FL plan for mobility enhancements in RAN1#119
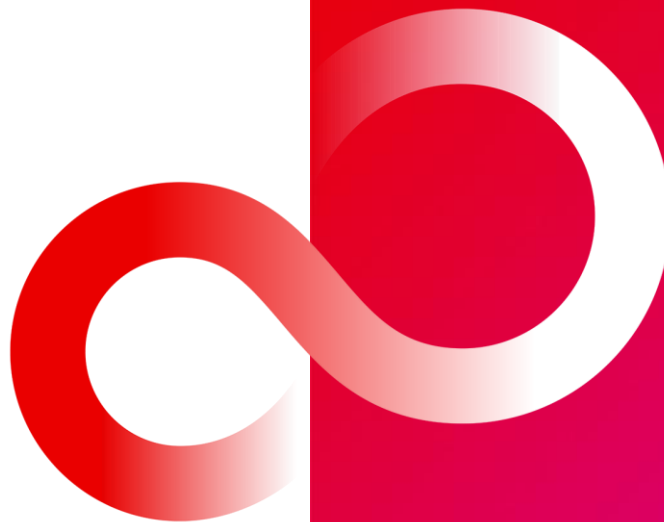
Agenda Item: 9.9.1

Source: Moderator (Fujitsu)

Document for: Information

WID update at RAN#105

Updated WID in RP-242356

- Specify support for inter-CU Layer1/Layer 2 Triggered Mobility (LTM) [RAN2, RAN3]
  - Prioritize the case when CU is acting as MN when DC is not configured
  - When DC is configured, inter-CU LTM can be configured either in MN or in SN but not both at the same time. For such cases:
    - As secondary priority, support the case where CU is acting as SN and MN is unchanged
    - As secondary priority, support the case where CU is acting as MN and SN is unchanged or SN is released
  - Specify support for subsequent LTM mobility procedures aiming to avoid RRC configuration between cell switches as per Rel-18 LTM
    - Coordination with SA3 needed with respect to security key handling
  - Note: Rel. 18 intra-CU LTM procedure is considered as baseline for adding inter-CU support
- Measurements related enhancements for purpose of supporting LTM: [RAN2, RAN1]
  - Measurement related enhancements are applicable to Intra-CU MCG/SCG LTM and Inter-CU MCG/SCG LTM
  - Specify necessary components to support event triggered L1 measurement reporting [RAN2, RAN1]
    - ~~RAN1 and RAN2 to progress independently on the event triggered measurements objectives of their respective MIMO and Mobility enhancement WIs. Review progress at RAN#105 to see if any modification of objectives is required to avoid/manage any overlap in the work~~
  - Specify support for CSI-RS measurements for LTM procedures and enable CSI-RS based beam management , ~~and/or other necessary physical layer operations on candidate cells before LTM~~ [RAN1]
  - Specify CSI acquisition on candidate cell(s) based on CSI-RS before or during LTM cell switch [RAN1]
NOTE: RAN1 WG to decide on whether to support CSI report before or during the LTM cell switch, as part of the CSI acquisition procedure.
- Specify support of conditional Intra-CU LTM [RAN2, RAN3, RAN1]
  - Specify UE evaluated conditions for triggering LTM
  - Aim to support conditional LTM including subsequent LTM
  - Limit specifying the conditional LTM to the scenario where the UE is in non-DC
    - ~~Prioritise intra-CU LTM~~
  - Checkpoint at RAN#107 to review the objective on whether Intra-CU conditional LTM can be specified to DC scenarios and if so, to which cases ~~at RAN#105~~. RAN WG work to not start before this checkpoint
- Specify RRM requirements related to the above objectives as necessary [RAN4]

L1 measurement based on CSI-RS

FUJITSU

- **Mid-Low priority:** Time domain property for CSI-RS transmission
  - support of semi-persistent: wait for RAN3 reply
  - aperiodic CSI-RS transmission: still open
  - It was pointed out that more coordination between candidate & serving cell is needed compared with
  - More with this, coordination between serving cell and candidate cell(s) may be required for aperiodic CSI-RS
  - FL thinks this WI can be concluded without aperiodic CSI-RS. If the number of interested companies is small, FL would skip the discussion in RAN1#119

