**3GPP TSG RAN WG1 Meeting #113 draft R1-2305128**

**Incheon, Korea, May 22nd – 26th, 2023**

**Source: Moderator (Fujitsu, MediaTek)**

**Title: FL summary 1 on L1 enhancements for inter-cell beam management**

**Agenda Item: 9.10.1**

**Document for: Information**

# Introduction

This contribution is a Feature Lead (FL) summary for A.I. 9.10.1: L1 enhancements for inter-cell beam management.

# Plan for GTW/Online discussion



##### [Proposals for Tuesday Online]

##### [Proposals for Wednesday Online]

##### [Proposals for Thursday Online]

##### [Proposals for Friday Online]

# Contact Person

Please input the contact information for each company below:

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# List of Contributions

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| --- | --- | --- |
| [**R1-2304352**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_113/Docs/R1-2304352.zip) | L1 enhancements for inter-cell beam management | FUTUREWEI |
| R1-2304399 | L1 enhancements for inter-cell beam management | ZTE |
| R1-2304498 | Discussion on L1 enhancements for L1/L2 mobility | vivo |
| R1-2304576 | Discussion on L1 enhancements for inter-cell beam management | Spreadtrum Communications |
| R1-2304659 | L1 enhancements for inter-cell beam management | Huawei, HiSilicon |
| R1-2304712 | Further discussion on L1 enhancements for inter-cell beam management | CATT |
| R1-2304774 | Views on L1 enhancements for inter-cell beam management | Fujitsu |
| R1-2304785 | L1 enhancements to inter-cell beam management | Ericsson |
| [**R1-2304823**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_113/Docs/R1-2304823.zip) | L1 Enhancements for Inter-cell Beam Management | Intel Corporation |
| R1-2304880 | Discussion on L1 enhancements for inter-cell beam management | xiaomi |
| R1-2304957 | L1 enhancements for inter-cell beam management | Lenovo |
| R1-2305007 | L1 enhancements for inter-cell beam management | KDDI Corporation |
| R1-2305010 | Discussion on L1 enhancements for inter-cell beam management | Google |
| R1-2305050 | L1 enhancements for inter-cell beam management | Sony |
| [**R1-2305072**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_113/Docs/R1-2305072.zip) | Discussion on L1 enhancements for inter-cell beam management | NEC |
| R1-2305112 | Discussion on L1 enhancements for inter-cell beam management | CMCC |
| R1-2305156 | Layer-1 Enhancements for L1/L2-triggered Mobility | Nokia, Nokia Shanghai Bell |
| R1-2305263 | L1 enhancements to inter-cell beam management | Apple |
| R1-2305302 | Enhancements on inter-cell beam management for mobility | LG Electronics |
| [**R1-2305356**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_113/Docs/R1-2305356.zip) | L1 Enhancements for Inter-Cell Beam Management | Qualcomm Incorporated |
| R1-2305418 | Discussions on Inter-cell beam management enhancement | OPPO |
| [**R1-2305480**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_113/Docs/R1-2305480.zip) | Discussion on multi-TA indication for LTM | ASUSTEK COMPUTER |
| R1-2305533 | On L1 enhancements for inter-cell beam management | Samsung |
| R1-2305613 | Discussion on L1 enhancements for inter-cell mobility | NTT DOCOMO, INC. |
| R1-2305667 | L1 enhancements for inter-cell beam management | MediaTek Inc. |
| R1-2305693 | Discussion on L1 enhancements for L1L2-triggered mobility | Panasonic |
| R1-2305712 | Discussion on measurement enhancement of L1L2 triggered mobility | Transsion Holdings |
| R1-2305783 | Discussion on L1 enhancements for inter-cell beam management | FGI |
| R1-2305856 | Discussion on L1 enhancements for inter-cell beam management | InterDigital, Inc. |

# Discussion

## L1 measurement

### [Closed] L1 Intra-frequency measurement

##### [Conclusion at RAN1#110b-e]

Agreement

* For Rel-18 L1/L2 mobility, L1 intra-frequency measurement for candidate cell is supported
  + At least the following aspects are for RAN1 further study:
    - RAN1 assumes Rel-17 ICBM CSI measurement as starting point.
    - Whether and how to apply relaxation for the restrictions imposed on the Rel-17 intra-frequency L1 non-serving cell measurement defined in 9.13.2 of TS38.133, where RAN4 impact is foreseen, e.g.
      * SFN offset alignment compared with serving cell
      * BWP setting, i.e. non-serving cell SSB should be covered by serving cell active BWP
      * Introduction of symbol level gap or SMTC for larger Rx timing difference (i.e. larger than CP length)
    - Commonality with intra-frequency L3 measurement
    - Commonality with L1 inter-frequency measurement for measurement configuration
* Send an LS to RAN4 (CC RAN2)
  + RAN1 to ask RAN4 if the restriction on e.g., SFN offset alignment, BWP setting and Rx timing difference, etc, described in 9.13.2 of TS38.133 for intra-frequency L1 non-serving measurement can be relaxed or not.
  + RAN1 assumes Rel-17 ICBM CSI measurement as starting point.

##### [Conclusion at RAN1#111]

No discussion as LS from RAN4 had not been received at that time.

##### [Conclusion at RAN1#112]

No discussion as LS from RAN4 requires no RAN1 discussion.

##### [Conclusion at RAN1#112bis-e]

No discussion as LS from RAN4 requires no RAN1 discussion.

##### [Summary of Contributions]

* Intel:
  + Use Rel-17 ICBM CSI measurement framework with extension to candidate cells where the SSB RTD is larger than CP length for SCS of the given carrier

##### [FL observation]

FL sees no urgent issue on L1 intra-frequency measurement from the contribution submitted to this meeting. Given this situation, FL close this

##### [Comments if any]

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### [Closed] L1 Inter-frequency measurement

##### [Conclusion at RAN1#110b-e]

Agreement

* For Rel-18 L1/L2 mobility, further study the potential RAN1 spec impact of L1 inter-frequency measurement
  + The definition and scenarios of L1 inter-frequency measurement is determined by RAN4, and RAN1 assumes at least the following until receiving their confirmation
    - The scenarios not included in intra-frequency are regarded as inter-frequency, which includes at least the following scenarios:
      * The frequency of the measured RS not covered by any of the active BWPs of SpCell and Scells configured for a UE, but covered by some of the configured BWPs of SpCell and Scells configured for a UE.
      * The frequency of the measured RS not covered by any of the configured BWPs of SpCell and Scells configured for a UE
  + At least the following aspect is studied:
    - Commonality with L1 intra-frequency measurement for measurement configuration
* Send an LS to RAN4 (CC RAN2)
  + RAN1 would like to confirm our understanding that the supported scenarios not included in intra-frequency are regarded as inter-frequency, which includes at least the following scenarios:
    - The frequency of the measured RS not covered by any of the active BWPs of SpCell and Scells configured for a UE, but covered by some of the configured BWPs of SpCell and Scells configured for a UE.
    - The frequency of the measured RS not covered by any of the configured BWPs of SpCell and Scells configured for a UE
  + It is RAN1 understanding that the introduction of measurement gap and SMTC for L1 inter-frequency measurement, if any, is expected to be a RAN4 issue
  + Note: this content is included in the LS agreed for intra-frequency L1 measurement

##### [Conclusion at RAN1#111]

Agreement

* For Rel-18 LTM, L1 inter-frequency measurement is supported from RAN1 point of view.

