**3GPP TSG RAN WG1 #119 R1-240xxxx**

**Orlando, USA, November 18th – 22nd, 2024**

**Source: Moderator (Fujitsu)**

**Title: FL summary 1 of Measurements related enhancements for LTM**

**Agenda Item: 9.9.1**

**Document for: Information**

# Introduction

This contribution is a Feature Lead (FL) summary for A.I. 9.9.1: Measurements related enhancements for LTM

# Plan for Online discussion

##### [Proposals for Monday Online]

[[FL proposal 5.1-v2]](#_[FL_proposal_5.1-v2]) CSI acquisition framework

[[FL Proposal 3-4-v2]](#_[FL_Proposal_3-4-v2]) RS of serving cell for event evaluation

[[FL Proposal 4-1-v2]](#_[FL_Proposal_4-1-v2]) Beam management based on CSI-RS for BM

##### [Proposals for Wednesday Online]

##### [Proposals for Thursday offline]

# Contact people

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# List of Contributions

|  |  |  |
| --- | --- | --- |
| [**R1-2409381**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_119/Docs/R1-2409381.zip) | Discussion on measurements related enhancements for LTM | ZTE Corporation, Sanechips |
| [**R1-2409422**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_119/Docs/R1-2409422.zip) | Measurements related enhancements for LTM | Huawei, HiSilicon |
| [**R1-2409492**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_119/Docs/R1-2409492.zip) | Discussion on measurements related enhancements for LTM | LG Electronics |
| [**R1-2409525**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_119/Docs/R1-2409525.zip) | Discussion on measurements related enhancements for LTM | CMCC |
| [**R1-2409612**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_119/Docs/R1-2409612.zip) | Views on Rel-19 measurement related enhancements for LTM | Samsung |
| [**R1-2409648**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_119/Docs/R1-2409648.zip) | Discussion on measurements related enhancements for LTM | Spreadtrum, UNISOC |
| [**R1-2409696**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_119/Docs/R1-2409696.zip) | Discussion on measurements related enhancements for LTM | vivo |
| [**R1-2409771**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_119/Docs/R1-2409771.zip) | Measurement related enhancements for LTM | Nokia |
| [**R1-2409820**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_119/Docs/R1-2409820.zip) | Measurement related enhancements for LTM | Apple |
| [**R1-2409909**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_119/Docs/R1-2409909.zip) | Discussion on measurements related enhancements for LTM | Xiaomi |
| [**R1-2409956**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_119/Docs/R1-2409956.zip) | Discussion on measurements related enhancements for LTM | CATT |
| [**R1-2409973**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_119/Docs/R1-2409973.zip) | Measurements related enhancements for LTM | Lenovo |
| [**R1-2409975**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_119/Docs/R1-2409975.zip) | Measurement related enhancements for LTM | Ericsson |
| [**R1-2409991**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_119/Docs/R1-2409991.zip) | Discussion on measurement related enhancements for LTM | Lekha Wireless Solutions |
| [**R1-2410017**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_119/Docs/R1-2410017.zip) | Measurements related enhancements for LTM | InterDigital, Inc. |
| [**R1-2410041**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_119/Docs/R1-2410041.zip) | Measurements enhancements for LTM | TCL |
| [**R1-2410115**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_119/Docs/R1-2410115.zip) | Discussions on measurement enhancement for LTM | OPPO |
| [**R1-2410124**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_119/Docs/R1-2410124.zip) | Discussion on measurement related enhancements for LTM | Fujitsu Limited |
| [**R1-2410168**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_119/Docs/R1-2410168.zip) | Discussion on measurements related enhancements for LTM | Google |
| [**R1-2410212**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_119/Docs/R1-2410212.zip) | Discussion on measurements related enhancements for LTM | NEC |
| [**R1-2410238**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_119/Docs/R1-2410238.zip) | Measurements related enhancements for LTM | Sony |
| [**R1-2410244**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_119/Docs/R1-2410244.zip) | LTM measurements related enhancements | MediaTek Inc. |
| [**R1-2410276**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_119/Docs/R1-2410276.zip) | Measurements related enhancements for LTM | ETRI |
| [**R1-2410348**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_119/Docs/R1-2410348.zip) | Measurement Enhancements for LTM | Meta |
| [**R1-2410403**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_119/Docs/R1-2410403.zip) | Discussion on measurement related enhancements for LTM | NTT DOCOMO, INC. |
| [**R1-2410432**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_119/Docs/R1-2410432.zip) | Discussion on measurements related enhancements for LTM | KDDI Corporation |
| [**R1-2410493**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_119/Docs/R1-2410493.zip) | Measurements related enhancement for LTM | Qualcomm Incorporated |
| [**R1-2410543**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_119/Docs/R1-2410543.zip) | Discussion on measurements related enhancements for LTM | Sharp |

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| R1-2410186 | FL summary 1 of Measurements related enhancements for LTM | Moderator (Fujitsu) |
| R1-2410187 | FL summary 2 of Measurements related enhancements for LTM | Moderator (Fujitsu) |
| R1-2410188 | FL summary 3 of Measurements related enhancements for LTM | Moderator (Fujitsu) |
| R1-2410189 | Final FL summary of Measurements related enhancements for LTM | Moderator (Fujitsu) |

# Discussion

## L1 measurement based on CSI-RS

### [No issue] Measurement quantity

##### [Agreements in previous meetings]

**Agreement (RAN1#118)**

* Support L1-RSRP measurement based on CSI-RS
* FFS: Support L1-SINR measurement based on CSI-RS

**Conclusion (RAN1#118bis)**

There is no consensus in RAN1 on the support L1-SINR measurement based on CSI-RS for candidate cells

##### [Conclusion]

No issues are identified in this meeting.

### [No issue] Support of intra- and inter frequency measurement

##### [Agreements in previous meetings]

**Agreement(RAN1#118bis)**

From RAN1 perspective, there is no restriction with regards to the frequency location of CSI-RS used for L1-measurement

##### [Conclusion]

No issues are identified in this meeting.

### [Mid] Time domain property of CSI-RS for measurement

##### [Agreements in previous meetings]

**Agreement(RAN1#118)**

For gNB scheduled reporting and event triggered reporting

* At least periodic CSI-RS is supported for L1-RSRP measurement for candidate cell
  + FFS: aperiodic and semi-persistent CSI-RS
* At least CSI-RS for beam management is supported for L1-RSRP measurement for candidate cell
  + FFS: CSI-RS for mobility

Working Assumption(RAN1#118bis)

In addition to periodic CSI-RS, semi-persistent CSI-RS is supported for candidate cell L1-RSRP measurement for gNB scheduled reporting from RAN1 perspective

* Send an LS to RAN3 (CC RAN2) to ask for the feasibility of specifying the signalling for coordination between serving cell and candidate cell(s) on the transmission of semi-persistent CSI-RS(s) and any other potential issues (e.g. RAN3 workload).

Support of semi-persistent CSI-RS is subject to UE capability.

Final LS in R1-2409283.

##### [Summary of contributions]

**Support of semi-persistent and aperiodic CSI-RS transmission for event triggered reporting**

* Yes(2): Nokia(SP), CATT(SP, A)
  + The goal is to reduce reporting overhead, there should be no difference in terms of the type of RS used for measurements in two reporting methods.
  + supporting SP/AP CSI-RS provides more flexibility for LTM
* No/low priority(3): Samsung, Spreadtrum, MediaTek(A)
  + RAN1 also needs to identify and assess necessary enhancements needed to support aperiodic and semi-persistent CSI-RS for L1-RSRP measurement(s) on candidate cell(s).

**Support of Aperiodic CSI-RS transmission for gNB scheduled reporting**

* Yes (5): ZTE, Huawei, CATT, Google, Lenovo
  + Fast measurement for candidate cell with less overhead
  + To avoid some unnecessary measurement and save energy consumption at UE side
  + For the network side, the same approach as semi-persistent can be used (on-off of CSI-RS transmission)
  + Send LS to RAN3 asking for feasibility of coordination between serving cell and candidate cells in inter-DU and inter-CU scenarios, similar to SP
  + Quick measurement on candidate cells
* No/low priority (4): Samsung, Spreadtrum, Fujitsu, MediaTek
  + RAN1 needs to first identify and assess necessary enhancements needed to support aperiodic CSI-RS for L1-RSRP measurement(s) on candidate cell(s)
  + Multiple report is required. Periodic and semi-persistent CSI-RS resource are sufficient.

**Mechanism to trigger aperiodic CSI-RS transmission**

* ZTE
  + Whether the existing MAC CE for semi-persistent CSI-RS Resource Set Activation/Deactivation can be extended to candidate cell if SP CSI-RS is supported in Rel-19 LTM.
  + Aperiodic may require more frequent coordination between serving cell and candidate cells
* Ericsson
  + If semi-persistent CSI-RS is agreed to be supported for LTM, keep legacy principles for SP CSI-RS: the LTM-CSI-ResourceConfiguration should indicate the resourceType semi-persistent, the network indicates when transmission is turned ON/OFF with a MAC CE, reporting is a separate configuration.
* *FL view: we can go step by step – the necessary discussion can be started after the WA is confirmed (i.e. obtaining reply from RAN3)*

##### [FL Observation]

FL thinks the following aspects need to be considered to solve the remaining issues:

* **Aspect 1: Confirmation of WA: can be done after reception of reply LS from RAN3.** 
  + Discussion on the detailed mechanism of activation/deactivation can be performed after that.
* **Aspect 2: Resolution of the support of semi-persistent CSI-RS transmission for event triggered reporting: can be handled in this meeting.**
  + FL thinks it depends on the presence of activation/deactivation mechanism of event triggered reporting
    - If the LTM events and evaluation are always active after RRC configuration, the UE expects that CSI-RS is always transmitted by periodic resource. There would be no chance for candidate cells to turn off the CSI-RS transmission.
    - If the LTM events and evaluation can be activated/deactivated, use of semi-persistent CSI-RS resource is more relevant.
  + If FL understanding is correct, the best way forward is to ask RAN2 the presence of activation/deactivation mechanism of evaluation for LTM events. If their answer is yes, FL thinks the same approach as gNB scheduled report can be taken.
  + Another approach is just to rely on periodic CSI-RS to simplify the specification.
* **Aspect 3:** Aperiodic CSI-RS (for both event triggered reporting and gNB scheduled reporting) is further discussed taking into account the following aspects:
  + Additional spec impact to RAN3 on top of SP, i.e. the same mechanism as SP can be used or, a new mechanism is needed
  + Whether aperiodic CSI-RS resource is needed for CSI acquisition
  + Especially for event triggered reporting, the technical feasibility needs further assessment as the UE autonomously perform the event evaluation once the LTM event is configured/activated without gNB awareness.

##### [FL Proposal 1-3-v1]

Companies are encouraged to provide their view on the following FL suggestion

* For the support of semi-persistent CSI-RS transmission for event triggered reporting,
  + Approach 1:
    - The necessity depends on the presence of activation/deactivation mechanism of event triggered reporting
      * If the LTM events and evaluation are always active after RRC configuration, the UE expects that CSI-RS is always transmitted by periodic resource. There would be no chance for candidate cells to turn off the CSI-RS transmission
      * If the LTM events and evaluation can be activated/deactivated by e.g. MAC CE, use of semi-persistent CSI-RS resource is more relevant
    - RAN1 to ask RAN2 the presence of activation/deactivation mechanism of evaluation for LTM events. If their answer is yes, the same approach as gNB scheduled report can be taken, i.e. set working assumption
  + Approach 2:
    - semi-persistent CSI-RS is not considered for event triggered reporting

##### [Comments to FL Proposal 1-3-v1]

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| Company | Comment | FL reply | |
| Fujitsu | We slightly support Approach 2 since the gNB does not know when the SP CSI-RS should be activated. It seems that the periodic CSI-RS is sufficient for the event triggered reporting. |  | |
| Ericsson | We prefer approach 2. One of the main motivations for event-driven reporting is that the UE takes care of the measurements. If the NW has to control what measurements are performed, parts of the benefits are lost. |  | |
| Google | Approach 1 is fine to us. We agree with FL that there is no chance for candidate cells to turn off the CSI-RS transmission, if we only support periodic CSI-RS, which reduces spectrum usage efficiency/flexibility.  One suggestion is to clarify in the main bullet that the support of SP CSI-RS is for L1-RSRP measurement for candidate cell. |  | |
| Nokia | We support the use of SP CSI-RSs for both types of reporting. As agreed in the last meeting, SP CSI-RSs offer benefits, in terms of enabling the selection of appropriate CSI-RSs for measurements with reduced energy consumption on both the network and UE sides. These advantages should also extend to event-triggered reporting. Restricting certain features could otherwise limit the utility of event-triggered reporting.  Therefore, we suggest to first agree on supporting SP CSI-RSs for event-triggered reporting in RAN1 and then sending an LS to RAN2 reflecting this decision |  | |
| ZTE | **SP CSI-RS transmission**  For gNB scheduling reporting, at least SP CSI-RS should be supported and have an agreement for intra-DU case. As for inter-DU/CU, we can wait for the progress of discussion from RAN3.  For event triggered reporting, we tend to support approach 2 since it will make UE triggered reporting method rely on the control of whether SP CSI-RS transmission is triggered by gNB, which greatly affects the benefits brought by UE triggered reporting.  **AP CSI-RS transmission**  For gNB scheduling reporting, it is similar as SP CSI-RS. At least AP CSI-RS for intra-DU should be supported first and then whether to support it for inter-DU/CU can reuse similar way for SP CSI-RS.  For event triggered reporting, the same reason as SP CSI-RS mentioned above. |  | |
| NTT DOCOMO | We think that this depends on whether all configured RS resource sets should be evaluated after RRC configuration, or part of configured resource sets activated by NW should be evaluated. |  | |
| Qualcomm | In the MIMO Ph5 WI, the support for semi-persistent/aperiodic CSI-RS resources for UE-initiated beam management remains an open issue, despite discussions in several past meetings. To maintain design commonality, we could take **approach 2** for now, unless any further progress is made in the MIMO WI. |  | |
| Spreadtrum | For the aspects of time domain behavior of CSI-RS, in order to reduce spec effort, especially the coordination between serving cell and candidate cell(s), a unified CSI-RS design for gNB scheduled reporting or event triggered LTM reporting should be considered. For SP-CSI-RS, considering that the working assumption was made and an LS was sent to RAN3 for gNB scheduled reporting, the discussion on SP-CSI-RS can be postponed until the reply from RAN3 is received. |  | |
| Lenovo | We prefer approach 2 at this stage. The benefit of supporting SP CSI-RS for event triggered reporting is not clear and the NW don’t how when to activate or deactivate the SP CSI-RS for certain event. |  | |
| Xiaomi | For SP CSI-RS, we prefer Approach 1. For example. Only when the report of Event LTM2: Beam of serving cell becomes worse than absolute threshold is received, gNB can activate the SP CSI-RS for candidate cell of Event LTM3, LTM 4 and LTM 5. |  | |
| Samsung | We prefer approach 2, i.e., not considering semi-persistent CSI-RS for event triggered LTM reporting. We also do not think AP CSI-RS triggering is needed. Similar issue was discussed in MIMO UEIBM and has no conclusion due to lack of benefits of having AP/SP CSI-RS in the context of event-triggered/UE-initiated reporting, and increased complexity. |  | |
| vivo | We prefer Approach 2. As mentioned by FL, if semi-persistent CSI-RS resource is supported, corresponding event evaluation and reporting procedure should be activated/deactivated based on the state of the CSI-RS resource. Thus, additional specification efforts will be introduced. Besides, in our view, periodic CSI-RS resource is sufficient for UE to measure and evaluate. Therefore, semi-persistent CSI-RS resource is not needed for event-triggered reporting. |  | |
| CMCC | Support Approach 2. Support of semi-persistent event-triggered LTM is not needed. |  | |
| CATT | In our view, while the UE expects that CSI-RS is already transmitted periodically when it receives RRC configuration of the LTM events and evaluation, it does not necessarily mean the CSI-RS has to be periodic, and the necessity of MAC activation/deactivation, e.g., by the following sequence:   * start the transmission of SP CSI-RS of candidate cells; * UE RRC configuration of LTM events and evaluation * Release UE RRC configuration of LTM events and evaluation if necesary * stop the transmission of SP CSI-RS of candidate cells.   Thus, for OP1, we suggest the following change:   * The necessity depends on the presence of ~~activation/deactivation~~ start/stop mechanism of event triggered reporting   Another reason for supporting SP CSI-RS transmission for event triggered reporting is that the measurement RS for serving cell has been decided to be derived from QCL RS(s) or SSB QCLed with the QCL RS of the indicated joint/DL TCI state, the QCL RS of the indicated joint/DL TCI state can be a SP/AP CSI-RS. |  |
| InterDigital | Fine with approach 2 for now. |  | |
| ETRI | We support Approach 2. In the case of event triggered reporting, the UE determines whether an event has occurred. If SP CSI-RS transmission is supported, the interruption or resumption of CSI-RS transmission by the gNB could affect the event measurement.  For example, if the gNB decides to stop the transmission while the UE is calculating the CSI-RS during the TTT period to evaluate an event, the evaluation process could be reset even if the event is about to occur.  Therefore, for event triggered reporting, where the gNB lacks awareness of the UE’s evaluation status, excluding SP CSI-RS transmission appears to be the more appropriate approach. |  | |
| ITRI | We prefer approach 2. The benefit of supporting SP CSI-RS for event triggered reporting is not clear. |  | |
| Huawei, HiSilicon | We support approach 1. It can also be discussed after receiving response from RAN3. |  | |
| LG | We support Alt 2. As other companies mentioned, there is no clear method how UE knows whether candidate cell activated SP CSI-RS or not. We agree with the benefit of SP CSI-RS but because of above reason, we don’t support the Alt 1. |  | |
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### [Low] Type of CSI-RS for L1 measurement