- **Low priority:** Type of CSI-RS, i.e. for mobility
  - Potential benefit: CSI-RS for mobility has already been configured for L3 mobility, which may be reused for LTM purpose
  - Question: the benefit to introduce two configuration (i.e. CSI-RS for BM and mobility) for the same purpose
  - Majority companies see no strong necessity
  - FL thinks this WI can be concluded without CSI-RS for mobility. If the number of interested companies is small, FL would skip the discussion in RAN1#119

- **Mid-Low priority:** Restriction on QCL source of CSI-RS
  - The following issue can be further discussed in RAN1#119 based on companies' contribution, while companies view on the necessity is not clear yet
  - [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

- **Mid-Low priority:** CSI-RS configuration
  - LTM-TCI-info in Rel-18 has already included CSI-RS. If this can be reused, what is the missing RRC parameters?
  - Otherwise, where and which parameters should be defined?
  - The RRC structure (completely reuse this or add a new IE) is up to RAN2
  - The necessity of the restriction of CSI-RS configuration, e.g. same bandwidth, number of ports etc. → Companies' view is appreciated
  - FL suggestion is to focus on the necessary additional parameter(s) for CSI-RS in RAN1#119, if exists

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Agreement (118)
- Support L1-RSRP measurement based on CSI-RS
- FFS: Support L1-SINR measurement based on CSI-RS

Agreement (118)
- Explicit configuration of CSI-RS resource(s) for candidate cell(s) for L1-measurement is supported

Agreement (118)
For gNB scheduled reporting and event triggered reporting
- At least periodic CSI-RS is supported for L1-RSRP measurement for candidate cell
  - FFS: aperiodic and semi-persistent CSI-RS
- At least CSI-RS for beam management is supported for L1-RSRP measurement for candidate cell
  - FFS: CSI-RS for mobility

Agreement (119)
From RAN1 perspective, there is no restriction with regards to the frequency location of CSI-RS used for L1-measurement

Conclusion (119)
There is no consensus in RAN1 on the support L1-SINR measurement based on CSI-RS for candidate cells

Working Assumption (119)
In addition to periodic CSI-RS, semi-persistent CSI-RS is supported for candidate cell L1-RSRP measurement for gNB scheduled reporting from RAN1 perspective
- Send an LS to RAN3 (CC RAN2) to ask for the feasibility of specifying the signalling for coordination between serving cell and candidate cell(s) on the transmission of semi-persistent CSI-RS(s) and any other potential issues (e.g. RAN3 workload).
Support of semi-persistent CSI-RS is subject to UE capability.
Final LS in R1-2409283.

gNB scheduled reporting

- **FL sees no open issue for gNB scheduled reporting**

Agreement (118)
- CSI-RS based L1-RSRP report is supported for gNB scheduled measurement reporting
- FFS: CSI-RS based L1-SINR report is supported for gNB scheduled measurement reporting
- Rel-18 LTM CSI reporting framework is the baseline for CSI-RS based L1-measurement report by gNB scheduled measurement reporting

Agreement (119)
The agreement "Rel-18 LTM CSI reporting framework is the baseline for CSI-RS based L1-measurement report by gNB scheduled measurement reporting" made in RAN#118 is further clarified for L1-RSRP as follows:
- UCI format defined in Table 6.3.1.1.2-8C of TS38.212 can be used by replacing SSBRI with CRI.
- Whether the L1-RSRP(s) of serving cell is always included is configurable (in line with Rel-18)
- The quantization method defined in clause 5.2.1.4.3 of TS38.214 and bit width defined in Table 6.3.1.1.2-6 of TS38.212 can be used
- No L1 specified filtering for time and spatial domain is introduced
- No enhancement on how to report L cells x M beams
- Periodic reporting on PUCCH is supported
    - FFS: semi-persistent reporting on PUCCH/PUSCH, and aperiodic reporting on PUSCH