##### [Conclusion at RAN1#112]

No discussion as LS from RAN4 requires no RAN1 discussion.

##### [Conclusion at RAN1#112bis-e]

No discussion as LS from RAN4 requires no RAN1 discussion.

##### [Summary of Contributions]

* + Huawei
    - A UE capability of L1 intra-frequency measurement without gap can be introduced for LTM. And L1 measurement gap should be configured for the UE in asynchronous measurement scenario if UE do not indicate the capability.
    - Support UE to report the RTD exceed CP or L1 measurement cannot be handled without gap according to its capability.
  + Xiaomi
    - L1 measurement gap/window needs to be introduced to support inter-frequency beam measurement.
  + Lenovo
    - Considering the following two options for CSI report for LTM
      * Option 1: Introduce a RF switching gap for CSI report configured for LTM for inter-frequency measurement.
      * Option 2: A UE can be configured with multiple measurement gaps for L1 measurement for LTM, and each CSI report for LTM is associated with a measurement gap to obtain the corresponding beam report.
  + Google
    - Support introducing symbol-level L1 measurement gap for SSB/CSI-RS from the neighbouring cells configured for L1-RSRP/L1-SINR report or CBD.
  + FGI
    - For inter-frequency measurement, measurement gap information needs to be provided to a UE.

##### [FL observation]

As we have already agreed and sent an LS to RAN4, issues related to measurement gap should be handled in RAN4. Other than that, FL sees no issue to discuss in RAN1#113. With this, the discussion in this section is closed without FL proposal.

##### [Comments if any]

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### void

### [Closed] Measurement RS

##### [Conclusion at RAN1#110b-e]

Agreement

* For Rel-18 L1/L2 mobility,
  + SSB is supported for L1 intra-frequency measurement
  + SSB is supported for L1 inter-frequency measurement if inter-frequency L1 measurements are supported
* Further study the following L1 measurement RS for candidate cell
  + CSI-RS for tracking, beam management, CSI and mobility, CSI-IM, which is for L1 intra-frequency and L1 inter-frequency (if supported)

##### [Conclusion at RAN1#111]

The FL proposal 1-4-v3 was not due to the lack of time during RAN1#111. Companies are encouraged to perform their analysis based on the latest proposal below:

* For Rel-18 LTM,
  + L1 measurement based on CSI-RS for beam management for candidate cells is supported for L1 intra-frequency measurement and L1 inter-frequency measurement if supported in RAN4
    - The definition of intra- and inter- frequency for CSI-RS is defined in RAN4
    - The CSI-RS is explicitly linked to a candidate cell
    - Applicability to L1-RSRP and/or L1-SINR is separately discussed.
    - FFS for the support of other CSI-RS types (i.e. tracking, CSI, mobility and CSI-IM).

##### [Conclusion at RAN1#112]

The following FL was not able to be discussed again because of the lack of time.

* [Working assumption: CSI-RS is introduced for L1-RSRP measurement from RAN1 point of view
  + Intra- and inter- frequency is supported
  + At least CSI-RS for BM [mobility] is supported
  + Send an LS to RAN4 to explicitly ask their feasibility to finalize their work in Rel-18]

##### [Conclusion at RAN1#112bis-e]

The following proposal was listed as a topic for Tuesday GTW (2nd week), it was not discussed due to the lack of time.

Working assumption: CSI-RS is introduced for L1-RSRP measurement from RAN1 point of view

* + Intra- and inter- frequency L1 measurement is supported
  + At least CSI-RS for BM is supported
  + Send an LS to RAN4 to explicitly ask their feasibility to finalize their work in Rel-18, and the WA is confirmed when positive feedback is received from RAN4.
    - The following is included in the LS
      * RAN1 understands that the definition of intra-and inter- frequency may be different from that for L3 measurement. However, RAN1 hasn’t discussed this issue yet and has not baseline for this definition.
      * It is expected that, if RAN4 agrees to specify CSI-RS based L1-RSRP measurement in Rel-18, RAN4 could define the definition of intra- and inter-frequency and inform RAN1 of their decision.

##### [Summary of contributions]

* **Support the introduction of CSI-RS**
  + For BM: Futurewei, ZTE, vivo, Huawei, CATT, Intel, Lenovo, Nokia, Apple, LGE, Qualcomm, DCM, IDC
  + For tracking: ZTE, Huawei, Apple, Qualcomm
  + For CSI: Huawei
  + For mobility: CATT, Samsung
  + Type is not clearly mentioned: KDDI, CMCC, FGI
  + Working assumption and ask RAN4 for their feasibility: ZTE
  + Other aspects:
    - Vivo: To avoid invalid measurement, at least one CSI-RS resource involved in the CSI resource setting is overlapped with the BWP associated with the CSI resource setting, if CSI-RS based L1 measurement is supported.
* **Not support**
  + Ericsson, MediaTek

##### [FL observation]

Firstly, the situation has not be changed for a couple of meetings.

Even though large number of companies are interested in the introduction of CSI-RS for L1 measurement, FL sees a sustained concern to agree the introduction of CSI-RS in Rel-18 considering the overload situation in RAN4. . FL shares this view. Also, the benefit of CSI-RS is also questioned. The potential agreement in this meeting would be to take a working assumption conditioned on the RAN4 feasibility. However, this approach is not feasible because RAN1 has only two meetings to conclude this WI.

Therefore, FL believes CSI-RS cannot be introduced in Rel-18 due to the lack of time unless the WI is extended. Also, rather than taking time for this issue, FL thinks we should spend our time on other important and essential issues.

However, FL thinks that continuing discussion using FL summary might be helpful for the smooth discussion in Rel-19 (is a follow-up WI can be approved). FL can show the final form of FL proposal in the last meeting below, and comments from companies are greatly appreciated.

Working assumption: CSI-RS is introduced for L1-RSRP measurement from RAN1 point of view

* + Intra- and inter- frequency L1 measurement is supported
  + At least CSI-RS for BM is supported
  + Send an LS to RAN4 to explicitly ask their feasibility to finalize their work in Rel-18, and the WA is confirmed when positive feedback is received from RAN4.
    - The following is included in the LS
      * RAN1 understands that the definition of intra-and inter- frequency may be different from that for L3 measurement. However, RAN1 hasn’t discussed this issue yet and has not baseline for this definition.
      * It is expected that, if RAN4 agrees to specify CSI-RS based L1-RSRP measurement in Rel-18, RAN4 could define the definition of intra- and inter-frequency and inform RAN1 of their decision.