##### [Agreements in previous meetings]

***Agreement***

For gNB scheduled reporting and event triggered reporting

* At least periodic CSI-RS is supported for L1-RSRP measurement for candidate cell
  + FFS: aperiodic and semi-persistent CSI-RS
* At least CSI-RS for beam management is supported for L1-RSRP measurement for candidate cell
  + FFS: CSI-RS for mobility

##### [Summary of contributions]

**Support of CSI-RS for mobility for L1 measurement**

* Yes(3): Samsung, Spreadtrum, CATT
  + The CSI-RS for mobility resources have similar functionality as that of CSI-RS for BM. If CSI-RS for mobility resources are configured for a UE, it is beneficial to reuse them also for L1-RSRP measurement.
  + To share the resource for L1 (BM) and L3(Mobility)
  + The shared CSI-RS for mobility can be used for different measurement requirements for L1 and L3 to increase the resource efficiency
    - FL note: RAN1 spec impact needs to be clarified? Or just a configuration issue?
* No(9): Huawei, Nokia, Ericsson, Fujitsu, MediaTek, Meta, DOCOMO, Qualcomm, vivo
  + CSI-RS-ResourceConfigMobility is less flexible than NZP-CSI-RS-ResourceSet
  + RAN4 agreed to optionally support using SSB based L3 measurement results for L1 measurement reporting. Whether to support using CSI-RS based L3 measurement results for L1 measurement report is up to RAN4
  + measurement requirements for L1 reporting and L3 reporting are different
  + The CSI-RS for mobility configuration introduces restrictions on parameters that are not needed and it is more complex.
  + This makes the association between measurement resources and candidate cells indirect and complicated.
  + The only difference between these types of CSI-RS is how they are configured to the UE: the actual transmission is the same. To be precise, CSI-RS for beam management is a CSI-RS resource set with repetition off. The CSI-RS resources (NZP-CSI-RS-Resource) in the set are all single-port or dual-port
  + From a physical resource perspective, the same CSI-RS resource can be configured as both L3 and L1 measurement resources by the network. This means that there is no extra overhead to accommodate both legacy L3 measurement and Rel-19 LTM L1 measurement UEs within the same network.
  + The measurement requirements for L1 reporting and L3 reporting are different.

##### [FL Observation]

FL’s understanding of “CSI-RS for mobility is supported for L1 measurement” is that existing CSI-RS resources configured by *CSI-RS-ResourceConfigMobility* can be used for L1-RSRP measurement. RAN4 impact is expected. Potential impact in RAN1 is to associate *CSI-RS-ResourceConfigMobility* and *LTM-CSI-ReportConfig*. From the actual transmission viewpoint, CSI-RS for mobility and BM can be the same and RAN1 and RAN4 spec impact can be avoided by network configuration.

Similar to the situation at RAN1#118bis, clear majority doesn’t see the necessity to introduce CSI-RS for mobility for L1 measurement. The benefit proposed by the proponents is to reuse the existing CSI-RS for L3 mobility. However, opponents point out the less flexibility of *CSI-RS-ResourceConfigMobility* as well as the difference of measurement methodology from UE perspective.

Given the situation above, FL suggests not to support CSI-RS for mobility for L1 measurement in Rel-19.

##### [FL Proposal 1-4-v1]

Conclusion

* No consensus to support CSI-RS for mobility for L1 measurement in Rel-19

*FL note: to save our online time at RAN1#119, FL will bring this proposal only when clear majority supports this proposal*

##### [Comments to FL Proposal 1-4-v1]

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| Company | Comment | FL reply | | |
| Fujitsu | We support FL proposal. We don’t have to introduce the CSI-RS for mobility whose configuration/requirement is different from CSI-RS for BM. |  | | |
| Ericsson | Support. We do not see the need to introduce CSI-RS for mobility – the configuration is anyway a subset of the configuration for CSI-RS |  | | |
| Google | Support |  | | |
| Nokia | Support |  | | |
| ZTE | Support |  | | |
| NTT DOCOMO | We support FL proposal. |  | | |
| Qualcomm | Support |  | | |
| NEC | Support |  | | |
| Samsung | Not support. We think it is natural to extend the support of CSI-RS for mobility to LTM as necessary configuration of the CSI-RS for mobility is already in place. |  | | |
| vivo | Support |  | | |
| CMCC | Not support. From the network’s perspective, we may configure CSI-RS for LTM and CSI-RS for mobility with the same resource to reduce the resource overhead and reduce UE measurement complexity as well. |  | | |
| CATT | Not support.  As FL stated: *“CSI-RS for mobility is supported for L1 measurement” is that existing CSI-RS resources configured by CSI-RS-ResourceConfigMobility can be used for L1-RSRP measurement” and “*Potential impact in RAN1 is to associate *CSI-RS-ResourceConfigMobility* and *LTM-CSI-ReportConfig.”* Our intention is not for the NW to configure *CSI-RS for mobility* ***specifically***for LTM. If *CSI-RS for mobility* ***is* *already configured****,* it can be usedfor LTM. |  | |
| ETRI | Support |  | | |
| ITRI | Suuport. |  | | |
| Huawei, HiSilicon | support | |  | |
| LG | Support |  | | |
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### [Low] QCL source of CSI-RS for candidate cells

##### [Agreement of previous meetings]

No discussions

##### [Summary of contributions]

**Measurement timing requirement**

* Samsung
  + To support CSI-RS measurements for LTM procedures, support UE to measure the CSI-RS based on the timing of the associated candidate cell if the associated SSB in the candidate cell is provided for the CSI-RS.
* CATT
  + In Rel-19 LTM, CSI-RS for L1-RSRP measurement of a candidate cell should be associated with SSB of the corresponding candidate cell for obtaining the timing of cell.
* Lenovo
  + If the QCLed SSB for a CSI-RS from a candidate cell is not detected by the UE, the UE shall not measure the CSI-RS.
  + Study the DL synchronization procedure for CSI-RS reception from candidate cells before cell switch command.
* TCL
  + Support CSI-RS based L1 measurements aligned with the timing of the candidate cell(s).

##### [FL observations]

Four companies discuss the details of CSI-RS measurement timing based on the associated SSB. FL understanding is that there would be no impact on RAN1 specification, i.e. the timing requirement is reflected in the RAN4 specifications.

##### [FL proposal 1-5-v1]

* *Companies are encouraged to provide their views on the following aspect:*
  + *Regarding timing of CSI-RS detection for L1 measurement,* 
    - *Approach 1: RAN1 will further study the RAN1 spec impact, i.e. define the timing based on the QCL SSB*
    - *Approach 2: No RAN1 discussion, i.e. necessary discussion is performed in RAN4*

*FL note: this question is not intended for online agreement, but to gather companies view.*

##### [Comments to FL Proposal 1-5-v1]

|  |  |  |  |
| --- | --- | --- | --- |
| Company | Comment | FL reply | |
| Fujitsu | We support Approach 2. In our understanding, the preliminary of the CSI-RS reception is to align the DL synchronization on the corresponding candidate cell. Hence, we think no RAN1 discussion is needed. |  | |
| Ericsson | Prefer approach 2. We note that already in Rel-18, the UE can find the TRS using the SSB info. The same procedure would apply for CSI-RS measurements. |  | |
| Goggle | Share similar views as Ericsson. |  | |
| Nokia | We also prefer approach 2. |  | |
| ZTE | We slightly prefer approach 2. |  | |
| NTT DOCOMO | We prefer Approach 2. |  | |
| Qualcomm | Support approach 2. |  | |
| Spreadtrum | Support approach 2 |  | |
| NEC | Agree with FL’s understanding, i.e., no spec impact on RAN1 specification. |  | |
| Samsung | We prefer approach 1. We think the timing assumption needs to be discussed and clarified in RAN1. |  | |
| vivo | We prefer Approach 2. |  | |
| CMCC | Support Approach 1. SSB can be configured to obtain the timing for CSI-RS for mobility. Similarly, SSB from candidate cell can be configured for CSI-RS to obtain the timing. |  | |
| CATT | Support Approach 1. From RAN1’s perspective, there is a need to ensure “CSI-RS for L1-RSRP measurement of a candidate cell be associated with SSB of the corresponding candidate cell” in order to obtaining the timing of cell. |  |
| ETRI | We support Approach 2. |  | |
| ITRI | We prefer approach 2. |  | |
| Huawei, HiSilicon | Although there may not be RAN1 impact, we think clarification from RAN1 may help other WG to make the changes |  | |
| LG | Support approach 2. |  | |

### [Low] High level design of CSI-RS configuration

##### [Agreements in previous meetings]

Agreement

* Explicit configuration of CSI-RS resource(s) for candidate cell(s) for L1-measurement is supported

RAN2#127b made the following agreements

**Agreements on L1 event triggered MR**

1. For measurement resource configuration, R18 LTM CSI resource configuration is reused if possible. If CSI-RS resource only IE needs to be defined, we can revisit it in the stage 3.
2. For measurement reporting configuration, R18 LTM-CSI-ReportConfig is reused if possible. We can revisit it in the stage 3 if needed.
3. For association between measurement resource configuration and measurement reporting configuration, R18 LTM way is reused if possible. We can revisit it in the stage 3 if needed.

##### [Summary of contributions]

Necessary parameters for CSI-RS configuration

* ZTE
  + The CSI-RS related parameters (e.g., port, density, periodicity, bandwidth, absoluteFrequencyPointA, etc) in legacy CSI framework should be directly reused for CSI-RS measurement of candidate cell in Rel-19 LTM
* CMCC
  + To support CSI-RS measurement for LTM on any frequency location, additional information needs to be introduced in the candidate cell measurement configuration, such as Point A configuration and SCS.
    - The point A and SCS configuration for CSI-RS for LTM can be configured at least cell level under LTM-Candidate.
  + Support LTM-Candidate to configure CSI-RS from non-serving cell for each physical cell:
    - Multiple CSI-RS resources are directly configured to each candidate cell.
    - LTM-CSI-ResourceConfig provides a relationship between CSI-RS index and candidate cell ID.
    - LTM CSI reporting framework is reused to configure CSI-RS from non-serving cell as measurement RS for LTM beam reporting.
* Samsung
  + To support CSI-RS measurements for LTM procedures, specify procedure(s) for associating between the measurement CSI-RS resources and candidate cells.
    - Alt1 (implicit association): association between the configured CSI-RS resource(s) and the candidate cell(s) can be based on association between the SSBs (QCL’ed with the configured CSI-RS resource(s)) and the candidate cells
    - Alt2 (explicit association): each of the configured CSI-RS resource(s) is associated to an entry (a candidate cell ID) in the ltm-CandidateIdList – detailed signalling design is up to RAN2
  + Spreadtrum
    - Support CSI-RS configuration similar to SSB, i.e. CSI-RS resource set including CSI-RS resource list is configured under Rel-19 LTM CSI resource configuration.
    - The corresponding relationship between the candidate cell and the CSI-RS resource can be determined based on the correspondence between the candidate cell and root SSB for the CSI-RS resource or root SSB for QCL source RS of the CSI-RS resource.
* Nokia
  + For CSI-RS based L1 measurements in Rel-19 LTM, the NZP-CSI-RS-ResourceSet and NZP-CSI-RS-Resource within LTM-TCI-Info-r18 for each candidate cell is used to provide CSI-RS configurations for L1 measurements of candidate cells with at least the following updates:
    - repetition field is configured
  + For CSI-RS based L1 measurements in Rel-19 LTM, Rel-18 framework for configuring a list of SS/PBCH blocks along with their respective candidate cells IDs within an LTM-CSI-ResourceConfig for an LTM report configuration is extended to include a list of NZP-CSI-RSs along with their respective candidate cells IDs.
* Apple
  + Only support resource(s) with a same RS type (i.e., either CSI-RS or SSB) to be configured in a resource set for candidate cell(s).
* CATT
  + All the parameters of CSI-RS for BM in legacy CSI framework, including ’repetition’, can be directly reused for CSI-RS based measurement for LTM.
* Ericsson
  + If semi-persistent CSI-RS is agreed to be supported for LTM, keep legacy principles for SP CSI-RS: the LTM-CSI-ResourceConfiguration should indicate the resourceType semi-persistent,
* DOCOMO
  + For RRC parameter for CSI-RS resource configuration for candidate cell, legacy RRC parameter should be a starting point.
* Qualcomm
  + Legacy CSI-RS resource and resource set configuration parameters can be reused for CSI-RS-based LTM L1 measurement:
    - subcarrierSpacing-r18, absoluteFrequencyPointA-r18, and cyclicPrefix-r18 in NZP-CSI-RS-Resource IE.
    - repetition and resourceType-r18 in NZP-CSI-RS-ResourceSet IE.

