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

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

**Agenda item:** 8.16.1.3 /8.16.1.4 /8.16.1.5

**Source:** OPPO

**Title:** Email discussion summary for RAN4#94e\_#66\_NR\_CSIRS\_L3meas\_RRM\_Part\_2

**Document for:** Information

# Introduction

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

In order to make progress on CSI-RS L3 measurement, we would like to discuss the following topics/issues and try to get some agreements in this meeting.

* + Topic #1:Measurement capability (sub-agenda 8.16.1.3)

Sub-topic 1-1: Applicability and assumption for CSI-RS based measurement capability

* + - Issue 1-1-1:Applicability for CSI-RS based measurement capability
    - Issue 1-1-2:Measurement capabilities per MO or per layer

Sub-topic 1-2: Requirements for measurement capability

* + - Issue 1-2-1:Number of frequency layers to be monitored
    - Issue 1-2-2:Number of cells to be monitored
    - Issue 1-2-3:Number of CSI-RS resource/beams to be monitored
    - Issue 1-2-4:UE capability to indicate maximum number of CSI-RS resources in a slot per MO
  + Topic #2: Measurement requirements for intra and inter-frequency measurement (sub-agenda 8.16.1.4/.5)

Sub-topic 2-1: Framework of CSI-RS based measurement requirements

* + - Issue 2-1-1: Components of CSI-RS based measurement requirements
    - Issue 2-1-2: Specification structure of CSI-RS L3 intra-f/inter-f measurement requirement

Sub-topic 2-: Key open issues

* + - Issue 2-2-1: CSSF
    - Issue 2-2-2: Scaling factor for RX beam sweeping
    - Issue 2-2-3: Factors to consider for scheduling restriction
    - Issue 2-2-4: Requirements for scheduling restriction
    - Issue 2-2-5: Whether to restrict CSI-RS resources outside of DRX/MG duration
    - Issue 2-2-6: Others

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

* **1st round**: Collect views from companies, and try to achieve agreements on the two sub-agenda:
  + Measurement capability
  + Measurement requirement for intra/inter-frequency measurement
* **2nd round**: Discuss the remaining issues and propose a way forward for next meeting

Note: Since some issues are highly related to definition of CSI-RS intra/inter-frequency measurement, we try to recognize these and suggest to collect views in 1st round and try to get agreements in 1st/2nd round.

# 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** |
| [**R4-2000464**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000464.zip) | MediaTek inc. | Observation 1: SSB-based cell detection is still required for CSI-RS based L3 measurement.  Proposal 1: Requirement is only defined when  • the CSI-RS based measurement is configured with SSB based measurement within the same MO,  • UE can perform CSI-RS and SSB measurement with overlapped bandwidth in the same time duration Proposal 2: Given proposal 1 is agreed, CSI-RS based L3 measurement does not add additional frequency layers to be monitored on top of the number specified for SSB based measurement.  Observation 2: If proposal 1 is not agreed, CSI-RS based L3 measurement will add additional frequency layers to be monitored on top of the number specified for SSB based measurement, resulting the extended measurement delay of every frequency layer.  Observation 3: If RAN4 allows some CSI-RS resources in the same MO to be intra-frequency and the other to be inter-frequency, the total number of frequency layers to be monitored will be increased further.  Proposal 3: There is no need to introduce additional number of cells to be monitored per layer based on L3 CSI-RS on top of the requirements already specified for SSB.  Proposal 4: 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 5: If network configures more CSI-RS resources in an MO than the UE measurement capability, the UE behavior is undefined. |
| [**R4-2000585**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000585.zip) | CATT | Proposal 1: CSI-RS based UE measurement capabilities shall specified in terms of:  - Number of carrier to be monitored if CSI-RS resources are configured  - Number of cell to be monitored per MO  - Number of CSI-RS resources to be monitored per MO  Proposal 2: UE shall be able to measure at least 3 CSI-RS frequency layers.  Proposal 3: UE shall be able to measure at least 8 NR frequency layers in total, including SSB frequency layers and CSI-RS frequency layers.  Proposal 4: UE shall be able to measure at least 14 carriers of all RATs in total.  Proposal 5: For the number of CSI-RS resource, UE shall monitor at least 32 CSI-RS resources per frequency layer considering mobility performance and UE’s complexity. |
| [**R4-2000995**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000995.zip) | OPPO | Observation 1：CSI-RS resource for mobility is beneficial to be configured with associated SSB, which can reduce the complexity of both network and UE implementation.  Proposal 1: Share the current number of frequency layers to be monitored for both SSB based measurement and CSI-RS frequency layers.  • UE shall be able to measure at least 7 NR frequency layers in total, including SSB frequency layers and CSI-RS frequency layers.  • UE shall be able to measure at least 13 carriers of all RATs in total, including SSB frequency layers and CSI-RS frequency layers.  Proposal 2: No need to introduce additional number of cells to be monitored per layer based on L3 CSI-RS on top of the requirements already specified for SSB.  Proposal 3: 32 CSI-RS resources can be as baseline for discussion, and RAN4 can further decide the value based on more vendors’ input. |
| [**R4-2001276**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001276.zip) | ZTE | Proposal 1. A UE shall be capable of monitoring at least 7 NR inter frequency layers configured by serving cell. The UE shall be capable of performing measurements including (SS-RSRP, SS-RSRQ, SS-SINR, CSI-RSRP, CSI-RSRQ, CSI-SINR, E-UTRAN RSRP, E-UTRAN RSRQ, E-UTRAN RS-SINR measurements, etc.) of detected cells on all the layers.  Proposal 2. 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 3. 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.  Proposal 4. UE shall be capable of performing CSI-RS based measurements for at least [6] identified cells in FR2 for intra frequency measurement and at least [4] identified cells in FR2 for inter frequency measurement.  Proposal 5. FFS the requirements for total number of cells the UE shall be capable of performing SSB based and CSI-RS based measurements.  Proposal 6. 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. |
| [**R4-2001647**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001647.zip) | Huawei, HiSilicon | Proposal 1: UE shall be able to measure at least 3 CSI-RS frequency layers for CSI-RS based mobility.  Proposal 2: UE shall be able to measure at least 7 SSB frequency layers, including MO with SSB as mobility RS, and MO with CSI-RS as mobility RS with associated SSB.  Proposal 3: UE shall be able to measure at least 8 NR frequency layers in total, including SSB frequency layers and CSI-RS frequency layers.  Proposal 4: UE shall be able to measure at least 14 carriers of all RATs in total.  Proposal 5: RAN4 should discuss the total number of cells and CSI-RS resources UE should measure per MO.  Proposal 6: Update existing UE capability maxNumberCSI-RS-RRM-RS-SINR or define another capability for UE to indicate maximum number of CSI-RS resources in a slot per MO.  Proposal 7: The UE capability on UE buffering and processing time RAN1 defined for PRS is re-used for CSI-RS. Alternatively, define UE capability on the minimum separation between two slots with CSI-RS resources. |

## 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: Assumption and applicability

*Sub-topic description*

In this section, we discuss assumption and applicability of CSI-RS based measurement capability.

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

**Issue 1-1-1: Applicability of CSI-RS based measurement capability**

* Proposals
  + Option 1(MediaTek, OPPO): Only define the requirements when the CSI-RS based measurement is configured with SSB based measurement within the same MO, and UE can perform CSI-RS and SSB measurement with overlapped bandwidth in the same time duration
  + Option 2(Ericsson, CATT, CMCC, Huawei, DOCOMO, ZTE, Nokia): No restriction on MO configurations
  + Option 3: Object Option 1 but consider other possible restriction in order to specify requirements for the limited or selected scenarios.
* Recommended WF
  + Collect the views from companies and try to achieve agreement in 1st round discussion
  + If Option 1 is agreed, CSI-RS based L3 measurement does not add additional frequency layers to be monitored on top of the number specified for SSB based measurement.
  + If Option 1 is not agreed, FFS measurement capability on top of the number specified for SSB based measurement, including
    - frequency layers to be monitored
    - cells to be monitored
    - CSI-RS resource/beams to be monitored

**Issue 1-1-2: Measurement capabilities per MO or per layer**

* Proposals
  + Option 1: RAN4 should discuss the total number of cells and CSI-RS resources UE should measure per MO
  + Option 2: RAN4 should discuss the total number of cells and CSI-RS resources UE should measure per layer
* Recommended WF
  + RAN4 design shall not contradict RAN2 agreements on MO signalling
    - the same MO can configure more than one frequency layer
  + Tentative agreement:

RAN4 would reuse the rules for SSB based measurement, which means number of cells and CSI-RS resources to be discussed per layer.

### Sub-topic 1-2: Requirements of measurement capabilities

*Sub-topic description*

In this section, we discuss measurement capabilities for CSI-RS based L3 measurement including:

* number of frequency layers to be monitored
* number of cells to be monitored per layer
* number of CSI-RS resource/beams to be monitored per layer

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

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

* Proposals
  + Option 1 (MediaTek, OPPO, ZTE, Apple, Ericsson, DOCOMO):

No need to introduce additional frequency layer, reusing the current UE measurement requirements defined in TS38.133

* + - UE shall be able to measure at least 7 NR frequency layers in total, including SSB frequency layers and CSI-RS frequency layers.
    - UE shall be able to measure at least 13 carriers of all RATs in total, including SSB frequency layers and CSI-RS frequency layers.
  + Option 2 (CATT):
    - 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.
    - UE shall be able to measure at least 14 carriers of all RATs in total.
    - For associated SSB case, UE is required to detect SSB on target cell firstly, then the configured CSI-RS can be measured. So, the measurement capability can be considered as SSB based measurement capability. For non-associated SSB case, It is required UE capable to perform CSI-RS based layers.
  + Option 2a (Huawei):

Based on option 2 for issue 1-1-1

* + - 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.
    - UE shall be able to measure at least 14 carriers of all RATs in total.
* Recommended WF
  + Tentative agreement: Option 1
  + Collect the views from companies and try to achieve agreement in 1st round discussion