##### [Comments if any]

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### [Closed] Measurement quantity

##### [Conclusion at RAN1#110b-e]

Agreement

* For candidate cell measurement for Rel-18 L1/L2 mobility,
  + L1-RSRP is supported for intra-frequency candidate cell measurement.
  + Further study the following measurement quantities for candidate cell measurement
    - L1-RSRP for inter-frequency (if supported)
    - L1-SINR for intra-frequency and inter-frequency (if supported)
* FFS: to assess the use case and the benefit of UL measurement instead of/in addition to DL L1 measurement, which includes:
  + How the UL measurement result is used, e.g. handover decision
  + Signals/channels used for UL measurement, e.g. SRS
  + Spec impact including other WGs, e.g. definition of gNB measurement, interface to transfer RS configuration or measurement results
  + Note: The next discussion will take place based on companies’ contribution in future meeting.

##### [Conclusion at RAN1#111]

Agreement

* For candidate cell measurement for Rel-18 LTM,
  + SSB based L1-RSRP is supported for intra-frequency measurement
  + SSB based L1-RSRP is supported for inter-frequency measurement from RAN1 point of view
  + FFS: L1-SINR, CSI-RS based L1-RSRP

##### [Conclusion at RAN1#112]

The following FL was not able to be discussed again because of the lack of time.

* [CSI-RS based L1-SINR (with channel measurement and interference measurement using CSI-RS) is introduced from RAN1 point of view
  + If supported, both intra- and inter-frequency L1-SINR is supported
  + Send an LS to RAN4 to explicitly ask their availability in Rel-18]

It was pointed out that the benefit of SINR cannot be achieved without CSI-RS. In addition, some companies showed the concern on the L1-SINR.

##### [Conclusion at RAN1#112bis-e]

No FL proposal was made due to the lack of consensus on CSI-RS, which is very important to enjoy the benefit of L1-SINR.

##### [Summary of contributions]

* **Support of L1-SINR(7)**
  + Futurewei, Huawei, KDDI, Google, CMCC, DOCOMO, FGI
* **Not support/low priority(5)**
  + CATT, Intel, Apple, MediaTek, IDC
* **Further study is necessary(1)**
  + Samsung

##### [FL observation]

The situation remains unchanged from the previous meetings on the introduction of L1-SINR. Also considering the situation where the introduction of CSI-RS has not been agreed yet, FL cannot expect any progress on this matter in this meeting. Especially, FL thinks it would be so hard to finalize the standardization of L1-SINR in Rel-18 given the remaining time in RAN1 and RAN4 workload.

Also, it would be helpful to continue the discussion here for the smooth discussion in Rel-19 (if the follow-up WI can be approved). The following is the proposal from DOCOMO and it actually tries to address the concern to L1-SINR brought up so far.

**Proposal 3 in R1-2305613**

* **Support L1-SINR for intra-frequency and inter-frequency measurement. Further study following two methods to mitigate the impact of varying interference.**
  + **Use L1-RSRP and L1-SINR together to select the beams to report.**
  + **Introduce UE/event triggered reporting, with the new event(s) considering time domain and/or spatial domain variations, e.g., a report is triggered when certain measurement threshold condition is met for a time duration or multiple beams.**

The comment from companies are greatly appreciated for our future discussion.

With this understanding, the discussion in this section is closed without FL proposal.

##### [Comments if any]

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### [Closed] Filtering for L1 measurement results

##### [Conclusion at RAN1#110b-e]

FL proposal below was not agreed and postponed to the further RAN1 meeting.

* For Rel-18 L1/L2 mobility, [study the importance of mitigating the ping-pong issue for L1/L2 mobility, which is expected to align with RAN2. If important ~~yes~~,] further study at least the following mitigation aspects: FL: A concern was raised if RAN1 can perform a proper study on ping-pong issue, CATT, Samsung, LG wants to keep it. FL thinks we can keep it as long as companies say they can perform their analysis,
  + UE-based filtering to the L1 measurement results, where the definition of filtering includes:
    - Time domain filtering: e.g. exact definition of time domain filtering, and/or
    - Cell-level (spatial domain) filtering: e.g. how many beams are averaged, and/or how the beams are chosen.
  + Applicability to L1-RSRP and L1-SINR (if supported)
  + Applicability to intra-frequency and inter-frequency (if supported)
  + Necessity to be specified in standard considering the presence of alternative implementation-based solutions, e.g. gNB-based filtering and/or L3 measurement (when involved)

##### [Conclusion at RAN1#111]

Given the comments from companies, FL believes no positive result can be obtained on this topic even when we discuss the discussion in this meeting. Therefore, FL would like to take approach 1 this meeting and to encourages to have offline discussions for the next meeting.

With this analysis, the discussion on this section is closed. If companies have any comments, the following table can be used or further input.

##### [Conclusion at RAN1#112]

No discussion was held as no progress was expected

##### [Conclusion at RAN1#112bis-e]

No discussion was held as no progress was expected

##### [Summary of contribution and FL observation]

While some companies still propose to introduce time domain and/or cell domain filtering for L1 measurement result, FL thinks this is not an essential feature for Rel-18 LTM, and the discussion will not take us anywhere given the past RAN1 discussions (as no consensus on the ping-pong issue and the feasibility of RAN1 evaluation etc).

Therefore, no FL proposal is made in this section and the discussion in this section is closed.

##### [Comments if any]

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### [High] Configurations for L1 measurement

##### [Conclusion at RAN1#111]

The following proposal was not treated in RAN1#111 and postponed to next meeting. Since this functionality is essential for Rel-18 LTM, companies are encouraged to perform their analysis based on the final proposal (i.e. FL proposal 1-7-v3) as well as the companies comments for this proposal above. Especially, there was a big discussion on the difference between Option 2 and 3. Also, it was pointed out (from October meeting) that Option 4 for intra-frequency will violate our former agreement on the “Rel-17 ICBM baseline”. They are key discussion points in the next meeting.

* For Rel-18 LTM, further study the following structure for L1 measurement configurations.
  + Option-1: Based on CSI measurement configuration specified in Rel-17 ICBM
    - CSI-MeasConfig for serving cell and candidate cell(s), which requires inter-DU coordination
    - For inter-frequency, at least the frequency information, SMTC or measurement gap (MG) with candidate cell are additionally introduced
  + Option-2: Introduce ~~an independent~~ a measurement configuration for candidate cell(s) [and serving cell] ~~from serving cell configurations, which~~, and the measurement configuration is decoupled with serving cell configuration.~~Introduce an independent measurement configuration for all candidate cell(s) and serving cell(s) (FL note: Suggested by DOCOMO and their intention is to enable reporting for candidate cells with that for serving cell ) from serving cell configurations, which is decoupled with serving cell configuration.~~
    - ~~L1 measurement resource set can be configured outside candidate cell configurations (i.e. ServingCellConfig or CellGroupConfig)~~
    - Separate CSI-MeasCofig is configured for candidate cell from the CSI-MeasConfig for serving cell
  + Option-3: Use measurement configuration for each candidate cell
    - L1 measurement resource set can be configured inside candidate cell configurations (i.e. ServingCellConfig or CellGroupConfig)
  + Option-4: Do not include RS information or cell information in measurement configurations
    - For intra-frequency, neither SSB/RS indices nor PCI is configured.
    - For inter-frequency, neither SSB/RS indices nor PCI is configured, but frequency information is configured
  + Note: Proponents of each option are encouraged to bring the detailed explanation in RAN1#112.