RRC structure: where are the necessary IEs defined?

* ZTE
  + The existing SSB configuration framework should be reused for CSI-RS configuration including the following.
    - CSI-RS resource configuration
      * A list of NZP CSI-RS resources (e.g., provided by ltm-NZP-CSI-RS-ResourceToAddModList-r19) and a list of NZP CSI-RS resource sets (e.g., provided by ltm-NZP-CSI-RS-ResourceSetToAddModList-r19) are configured per candidate cell (provided by LTM-Candidate-r18).
    - CSI-RS measurement resource configuration
      * One NZP CSI-RS resource set (e.g., provided by ltm-nzp-CSI-RS-ResourceList-r19) is configured across candidate cells (provided by LTM-CSI-ResourceConfig-r18 in LTM-Config-r18), where each NZP CSI-RS resource from the ltm-NZP-CSI-RS-ResourceList-r19 is associated with a candidate cell index from ltm-CandidateIdList-r18.
* Huawei
  + For CSI-RS based L1 measurement for Rel-19 LTM, the configuration of CSI-RS Resource and CSI-RS Resource Set can be configured under candidate cell’s RRC configuration.
* Vivo
  + To obtain CSI-RS-based measurement results on multiple candidate cells, similar to LTM-CSI-SSB-ResourceSet in LTM-CSI-ResourceConfig, corresponding NZP-CSI-RS resource set includes NZP-CSI-RS resources from different candidate cells, regardless of gNB scheduled reporting and event-triggered reporting.
* Nokia
  + For CSI-RS based L1 measurements in Rel-19 LTM, the NZP-CSI-RS-ResourceSet and NZP-CSI-RS-Resource within LTM-TCI-Info-r18 for each candidate cell is used to provide CSI-RS configurations for L1 measurements of candidate cells with at least the following updates:
    - ltm-NZP-CSI-RS-ResourceToAddModList-r18 and ltm-NZP-CSI-RS-ResourceSetToAddModList-r18 can be placed outside of the LTM-TCI-Info
* Apple
  + The measurement resource for candidate cells are explicitly configured by RRC signal outside of candidate cell’s RRC configuration (Same as in Rel-18 LTM)
* CATT
  + The RRC structure of configuring TRS as QCL source for SSB based L1-RSRP measurement in Rel-18 LTM can be reused for the configuration of CSI-RS based L1-RSRP measurement in Rel-19 LTM.
* Ericsson
  + Candidate cell CSI-RS resources and resource sets for beam management can be configured per LTM Candidate in LTM-TCI-Info
  + Specify the CSI-RS for LTM measurements in the LTM-CSI-ResourceConfig.
* TCL
  + The CSI-RSs configuration for LTM procedures can utilize IE ‘LTM-CSI-ResourceConfig’
* Google
  + On configuring LTM CSI-RS for beam measurement/report, at least support the following option
    - Option 1: NW can configure an LTM NZP CSI-RS resource set including CSI-RS(s) across configured LTM candidate cell(s);
      * CSI-RS(s) and SSB(s) are configured in different LTM CSI resource set(s)
* Qualcomm
  + For CSI-RS-based LTM L1 measurement, both event-triggered and gNB-scheduled reporting should use the Rel-18 LTM CSI Resource Setting as the baseline.

**Necessity of configuration restriction and how it can be provided**

* Huawei
  + An LTM CSI report configuration can be associated with multiple CSI-RS resource sets from multiple candidate cells.
    - the function of CSI-RS (e.g. “*repetition*” configured for BM, “*trs-Info*” configured for TRS) is configured per CSI-RS resource set rather than per CSI-RS resource*.* And the offset between DCI triggering aperiodic CSI-RS resources and CSI-RS resources transmission is also configured for CSI-RS resource set.
    - the CSI-RS resources in a CSI-RS resource set should have the same periodicity, the same starting RB and number of RBs, the same *density*, *nrofPorts*, and *cdm-type*
* LG
  + multiple NZP CSI-RS of multiple candidate cells are configured within a resource set.
* CATT
  + CSI-RS resource set for LTM should include NZP CSI-RS resource(s) of one or multiple candidate cells.
* Lenovo
  + The CSI-RS resources from different candidate cells but associated with a same LTM-CSI-ReportConfig should be configured with a same bandwidth.
* TCL
  + The CSI-RS resources for L1-RSRP measurement for serving cell and candidate cell(s) should meet certain time domain restrictions.
* DOCOMO
  + For CSI-RS resource configuration associated with same/different candidate cell, support at least following restrictions.
    - Same port number
    - Same density
    - Repetition configuration for a set should be set as “OFF”.
* Qualcomm
  + Further study is needed on the conditions and requirements for CSI-RS resources to ensure fairness across different cells for LTM event evaluation:
    - Periodicity, bandwidth, frequency domain density, etc.
    - Intra- and inter-frequency comparison of L1 measurements.

##### [FL observation]

So many aspects are provided for RRC parameters and structure for CSI-RS configuration. As long as FL understands, most of the companies thinks the existing parameters defined for CSI-RS (which includes the parameters defined in Rel-18 for LTM TCI states) can be a good starting point.

**Association between report config and CSI-RS resource**

Regarding the structure for CSI-RS, most of the companies thinks the exiting mechanism for SSB can be reused. Therefore, the following approach can be taken as the first step. Also, some companies mentioned that some of the parameters needs to be aligned within the report configuration. This is also something we need to further discuss. Thus, we can structure the first step agreement including these aspects:

* The association between CSI-RS configuration and report configuration is realized by *LTM-CSI-ResourceConfigId* included in *LTM-CSI-ReportConfig* as used for Rel-18 LTM L1-measurement based on SSB
* *LTM-CSI-ResourceConfig* in Rel-19 can include a list of *NZP-CSI-RS-ResourceSet,* which can associate with a list of *NZP-CSI-RS-Resource*
  + The parameters defined in NZP-CSI-RS-Resource and NZP-CSI-RS-ResourceSet for Rel-18 are the baseline
    - FFS how and whether to add/modify the parameters
  + FFS how to associate the NZP-CSI-RS-Resource or NZP-CSI-RS-ResourceSet with candidate cell
* FFS the necessity of alignment of the CSI-RS configuration within or across candidate cell within a report configuration, e.g.
  + port number, frequency domain, density bandwidth, setting of repetition, periodicity

This will be proposed as a FL proposal in this meeting. It is noted that this can be a study proposal for the next meeting.

**RRC structure**

On top of RAN2 agreements, it would be important to decide where NZP-CSI-RS-Resources and resource set are provided. FL thinks it would be too early to discuss/down-select the options. Companies are encouraged to further assess the options to take.

* Option 1: Under LTM-Config
  + In this case, a resource set can include multiple candidate cells. Hence, it would be necessary to introduce solution to identify which candidate cell the NSP-CSI-RS resource
* Option 2: Under LTM-Candidate
  + In this case, a resource set is composed of NZP CSI-RSs for a single candidate cell
  + NZP CSI-RS resources and resource sets under LTM-Candidate are used for L1-RSRP measurement while NZP CSI-RS resources and resource sets under LTM-TCI-Info are used for candidate TCI state activation and indication
* Option 3: Reuse existing NZP-CSI-RS-Resources and resource set defined under LTM-TCI-info

##### [FL proposal 1-6-v1]

Companies are encouraged to provide their views on the following FL proposal

* For the CSI-RS sources configuration used for gNB scheduled reporting and event triggered reporting
  + The association between *LTM-CSI-ResourceConfig* and *LTM-CSI-ReportConfig* is realized by *LTM-CSI-ResourceConfigId* included in *LTM-CSI-ReportConfig* as used for Rel-18 LTM L1-measurement based on SSB
  + *LTM-CSI-ResourceConfig* in Rel-19 can include a list of *NZP-CSI-RS-ResourceSet,* which can be associated with a list of *NZP-CSI-RS-Resource*
  + The parameters defined in NZP-CSI-RS-Resource and NZP-CSI-RS-ResourceSet for Rel-18 are the baseline
    - FFS how and whether to add/modify the parameters
  + FFS how to associate NZP-CSI-RS-Resource and/or NZP-CSI-RS-ResourceSet with a candidate cell
  + FFS the necessity of alignment of the CSI-RS configuration within a candidate cell, a report configuration and/or a resource set, e.g.
    - port number, frequency domain, density, bandwidth, setting of repetition, periodicity

*FL note: this proposal is not aiming an agreement at RAN1#119.*

##### [Comments to FL Proposal 1-6-v1]

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Company | Comment | FL reply | | |
| Ericsson | For the configuration of the NZP-CSI-RS-ResourceSet with repletion (“CSI-RS for beam management”), it would make sense to reuse the NZP-CSI-RS-ResourceSet configuration in the LTM-TCI-Info. |  | | |
| Google | This proposal is a good starting point. |  | | |
| ZTE | In principle, we can reuse similar SSB based configuration framework in Rel-18 for CSI-RS for beam management in Rel-19. Besides, further discuss which parameters are necessary for CSI-RS for beam management. As for whether CSI-RS resource/set configuration for beam management should be placed under the existing LTM-TCI-Info or other Information elements, it should be left to RAN2 for decision. From our perspective, CSI-RS for BM is different from TRS. because TRS function to be achieved in Rel-18 depends on activated LTM TCI state. But such restriction is not for CSI-RS for BM. So it may give some reader the wrong implication that CSI-RS for BM also depends on activated LTM TCI state if CSI-RS resource/set configuration for BM is placed under LTM-TCI-Info. |  | | |
| NTT DOCOMO | We are fine in principle. |  | | |
| Spreadtrum | Fine to configure CSI-RS resource set including CSI-RS resource list under LTM CSI resource configuration. |  | | |
| Samsung | In terms of configuration, we prefer to reuse Rel-18 LTM SSB based framework. |  | | |
| vivo | We are fine with the first two sub-bullets in this proposal.  For the third bullet, we prefer the CSI-RS for BM on candidate cell reuses the *ltm-NZP-CSI-RS-ResourceToAddModList* and *NZP-CSI-RS-ResourceSet* configuration in the *LTM-TCI-Info* configuration, except for the high layer parameter “*trs-info*”. In addition, whether high layer parameter “*repetition*” is needed for CSI-RS for BM should be considered.  For the forth bullet, we support an NZP-CSI-RS resource is associated with a candidate cell and it can be achieved by reusing the same mechanism as Rel-18 LTM, i.e., one NZP-CSI-RS set and a list of candidate cell identities are configured within a *ltm-CSI-ResourcConfig*, and the two lists have the same number of component elements.  For the last bullet, we think at least the RS configuration restriction with a candidate cell is not needed. While for measurement and reporting, from the perspective of comparison fairness, it may need further study. |  | | |
| CATT | In our opinion, it is possible that one *LTM-CSI-ResourceConfig* may only include a single *NZP-CSI-RS-ResourceSet* which is associated with CSI-RS resources of multiple candidate cells. The necessity of including a list of *NZP-CSI-RS-ResourceSet* in one *LTM-CSI-ResourceConfig* is not quite clear. |  | |
| ITRI | Fine with the proposal in principle. |  | | |
| Huawei, HiSilicon | fine with the FL proposal | |  | |
| LG | We support FL’s intention to use same framework of Rel-18 SSB. But regarding *NZP-CSI-RS-ResourceSet* in 2nd sub bullet, it need be clarified the NZP-CSI-RS-ResourceSet implies the CSI-RS resource for BM included in *LTM-TCI-Info.* So, we suggest to use new parameter ‘ltm-NZP-CSI-RS-ResourceSet’ |  | | |
|  |  |  | | |
|  |  |  | | |
|  |  |  | | |

### [Closed] 2nd level details for CSI-RS for measurement

##### [Summary of contributions]

**UE capability**

* LG
  + LTM CSI resources should be counted for the active CSI-RS ports or resources.
    - FFS: whether it is counted as conventional active CSI-RS ports or resource in active BWP or newly introduced active CSI-RS ports or resource for LTM
* *FL note: UE capability issue can be discussed at later stage*

**Restriction on configuration**

* Lenovo
  + Each CSI-RS resource associated with an LTM-CSI-ReportConfig is QCLed with an SSB associated with a same LTM-Candidate-ID.
* *FL note: the necessity of this restriction depends on the RRC structure. This issue can be discussed at later stage*

**Others**

* ETRI
  + For each candidate cell to transmit its own CSI-RS resource set, specify one of the following options:
    - Alt1: Specify an SSB-grouping based TRP indication to identify which TRP is transmitting the SSB.
    - Alt2: Specify that the PDCCH-order based UL TA acquisition for each candidate cell shall be mandatorily performed in early sync stage.
* *FL note: the proponent is encouraged to discuss offline. More number of supporting companies are needed for online/official offline discussion.*

##### [Conclusion]

The issues categorized in this section will not be treated in RAN1#119. Interested companies are encouraged to have offline discussion. With this, the discussion of this section is closed.

## gNB scheduled reporting

### [No issue] Further details of report framework

##### [Agreement in previous meetings]

Agreement(RAN1#118)

* CSI-RS based L1-RSRP report is supported for gNB scheduled measurement reporting
* FFS: CSI-RS based L1-SINR report is supported for gNB scheduled measurement reporting
* Rel-18 LTM CSI reporting framework is the baseline for CSI-RS based L1-measurement report by gNB scheduled measurement reporting

**Agreement(RAN1#118bis)**

The agreement “Rel-18 LTM CSI reporting framework is the baseline for CSI-RS based L1-measurement report by gNB scheduled measurement reporting” made in RAN#118 is further clarified for L1-RSRP as follows:

* UCI format defined in Table 6.3.1.1.2-8C of TS38.212 can be used by replacing SSBRI with CRI.
* Whether the L1-RSRP(s) of serving cell is always included is configurable (in line with Rel-18)
* The quantization method defined in clause 5.2.1.4.3 of TS38.214 and bit width defined in Table 6.3.1.1.2-6 of TS38.212 can be used
* No L1 specified filtering for time and spatial domain is introduced
* No enhancement on how to report L cells x M beams
* Periodic reporting on PUCCH is supported
  + FFS: semi-persistent reporting on PUCCH/PUSCH, and aperiodic reporting on PUSCH

**Agreement(RAN1#118bis)**

For CSI-RS based L1-measurement report by gNB scheduled measurement reporting, semi-persistent reporting on PUCCH/PUSCH and aperiodic reporting on PUSCH are supported

##### [Conclusion]

No issues are raised in this meeting.

