inter-frequency shall take into account the active BWP to better align the UE behavior in different measurement scenarios.  **Proposal2:** The CSI-RS based intra-frequency measurement shall consider the case where the CSI-RS resource of the neighbor cell to be measured is within the active BWP.  **Proposal3:** The CSI-RS based intra-frequency measurement shall consider the case where the CSI-RS resource of the neighbor cell to be measured is partially overlapping with the active BWP, and the UE only measures the part of CSI-RS resource within the active BWP.  **Proposal4:** The CSI-RS based intra-frequency measurement is defined as below:  CSI-RS based intra-frequency measurement: a measurement is defined as a CSI-RS based intra-frequency measurement provided the bandwidth of the CSI-RS resources on the neighbor cell configured for measurement is partially or completely within the active BWP of the UE, and SCS and CP type of the CSI-RS resources of the neighbor cell and the SCS of the serving cell are the same.  **Proposal5:** Measurement gaps are not required for CSI-RS based intra-frequency measurements.  **Proposal6:** It is proposed to first work on the CSI-RS based intra-frequency measurement requirements in RAN4. |
| R4-2000792 | Apple | **Proposal 1:**   * When the SCS of CSI-RS on serving cell and target cell is the same and the CSI-RS resource of the target cell is fully contained within the active BWP of the serving cell, the corresponding CSI-RS L3 measurement is defined as intra-frequency measurement without gap. * When the SCS of CSI-RS on serving cell and target cell is NOT the same or the CSI-RS resource of the target cell is fully contained within the active BWP of the serving cell, the corresponding CSI-RS L3 measurement is defined as inter-frequency measurement.   **Proposal 2:** Multiple intra-frequency measurement objects can be configured for intra-frequency measurements.  **Proposal 3:** In Rel-16, all CSI-RS resources configured in the same measurement object not only have the same center frequency but also have the same bandwidth.  **Proposal 4:** CSI-RS resource bandwidth, density and periodicity should not be used to distinguish between CSI-RS based intra- and inter-frequency measurement. |
| R4-2000946 | NTT DOCOMO | **Observation 1:** The denominator of the CSI-SINR is derived using REs carrying CSI-RS resources. It might be difficult to compare two SINR with different BWs, since measured interference can be different depending on measured frequency.  **Observation 2:** The problem in observation 1 can be avoided by proper NW implementation.  **Proposal 1:** Following case should be applied for MO configuration.   * Case 2: all CSI-RS resources in the same MO have the same center frequency, SCS, CP type configured. BW can be different.   **Observation 3:** If CSI-RS resources of the target cells are fully included in active BWP with the same SCS, the UE can receive them without RF retuning regardless of their frequency location.  **Proposal 2:** Following option should be applied for condition of intra-frequency measurement.   * Option 2: the bandwidth of the CSI-RS on the neighbor cell is within the active BWP of UE   **Observation 4:** Option 2 doesn’t contradict RAN2 specification, since CSI-RS resources with different frequency location can be configured with different MOs.  **Observation 5:** It is relatively easy to specify the requirements of CSI-RS inter-frequency measurement all of CSI-RS resources can be covered by existing gap pattern.  **Proposal 3:** When CSI-RS is not available in the serving cell, the requirements of inter-frequency measurement should be applied. |
| R4-2000994 | OPPO | **Proposal 1:**  A measurement is defined as a CSI-RS based intra-frequency measurement, provide that the center frequency, bandwidth, SCS and CP duration on the serving cell and neighbor cell are the same, and the bandwidth of the CSI-RS on the neighbor cell is within the active BWP of the UE. Otherwise, a measurement is defined as a CSI-RS based inter-frequency measurement.  **Proposal 2:** A measurement for case 2 is defined as a CSI-RS based inter-frequency measurement.  **Proposal 3:** RAN4 just consider RRM requirements for Case 1 MO configuration, and no requirement is defined for case 2 MO configuration. |
