**3GPP TSG RAN WG1 #118b R1-2408357**

**Hefei, China, October 14th – 18th, 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]

##### [Proposals for Wednesday Online]

##### [Proposals for Thursday Online]

##### [Proposals for Friday Online]

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# List of Contributions

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| --- | --- | --- |
| [**R1-2407658**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2407658.zip) | Measurements related enhancements for LTM | Huawei, HiSilicon |
| [**R1-2407719**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2407719.zip) | Discussion on measurements related enhancements for LTM | Spreadtrum Communications |
| [**R1-2407777**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2407777.zip) | Discussion on measurements related enhancements for LTM | ZTE Corporation, Sanechips |
| [**R1-2407876**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2407876.zip) | Discussion on measurements related enhancements for LTM | vivo |
| [**R1-2407918**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2407918.zip) | Discussion on measurements related enhancements for LTM | CMCC |
| [**R1-2407981**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2407981.zip) | Measurements related enhancements for LTM | Xiaomi |
| [**R1-2408062**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408062.zip) | Discussion on measurements related enhancements for LTM | CATT |
| [**R1-2408090**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408090.zip) | Discussion on measurements related enhancements for LTM | LG Electronics |
| [**R1-2408168**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408168.zip) | Discussions on measurement enhancement for LTM | OPPO |
| [**R1-2408203**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408203.zip) | Measurements related enhancements for LTM | Lenovo |
| [**R1-2408305**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408305.zip) | Discussion on measurement related enhancements for LTM | Lekha Wireless Solutions |
| [**R1-2408353**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408353.zip) | Measurement related enhancements for LTM | Panasonic |
| [**R1-2408372**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408372.zip) | Discussion on measurements related enhancements for LTM | Google |
| [**R1-2408379**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408379.zip) | Discussion on measurements related enhancements for LTM | NEC |
| [**R1-2408423**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408423.zip) | Measurements related enhancements for LTM | Sony |
| [**R1-2408433**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408433.zip) | Measurements related enhancements for LTM | InterDigital, Inc. |
| [**R1-2408486**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408486.zip) | Measurements enhancements for LTM | Apple |
| [**R1-2408497**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408497.zip) | Measurements enhancements for LTM | TCL |
| [**R1-2408508**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408508.zip) | Discussion on measurement related enhancements for LTM | Fujitsu Limited |
| [**R1-2408542**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408542.zip) | Discussion on measurements related enhancements for LTM | Sharp |
| [**R1-2408577**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408577.zip) | Discussion on measurements related enhancements for LTM | ETRI |
| [**R1-2408605**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408605.zip) | Measurement related enhancements for LTM | Ericsson |
| [**R1-2408661**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408661.zip) | Views on Rel-19 measurement related enhancements for LTM | Samsung |
| [**R1-2408714**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408714.zip) | LTM measurements related enhancements | MediaTek Inc. |
| [**R1-2408722**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408722.zip) | Measurement related enhancements for LTM | Nokia |
| [**R1-2408800**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408800.zip) | Discussion on measurement related enhancements for LTM | NTT DOCOMO, INC. |
| [**R1-2408865**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408865.zip) | Measurements related enhancement for LTM | Qualcomm Incorporated |
| [**R1-2408886**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408886.zip) | Discussion on measurements related enhancements for LTM | KDDI Corporation |

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| R1-2408356 | FL plan for mobility enhancements in RAN1#118bis | Moderator (Fujitsu) |
| R1-2408357 | FL summary 1 of Measurements related enhancements for LTM | Moderator (Fujitsu) |
| R1-2408358 | FL summary 2 of Measurements related enhancements for LTM | Moderator (Fujitsu) |
| R1-2408359 | FL summary 3 of Measurements related enhancements for LTM | Moderator (Fujitsu) |
| R1-2408360 | Final FL summary of Measurements related enhancements for LTM | Moderator (Fujitsu) |

# Discussion

## L1 measurement based on CSI-RS

### [High] 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

##### [Summary of contributions]

**Introduction of L1-SINR based on CSI-RS**

* Support L1-SINR (9)
	+ Huawei, LGE, Lekha, TCL, Fujitsu, Ericsson, DOCOMO, Qualcomm, KDDI
* Not support L1-SINR in Rel-19 (9)
	+ Spreadtrum(?), ZTE, vivo, xiaomi, CATT, IDC, Samsung, MediaTek, Nokia

Discussion points to make the decision:

* Benefit: better candidate cell qualification considering interference especially for inter-frequency scenario, e.g.
	+ Band X: high RSRP but very high interference due to dense deployment
	+ Band Y: low RSRP but no interference thanks to isolated deployment
* UE complexity to measure multiple resources for interference measurement
	+ IMR would be available, which can be configured in *LTM-CSI-ReportConfig*
	+ How about usinga single *NZP-CSI-RS-resource* for interference measurement?
* Unstable measurement results due to fluctuation of interference
	+ Introduction of L1 specified filtering is proposed
* Complicated design of UE capability(ies)
* Intra- and/or inter-frequency
	+ It is pointed out at least inter-frequency should be supported
* RAN1 and RAN4 workload

##### [FL Observation]

Given the split view from companies, it is not easy to make the decision on majority basis.

The situation can be summarized as follows considering the discussion so far.

* FL thinks the proponents have already provided the reason why L1-SINR is necessary on top of L1-RSRP (i.). It is not so clear why the rationale does not make sense – take some time to discuss during the meeting.
* The solution to configure IM has been proposed
* Filtering is proposed to overcome the unstable interference.
* It is not still clear yet if the necessary standardization work will fit into the allocated TUs in RAN1 and RAN4.

It is noted that the introduction of L1-SINR should be decided in this meeting to finalize stage 2 discussion in time.

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

* Alt.1 Support L1-SINR measurement based on CSI-RS: Supported by Huawei, LGE, Lekha, TCL, Fujitsu, Ericsson, DOCOMO, Qualcomm, KDDI (9)
	+ L1 specified filtering is applied for the reported measurement results
	+ IMR is [not] provided for interference measurement [in *LTM-CSI-ReportConfig*]
	+ Support [Intra- and] inter-frequency scenario(s)
	+ [ask RAN4 if it is feasible to finish the work within the allocated TUs]
* Alt.2 Not support L1-SINR measurement based on CSI-RS in Rel-19: Supported by Spreadtrum, ZTE, vivo, xiaomi, CATT, IDC, Samsung, MediaTek, Nokia (9)

*FL note: offline discussion may not help considering the long history of this topic. FL suggestion is to directly go to online session for final decision.*

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

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| --- | --- | --- |
| Company | Comment | FL reply |
| Fujitsu | All concerns and corresponding solutions of the introduction L1-SINR have been well-studied in the proponents’ contributions. The remaining issue is how to proceed the discussion within the limited time. From our perspective, we can restrict the L1-SINR measurement and reporting only in the event triggered reporting. |  |
| Ericsson | Previously we were concerned about the RAN4 workload, but after internal check, this seems less of an issue – the additional RAN4 work to support L1-SINR seems small. As far as we have seen from the discussion, no one really questions that L1-SINR is useful. As always, new functionality will be subject to UE capability.  |  |
| Xiaomi | Prefer alt 2. |  |
| TCL | Some companies are concerned that interference is not stable within a single slot. We believe that L1-SINR can be used as a condition for event-triggered L1 measurement reporting, since *TimeToTrigger* has been agreed upon for event-triggered L1/L2 reporting in RAN2 |  |
| NTT DOCOMO | We believe L1-SINR is important for mobility operation especially for inter-F scenario. We’re okay with subject to UE capability. |  |
| ZTE | We don’t tend to limit L1-SINR only for event triggered reporting if supported. From our perspective, we would like to know that if L1-SINR is agreed, what type of interference measurement resource may be used to perform interference measurement, ZP CSI-RS, or NZP CSI-RS, or both. |  |
| Samsung | Supporting L1-RSRP would suffice for mobility purposes. We do not see a need to support L1-SINR as an additional metric even for event-triggered schemes and specify the corresponding enhancements. From the above observations, it is quite obvious that there is no consensus to support L1-SINR.  |  |
| OPPO | L1-SINR is not proper measurement metric for LTM, especially considering L1-RSRP is already supported. The L1-SINR does have concerns of dynamic interference measurement. The time for tigger does not resolve this concern. SINR-type measurement can only be used for link adaptation, not cell switch.  |  |
| vivo | Prefer Alt.2. |  |
| Google | We share similar views as DOCOMO and support introducing that.  |  |
| Nokia | Given that we have limited TUs in RAN1, and supporting L1-SINR will open multiple aspects to resolve further like, what kind of IMR resources and the relevant configuration details, L1 filtering, reporting mechanism (e.g., as mentioned by TCL above that it can only be applicable to event triggered reporting) we prefer Alt.2. |  |
| CATT | Support Alt.2. For Alt.1, it is unclear how to apply L1 specified filtering for SINR measurement results, given that we so far don’t even have an agreement on L1 specified filtering for RSRP. It is unclear whether/how IMR is provided for interference measurement. It is also not quite clear why the L1-SINR is more important in the event triggered reporting than in the gNB scheduling reporting. |  |
| CMCC | Support L1-SINR for both gNB scheduled and event triggered reporting. Interference level is a key factor for handover. However, in legacy, CMR and IMR are one-to-one mapping, which may increase the resource overhead for UE to measure all the candidate cells. The method to reduce the overhead for IMR measurement should be further discussed. |  |
| Huawei, HiSilicon | We support to specify L1-SINR for LTM as it provide more comprehensive information for gNB to determine cell switch. The support of L1-SINR can be based on UE capability. however, we would like to split the discussion of L1 filtering from the L1-SINR. We think the filtering can be up to UE/NW implementation.  |  |
| Qualcomm | We support Alt-1. We don’t think the additional workload, both in RAN1 and RAN4, would be too excessive, considering that we already have different baselines that we can start with, such and Rel-18 discussion and existing design for beam management. |  |
| Lenovo | We think L1-RSRP should be sufficient for mobility. Considering that interference may be dynamic among different cells, SINR may not be suitable for LTM |  |

### [High] Support of intra- and inter frequency measurement

##### [Agreements in previous meetings]

No agreements yet

##### [Summary of contributions]

**Support of intra- and inter frequency CSI-RS based L1-measurement**

* Yes: Huawei, Spreadtrum, ZTE, vivo, LGE, Lekha, IDC, Fujitsu, Samsung, MediaTek

**Details of the definition**

* Up to RAN4:
	+ Spreadtrum, vivo, Fujitsu, MediaTek
* Use existing definition: Samsung
	+ FL note: the current definition is made by RAN4, then the final decision can be made by RAN4
* Discuss in RAN1: Huawei
	+ The CSI-RS based L1 measurement is defined as intra-frequency measurement provided that the bandwidth of NZP-CSI-RS resource(s) of a candidate cell is within the DL active BWP of the serving cell, and the SCS/CP of the NZP-CSI-RS resource(s) of a candidate cell and the DL active BWP of the serving cell are same. It should be further discussed when the DL active BWP of the serving cell is within the bandwidth of NZP-CSI-RS resource(s) of a candidate cell.