### [Closed] Other aspects

##### [Summary of contributions]

* LG
  + CRI selection can be done by two-step; cell quality first resource quality second manner.
* Lenovo
  + Support group based beam report for LTM CSI report to enable the multi-TRP operation after switch to the new serving cell.
  + FFS: whether the number of candidate cells is restricted to two.
* Vivo
  + Same as Rel-18 LTM, the source cell and/or target cell configured with mTRP should be considered in Rel-19 LTM.

##### [Conclusion]

The proposals above are single company proposals. Companies are encouraged to have more offline discussion to get more support.

## Event triggered reporting

### [No issue] Report container

##### [Agreement in previous meetings]

RAN2 agreed to support MAC CE for the container of event triggered reporting. Therefore, RAN1 discussion on this aspect is not necessary anymore.

##### [Conclusion]

No further discussion is planned unless requested by RAN2

### [No issue] Report quantity

##### [Agreements in previous meetings]

Agreement(RAN1#118)

* SSB based L1-RSRP measurements is supported for event triggered reporting
* CSI-RS based L1-RSRP measurements is supported for event triggered reporting
* FFS: CSI-RS based L1-SINR measurements is supported for event triggered reporting

##### [Conclusion]

No further discussion is necessary as no consensus was achieved to introduce L1-SINR

### [Closed] Report format and contents

##### [Summary of the contributions]

* Spreadtrum
  + The event triggered report via MAC CE can include the cell(s) and beam(s) satisfying the event.
  + The identification of event that triggers the report should be included in the event triggered report when multiple LTM events are configured.
* Xioami
  + At least one reported beam in the event-triggered beam report for LTM should satisfy the condition of the Event.
  + Regarding the reported beams in beam report triggered by Event for LTM, support reporting different number of beams for different candidate cells.
    - Alt 1: only report the beam(s) satisfying the event.
    - Alt 2: only report the beam(s) of candidate cell(s) with at least one beam satisfying the Event
    - Alt 3: the number of reported beam(s) of candidate cell(s) with at least one beam satisfying the Event can be more than that of other candidate cells.
* Lenovo
  + For Event LTM2, the NW can configure the UE to report the measurement result of the current beam of the serving cell.
  + For Event LTM3, EventLTM4 and Event LTM5, the UE shall report N beams from candidate cells and the NW can further configure the UE to include the measurement result of the beam of serving cell.
* OPPO
  + UE reports one indicator to indicate which LTM event is triggered in LTM event-triggering reporting.
  + For event LTM 2, the UE reports the L1-RSRP measurement of the RS corresponding to the indicated TCI state of serving cell.
    - The reported L1-RSRP measurement can be a differential L1-RSRP measurement with a reference to the corresponding threshold
  + For event LTM 3, the UE reports:
    - The L1-RSRP measurement of all the beam evaluation RSs of candidate cell that satisfy the event LTM 3 trigger condition and their corresponding CRI/SSBRIs
    - the L1-RSRP measurement of serving cell.
    - The reported L1-RSRP measurement of candidate cell is differential L1-RSRP with a reference to the L1-RSRP of the serving cell.
  + For event LTM 4, the UE reports the L1-RSRP measurement of all the beam evaluation RSs of candidate cell that satisfy the event LTM 4 trigger condition and their corresponding CRI/SSBRI
    - UE reports the differential L1-RSRP of each reported CRI/SSBRI with a reference to the configured L1-RSRP threshold
  + For event LTM 5, the UE reports:
    - The differential L1-RSRP of each RS of candidate cell that satisfies the condition of event LTM 5 with reference to the L1-RSRP threshold configured for candidate cell and the corresponding CRI/SSBRI.
    - The differential L1-RSRP of serving cell with reference to the L1-RSRP threshold configured for serving cell.

##### [Conclusion]

FL has no intention to discuss the issues on format of event triggered reporting as this is led by RAN2. Interested companies are encouraged to bring their proposals to RAN2.

### [Closed] RS of serving cell for event evaluation

##### [Agreement in previous meetings]

**Agreement(RAN1#118)**

* For the identification of the serving cell RS for event evaluation,
  + At least the following options are further studied in RAN1, where different options could apply to different LTM event
    - Option. 1: Derived from QCL (type-D) RS(s) of the indicated joint/DL TCI state for the serving cell
    - Option. 2: Derived from QCL RS(s) or SSB QCLed with the QCL RS of the indicated joint/DL TCI state for the serving cell
      * QCL RS or SSB is configured by the network
    - Option. 3: Measurement RS(s) is/are explicitly configured
    - Option. 4: Derived from QCL RSs of activated TCI states with the best quality, or SSB which is QCLed with the QCL RSs of activated TCI states with the best quality.
    - Option 6: Derived from QCL RSs of activated TCI states, or SSB which is QCLed with the QCL RSs of activated TCI states
* The RSs of the candidate cell(s) for event evaluation are explicitly configure
* Note: Companies are encouraged to take into account the RAN2 agreement (i.e current beam rather than best beam) for their further study.

**Agreement(RAN1#118bis)**

The serving cell RS for event evaluation is at least derived from QCL RS or SSB QCLed with the QCL RS of the indicated joint/DL TCI state for the serving cell

* QCL RS above is the RS w.r.t. QCL-TypeD when the indicated joint/DL TCI state is configured with two QCL RSs
* FFS: Details on determination of QCL RS or SSB QCLed with QCL RS

Note: This does not imply the support of mTRP scenarios

For info: LTM events in RAN2:

* Event LTM2: Beam of serving cell becomes worse than absolute threshold;
* Event LTM3: Beam of candidate cell becomes amount of offset better than beam of serving cell;
* Event LTM4: Beam of candidate cell becomes better than absolute threshold;
* Event LTM5: Beam of serving cell becomes worse than absolute threshold1 AND Beam of candidate cell becomes better than another absolute threshold2.

##### [Summary of contributions]

* ZTE
  + For evaluation of LTM event, QCL RS or SSB QCLed with the QCL RS of the indicated TCI state for the serving cell is selected by NW configuration.
  + When QCL RS of the indicated TCI state for the serving cell is selected, if TRS is configured as QCL RS, UE assumes that the CSI-RS resource in the indicated TCI state is configured in a CSI-RS resource set configured with repetition.
* Huawei
  + For event LTM3 and event LTM5, the RS type of the serving cell is determined from RS type of candidate cells. A UE is expected to be configured with RSs with same RS type across all candidate cells if these RSs are associated with a report configuration with event LTM3 and event LTM5.
* LG
  + QCL RS or SSB QCLed with the QCL RS for serving cell RS for event evaluation can be clarified as follows;
    - When indicated new beam RS is SSB, SSB QCLed with the QCL RS of the indicated joint/DL TCI state for the serving cell is used for event evaluation.
    - When indicated new beam RS is CSI-RS, QCL RS of the indicated joint/DL TCI state for the serving cell is used for event evaluation.
* CMCC
  + If the RS(s) for candidate cell are CSI-RS configured in a CSI-RS resource set configured with repetition, the serving cell RS for event evaluation is the QCL RS of the indicated joint/DL TCI state, if the RS(s) for candidate cell are SSB, the serving cell RS for event evaluation is the SSB QCLed with the QCL RS of the indicated joint/DL TCI state.
* Spreadtrum
  + For LTM2, LTM3 and LTM5, enabling one of either QCL RS or SSB QCLed with QCL RS of the indicated TCI state for serving cell RS determination is selected by gNB.
  + For LTM3 and LTM5, enabling of two schemes for serving cell RS determination should ensure the same RS type for serving cell RS and candidate cell RS.
  + Only support unified TCI framework for beam indication mechanism in Rel-19 LTM.
* Vivo
  + Support reusing the solution of the AI 9.2.1 to determine the measurement RS of event-triggered reporting for LTM, i.e., either CSI-RS for BM or SSB is configured as candidate cell beam and the measurement RS of the serving cell beam is determined by the candidate cell beam.
  + Same as Rel-18 LTM, the source cell and/or target cell configured with mTRP should be considered in Rel-19 LTM.
    - For the case that the source cell is configured with mTRP, how to determine the measurement RS of the serving cell beam based on the two indicated TCI states should be discussed.
* Nokia
  + For the serving RS, the determination of QCL RS or SSB QCLed with QCL RS of the indicated DL/joint TCI state is based on following implicit manner:
    - If the candidate RS is SSB, then the SSB QCLed with the QCL RS of the indicated DL/joint TCI state is used.
    - If the candidate RS is CSI-RS, and the indicated DL/joint TCI state has a QCL RS with QCL 'typeD' configured in an NZP-CSI-RS-ResourceSet with higher layer parameter repetition, the QCL RS of the indicated DL/joint TCI state is used.
    - If the candidate RS is CSI-RS and the indicated DL/joint TCI state contains only one TRS, then the SSB QCLed with the QCL RS of the indicated DL/joint TCI state is used.
  + For event evaluation, when the candidate RS is a CSI-RS and the indicated DL/joint TCI state has a QCL RS with only one TRS, the SSB QCLed with the candidate RS should be used.
  + mTRP operation can be supported in the serving cell for an LTM UE. FFS: how to determine the indicated TCI state as the serving beam for Rel-19 event triggered L1 measurement reporting.
* Apple
  + Reusing the same implicit rule to ensure the same RS type for both serving and neighbor cell for event LTM3 and event LTM5:
    - If the RS(s) for candidate beams of candidate cells are CSI-RS, Schme-1 is used for measurement resource of current serving cell.
    - Otherwise, the Scheme-2 is used.
* Xiaomi
  + Support to decide the RS type of serving cell RS as same as the RS type of candidate cells’ RSs implicitly.
* CATT
  + Measurement RS(s) is/are explicitly configured.
  + If the measurement RS for candidate cell is configured as a set of SSB(s), the measurement RS for the serving cell should be the SSB which is QCLed with the QCL RS in the indicated TCI state. When the measurement RS for candidate cell is CSI-RS, the measurement RS for serving cell should be the QCL RS of the indicated joint/DL TCI state.
* Lenovo
  + Regarding event LTM3 and event LTM5, if the RS(s) for neighboring cell are CSI-RS, QCL RS of the indicated joint/DL TCI state for the serving cell is used, otherwise, if the RS(s) for neighboring cell are SSB, SSB QCLed with QCL RS of the indicated joint/DL TCI state for the serving cell is used.
* Ericsson
  + The network decides which of QCL RS or SSB QCLed with QCL RS should be used for the serving cell.
  + If the candidate beams are configured in a CSI-RS resource set configured with repetition, the serving cell RS is the QCL RS in the indicated TCI state; otherwise, the serving cell RS is the SSB QCLed with QCL RS.
* IDC
  + Network configuration determines if the serving cell RS for event evaluation is either (a) the QCL RS of the indicated TCI state or (b) the SSB QCL’ed with the QCL RS of the indicated TCI state.
* OPPO
  + If the RS for candidate cell evaluation is CSI-RS for beam management, the serving cell RS is the QCL RS in the indicated joint/DL TCI state.
  + If the RS for candidate cell evaluation is SSB, the serving cell RS is the SSB that the QCL RS in the indicated joint/DL TCI state is QCLed to.
  + When the serving cell is configured with mTRP and has two indicated joint/DL TCI states:
    - The UE derive two RSs for serving cell evaluation and each RS is from the QCL RS or the SSB that the QCL RS is QCLed to of each indicated joint/DL TCI state.
    - The L1-RSRP measurement of serving cell for event evaluation is the minimum value of the L1-RSRP measurement of those two RSs.
* Fujitsu
  + Use the root SSB associated with QCL RS as serving cell RS for evaluation for the LTM event where the measurement RS is configured to SSB.
  + LTM event configured with CSI-RS for BM as the measurement RS is valid only when TCI state associated with the CSI-RS for BM is indicated.
* Sony
  + For the serving cell RS for event evaluation, either QCL RS or SSB QCLed with QCL RS should be selected by network.
* Meta
  + The RS type for determining LTM event trigger for serving cell can be configured by the network and the UE should expect the candidate cell measurement RS and the serving cell measurement RS to be the same type i.e., either SSB or CSI-RS.
* DOCOMO
  + On current RS selection from QCL RS or SSB QCLed with QCL RS of the indicated TCI state, support to configure explicit RRC parameter per event configuration.
    - explicit manner can cover all event types. Also, different RS types may be configured for different event types
  + Support to study the current beam determination when serving cell is in MTRP operation and has two indicated TCI states.
    - Support that current beam is determined from a fixed TCI state from the two indicated TCI states.
* Qualcomm
  + QCL RS in the indicated TCI state, if CSI-RS resources are configured for LTM L1 measurement.
  + SSB QCLed with the QCL RS in the indicated TCI state, otherwise.

##### [FL Observation]

We have 2 issues in this meeting

* Issue 1: Resolution of FFS part
  + Necessity of explicit signaling
  + Handling of TRS case (i.e. CSI-RS with repetition is not provided in the indicated TCI state)
* Issue 2: support of mTRP for serving cell
  + Whether mTRP can be supported or not
  + How to choose one RS from multiple TCI states

For issue 1, a good analysis is provided by Nokia, FL’s analysis is added based on this table:

**Table 5.3.4-1**



|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Case | FR1/FR2 | **Candidate RS for measurement** | **QCL RS of Indicated TCI State** | **Option for serving RS determination** |
| 1 | FR1 | SSB | TRS  (TRS is QCLed with SSB) | SSB QCLed with QCL RS |
| 2 | FR1 | CSI-RS | TRS (TRS QCLed with SSB) | SSB QCLed with QCL RS (L1-measurement based on TRS is not supported) |
| 3 | FR2 | SSB | TRS + TRS (TRS is QCLed with SSB + SSB, or TRS is QCLed with SSB + CSI-RS (with rep)) | SSB QCLed with QCL RS |
| 4 | FR2 | CSI-RS | TRS + TRS (TRS is QCLed with SSB + SSB, or TRS is QCLed with SSB + CSI-RS (with rep)) | If TRS is QCLed with SSB + SSB, - SSB QCLed with QCL RS (L1-measurement based on TRS is not supported)  If TRS is QCLed with SSB + CSI-RS (with rep), then - opt 4-1. SSB QCLed with QCL RS - opt 4-2. QCL RS - opt 4-3. Explicitly configured between alt 4-1 and 4-2 |
| 5 | FR2 | SSB | TRS + **CSI-RS (with rep)** | SSB QCLed with QCL RS |
| 6 | FR2 | CSI-RS | TRS + **CSI-RS (with rep)** | opt 6-1. SSB QCLed with QCL RS opt 6-2. QCL RS opt 6-3. Explicitly configured between alt 6-1 and 6-2 |

FL would like companies to check if this is the exhaustive list of the possible cases. If so, the discussion can focus on case 4 and 6.

For issue 2, the input from the companies is not enough to initiate the discussion at this meeting.