**Issue 1-2-2: number of cells to be monitored per layer/MO**

* Proposals
  + Option 1 (MediaTek, OPPO, Apple, Ericsson): No need to introduce additional number of cells to be monitored per layer based on L3 CSI-RS on top of the requirements already specified for SSB.
  + Option 2 (ZTE): 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.
  + Option 3 (Huawei, CATT): RAN4 should discuss the total number of cells and CSI-RS resources UE should measure per MO.
  + Recommended WF
  + Tentative agreement: Option 1
  + Collect the views from companies and try to achieve agreement in 1st round discussion

**Issue 1-2-3: number of CSI-RS resource/beams to be monitored per layer/MO**

* Proposals
  + Option 1(CATT, Huawei, OPPO): UE shall monitor at least 32 CSI-RS resources per frequency layer
  + Option 2(ZTE, Ericsson, CATT): 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(MediaTek): Requirements defined the same requirements as those for SSB.
  + Option 4(Qualcomm): The total number of CSI resources that UE can monitor should come from the UE capability *maxNumberCSI-RS-RRM-RS-SINR*. How to split that up per layer would or MO would depend on resolution of Issue 1-1-1 and Issue 1-2-1.
  + Recommended WF
  + Collect the views from companies and try to achieve agreement in 1st round discussion
    - FFS on UE behaviour if network configures more CSI-RS resources in an MO than the UE measurement capability

**Issue 1-2-4: UE capability to indicate maximum number of CSI-RS resources in a slot per MO**

* Proposals
  + Option 1(Huawei, OPPO, Ericsson, CATT, Qualcomm, CMCC): Reuse existing UE capability *maxNumberCSI-RS-RRM-RS-SIN*R ~~and update the value~~.
  + Option 2(Huawei): Define another capability for UE to indicate maximum number of CSI-RS resources per MO in a slot.
  + Recommended WF
  + Collect the views from companies and try to achieve agreement in 2nd round discussion
    - FFS on UE capability
    - ~~FFS how to account the UE buffering and processing capability in the requirements~~
    - Send LS and ask for RAN1/2’s view if needed

**Issue 1-2-5: UE buffering and processing capability**

* Proposals
* Option 1: The UE capability on UE buffering and processing time RAN1 defined for PRS is re-used for CSI-RS. Alternatively, define UE capability on the minimum separation between two slots with CSI-RS resources.
  + Recommended WF
  + Collect the views from companies and try to achieve agreement in 2nd round discussion

## Companies views’ collection for 1st round

### Open issues

|  |  |
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| **Company** | **Comments** |
| OPPO | Sub topic 1-1: Assumption and applicability  Issue 1-1-1: Support Option 1. Regarding the definition of CSI-RS intra-frequency and inter-frequency, the restriction of MO configuration is beneficial to specify requirements for the limited or selected scenarios. In this case, CSI-RS based L3 measurement does not add additional frequency layers to be monitored on top of the number specified for SSB based measurement.  Issue 1-1-2: Prefer capability as per layer, which follows the similar rules for SSB based measurement.  Sub topic 1-2: Requirements of measurement capabilities  Issue 1-2-1: support Option 1. The reason is similar as issue 1-1-1.  Issue 1-2-2: support Option 1  Issue 1-2-3: support Option 1  Issue 1-2-4: support Option 1 |
| Apple | Issue 1-1-1: It is not very clear of us on option 1. Does that mean CSI-RS and SSB not only share the same center frequency but also share the same OFDM symbol? In general, we think this restriction is quite strong.  Issue 1-1-2:Option 2 seems more reasonable than option 1. Depend on the conclusion of MO definition/restriction, there can be multiple MO per frequency layer and multiple frequency layer per MO. If we limit all bandwidth in the same MO to be the same, we then eliminate the case of multiple frequency layer per MO. The situation becomes clear that we only need to focus on number of cells and CSI-RS resources per frequency layer, which can include multiple MO.  Issue 1-2-1: Option 1….  Issue 1-2-2: option 1  Others: |
| QC | Issue 1-1-1: Applicability of CSI-RS based measurement capability  Not clear on why the restriction is needed to be in the same MO. It is understood that in order to do CSI-RS measurement either there will be an associated SSB that UE is racking for timing or that sync to serving cell is indicated in some fashion. Why is the restriction important?  Issue 1-2-1: number of frequency layers to be monitored  What does a frequency layer for CSI-RS mean. Is it just the same center frequency of CSI-RS resource or same center frequency and BW, With SSB it is simpler definition since BW is always the same.  Issue 1-2-3: number of CSI-RS resource/beams to be monitored per layer/MO  The total number of CSI resources that UE can monitor should come from the UE capability maxNumberCSI-RS-RRM-RS-SINR. How to split that up per layer would or MO would depend on resolution of Issue 1-1-1 and Issue 1-2-1  Issue 1-2-4: UE capability to indicate maximum number of CSI-RS resources in a slot per MO  We agree with option 1, but we shouldn’t need to update the value since it is UE capability. |
| Ericsson | Issue 1-1-1: option 2 (no restriction)  Issue 1-1-2: option 2 (per frequency layer)  Issue 1-2-1: option 1  Issue 1-2-2: option 1  Issue 1-2-3: option 2  Issue 1-2-4: option 1 |
| CATT | Issue 1-1-1: Applicability of CSI-RS based measurement capability  Same view as QC, the restriction is not needed, and both associated SSB case and non-associated case shall be considered. For non-associated SSB case, the target cell is synchronized to the serving cell, e.g. in TDD network scenarios, UE is not required to detect the target SSB for tracking timing. From our perspective, this is more useful case.  **Issue 1-1-2: Measurement capabilities per MO or per layer**  According to RAN1/RAN2’s agreement, frequency layer is Measurement object (MO), so not very clear the intention for this issue. In RAN4, according to my understanding, the capability should be defined per frequency layer.  **Issue 1-2-1: number of frequency layers to be monitored**  At least 3 CSI-RS frequency layer;  At least 8 NR frequency layers in total, including SSB frequency layers and CSI-RS frequency layers  At least 14 carriers of all RATs in total  For associated SSB case, UE is required to detect SSB on target cell firstly, then the configured CSI-RS can be measured. So, the measurement capability can be considered as SSB based measurement capability. For non-associated SSB case, It is required UE capable to perform CSI-RS based layers.  **Issue 1-2-2: number of cells to be monitored per layer/MO**  Support option 3, need more discussion on the number.  **Issue 1-2-3: number of CSI-RS resource/beams to be monitored per layer/MO**  Option 1 can be discussed as start point. Option 2 is also fine for us.  **Issue 1-2-4: UE capability to indicate maximum number of CSI-RS resources in a slot per MO**  Support option 1. |
| Intel | Sub topic 1-1:  Issue 1-1-2: Before discussing the UE capability requirement, prefer to discuss MO configuration, intra-frequency measurement definition and layer definition first. There may be some new scenarios, it’s hard to decide which one is simpler. If there are both intra and inter frequency measurement in one MO, can we still define the UE capability requirement based on MO? In one MO, if there several bandwidths, do they belong to same layer or different layer? If the intra-frequency measurement is defined without fixing the center-frequency, there may be several MOs for intra-frequency. Whether to define the MO number for intra-frequency?  Sub topic 1-2: same as the comment about Sub topic 1-1. |
| CMCC | Issue 1-1-1: option 2 (no restriction on MO configuration)  Issue 1-1-2: not clear with this issue, what is the difference between MO and layer? According to the RAN1 LS (R4-1905310), it is agreed in RAN1 agreed that ‘frequency layer’ used in RAN1 specification should be changed to ‘measurement object’.  Issue 1-2-1: we do not agree to reuse the measurement capability specified for SSB based measurement. More discussion is needed  Issue 1-2-2: we do not agree to reuse the measurement capability specified for SSB based measurement. More discussion is needed  Issue 1-2-3: more discussion is needed  Issue 1-2-4: for option 1, we are OK to reuse existing UE capability on the number of CSI-RS resources, but we need clarification on the wording “update the value” |
| MTK | Issue 1-1-1: option 1  CSI-RS is not designed for cell search. Cell detection based on SSB is needed for UE to know the target cell is closed enough to UE before UE really spends time and power to measure the CSI-RS. Otherwise, UE just wastes its time and power to measure the cells that are far away and has no impact to the current mobility need. Whether SSB and CSI-RS are overlapped in time or frequency is also important, but this can be discussed later.  Issue 1-1-2:  This decision should depends on the outcome of the intra-/inter-definition discussion. If eventually one MO = one layer, then Option 1 = Option 2. At least moment, Option 2 can be treated as a tentative agreement. So that the framework still aligns with what we have in SSB case.  Issue 1-2-1: option 1  Allowing more frequency layer will potentially increase the CSSF value, leading to long delay of the measurement. We do not see the benefit to further increase the total number.  Issue 1-2-2: option 1  Similar comment as Issue 1-1-1. CSI-RS was not designed for cell search. UE still need to perform SSB-based cell search before conducting CSI-RS based measurement, no matter the CSI-RS is with or without associated SSB.  Issue 1-2-3: option 3  The only analysis we have so far is what we did in Rel-15 for SSB. In our understanding, the analysis is generic through the controlling of the FFT beamforming coefficients. (simulation assumption in R4-1709903) Therefore, the conclusion is already applicable to both SSB and CSI-RS.  Issue 1-2-4: FFS  We think some more discussions on UE capability *maxNumberCSI-RS-RRM-RS-SINR* are required. For an example,   * Does this capability apply to inter-frequency case and intra-frequency with gap. * How to handle different SCS on different CCs, where the slot durations of different CCs are different.   How to handle the case of async NR DC, where the slot boundary are not aligned. |
| Huawei, HiSilicon | Issue 1-1-1: Option 2. For option 1, we think it is a very strong limitation for NW to make sure SSB always occurs at same time and frequency as CSI-RS. Also, it implies a subset of the feature defined by RAN1/2 (CSI-RS w/o associated SSB) is not supported.  Issue 1-1-2: We understand MO is equivalent as frequency layer, and this has been already agreed by RAN1. Thus, the measurement capability in terms of number of layers is same as number MOs, the number of cells/beams is defined on per MO basis.  Issue 1-2-1: We cannot agree on option 2 as such. We suggest to first reach consensus on the issues in sub-topic 1-1 so that companies have common understanding about the meaning of each option. Our proposal for this issue is option 2 based on option 2 for issue 1-1-1. In our view CSI-RS measurement is additional measurement to SSB measurement.  Issue 1-2-2: Same comment as for issue 1-2-1. Option 1 is based on certain assumptions in issue 1-1-1, so suggest first discuss on sub-topic 1.  Issue 1-2-3: Option 1.  Issue 1-2-4: First, UE buffering and processing capability in the second bullet is a separate issue from the per slot processing capability addressed by current issue 1-2-4. There is similar discussion in Positioning WI and we think it is an important consideration factor in defining the measurement requirements, so we appreciate opinions on this issue from other companies. For the per slot processing capability in current issue 1-2-4, both options are fine for us. |
| DOCOMO | Issue 1-1-1: We prefer option 2. For option 1, we think there is no need to make such a strong restriction that CSI-RS based measurement is configured with SSB based measurement within the same MO.  Issue 1-2-1: Option 1 is our preference. In option 2, we don't find clear necessity to limit the number of CSI-RS frequency layers as 3. |
| ZTE | Issue 1-1-1: Option 2.  Not fully understand what option 1 means.  Issue 1-1-2: In the past MO is equivalent of frequency layer. There were discussions during early CSI-RS L3 mobility a few meetings ago. RAN1 agreed to use MO instead of frequency layer. From RAN4 perspective, we think the two are still interchangeable.  Issue 1-2-1: Option 1.  Issue 1-2-2: Option 2.  It is important to have requirements on number of cells per frequency layer for CSI-RS based measurement. It is not clear how UE will share the capability of measuring SSB and measuring CSI-RS. The total number for both SSB and CSI-RS can be further studied.  Issue 1-2-3: Option 2.  We think option 2 is better than option 1 in terms of UE complexity since in some cases less CSI-RS resources are need to be measured.  Issue 1-2-4: FFS on UE capability. |
| Nokia, Nokia Shanghai Bell | Sub topic 1-1:  Issue 1-1-1: We support Option2. No need to apply such restriction.  Issue 1-1-2: The definition of frequency layer needs to be clarified.  RAN1 has informed in reply LS: “frequency layer for CSI-RS mobility resources is measurement object (MO)”. We can discuss how to align the understanding.  Sub topic 1-2: This shall be discussed after the intra-f vs. inter-f definition is concluded. |