##### [Conclusion at RAN1#112]

Agreement

* For L1-RSRP measurement RS configuration
  + For SSB based L1-RSRP measurement:
    - As a starting point, at least the following information needs to be provided to a UE, e.g.
      * For intra- and inter- frequency: PCI or logical ID (e.g., as being defined in R17 ICBM), time domain (e.g. SMTC or periodicity and SSB position in burst)
      * For inter-frequency: frequency domain location (e.g. center frequency), SCS
      * FFS: transmission power (for pathloss calculation)
    - Note: other parameters included in the configuration can be further discussed
    - Including above agreement into the LS
  + The detailed design of RRC structure is up to RAN2, and send an LS to RAN2 to request to work on the RRC structure design on the measurement configuration.
    - Following RAN1 understanding will be provided in the LS
      * RAN1 has discussed the following configuration options for L1 measurement configurations for SSB till RAN1#112:
        + Option 1) Configurations for L1 measurement RS is provided under ServingCellConfig for the serving cells

is useful to reuses the mechanism for Rel-17 ICBM and necessary information to support inter-frequency measurement will be added there.

* + - * + Option 2) Configurations for L1 measurement RS is provided separately from ServingCellConfig for the serving cells and CellGroupConfig for the candidate cells

is useful to avoid the duplicated configurations for L1 measurement RSs, [and avoid UE to process configurations ~~for L1 measurement RS~~ provided under CellGroupConfig for the candidate cells]

* + - * + Option 3) Configurations for L1 measurement RS is provided under CellGroupConfig for the candidate cells

can achieve the similar benefit as Option 2) by directly referring to the candidate cell configurations.

* + - * Note RAN2 has a full flexibility to design the whole RRC structure design.
      * RAN1 believes this is RAN2 expert region, and respectfully asks RAN2 to finalize the RRC structure design after RAN1 finalizes the discussion on RRC parameters.
      * It is noted that RAN1 foresees the necessity of similar discussions on TCI state pool for candidate cells and L1 measurement report configurations.

##### [Conclusion at RAN1#112bis-e]

The discussion on the configuration for L1 measurement RS is closed without any consensus. Firstly, many companies expressed that RAN1 discussion is necessary to further down select the time domain information for intra-frequency measurement: i.e. providing SBB position or smtc. However, after some round of discussion, majority companies started saying that this can be left to RAN2. If so, interested companies are encouraged to discuss with their RAN2 colleagues to avoid the misunderstanding between RAN1 and RAN2.

Agreement

* RRC parameter ss-PBCH-BlockPower for candidate cells is included in the LTM configuration.
  + UE needs the parameter to (at least) perform RACH towards candidate cells
  + Note: how to capture this parameter and RRC structure are up to RAN2

##### [Summary of contributions]

* ZTE:
  + For Intra- and inter-frequency: Cell identification (e.g., PCI), ssb-Periodicity, ssb-PositionInBurst and measurement gap should be included in measurement configuration.
  + For inter-frequency, at least ssb-Freq, ssbSubcarierSpacing should be included in measurement configuration
  + FFS: half Frame index and SFN related information (e.g., sfn0-Offset (sfn-Offset and integerSubframeOffset) and sfn-SSB-Offset).
* Vivo
  + At least for SSB-based intra-frequency L1 measurement for candidate cell(s) in the unsynchronized scenario in FR2 and synchronized scenario in FR1/2, if downlink synchronization is always performed before L1 measurement, the time domain location of SSB can be determined by ssb-PositionsInBurst and ssb-Periodicity, i.e., Option 2.
* Spreadtrum
  + Align with RAN2 decision, SMTC location is provided to UE as time domain information of SSB-based measurement.
  + RAN2 has already agreed that RS configuration is external to the serving cell and candidate cells, they can include PCI or logical ID.
* Huawei
  + For SSB based L1 measurement for candidate cell(s), the frequency domain information include center frequency and subcarrier spacing of SSB. The time domain information include indication of SSB to measure, periodicity of SSB and offset value for UE to determine start point of a periodicity. Detail IE structure is up to RAN2.
* CATT
  + Time domain: SSB transmission periodicity, SSB time domain position (ssb-PositionsInBurst)
  + Frequency domain: center frequency of SSB, SCS
* Ericsson
  + This would mean that we use the SMTC window, and potentially also *ssb-ToMeasure* and *deriveSSB-IndexFromCell.* Periodicity and SSB position in burst seem less appropriate.
* Xiaomi
  + About the time domain information of candidate cell’s SSB, we support alt.2 that smtc is configured.
* Apple
  + For intra-frequency and inter-frequency measurement, the following can be provided as time-domain parameters for L1-RSRP measurement configuration:
    - SMTC window, ssb-ToMeasure and deriveSSB-IndexFromCell.
* Samsung
  + For the configuration of intra-frequency time domain information for L1 measurement ssb-Periodicity and ssb-PositionsInBurst are provided.
* MediaTek
  + For Rel-18 L1/L2 mobility SSB based L1-RSRP measurement, the time domain information of the measured SSB provided in measurement configuration are SSB periodicity and SSB index.

##### [FL observation]

Even though many companies showed their view that this issue can be discussed in RAN2, many companies showed their views on the time domain information for L1 measurement. The summary of the proposal on time domain information for L1 measurement RS is as follows:

* **SMTC(4)**
  + Spreadtrum, Ericsson, Xiaomi, Apple
* **ssb-Periodicity, ssb-PositionInBurst (6)**
  + ZTE, vivo, Huawei, CATT, Samsung, MediaTek

The companies’ view is almost even, so it is not easy to make a conclusion from the contribution review. However, it seems that RAN2 has already agreed to go with SMTC, according to their LS (sited below).

* The location of RS configuration for SSB-based measurements of candidate cells is external to the ServingCellConfig(s) of current serving cells and external to the configuration of the LTM candidate cells. The RS configuration, per RAN1 agreement, can include PCI or logical ID, SMTC location, frequency location, and SCS.

FL doesn’t see the strong support to revert the RAN2 agreement, and hence FL would like to propose the following.

##### [FL Proposal 5-1-7-v1]

* For L1-RSRP measurement RS configuration for SSB based L1-RSRP measurement, RAN1 confirms the following RAN2 agreement
  + For intra- and inter- frequency, SMTC is provided to a UE as a time domain information.