##### [FL Observation]

No companies showed their concern to support intra- and inter frequency CSI-RS based L1-measurement. The issue is which working group (i.e. RAN1 or RAN4) will specifies the definition of intra and inter frequency. Clear majority thinks this should be done in RAN4 while one company suggests RAN1.

To move forward, FL would like to suggest leaving this issue to RAN4 but the proposal from Huawei can be included in the LS.

##### [FL Proposal 1-2-v1]

* Support of intra- and inter-frequency CSI-RS based L1-measurement from RAN1 perspective
* Send an LS to RAN4 to specify the definition of intra- and inter-frequency including the following request:
	+ RAN4 to discuss the following case when the DL active BWP of the serving cell is within the bandwidth of NZP-CSI-RS resource(s) of a candidate cell, where the SCS and CP of the NZP-CSI-RS resource(s) at the candite cell is the same as serving cell.
	+ 

##### [Comments to FL Proposal 1-2-v1]

|  |  |  |
| --- | --- | --- |
| Company | Comment | FL reply |
| Fujitsu | Support the FL Proposal 1-2-v1 |  |
| Ericsson | Support the first bullet. We do not see the need to ask RAN4 to do special things. We’ve already seen the above proposal in RAN4 contributions. |  |
| Xiaomi | Fine to support intra- and inter-frequency CSI-RS based L1-measurement and the definition can be decided by RAN4. |  |
| TCL | Support the first bullet. We agree the Ericsson’s opinion, for the second bullet, the same question has been study in RAN4;  |  |
| Spreadtrum | Support the FL Proposal. |  |
| NTT DOCOMO | Agree with Ericsson. |  |
| ZTE | RAN1 only needs to focus on whether to support intra- and inter-frequency measurement. As for the definition and how to define, they can be left to RAN4. |  |
| Samsung | Fine with the first bullet. |  |
| InterDigital | Support first bullet |  |
| OPPO | 1st bullet is fine.But the 2nd bullet of asking RAN4 to do their work seems not needed.  |  |
| vivo | Support the definition of intra- and inter-frequency CSI-RS based L1-measurement is left to RAN4. But the additional request may be not needed. |  |
| Google | Support in principle. Regarding whether to send LS can be further discussed.  |  |
| Nokia | Support 1st bullet. No need to send any information to RAN4 as this will be discussed in anyway there. |  |
| CATT | Support first bullet. For the second bullet, it is up to RAN4 to define the measurements. It might be good enough to have a note for that instead sending may an LS to RAN4. |  |
| CMCC | Support the first bullet. |  |
| Huawei, HiSilicon | We are supportive of both inter and intra frequency measurement. However, when we make agreement to support them, we should at least have an assumption what is the inter and intra frequency measurement before we send LS to RAN4. Otherwise, there may be confusion between RAN1 and RAN4 whether we are talking the same thing. In R18 LTM, similar exercises were applied when RAN1 agreed on the inter/intra frequency measurement based on SSB. |  |
| Qualcomm | Support the proposal. We generally agree with other companies view that the first bullet should suffice. |  |
| NEC | Support FL’s proposal. |  |
| Lenovo | We think the first bullet is sufficient. |  |

### [High] Time domain property of CSI-RS for 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 Aperiodic CSI-RS transmission**
	+ Yes (9): Huawei, CATT, Lenovo, Lekha, Sony, TCL, Fujitsu, Ericsson (from RAN1 perspective), DOCOMO
		- To obtain L1 measurement results with a specific and short timeline
		- RS overhead reduction – adaptive transmission considering the UE speed
		- At least for Intra-DU. FFS (in RAN2/RAN3) for Inter-DU, Inter-CU case – an LS may be needed
		- To avoid unnecessary interference
		- Not to prevent NES operation
	+ No (5): Spreadtrum, OPPO, IDC, Samsung (if the impact is big), MediaTek
		- Additional UE signaling needed
		- Coordination between gNBs and the latency to start the CSI-RS transmission
		- Not useful for event evaluation, which requires periodic monitoring by the UE
	+ Further discussion: Nokia
		- The need for semi-persistent and aperiodic CSI-RSs for LTM should be discussed in the context of CSI-RS-based beam management (e.g. repetition=on) and CSI acquisition procedures.
* **Support of Semi-persistent CSI-RS transmission,**
	+ Yes (11): Huawei, Xiaomi, CATT, OPPO, Lenovo, Lekha, Sony, TCL, DOCOMO, Fujitsu, Ericsson (from RAN1 perspective)
	+ No (4): Spreadtrum, IDC, Samsung (if the impact is big), MediaTek
		- Further discussion: Nokia

##### [FL Observation]

While most of the use cases are covered by periodic CSI-RS, additional benefits by semi-persistent/aperiodic CSI-RS are provided by the proponents while a couple of technical challenges are pointed out, i.e. the coordination between serving cell and candidate cell(s). Given the number of the supporting companies and the potential benefits, FL suggests supporting both aperiodic and semi-persistent CSI-RS transmission. If it is necessary to address the concern on aperiodic (which requires more frequent coordination between gNBs), RAN1 can support only semi-persistent CSI-RS (on top of periodic) because less concerns are observed from the proposals.

FL preference is to separately discuss necessity of repetition=on(section5.4.2) and CSI-acquisition(5.5.3) to keep the discussion isolated as much as possible.

Regarding the necessity of the coordination between gNBs, the discussion can be easier if the use case is limited to intra-DU and/or intra-CU case scenarios. Otherwise, an LS to RAN3 would be needed to specify the necessary signaling.

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

* Semi-persistent [and aperiodic] CSI-RS is supported for L1-RSRP measurement for candidate cell
	+ Alt 1: Supported for only intra-DU/CU case
	+ Alt-2: Supported for both intra- and inter-DU/CU case, and send an LS to RAN3 to define the necessary signaling to start/stop the CSI-RS transmission

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

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| --- | --- | --- |
| Company | Comment | FL reply |
| Fujitsu | Although periodic CSI-RS transmission was already agreed, it is inevitable to occur the interference and disturb NES operation. From our point of view, both or either of semi-persistent and aperiodic CSI-RS transmission which is controllable by NW. |  |
| Xiaomi | Fine to support semi-persistent CSI-RS, but not prefer aperiodic CSI-RS.  |  |
| TCL | We think this issue need further study. |  |
| Spreadtrum | Suggest listing the possible spec impact for further discussion on the necessity of supporting SP/AP-CSI-RS, e.g. SP-CSI-RS activation/deactivation for candidate cell, AP-CSI-RS triggering for candidate cell, timing for above activation/triggering and so on. |  |
| NTT DOCOMO | We support semi-persistent and aperiodic CSI-RS from specification perspective. NW can decide/choose which type to use in implementation. |  |
| ZTE | It is useful to support SP and AP CSI-RS since it can avoid some unnecessary measurement at UE side. Besides, from RAN1 perspective, it is invisible that current measurement is intra-DU, inter-DU intra CU or inter-CU and can be said to be indistinguishable. So we don’t tend to limit it in RAN1. |  |
| Samsung | We think more discussions are needed for this issue. At least we need to decouple SP and AP as they use quite different triggering/activation mechanisms.  |  |
| InterDigital | To clarify, we think A-CSI-RS may be necessary for CSI acquisition of candidate/target cell. We prefer that both are supported and possibly restrict to intra-DU/CU (Alt. 1) |  |
| OPPO | We are ok with semi-persistent CSI-RS. But for AP CSI-RS, further discussion is needed to check whether it is feasible.  |  |
| vivo | Do not support this proposal. In our view, periodic CSI-RS resource for BM is already sufficient. It is unnecessary to introduce semi-persistent and aperiodic CSI-RS resource for BM. If introduced, additional spec efforts on RAN1&RAN2&RAN3 will be required, which are listed by Spreadtrum. |  |
| Google | We support SP and AP CSI-RS. We prefer Alt2. SP and AP CSI-RS have been supported in R18, and we do not see any further issue from RAN1 POV.  |  |
| Nokia | OK with Alt1 with intra-DU only. We can discuss inter-DU cases later.  |  |
| CATT | Support SP/AP CSI-RS for L1-RSRP measurement for candidate cell. |  |
| CMCC | Support SP and AP CSI-RS. For CSI acquisition, AP CSI-RS is needed to provide AP CSI reporting for target cell.  |  |
| Huawei, HiSilicon | We support both AP and SP CSI-RS at least for intra DU scenario. Whether to support inter DU or inter CU can be left for RAN2/3 decision according to their investigation on the higher layer message exchange. From RAN1 perspective, we do not see big difference from intra DU case. The conclusion made here can be applied to CSI acquisition before CSC as well. |  |
| Qualcomm | We are generally fine with the proposal. However, we think RAN1 is transparent to the Alt-1 and Alt-2 and need not discuss them.  |  |
| Lenovo | We agree with DOCOMO that semi-persistent and aperiodic should be supported from specification perspective.  |  |

### [Mid] 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): CATT, LGE, Samsung
	+ 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)
* No(8): Huawei, Fujitsu, vivo, Ericsson, MediaTek, Nokia, DOCOMO, Qualcomm
	+ *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.