### 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.*

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| --- | --- |
| **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.*

In 1st round, we have discussed the following issues. Tentative agreements or candidate options could be hardly achieved due to diverse views form companies. More discussion are needed in the 2nd round if possible.

* + *Topic #1:Measurement capability (sub-agenda 8.16.1.3)*

*Sub-topic 1-1: Applicability and assumption for CSI-RS based measurement capability*

* + - Issue 1-1-1:Applicability for CSI-RS based measurement capability
    - Issue 1-1-2:Measurement capabilities per MO or per layer

*Sub-topic 1-2: Requirements for measurement capability*

* + - Issue 1-2-1:Number of frequency layers to be monitored
    - Issue 1-2-2:Number of cells to be monitored
    - Issue 1-2-3:Number of CSI-RS resource/beams to be monitored
    - Issue 1-2-4:UE capability to indicate maximum number of CSI-RS resources in a slot per MO
    - (New) Issue 1-2-5: UE buffering and processing capability

NOTE: The supported companies or issues for the sub-topics have already been updated according to the comments or TDocs proposed by companies.

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|  | **Status summary** |
| **Sub-topic#1-1** | **Issue 1-1-1: Applicability of CSI-RS based measurement capability**  *Tentative agreements:* No tentative agreements.  FFS on whether to introduce restriction of MO configuration to specify requirements for the limited or selected scenarios.  *Recommendations for 2nd round:*  *Candidate options:*   * Option 1(MediaTek, OPPO): Only define the requirements when the CSI-RS based measurement is configured with SSB based measurement within the same MO, and UE can perform CSI-RS and SSB measurement with overlapped bandwidth in the same time duration * Option 2(Ericsson, CATT, CMCC, Huawei, DOCOMO, ZTE, Nokia): No restriction on MO configurations * Option 3: Object Option 1 but consider other possible restriction in order to specify requirements for the limited or selected scenarios.   According to the conclusion of MO definition/restriction in Part 1, FFS on whether to introduce restriction of MO configuration to specify requirements for the limited or selected scenarios.  **Issue 1-1-2: Measurement capabilities per MO or per layer**  *Tentative agreements:* No tentative agreements.  Further discuss how to align the understanding of MO and frequency layer in RAN4.  *Recommendations for 2nd round:*  According to RAN1’s reply LS “frequency layer for CSI-RS mobility resources is measurement object (MO)”, at this stage, most companies agree to define measurement capabilities per layer. But it still depends on the outcome of the intra-/inter-definition discussion, and MO definition/restriction, e.g., if per MO ≠per layer.  Views are expected to be further collected for the example questions from companies, to further clarify the understanding of MO configuration, intra-frequency measurement definition and layer definition.   * If there are both intra and inter frequency measurement in one MO, can we still define the UE capability requirement based on MO? * In one MO, if there several bandwidths, do they belong to same layer or different layer? * If the intra-frequency measurement is defined without fixing the center-frequency, there may be several MOs for intra-frequency. Whether to define the MO number for intra-frequency? |

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|  | **Status summary** |
| **Sub-topic#1-2** | *Tentative agreements:* No Tentative agreements.  Sub topic# 1-2 shall be discussed after the intra-f vs. inter-f definition is concluded.  *Recommendations for 2nd round:*  Number of frequency layers and cells to be monitored can be decided after we reach consensus on the issues in sub-topic 1-1.  **Issue 1-2-1:Number of frequency layers to be monitored**  *Candidate options:*  A frequency layer for CSI-RS is   * Option 1: just the same center frequency of CSI-RS resource * Option 2: the same center frequency and BW of CSI-RS resource   *Candidate options and recommended WF:*   * Option 1 (MediaTek, OPPO, ZTE, Apple, Ericsson, DOCOMO): CSI-RS based L3 measurement does not add additional frequency layers and cells to be monitored on top of the number specified for SSB based measurement. * Option2 (CATT):   + 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.   + UE shall be able to measure at least 14 carriers of all RATs in total.   + For associated SSB case, UE is required to detect SSB on target cell firstly, then the configured CSI-RS can be measured. So, the measurement capability can be considered as SSB based measurement capability. For non-associated SSB case, it is required UE capable to perform CSI-RS based layers. * Option 2a (Huawei):   Based on option 2 for issue 1-1-1(No restriction on MO configurations)   * + 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.   + UE shall be able to measure at least 14 carriers of all RATs in total.   **Issue 1-2-2:Number of cells to be monitored**  Further discuss based on the updated options from companies.  **Issue 1-2-3: number of CSI-RS resource/beams to be monitored per layer/MO**  Further discuss based on the updated options from companies.  **Issue 1-2-4: UE capability to indicate maximum number of CSI-RS resources in a slot per MO**  Based on majority view from companies, we can focus on that Reuse existing UE capability maxNumberCSI-RS-RRM-RS-SINR.  More discussions on UE capability *maxNumberCSI-RS-RRM-RS-SINR* are required.   * FFS whether the indicated number is per UE or per frerquency layer/MO * Whether this capability apply to inter-frequency case and intra-frequency with gap. * How to handle different SCS on different CCs, where the slot durations of different CCs are different. * How to handle the case of async NR DC, where the slot boundary are not aligned.   According to comments from Huawei, a new open issue is added. Appreciate opinions on this issue from other companies.  **Issue 1-2-5: UE buffering and processing capability**  Option 1: The UE capability on UE buffering and processing time RAN1 defined for PRS is re-used for CSI-RS. Alternatively, define UE capability on the minimum separation between two slots with CSI-RS resources. |

*Recommendations on WF/LS assignment*

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|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 | WF on CSI-RS based measurement capability | TBD |

### 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)

The discussion of measurement capability highly depends on the definition/restriction of intra-frequency and inter-frequency measurement.

We suggest to firstly **align the understanding of MO and frequency layer** in RAN4. Companies are encouraged to provide views on the this, in order to **clarify the understanding of MO configuration, intra-frequency measurement definition and layer definition**. And **whether to restrict MO configuration to specify requirements for the limited or selected scenarios** are suggested to discuss in 2nd round as well.

Any new comment is appreciated if possible. Otherwise, the remaining issues will be captured in the WF and deferred to next RAN4 meeting.

### Sub-topic 1-1: Assumption and applicability

**Issue 1:** **Align the understanding of MO and frequency layer**

In 1st round discussion, most companies agree to define measurement capabilities per layer.

The following questions can be used as a start point.

For example:

* Q1 :A frequency layer for CSI-RS is

Option 1: just the same center frequency of CSI-RS resource

Option 2: the same center frequency and BW of CSI-RS resource

* Q2: If there are both intra and inter frequency measurement in one MO, can we still define the UE capability requirement based on MO?
* Q3: In one MO, if there several bandwidths, do they belong to same layer or different layer?
* Q4: If the intra-frequency measurement is defined without fixing the center-frequency, there may be several MOs for intra-frequency. Whether to define the MO number for intra-frequency?