##### [Comments to FL Proposal 5-1-7-v1]

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## L1 measurement reporting

### [High] Contents of gNB scheduled L1 measurement reporting

##### [Conclusion at RAN1#110b-e]

Agreement

* For L1 measurement report for Rel-18 L1/L2 mobility, further study the following mechanisms:
  + Report as UCI on PUCCH or PUSCH
    - Periodic report on PUCCH, semi-persistent report on PUCCH/PUSCH, and aperiodic report on PUSCH
    - Potential enhancements to Rel-17 ICBM report format to accommodate Rel-18 scenarios, e.g.
      * Inter-frequency measurement, if supported
      * Increasing the maximum number of reported beams, which is 4 for Rel-17 ICBM
      * Flexible size beam report, e.g., two-part UCI (e.g., the 1st part contains the best beam/cell and the number (e.g., N) of reported beams/cells, the 2nd part contains the rest (N-1) beams/cells
      * Reducing the reporting overhead by e.g. choosing beams/cells per frequency or across frequencies to report (FFS how)
  + Report on MAC CE
    - Both gNB scheduled and/or UE initiated (if supported) report are studied

##### [Conclusion at RAN1#111]

Agreement

* For gNB scheduled L1 measurement report for Rel-18 LTM, report as UCI is supported
  + Semi-persistent report on PUSCH, and aperiodic report on PUSCH are supported
    - FFS: periodic and semi-persistent PUCCH
  + In a single report instance, report for serving cell and candidate cell(s) for intra-frequency and/or inter-frequency can be included.

##### [Conclusion at RAN1#112]

The last version of FL proposal:

* For L1 measurement reporting for LTM,
  + At maximum [4] beams (4 is a starting point, FFS: the values and UE capabilities) from candidate cell(s) [and serving cells] configured for measurement & reporting can be reported in a single report instance
    - FFS whether the configured candidate cell(s) can be activated
    - FFS how to choose the beams to be reported from multiple candidate cells, e.g. from all configured/activated candidate cells, from each candidate cell, from each group of candidate cells, from selected candidate cells
  + [Additionally/At least]1 beam from the serving cell is included in the report instance
    - FFS: always included or depending on the gNB configuration

It was pointed out that the light blue part of 5-2-1-v4 is the most important issue, and the agreement on the numbers is meaningless without knowing how to choose the beams to be reported. In other word, the consensus of the group was that the following discussion should be resolved in the next meeting, and then we can go to the next step discussion (e.g. number of beams, necessity of 2-part report).

**Important discussion in RAN1#112bis-e**

* FFS whether the configured candidate cell(s) can be activated
* FFS how to choose the beams to be reported from multiple candidate cells, e.g. from all configured/activated candidate cells, from each candidate cell, from each group of candidate cells, from selected candidate cells

##### [Conclusion at RAN1#112bis-e]

Agreement

For the beam selection for SSB based L1-RSRP measurement report,

* Beam selection is performed across the L cells from configured (or activated, if introduced) cells, i.e. M beams for each of the L cells
  + FFS: How to select the L cells and M beams per cells is up to UE
* M x L beams are reported in a single report instance
  + Max values of M and L are based on UE capability, and at least M x L=4 is supported as a UE capability, other UE capabilities are FFS
    - FFS if UE is allowed to report less than M x L beams
  + The values of M and L are configured to the UE in the reporting configuration
* FFS: The following configurability is introduced in the report configuration
  + 1) Whether serving cell is always selected in the L cell selection performed by the UE, and applicable when a UE is configured with L>=2
  + 2) at least one of the inter-frequency cells is always selected in the L cell selection performed by the UE, and applicable when a UE is configured with L>=2 and at least one cell in inter-frequency

##### [Summary of contributions]

* **How to choose the cells and beams to be reported**
  + Define a rule
    - ZTE
      * M x L beams in a single report instance are selected based on L best cells and M best beams for each of L best cells.
    - Nokia
      * For the L best cells, the ranking of cells is performed based on the average L1-RSRP determined over the measured beams of each cell.
        + Alt1: a minimum quality threshold (e.g., L1-RSRP) is configured for selecting the measured beams for averaging, i.e., measured beams above the minimum quality threshold are used for averaging to derive the cell quality value
        + Alt2: highest quality measured beam (e.g., largest L1-RSRP) for a cell is used as the cell quality
      * For the M beams for each of the selected L cells, the UE shall report M largest measured L1-RSRP values.
    - Apple
      * UE selects the ‘L’ cells based on the largest measured L1-RSRP value and then report ‘M’ best beam for each selected cell.
    - Samsung
      * The UE determines the cells and beams per cell to report based on the RSRP of each measured beam
    - IDC
      * The M beams for each of the L cells are the beams with the largest measured L1-RSRP value
      * Consider a cell-level beam quality metric for selection of the L cells.
  + Up to UE implementation
    - Vivo, spreadtrum, Huawei, Fujitsu, Ericsson, Intel, CMCC, OPPO, MediaTek
* **Report format for cell(s)/beam(s) of the measurement result(s)**
  + ZTE
    - Whether cell information corresponding to reported beam should be explicitly included in a single report instance needs to be clarified.
  + Vivo
    - Support reporting measurement RS indices and corresponding L1 measurement result only.
  + Ericsson
    - The identifier in the LTM measurement report can be mapped to a candidate configuration.
  + Xiaomi
    - To distinguish the measurement results of each cell, PCI or configuration index of each reported cell should be included in report instance.
    - For each beam in the report instance, at least the corresponding measurement RS indicator and measurement quantity need to be included.
  + Nokia
    - For a beam measurement in a report, RS ID (SSB-index) which can be specific to a reporting configuration and a value indicating the associated L1-RSRP are used
  + Apple
    - For measurement report associated with serving cell in LTM operation, L1-RSRP result is included without need of SSBRI information.
  + Qualcomm
    - The reported contents per cell are concatenated cell by cell
      * The reported contents per cell includes cell ID followed by {SSB ID and L1-RSRP} per reported beam
  + IDC
    - RRC configures a separate set of resources for channel measurement for each frequency.
    - L1 measurement report indicates which set(s) of inter-frequencies are included.
* **whether UE is allowed to report less than M x L beams**
  + Support (i.e. allowed):
    - vivo (Support flexible-size beam report to accommodate the larger number of beams to be reported), CATT (The reported beam satisfies that its L1-RSRP is larger than that of the beam of serving cell plus a configured RSRP offset value.), Intel(UE may send L1-RSRP report with different values of M and L for each reporting instance.), OPPO(Support 2-part UCI for L1-RSRP measurement reporting of candidate cells for LTM), Samsung (Two-part UCI reporting is used)
  + Not support (i.e. not allowed):
    - ZTE, spreadtrum, Huawei, Ericsson, CMCC, Nokia, LGE, DOCOMO
      * Complicated from NW perspective
  + FL note: the UE behavior should be clarified when M>1 is configured but the cell operates only one beam or UE cannot find 2nd beam
    - Ericsson has provided the solution: The UE reports the lowest possible RSRP values, for arbitrarily chosen beam identifier (cell identifier and SSB index), or the UE repeats the measurements from one of the cells it did find.
* **Support of additional configurability**
  + Beams for serving cell are always included
    - Support: Futurewei, ZTE, vivo, Huawei, CATT, Fujitsu, Ericsson, Nokia, Apple, Samsung, DOCOMO, IDC
    - Not support: Spreadtrum, LGE, MediaTek
      * Legacy reporting can be used to obtain serving cell report
  + Inter frequency cell is always included
    - Support: Huawei, Fujitsu, CMCC (“how many “ is also configurable), DOCOMO (applicable when more than X% (e.g., X=50 or even larger) of the candidate cells are in inter-frequency and/or the configured value of L is no smaller than Y (e.g., Y=3 or even larger) ), IDC(offset larger than the best intra-frequency L1-RSRP)
    - Not support: Futurewei, ZTE, vivo, Spreadtrum, LGE
      * Concern is overhead
      * This can be done by multiple report configuration
* **(Maximum) number of beams (M) and cells(L) to be reported**
  + Ericsson: For maximum value, M=4, L=8
  + Apple: MxL=2 for UE capability
  + LG: Larger than 4
  + DOCOMO: Larger than 4, e.g. M x L = 8
  + MediaTek: M x L=1, 2, 3 as UE capability
* **Other aspects**
  + Vivo
    - Support to report downlink receiving timing offset between different cells in L1/L2 report.
  + Ericsson
    - All LTM reports are zero-padded to ensure that the payload is always 12 bits or larger.
  + Nokia
    - Selecting cells/beam can be further optimized where in a reporting instance, beams from the synched candidate cells (for which the valid TA information is available) are prioritized over the non-synced candidate cells (for which the valid TA information is not available).
  + Qualcomm
    - To facilitate mTRP operation on the new cell, R17 group-based beam report can be extended to LTM to identify a group of simultaneously receivable DL beams for a candidate cell
      * Two CMR resource sets can be configured with each set including RS configured for LTM L1 measurement