##### [FL Proposal 3-4-v1]

* Companies are requested
  + to check if nothing is missed in Table 5.3.4-1, and
  + to agree the green shadow part is approved as no other option serving RS determination is available.

*FL note: a formal FL proposal will be made based on the input from companies.*

##### [Comments to FL Proposal 3-4-v1]

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Company | Comment | FL reply | | |
| Fujitsu | We think all possible cases are listed in the table. Explicit signaling is not needed, but the corresponding RS can be derived according to the candidate measurement RS. |  | | |
| Ericsson | For MIMO, the serving RS is determined from the candidate RS. MIMO has made the assumption that when CSI-RS is configured as a candidate, the UE may assume that the CSI-RS in the indicated TCI state is (also) configured in a CSI-RS resource set with repetition. Note that one CSI-RS resource can be in multiple CSI-RS resource sets: both in a CSI-RS resource set with trs-info (“TRS”) and in a CSI-RS resource set with repetition (“CSI-RS for beam management”).  With this understanding, rows 2 and 4 are inaccurate, and violate the assumption of “same RS type”. In our understanding, for rows 2 and 4, the UE would performance measurements on CSI-RS in that case.  Then we feel that the QCL source of the TRS is important: of the QCL source of the TRS is used, the SSB would always be used. So the yellow part in row 4 can be deleted.  For row 6, a CSI-RS must be used: using SSB violates the “same type” agreement. |  | | |
| Google | We have the same understanding as Ericsson on MIMO’s progress. Hence, row 2, row 4 and row 6 should be updated, which are just based on candidate RS type. |  | | |
| Nokia | More discussion is needed on row 2 and 4. If SSB QCLed with TRS is used, then we need to further clarify that we need to use the SSB QCLed with candidate CSI-RS to make sure same type of RS is used which should be fine for LTM. Otherwise, we need to follow the approach agreed upon for UEIBM (as described above by Ericsson).  For row 6, it should be option 6-2 – the QCL RS of the indicated TCI state which is a CSI-RS (which is of the same type as the candidate RS) in this case. Other options are not needed. |  | | |
| ZTE | We agree with the understanding from Ericsson, that is, LTM can directly follow the design of UEIBR. Besides, another relative simple approach is to introduce a new parameter in RRC to indicate RS type for event evaluation. |  | | |
| NTT DOCOMO | First, we think the MIMO UEIBR design can be reused for Mobility regarding implicit determination. Second, considering more events are supported for mobility, and different RS types can be configured for different events, explicit RRC parameter on RS type for current beam is a better choice for Mobility.  Also, for row 2, 4 and, 6, we have the same understanding as Ericsson. For row 4, based on the following spec., SSB is always configured as root QCL type-D source RS.  TS38.214 5.1.5  For a CSI-RS resource in an *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *repetition,* the UE shall expect that a TCI-State indicates one of the following quasi co-location type(s):  - 'typeA' with a CSI-RS resource in a *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *trs-Info* and, when applicable, 'typeD' with the same CSI-RS resource, or  - 'typeA' with a CSI-RS resource in a *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *trs-Info* and, when applicable, 'typeD' with a CSI-RS resource in a *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *repetition*, or  - 'typeC' with an SS/PBCH block and, when applicable, 'typeD' with the same SS/PBCH block, the reference RS may additionally be an SS/PBCH block having a PCI different from the PCI of the serving cell. The UE can assume center frequency, SCS, SFN offset are the same for SS/PBCH block from the serving cell and SS/PBCH block having a PCI different from the serving cell. |  | | |
| Qualcomm | We share the same view as Ericssion’s. We can leverage the agreed design in MIMO Ph5 UEIBM, and some rows (rows 2, 4, and 6) are not fully aligned with the UEIBM agreements. |  | | |
| Spreadtrum | Agree with the understanding from Ericsson, the rows that are not aligned with MIMO conclusions need to be updated. |  | | |
| Lenovo | Agree with Ericsson. The RS determination agreed to UEI beam report in MIMO can be fully reused for LTM. |  | | |
| Xiaomi | We also prefer to follow the design of UEI BR, i.e., the RS type of serving beam RS can be same as the RS type of candidate cell’s RS for Event LTM 3 and 5.  While for Event LTM 1, if the QCL Type D RS of the indicated TCI state is a CSI-RS resource associated with a CSI-RS resource set configured with *repetition*, CSI-RS will be used as the serving beam RS. Otherwise, SSB will be used as the serving beam RS. It is unnecessary to depend on the QCL source of the TRS. |  | | |
| Samsung | We support to follow MIMO UEIBM design (event-2) for determining current serving cell beam type, i.e., based on the type of the candidate cells beam(s). Same handling of TRS in MIMO UEIBM can also be used here. We do not think we need additional rules/considerations here. |  | | |
| vivo | We share the same view as Ericsson that LTM can reuse the implicit RS determination mechanism designed for UEIBR to ensure serving cell beam RS and candidate cell beam RS(s) has the same RS type. Based on the principle, rows 2,4 should be updated. And for row 6, except option 6-2, other options should be removed. |  | | |
| CMCC | Support Case 1, 3, 5 when candidate cell RS is SSB, SSB QCLed with QCL RS is used as serving cell RS.  For Case 2 and the green shadow part in Case 4, the RS types for candidate cell and serving cell are different. Since the Tx power and beam width are different for SSB and CSI-RS for beam management, it is not fair to compare these two types of RS. So, when the candidate cell RS is CSI-RS for beam management, gNB should ensure the QCL RS (QCL type-D RS for FR2) of the indicated TCI state is CSI-RS configured with repetition. Or else, it is error case. |  | | |
| CATT | | The advantage of leveraging explicit signalling for serving RS measurement is that the current LTM CSI report configuration framework can be leveraged as much as possible. e.g. in one LTM-CSI-ResourceSet, both serving cell measurement RS and candidate cell measurement RS can be configured. |  | |
| ITRI | Share the same view as Ericssion. |  | | |
| Huawei, HiSilicon | | Agree with Ericsson. The RS for candidate cell should be configured with same type. Then the MIMO mechanism can be reused. | |  | |
| LG | Agree with Ericsson. If type measurement resources are not same, it can’t be said it is fair comparison. If the type is different among comparing resources, additional to power offset, beam width and time/frequency resource will be different. It should be unified to same type of resources to make comparison. |  | | |
| Apple | The situation is exactly same as MIMO use case and we should use the same solution. In general, as long as the CSI-RS is configured as meausurement resource for candidate cell, the measurment resource should use CSI-RS to implement the general rule of ‘same RS type’ for candidate and serving cell.  In short, the following can be considered with minor modifications based on the MIMO agreement:   |  | | --- | | * If the RS(s) for candidate cell(s) are CSI-RS configured in a CSI-RS resource set configured with repetition, QCL RS of the indicated TCI-state is used for the serving cell; otherwise, SSB QCLed with QCL RS of the indicated TCI-state is used for the serving cell. * UE does not expect the following configuration:   + CSI-RS resource in the indicated TCI state of serviing cell is NOT configured in a CSI-RS resource set configured with repetition, and   + CSI-RS is configured as measurment resource for the candidate cell(s). | |  | | |
|  |  |  | | |
|  |  |  | | |
|  |  |  | | |
|  |  |  | | |
|  |  |  | | |
|  |  |  | | |

##### [FL Proposal 3-4-v2]

For the identification of the serving cell RS for event evaluation,

* If the RS(s) for candidate cell(s) are CSI-RS configured in a CSI-RS resource set configured with repetition, QCL RS of the indicated TCI-state is used for the serving cell; otherwise, SSB QCLed with QCL RS of the indicated TCI-state is used for the serving cell.
  + UE does not expect the following configuration:
    - CSI-RS resource in the indicated TCI state of serving cell is NOT configured in a CSI-RS resource set configured with repetition, and
    - CSI-RS is configured as measurement resource for the candidate cell(s).
* FFS the current beam determination when serving cell is in mTRP operation and has two indicated TCI states.

*FL note: the proposal follows the mechanism as UEIBR. The behavior achieved by FL proposal above is summarized in the table below. One company may want to discuss the different between UEIBR and LTM, especially for case 2 and 4.*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Case | FR1/FR2 | **Candidate RS for measurement** | **QCL RS of Indicated TCI State** | **Option for serving RS determination** |
| 1 | FR1 | SSB | TRS  (TRS is QCLed with SSB) | SSB QCLed with QCL RS |
| 2 | FR1 | CSI-RS | TRS (TRS QCLed with SSB) | ~~Opt 2-1: SSB QCLed with QCL RS (L1-measurement based on TRS is not supported)~~ Opt 2-2: QCL RS (follow the agreement in MIMO UEIBM, i.e. assuming association between TRS and CSI-RS with repetition is achieved by configuration of CSI-RS resource set, i.e.) |
| 3 | FR2 | SSB | TRS + TRS (TRS is QCLed with SSB + SSB, or TRS is QCLed with SSB + CSI-RS (with rep)) | SSB QCLed with QCL RS |
| 4 | FR2 | CSI-RS | TRS + TRS (TRS is QCLed with SSB + SSB, ~~or TRS is QCLed with SSB + CSI-RS (with rep))~~ | If TRS is QCLed with SSB + SSB, ~~Opt 4a-1: SSB QCLed with QCL RS (L1-measurement based on TRS is not supported)~~ Opt 4a-2: QCL RS (follow the agreement in MIMO UEIBM, i.e. assuming association between TRS and CSI-RS with repetition is achieved by configuration of CSI-RS resource set, i.e.)  ~~If TRS is QCLed with SSB + CSI-RS (with rep), then - opt 4b-1. SSB QCLed with QCL RS - opt 4b-2. QCL RS - opt 4b-3. Explicitly configured between alt 4b-1 and 4b-2~~ |
| 5 | FR2 | SSB | TRS + **CSI-RS (with rep)** | SSB QCLed with QCL RS |
| 6 | FR2 | CSI-RS | TRS + **CSI-RS (with rep)** | ~~opt 6-1. SSB QCLed with QCL RS~~ opt 6-2. QCL RS ~~opt 6-3. Explicitly configured between alt 6-1 and 6-2~~ |

##### [Conclusion]

The following agreement was made during the online session on Monday.

**Agreement**

For the identification of the serving cell RS for event evaluation,

* If the RS(s) for candidate cell(s) are CSI-RS configured in a CSI-RS resource set configured with repetition, QCL RS of the indicated TCI-state is used for the serving cell; otherwise, SSB QCLed with QCL RS of the indicated TCI-state is used for the serving cell.
  + UE does not expect the following configuration:
    - CSI-RS resource in the indicated TCI state of serving cell is NOT configured in a CSI-RS resource set configured with repetition, and
    - CSI-RS is configured as measurement resource for the candidate cell(s).

It is noted that FFS related to mTRS was deleted due to the lack of support at this meeting.

With this, the discussion of this section is closed

### [Mid] Filtering of measurement results for evaluation and reporting

##### [Summary of contributions]

**Necessity of L1-specified filtering for event evaluation and reporting**

* Yes(5) Nokia, CATT, DOCOMO, KDDI, Ericsson
  + first order IIR filtering
  + Simulation results are provided by Nokia and Ericsson
    - Observation by Nokia
      * The benefits of additional L1 filtering are not clearly evident or in other words finding the optimal parameters for coefficients and TTT may not be straightforward. Nevertheless, it could be beneficial to leave the decision regarding additional L1 filtering for event-triggered LTM to the network.
      * Support network configurable L1 filtering for event-triggered L1 measurement reporting for LTM.
    - Observation by Ericsson
      * Large variance in L1-RSRP cannot be handled well by TTT mechanisms: If TTT is too long then temporary dips will reset the timer and delay the event. If TTT is too short then it leads to frequent ping-pong handovers.
      * A network configurable filter can reduce the variance of RSRP, making the trend clear such that TTT and event thresholds and offsets can be properly configured
      * A network configurable filter can ensure consistent variance of the RSRP measurements used for event evaluation
      * Different network deployments and network configurations require different filter settings for optimal performance
      * With NW-configurable filtering, the number of ping-pong handovers is reduced.
      * Introduce a network configurable filter in MAC. Event conditions should be evaluated on RSRP measurements that are filtered with the network configurable filter
      * The network configurable filter is a first order IIR filter.
* No(7), ZTE, Huawei, Apple, Lenovo, MediaTek, Qualcomm, vivo
  + TTT can solve the issue
  + Can be left to UE implementation

##### [Summary of contributions]

FL view is summarized as follows:

* There is a tendency where UE vendors don’t want to specify anything related to filtering while network side want more controllability.
* UE filtering can solve the problem because it is anyway filtering. The problem is the filtering method (i.e. coefficient) may not be the same as network expectation.
* According to RAN2 agreement, periodic report is still available for event triggered reporting. If so, filtering operation may be possible at the network side.
* Some companies think TTT would provide the same effect as filtering, while some companies don’t

Considering the fact that this is independent from other open issues, FL thinks that official offline discussion would help the better understanding among companies.