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| **Issue 1** | **Question** | **Comments** |
| CMCC | Q1 | Option 1. In our understanding, a frequency layer is a MO. |
| Q2 | Q2 is related to the definition of intra-frequency measurement. It is better to avoid this case when discussing intra-frequency measurement definition |
| Q3 | Need further discussion |
| Q4 | Q4 is related to the definition of intra-frequency measurement. It is better to avoid this case when discussing intra-frequency measurement definition |
| Huawei, HiSilicon | Q1 | Option 1, same as CMCC we understand MO is identical to frequency layer. |
| Q2 | It depends on the outcome from the discussion on intra/inter-f definition. At least with we definition we proposed, this will never happen. We suggest to discuss this later rather than based on speculation. |
| Q3 | We do not understand the scenario. All resources in an MO must have same centre frequency, so how could we have several ‘bandwidth’? Or it is referring to whether or not in requirements we assume resources in an MO have same BW? |
| Q4 | Same comment as for Q2. |
| Nokia, Nokia Shanghai Bell | Q1 | We think option1 does not well reflect RAN1 indication.  From RAN1 reply LS, it indicates “frequency layer is MO”. However, RAN2 spec allows to configure multiple MOs with the same center frequency. Are they considered to be one frequency layer or multiple? So maybe the options could be rephrased as:  Q1 :A frequency layer for CSI-RS is  Option 1: just the same center frequency of CSI-RS resource (could comprsing multiple MOs with the center frequecy)  Option 2: the same center frequency and BW of CSI-RS resource  Option 3: one MO i.e. same center frequency, same SCS |
|  | Q2, Q4 | It depends on how we define the intra-f measurement. Could be discussed later. |
|  | Q3 | Within one MO, the bandwidth of CSI-RS resources could be different. But they belong to one frequency layer. |
| OPPO | Q1 | Option 2.  From moderator’s perspective, we are fine to capture it in WF as recommended by Nokia for further decision in next meeting. |
| Q2 | Agree with CMCC, Huawei and Nokia. It depends on the outcome from the discussion on intra/inter-f definition. If no conclusion in 2nd round, suggest to discuss it in next meeting. |
| Q3 | It depends on Q1. From RAN2’s perspective, an MO shall have same centre frequency. If a frequency layer for CSI-RS is defined as option 2, then different BWs means different layers. We can further discuss it in next meeting. |
| Q4 | Same comment as for Q2. |
| Intel | Q1 | prefer to align one MO with one layer. |
| Q2 | depends on the definition of intra-f. when discussing the definition of intra-f, it’s better to avoid the scenario. |
| Q3 | depends on the definition of intra-f. if the two bandwidths are classified as intra-f and inter-f, can they be counted as same layer? when discussing the definition of intra-f, it’s better to consider the scenario. |
| Q4 | depends on the definition of intra-f. when discussing the definition of intra-f, it’s better to consider the scenario. |
| Docomo | Q1 | We also have the same understanding as CMCC and Huawei, so we prefer option 1. |
| Q2 | Agree with Huawei. We should reach the conclusion about intra/inter-frequency definition firstly. |
| Q3 | According to TS.38.331, multiple CSI-RS resources with different BWs can be configured in one MO. Thus, we think they belong to same layer if the answer of Q1 is that a frequency layer is same as a MO. |
| Q4 | Agree with CMCC. |
| MTK | Q1-Q5 | Suggest to postpone the discussion after concluding the intra-/inter-definition |

**Issue 2: Whether to restrict MO configuration to specify requirements for the limited or selected scenarios**

* + - Option 1: Yes. How?
  + Option 1a: Only define the requirements when the CSI-RS based measurement is configured with SSB based measurement within the same MO, and UE can perform CSI-RS and SSB measurement with overlapped bandwidth in the same time duration.
  + Option 1b: Others. How?
    - Option 2: No.

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| **Issue 1** | **Supported option** | **Comments** |
| CMCC | Option 2 | Both the case with associated SSB and the case without associated SSB need to be considered |
| Huawei, HiSilicon |  | We are open to discuss if some scenarios can be excluded from the requirements if they are not practical or beneficial, but we think the current option 1a is too limiting. |
| Nokia, Nokia Shanghai Bell | Option2 | The MO configuarion is network implementation which should not be restricted. But we can discuss some reasonsable scenarios where the requirement shall apply. |
| OPPO | *Option 1* | We understand the intention to specify requirements for limited scenarios.  If companies cannot agree with 1a, we suggest to further study possibility to introduce other restriction in next meeting. |
| Docomo | *Option 2* |  |
| MTK | Option 1 | As we explained several times. CSI-RS was not designed for detection. UE anyway needs to use SSB for cell detection to know whether a certain cell is its neighboring cell before measurement. Configuring CSI-RS without associated SSB is just a waste of UE power. |

### Sub-topic 1-2: Requirements of measurement capabilities

In 2nd round, we are suggested to continue discussing measurement capabilities for CSI-RS based L3 measurement based on issues summarized/updated in 1st round. Any new comment is appreciated if possible. Otherwise, the remaining issues will be captured in the WF and deferred to next RAN4 meeting.

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

* Proposals
* Option 1 (MediaTek, OPPO, ZTE, Apple, Ericsson, DOCOMO):
  + CSI-RS based L3 measurement does not add additional frequency layers and cells to be monitored on top of the number specified for SSB based measurement.
* Option 2(Huawei):

Assuming no restriction on MO configurations:

* + 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.
  + UE shall be able to measure at least 14 carriers of all RATs in total.
* Option 3(CATT):
  + If CSI-RS is configured with associated SSB, the measurement capability can be considered the same as SSB based measurement capability.(as option 1)
  + If CSI-RS is not configured with any associated SSB, UE is capable to perform CSI-RS based layers.(as option 2)
* Not preclude other options.

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| Issue 1-2-1 | **Supported option** | **Comments** |
| CMCC | *Option 2* |  |
| Huawei, HiSilicon | *Option 2* | We understand before discussing the details we should have a common assumption on the scenarios as addressed in Issue 2 of Sub-topic 1-1.  In our view, CSI-RS measurement does not come for free even the resource is with associated SSB, and it is additional measurement to existing SSB measurement. |
| Nokia, Nokia Shanghai Bell |  | This can be discussed after we get it clear what “frequency layer” means for CSI-RS based L3 measurement. |
| OPPO | *Option1* | From moderator’s perspective, if no consensus, we suggest to capture this issue with all candidate options above in WF for further decision in next meeting. |
| Intel |  | This can be discussed later when we are clear about “frequency layer” and the configuration of MO. |
| Docomo | *Option 1* |  |
| MTK | *Option 1* | Adding more frequency layers is going increase the value of CSSF and eventual the measurement of all frequency layers become slow. |

**Issue 1-2-2: number of cells to be monitored per layer/MO**

* Proposals
  + Option 1 (MediaTek, OPPO, Apple, Ericsson): No need to introduce additional number of cells to be monitored per layer based on L3 CSI-RS on top of the requirements already specified for SSB.
  + Option 2 (ZTE): 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.
  + Option 3 (Huawei, CATT): RAN4 should discuss the total number of cells and CSI-RS resources UE should measure per MO.

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| Issue 1-2-2 | **Supported option** | **Comments** |
| CMCC | *Option 3* |  |
| Huawei, HiSilicon | *Option 3* | Again, this depends on Issue 1 in Sub-topic 1-1. |
| Nokia, Nokia Shanghai Bell |  | This can be discussed after we get it clear what “frequency layer” means for CSI-RS based L3 measurement. |
| OPPO | *Option 1* | From moderator’s perspective, if no consensus, we suggest to capture this issue with all candidate options above in WF for further decision in next meeting. |
| Intel |  | This can be discussed later when we are clear about “frequency layer” and the configuration of MO. |
| MTK | Option 1 | As we explained several times. CSI-RS was not designed for detection. UE anyway needs to use SSB for cell detection to know whether a certain cell is its neighboring cell before measurement. |

**Issue 1-2-3: number of CSI-RS resource/beams to be monitored per layer/MO**

* Proposals
  + Option 1(CATT, Huawei, OPPO): UE shall monitor at least 32 CSI-RS resources per frequency layer
  + Option 2(ZTE, Ericsson, CATT): 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(MediaTek): Requirements defined the same requirements as those for SSB.
  + Option 4(Qualcomm): The total number of CSI resources that UE can monitor should come from the UE capability *maxNumberCSI-RS-RRM-RS-SINR*. How to split that up per layer would or MO would depend on resolution of Issue 1-1-1 and Issue 1-2-1.

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| Issue 1-2-3 | **Supported option** | **Comments** |
| CMCC | *Option 1* |  |
| Huawei, HiSilicon | *Option 1* | We understand this may also depend on Issue 1 in Sub-topic 1-1. |
| Nokia, Nokia Shanghai Bell |  | This can be discussed after we get it clear what “frequency layer” means for CSI-RS based L3 measurement. |
| OPPO | *Option 1* | From moderator’s perspective, if no consensus, we suggest to capture this issue with all candidate options above in WF for further decision in next meeting. |
| Intel |  | agree with Nokia. This can be discussed later when we are clear about “frequency layer” and the configuration of MO. |
| MTK | *Option 3* | We need to see the analysis why UE has to measure more CSI-RS beams than SSB beams. Otherwise, we should keep the same requirement as SSB. |

**Issue 1-2-4: UE capability to indicate maximum number of CSI-RS resources in a slot per MO**

Majority view is supporting Option 1(Huawei, OPPO, Ericsson, CATT, Qualcomm, CMCC):

* Reuse existing UE capability *maxNumberCSI-RS-RRM-RS-SIN*R.

Open issues for 2nd round discussion include:

* Q1: FFS whether the indicated number is per UE or per frerquency layer/MO
* Q2: Whether this capability apply to inter-frequency case and intra-frequency with gap.
* Q3: How to handle different SCS on different CCs, where the slot durations of different CCs are different.
* Q4: How to handle the case of async NR DC, where the slot boundary are not aligned.

RAN4 decide to send LS to ask for RAN1 and RAN2 if needed in next meeting.

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| **Issue 1-2-4** | **Question** | **Comments** |
| CMCC | Q1 | The *maxNumberCSI-RS-RRM-RS-SIN*R can be reused which is the maximum number of CSI-RS resources across all measurement frequencies per slot according to RAN1/2. As for whether additional UE capability per MO is needed or not can be further discussed. |
| Q2 |  |
| Q3 |  |
| Q4 |  |
| Huawei, HiSilicon | Q1 | Agree with CMCC that currently the capability is per UE, i.e. maximum number of CSI-RS resources across all measurement frequencies per slot. We think the maximum number of CSI-RS resources per slot per MO may be more relevant to RAN4 requirements, so we suggest to update the existing capability or add new capability. |
| Q2 | To us the maximum number of CSI-RS resources per slot per MO may be more relevant to RAN4 requirements. If we have such capability it will apply for each MO no matter it is intra- or inter-frequency. |
| Q3 | Need more time to check, current capability is not dependent on SCS. |
| Q4 | To us the maximum number of CSI-RS resources per slot per MO may be more relevant to RAN4 requirements. For such capability we do not need to consider another MO in another CG. |
| Nokia, Nokia Shanghai Bell |  | We somehow support Option1.  By now we don’t see any reason why existing parameter cannot be reused. Maybe some clarification can be done on “measurement frequency” considering CSI-RS based measurements. |
| OPPO |  | From moderator’s perspective, we suggest to firstly agree on Option 1 as  Reuse existing UE capability *maxNumberCSI-RS-RRM-RS-SIN*R.  The remaining open issues (Q1-Q4) can be captured in WF for further decision in next meeting. |
| MTK |  | We do not see how *maxNumberCSI-RS-RRM-RS-SIN*R can be used to define max # per MO. This IE considered all frequency layers in one slot, while RAN4 is considering a single frequency in all slots. |

**Issue 1-2-5: UE buffering and processing capability**

FFS on UE buffering and processing capability.