##### [FL Observation]

Clear majority doesn’t see the necessity to introduce CSI-RS for mobility for L1 measurement. The benefit proposed by the opponents 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

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

|  |  |  |
| --- | --- | --- |
| Company | Comment | FL reply |
| Fujitsu | We support FL proposal.  |  |
| Ericsson | Maybe it’s too early to declare ‘no consensus’. Technically, as we understand it, we can reuse a transmitted ‘CSI-RS for mobility’ also for LTM – it’s just a special case of ‘CSI-RS for beam management‘ |  |
| TCL | We support this proposal. |  |
| Spreadtrum | Support the conclusion. |  |
| NTT DOCOMO | Support |  |
| ZTE | Support the proposal |  |
| Samsung | We also think it is too early to make a conclusion of no consensus. |  |
| InterDigital | Support |  |
| OPPO | Support |  |
| vivo | Support |  |
| Google | Support  |  |
| Nokia | Support |  |
| CATT | Too early to make a conclusion of no consensus. ‘CSI-RS for mobility’ is configured specifically for mobility, while cell switching is just simply a special case of mobility. It is obviously beneficial to reuse CSI-RS for mobility for the cell switching. |  |
| Huawei, HiSilicon | Support. Report L3 result in L1 container is up to RAN4 same as in R18 |  |
| Qualcomm | We support the conclusion. |  |
| NEC | Support |  |
| Lenovo | Support |  |

### [Low] QCL source of CSI-RS for candidate cells

##### [Agreement of previous meetings]

No discussions

##### [Summary of contributions]

**QCL association**

* Vivo: CSI-RS for BM on candidate cell should be associated with an SSB, e.g., SSB as the QCL source RS; otherwise, UE performs CSI-RS-based measurement based on the serving cell synchronization information.
* 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 should be associated with SSB of the corresponding candidate cell.
* Lenovo: Each CSI-RS resource associated with a LTM-CSI-ReportConfig is QCLed with an SSB associated with a same LTM-Candidate-ID.
* Fujitsu: CSI-RS configurations (NZP-CSI-RS-Resource) for L1 measurement under LTM-TCI-info to enable the QCL association between CSI-RS for BM (L1 measurement) and TRS (beam indication)

##### [FL observations]

5 companies see the necessity to associate CSI-RS for BM with SSB as CQL source RS for the DL synchronization (timing detection of the candidate cell). FL is wondering if SSB needs to be a direct QCL RS for this case because SSB can be root QCL source of the CSI-RS, which would be enough for timing detection. On the other hand, one company thinks CSI-RS for BM should be associated with TRS for the linkage between L1 measurement and beam indication (assuming that only SSB and TRS are supported for candidate cell beam indication). It is noted that this issue is discussed under section 5.4.1, and hence we would focus on timing detection in section.

FL thinks more views from companies are needed to decide the direction on this aspect.

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

* Companies are encouraged to study and provide their views on the following issues aiming at the progress at RAN1#119
	+ The QCL source of a CSI-RS for BM shall include SSB of the corresponding candidate cell, which is used for DL synchronization, i.e. timing detection

*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 think it might be unnecessary to indicate the QCL source, directly as SSB is already associated with CSI-RS for root QCL source, as mentioned in the FL observation. |  |
| Ericsson | This would be handled in the same way as for TRS, which is already supported in Rel-18 LTM. |  |
| TCL | We believe that this scenario applies no only to BM, but also to L1 measurement, e.g. CSI-RS based L1-RSRP/L1-SINR measurement. Therefore, we suggest change the bullet as follows:* + The QCL source of a CSI-RS for BM ***and/or L1-RSRP/L1-SINR (if supported) measurement*** shall include SSB of the corresponding candidate cell, which is used for DL synchronization, i.e. timing detection
 |  |
| NTT DOCOMO | OK to further study the issue. |  |
| ZTE | It seems to be a common issue, also be applicable to CSI-RS for CSI acquisition.  |  |
| vivo | Besides SSB, we are fine to discuss TRS as the QCL source RS of CSI-RS for BM. Thus, UE could measure CSI-RS for BM based on the fine synchronization information acquired by the TRS. |  |
| Nokia | We support providing QCL source RS information including both SSB and another CSI-RS (i.e., all allowed QCL relations for a CSI-RS) directly for each CSI-RS, not via TCI state ID. This is because CSI-RS configuration information of each DU would be shared with the source CU during F1/Xn setup so that the source CU can prepare measurement sets – this is the same method used in R18 for SSBs. QCL source information via TCI state ID will require to share the information of TCI states during F1/Xn setup which is not needed. Therefore, QCL source information via directly providing the RS info is a better way.  |  |
| CATT | QCL for CSI-RS for BM can be optional. If SSB is not configured as the QCL source of a CSI-RS for BM, the DL timing of CSI-RS for BM may not clear. Therefore, we support to explicitly configure QCL association between CSI-RS for BM and SSB. |  |
| Qualcomm | We don’t see any reason to deviate from the legacy QCL principle. As FL observed, SSB can be the root QCL source, and the target CSI-RS can be directly or indirectly QCLed with the root through other CSI-RS (for BM or tracking). |  |
|  |  |  |
|  |  |  |

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

##### [Agreements in previous meetings]

Agreement

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

##### [Summary of contributions]

**RRC Structure:**

*FL note: In Rel-18, the FL session focused on the functionality perspective, and the RRC discussion is fully handled in the RRC parameter session by the moderator. FL suggestion is to take the same approach in Rel-18, i.e. the following issues are not discussed in RAN1#118bis.*

* High level discussion on the structure:
	+ Qualcomm: 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.
* Where to define NZP-CSI-RS resource and resource set for L1 measurement
	+ Apple: The measurement resource for candidate cells is explicitly configured by RRC signal outside of candidate cell’s RRC configuration (Same as in Rel-18 LTM).
	+ There are multiple proposals to provide LTM NZP-CSI-RS resource and resource set outside of candidate cell’s RRC configuration
		- Reuse LTM-TCI-Info-r18 to support L1-measurement of candidate cells.
		- Defined under LTM-Config (across candidate cells)
		- Defined under LTM-Candidate (separately for candidate cells)
		- NW can configure an LTM NZP CSI-RS resource set including CSI-RS(s) across configured LTM candidate cell(s);
* Where to define CSI-RS resource list referred from report configuration
	+ Majority companies proposed to take similar mechanism as SSB: extend LTM resource configuration (*LTM-CSI-ResourceConfig*) under *LTM-Config* to support CSI-RS
		- Association for the CSI-RS resource(s) and candidate cell, implicit association (QCL source SSB) and explicit association (by addition candidate cell ID) are proposed

**Parameters of CSI-RS**

*FL note: Majority of the companies thinks the necessary parameters for CSI-RS have already been captured in Rel-18 specifications. If no new RRC signaling is required, we can discuss directly discuss under RRC parameter discussion. FL thinks it is not necessary to discuss this meeting.*

* 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.
* Vivo: Re-use R18 NZP CSI-RS resource configuration for R19 CSI-RS for LTM L1 measurements. RB configuration restriction of all CSI-RS resources for BM is not needed for R19 CSI-RS based LTM L1 measurements.
* Qualcomm
	+ subcarrierSpacing-r18, absoluteFrequencyPointA-r18, and cyclicPrefix-r18 in NZP-CSI-RS-Resource IE.
	+ repetition and resourceType-r18 in NZP-CSI-RS-ResourceSet IE.
* CATT:
	+ All CSI-RS parameters in legacy CSI framework, including ’repetition’, can be directly reused for CSI-RS based measurement for LTM.

**Solutions to reduce the measurement burden at a UE**

*FL note: The following topic was not approved in RAN#105 🡪 No plan to discuss in RAN1#118bis unless approved in RAN plenary or any important issues are identified*

* Vivo: For periodic CSI-RS for BM, the reduction of UE measurement overhead should be considered, e.g., dynamically indicating CSI-RS resource(s) to be measured or start to measure only after a certain condition is satisfied or after the reception of measurement indication from the network side.
* CATT: Support using MAC-CE to activate/deactivate the measurement of CSI-RS resources of the candidate cells.
* LGE: multiple NZP CSI-RS of multiple candidate cells are configured within a resource set.
* 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.
* NEC: Support to introduce MAC CE to activate/deactivate the candidate cells configured in the LTM measurement report.
* Apple: Study a faster measurement resource update indication for candidate cells.
* Nokia: Support dynamic updates of CSI-RSs associated with a report configuration. FFS: Signalling and procedure details.
	+ The RAN2 agreement requiring all candidate cells to use the source CU's common CSI resource configurations limits their ability to choose different configurations for measurements in subsequent cell switches.
* ETRI: We propose that the UE requests the serving cell to exclude certain CSI-RS from the candidate CSI-RS list, and the serving cell updates the list accordingly. The criteria for determining which CSI-RS to exclude remains FFS.

**Other details:**

*FL note: the issues described below needs more companies view to initiate the online/offline discussion. Interested companies are encouraged to have offline discussion for RAN1#119.*

* Lenovo: The CSI-RS resources from different candidate cells but associated with a same LTM-CSI-ReportConfig should be configured with a same bandwidth.
* Lenovo: Study the DL synchronization procedure for CSI-RS reception from candidate cells before cell switch command.
* ETRI: Specify a method to prevent ambiguity in CSI-RS resource allocation for each candidate cell.

##### [Conclusion]

FL sees no strong necessity to discuss the issues here in this meeting due to the reasons described above. The discussion of this section is closed without any FL proposals.