##### [FL Proposal 3-5-v1]

Companies are requested their views on the following approaches for the necessity of filtering

* Approach 1: L1-specified filtering for L1-RSRP based on SSB and CSI-RS is introduced for event evaluation and reporting
  + The network configurable filter is a first order IIR filter, which gives more flexibility for the network
* Approach 2: No L1-specified filtering for L1-RSRP based on SSB and CSI-RS is introduced for event evaluation and reporting

*FL plan is to have official offline discussion based on simulation results (*[**R1-2409771**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_119/Docs/R1-2409771.zip) **Nokia,** [**R1-2409975**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_119/Docs/R1-2409975.zip) **Ericsson***) in this meeting or the next meeting. Considering the independency from other issues, FL thinks this issue is not super urgent.*

##### [Comments to FL Proposal 3-5-v1]

|  |  |  |  |
| --- | --- | --- | --- |
| Company | Comment | FL reply | |
| Fujitsu | We support Approach 1. Our concern is the reliability of the measurement results. TTT can guarantee the reliability to trigger the reporting in event evaluation, but not measurement results that the serving cell determines the cell switch by the measurement results. Moreover, if the filtering of the measurement results is performed by UE implementation, the reliability also strongly depends on the filtering method of the UE, and thus the serving cell may not fairly compare the measurement results, or the cell switch decision may not be fairly performed. |  | |
| Ericsson | We do not think it is accurate to state that is “L1-specified filtering”. The filtering will most likely be specified in a RAN2 specification. We understand that this would be more acceptable to some companies. |  | |
| ZTE | Support approach 2 and leave it to UE implementation. |  | |
| NTT DOCMO | We support Approach 1. Currently, TTT was supported in RAN2. Due to variable L1 measurement result, if short TTT length is configured, it could lead to ping-pong issue. On the other hand, if long TTT length is configured, event would be never satisfied. Also, if filtering by UE implementation is used, NW could not configure parameter related to event properly. Thus, we think that NW configured L1-filtering is needed in addition to TTT. |  | |
| Spreadtrum | Support approach 2. |  | |
| NEC | We support Approach 1. The event triggered measurement reporting should not be based on just one-shot comparison. When the report is triggered, certain measurement threshold condition should be met based on filtered L1 results.  As the measurement itself is periodic, filtering would be performed on already known measurement results prior to event triggering condition is fulfilled. Furthermore, the filtering window and triggering threshold could be set by the network such that there is no time delay at triggering the LTM event. |  | |
| Lenovo | Support approach 2. It should be leave to UE implementation. |  | |
| Xiaomi | Support approach 2. |  | |
| Samsung | We prefer approach 2. Filtering is subject to UE. In RAN1 specification, L1 filtering is not specified. |  | |
| vivo | Support approach 2 and leave it to UE implementation. |  | |
| CATT | Support Approach 1. |  |
| InterDigital | Prefer Approach 1. Have some concern that there may be performance impact with Approach 2. |  | |
| ITRI | Support approach 2. |  | |
| Huawei, HiSilicon | Support approach 2 |  | |
| LG | Support approach 2. It could be aligned with gNB indicated report which is agreed with UE implementation. |  | |

### [Closed] Other issues for event triggered reporting

##### [Summary of contributions]

* Nokia
  + Allowing the UE to conduct CSI-RS measurements from different LTM candidate and serving cells with different Rx beamwidths/gains could result in suboptimal cell-switch decisions by the network.
  + RAN1 should discuss if and how to ensure appropriate Rx beams (e.g., wide versus refined Rx beams) are consistently used for measurements across serving cell and different LTM candidate cells.
  + *FL note: This issue is currently discussed by a single company. Interested companies are invited their views in the next meeting.*

**Handling of serving cell RS configuration for event evaluation**

* Qualcomm
  + For event evaluation and measurement reporting for Events LTM2, LTM3, and LTM5, the current SpCell and corresponding RSs should always be included in the LTM configuration.
  + *FL note: In Rel-18 similar issue on SpCellInclusion was discussed in RAN2. FL expect that RAN2 can make the decision.*

**Measurement RS for candidate cells**

* Google
  + For evaluating beams of candidate cell for an LTM triggering event, UE measures a RS resource set, which is explicitly configured per LTM candidate cell.
  + *FL note: RAN2 is expected to discuss this issue, and explicitly request to RAN1.*

**Coexistence**

* NEC
  + Support simultaneous configuration of both UE event triggered report and any of NW triggered periodic/semi-persistent/aperiodic report.
* Sharp
  + The UE does not expect to be configured with both event-triggered LTM L1 measurement report and network-triggered LTM L1 measurement report at the same time to avoid LTM L1 report duplication.
* *FL note: Coexistence is a RAN2 issue.*

**Interaction between L1 and MAC**

* Qualcomm
  + To assist event evaluation in the MAC layer, the PHY layer should provide L1 measurement results for all or MAC-indicated resources in the configured LTM measurement resources for both serving and candidate cells.
  + *FL note: Considering the independency from other issues, this can be discussed at later stage of Rel-19.*

**Others**

* NEC
  + Support simplified event-triggered L1 measurement reporting for LTM candidate cells with limited event types.
  + Specify measurement value thresholds for the start or stop of event triggered L1 measurement reporting.
  + Support event triggered measurement reporting with optional TCI state indication.
  + Support event triggered measurement reporting with optional CFRA resource indication and UL access resource selection.
* *FL note: more relevant to discuss in RAN2.*

##### [Conclusion]

The discussion of this section is postponed/closed without FL proposals to avoid the potential overlap with RAN2 work. The discussion may be started from the next meeting depending on the RAN2 progress/request.

## Beam Management based on CSI-RS

### [Closed] Candidate TCI states activation and indication based on CSI-RS

##### [Agreements in previous meetings]

No agreements yet

##### [Summary of the contributions]

Support of CSI-RS for BM as the referenceSignal with QCL-TypeD for an LTM TCI state

* Yes(6): Huawei, vivo, Nokia, Fujitsu, DOCOMO, Qualcomm
  + For quick narrow beam alignment in LTM procedure
  + Transmission performance within/after cell switch based on a fine Tx-Rx beam pair can be improved significantly.
  + In cases where the UE does not support using a TRS as the QCL RS for a candidate TCI state, the candidate TCI state should allow the CSI-RS used for BM to function directly as the QCL RS with QCL type 'typeD
  + Straightforward manner and the configuration flexibility for the beam indication.
  + it seems feasible to support the CSI-RS for LTM L1 measurement as a QCL source RS, at least for ‘typeD’. However, even in this case, another TRS would still be needed as a QCL-TypeA source
  + The following case, which is a typical configuration for Rel-17 unified TCI framework, cannot be supported.
    - 
* No(3): CATT, MediaTek, Spreadtrum
  + Rel-18 mechanism (TRS for Type-A and D) is sufficient

##### [FL observation]

According to the email discussion at RAN1#118bis, majority of the companies saw no strong necessity to support CSI-RS for BM as QCL RS of Candidate TCI states because TRS, which is actually CSI-RS, is supported. However in this meeting, more number of companies sees the necessity.

FL understanding is that CSI-RS for BM (i.e. w/ repetition) has already been supported for legacy TCI states, and hence the cost to additionally support of CSI-RS for BM is not such high. Thus, the question here is whether the justification to introduce for CSI-RS for BM for candidate TCI state pointed out by 6 proponents are valid or not.

##### [FL Proposal 4-1-v1]

* For the introduction of CSI-RS for BM as the referenceSignal with QCL-TypeD for an LTM TCI state, companies are invited to provide their view on the justifications described in the companies’ contributions
  + - For quick narrow beam alignment in LTM procedure
    - Transmission performance within/after cell switch based on a fine Tx-Rx beam pair can be improved significantly.
    - In cases where the UE does not support using a TRS as the QCL RS for a candidate TCI state, the candidate TCI state should allow the CSI-RS used for BM to function directly as the QCL RS with QCL type 'typeD
    - Straightforward manner and the configuration flexibility for the beam indication.
    - it seems feasible to support the CSI-RS for LTM L1 measurement as a QCL source RS, at least for ‘typeD’. However, even in this case, another TRS would still be needed as a QCL-TypeA source
    - The QCL setting, which is available for Rel-17 unified TCI, cannot be used without the introduction of CSI-RS w/ repetition.

*FL note: a new FL proposal will be made after checking the companies’ input*

##### [Comments to FL Proposal 4-1-v1]

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Company | Comment | FL reply | | |
| Fujitsu | Rel-18 LTM supports only TRS and SSB as a QCL source, however, by introducing CSI-RS for BM in Rel-19 LTM, it cannot be indicated by TCI state as QCL source. In our understanding, the gNB can implicitly configure the CSI-RS for BM as QCL source, but not cover all cases such as TRS is not supported in the target cell. One straightforward method is to enable the CSI-RS for BM as QCL source. |  | | |
| Ericsson | We do not see that the NW would configure periodic CSI-RS with repetition. But it is simple to include this in the specification. |  | | |
| Google | We do not see the issue. Isn’t it already supported by legacy QCL rule? Excluding it would become a new QCL rule, which seems unnecessary at this stage. |  | | |
| Nokia | Rel-18 LTM TCI state **cannot** have a CSI-RS for BM as a QCL source. **This is essential; without it, the entire objective of enabling CSI-RS-based beam management (BM) cannot be achieved.**  To address Ericsson’s question: The intention here is not to introduce CSI-RSs with "repetition = ON"; they can be with "repetition = OFF."  To address Google’s question: This is not a new QCL rule. In Rel-18, due to the lack of CSI-RS measurements, one of the Rel-17 unified TCI state QCL relations was ruled out. The proposal is simply to allow that relation now that CSI-RS measurements are available.  **Finally, a straightforward question to all companies opposing this: how can an indicated candidate TCI state utilize a narrow gNB Tx beam without allowing QCL relation to a BM CSI-RS?**  **And then a bigger question - what is the motivation of enabling CSI-RS based L1-RSRP measurements then?** |  | | |
| ZTE | In the existing specification, TRS is used as QCL RS for PDSCH/PDCCH, not CSI-RS for BM. So, if we support CSI-RS for BM for PDCCH/PDSCH reception, whether it should be discussed or evaluated in MIMO first. |  | | |
| NTT DOCOMO | We support to configure TRS as source QCL type-A RS and CSI-RS for BM as source QCL type-D RS in TCI state for candidate cell(s) as R17 unified TCI state.  Also, CSI-RS for BM is not configured in TCI state for candidate cell in Rel-18 LTM.  TS38.331 *NZP-CSI-RS-ResourceSet*  ***repetition***  Indicates whether repetition is on/off. If the field is set to *off* or if the field is absent, the UE may not assume that the NZP-CSI-RS resources within the resource set are transmitted with the same downlink spatial domain transmission filter (see TS 38.214 [19], clauses 5.2.2.3.1 and 5.1.6.1.2). It can only be configured for CSI-RS resource sets which are associated with *CSI-ReportConfig* with report of L1 RSRP, L1 SINR or "no report". This field is not present in case *NZP-CSI-RS-ResourcesSet* is received as part of an *LTM-Candidate* IE. |  | | |
| NEC | We have the similar view with Nokia. If ‘CSI-RS for BM as the referenceSignal with QCL-TypeD for an LTM TCI state’ is not supported, we question the motivation of introducing CSI-RS based L1 measurement in R19 LTM. |  | | |
| Lenovo | According to TS38.214, for PDSCH/PDCCH, the TCI-state can indicates ‘a 'typeA' with a CSI-RS resource in a *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *trs-Info* and, when applicable, 'typeD' with a CSI-RS resource in an *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *repetition’.* We support to configure CSI-RS for BM as the referenceSignal with QCL-TypeD for an LTM TCI state. |  | | |
| Xiaomi | Slightly prefer to support it and narrow beam can be identified by CSI-RS for BM. |  | | |
| Samsung | We do not support introducing new QCL rule. We do not see the necessity of configure CSI-RS with repetition for this case, TRS would suffice for PDCCH/PDSCH DM-RS. |  | | |
| vivo | We share the similar view with Nokia that CSI-RS for BM is the QCL RS of the *CandidateTCI-State/ CandidateTCI-UL-State* is necessary. If not, according to the current specification, the TRS and PDCCH/PDSCH is transmitted and received by a wide Tx-Rx beam pair. Thus, the CSI-RS-based beam management procedure is meaningless. |  | | |
| CMCC | Support CSI-RS for BM as the *referenceSignal* with QCL-TypeD for an LTM TCI state. For event-triggered LTM, the RS for candidate cell is CSI-RS for BM or SSB, if LTM is triggered by the event evaluation, it is straight forward to indicate the CSI-RS for BM as LTM TCI state. Additionally, since SSB and TRS are wide beam, CSI-RS for beam management can enable quick narrow beam alignment in LTM procedure. |  | | |
| CATT | Low priority, given that TRS is already supported. |  | |
| ITRI | Prefer to support the CSI-RS for BM as the reference signal with QCL-TypeD for a LTM TCI state. |  | | |
| Huawei, HiSilicon | Shared similar view as Nokia. We support CSI-RS for BM as QCL type D RS for LTM TCI state as it speeds up the procedure for UE to use narrow beam after CSC. We think similar design is supported for serving cell. | |  | |
|  |  |  | | |

##### [FL Proposal 4-1-v2]

*FL note: companies views are still split. FL suggestion is going to online session directly.*

* CSI-RS for BM as the *referenceSignal* with QCL-TypeD is supported for an LTM TCI state, where TRS is configured as *referenceSignal* with QCL-TypeA
  + *FL note: this configuration has already been supported for Rel-17 unified TCI framework for a serving cell*
  + Support
    - Fujitsu, Nokia, DOCOMO, NEC, Lenovo, Xiaomi, CMCC, ITRI, Huawei
  + Not support (i.e. Rel-18 LTM mechanism with TRS is sufficient)
    - Ericsson, Google, ZTE, Samsung, CATT,

##### [Conclusion]

The following agreement was made during the online session on Monday.

**Agreement**

* CSI-RS for BM as the *referenceSignal* with QCL-TypeD is supported for an LTM TCI state, where TRS is configured as *referenceSignal* with QCL-TypeA

With this, the discussion of this section is closed.

### [Low] UE Rx beam management

##### [Agreements in previous meetings]

No agreements yet

##### [Summary of the contributions]

* Vivo
  + If UE Rx beam sweeping before cell switch is supported, corresponding NZP-CSI-RS resource set includes NZP-CSI-RS resources from a certain candidate cell and repetition “on” should be included for gNB scheduled reporting.
* Nokia
  + To enable CSI-RS-based beam management for LTM, RAN1 should discuss the following options to support UE Rx beam refinement based on CSI-RSs from candidate cells:
    - Option 1: Support RX beam refinement with candidate cell CSI-RSs with repetition set to ‘ON’ if semi-persistent CSI-RS are supported.
    - Option 2: Support RX beam refinement with candidate cell CSI-RSs with repetition set to ‘OFF’ only.
    - Option 3: No support for additional RX beam refinement using candidate cell CSI-RSs.
* CATT
  + Rx beam refinement with ‘repetition’ set to ‘on’ is supported for both gNB scheduled reporting and event triggered reporting.

##### [FL observation]

The issue on Rx beam refinement was discussed in this meeting based on the FL summary discussion at RAN1#118bis. Nevertheless, the input from the companies is not enough to proceed.

FL would like to suggest gathering the companies view again at this meeting based on the suggestion from Nokia.

##### [FL Proposal 4-2-v1]

* Companies are encouraged to provide their views on the options below to support UE Rx beam refinement based on CSI-RSs from candidate cells:
  + Option 1: Support RX beam refinement with candidate cell CSI-RSs with repetition set to ‘ON’ if semi-persistent CSI-RS are supported.
  + Option 2: Support RX beam refinement with candidate cell CSI-RSs with repetition set to ‘OFF’ only.
  + Option 3: No support for additional RX beam refinement using candidate cell CSI-RSs.