* Option 1: UE capability on UE buffering and processing time RAN1 defined for PRS is re-used for CSI-RS L3 measurement.
* Option 2：Define UE capability on the minimum separation between two slots with CSI-RS resources.

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| Issue 1-2-5 | **Supported option** | **Comments** |
| CMCC |  | Need more discussion |
| Huawei, HiSilicon |  | Suggest to include this issue in the WF so that companies can provide views next meeting. |
| Nokia, Nokia Shanghai Bell |  | Could have more discussion. |
| OPPO |  | Agree with Huawei to be captured in WF for further decision in next meeting. |
| MTK |  | FFS |

## 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: 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

|  |  |  |
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| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2000465**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000465.zip) | MediaTek inc. | Observation 1: SSB-based cell detection is still required for CSI-RS based cell identification.  Observation 2: According to TS38.331, if associatedSSB is configured, the timing reference of the CSI-RS follows the target cell.  • If deriveSSB-IndexFromCell is not indicated, UE has to decode the PBCH of the target cell to get SFN, frame boundary and symbol-level timing with remaining error within CP before measuring the CSI-RS.  • If deriveSSB-IndexFromCell is indicated, UE can resolve the remaining symbol-level timing ambiguity of deriveSSB-IndexFromCell through the timing estimated from SSB.  Observation 3: If associatedSSB is not configured, UE has to measure up to 96 CSI-RS resources per MO. This is a huge waste of UE’s computation power.  Observation 4: UE has to maintain a separate AGC control for CSI-RS measurement.  Proposal 1: RAN4 does not specify requirements for the case that associatedSSB is not configured.  Proposal 2: The AGC control for L3 CSI-RS is more challenging than SSB and should be considered in the requirements.  Proposal 3: The requirement of CSI-RS based cell identification consists of the following 3 components: 1) Cell search via SSB with AGC margin, 2) PBCH decoding and 3) CSI-RS measurement with AGC margin.  Proposal 4: RAN4 should avoid to create new definition of CSI-RS specific CSSF or change the framework of CSSF in this WI and should try to re-use the existing requirement as much as possible.  Proposal 5: The CSI-RS resource configured for L3 measurement is not shared with other L1 measurement.  Proposal 6: The FFT window timing for intra frequency measurement always follows the serving cell timing.  Proposal 7: Scheduling restriction for CSI-RS based L3 measurement is still needed to address the issues of 1) collision with UL transmission and DL measurement on TDD carrier and 2) the need of Rx beam sweeping in FR2.  Proposal 8: The scheduling restriction on the additional OFDM symbols before and after SSB is not needed for CSI-RS based L3 measurement. |
| [**R4-2000586**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000586.zip) | CATT | Proposal 1: If associated SSB is not configured for CSI-RS resources, the CSI-RS identification time can be expressed as: TCSI-RS\_identification\_without\_associatedSSB = TCSI-RS\_measurement\_period.  Proposal 2: If associated SSB is configured for CSI-RS resources, the CSI-RS identification time can be expressed as: TCSI-RS\_identification\_with\_associatedSSB = TPSS/SSS\_sync + TCSI-RS\_measurement\_period.  Proposal 3: If the CSI-RS resource is configured with associated SSB and QCLed to the associated SSB, the CSI-RS based measurement requirement does not need to consider the scaling factor due to Rx beam sweeping.  Proposal 4: 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 5: the CSSFwithin\_gap specified in 38.133 should be updated by considering the CSI-RS based measurement within the active BWP, and the CSSFoutside\_gap specified in 38.133 should be updated by considering the CSI-RS based measurement outside the active BWP.  Proposal 6: For CSI-RS based measurement, the following options can be considered to define the corresponding requirements:  • Option 1: UE is allowed not to measure the CSI-RS resources that are not within DRX on-duration or measurement gap;  • Option 2: No UE performance requirement is defined for the CSI-RS resources that are not within DRX on-duration or measurement gap;  • Option 3: the network needs to make sure the configured CSI-RS resources falls within the configured measurement gaps |
| [**R4-2000947**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000947.zip) | NTT DOCOMO, INC. | Observation 1: The method of identify timing synchronization is not related to measurement requirements directly.  Proposal 1: RRM requirements should be specified based on the configuration of associatedSSB, e.g., if both ssbIndex and isQuasiColocated are provided, Rx beam sweeping is not needed. |
| [**R4-2000996**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000996.zip) | OPPO | Proposal 1: If associatedSSB is not configured, two options are to be down selected for CSI-RS L3 measurement.  Option 1: No requirements specified for CSI-RS L3 measurement  Option 2: CSI-RS identification time is the CSI-RS measurement periodicity  Proposal 2: If associated SSB is configured for CSI-RS resources, CSI-RS based cell identification consists: 1) Cell search via SSB, 2) PBCH decoding and 3) CSI-RS measurement.  Proposal 3: Study the impact of AGC control and if any define AGC margin additionally.  Observation 1: From specification’s perspective, the structure of CSI-RS L3 measurement can be more concise than those of SSB.  Proposal 4: Intra-frequency measurement can all be configured without gaps if the definition of intra-frequency includes the bandwidth of the CSI-RS on the neighbor cell is within the active BWP of the UE. Otherwise, all others are inter-frequency measurement with gaps.  Proposal 5: RAN4 try to re-use the existing requirement of CSSF as much as possible, and the framework of CSSF can be shared by SSB and CSI-RS based L3 measurement.  Observation 2: RAN4 to consider the collision with UL transmission and DL measurement for TDD band on FR1, and Rx beam sweeping and intra-band carrier aggregation on FR2, for scheduling restriction of CSI-RS based L3 measurement without gaps.  Proposal 6: If CSI-RS based L3 measurement is configured without gaps, the requirements of scheduling restriction can be chosen from two options:  • Option 1: the scheduling restriction on the additional OFDM symbols before and after SSB is not needed for CSI-RS based L3 measurement.  • Option 2: define scheduling restriction on CSI-RS to be measurement and additional X OFDM symbol before and after consecutive CSI-RS symbols to be measured, FFS on X value.  Proposal 7: If CSI-RS is configured with associated SSB and QCL-ed to the associated SSB, no Rx sweeping is needed, and do not define any scaling factor due to Rx beam sweeping.  Proposal 8: If CSI-RS configured with associated SSB but not QCL-ed to the associated SSB, Rx sweeping is needed and FFS on the scaling factor N. |
| [**R4-2001658**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001658.zip) | Huawei, HiSilicon | Proposal 1: CSI-RS measurement requirement is the CSI-RS measurement periodicity when associatedSSB is not configured.  Proposal 2: The above requirement is applicable assuming that the timing between serving cell and the neighbour cell is frame boundary synchronized.  Proposal3:  If the MO includes the serving CSI-RS resource with associated SSB, for the cells in the same MO,  o For FR1 FDD cell, UE can perform PSS/SSS detection and DMRS matching to acquire time index of each cell in the MO.  o For TDD cell or FR2 cells, UE can perform PSS/SSS detection to acquire symbol level timing of each cell in the MO.  o If the MO doesn’t include the serving CSI-RS resource and the CSI-RS resource associated SSB is configured, UE needs to perform PSS/SSS detection, DMRS matching and PBCH decoding to acquire SFN, frame boundary timing, slot timing and symbol level timing of one cell. For the other cells in the same MO,  o For FR1 FDD cell, UE can perform PSS/SSS detection and DMRS matching to acquire time index of each cell in the MO.  o For FR1 TDD cell or FR2 cells, UE can perform PSS/SSS detection to acquire symbol level timing of each cell in the MO.  Proposal 4: If CSI-RS is not QCL-ed to the associated SSB, UE needs to sweep the RX beam. If the CSI-RS is QCL-ed to the associated SSB, no Rx sweeping is needed.  Proposal 5: If UE is not able to support mixed numerology of data and CSI-RS L3 mobility, the following scheduling restrictions apply due to CSI-RS based L3 intra-frequency 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 the 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.  Proposal 6: 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 7: Scheduling restriction shall be considered when UE performs RX beam sweeping. |

## 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 2-1: Framework of CSI-RS based measurement requirements

*Sub-topic description*

As guideline, framework of CSI-RS based measurement requirements is to be discussed firstly, including:

* Components of CSI-RS based measurement requirements
* Specification structure of CSI-RS L3 intra-f/inter-f measurement requirement

Note: according to whether CSI-RS configured with associatedSSB or not, the requirements could be defined for two cases.

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

**Issue 2-1-1: Components of CSI-RS based measurement requirements**

* Proposals

***Case1: if associatedSSB is not configured***

* + Option 1(OPPO, Ericsson, MediaTek): No requirements specified for CSI-RS L3 measurement
  + Option 2(CATT, Huawei): CSI-RS identification time is the CSI-RS measurement periodicity
    - Option 2a (Apple): If sufficient synchronization of severing cell and neighbor cell can be guaranteed, option 2 is OK
    - Option 2b(CMCC, ZTE, Nokia): Requirements for both Case 1 and Case 2 are specified.
    - Option 2c (Nokia): If associatedSSB is not configured, the UE shall base the timing on its serving cell. The requirement needs at least consider the CSI-RS measurement time.