## gNB scheduled reporting

### [Mid] Further details of report framework

##### [Agreement in previous meetings]

Agreement

* 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

##### [Summary of contributions]

* L1-SINR
	+ FL note: L1-SINR for gNB scheduled reporting will be discussed after the general discussion in section 5.1.1 (Measurement quantity) is concluded.
* Format
	+ UCI format defined in Table 6.3.1.1.2-8C of TS38.212 can be used to report CSI-RS based L1-RSRP by replacing SSBRI with CRI.
		- Huawei, CATT, IDC, Fujitsu, Samsung, Nokia, DOCOMO, Qualcomm
* Inclusion of SpCell report
	+ For CSI-RS based measurement reporting, whether the beams of serving cell always included in a single reporting instance is configurable, as legacy in Rel-18 LTM
		- ZTE, IDC, Fujitsu, Nokia
* Quantization
	+ The quantization method defined in clause 5.2.1.4.4 of TS38.213 and bit width defined in Table 6.3.1.1.2-6A of TS38.212 can be used for L1-RSRP based on CSI-RS (and L1-SINR if supported?) reporting.
		- Huawei, ZTE, IDC, Fujitsu, Nokia, DOCOMO
* Filtering
	+ No filtering for time and spatial domain is necessary
		- Huawei, Spreadtrum, MediaTek
	+ Yes
		- CATT (need confirmation), Fujitsu (Discussion needed for L1-SINR)
* Cell and beam selection
	+ No change from Rel-18
		- Nobody explicitly proposed this.
	+ CRI selection can be done by two-step; cell quality first resource quality second manner.
		- LGE
* Container and time domain property for reporting
	+ Support periodic reporting on PUCCH, semi-persistent reporting on PUCCH/PUSCH, and aperiodic reporting on PUSCH.
		- IDC, Nokia, DOCOMO

##### [FL Observation]

Clear majority has a common understanding that CRI is needed to support CSI-RS based L1 measurement report. For other parts, no change is needed from Rel-18.

##### [FL Proposal 2-1-v1]

* 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 beams of serving cell always included in a single reporting instance is configurable
	+ The quantization method defined in clause 5.2.1.4.4 of TS38.213 and bit width defined in Table 6.3.1.1.2-6A of TS38.212 can be used
	+ No L1 specified filtering for time and spatial domain is introduced
	+ The mechanism to choose L cells x M beams is the same as Rel-18
	+ Periodic reporting on PUCCH, semi-persistent reporting on PUCCH/PUSCH, and aperiodic reporting on PUSCH are supported

##### [Comments to FL Proposal 2-1-v1]

|  |  |  |
| --- | --- | --- |
| Company | Comment | FL reply |
| Fujitsu | Support FL proposal 2-1-v1.  |  |
| Ericsson | Support FL proposal 2-1-v1.  |  |
| Xiaomi | Support FL proposal 2-1-v1. |  |
| TCL | Support FL proposal 2-1-v1.  |  |
| Spreadtrum | Support FL proposal 2-1-v1. |  |
| NTT DOCOMO | Support FL proposal 2-1-v1.  |  |
| ZTE | Support FL proposal 2-1-v1. |  |
| Samsung | Support in principle |  |
| InterDigital | Support |  |
| OPPO | Support |  |
| vivo | Support. |  |
| Google | Support  |  |
| Nokia | Support in principle. |  |
| CATT | Suggest removing the bullet “No L1 specified filtering for time and spatial domain is introduced” since whether to use L1 specified filtering is still under discussion of other proposals. |  |
| CMCC | Support |  |
| Huawei, HiSilicon | Support  |  |
| Qualcomm | Support the proposal. |  |
| NEC | Support |  |
| Lenovo | Support |  |

### [Closed] Other aspects

##### [Summary of contributions]

* Lenovo: Support group based beam report for LTM CSI report to enable the multi-TRP operation after switch to the new serving cell.

##### [Conclusion]

Given the essentiality of group based beam report and the interest level of the companies, it is not necessary to discuss this issue in RAN1#118bis. Interested companies are encouraged to discuss offline. With this understanding, the discussion of this section is closed.

## Event triggered reporting

### [Closed] 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.

##### [Summary of contributions]

* Google: RAN1 to discuss whether to support UCI based manner for transmitting UE-initiated beam report for LTM, on top of MAC CE based manner.
	+ *FL note: This proposal will cause a very big controversy in RAN1 as well as RAN2. To avoid consuming the allocated TUs, FL plans not to discuss this issue*
* LGE: At least event triggered report is signaled via MAC-CE or UCI, not both.

##### [Conclusion]

No further discussion is planned unless requested by RAN2

### [Closed] Report quantity

##### [Agreements in previous meetings]

Agreement

* 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]

L1-SINR is discussed under section 5.1.1. The discussion of this section is opened as necessity.

### [Closed] Report format and contents

##### [Summary of the contributions]

* Huawei
	+ Support at least L1-RSRP and L1-SINR as report quantities of event triggered L1 measurement.
	+ Support N ≥ 1 beam(s) are reported together with corresponding RS ID in a report instance.
	+ Depending on the triggering event, a L1 report may contain measurement result(s) from serving cell RS only or candidate cell RS only, or both. The identification of the event triggering the L1 report should also be included.
* Vivo
	+ At least the following contents should be considered for reporting:
		- Report configuration index(es);
		- Explicit or implicit identifier(s) of the candidate cell with at least one beam satisfies the condition of the event;
		- Candidate cell(s) beams that satisfy the condition of the event;
		- The beam of the serving cell (configurable).
* Xiaomi
	+ 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.
	+ Report Event ID in the Event-triggered beam report for LTM.
* CATT
	+ Regarding the reporting contents of the NR Rel-19, the following options can be considered:
		- Option 1: N beam(s) are reported in the report instance, where N $\in $ {1, 2, ...., Nmax} with Nmax being configured by gNB, and the reported N measurement result(s) should satisfy the condition of triggering events.
		- Option-2: N≥ 1 beam(s) are reported in the report instance with N being configured by gNB, at least one of the N reported beam(s) should satisfy the condition of the triggering events.
	+ For the event triggered LTM reporting, support differential reporting format for L1 measurements.
* 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 satifies 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.
* Lenovo
	+ Support the following report contents for each events:
		- 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 configure to include the measurement result of the beam of serving cell.
* Google :
	+ Report contents of an UEI LTM beam report at least include the followings:
		- RS index,
		- Measurement metric of RS quality,
		- LTM event ID,
		- LTM candidate ID.
* Apple
	+ Rel-18 LTM beam report content is the starting point for the event-trigger report with including the triggering beam information.
	+ Study method to indicate the triggered event for event-triggered report.
* Nokia
	+ For events LTM3, LTM4, and LTM5, at least the RS resource indicator (with associated cell information), L1-RSRP for the candidate beams meeting the configured event criteria, and event/report config ID should be reported.
		- FFS: Whether the quality of the serving cell needs to be reported for events LTM3, LTM4, and LTM5.
		- FFS: Whether any information needs to be reported for event LTM2, given its focus on the serving cell.
* DOCOMO
	+ For all LTM events,
		- RS index (i.e., SSBRI or CRI) and corresponding measurement result (i.e., L1-RSRP or L1-SINR)
		- Event ID and/or Report config ID
	+ For Event LTM2/3/5,
		- Support that the inclusion of current SpCell in the L1 measurement report is configurable
	+ For the reporting format/contents of Event-triggered beam report, support Opt2.
		- Opt2: The maximum number of candidate cells and the max number of beams per candidate cell in a single report instance is configured by NW. The actual number of candidate cell and actual number of beams per candidate cell in single report instance are determined by UE based on whether beam satisfies the condition.
* 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.
	+ For event-triggered LTM L1 measurement reporting, the legacy (Rel-18) L1 measurement reporting contents are reused. When multiple LTM events are configured, the ID of the triggered event is also included.

##### [Conclusion]

FL assumes that RAN2 will have the same/similar discussion on this aspect. To avoid the overlap between RAN1 and RAN2, no discussion is planned unless explicitly requested by RAN2.

With this, the discussion of this section is closed without any discussion.

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

##### [Agreement in previous meetings]

**Agreement**

* 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.

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]

**Type of RS for serving cell and candidate cell**

* Then, how the same type can be ensured for LTM 2, 3 and 5?
	+ For serving cell: a rule is given
	+ For candidate cell: explicitly configured
* Is this ensured by RAN2 (in terms of the configuration rule), or is RAN1 level mechanism necessary?

**Choice of options:**

* Option. 1: Derived from QCL (type-D) RS(s) of the indicated joint/DL TCI state for the serving cell
	+ Huawei, Xiaomi, LGE, IDC, TCL, Samsung, Nokia, KDDI
* 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
	+ Huawei, CMCC, Xiaomi, CATT, Oppo (for Pcell), IDC,Lenovo, Sony, Apple, TCL, Fujitsu, Ericsson, MediaTek, Nokia, DOCOMO, KDDI
* Option. 3: Measurement RS(s) is/are explicitly configured
	+ Huawei, CATT, TCL
* 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.
	+ No support
* Option 6: Derived from QCL RSs of activated TCI states, or SSB which is QCLed with the QCL RSs of activated TCI states
	+ No support
* For evaluation of LTM event, the RS(s) of serving cell are the RS(s) same as or associated with QCL RS(s) provided in indicated TCI state(s) for serving cell.
	+ Note that if there are two QCL RSs in indicated TCI state, the RS of serving cell is derived from RS w.r.t. QCL-TypeD, if applicable.
	+ ZTE
* When TRS is the QCLed RS in the indicated TCI state, SSB which is QCLed with the TRS in the indicated TCI state is used for LTM event evaluation for serving cell.
	+ CMCC
* If same RS type cannot be ensured for both serving and candidate cells, QCLed SSB is used
	+ Panasonic
* If no TCI state is indicated, SSB used in random access procedure is used
	+ Panasonic
* For LTM event evaluations (events LTM 3/4/5), the current beam RS for serving cell measurements can also be derived from the activated TCI state for PDCCH (Rel-15/16 framework).
	+ The serving cell may operate using the Rel-15/16 TCI state framework (i.e., non-unified TCI state). To support event-triggered LTM reporting in different network deployments, the activated TCI state for PDCCH should be used to derive the current beam RS.
	+ Nokia

**How the options apply to each LTM event:**

* Different option may apply to each event.