##### [FL observation]

In this meeting, we can focus on the resolution of FFSs in the last meeting because they includes essential issues.

* **Issue No.1: How to choose the L cells and M beams to be reported**
  + Alt.1 Define a clear rule (5)
  + Alt .2 Up to UE implementation (9)

FL’s impression is that considering the difference of the rule in best cell criteria, there would be a risk to spend large amount of our precious time for this issue, which is not desirable. Even with going with “up to UE implementation”, it is still expected that UE will choose “better” cell by its choice. Given this analysis, UL proposal is to take Alt.2

* **Issue No. 2:** **whether UE is allowed to report less than M x L beams**
  + Alt. 1 Support (i.e. allowed): (5)
  + Alt. 2 Not support (i.e. not allowed): (8)

FL’s understanding is that UCI report should be fixed to avoid the decoding complexity at gNB side, and hence two-part CSI report will be introduced. The important thing here is that FL didn’t see the strong necessity to support two-part CSI to conclude Rel-18 LTM. Therefore, FL suggestion is take Alt.2 i.e. not to confirm this FFS.

* **Issue 3: Support of additional configurability**
  + Beams for serving cell are always included
    - Support: (12)
    - Not support: (3)
  + Beams for inter-frequency cell are always included
    - Support: (5)
    - Not support: (4)

A clear majority was found for the inclusion of the beams for serving cell. On the other hand, the situation is not so easy for the inclusion of inter-frequency. FL suggestion is to discuss online/official offline to find a common ground for this issue.

* **Issue 4: values of M(beams), L(cells) and M\*L (other than M\*L=4)**
  + Ericsson: For maximum value, M=4, L=8
  + Apple: MxL=2 for UE capability
  + LG: Larger than 4
  + DOCOMO: Larger than 4, e.g. M x L = 8
  + MediaTek: M x L=1, 2, 3 as UE capability

FLs understanding is that the discussion on UE capability can be separate, so we can just discuss the value(s) supported for M and L. FL would like to propose, considering the middle ground, the following values.

* M = 1, 2, 3, 4
* L = 1, 2, 3, 4
* Maximum value of M\*L = 8 (lower value is UE capability)

##### [FL Proposal 5-2-1-v1]

* For the beam selection for SSB based L1-RSRP measurement report,
  + For the selection of L cells and M beams, the following behaviour is UE-specifically configured
    - (1) How to select the L cells and M beams per cells is up to UE
    - (2) serving cell is always selected, and selection of L-1 cells and M beams per cells is up to UE
    - [(3) inter-frequency cell is always selected, and selection of L-1 cells and M beams per cells is up to UE] *# FL note: need further discussion*
  + For the value of M, L
    - the following values are supported as UE capability
      * M = 1, 2, 3, 4
      * L = 1, 2, 3, 4
    - The maximum value of M \* L is 8

##### [Comments to FL Proposal 5-2-1-v1]

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### [Mid] Quantization of L1 measurement result

##### [Summary of contributions]

* ZTE
  + Regarding RSRP quantization and differential report, the similar method as in legacy L1-RSRP reporting should be reused for Rel-18 LTM.
    - X reported RSRP values consist of reference RSRP (e.g., corresponding to the best or strongest beam) and X-1 differential RSRP (e.g., corresponding to other reported beams except the best or strongest beam).
* CATT
  + A two-stage differential L1-RSRP report should be supported. In the first stage, differential L1-RSRP is calclulated per cell, and in the second stage, differential L1-RSRP is calculated among the absolute L1-RSRPs of the total L cells.
* Ericsson
  + The beam measurements are grouped per cell.
  + Differential encoding of the RSRP values is performed per cell.
* Nokia
  + largest measured value of L1-RSRP is quantized to a 7-bit value in the range [-140, -44] dBm with 1dB step size, and the remaining RSRP values are indicated with a differential L1-RSRP quantized to a 4-bit value where the differential L1-RSRP value is computed with 2 dB step size with a reference to the largest measured L1-RSRP value
  + To limit the bit-width size of SSB-index or CRI, similar constraint as in Rel-15/17 on the maximum number of measurement RSs for a reporting configuration can be reused.
* Qualcomm
  + The first reported beam of the first reported cell is the strongest and has absolute L1-RSRP value
    - All the remaining reported beams across all reported cells have differential L1-RSRP values w.r.t the strongest L1-RSRP value
* Samsung
  + The first reported beam is the strongest beam across all cells. Differential reporting is used for remaining beams

##### [FL observation]

The majority view is that the same approach as legacy L1-RSRP report can be reused for LTM L1-RSRP report. The difference is how many beams can be for absolute value report. In this meeting, we can list the potential approach, and down selection can be done in the next meeting. This approach would be appropriate because no impact on RRC signaling is foreseen.