***Case 2: if associatedSSB is configured for CSI-RS***

* + Option 1(OPPO, Apple, Ericsson, MediaTek): CSI-RS based cell identification consists of:
    - 1) Cell search via SSB,
    - 2) PBCH decoding
    - 3) CSI-RS measurement.
    - FFS AGC margin.
  + Option 2 (Huawei)
* If the MO includes the serving CSI-RS resource with associated SSB, for the cells in the same MO,
  + For FR1 FDD cell, UE can perform PSS/SSS detection and DMRS matching to acquire time index of each cell in the MO.
  + For TDD cell or FR2 cells, UE can perform PSS/SSS detection to acquire symbol level timing of each cell in the MO.
* If the MO doesn’t include the serving CSI-RS resource and the CSI-RS resource associated SSB is configured, UE needs to perform PSS/SSS detection, DMRS matching and PBCH decoding to acquire SFN, frame boundary timing, slot timing and symbol level timing of one cell. For the other cells in the same MO,
  + For FR1 FDD cell, UE can perform PSS/SSS detection and DMRS matching to acquire time index of each cell in the MO.
  + For FR1 TDD cell or FR2 cells, UE can perform PSS/SSS detection to acquire symbol level timing of each cell in the MO.
* Recommended WF
  + Collect the views from companies and try to agree on the framework for the measurement delay
  + Tentative agreement:
  + For Case1: if associatedSSB is not configured
    - No requirements specified for CSI-RS L3 measurement
  + For Case 2: if associatedSSB is configured for CSI-RS
    - CSI-RS based cell identification consists:
      * 1) Cell search via SSB,
      * 2) PBCH decoding
      * 3) CSI-RS measurement.
    - AGC margin should be considered.

**Issue 2-1-2: Specification structure of CSI-RS L3 intra-f/inter-f measurement requirement**

* Proposals
  + Option 1(OPPO, DOCOMO):

Intra-frequency measurement can all be configured without gaps if the definition of intra-frequency includes the bandwidth of the CSI-RS on the neighbour cell is within the active BWP of the UE. Otherwise, all others are inter-frequency measurement with gaps.

* Recommended WF (OPPO, Apple, Ericsson, Intel, MediaTek, Huawei, CMCC, ZTE, Nokia)
  + Wait for the conclusion of NR\_CSIRS\_L3meas\_RRM\_Part\_1

### Sub-topic 2-2: Key open issues

*Sub-topic description*

According to companies’ inputs, we suggest to discuss the following key open issues for intra/inter-frequency measurement, including

* CCSF
* Scaling factor for Rx beam sweeping
* Scheduling restriction
  + Factors to consider for scheduling restriction
  + Requirements for scheduling restriction
* Whether to restrict CSI-RS resources outside of DRX/MG duration
* Others

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

**Issue 2-2-1: CSSF**

* Proposals
  + Option 1(OPPO, Ericsson, Intel, MediaTek):

RAN4 to re-use the existing requirement of CSSF as much as possible, and the framework of CSSF can be shared by SSB and CSI-RS based L3 measurement.

* + Option 2(CATT):

The CSSFwithin\_gap specified in 38.133 should be updated by considering the CSI-RS based measurement within the active BWP, and the CSSFoutside\_gap specified in 38.133 should be updated by considering the CSI-RS based measurement outside the active BWP.

* + Option 3(Huawei): The detailed CSSF calculation shall consider both CSI-RS MO and SSB MO
* Recommended WF
  + Collect the views from companies and try to achieve agreement in 1st or 2nd round discussion

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

* Proposals
  + Option 1(OPPO, DOCOMO, CATT, Ericsson, Intel, Huawei, ZTE):
  + If CSI-RS is not QCL-ed to the associated SSB, UE needs to sweep the RX beam.
    - FFS on the scaling factor N
  + If the CSI-RS is QCL-ed to the associated SSB, no Rx sweeping is needed
  + Option 1a (Qualcomm, CATT):
  + If CSI-RS is not QCL-ed to the associated SSB, UE needs to sweep the RX beam.
    - FFS on the scaling factor N
  + If the CSI-RS is QCL-ed to the associated SSB, no Rx sweeping is needed only **after** SSB has been detected. SSB detection would still need beam sweeping.
  + Option 2 (CMCC): The case without associatedSSB configured also needs to be studied.
* Recommended WF
  + Tentative Agreement:
  + If CSI-RS is not QCL-ed to the associated SSB, UE needs to sweep the RX beam.
    - FFS on the scaling factor N
  + If the CSI-RS is QCL-ed to the associated SSB, no Rx sweeping is needed.

**Issue 2-2-3: Factors to consider for scheduling restriction**

* Proposals
  + Option 1(OPPO, MediaTeK):
  + Scheduling restriction for CSI-RS based L3 measurement is still needed to address the issues of
    - 1) collision with UL transmission and DL measurement on TDD carrier and
    - 2) the need of Rx beam sweeping in FR2.
  + Option 2 (CATT, Intel, CMCC, Huawei):
  + 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
  + Option 3(ZTE): identify all possible factors which would cause scheduling restriction first. It’s not clear whether scheduling restriction is needed for collision between UL transmission and DL measurement for TDD carrier
* Recommended WF
  + Tentative Agreement(Ericsson, MediaTeK, OPPO):
    - RAN4 agree to consider for scheduling restriction for CSI-RS L3 measurement
      * 1) collision with UL transmission and DL measurement on TDD carrier and

2) the need of Rx beam sweeping in FR2.

* + - FFS the impact of mix-numerology in 1st round and try to achieve agreement in 2nd round

**Issue 2-2-4: Requirements for scheduling restriction**

* Proposals
  + 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):
  + The scheduling restriction on the additional OFDM symbols before and after SSB is not needed for CSI-RS based L3 measurement.
  + Option 3(OPPO):
  + Define scheduling restriction on CSI-RS to be measurement and additional X OFDM symbol before and after consecutive CSI-RS symbols to be measured. FFS on X value.
* Recommended WF(OPPO, Qualcomm, Intel, MediaTeK, Huawei)
  + Tentative Agreement: the requirements are only discussed for CSI-RS based L3 measurement without gaps
  + Collect views from companies
    - FFS on additional X OFDM symbol before and after consecutive CSI-RS symbols to be measured
    - FFS on additional Y OFDM symbols before and after SSB

**Issue 2-2-5: Whether to restrict CSI-RS resources outside of DRX/MG duration**

* Proposals
  + Option 1(CATT): UE is allowed not to measure the CSI-RS resources that are not within DRX on-duration or measurement gap;
  + Option 2 (OPPO, Qualcomm, CATT, Intel, MediaTeK, Huawei): No UE performance requirement is defined for the CSI-RS resources that are not within DRX on-duration or measurement gap;
  + Option 3(CATT): the network needs to make sure the configured CSI-RS resources falls within the configured measurement gaps
* Recommended WF
  + Tentative Agreement: Option 2

**Issue 2-2-6: Others**

* Proposal 1:
  + Option1 (MediaTek): The CSI-RS resource configured for L3 measurement is not shared with other L1 measurement.
* Proposal 2:
  + Option1 (MediaTek): The FFT window timing for intra frequency measurement always follows the serving cell timing.
    - Option 1a(Huawei): There is no associated SSB, option 1 is agreeable.
  + Option 2 (ZTE): FFT window timing is UE implementation dependent.
* Recommended WF
  + Tentative Agreement (OPPO, MediaTeK):
    - Agreement: The FFT window timing for intra frequency measurement always follows the serving cell timing.
    - FFS CSI-RS resource configured for L3 measurement is not shared with other L1 measurement.