##### [FL Observation]

No companies proposed Option 4 and 6 because these options are not aligned with RAN2 agreements. FL thinks these options can be removed from the candidates.

Option 2 has clear majority support, and hence FL believes Option 2 can be the baseline for our further discussion.

For option 1, FL thinks this is a special case for option 2, e.g. (case 1) applicable when the indicated TCI state is TRS, which does not allow beam measurement, (case 2) two QCL RSs in the indicated TCI state are available. In this sense, option 1 can also be considered to handle the exceptional cases for option 2.

For option 3, FL thinks this is not fully aligned with RAN2 agreement because it would be less flexible due to due to subsequent LTM. Considering the fact that only a small number of companies support this option, FL is not fully sure if this option needs to be adopted in Rel-19.

There are proposals on exceptional cases like below, which may need specific handling:

* Consistency with the RS type between serving cell and candidate cell
	+ This applies to LTM3 and LTM5. Further discussion is necessary as no concrete proposal is found in this meeting and some companies mention this is RAN2 issue
* The case where not valid TCI state, including TCI state in Rel-17 unified TCI framework, is available
	+ Case 1: no TCI state is indicated
	+ Case 2: Rel-15/16 TCI state is used in the serving cell

However, the companies view on the solution is not clear at this stage. Hence, FL proposal is to put FFS aiming at the discussion at RAN1#119. It is noted that Rel-15/16 TCI framework was discussed by no consensus at the previous meeting.

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

* The serving cell RS for event evaluation is 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 or determined by the following rules
		- Type-D QCL RS(s) of the indicated TCI state(s) when the indicated TCI state(s) is/are configured with two RSs, which are not TRS
		- SSB when TRS is the QCLed RS in the indicated TCI state(s)
	+ FFS how to ensure the same RS type for serving cell and candidate cell for LTM3 and LTM5
	+ FFS how to handle the situation where no TCI state[, including TCI state in Rel-17 unified TCI framework] is indicated

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

|  |  |  |
| --- | --- | --- |
| Company | Comment | FL reply |
| Fujitsu | Support FL proposal 3-4-v1. For the first FFS, we think there are two candidate solutions. Firstly, for the case that only SSB is configured, it is preferred to define a rule that SSB should be used in the event evaluation. As the second solution, the NW can configure to guarantee the same type RSs. |  |
| Ericsson | Support the main bullet, but not the first subbullet: this should be configured by the NW  |  |
| Xiaomi | Support the main bullet. As for the first sub-bullet, it can be decided after the conclusion in AI MIMO UEI BR. In addition, ‘Type-D QCL RS(s) of the indicated TCI state(s) when the indicated TCI state(s) is/are configured with two RSs, which are not TRS’ can be revised to ‘Type-D QCL RS(s) of the indicated TCI state(s) when ~~the indicated TCI state(s) is/are configured with two RSs, which are not TRS~~ it is a CSI-RS configured with higher layer parameter *repetition*’ By the way, what does the yellow part in the FFS mean? In our understanding, for Rel-17 unified TCI state framework, a default indicated TCI state can be applied before the application of the indicated TCI state. Thus, the indicated TCI state is always existed for Rel-17 unified TCI state. |  |
| TCL | Support FL proposal 3-4-v1. |  |
| Spreadtrum | Support FL proposal 3-4-v1. |  |
| NTT DOCOMO | OK with the main bullet. We think first and second bullets are duplicated discussion with MIMO UEIBR. Also not sure about the case of third bullet. |  |
| ZTE | The main bullet is sufficient, we don’t identify the need to discuss other bullets.Besides, we suggest to add “*Note that if there are two QCL RSs in indicated TCI state, the RS of serving cell is derived from RS w.r.t. QCL-TypeD, if applicable*” |  |
| Samsung | We also think the main bullet would suffice now. Intentions of other bullets or FFSs are not clear to us. |  |
| InterDigital | Support main bullet |  |
| OPPO | The main bullet is sufficient. And we can also ok with the note suggested by ZTE. |  |
| vivo | Fine with the main bullet. As for the first and second sub-bullet, it can share the same scheme as AI 9.9.1 UEIBM in MIMO after the scheme design is complete. As for the third bullet, corresponding use case is ambiguous, further clarification may be needed.  |  |
| Google | We are fine with the main bullet. Regarding the first subbullet, we agree with Ericsson that this should be configured by NW. On TRS, there has been similar discussion on whether/how to measure TRS if TRS is the QCL RS of the indicated TCI state. We can defer related discussion here. Regarding FFS in the second subbullet, we do not see the need. It can be controlled by NW. If NW see the need to have the same RS type, NW can ensure that.  |  |
| Nokia | Support the main bullet and FFSs. |  |
| CATT | Support the main bullet. We may need a further discussion on whether the QCL RS or SSB is configured by the network or can be determined by using certain rules. |  |
| CMCC | Support the main bullet. The sub-bullets are key issues that need to be solved, since the issues are also discussed in R19 MIMO, we can postpone the discussion and wait for the progress of MIMO. |  |
| Huawei, HiSilicon | We are fine with the main bullet (i.e. Option 2) by adding “at least” at beginning. At the same time, we still think the option 3 should be kept due to the following reasons:1. The indicated TCI may not reflect the cell quality for mobility purpose. 2. It is the straightforward solution to 2 FFS points. 3. it is a solution to make most use of existing RS configuration in R18 LTM where the serving cell is configured as candidate cell when it is expected to be compared with other candidate cell.  |  |
| Qualcomm | We share the same view as Ericsson, and the main bullet would be sufficient. |  |
| Lenovo | The main bullets should be sufficient. We are fine with ZTE’s note. |  |

### [Mid] Filtering for measurement results for reporting

##### [Agreements in previous meetings]

No agreements yet

##### [Summary of contributions]

* L1 specified filtering is not necessary, i.e. L1 filtering should be left to UE implementation and not to be specified (5)
	+ Huawei, Lenovo, Apple, MediaTek, Qualcomm
* L1 specified filtering is necessary
	+ CMCC, CATT, Fujitsu, Ericsson (4)
	+ Rationale
		- One shot result is not stable (Ericsson provided a simulation result) and the fluctuation is large
* 
* Figure 1: L1-RSRP for three LTM Candidates. For each candidate, the SSB with highest SS-RSRP is used.
	+ Filtering method
		- Support specified L1 filtering for LTM beam reporting, if within a time window (which is configurable), the number of same Event occurs greater than or equal to a configurable number M, LTM beam report is triggered.
		- Use a first order IIR network configurable filter like the one used for L3 filtering.

##### [FL Observation]

In the discussion in previous meeting, it was found out that companies are expressing their view from different angle, i.e. event evaluation only, reported data only, or both. In this section, the discussion focuses on “filtering for measurement results for reporting” and filtering for event evaluation is separately discussed in section 5.3.5 (even though FL has no plan to discuss it in this meeting).

FL’s understanding is that, differently from gNB scheduled reporting, the report can be obtained on one-shot basis. Thus, filtering cannot be performed at gNB side. This may be a rationale to introduce L1 specified filtering to give a better controllability by gNB.

Even though the companies’ views are currently split to half and half, it was not clear to FL whether the number of proponent/opponent is correctly reflected here because most of the companies didn’t clearly mention which aspect(event evaluation or reporting) they are talking about, reporting or event evaluation. Given this situation, FL suggestion is to continue email and offline discussion to check the companies’ view.

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

* Alt.1: L1 specified filtering is introduced for L1 measurement results reported by event triggered reporting
	+ FFS: filtering method
* Alt.2: L1 specified filtering is NOT introduced for L1 measurement results reported by event triggered reporting

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

|  |  |  |
| --- | --- | --- |
| Company | Comment | FL reply |
| Fujitsu | We prefer Alt.1. We have strongly concern about cell switch based on the uncertain measurement results, a.k.a ‘the ping-pong’ issue. As shown in the simulation results from Ericsson’s contribution, the performance gap is apparent between with and without L1-filtering. |  |
| Ericsson | Note that our results use L1-filtering as specified in RAN4: in that sense, it is not a one-shot measurement.We prefer to specify NW-controlled filtering that is applied on top of the L1-filtering – we do not propose to modify the L1-filtering. In our view, it makes sense that the NW-controlled filtering is specified on L2, i.e., in the MAC specification.This filtering is particularly important for the event evaluation.  |  |
| TCL | We prefer Alt.2. |  |
| Spreadtrum | Support Alt.2 and suggest clarifying the purpose of filtering, i.e. for event evaluation or for reporting. |  |
| NTT DOCOMO | We’re a little confused about separate discussion on L1-filtering for event evaluation and beam reporting. Does it mean separate configuration/design may be introduced for event evaluation and beam reporting? Or event evaluation is based on L1-filtering but beam reporting is not? We don’t think it is reasonable to have separate designs for event evaluation and beam reporting. |  |
| ZTE | Support Alt-2 since similar function or purpose has been achieved by TTT. |  |
| Samsung | Support Alt-2. |  |
| OPPO | Support Alt-2, no need to specify filtering operation. How to measure L1-RSRP is up to UE implementation.  |  |
| vivo | In our view, the measurement quantity for event evaluation and report quantity should be aligned first, which means that either both are the filtered results or neither is the filtered result. Therefore, to avoid ambiguity, we suggest to revising Alt-1 and Alt-2 as follows:* Alt.1: L1 specified filtering is introduced for L1 measurement results within event evaluation and reporting procedure
	+ FFS: filtering method
* Alt.2: L1 specified filtering is NOT introduced for L1 measurement results within event evaluation and reporting procedure
 |  |
| Nokia | As commented by some companies, we also think it would be better to first clarify what we mean by filtering for event evaluation and filtering for reporting. Based on our understanding, although filtering for reporting is discussed here but the results shown in Ericsson’s contribution seem to be using filtering for event evaluation.  |  |
| CATT | Support Alt.1. Similar to those of the L3 RRM measurement, spatial filtered L1-RSRP should also be supported for inter-cell mobility. The spatial filtered L1-RSRP could be calculated by linear averaging of those L1-RSRPs above a configured threshold within a cell. |  |
| CMCC | Support Alt.1. To improve the reliability of beam reporting and reduce the frequent “ping-pang” switching, specified L1 filtering is needed for both event evaluation and beam reporting. |  |
| Huawei, HiSilicon | We prefer Alt 2.  |  |
| Lenovo | Support Alt2. |  |
|  |  |  |
|  |  |  |
|  |  |  |