*FL note: this question is not intended for online agreement at this meeting*

##### [Comments to FL Proposal 4-2-v1]

|  |  |  |  |
| --- | --- | --- | --- |
| Company | Comment | FL reply | |
| Fujitsu | We support Option3. The purpose of the UE RX beam refinement is to obtain the best measurement results of candidate cell(s) as well as that of serving cell, because the RX beam refinement for serving cell is well-adjusted, but not for candidate cell. Consequently, in gNB side, fair comparison may not be conducted. In our understanding, such comparison gap may be controlled by the gNB such as to adjust offset in event LTM3. |  | |
| Ericsson | The specification impact of this is unclear. |  | |
| Nokia | With the support of SP CSI-RSs, option 1 can be allowed. |  | |
| ZTE | Before the motivation and spec impact are not analyzed clearly, we support option 3. |  | |
| NTT DOCOMO | We support Option-3 because this issue can be controlled by gNB. |  | |
| Spreadtrum | Support Option-3. |  | |
| Samsung | Motivation of the proposal is unclear to us. Whether UE-side beam refinement is conducted or not should be subject to the UE. |  | |
| CATT | We support RX beam refinement with candidate cell CSI-RSs with repetition set to ‘ON’ regardless of the time domain behavior of CSI-RS. |  |
| ITRI | Support option 3. |  | |
| LG | Same with ZTE, we should clarify motivation and spec impact first. |  | |
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## CSI acquisition for candidate cell(s)

### [High] CSI acquisition framework i.e. timing of measurement and reporting

##### [Agreements in the previous meetings]

**Agreement (RAN1#118bis)**

The following alternatives are further studied:

* Alt-1: CSI-RS measurement and CSI reporting operations are performed before reception of LTM Cell Switch Command (CSC) MAC CE.
  + The report is sent to the serving cell and transferred to the candidate/target cell(s)
* Alt-2: CSI-RS measurement can start before reception of LTM CSC MAC CE and CSI reporting operation is performed after reception of LTM CSC MAC CE.
  + The report is sent directly to target cell
* Alt-3: CSI-RS measurement and CSI reporting operations are performed after reception of LTM CSC MAC CE.
  + The report is sent directly to target cell

Companies are requested to provide the details of exact report timing and triggering mechanism in the next meeting

##### [Summary of contributions]

The difference of each option is summarized as follows. Note the common aspects are not captured here, e.g.

* Each LTM candidate need to provide its report configuration for CSI acquisition to the source cell.

It is noted that the aspects with green shadow are the potential benefit over other alternatives

|  |  |  |  |
| --- | --- | --- | --- |
|  | Alt 1 | Alt 2 | Alt 3 |
| Measurement trigger | Reuse legacy mechanism  DCI  MAC CE | New mechanism is needed  - Reuse/modify the current LTM CSI reporting mechanisms  - Candidate TCI state activation  - New L1/L2 mechanism  - LTM event triggered | CSC  RAR UL grant for RACH-based LTM |
| Candidate cells to be measured and overhead of CSI-RS resource | Multiple candidate cells  *Additional mechanism to limit/validate candidate cells to measure, e.g new MAC CE or modified Candidate TCI state activation MAC CE* | Multiple candidate cells before CSC  Target cell only after CSC | Target cell only |
| Storage time of measurement result | Short | Long | Short |
| Impact on cell switch delay due to CSI measurement | none | Exist if measurement is performed after CSC | Exist |
| Report trigger | Reuse legacy mechanism  DCI  MAC CE | CSC  RAR UL grant for RACH-based LTM  L1 measurement report | CSC  RAR UL grant for RACH-based LTM |
| Type of CSI resource for measurement | Periodic – issue on overhead (especially for large number of ports/candidate cell) needs discussion  Aperiodic? – should be aligned with L1 measurement  Semi persistent - should be aligned with L1 measurement | Periodic  Aperiodic? – should be aligned with L1-RSRP measurement  Semi persistent - should be aligned with L1-RSRP measurement  Discussion needed if measurement is performed before CSC and/or after CSC | Periodic  Aperiodic  Semi persistent |
| Report type | Periodic  Aperiodic  Semi persistent | Aperiodic is more appropriate  Feasibility on Periodic and Semi-persistent needs discussion | Aperiodic is more appropriate  Feasibility on Periodic and Semi-persistent needs discussion |
| Report resource | Reuse legacy mechanism | New mechanism is required, for example - PUSCH MSG 3 for RACH-based LTM cell switch - CSI reporting is carried in PUSCH scheduled by RAR UL grant if RACH-based cell switch is performed. - The first UL channel (either CG-based or DG-based PUSCH) after receiving cell switch command for RACH-less LTM, i.e. PUSCH carrying RRC Reconfiguration complete message - CG-PUSCH dedicated for the first CSI reporting in candidate cell. - UL channel scheduled by cell switch command - UL channel scheduled by target cell (e.g. based on the indication included in RRC reconfiguration complete message) - UE initiated report by MAC CE | New mechanism is required, for example - PUSCH MSG 3 for RACH-based LTM cell switch - CSI reporting is carried in PUSCH scheduled by RAR UL grant if RACH-based cell switch is performed. - The first UL channel (either CG-based or DG-based PUSCH) after receiving cell switch command for RACH-less LTM, i.e. PUSCH carrying RRC Reconfiguration complete message - CG-PUSCH dedicated for the first CSI reporting in candidate cell. - UL channel scheduled by cell switch command - UL channel scheduled by target cell (e.g. based on the indication included in RRC reconfiguration complete message) - UE initiated report by MAC CE |
| Report overhead | High if report contains the CSI for multiple candidate cells | Low because only the CSI for target cell is contained | Low because only the CSI for target cell is contained |
| Time gap from trigger to report | Same as legacy? Or Need discussion | Need discussion {Z, Z’}, which is the minimum time gap required for the UE for the serving cell, may not be applicable to “triggered by serving cell triggered – reported to target cell” | Same as legacy? Or need discussion |
| Report destination | Serving cell (and transferred to target cell) | Target cell | Target cell |
| Potential outdating of the measurement result | Yes  (Impacted by the transfer delay from serving cell to candidate cell, impact can be minimized by scheduler) | Yes or No depending on when the CSI measurement is performed | No |
| Other aspects |  | The report configuration for CSI acquisition should be shared between the source cell, the target cell and the UE. The UE should keep it over cell switch execution | The benefit over Rel-18 needs clarification |

* Companies’ preference
  + Alt 1 (15):
    - ZTE(1st), LG, CMCC, Spreadtrum, Nokia, CATT, IDC(2nd), OPPO, Fujitsu (2nd), Google, NEC, Sony, Meta, DOCOMO, KDDI
  + Alt 2 (12):
    - ZTE(2nd), Huawei, Nokia, Apple, Xiaomi, Ericsson, IDC(1st), Fujitsu(1st), Google, MediaTek, ETRI, Meta
  + Alt 3 (6):
    - vivo, Apple, NEC, Sony, MeidaTek, Sharp
  + Measurement timing should be decided first: Samsung
    - Alt 1or2 vs Alt 3

##### [FL observation]

Companies have provided their comprehensive study at this meeting. On the other hand, the analysis is too complicated due to various aspects to consider. Also, FL thinks that all alternatives will work even though the potential impacts are different for each option.

Rather than performing the comparison from multiple aspects, FL suggest performing down-selection based on the number of companies, i.e. drop alternative 3. The reason is that the benefit of Alt.3 is not clear, as many companies pointed out, over Rel-18 LTM while it has an impact on cell switch delay (i.e. interruption time), which is not aligned with LTM concept.

##### [FL proposal 5.1-v1]

* For CSI acquisition, only Alt 1 and 2 agreed in RAN1#118bis are further studied.

*FL note: FL suggests discussing this as a very first topic in RAN1#119 (i.e. on Monday online session). After the agreement in the first session, FL plan is to discuss the further details on Alt 1 and Alt 2 to conclude during RAN1#119.*

##### [Comments to FL Proposal 5-1-v1]

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Company | Comment | FL reply | | |
| Fujitsu | We agree the FL proposal to drop Alt.3. For Alt.1 and Alt.2, it is required the method to select candidate cells to be measured in order to reduce the measurement overhead in UE side. For Alt.1, the specification impact is less as existing CSI framework can be reused. Since Alt.1 has an additional process of reporting to serving cell and transferring to candidate cell, it takes more time from measurement to reporting to candidate cell than Alt.2, that is, the reliability from the perspective of result newness might be inferior to Alt.2. |  | | |
| Ericsson | OK to drop Alt3. |  | | |
| Google | Support FL proposal |  | | |
| Nokia | Support |  | | |
| ZTE | Support this proposal. |  | | |
| Spreadtrum | Support FL proposal |  | | |
| Lenovo | Support to move on with Alt1 and Alt2. |  | | |
| Xiaomi | We think Alt 3 can reduce the CSI measurement complexity at UE side. If only CSI of target cell is required to be measured with Alt 2, i.e., the measurement can be triggered after the target cell selection but before or at the same time as the CSC transmission, we are fine to keep Alt 2 and drop Alt 3. |  | | |
| Samsung | As pointed out by the FL, there are many design aspects need to considered if we treat both measurement and reporting parts altogether. As analyzed in our tdoc, we prefer to first address the measurement part first, which includes time domain behaviors of the measurement RSs, and the corresponding operations. After the measurement part is clear, we can discuss the subsequent reporting procedures – same discussion order as in other CSI measurement/reporting frameworks. |  | | |
| vivo | From the perspective of RS overhead, UE measurement overhead and computation complexity, Alt 3 is preferred most. However, if majority is to drop it because of its long cell switch latency, we can live up with it and accept Alt 1 with a prerequisite that the number of candidate cell on which UE can perform CSI measurement before the reception of cell switch command is only 1, i.e., the target cell. |  | | |
| CMCC | Support FL proposal and support Alt.1. As summarized by FL, Alt.2 also needs UE to measure multiple candidate cells before CSC, the resource overhead is same as Alt.1. While the spec impact of Alt.2 is large, e.g., how to trigger the aperiodic CSI report, how to define the CSI processing time, how to report the CSI. |  | | |
| CATT | Support. In our view, we may consider Alt.1 as the baseline, and Alt.2 as the further enhancements. |  | |
| InterDigital | Support FL proposal. |  | | |
| ETRI | Support FL proposal |  | | |
| ITRI | Support. |  | | |
| Huawei, HiSilicon | For Alt 1, we may need to check to RAN3 about the feasibility | |  | |
| LG | Support to narrow down the scope. |  | | |
| Apple | Fine to drop Alt.3 for progress. |  | | |
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##### [FL proposal 5.1-v2]

*FL note: according to the input in the 1st round, companies are OK to drop alt 3*

* For CSI acquisition, only Alt 1 and 2 agreed in RAN1#118bis are further studied.

##### [FL proposal 5-1-v3]

As suggested by Mr. Chair during the online session on Monday, FL would like to discuss the measurement aspect first.

The difference between measurement before CSC and after CSC is summarized below (which needs offline discussion for consolidation):

|  |  |  |
| --- | --- | --- |
|  | CSI measurement before CSC Alt 1, 2 | CSI measurement after CSC Alt 3 |
| Measurement trigger | Reuse/modify legacy mechanism: DCI, MAC CE  New mechanism, e.g. : Candidate TCI state activation A new DCI or MAC CE Triggered by LTM event (autonomous) | CSC (explicit field for measurement trigger or implicit)  RAR UL grant for RACH-based LTM |
| Candidate cells to be measured and overhead of CSI-RS resource | Multiple candidate cells before CSC *Additional mechanism to limit/validate candidate cells to measure, e.g new MAC CE or modified Candidate TCI state activation MAC CE*  Target cell only after CSC when the measurement is continued after CSC for alt 2 | Target cell only |
| Storage time of measurement results | Short for alt 1  Long for alt 2 | Short |
| Impact on cell switch delay due to CSI measurement | None  Exist if measurement is performed after CSC for alt 2. | Exist |
| Potential outdating of the measurement result | Yes or No Alt. 1 Impacted by the transfer delay from serving cell to candidate cell Alt 1 and 2: impact can be minimized by scheduler Alt2. No impact if the measurement is continued after cell switch command | No |

FL observation:

* Alt 1 or 2 (measurement before CSC)
  + Drawback 1: number of candidate cells to be measured
    - Proponents suggest introducing mechanism(s) to limit/validate candidate cells to measure
  + Drawback 2: Outdated CSI
    - Proponents suggest solving by gNB scheduler implementation
* Alt 3 (measurement after CSC)
  + Drawback 1: impact on cell switch delay
    - FL would like to understand if this can be mitigated or not

**Way forward?? To be updated after offline discussion on Wednesday**

* Alt 1 or 2 (measurement before CSC)
* Alt 3 (measurement after CSC)

##### [Comments to FL Proposal 5-1-v3]

Please provide your view on FL proposal 5-1-v3, especially for the table.

|  |  |  |
| --- | --- | --- |
| Company | Comment | FL reply |
| Nokia | We support to trigger measurements before CSC with some solution to minimize the number of measurements. But that does not mean that UE can not allow to update measurements for the target cell after receiving the CSC, specially when periodic CSI-RSs are used – this we can discuss further. |  |
| InterDigital | Regarding “Impact on cell switch delay due to CSI measurement” for Alt. 2/Alt. 3: is it assumed that the UE waits for CSI results to be available before executing cell switch? It would seem more reasonable that the UE executes cell switch regardless of whether CSI is available or not, and possibly provides the CSI results later when available. |  |
| ZTE | Support Alt1 and Alt2.  For Alt1/2, at least periodic CSI-RS can be supported first. While for Alt3, even if periodic CSI-RS is supported, it still cannot avoid introducing additional interruption latency to measure, and the length of latency depends on configured periodicity.  Regarding overhead of measurement for Alt1/2, CSI acquisition is performed per candidate cell. It is not difficult to control or reduce such overhead to measure. Besides, similar situation also exist in SSB based measurement in Rel-18 LTM, the overhead caused by measurement for all configured candidate cell was not seen as a problem at that time.  Regarding latency for Alt3, it depends on at least one of the following:   1. RS configuration to measure from RRC Pre-configuration before LTM or RRC corresponding to target configuration ID in LTM CSC MAC CE; 2. Periodicity if periodicity CSI-RS is supported; 3. Mechanism to trigger AP/SP CSI-RS if AP/SP CSI-RS is supported; For example#1, If a new CSI request field in LTM CSC MAC CE is used to trigger AP CSI-RS, latency is caused by time between LTM CSC MAC CE and AP CSI-RS (if CSI-RS resource is from RRC pre-configuration) , or, parsing time of RRC corresponding to target configuration ID in LTM CSC MAC CE (if CSI-RS resource is from RRC corresponding to target configuration ID) and need to consider how to determine staring point of triggering offset to AP CSI-RS. For example#2, the existing DCI is used to AP CSI-RS, latency is caused by time between LTM CSC MAC CE and DCI triggering AP CSI-RS, even may need to consider parsing time of RRC corresponding to target configuration ID in LTM CSC MAC CE. 4. Timeline between CSI reference resource and CSI reporting. Because transmission or measurement occasion of RS resource associated with the CSI reporting is no later than CSI reference resource.   In addition to latency for Alt3, mechanism to trigger AP/SP CSI-RS also needs spending more time to discuss. |  |
| Ericsson | Candidate cells to be measured: We should add that Alt-1 and Alt-2 can be limited to measurements on a single LTM candidate cell, for example a cell that has received a TCI state activation.  Storage time: With Alt-2, assuming periodic or SP CSI-RS, the UE keeps the latest measured CSI until the next transmission occasion or completion of cell switch.  Impact on cell switch delay: Impact on cell switch delay can be avoided for Alt-2. For example, with SP or periodic CSI-RS, the UE reports the latest measured CSI upon completion of cell switch. Alternatively, as suggested by InterDigital, the UE completes Cell Switch and reports the CSI later when it is available.  Although the alternatives have different specification impact, each one of them is feasible. |  |
| Fujitsu | Measurement can be performed at four places as below together with the selection of the candidate cells to be measured.  1) Reception of PDCCH order (Alt-1 and Alt-2): The serving cell can indicate the candidate cell to be measured via PDCCH order. In this case, follow-up procedures exist such as TCI state activate/deactivate, so the result may be outdated.  2) Reception of TCI state activation/deactivation MAC CE (Alt-1 and Alt-2): If only one MAC CE is used for the TCI state activation/deactivation, then only one cell can be designated for the measurement. Also, the newer measurement result compared to the timing of 1) can be obtained.  3) Reception of Cell Switch Command (Alt-3): The newest measurement result can be obtained, but large cell switch delay is expected.  4) Dedicated signal (Alt-1, Alt-2, Alt-3): Selection of candidate cell to be measured can be performed by the dedicated signal such as MAC CE. At this timing, UE can measure CSI. On the other hand, additional procedures/signals are required for this alternative.  Based on our analysis, the candidate cell selection can be achieved for Alt-1 and Alt-2 as well as Alt-3, and the comparatively newer measurement result can be obtained if the measurement is performed right before CSC. Therefore, we prefer Alt-1 and/or Alt-2 (i.e., measurement before CSC). |  |
| MediaTek | We have a suggestion. Each row in the table is related to one of these three aspects: 1) Spec impact, 2) Performance, 3) Complexity.  We would like to suggest adding one of these tags to the left column for each row. This way, it will be more clear to study the table. For example,   * Measurement trigger (spec impact) * Candidate cells to be measured and overhead of CSI-RS resource (complexity, performance) * Storage time of measurement results (complexity)   etc. |  |
|  |  |  |
|  |  |  |