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Sub-topic 2-1: Framework of CSI-RS based measurement requirements  Issue 2-1-1: Agree with tentative agreement.  Issue 2-1-2: Wait for the conclusion of NR\_CSIRS\_L3meas\_RRM\_Part\_1.  Sub-topic 2-2: Key open issues  Issue 2-2-1: Support option 1. Re-use the existing requirement of CSSF as much as possible, and the framework of CSSF can be shared by SSB and CSI-RS based L3 measurement.  Issue 2-2-2: Agree with tentative agreement.   * If CSI-RS is not QCL-ed to the associated SSB, UE needs to sweep the RX beam. * If the CSI-RS is QCL-ed to the associated SSB, no Rx sweeping is needed.   Issue 2-2-3: Agree with tentative agreement.  RAN4 agree to consider for scheduling restriction for CSI-RS L3 measurement  1) collision with UL transmission and DL measurement on TDD carrier and  2) the need of Rx beam sweeping in FR2.  Issue 2-2-4: Prefer Option 3.  As we can agree firstly, the requirements are only discussed for CSI-RS based L3 measurement without gaps. And whether it applies to intra-frequency or/and inter-frequency depends on the conclusion of email discussion of NR\_CSIRS\_L3meas\_RRM\_Part\_1.  As for intra-frequency CSI-RS based L3 measurement, majority companies support SCSs of CSI-RS for serving cell and neighbour cell are the same. If this is the case, the mix-numerology between data/SSB of serving cell and CSI-RS of neighbour cell would not exist.  Issue 2-2-5: Prefer Option 2.  Issue 2-2-6: Agree with tentative agreement. The FFT window timing for intra-frequency measurement always follows the serving cell timing. |
| Apple | Issue 2-1-1: in Case 1, the synchronization level between serving and target cell needs to be clarified. If sufficient synchronization can be guaranteed, option 2 is OK. In case 2, option 1 is OK.  Issue 2-1-2: it seems the title of issue and proposal are not fully aligned. If spec structure is the concern, we should have a dedicated section for CSI-RS based L3 measurement. If the discussion is about gap or gapless based measurement, I agree we should hold this until the definition of inter-/intra-frequency becomes clear. |
| QC | Issue 2-1-1: Components of CSI-RS based measurement requirements  For Case1, for option 2 what is the sync assumption between serving cell and CSI-RS resource from other cells  Issue 2-2-2: Scaling factor for RX beam sweeping  For the case where CSI-RS is QCL’d to SSB, no beam sweeping needed only **after** SSB has been detected. SSB detection would still need beam sweeping.  Issue 2-2-4: Requirements for scheduling restriction  We agree with WF. IF we can restrict to specifying requirements only for cases where no gaps are needed that will simplify the requirements quite a lot. The overhead for doing CSI-RS measurements with gaps really gives no benefit over SSB.  Issue 2-2-5: Whether to restrict CSI-RS resources outside of DRX/MG duration  Agree with option 2 in terms of DRx. As said in 2-2-4 we should restrict to defining requirements without gaps.  Issue 2-2-6: Others  For proposal 1, need more clarification as to why the restriction is needed.  For proposal 2, we assume that this means that performance requirements will be defined based on serving cell timing. |
| Ericsson | Issue 2-1-1: support the proposed WF  Issue 2-1-2: the proposed WF is fine  Issue 2-2-1: option 1  Issue 2-2-2: the proposed WF is acceptable  Issue 2-2-3: the proposed WF looks ok  Issue 2-2-4: needs further discussion  Issue 2-2-5: needs further discussion  Issue 2-2-6: needs further discussion |
| CATT | **Issue 2-1-1: Components of CSI-RS based measurement requirements**  Do not agree the recommended WF. Non-associated SSB case shall be supported, and we can further discuss the synchronization assumption, as Apple mentioned above. In our understanding, if the target cell and the serving cell are synchronized, there is no need to detect SSB. And for case 2, why UE should decode PBCH? SSN index will configured to UE is associated SSB is configured.  **Issue 2-2-1: CSSF**  The CSSF need to be updated by considering the CSI-RS based measurement. It depends on the conclusion on intra-frequency and inter-frequency measurement definition. We can refer the discussion and conclusion on inter-frequency measurement without gap in RRM enhancement WI.  **Issue 2-2-2: Scaling factor for RX beam sweeping**  Agree with QC  **Issue 2-2-3: Factors to consider for scheduling restriction**  My understanding is that the SCS of CSI-RS for RRM is configured independently of the PDSCH/PDCCH SCS. CSI-RS for RRM is in general configured for serving all UEs, while PDSCH/PDCCH is more related to individual UEs. So there is not necessary to restrict that the SCS of CSI-RS is always the same as PDCCH/PDSCH.  **Issue 2-2-4: Requirements for scheduling restriction**  Need more discussion.  **Issue 2-2-5: Whether to restrict CSI-RS resources outside of DRX/MG duration**  Either option is OK for us. |
| Intel | Issue 2-1-1: For case 1, clarify how UE do measurement if associatedSSB is not configured. If the timing of serving cell can be used, then the requirement can be defined. For case 2, we can agree on option 1.  Issue 2-1-2: agree with Recommended WF.  Issue 2-2-1: agree with option 1.  Issue 2-2-2: agree with recommended WF.  Issue 2-2-3: agree with option 2.  Issue 2-2-4: agree with recommended WF.  Issue 2-2-5: agree with recommended WF. |
| CMCC | Issue 2-1-1: We are not OK with the recommended WF. It is preferred to specify requirements for the case with *associatedSSB* and the case without *associatedSSB*  Issue 2-1-2: it is related to the definition of intra-frequency measurement  Issue 2-2-1: it is related to the definition of intra-frequency measurement  Issue 2-2-2: only the case with *associatedSSB is considered. The case* without *associatedSSB* configured also needs to be studied.  Issue 2-2-3: Mix-numerology between data of serving cell and target CSI-RS need to be considered  Issue 2-2-4: needs further discussion  Issue 2-2-5: needs further discussion  Issue 2-2-6: needs further discussion |
| MTK | Issue 2-1-1: Support the proposed WF  Is it possible to share some technical analysis on Option 2 in Case 1?  Issue 2-1-2: Support the proposed WF  Issue 2-2-1: Support Option 1  One compromise for the progress is that RAN4 only specifies requirements for intra-freq wo gap and inter-freq w/ gap. So that actually we will not have so many cases to handle.  Issue 2-2-2: FFS  The SSB needs to be detected first. Furthermore, even if the CSI-RS measurement requires no additional Rx sweeping, it does not mean UE can receive serving cell data and measure CSI-RS at the same time. Therefore, scheduling restriction is still needed.  If the CSI-RS comes at the same OFDM symbol as SSB, then Rx beam sweeping should still be assumed.  Issue 2-2-3: Support the proposed WF  Issue 2-2-4: Support the proposed WF  Issue 2-2-5: Support the proposed WF  Issue 2-2-6: Support the proposed WF |
| Huawei, HiSilicon | Issue 2-1-1: In case 1, the UE may base the timing of the CSI-RS resource on the timing of the serving cell. Network shall guarantee that UE can use the serving cell timing to measure a CSI-RS resource transmitted by neighbour cells. Therefore, the serving cell and the neighbour cell should be frame boundary synchronized. In the scenario UE is not required to perform cell identification and can directly measure the signal quality on the indicated CSI-RS resource. So option2 is reasonable.  For case 2, multiple cases shall be considered. The detail can refer to document [R4-2001658]. In summary:   * If the MO includes the serving CSI-RS resource with associated SSB, for the cells in the same MO,   + For FR1 FDD cell, UE can perform PSS/SSS detection and DMRS matching to acquire time index of each cell in the MO.   + For TDD cell or FR2 cells, UE can perform PSS/SSS detection to acquire symbol level timing of each cell in the MO. * If the MO doesn’t include the serving CSI-RS resource and the CSI-RS resource associated SSB is configured, UE needs to perform PSS/SSS detection, DMRS matching and PBCH decoding to acquire SFN, frame boundary timing, slot timing and symbol level timing of one cell. For the other cells in the same MO,   + For FR1 FDD cell, UE can perform PSS/SSS detection and DMRS matching to acquire time index of each cell in the MO.   + For FR1 TDD cell or FR2 cells, UE can perform PSS/SSS detection to acquire symbol level timing of each cell in the MO.   Issue 2-1-2: agree with the recommended WF.  Issue 2-2-1: option 1 and option 2 is not contradictory. The detailed CSSF calculation shall consider both CSI-RS MO and SSB MO.  Issue 2-2-2: agree with the recommended WF.  Issue 2-2-3: support option2. SCS of CSI-RS resource for mobility can be different with the serving cell PDSCH/PDCCH. If UE is not able to support mixed numerology of data and CSI-RS L3 mobility, scheduling restriction shall be considered.  Issue 2-2-4: agree with the recommended WF.  Issue 2-2-5: support option 2.  Issue 2-2-6: For proposal 1, needs further study.  For proposal 2, if there is no associated SSB, option 1 is agreeable. However we think the most important thing needs to discuss is the timing difference between target cell and serving cell. If associated SSB is indicated, the condition is invalid. |
| DOCOMO | Issue 2-1-2: We support option 1 because we think that if target CSI-RS is fully included in the active BWP, the UE can measure them without measurement gap.  Issue 2-2-2: Recommended WF is fine for us. |
| ZTE | Issue 2-1-1: Requirements for both Case 1 and Case 2 are specified.  Issue 2-1-2: Depending on the definition of intra-frequency measurement  Issue 2-2-1: Depending on the definition of intra-frequency measurement  Issue 2-2-2: Agree with recommended WF.  Issue 2-2-3: It would be better to identify all possible factors which would cause scheduling restriction first. It’s not clear whether scheduling restriction is needed for collision between UL transmission and DL measurement for TDD carrier  Issue 2-2-4: FFS on scheduling restriction requirements  Issue 2-2-5: FFS  Issue 2-2-6: It’s not clear to us about the L1 and L3 CSI-RS resource sharing. Does it mean L3 and L1 CSI-RS resources have to be different?  FFT window timing is UE implementation dependant. |
| Nokia, Nokia Shanghai Bell | Subtopic 2-1:  Issue 2-1-1: The requirements shall be defined for both case 1 and case 2.  If associatedSSB is not configured, the UE shall base the timing on its serving cell. The requirement needs at least consider the CSI-RS measurement time. Other factors are FFS.  Issue 2-1-2: Agree to the proposed WF.  Subtopic 2-2: These can be discussed after the intra-f vs. inter-f is concluded. |

### 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.*

In 1st round, we have discussed the following issues. Tentative agreements or candidate options could be hardly achieved due to diverse views form companies. More discussion are needed in the 2nd round if possible, The measurement requirement is quite related to the definition of intra-frequency and inter-frequency measurement. No conclusion could be done before that. So we can try our best to get some common understanding firstly.

* + *Topic #2: Measurement requirements for intra and inter-frequency measurement (sub-agenda 8.16.1.4/.5)*

*Sub-topic 2-1: Framework of CSI-RS based measurement requirements*

* + - Issue 2-1-1: Components of CSI-RS based measurement requirements
    - Issue 2-1-2: Specification structure of CSI-RS L3 intra-f/inter-f measurement requirement

*Sub-topic 2-: Key open issues*

* + - Issue 2-2-1: CSSF
    - Issue 2-2-2: Scaling factor for RX beam sweeping
    - Issue 2-2-3: Factors to consider for scheduling restriction
    - Issue 2-2-4: Requirements for scheduling restriction
    - Issue 2-2-5: Whether to restrict CSI-RS resources outside of DRX/MG duration
    - Issue 2-2-6: Others

NOTE: The supported companies or issues for the sub-topics have already been updated according to the comments or TDocs proposed by companies.