| R4-2001014 | NEC | **Observation 1:** SSB based intra/inter frequency measurement definition is defined for measurement object.  **Observation 2:** CSI-RS resources in the same MO shall have same centre frequency and SCS  **Observation 3:** Centre frequency cannot be used for differentiation of intra and inter frequency measurement object based on RAN1 restriction.  **Proposal 1:** A measurement object is defined as a CSI-RS based intra-frequency measurement object provided:   * SCS of CSI-RS on the serving cell and neighbour cell is the same * CP type of CSI-RS on serving cell and target cell is the same (It is applied for SCS = 60KHz) * Bandwidth of the CSI-RS on the neighbour cell is within the active BWP of the UE * Bandwidth of CSI-RS on the target cell is the same as bandwidth of CSI-RS on the serving cell   **Proposal 2:** A measurement object is defined as a CSI-RS based inter-frequency measurement object if it is not intra-frequency measurement object. |
| R4-2001277 | ZTE | **Proposal 1:** The definition of intra-frequency measurement and inter-frequency measurement for CSI-RS based RRM measurement should be defined as follows.  *-* CSI-RS based intra-frequency measurement: a measurement is defined as a CSI-RS based intra-frequency measurement provided  the centre frequency of the CSI-RS resource on the neighbour cell configured for measurement is the same as centre frequency of the CSI-RS resource on the serving cell configured for measurement, and  the bandwidth of the CSI-RS resource on the neighbour cell configured for measurement is the same as bandwidth of the CSI-RS resource on the serving cell configured for measurement, and  the subcarrier spacing of the two CSI-RS resources on the neighbour cell and on the serving cell are the same.  - CSI-RS based inter-frequency measurement: a measurement is defined as a CSI-RS based inter-frequency measurement provided  the centre frequency of the CSI-RS resource on the neighbour cell configured for measurement is not the same as centre frequency of the CSI-RS resource on the serving cell configured for measurement, or  the bandwidth of the CSI-RS resource on the neighbour cell configured for measurement is not the same as bandwidth of the CSI-RS resource on the serving cell configured for measurement, or  the subcarrier spacing of the two CSI-RS resources on the neighbour cell and on the serving cell are the same.  **Proposal 2:** If no CSI-RS resources on serving cell is configured in one measurement object the measurement is inter frequency measurement. The RRM requirements for CSI-RS based inter frequency measurement applies. |
| R4-2001656 | Huawei, HiSilicon | **Proposal 1:** The reference point of centre frequency of CSI-RS resources on the serving cell shall be defined.  **Proposal 2:** CSI-RS based intra-frequency MO shall include the CSI-RS resource indicated in servingcellMO.  **Proposal 3:** The limitation of the same bandwidth of CSI-RS resources on the target cell as bandwidth of CSI-RS resources on the serving cell is not necessary and putting additional restriction on network configuration.  **Proposal 4:** The definition of CSI-RS based intra-frequency measurement can be specified as below:   * the centre frequency of CSI-RS resources on the target cell configured for measurement is the same as centre frequency of CSI-RS resource on the serving cell, if available, indicated for measurement, and, * the SCS of CSI-RS on serving cell and target cell is the same   where all CSI-RS resources from the same MO should have the same centre frequency, otherwise the measurement is defined as a CSI-RS based inter-frequency measurement. |
| R4-2001656 | Huawei, HiSilicon | Reply LS on clarification about CSI-RS measurement |
| R4-2002055 | Qualcomm | **Proposal 1**: RAN4 to define requirements for CSI-RS based measurements for the following CSI-RS configuration only: 48 PRB’s and density D =3.  **Proposal 2**: CSI-RS measurements to be considered intra-frequency if the CSI-RS of neighbor cell has the same location, bandwidth, SCS and CP duration as that of serving cell and the CSI-RS lies within the active BWP.  **Proposal 2a:** All CSI-RS measurements that don’t fall under proposal 1 are considered inter-frequency.  **Proposal 3**: The tuning time for CSI-RS based measurements that are outside UE’s active BWP will be same as that for BWP switch. |