### [Closed] Filtering for measurement results for event evaluation

##### [Agreements in previous meetings]

No agreements yet

##### [Summary of contributions]

* L1 specified filtering operation is not supported in event evaluation
	+ ZTE, vivo, Apple, Samsung, MediaTek, DOCOMO
	+ Fujitsu, Nokia: Wait until RAN2 finalizes their discussion on TTT/hysteresis
* To avoid the ping-pong effect, L1 cell-level measurement result, i.e. spatial filtered L1-RSRP, should be supported in addition to the beam-level L1-RSRP.
	+ CATT, NEC

##### [FL Observation]

In the discussion in previous meeting, it was found out that companies are expressing their view from different angle. In this section, the discussion focuses on “filtering for measurement results for event evaluation” and filtering for reporting is separately discussed in section 5.3.6.

Majority view for this issue is that RAN2 mechanism, TTT/hysteresis, can solve the potential issue, which FL agrees. Thus, FL suggestion is to postpone the discussion in RAN1 until the RAN2 mechanism becomes clear.

##### [Conclusion]

The discussion of this section is closed without FL proposal. Please note that a high level discussion on filtering is performed under section 5.3.5.

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

**FL has no intention to proceed the issues categorized here in this meeting. The necessary discussion in RAN1 will be explicitly triggered by RAN2.**

##### [Summary of contributions]

**Layer to handle L1 measurement result**

* 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: this may be the common understanding given the RAN2 agreement below:*
		- *MAC layer handles the event evaluation and measurement report triggering.*

**Configuration aspect**

* 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.

**Resource allocation for scheduling**

* Apple
	+ A dedicated SR resource is configured by RRC signal for event-triggered report.
	+ Once an event is triggered after evaluation, a UE requests a dynamic PUSCH resource for the event-triggered report (i.e., Mode A in MIMO)
* Ericsson
	+ Introduce a special SR for requesting resources to send an event-triggered L1 measurement report.

**DL and UL synchronization**

* Panasonic: UE reports DL and/or UL autonomous early sync status to NW in event-triggered L1 measurement report or a separate message. FFS: report content (e.g. a flag for each measured beam/cell)

**RS for candidate cells**

*FL note: we have already agreed to use explicit configuration 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.

**Coexistence with gNB scheduled reporting**

*FL note: coexistence is basically a RAN2 issue* 🡪 *please bring this proposal to RAN2*

* 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.

**UE autonomous TCI state activation**

*FL note: this was discussed in RAN#105 but not agreed to include in the objective.*

* Sharp: Support UE to autonomously activate TCI states associated to the event triggered report without Candidate Cell TCI States Activation/Deactivation MAC CE to reduce both candidate TCI state activation delay and signalling overhead.
* Ericsson: Support UE autonomous TCI state activation: After sending an event-triggered LTM measurement report, the UE will activate the candidate TCI states that are associated with the reference signals in the measurement report.
	+ For each measurement target, the UE includes a flag that indicates if the corresponding candidate TCI states are activated.

**Others**

* NEC: Support event triggered measurement reporting with optional TCI state indication.
* NEC: Support event triggered measurement reporting with optional CFRA resource indication and UL access resource selection.
* TCL: For LTM2 event evaluation, SSB or CSI-RS based L1 measurement reporting for candidate cell(s) should be supported.
* Nokia: RAN1 to study whether and how periodic reporting is supported after an event to report is met
	+ FL suggestion is to bring this proposal to RAN2
* Support low-latency activation/deactivation of RRC-configured event-triggered reporting for LTM.
	+ FL suggestion is to bring this proposal to RAN2

##### [Conclusion]

The discussion of this section is 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

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

##### [Agreements in previous meetings]

No agreements yet

##### [Summary of the contributions]

* Vivo
	+ Support CSI-RS for BM as the QCL source RS of Candidate TCI/TCI-UL state.
* Fujitsu
	+ Provide CSI-RS configurations (NZP-CSI-RS-Resource) for L1 measurement under LTM-TCI-info to enable the QCL association between CSI-RS for BM (L1 measurement) and TRS (beam indication)
	+ With this RRC structure, it is not necessary to support CSI-RS for BM for source QCL RS in the candidate TCI states
* Nokia
	+ To enable CSI-RS-based beam management, a periodic candidate TRS and/or an LTM TCI state can have QCL type ‘D’ with a CSI-RS from a resource set configured with the higher layer parameter repetition.
* MediaTek
	+ Do not support CSI-RS for BM as QCL source RS in LTM TCI state(s).

##### [FL observation]

While some proposals are observed in this meeting, it is not clear what is the common understanding on the necessity to support CSI-RS based operation for beam indication by candidate TCI state. Therefore, FL would like to propose to gather companies view first on this matter at this meeting, aiming at the detailed discussion in RAN1#119 (if necessary)

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

* Companies are encouraged to study and provide their views on the following issues aiming at the progress at RAN1#119
	+ Necessity to support CSI-RS for BM as the QCL source RS of candidate TCI/TCI-UL state for beam indication.
		- It is noted that TRS has already been supported as the QCL source RS of Candidate TCI/TCI-UL state in Rel-18
		- If CSI-RS for BM is supported, the relationship between measurement result and indicated beam becomes very clear. Are there any issues if not supported?
			* i.e. QCL association between CSI-RS for BM (L1 measurement) and TRS (beam indication) is needed, or
			* the system will work without such association, serving cell and/or candidate cell can handle by implementation

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

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

|  |  |  |
| --- | --- | --- |
| Company | Comment | FL reply |
| Fujitsu | In our analysis, there might be no need to support CSI-RS for BM as a QCL source if the NZP-CSI-RS-Resource is configured under LTM-TCI-Info together with TRS. In that case, the QCL relation is implicitly associated between TRS and CSI-RS for BM. |  |
| Ericsson | We do not see that this would be needed: the QCL source is anyway an individual CSI-RS resource.  |  |
| NTT DOCOMO | No need. |  |
| ZTE | Share the same view with Ericsson. |  |
| Samsung | We do not see the need to introduce additional QCL rule(s). |  |
| OPPO | Do not support the introduce new QCL rules |  |
| vivo | In our view, it is necessary to introduce CSI-RS for BM as QCL source RS of the Candidate TCI state. The motivation of early beam measurement and reporting based on CSI-RS for BM is to achieve early beam refinement. If not supported, the QCL source RS of the TCI state indicated in the CSC is SSB or TRS, and the TRS is QCLed with SSB, thus only rough beam can be used after cell switch and early beam refinement is meaningless. As for the association between TRS and CSI-RS for BM, it is a kind of TCI enhancement, i.e., a CSI-RS for BM as the QCL source RS of the TCI state of a TRS.  |  |
| Google | Support CSI-RS for BM as QCL source. This has been in existing QCL rule from Rel-17. Why support of this would be new or additional QCL rule?  |  |
| Nokia  | We share the same view with vivo and Google. Note that CSI-RS based BM is captured as an objective in WID – therefore it should be discussed and supported. That simply means a candidate TCI state can be associated with a CSI-RS (from a resource set configured with repetition). In Rel-18, since only SSB measurements are available, either a candidate TCI state can only be associated with a SSB or a TRS, where the TRS is associated with a SSB. But with Rel-19 CSI-RS measurements, the remaining allowed (in Rel-17) QCL relations should be applicable. That means, a candidate TCI state can be associated with a CSI-RS (from a resource set configured with repetition) or a TRS, where the TRS can be associated with a CSI-RS (from a resource set configured with repetition). Without this, we’re not sure what we mean by CSI-RS based BM.  |  |
| CATT | We don’t see the necessity of further support CSI-RS for BM as the QCL source RS. As mentioned by FL, the system will work without such association. |  |
| Lenovo | We are fine to configure CSI-RS for BM as the source QCL for Candidate cell TCI state, which has been supported by Rel-17 QCL chain for the indicated TCI state. |  |

### [Low] UE Rx beam management

##### [Agreements in previous meetings]

No agreements yet

##### [Summary of the contributions]

* 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’
		- 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,
* 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.
* Apple:
	+ For event-triggered measurement report, a separate CSI-RS resource set with ‘repetition’ set to ‘off’ is configured in LTM-CSI-ResourceConfig outside of the candiate cell configuration.
* ETRI:
	+ We propose prioritizing uplink beam management before cell switching when a UE is engaged in high-quality uplink services, as this would be more effective than focusing solely on downlink beam management. Relying on channel reciprocity to apply downlink beams to the uplink may result in inaccurate beam management and degrade service quality after the switch.

##### [FL observation]

The issue on Rx beam refinement was raised in this meeting. FL would like to start the discussion by gathering the companies view first.

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

* Companies are encouraged to study and provide their views on the following issues aiming at the progress at RAN1#119
	+ The necessity of Rx beam refinement i.e. by allowing repetition is set to “on”
	+ The necessity to provide different configuration on repetition for event triggered reporting and gNB scheduled reporting.