##### [FL proposal 5-1-v4]

The difference between measurement before CSC and after CSC is summarized below (which needs offline discussion for consolidation):

|  |  |  |
| --- | --- | --- |
|  | CSI measurement before CSC Alt 1, 2 | CSI measurement after CSC Alt 3 |
| Measurement trigger (Spec impact) | Reuse/modify legacy mechanism: DCI, MAC CE  New mechanism, e.g. : Candidate TCI state activation A new DCI or MAC CE Triggered by LTM event (autonomous) | CSC (explicit field for measurement trigger or implicit)  RAR UL grant for RACH-based LTM |
| Candidate cells to be measured and overhead of CSI-RS resource (complexity, performance) | Multiple candidate cells before CSC *Additional mechanism to limit/validate candidate cell(s) to measure, e.g new MAC CE or modified Candidate TCI state activation MAC CE, implicitly limit to activated TCI state(s) or cell indicator field of PDCCH order*  Target cell only after CSC when the measurement is continued after CSC for alt 2 | Target cell only |
| Storage time of measurement results (complexity) | Short for alt 1  For alt 2 Long if one measurement is kept until the reporting occasion Short if the measurement is updated by using periodic CSI-RS reource | Short |
| Impact on cell switch delay due to CSI measurement  (Spec impact) | None for alt 1.  For alt 2, if measurement is performed after CSC, impact on cell switch delay exists. Otherwise, no impact.  ~~Exist if measurement is performed after CSC for alt 2.~~ | Exist, and the delay depends on  1. the timing of available CSI-RS resource and its triggering mechanism 2. Which how the RRC configuration of CSI-RS is provided, LTM-config or CellGroupConfig of the target cell |
| Potential outdating of the measurement result (performance) | Yes or No Alt. 1 Impacted by the transfer delay from serving cell to candidate cell Alt 1 and 2: impact can be minimized by scheduler and/or by keeping the measurement even after CSC until report is performed Alt2. No impact if the measurement is continued after cell switch command | No |

**Way forward?? To be updated after offline discussion on Wednesday**

* Alt 1 or 2 (measurement before CSC) – supported by xxx
  + Major drawbacks are UE complexity to handle number of candidate cells to be measured and potential outdated CSI
    - It is noted that proponent companies have already provided potential solutions
  + Necessary mechanism to go with Alt. 1 or 2
    - measuring only one candidate cell based on UE capability, and its triggering/indication mechanism
* Alt 3 (measurement after CSC) – supported by xxx
  + Major drawback is the potential additional cell switch delay caused by CSI measurement for a target cell, which needs RAN4 work
* Offline consensus is that both approaches are feasible even though their pros/cons are different

### [Closed] Time domain property of CSI reporting

##### [Summary of contributions]

* ZTE
  + For Alt-1, periodic, semi-persistent and aperiodic CSI report should be supported
  + For Alt-2/3, at least the following aspects should be discussed before supporting aperiodic CSI reporting:
    - Signaling to trigger AP CSI reporting, e.g., LTM CSC MAC CE or RAR UL grant
    - UL resource to carry AP CSI reporting, e.g., DG/CG-PUSCH to carry RRC Reconfiguration Completion, or PUSCH MSG 3
    - Timeline between signaling triggering AP CSI reporting and AP CSI transmission
* Huawei
  + Only support aperiodic CSI reporting for CSI acquisition to target cell during LTM cell switch.
* LG
  + The aperiodic CSI report triggered by DCI is supported for CSI acquisition on candidate cell.
* TCL
  + For Alternative 1, at least aperiodic CSI reporting should be supported.
  + For Alt 2, support semi-persistent and/or aperiodic CSI reporting triggered by the CSC MAC CE.
  + For Alt 3, support prioritizing aperiodic CSI measurement and reporting triggered by the CSC MAC CE.
* OPPO
  + Only support aperiodic CSI reporting is supported for candidate cell.
* Fujitsu
  + Support at least aperiodic CSI reporting for CSI acquisition.
* NEC
  + For Alt-3, AP CSI reporting can be considered.
* Qualcomm
  + Semi-persistent or aperiodic CSI reporting is applied.
* Sharp
  + Support aperiodic CSI reporting for RI, PMI, and CQI before reception of cell switch command if Alt-1 is supported. FFS: Supporting periodic and semi-persistent CSI reporting.
* CATT
  + Only aperiodic report on PUSCH is supported for CSI acquisition of candidate/target cell(s).

##### [Conclusion]

Clear majority of the companies show the interest on aperiodic reporting, which is reasonable to avoid the unnecessary reporting. FL thinks we can support at least aperiodic reporting, but the decision highly depends on the alternative (in section 5.5.1) to take.

Given this situation, FL suggest postponing the decision in the next meeting, i.e. after the clarity of the CSI acquisition framework.

### [Closed] Time domain property of CSI-RS transmission

##### [Summary of contributions]

* ZTE
  + At least periodic CSI-RS should be supported regardless of which framework of early CSI acquisition to be adopted.
  + periodic CSI-RS should be supported if Alt-2 is supported to reduce interruption latency.
* Huawei
  + At least periodic and semi-persistent CSI-RS transmission for CSI acquisition should be supported from RAN1 perspective. Whether to support Aperiodic CSI-RS for CSI acquisition could be discussed together with CSI-RS for BM.
* Apple
  + Support CSI asqusition for candidate cells only based on periodic and semi-persistent CSI-RS.
  + Support of CSI acqusition based on semi-persistent CSI-RS is subject to UE capability.
* CATT
  + At least aperiodic CSI-RS is supported for CSI acquisition of candidate/target cell(s).
* Ericsson
  + Support CSI acquisition on candidate cells based on periodic CSI-RS.
* TCL
  + Support the periodic CSI measurement of candidate cell(s).
* Qualcomm
  + Alt-1: Semi-persistent or aperiodic CSI-RS resources, if supported, are used.
  + Alt-2/3, Semi-persistent or aperiodic CSI-RS resources are used.

##### [Conclusion]

FL thinks the decision highly depends on the alternative (in section 5.5.1) to take. Given this situation, FL suggest postponing the decision in the next meeting, i.e. after the clarity of the CSI acquisition framework.

### [Closed] 2nd level details for CSI acquisition

*FL note: FL has no intention to discuss the issues categorized here in this meeting because they have a strong dependency on the CSI acquisition framework (timing of measurement and reporting)*

##### [Summary of contributions]

**Restrictions on the CSI configurations]**

* ZTE
  + For report quantity of CSI acquisition, it is proposed to support 'cri-RI-PMI-CQI' and 'cri-RI-CQI' if SRS transmission is supported in Rel-19 LTM.
  + For codebook type of CSI acquisition, at least Rel-15 Type I codebook and Rel-19 enhanced Type I codebook should be supported.
* Huawei
  + For the CSI report before or during the LTM cell switch, at least cri-RI-PMI-CQI with wideband CQI/PMI and Type-I codebook should be supported.
* LG
  + CQI-PMI-RI is supported as a report quantity of LTM CSI report.
* CMCC
  + Support CSI report with CRI, CQI, PMI and RI.
  + For PMI reporting, support both wideband and sub-band Type I codebook.
* Samsung
  + Regarding the supported CSI reporting modalities (e.g. report quantities and codebooks/codebook configurations) for CSI acquisition for candidate cell(s), RAN1 should do at least the following:
    - Feasibility assessment via various aspects of all the supported CSI reporting modalities in relation to the CSI-RS measurement aspects, in the context of the reception/application of LTM CSC and the corresponding RACH procedure before making down-selection
    - Benefit assessment via the customary system-level simulation with the user perceived throughout (UPT) statistics as the metrics, using L1-RSRP as the baseline, and fully reusing the Rel-19 CSI EVM (cf. AI 9.2.2).
* Spreadtrum
  + For UE complexity reduction and power saving, some configuration for CSI acquisition on candidate cells should be limited, e.g.
    - only Type I codebook is configured,
    - the number of CSI-RS ports per CSI-RS resource not exceeds 32,
    - the number of candidate cells for CSI measurement not exceeds N (e.g. 1 or 2).
    - RRC parameter reportQuantity in LTM-CSI-ReportConfig is used to indicate LTM beam report or LTM CSI report.
* Vivo
  + Support wideband Type 1 CSI reporting only, i.e. wideband PMI and CQI as report quantity.
* Nokia
  + support the reporting of CRI, CQI, PMI, and RI, where PMI is based on the Type 1 codebook.
* Apple
  + Support the report quantity configuration of ‘CRI-RI-PMI-CQI’ for Type-1 codebook for CSI report of candidate cell
* CATT
  + For CSI acquisition of candidate/target cell(s), support CSI report for Type-I codebook with report quantity configured with ‘CRI-RI-PMI-CQI’.
* Lenovo
  + At least support wideband CSI acquisition including WB CQI, RI and WB PMI acquisition for candidate cells before cell switch for LTM. FSS: support of subband CSI acquisition.
* Ericsson
  + Adapt LTM-CSI-ReportConfig to support relevant report quantities, including cri-RI-PMI-CQI.
  + Support reporting of CRI, CQI, PMI and RI for a Type I codebook for a candidate cell before or after LTM cell switch.
  + Support Type I codebook with up to 128 ports for CSI acquisition on candidate cells
* OPPO
  + For CSI measurement of candidate cell, the MIMO CSI framework is re-used:
    - Only support Type 1 single-panel codebook
    - Support wideband PMI, CQI and RI reporting
    - One NZP CSI-RS resource can be configured for CSI resource for a candidate cell.
* Google
  + On CSI acquisition for LTM cell switch, Type I codebook is supported.
  + On CSI acquisition for LTM cell switch, UE at least reports CQI, PMI, RI and CRI.
  + On CSI acquisition for LTM cell switch, do not support Type II codebook and subband reporting.
* DOCOMO
  + For the report contents of CSI acquisition for candidate cells,
    - Support configuration of Type I SP codebook only for candidate cell.
    - Support CRI, CQI, PMI and RI for a Type I SP codebook.

*FL note: after the successful completion of framework discussion in section 5.5.1, FL plans to discuss this issue in the next meeting.*

**Format of CSI report**

* Spreadtrum
  + The LTM CSI report includes the candidate cell IDs and their CSIs, where the number of reported candidate cells is configured by gNB.

**CSI-RS Resource configuration**

* ZTE
  + Similar CSI-RS configuration framework as BM should be reused for CSI acquisition.
    - CSI-RS resource(s) for candidate cell(s) for L1 measurement can be explicitly configured
* Huawei
  + Support unified CSI-RS resource configuration design for BM and CSI acquisition for LTM candidate cells.
  + Support UCI-based CSI reporting to target cell during LTM cell switch.
* Apple
  + A number of CSI-RS measurement resource sets are explicitly configured in LTM-Candidate IE for a candidate cell before cell-switch command MAC-CE.

**UE Capability**

* Samsung
  + Supporting CSI acquisition on candidate cell(s) before or during LTM cell switch should be based on new UE capabilities.

**Report priority**

* LG
  + Priority rules between LTM CSI report is introduced based on the existing priority rule.
    - LTM CSI report carrying L1-RSRP is prioritized to the LTM CSI report not carrying L1-RSRP.
* Spreadtrum
  + LTM beam report has a higher priority in case of collision with LTM CSI report, while both LTM beam report and LTM CSI report have a higher priority than CSI report configured with

**Others**

* LG
  + Discuss CSI reference resource and UE assumption for CQI/PMI/RI calculation to enable CSI acquisition for LTM.
    - there are several agreed UE assumptions to derive the CQI/PMI/RI calculation which is described in section 5.2.2.5.1 of TS 38.214
* LG
  + LTM CSI-RS resource only dedicated for the CQI acquisition is not supported.

##### [Conclusion]

The discussion of this section is closed without any FL proposals.

## [Closed] Conditional LTM

*FL note: the discussion will be kicked off after more clarity of the RAN1 tasks, RAN1#120 or later.*

##### [Summary of contributions]

* Huawei
  + RAN1 should at least discuss how to acquire the TA of candidate cell and how to determine the joint/separate DL/UL LTM TCI state of target cell for the conditional LTM.
* CATT
  + For Rel-19 CLTM, two thresholds can be defined to select target cell from candidate cells configured in *RRCReconfiguration*. The first threshold is used to select candidate cells for downlink and uplink synchronization, and the second threshold is used to determine the target cell for cell switch.
  + For PDCCH ordered RACH-based TA acquisition mechanism for CLTM, support a UE to send a request to indicate the candidate cells for TA acquisition.
  + For PDCCH ordered RACH based TA acquisition mechanism for conditional LTM, following options are considered for TA delivery:
    - RAR from the candidate cell
    - RAR from the serving cell
    - MAC CE from the serving cell
    - FFS: whether the MAC CE carries the TAs for multiple candidate cells.
  + For PDCCH ordered RACH-based TA acquisition mechanism for CLTM, TA validity maintenance is performed at the UE, where UE-based TA acquisition is applied to obtain the delta\_TA which is used to update the TA on the TA acquired by PDCCH ordered RACH. Delta\_TA is calculated by measuring the timing difference of SSB/CSI-RS received from serving cell and candidate cells.
* Sharp
  + Support UE to determine TCI states for candidate cells by itself in conditional LTM.

##### [Conclusion]

The discussion of this section is closed without any FL proposal since the agreements in RAN2 are not enough to trigger RAN1 discussion. Interested companies are encouraged to closely look at the discussion in RAN2.