## Open issues summary

Agreements on MO configuratoin and definition of intra-frequency and inter-frequency measurement agreed in R4-1913749 in RAN4#93 meeting:

**WF on MO configuration**

* MO configuration
  + Case 1: all CSI-RS resources in the same MO have the same center frequency, BW, SCS, CP type configured.
  + Case 2: all CSI-RS resources in the same MO have the same center frequency, SCS, CP type configured. BW can be different.
* RAN4 will study the RRM requirements at least for Case 1 MO configuration. FFS how to address Case 2.
* Note: this does not exclude defining requirements for Case 2.

**WF on CSI-RS based intra-frequency and inter-frequency measurement definition**

* Case 1: CSI-RS resource of serving cell is available
  + CSI-RS based intra-frequency measurement: a measurement is defined as a CSI-RS based intra-frequency measurement provided that:
    - the SCS of CSI-RS on the serving cell and neighbor cell is the same
    - the CP type of CSI-RS on serving cell and target cell is the same
      * It is applied for SCS = 60KHz
    - the center frequency, bandwidth and active BWP
      * Option 1: the center frequency of CSI-RS on the serving cell and neighbor cell is the same, and
      * Option 2: the bandwidth of the CSI-RS on the neighbor cell is within the active BWP of the UE, and
      * Option 3: the bandwidth of CSI-RS on the target cell is the same as bandwidth of CSI-RS resources on the serving cell
      * Any combination of options above
  + Note 1: the RAN4 design shall not contradict RAN2 agreements on MO signalling
  + Note 2: the definition of intra-frequency and inter-frequency measurement shall not impact RAN1’s agreement on the definition of the same MO
* Case 2: CSI-RS resource of serving cell is not available
  + Option 1: All MO are inter-frequency
  + Option 2: No requirement is applied

### MO configuration for RRM requirement

**Issue 1-1: Whether define RRM requirement for case 2 in MO configuration?**

* Option 1: Define (CATT, CMCC, NTT DOCOMO, Huawei)
  + Depending on whether the maximum BW of CSI-RS resource is within active BWP or not, the intra-frequency measurement can be handled as intra-frequency measurement with MG or intra-frequency measurement without MG. (CMCC)
  + The limitation of the same bandwidth of CSI-RS resources in one MO is not necessary and putting additional restriction on network configuration. (Huawei)
* Option 2: No requirement (Intel, MediaTek, CMCC, OPPO)
* Recommended WF
  + Need more discussion

### Intra-frequency and inter-frequency measurement definition

**Issue 2-1: When CSI-RS resource of serving cell is available, a measurement is defined as CSI-RS based intra-frequency measurement provided:**

* the SCS of CSI-RS on the serving cell and neighbor cell is the same
* the CP type of CSI-RS on serving cell and target cell is the same
  + It is applied for SCS = 60KHz
* the centre frequency, bandwidth and active BWP
  + Option 1: the reference is the centre frequency (Intel, CATT, CMCC, ZTE, Huawei, MediaTek)
    - Option 1a: (Intel, ZTE)
      * the center frequency of CSI-RS on the serving cell and neighbor cell is the same
      * the bandwidth of CSI-RS on the target cell is the same as that of CSI-RS resources on the serving cell
    - Option 1b: (CATT)
      * the center frequency of CSI-RS on the serving cell and neighbor cell is the same
      * the BW of CSI-RS resources in the same MO is the same
    - Option 1c: (CMCC)
      * the center frequency of CSI-RS on the serving cell and neighbor cell is the same
    - Option 1d: (Huawei)
      * the centre frequency of CSI-RS resources on the target cell configured for measurement is the same as centre frequency of CSI-RS resource on the serving cell indicated in servingCellMO
    - Option 1e: (MediaTek )
      * If an MO is indicated as *servingCellMO*, then only those CSI-RS resources in this MO can be considered as intra-frequency of the serving cell.
      * the SCS of intra-frequency CSI-RS resource should have the same SCS as UE’s active DL BWP
      * the BW of intra-frequency CSI-RS resource should have be the same as serving cell
  + Option 2: the reference is the active BWP of UE (Nokia, Apple, NTT DOCOMO, OPPO, NEC)
    - Option 2a: (Nokia)
      * the CSI-RS resources on the neighbor cell configured for measurement is partially or completely within the active BWP of the UE
    - Option 2b: (Apple, NTT DOCOMO, OPPO)
      * the bandwidth of the CSI-RS on the neighbor cell is within the active BWP of the UE
    - Option 2c: (NEC)
      * the bandwidth of the CSI-RS on the neighbor cell is within the active BWP of the UE
      * the bandwidth of CSI-RS on the target cell is the same as that of CSI-RS resources on the serving cell
  + Option 2d: the reference is centre frequency and the active BWP of UE (Qualcomm)
    - the center frequency of CSI-RS on the serving cell and neighbor cell is the same
    - the bandwidth of the CSI-RS on the neighbor cell is within the active BWP of the UE
    - the bandwidth of CSI-RS on the target cell is the same as that of CSI-RS resources on the serving cell
* Recommended WF
  + Need more discussion