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

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

|  |  |  |
| --- | --- | --- |
| Company | Comment | FL reply |
| Fujitsu | Support the FL proposal. We need to clarify the report setting. Generally, if the parameter is set to ‘*repetition*=*on*’, then there will be a case that the report quantity (*reportQuantity*) is set as ‘*none*’, since the CSI-RS with ‘*repetition*=*on*’ uses for the UE RX beam refinement, and thus no measurement result to be reported exists. Otherwise, the measurement results may not be reliable. The question is whether the reportQuantity is set to ‘none’ if we adopt RX beam refinement in Rel-19 LTM. |  |
| Ericsson | OK to study. We currently do not see the need to support repetition ‘on’ |  |
| TCL | We don't see the necessary to support repetition ‘on’, we think the periodic or semi-persistent RS can realize the similar effect. |  |
| NTT DOCOMO | OK to study it. |  |
| ZTE | We are fine for studying this issue, but it is unclear what the motivation is for supporting Rx beam refinement. |  |
| Samsung | We are open to discuss but comparing with other issues/items for L1 measurement/reporting, this issue can be deprioritized. |  |
| InterDigital | OK |  |
| OPPO | The L1 measurement on CSI-RS of candidate is to facilitate LTM cell switch. It is not clear why Rx beam refinement is needed for that. |  |
| vivo | Support to discuss. |  |
| Google | OK to study  |  |
| Nokia | Support to study as it is an important issue related to CSI-RS based BM objective.  |  |
| CATT | Whether to set repetition ‘on’ or ‘off’ can be up to gNB. |  |
| Lenovo | Fine to study. |  |

## CSI acquisition for candidate cell(s)

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

##### [Summary of contributions]

The alternatives for CSI acquisition framework can be categorized as follows (sited from ZTE's paper)

  

Alt-1 Alt-2 Alt-3

The framework of early CSI acquisition before or during LTM cell switch

* **Alt-1: CSI-RS measurement and CSI reporting operations are performed before reception of LTM Cell Switch Command (CSC) MAC CE.**
	+ ZTE, Spreadtrum, ~~Xiaomi~~, CATT, OPPO, Google, NEC, IDC, SONY, TCL, Ericsson
* **Alt-2: CSI-RS measurement is performed before reception of LTM CSC MAC CE and CSI report is transmitted after reception of LTM CSC MAC CE.**
	+ Huawei, ~~Xiaomi~~, [Google?], [NEC?], SONY, MediaTek
* **Alt-3: CSI-RS measurement and CSI reporting operations are performed after reception of LTM CSC MAC CE.**
	+ Huawei, vivo, Xiaomi, LGE, Lenovo, Google, NEC, IDC, Apple, Ericsson, MediaTek, DOCOMO
	+ TCL, report is triggered by the target cell

Discussion points, which characterize the alternatives above

* RS overhead
	+ Depends on CSI-RS periodicity and number of candidate cells the UE needs to measure
* UE Complexity to measure the CSI from multiple (many) candidate cells
	+ Depends on how many candidate cells the UE needs to perform CSI measurement
		- After cell switch, the CSI acquisition is needed only for the target cell.
	+ To limit CSI acquisition measurements to a subset of prepared candidate cells:
		- Network to enable CSI acquisition for each candidate cell
		- Selected cells/beams based on early DL/UL synchronization status
		- Selected cells/beams for L1 measurement reporting
		- Selected cell/beam for the cell switch
* Reporting overhead
	+ Report of many candidate cells will cause UL overhead
* Necessity of coordination between serving cell and candidate cell in the inter-DU/inter-CU case
	+ data forwarding: CSI measurement results from source cell to target cell
	+ indication to transmit/suspend aperiodic/semi-persistent CSI-RS, if supported
* Measurement and reporting timeline
	+ Legacy timeline can be reused for “before cell switch”, or new timeline is necessary for “during cell switch” (which may lead to more cell switch delay/interruption time)
	+ The reported CSI may be aged if it is measured too early
* Mechanism to configure/indicate the CSI measurement resource and reporting UL resources
* Necessity of measurement gap

##### [FL observation]

This is the first meeting to discuss CSI acquisition, thus the discussion on the pros/cons for each option is not matured. In addition, tons of aspects to consider prevents our quick decision. More discussion based on companies’ detailed analysis is needed for proper decision. It is noted that FL thinks it is not necessary to support two or more options for compromise.

The concern from FL is that the other issues in section 5.5.2, 5.5.3, 5.5.4 are highly related to this discussion. For the better progress in the next meeting, down selection in this meeting is quite important.

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

* The following options for CSI acquisition framework are further discussed, aiming at the down selection at RAN1#118bis
	+ 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 cell(s)
		- Supported by ZTE, Spreadtrum, ~~Xiaomi~~, CATT, OPPO, Google, NEC, IDC, SONY, TCL, Ericsson
	+ [Alt-2: CSI-RS measurement is performed before reception of LTM CSC MAC CE and CSI report is transmitted after reception of LTM CSC MAC CE.
		- The report is sent directly to target cell]
		- Supported by Huawei, ~~Xiaomi~~, [Google?], [NEC?], SONY, MediaTek
		- FL note: Can we delete this option to save time?
	+ 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
		- Huawei, vivo, Xiaomi, LGE, Lenovo, Google, NEC, IDC, Apple, Ericsson, MediaTek, DOCOMO, TCL

*FL note 1: the companies’ position may not be accurate from the contributions. Update is needed during the meeting.*

*FL note 2: this topic is treated official offline first.*

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

|  |  |  |
| --- | --- | --- |
| Company | Comment | FL reply |
| Fujitsu | Alt.1 may have less specification impact while the measured CSI might be outdated due to comparatively long term until cell switch. On the other hand, Alt.3 can provide nearly actual CSI, besides, the interruption time increases. For the consideration of the purpose of CSI acquisition, we slightly prefer Alt-3. |  |
| Ericsson | In our understanding, the CSI measurement should be performed before the CSC to make it possible for the UE to perform the measurements. This leaves Alt-1 and Alt-2. We propose that RAN1 studies Alt-1 and Alt-2.How is Alt3 different from legacy? |  |
| Xiaomi | In order to reduce the measurement complexity, we prefer UE to only measure the CSI of the target cell indicated in CSC MAC CE. So we slightly prefer Alt 3. |  |
| TCL | We support further study Alt-1 and Alt-3. For Alt3, we think it only applies to AP CSI-RS. |  |
| Spreadtrum | We support Alt-1 to reduce the complexity of spec design, such as reusing Rel-18 LTM CSI framework as much as possible. If CSI report is triggered during the LTM cell switch, it may be necessary to support triggering CSI via cell switch command. Compared to CSI reporting before cell switch, the performance gain is unclear and complex spec design is needed.From the perspective of UE complexity reduction and power saving for CSI reporting before cell switch, we can limit some configuration for CSI acquisition, e.g. only Type I codebook is allowed to be configured, the number of CSI-RS ports per CSI-RS resource shall not exceed 32, the number of candidate cells for CSI measurement not exceeds N (e.g. 1 or 2), etc.  |  |
| NTT DOCOMO | We support both Alt-1 and Alt-3. To show the difference from legacy, we suggest following revision for Alt-3.Alt-3: CSI-RS measurement and CSI reporting operations are performed after reception of LTM CSC MAC CE if triggered by LTM CSC MAC CE.For Alt-2, similar revision may be needed. |  |
| ZTE | Compared with Alt-1/2, Alt-3 will not only introduce additional interruption latency, also involves new design rule on CSI reporting. So we tend to at least perform RS measurement before LTM CSC MAC CE. Besides, we also think that it is too early and rather hasty to make a decision on which option will be supported in Rel-19 LTM at this stage since more discussions and analysis for each option have not been done.  |  |
| Samsung | We do not see the urgency or necessity to do downselection at the current stage given that these alternatives are not fully discussed, and there are not enough details for each of the alternatives listed above. We are not comfortable with the discussion order here – we are fine to first address how/when the measurement would take place because measurement related discussions would always take precedence when discussing and specifying CSI measurement/reporting framework.  |  |
| InterDigital | Support focusing on Alt. 1 and Alt. 3. NTT DOCOMO clarification could be helpful for Alt. 3, i.e. the measurement is triggered by the CSC. |  |
| OPPO | We prefer to support CSI measurement and report before the LTM Cell switch command for two reasons: (1) minimized spec effort and impact, we can fully reuse the current CSI report framework. (2) it can minimize the interrupt time, which we believe it is the main motivation for this early CSI acquisition of candidate cells. |  |
| vivo | Support Alt-3 and we are also fine with NTT DOCOMO’s revision. |  |
| Google | Alt-1 would be the baseline. However, Alt-2/3 is more beneficial. Selection of PMI would change more dynamically than beam indication, therefore, a CSI report before LTM CSC would be outdated and less useful.  |  |
| Nokia | We support to mainly study Alt-1 and Alt-2. Early CSI acquisition should mean early measurements before the cell switch, similar to early DL and UL synch. Alt-3 may increase the HO interruption, which should be avoided; otherwise, the gain from CSI acquisition may not be evident.  |  |
| CATT | Support Alt-1.For Alt-2, as CSI-RS measurement is performed before cell switch command, it has similar issue (outdated CSI) as that of Alt-1. For Alt-3, the procedure of CSI-RS measurement and CSI reporting introduced during cell switch may increase cell switch delay. This is not aligned with the purpose of LTM. By the way, for Alt-3, it may need clarify the reporting time, such as “no later than first UL data transmission”. Alt-3: CSI-RS measurement and CSI reporting operations are performed after reception of LTM CSC MAC CE and but no later than first UL data transmission. |  |
| CMCC | Support Alt-3. For Alt-1 and Alt-2, UE may measure the CSI-RS from all candidate cells. Firstly, CSI-RS for CSI acquisition may up to 128 ports. Secondly, since the best beam for candidate cell is unknow, UE may measure CSI-RS of different beams. The resource overhead and measurement complexity are very high for Alt-1 and Alt-2. |  |
| Huawei, HiSilicon | We support Alt 2 and Alt 3 because the solutions have least report overhead and least impact on other WGs. The alt 2 can measure CSI early which can reduce the interruption while alt 3 requires less processing capability at UE before cell switch. Share the views from companies above that we can clarify each options in this meeting and leave the down selection after everybody have exact understanding of each options.  |  |
| Qualcomm | We support keeping all three alternatives on the table at this stage.  |  |
| NEC | We support Alt-1 and Alt-3. To our understanding, the main motivation of LTM is to reduce interruption latency, therefore, Alt-1may be more in line with this. |  |
| Lenovo | Alt3 is not clear to us, does the UE can only perform the CSI measurement after the UE successfully switch to the target cell? If yes, we don’t support Alt 3. Our understanding on Alt3 is that the UE can perform CSI measurement during the CSC, i.e., after receiving the CSC and before transmitting the first UL transmission. |  |

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

##### [Summary of contributions]

* Periodic reporting
	+ None
* Semi-persistent reporting
	+ None
* Aperiodic reporting
	+ ZTE, CMCC, Xiaomi, LGE, OPPO, SONY, Fujitsu, DOCOMO
* By MAC CE
	+ Sony

##### [FL observation]

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 and other mechanism can be FFS.