##### [FL proposal 5-5-2-v1]

* For the report of SSB based L1-RSRP,
  + L1-RSRP is quantized to a 7-bit value in the range [-140, -44] dBm with 1dB step size, and the remaining RSRP values are indicated with a differential L1-RSRP quantized to a 4-bit value where the differential L1-RSRP value is computed with 2 dB step size with a reference to the largest measured L1-RSRP value
  + The following option is down-selected in RAN1#114
    - Option A: Differential encoding is performed per cell, i.e. for each cell, a beam to apply absolute L1-RSRP is chosen among M beams and the differential L1-RSRP is applied to M-1 beams
    - Option B: a beam to apply absolute L1-RSRP is chosen among M \*L beams and the differential L1-RSRP is applied to M\*L-1 beams
  + *FL note: considering different cell may have quite different RSRP, FL thinks option A would be reasonable. Offline discussion is expected*

##### [Comments to FL Proposal 5-2-1-v1]

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### [Closed] Container of gNB scheduled L1 measurement reporting

##### [Conclusion at RAN1#110b-e]

Agreement

* For L1 measurement report for Rel-18 L1/L2 mobility, further study the following mechanisms:
  + Report as UCI on PUCCH or PUSCH
    - Periodic report on PUCCH, semi-persistent report on PUCCH/PUSCH, and aperiodic report on PUSCH
    - Potential enhancements to Rel-17 ICBM report format to accommodate Rel-18 scenarios, e.g.
      * Inter-frequency measurement, if supported
      * Increasing the maximum number of reported beams, which is 4 for Rel-17 ICBM
      * Flexible size beam report, e.g., two-part UCI (e.g., the 1st part contains the best beam/cell and the number (e.g., N) of reported beams/cells, the 2nd part contains the rest (N-1) beams/cells
      * Reducing the reporting overhead by e.g. choosing beams/cells per frequency or across frequencies to report (FFS how)
  + Report on MAC CE
    - Both gNB scheduled and/or UE initiated (if supported) report are studied

##### [Conclusion at RAN1#111]

Agreement

* For gNB scheduled L1 measurement report for Rel-18 LTM, report as UCI is supported
  + Semi-persistent report on PUSCH, and aperiodic report on PUSCH are supported
    - FFS: periodic and semi-persistent PUCCH
  + In a single report instance, report for serving cell and candidate cell(s) for intra-frequency and/or inter-frequency can be included.

##### [Conclusion at RAN1#112]

Due to the lack of time, the following FL proposal was not treated in RAN1#112.

* Periodic and semi-persistent PUCCH are also supported for gNB scheduled L1-measurement reporting.

##### [Conclusion at RAN1#112bis-e]

Agreement

* Periodic and semi-persistent report on PUCCH are also supported for gNB scheduled L1-measurement reporting

##### [Summary of contributions]

* Support MAC-CE
  + Intel, LGE, IDC

##### [FL observation]

FL sees the number of companies supporting MAC-CE is not enough to trigger the discussion. FL’s understanding is that the motivation is to accommodate large number of reporting beams (e.g. M\*L=16), but we haven’t had such an agreement so far.

In this sense, FL would like to propose to come back this issue in the next meeting. With this, the discussion of this section is closed without FL proposal.

##### [Comments if any]

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### [High] Configuration for gNB scheduled L1 measurement report

##### [Conclusion at RAN1#112]

Agreement related to an LS to RAN2

* + The detailed design of RRC structure is up to RAN2, and send an LS to RAN2 to request to work on the RRC structure design on the measurement configuration.
    - Following RAN1 understanding will be provided in the LS
      * RAN1 has discussed the following configuration options for L1 measurement configurations for SSB till RAN1#112:
        + Option 1) Configurations for L1 measurement RS is provided under ServingCellConfig for the serving cells

is useful to reuses the mechanism for Rel-17 ICBM and necessary information to support inter-frequency measurement will be added there.

* + - * + Option 2) Configurations for L1 measurement RS is provided separately from ServingCellConfig for the serving cells and CellGroupConfig for the candidate cells

is useful to avoid the duplicated configurations for L1 measurement RSs, [and avoid UE to process configurations ~~for L1 measurement RS~~ provided under CellGroupConfig for the candidate cells]

* + - * + Option 3) Configurations for L1 measurement RS is provided under CellGroupConfig for the candidate cells

can achieve the similar benefit as Option 2) by directly referring to the candidate cell configurations.

* + - * Note RAN2 has a full flexibility to design the whole RRC structure design.
      * RAN1 believes this is RAN2 expert region, and respectfully asks RAN2 to finalize the RRC structure design after RAN1 finalizes the discussion on RRC parameters.
      * It is noted that RAN1 foresees the necessity of similar discussions on TCI state pool for candidate cells and L1 measurement report configurations.

##### [Conclusion at RAN1#112bis-e]

No agreement was made under this section. Majority view is RRC structure discussion will directly go to RRC parameter AI.

##### [Summary of contributions]

* Introduce mechanism to measure/report subset of cell(s)/beam(s) from the configured set of cell(s)/beam(s), by e.g. MAC CE
  + ZTE, CATT, Nokia, Apple (For aperiodic report), Qualcomm, DOCOMO, Panasonic, IDC
* DOCOMO
  + On L1 measurement configuration,
    - For the maximum number of candidate cells for L1 measurement/reporting,
      * Support 7 (same as Rel-17 ICBM) for intra-frequency measurement
      * Support to study larger value than 7 for inter-frequency measurement
    - Support to study MAC CE based activation/deactivation of candidate beams/cells for L1 measurement.
    - Support to explicitly configure cell index for SSB/CSI-RS in CSI configuration signaling.
* NEC
  + Specify a default or configurable time duration for active L1 measurements of candidate cells for inter-cell mobility.
  + Specify measurement thresholds for activating/deactivating L1 measurements for inter-cell mobility.
  + Configure a measurement value threshold for a candidate cell to be included in LTM measurement report.
* Configuration parameters
  + Lenovo
    - For a CSI report for LTM, the RS configured in the CMR is associated with a PCI or a logical ID of a candidate cell.

##### [FL observation]

8 companies see the necessity to introduce the subset of cell(s)/beam(s) for reporting from the full-set of configured cell(s)/beam(s) because large number of cell(s)/beams(s) may be configured to a UE and frequency RRC reconfiguration is not desirable.

On the other hand, we have no agreement so far if measurement RS (SSB) is explicitly configured for the measurement config, and which information is included in the configuration. This point should be clarified first.