**Issue 2-2: When CSI-RS resource of serving cell is not available,**

* Option 1: (CATT, NTT DOCOMO, ZTE, OPPO, Huawei)
  + The MOs configured for CSI-RS based RRM measurement are defined as CSI-RS based inter-frequency measurement.
* Option 2: (MediaTek)
  + The definition of its intra- and inter-frequency depends on the SSB configured in the same MO if UE is able to measure both SSB and CSI-RS at the same time. Otherwise, there is no requirement.
* Recommended WF
  + Agree option 1.

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| CMCC | Issue 2-1:  Since the definition of CSI-RS based intra-frequency measurement has been discussed for several meetings and little progress has been made. To move forward, CMCC would like to provide a compromise way:   * Define the CSI-RS based intra-frequency measurement in a simple way, e.g. only SCS, CP type, and center frequency are considered. * But for the requirements, we can consider to specify requirements for the limited/selected scenarios to solve companies concern.   We would like to clarify why we prefer to have the definition in a simple way. Firstly, it is not preferred to have too much restriction on the network deployment. Secondly, if we go with the options that BW or active BWP is considered, it will introduce the case that there are both intra-frequency and inter-frequency in the same MO, or it may cause complexity in the requirements specification of UE measurement capability. We also understand companies concern, so if we go with above suggested definition, we can consider to specify requirements for the limited or selected scenarios.  Sub topic 1-2:  ….  Others: |
| ZTE | Issue 1-1: Requirements for case 2 can be specified if time allows. We think case 1 should be prioritized.  Issue 2-1: Comments on some of the options:  Option 1b: the condition ‘the BW of CSI-RS resources in the same MO is the same’ is more related to MO configuration rather than intra-frequency measurement definition. It would be better not to mix the two issues together.  Option 1c: We are also fine with this option.  Option 1d: It seems the same proposal as option 1c if I understand correctly.  Option 1e: We have different understanding about servingCellMO. It is mainly used for UE to identify which CSI-RS resources are of serving cells. The CSI-RS resources of other cells can be configured in servingCellMO or other MOs. It is unnecessary restriction that intra frequency measurement CSI-RS resources have to be configured in servingCellMO. Considering only 96 CSI-RS resources can be configured in one MO, the intra-frequency measurements may only be configured for one or two cells. In our view intra-frequency CSI-RS measurement is more important than inter-frequency. So it should be allowed that intra-frequency measurement can be configured in multiple MOs  Option 2: One of the main issue of this reference is that active BWP could change frequently. One MO is configured as intra frequency measurements in the first place if it is in the active BWP of the UE. When active BWP changes, it becomes inter frequency measurements.  The intra/inter frequency measurements should be defined from system perspective rather than UE perspective. Moreover the change from intra frequency measurements to inter frequency measurements is not known in L3 by which the MO is configured. The BWP change is mostly a L1 behaviour which can be triggered by DCI or timer. It is unknown to L3. So the measurements configured by L3 could exceeds UE capabilities of monitoring inter frequency layer with gaps. |