##### [FL proposal 5.2-v1]

* Aperiodic report on PUSCH is supported for CSI acquisition of candidate/target cell(s)
* FFS periodic and semi-persistent reporting

##### [Comments to FL Proposal 5-2-v1]

|  |  |  |
| --- | --- | --- |
| Company | Comment | FL reply |
| Fujitsu | Support FL proposal 5.2-v1. For both options of Alt.1 and Alt.3 in FL proposal 5.1-v1, the aperiodic reporting is adequate for CSI acquisition. Considering that it is beneficial for NW to use only the latest CSI report, periodic and semi-persistent reporting may increase reporting overhead. |  |
| Ericsson | Too early to decide – aperiodic reporting as defined in legacy suffers from a significant reporting delay. It is faster if the UE reports the CSI over MAC CE. |  |
| Xiaomi | Support and prefer to report the CSI via UCI on the PUSCH of the target cell. |  |
| TCL | We think this issue can be discussed when the issue 5.5.1 is decided.  |  |
| NTT DOCOMO | Support. |  |
| ZTE | Support FL proposal 5.2-v1 |  |
| Samsung | Not support. As we commented earlier, we are not comfortable with the discussion order here – we are fine to first address how/when the measurement would take place because measurement related discussions would always take precedence when discussing and specifying CSI measurement/reporting framework. |  |
| InterDigital | Ok to remove periodic and semi-persistent. Suggest to keep MAC CE open. |  |
| OPPO | Not support to discuss it now. We can discuss this issue after we have concluded the issue related with 5.5.1  |  |
| vivo | Support |  |
| Google | Support in principle. If there is concern on the report medium, we can leave it FFS.  |  |
| Nokia | This should be discussed later once we have more clarity on the meas and reporting timeline (issue 5.5.1). |  |
| CATT | Support |  |
| CMCC | Support. |  |
| Huawei, HiSilicon | It is one of the essential components for each option discussed in 5.5.1. we should discuss it case by case. |  |
| NEC | Not support. We think this issue is related to Issue 5.5.1. |  |
| Lenovo | We are fine that aperiodic CSI report on PUSCH should at least be supported. |  |
|  |  |  |

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

##### [Summary of contributions]

ZTE

* + At least periodic CSI-RS should be supported for Alt-1/2 corresponding to CSI-RS measurement to be performed before LTM cell switch.
	+ At least aperiodic CSI-RS should be supported for Alt-3 corresponding to CSI-RS measurement to be performed during LTM cell switch.

Ericsson

* + Support CSI acquisition on candidate cells based on periodic CSI-RS.

Samsung

* + Regarding CSI acquisition before or during LTM cell switch, support periodic, semi-persistent, and aperiodic CSI-RS(s) for CSI acquisition.
		- For SP/AP CSI-RS(s) for CSI acquisition, at least the following aspects should be specified
		- When the trigger/activation would occur, i.e., before or during the LTM cell switch, relative to the application of the LTM CSC considering the CSI processing timeline (e.g. Z/Z’)
	+ Detailed signalling medium(s) and method(s) for activation/triggering

##### [FL observation]

Even though the number of inputs is not enough to make an agreement, it seems reasonable to agree on supporting at least periodic CSI-RS, similarly to L1 measurement.

##### [FL proposal 5.3-v1]

* At least periodic CSI-RS is supported for CSI acquisition of candidate/target cell(s)

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

|  |  |  |
| --- | --- | --- |
| Company | Comment | FL reply |
| Fujitsu | Support FL proposal 5-3-v1. Besides, we think semi-persistent and aperiodic CSI-RS transmission might also be needed since there might be a case to use aperiodic CSI-RS transmission and measurement in order to avoid unnecessary CSI-RS transmission.  |  |
| Ericsson | Support |  |
| TCL | Support |  |
| NTT DOCOMO | Support. |  |
| ZTE | Support FL proposal 5.3-v1 |  |
| Samsung | Not support. We prefer to discuss periodic, semi-persistent and aperiodic manners together. To our understanding, periodic measurement is only favorable in “before” case, but not useful in “during” case. |  |
| InterDigital | OK if the CSI measurement is before CSC. If measurement is triggered by CSC, A-CSI-RS may be required otherwise the latency would be too high (or the overhead of P-CSI-RS would be too high).  |  |
| OPPO | Same comments as 5.5.2, we can first discuss the issue related with 5.5.1.  |  |
| vivo | It can be postponed until 5.5.1 is determined. |  |
| Google | Support. We can FFS SP and SP case.  |  |
| Nokia | Support, but OK to postpone this as well.  |  |
| CATT | Support. In addition, we also support semi-persistent CSI-RS and aperiodic CSI-RS. |  |
| Huawei, HiSilicon | Same as 5.5.2. it should be discuss with the framework in 5.5.1 |  |
| Qualcomm | As this issue is closely related to Issue 5.5.1, we don’t think we can make conclusion first on this issue, before a progress is made in Issue 5.5.1. |  |
| NEC | Not support. We think this issue is related to Issue 5.5.1. |  |
| Lenovo | Not support. We agree with companies that it can be postponed until 5.5.1 is determined. |  |

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

**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]

* Spreadtrum
	+ RRC parameter reportQuantity in LTM-CSI-ReportConfig is used to indicate LTM beam report or LTM CSI report.
	+ The LTM CSI report includes the candidate cell IDs and their CSIs, where the number of reported candidate cells is configured by gNB.
	+ 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 CSI-ReportConfig.
* Xiaomi
	+ CSI report of target cell can be reported on the PUSCH during random access procedure to target cell at least for LTM cell switch based on CFRA.
	+ For RACH-less LTM cell switch, UE reports the CSI report on the earlier available PUSCH from following two PUSCHs:
		- Option 1: PUSCH scheduled by DCI triggering CSI report of target cell.
		- Option 2: CG PUSCH configured by target cell or DG PUSCH scheduled by target cell
* Levono
	+ Support CSI acquisition and report to the candidate cells during the cell switch and the CSI for the target cell is transmitted in the first UL transmission in the new serving cell.
	+ The UE only needs to do CSI measurement on the CSI-RS resources associated with the activated or indicated TCI state for a candidate cell.
* Apple
	+ The triggered CSI report for candidate cell is multiplexed in the PUSCH scheduled by RAR if RACH procedure is triggered in the cell-switch operation. Otherwise, it is multiplexed in the first DG-PUSCH or CG-PUSCH.

**Restrictions on the CSI configurations**

* + 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.
	+ 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).
	+ 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.
	+ Vivo
		- Support wideband Type 1 CSI reporting only, i.e. wideband PMI and CQI during cell switch.
	+ CMCC
		- Support aperiodic CSI report with CRI, CQI, PMI and RI.
		- For PMI reporting, support both wideband and sub-band Type I codebook.
	+ LGE
		- LTM CSI-RS resource only dedicated for the CQI acquisition is not supported.
		- CQI-PMI-RI is supported as a report quantity of LTM CSI report.
	+ 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.
	+ 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.
	+ Apple
		- Support the report quantity configuration of ‘CRI-RI-PMI-CQI’ for Type-1 codebook for CSI report of candidate cell
	+ Ericsson
		- 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.
	+ 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).
	+ Nokia
		- For CSI acquisition on a candidate cell, support the reporting of CRI, CQI, PMI, and RI, where PMI is based on the Type 1 codebook.
	+ DOCOMO
		- Support configuration of Type I SP codebook only for candidate cell.
		- Support CRI, CQI, PMI and RI for a Type I SP codebook.

**Triggering mechanism of measurement and reporting**

* + Apple
		- Select one from the following as command for trigger CSI report for a candidate cell
			* Option 1: DCI format that schedules the PDSCH carrying a cell-switch command MAC-CE.
			* Option 2: Cell-switch command MAC-CE

**Time gap between trigger and CSI-RS reception**

* + Apple: The CSI-RS on candidate cell is applied starting from the first slot that is after ‘$∆$’ symbols relative to the the ending symbol of the triggering command on the serving cell, where ‘$∆$’ value is either hard-encoded in specification or subject to UE capability report.

**CSI-RS Resource configuration**

* + Samsung
		- The CSI-RS resource configuration(s) for CSI acquisition before or during LTM cell switch can be similarly provided relative to the CSI-RS resource configuration(s) for L1 measurement and reporting for Rel-19 mobility enhancements.

**Others**

* + LG
		- LTM CSI report carrying L1-RSRP (or L1-SINR) is prioritized to the LTM CSI report not carrying L1-RSRP (or L1-SINR).
	+ Samsung
		- Supporting CSI acquisition on candidate cell(s) before or during LTM cell switch should be based on new UE capabilities.

##### [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#119 or later.

##### [Conclusion]

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

## LS

Paused