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|  | **Status summary** |
| **Sub-topic#2-1** | *Tentative agreements:*  Need more discussion on whether/how to define requirements for Case 1 and Case 2.   * Case1: if associatedSSB is not configured * Case 2: if associatedSSB is configured for CSI-RS   Note that the above tentative agreement is based on majority view from companies.  *Recommendations for 2nd round:*  Issue 2-1-1: Components of CSI-RS based measurement requirements  **For Case1: if associatedSSB is not configured,**  *Tentative agreements:* The synchronization level between serving and target cell needs to be clarified.  *Candidate options:*   * + Option 1(OPPO, Ericsson, MediaTek): No requirements specified for CSI-RS L3 measurement   + Option 2(CATT, Huawei): CSI-RS identification time is the CSI-RS measurement periodicity * Option 2a (Apple): If sufficient synchronization of severing cell and neighbor cell can be guaranteed, option 2 is OK * Option 2b (CMCC, ZTE, Nokia): Requirements for both Case 1 and Case 2 are specified. * Option 2c (Nokia): If associatedSSB is not configured, the UE shall base the timing on its serving cell. The requirement needs at least consider the CSI-RS measurement time.   **For Case 2: if associatedSSB is configured for CSI-RS,**  CSI-RS based cell identification can consider: 1) Cell search via SSB, 2) PBCH decoding 3) CSI-RS measurement, 4) others. AGC margin should be considered as well.  *Candidate options:*   * Option 1: OPPO, Apple, Ericsson, MediaTek * Option 2: Huawei   Need more discussion based on the updated options above from companies.  Issue 2-1-2: Specification structure of CSI-RS L3 intra-f/inter-f measurement requirement  *Tentative agreements:* Wait for the conclusion of NR\_CSIRS\_L3meas\_RRM\_Part\_1.  Discuss specification structure for intra-f/inter-f measurement based on the conclusion of definition if possible.   * Option 1(OPPO, DOCOMO): Intra-frequency measurement can all be configured without gaps if the definition of intra-frequency includes the bandwidth of the CSI-RS on the neighbour cell is within the active BWP of the UE. Otherwise, all others are inter-frequency measurement with gaps. * Option 2(MediaTek): RAN4 only specifies requirements for intra-freq wo gap and inter-freq w/ gap |

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|  | **Status summary** |
| **Sub-topic#2-2** | The measurement requirement in sub topic #2-2 is quite related to the definition of intra-frequency and inter-frequency measurement. It is hard to reach conclusion for Sub topic 2-2.  *Tentative agreements:*  Issue 2-2-2: Scaling factor for RX beam sweeping   * If CSI-RS is not QCL-ed to the associated SSB, UE needs to sweep the RX beam.   + FFS on the scaling factor N * If the CSI-RS is QCL-ed to the associated SSB, no Rx sweeping is needed only after SSB has been detected. Note SSB detection would still need beam sweeping. * FFS the case without associatedSSB configured.   Note that the tentative agreement is based on majority view from companies.  *Recommendations for 2nd round:*  More discussion on the remaining issues are needed, especially for issue 2-2-4 and 2-2-6.  Issue 2-2-1: CSSF   * Option 1(OPPO, Ericsson, Intel, MediaTek) * Option 2(CATT) * Option 3(Huawei)   Need more discussion based on the updated options above from companies.  Issue 2-2-3: Factors to consider for scheduling restriction   * Option 1(OPPO, MediaTeK) * Option 2 (CATT, Intel, CMCC, Huawei) * Option 3(ZTE)   Need more discussion based on the updated options above from companies.  Issue 2-2-4: Requirements for scheduling restriction  *Tentative Work Assumption*(OPPO, Qualcomm, Intel, MediaTeK, Huawei): the requirements for scheduling restriction are only discussed for CSI-RS based L3 measurement without gaps   * Option 1(Huawei) * Option 2(MediaTek) * Option 3(OPPO)   Need more discussion based on the updated options above from companies.  Issue 2-2-5: Whether to restrict CSI-RS resources outside of DRX/MG duration   * Option 1(CATT) * Option 2 (OPPO, Qualcomm, CATT, Intel, MediaTeK, Huawei) * Option 3 (CATT)   Need more discussion based on the updated options above from companies.  Issue 2-2-6: Others  Need more discussion based on the updated options above from companies. |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 | WF on measurement requirements for CSI-RS based intra-frequency and inter-frequency measurements | TBD |

### 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)

The discussion on the following issues should be continued. We can try the best to reach a consensus in 2nd round discussion by **Wednesday 5pm US Pacific time Mar. 4,** or defer the remaining issues to next meeting.

* RAN4 agree to discuss whether/how to define measurement requirements for Case 1 and Case 2.
  + Case 1: if associatedSSB is not configured
  + Case 2: if associatedSSB is configured for CSI-RS
* Specification structure of CSI-RS L3 requirement
* CSSF
* Scaling factor for RX beam sweeping
* Scheduling restriction
* Restrict for CSI-RS resources outside of DRX/MG duration
* Others

Therefore, from moderator’s perspective, we suggest to focus on the highlight bullets above in 2nd round. And other issues are kept as open issues for discussion in next meeting if time allowed. Your comment or recommendation are appreciated. **The agreement and remaining issues will be captured in the WF and deferred to next RAN4 meeting.**

**Issue 2-1-1: Components of CSI-RS based measurement requirements**

**Case1: if associatedSSB is not configured**

* The synchronization level between serving and target cell needs to be clarified.
* Candidate options:
  + Option 1(OPPO, Ericsson, MediaTek): No requirements specified for CSI-RS L3 measurement
  + Option 2(CATT, Huawei): CSI-RS identification time is the CSI-RS measurement periodicity
    - Option 2a (Apple, Huawei): If sufficient synchronization of severing cell and neighbor cell can be guaranteed, option 2 is OK
    - Option 2b(CMCC, ZTE, Nokia): Requirements for both Case 1 and Case 2 are specified.
    - Option 2c (Nokia): If associatedSSB is not configured, the UE shall base the timing on its serving cell. The requirement needs at least consider the CSI-RS measurement time.

**Case 2: if associatedSSB is configured for CSI-RS**

* CSI-RS based cell identification can consider:
  + 1) Cell search via SSB
  + 2) PBCH decoding
  + 3) CSI-RS measurement,
  + AGC margin should be considered as well.
* FFS the case if the MO includes the serving CSI-RS resource with associated SSB
* FFS the case if the MO doesn’t include the serving CSI-RS resource and the CSI-RS resource associated SSB is configured

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| --- | --- | --- |
| Issue 2-1-1 | **Case** | **Comments** |
| CMCC | *Case1* | The requirements for the case without *associatedSSB* need to be specified. And the requirements could be CSI-RS measurement delay |
| *Case2* |  |
| Nokia, Nokia Shanghai Bell |  | Both case 1 and case 2 shall be considered when defining the requirements. The UE behavior in respective *associatedSSB* configuration can be clarified in next meeting. |
| OPPO | *Case1* | Support option 1 and can compromise to option 2a. |
| *Case2* | From moderator’s perspective, we suggest to capture the comment understanding as agreement in WF.   * CSI-RS based cell identification can consider at least :   + 1) Cell search via SSB   + 2) PBCH decoding   + 3) CSI-RS measurement,   + AGC margin should be considered as well.   And leave the remaining issue FFS in next meeting. |
| Docomo | *Case1* | At least in the case of intra-frequency measurement, timing difference between the serving cell and the target cell can be guaranteed by current MRTD as some companies mentioned for the comments for 2nd round discussion in part 1. Thus, we don’t need requirements of synchronization level for intra-frequency measurement, on the other hand, the case of inter-frequency measurement needs further discussion. |
| Huawei, HiSilicon |  | Case 1: add Huawei’s name on option 2a. The synchronization condition shall be guaranteed. If sufficient synchronization of severing cell and neighbor cell can be guaranteed, option 2 is OK.  Case 2: we delete “at least ” since in some case no need to decode PBCH. |
| OPPO |  | For DOCOMO’ s comment, I mostly agree with you, at least the synchronization level should be clarified for Case 1 without associated SSB. So I would like to suggest in draft WF: FFS whether to introduce requirements of synchronization level for intra-frequency and inter-frequency measurement(for Case 1).  For Huawei’s comment, we are ok with your recommendation. And draft WF would be updated correspondingly. |
| MTK | *Case1* | No requirement. As we explained several times. CSI-RS was not designed for detection. UE anyway needs to use SSB for cell detection to know whether a certain cell is its neighboring cell before measurement. Configuring CSI-RS without associated SSB is just a waste of UE power. |
| *Case2* | MO should always include serving cell CSI-RS.  If *deriveSSB\_IndexFromCell* is provided, UE may skip PBCH reading, if the associated SSB is already identified by UE. In this case, Case 2 actually has the same delay requirement as Case 1. |

**Issue 2-2-1:CSSF**

* Tentative Agreement:
* RAN4 to re-use the existing requirement of CSSF as much as possible, and the framework of CSSF can be shared by SSB and CSI-RS based L3 measurement.

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| Issue 2-2-1 | **Comments** |
| OPPO | From moderator’s perspective, I suggest to capture it as agreement in WF. |
| Huawei | Agree with the tentative agreement |
| MTK | This principle is agreeable. RAN4 has no time to build a new one. |

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

* Tentative Agreement:
* If CSI-RS is not QCL-ed to the associated SSB, UE needs to sweep the RX beam.
  + FFS on the scaling factor N
* If the CSI-RS is QCL-ed to the associated SSB, no Rx sweeping is needed only after SSB has been detected.
  + Note SSB detection would still need beam sweeping.
* FFS the case without associatedSSB configured.

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| Issue 2-2-2 | **Comments** |
| OPPO | From moderator’s perspective, I suggest to capture it as agreement in WF. |
| MTK | OK with OPPO’s suggestion. |

**Issue 2-2-3: Scheduling restriction**

* Tentative Agreement:
* Work Assumption：
  + the requirements for scheduling restriction are only defined for CSI-RS L3 measurement without gaps
* Identify all possible factors which would cause scheduling restriction
  + 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

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| Issue 2-2-3 | **Comments** |
| OPPO | From moderator’s perspective, I suggest to capture it as agreement in WF. |
| MTK | OK with OPPO’s suggestion. |

**Issue 2-2-5: Whether to restrict CSI-RS resources outside of DRX/MG duration**

* Tentative Agreement:
* No UE performance requirement is defined for the CSI-RS resources that are not within DRX on-duration or measurement gap

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| Issue 2-2-5 | **Comments** |
| CMCC | Need further discussion |
| OPPO | From moderator’s perspective, if no consensus, we suggest to capture all options in WF and further decide it in next meeting.   * Option 1(CATT): UE is allowed not to measure the CSI-RS resources that are not within DRX on-duration or measurement gap; * Option 2 (OPPO, Qualcomm, CATT, Intel, MediaTeK, Huawei): No UE performance requirement is defined for the CSI-RS resources that are not within DRX on-duration or measurement gap; * Option 3(CATT): the network needs to make sure the configured CSI-RS resources falls within the configured measurement gaps |

## 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”* |