Agreement (119)
For CSI-RS based L1-measurement report by gNB scheduled measurement reporting, semi-persistent reporting on PUCCH/PUSCH and aperiodic reporting on PUSCH are supported

Event triggered reporting - 1

- **High priority:** Further details on determination of QCL RS or SSB QCLed with QCL RS
  - gNB configuration can solve everything, or
  - Additional rule may be needed

- **Mid priority:** Necessity of L1 specified filtering mechanism
  - Filtering event evaluation and reporting
  - Time domain and cell level filtering needs to be discussed

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Agreement(118)
- SSB based L1-RSRP measurements is supported for event triggered reporting
- CSI-RS based L1-RSRP measurements is supported for event triggered reporting
- FFS: CSI-RS based L1-SINR measurements is supported for event triggered reporting

Agreement(118)
- For the identification of the serving cell RS for event evaluation,
  - At least the following options are further studied in RAN1, where different options could apply to different LTM event
    - Option. 1: Derived from QCL (type-D) RS(s) of the indicated joint/DL TCI state for the serving cell
    - Option. 2: Derived from QCL RS(s) or SSB QCLed with the QCL RS of the indicated joint/DL TCI state for the serving cell
      - QCL RS or SSB is configured by the network
    - Option. 3: Measurement RS(s) is/are explicitly configured
    - Option. 4: Derived from QCL RSs of activated TCI states with the best quality, or SSB which is QCLed with the QCL RSs of activated TCI states with the best quality.
    - Option 6: Derived from QCL RSs of activated TCI states, or SSB which is QCLed with the QCL RSs of activated TCI states
- The RSs of the candidate cell(s) for event evaluation are explicitly configure
- Note: Companies are encouraged to take into account the RAN2 agreement (i.e current beam rather than best beam) for their further study.

Agreement(119)
The serving cell RS for event evaluation is at least derived from QCL RS or SSB QCLed with the QCL RS of the indicated joint/DL TCI state for the serving cell
- QCL RS above is the RS w.r.t. QCL-TypeD when the indicated joint/DL TCI state is configured with two QCL RSs
- FFS: Details on determination of QCL RS or SSB QCLed with QCL RS
Note: This does not imply the support of mTRP scenarios

Event triggered reporting - 2

- FL sees no additional RAN1 issue based on the RAN2 new agreements

RAN2 Agreements on L1 event triggered MR
1. MR can be sent when the leaving condition is met, based on NW configuration.
2. Event triggered periodic MR can be supported, based on NW configuration.
3. For measurement resource configuration, R18 LTM CSI resource configuration is reused if possible. If CSI-RS resource only IE needs to be defined, we can revisit it in the stage 3.
4. For measurement reporting configuration, R18 LTM-CSI-ReportConfig is reused if possible. We can revisit it in the stage 3 if needed.
5. For association between measurement resource configuration and measurement reporting configuration, R18 LTM way is reused if possible. We can revisit it in the stage 3 if needed.
6. The entire event evaluation procedure is handled by MAC based on the latest L1 measured results reported by L1.
7. TTT operates only based on a timer (like TTT used in L3 event triggered MR).
8. Confirms WA (Same RS type should be used for both serving and neighbouring cell for event LTM3 and event LTM5).
9. Basic information included in MR MAC CE:
   - Beam information: FFS if SSBRI/CRI of N beams or (LTM configuration id + SSB/CSI-RS id)
   - Beam quantity: L1-RSRP or SINR (up to RAN1) of N beams
   - Triggered event information (e.g., ReportConfigID)
   MR MAC CE can include up to N beams (FFS whether the beam should satisfy the event or not).
   N is configurable by NW.
1. Additional information included in MR MAC CE:
   - The information and quantity of current beam, based on NW configuration.
   11. The legacy SR procedure for resource allocation is the baseline to send the event-triggered L1 measurements MAC CE.
   12. NW can configure a dedicated SR configuration for MR MAC CE transmission.