| CATT | Issue 1-1: Support option1, requirement should be defined for case 2 for MO configuration. CSI-RS BW restriction will have significantly impact on network flexibility.  Issue 2-1: Option1, support to use center frequency to define intra-frequency measurement.  Similar comment as ZTE, if the reference is the active BWP of UE, the intra-frequency measurement can become inter-frequency measurement with the change of active BWP of UE, and it is hard to define the requirement for UE capability.  According to RAN1/RAN2’s understanding, the frequency layer for CSI-RS mobility resources is measurement objet (MO), thus, the definition of intra/inter-frequency should be MO specific. According to 38.331, the SCS and center frequency are MO specific, so as long as the SCS and center frequency is the same, we can consider as intra-frequency measurement.  Similar as SSB based measurement, CSI-RS based measurement can be categorized as follows:   * Intra-frequency measurement without RF tuning (the BW of CSI-RS on target cell is smaller than or equal to that on serving cell) * Intra-frequency measurement with RF tuning (the BW of CSI-RS on target cell is larger than that on serving cell) * Inter-frequency measurement with gap * Inter-frequency measurement without gap |
| Huawei, HiSilicon | Issue 1-1: limitation of the same bandwidth of CSI-RS resources in one MO puts CSI-RS MO configuration restriction to network.  Issue 2-1: option 1d.  1. CSI-RS based intra-frequency MO shall include the CSI-RS resource indicated in servingcellMO;  2. Intra-frequency MO definition can be decouple with measurement gap. An intra-frequency MO can be without gap if all CSI-RS resources are within active BWP.  3. No need to limit the CSI-RS resource bandwidth is same. The reason is mentioned in issue1-1.  Issue 2-2  Agree with the recommended WF. |
| OPPO | Issue 1-1: prefer option 2.  Issue 2-1: Support option 2.  Regarding the comments from CATT and ZTE, the definition of capability would not follow the rules used for SSB, and can focus on the total number of intra-frequency and inter-frequency layers.  And we prefer that a measurement is defined as a CSI-RS based intra-frequency measurement, provide that at least the center frequency, bandwidth, SCS and CP duration on the serving cell and neighbor cell are the same, and the bandwidth of the CSI-RS on the neighbor cell is completely within the active BWP of the UE.  If it is this case, the measurement requirements for CSI-RS based L3 measurement can Avoid complications like what we did for SSB, and could be much clearer like LTE mechanism.   * intra-frequency measurement without gap * inter-frequency measurement with gap   Issue 2-2: Agree with the recommended WF. |
| Nokia, Nokia Shanghai Bell | Issue 1-1: We support Option 1.  UE is only required to measure the CSI-RS within the active BWP. No need to restrict to the same bandwidth in one MO.  Issue 2-1: We support Option2.  The intra-f measurement is understood if the UE can measure neighbour cells simultaneously with serving cell. This can be done if the CSI-RS bandwidth is within the active BWP. We can first study the case where the CSI-RS is fully within the active BWP, so either Option 2a or Option 2b is fine.  As for the same bandwidth, CSI-RSRP is defined as the linear average of the power within the configured bandwidth, so it is normalized to bandwidth and the bandwidth does not have to be the same.  Issue 2-2: This scenario can be down-prioritized until we have the basic requirement for case 1 i.e. CSI-RS is available in both serving and neighbor cells. We can return if some other companies want to re-discuss it. |
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### 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.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | 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.*

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

*Suggestion on WF/LS assignment*

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|  | **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*

|  |  |
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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 #3: Others (AI 8.16.1.6)