Beam Management based on CSI-RS

- **Mid priority:** QCL source of candidate TCI state   `No agreement at RAN1#118 and #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
  - Companies' views were split in RAN#118bis, and hence more discussion would be needed

- **Mid priority:** Rx beam refinement
  - 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.
  - Companies were OK for further study according to the input in RAN1#118bis. More detailed analysis is expected in RAN1#119

CSI acquisition - 1

- **High priority:**
  - The following pros and cons analysis are considered for the down-selection in RAN1#119

- Alt-1:
  - Pros: the existing framework can be reused for measurement and reporting, no impact on cell switch delay
  - Cons: more UE capability and UL overhead are required to measure multiple candidate cells, Outdated CSI, necessity of transferring measurement results (for inter-DU)

- Alt-2:
  - Pros: the existing framework can be reused for measurement, less UL overhead, [no impact on cell switch delay?? – this depends on the reporting mechanism]
  - Cons: more UE capability is required to measure multiple candidate cells, [new framework for reporting – companies may have different idea], Outdated CSI, Clarification on the reporting timeline

- Alt-3:
  - Pros: less UE capability and UL overhead are required thank to measure a single target cell, fresh CSI
  - Cons: [new framework for measurement and reporting – companies may have different idea], impact on cell switch delay due to target cell CSI measurement [and reporting] , Clarification on the reporting timeline

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Agreement(119)

The following alternatives are further studied:

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

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

CSI acquisition - 2

- **Low priority:** other aspects for CSI-acquisition, which may include the following aspects:
  - Time domain property of CSI reporting
  - Time domain property of CSI-RS resource
  - Restrictions on the CSI configurations
    - Quantity: 'cri-RI-PMI-CQI' and 'cri-RI-CQI'
    - Codebook type (Majority supports type I only)
    - bandwidth of CQI and PMI
    - Maximum number of CSI-RS port

- Note that some of these aspects are associated with the alternatives in the previous page – this shall be decided first

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Agreement(119)

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

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

Conditional Intra-CU LTM

- **Low priority:** RAN1 can discuss the L1 necessary support for conditional LTM based on the RAN2 agreements

- However, it would be good idea to wait for more RAN2 progress for the efficient discussion in RAN1

- FL plan is not to prioritize this issue in RAN1#119

RAN2 Agreements on C-LTM

1. Source cell sends the conditional LTM configuration via RRCReconfiguration to UE, which includes the LTM candidate configurations, and the corresponding execution conditions.
2. Event LTM3-like and LTM5-like are used as the conditional LTM execution condition. FFS on reuse of CHO conditions.
3. Source cell and each candidate cell provides its own execution condition for conditional LTM.
4. It is DU to generate the L1 execution condition. FFS on a case that L3 measurement is used.
5. RACH-less Conditional intra-CU LTM is supported.
6. RACH based conditional intra-CU LTM is supported.
7. UE based TA measurement mechanism is supported for conditional intra-CU LTM.
8. PDCCH ordered early TA acquisition is supported for conditional LTM.
9. Rel-18 Early candidate TCI State activation/deactivation is supported for conditional intra-CU LTM.
10. For RACH-less conditional LTM, CG-based first UL transmission on target cell is supported. FFS on DG-based approach.
11. The LTM completion defined for Rel-18 intra-CU LTM is reused for conditional LTM.

Note: Other necessary physical layer operations

- Based on the Chair's guidance at RAN1#118, the following items were discussed in RAN#105, and only item 1 was approved and clearly captured in the WID
  - Item 1: CSI acquisition for candidate cell be before cell switch
  - Item 2: Dynamic update of measurement RS or candidate cells to perform L1-measurement
  - Item 3: Enhancement on TRS in candidate TCI states to enable faster tracking
  - Item 4: UL-based measurement
  - Item 5: Early DL beam management
  - Item 6: Retention of activated candidate TCI states after cell switch
  - Item 7: TA acquisition based on CSI-RS
  - Item 8: Autonomous TCI state activation by event triggered report

- FL has no plan to discuss item 2 - 8 at RAN1#119
  - For item 7, the implication is that SSB is used for TA acquisition

Thank you