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2000466 | MediaTek | **Observation 1:** In current TS38.213 it has clearly specified that the SSB cannot be pre-empted.  **Observation 2:** One of the reason to preclude SSBs in the pre-emption is that SSBs are also required by neighboring cells UEs for L3 mobility purposes. These UEs are not able to monitor DCI format 2\_1 from their neighboring cells.  **Observation 3:** CSI-RS for L3 measurement is also required by UE in neighboring cells, but it is not precluded in TS38.213 at this moment.  **Proposal 1:** The indication by the DCI format 2\_1 is not applicable to receptions of CSI-RS for L3 measurement. Send an LS to RAN1 to update TS38.213. |
| R4-2000467 | MediaTek | RAN4 would like to kindly inform RAN1 that RAN4 has reached consensus that the CSI-RS for layer 3 measurement should not be pre-empted by DCI format 2\_1 because the CSI-RS are also intended to be received by neighbouring cell UEs which are unable to monitor DCI format 2\_1 transmitted from their neighbouring cells. |
| R4-2001648 | Huawei, HiSilicon | **Proposal 1:** When CSI-RS resource for mobility is configured without associated SSB, the CSI-RS measurement requirements apply provided that receive timing difference between the CSI-RS resource and the serving cell is within X, where X is [CP/2 corresponding the SCS of CSI-RS].   * RAN4 to further study the measurement performance with timing error larger than half CP.   **Proposal 2:** When CSI-RS resource for mobility is configured with associated SSB, the CSI-RS measurement requirements is not conditioned on network synchronization.  **Proposal 3:** When CSI-RS resource for mobility is configured with associated SSB, but is not QCL-ed with the associated SSB, timing error should be considered in the CSI-RS measurement requirements. |

## Open issues summary

### Pre-emption on CSI-RS L3 measurement

**Issue 1-1: Whether CSI-RS based L3 measurement shall be precluded in the pre-emption?**

* Option : Yes (MediaTek)
  + The indication by the DCI format 2\_1 is not applicable to receptions of CSI-RS for L3 measurement. Send an LS to RAN1 to update TS38.213
* Recommended WF
  + Agree the proposal from MediaTek

### Synchronization assumption for CSI-RS measurement requirements

**Issue 2-1: Synchronization assumption for CSI-RS measurement requirements**

* Proposal : (Huawei)
  + When CSI-RS resource for mobility is configured without associated SSB, the CSI-RS measurement requirements apply provided that receive timing difference between the CSI-RS resource and the serving cell is within X, where X is [CP/2 corresponding the SCS of CSI-RS].
    - RAN4 to further study the measurement performance with timing error larger than half CP.
  + When CSI-RS resource for mobility is configured with associated SSB, the CSI-RS measurement requirements is not conditioned on network synchronization.
  + When CSI-RS resource for mobility is configured with associated SSB, but is not QCL-ed with the associated SSB, timing error should be considered in the CSI-RS measurement requirements.
* Recommended WF
  + Need more discussion

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| CMCC | Issue 1-1:  From our point of view, more discussion is needed on whether it is necessary to send LS to RAN1 to update TS 38.213. Firstly, DL pre-emption is a Rel-15 feature, we are not sure whether it is a good approach to change RAN1 Rel-15 spec. Secondly, on which time/frequency resource that pre-emption is performed is up to network implementation. So may be this issue can be left to network implementation.  Sub topic 1-2:  ….  Others: |
| ZTE | Issue 2-1: When no associated SSB has been configured, a serving cell should be indicated for timing synchronization. It means the neighbor cell is synchronized to the serving cell. In this case the timing difference from UE perspective can be the MRTD of synchronized DC or CA. |
| CATT | Issue 1-1: Generally, we are fine with MTK’s proposal, FFS on how to implement in spec.  Issue 2-1: For non-associated SSB case, we think it applies in synchronized network, e.g. TDD cells. Thus, we think the cell phase synchronization accuracy requirement shall be applied. |
| Huawei, HiSilicon | Issue 2-1: The proposals have been made for many meetings but were not discussed. We understand they should be agreeable based on RAN1 spec (the timing reference for CSI-RS with and without associated SSB) as well as the WID (single FFT for sync case). In both cases, there could be timing error for the CSI-RS measurement, which may impact the measurement performance, and we suggest to study it as early as possible. Anyway, we appreciate more opinions on this issue. |
| Nokia, Nokia Shanghai Bell | Issue 1-1: This shall be firstly discussed in RAN1. After RAN1 designs the preemption principle, RAN4 can continue with the requirements.  Issue 2-1: This can be further discussed. |
|  |  |

### 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.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | 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.*

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

*Recommendations on WF/LS assignment*

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|  | **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*

|  |  |
| --- | --- |
| **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”* |