Furthermore, it is not clear at this moment if the legacy measurement report configuration (i.e. CSI-MeasConfig) is extended to support LTM or new IE is defined for LTM. To move forward, RAN1 need to confirm RAN2 agreement on the RRC structure as a first step

##### [FL Proposal 5-2-4a-v1]

* The following RAN2 assumption is confirmed
  + *For L1 measurements of LTM candidate cells, the reporting configuration is placed inside the ServingCellConfig of current serving cell(s).*
* Report configuration for LTM is defined
  + Alt.1: on top of the existing CSI-ReportConfig
  + Alt.2: by introducing a new IE independently from existing CSI-ReportConfig
  + *FL note: this issue can be directly discussed under RRC parameter session*

##### [FL Proposal 5-2-4b-v1]

* For the report configuration of L1 measurement,
  + Multiple report configurations can be configured to a UE (FFS the maximum value and UE capability)
  + L1 measurement RS configuration(s) is/are associated with each report configuration
    - i.e. indices of L1 measurement configurations are included in each report configuration

##### [FL Proposal 5-2-4c-v1]

* For each report configuration of L1 measurement,
  + Alt. 1: PCIs or its logical IDs with frequency information are included in the report configuration
    - UE performs the measurement based on [subset of] L1 measurement RS configuration associated with the report configuration, and UE needs to detect/report the configured PCIs only.
  + Alt. 2: PCIs or its logical IDs are not included in the report configuration
    - UE performs the measurement based on [subset of] L1 measurement RS configuration associated with the report configuration, and UE needs to blindly detect the cells
  + FFS: whether or how to perform subset selection for L1 measurement RS configuration

*FL note: discuss and choose one alternative in RAN1#113*

##### [FL Proposal 5-2-4d-v1]

* If Alt .1 of FL Proposal 5-2-4c-v1 is agreed
  + For the report configuration of L1 measurement,
    - Alt. 1: SSB information for each cell are included in each report configuration
      * i.e. UE needs to detect/report the configured SSBs for each PCIs only.
    - Alt. 2: SSB information for each cell are not included in report configuration
      * i.e. UE needs to blindly detect the SSBs for each cell.

*FL note: discuss and choose one alternative in RAN1#113*

##### [Comments to FL Proposal 5-2-4a-v1 5-2-4b-v1 5-2-4c-v1 5-2-4d-v1]

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### [Closed] UE/event triggered report for L1 measurement results

##### [Conclusion at RAN1#111]

Agreement

* For L1 measurement report for Rel-18 L1/L2 mobility, if UE event triggered report for L1 measurement is supported based on further study
  + - At least the following aspects may be considered
      * How to define UE event and exact definition of events,
      * Report container
      * Resource allocation/assignment for UE event triggered report
      * Necessity of indication to gNB when the condition UE event is met, and how
      * Necessity to define the condition to start/stop the reporting,
      * Contents of the report/reporting format, PCI, RS ID, measurement result etc.
      * The interaction with filtered L1 measurement results (if supported)
      * Support of simultaneous configuration of both UE event triggered and any of periodic/semi-persistence/aperiodic reporting, and solutions when both of them are configured.
      * Report destination, whether the report is sent to serving cell only or can be sent to one or more candidate cell(s).
      * Benefit when L3 measurement is involved

##### [Conclusion at RAN1#112]

The following FL proposal was not treated during RAN1#112 because of the lack of time

**Alt 1**

* UE event triggered report for L1 measurement is supported with the following design principle:
  + Supported the following trigger events (FFS on the necessity of modification) where the threshold and offset value (if needed) is configured by RRC
    - ~~A2 based/ Serving becomes worse than absolute threshold;~~
    - A3 based/Neighbor becomes amount of offset better than Pcell/PSCell;
    - ~~A4 based/ Neighbor becomes better than absolute threshold;~~
    - A5 based/Pcell/PSCell becomes worse than absolute threshold1 and neighbor/Scell becomes better than another absolute threshold2;
    - ~~Scell BFR framework~~
  + As for Start/Stop condition:
    - Time To Trigger (TTT) is introduced and time duration is configured by RRC, where UE event triggered report is performed when the configured event is continuously fulfilled within the configured time duration.
    - The report is performed only once after the fulfillment of the event, i.e. no stop condition is defined
  + No indication to notify the fulfillment of the event condition to gNB is introduced
  + MAC CE is used to convey the UE event triggered report
    - The scheduling of PUSCH is up to gNB
  + Contents/format defined for gNB scheduled reporting is reused as much as possible (FFS the modifications)
  + No filtering mechanism in time domain and cell level is introduced for L1 measurement results
  + No specific enhancement on report destination is necessary, i.e. UE follow the gNB indication of Tx spatial filter and pathloss reference RS using the existing mechanism
  + gNB scheduled reporting and UE event triggered reporting can be simultaneously configured

**Alt 2. (if Alt 1 is not agreeable)**

* + No consensus to introduce UE event triggered report for L1 measurement results in Rel-18

##### [Conclusion at RAN1#112bis-e]

No consensus on the following FL proposal:

* + No consensus to introduce UE event triggered report for L1 measurement results in Rel-18

##### [Summary of contributions]

* + Support of UE/event triggered L1 measurement report
    - Futurewei, ZTE, CATT, Intel, Xiaomi, KDDI, Google (Support extending the SCell BFR framework with new event definition for event-triggered beam report), Sony, NEC, CMCC, Nokia, Apple, LGE, Qualcomm, OPPO, Samsung, DOCOMO, FGI, IDC
  + Not support/low priority
    - Huawei, Ericsson, MediaTek

##### [FL observation]

Even though there are many (clear majority) companies supporting UE/event triggered L1 measurement report, it is quite challenging to finalize the standardization work in two meetings. Also, FL still believes that this functionality is optimization (assuming the presence of gNB-scheduled reporting) and not essential to close this WI. Furthermore, we have a lot of essential open issues and not time to discuss this issue is expected.

With this observation, FL would like to close the discussion in this section without FL proposal. However, it would be worthwhile to collect the view from companies for the smooth discussion in Rel-19 (if a follow-up WI can be agreed). For your reference, the final FL proposal in the last meeting is captured below. Interested companies are welcome to provide their views.

* UE event triggered report for L1 measurement is supported with the following design principle:
  + Supported the following trigger events (FFS on the necessity of modification) where the threshold and offset value (if needed) is configured by RRC
    - A3 based/Neighbor becomes amount of offset better than Pcell/PSCell;
    - A5 based/Pcell/PSCell becomes worse than absolute threshold1 and neighbor/Scell becomes better than another absolute threshold2;
  + As for Start/Stop condition:
    - Time To Trigger (TTT) is introduced and time duration (FFS exact values) is configured by RRC, where UE event triggered report is performed when the configured event is continuously fulfilled within the configured time duration.
    - The report is performed only once after the fulfillment of the event, i.e. no stop condition is defined
  + No indication to notify the fulfillment of the event condition to gNB is introduced
  + MAC CE is used to convey the UE event triggered report
    - The scheduling of PUSCH is up to gNB
  + Contents/format defined for gNB scheduled reporting is reused as much as possible (FFS the modifications)
  + FFS: No filtering mechanism in time domain and cell level is introduced for L1 measurement results, i.e. use L1 measurement result or L3 measurement result (i.e. time domain filtering and/or cell level filtering)
  + No specific enhancement on report destination is necessary, i.e. UE follow the gNB indication of Tx spatial filter and pathloss reference RS using the existing mechanism
  + gNB scheduled reporting and UE event triggered reporting can be simultaneously configured

##### [Comments if any]

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## Beam indication

### [Mid] Beam indication mechanism based on Rel-17 unified TCI framework

##### [Conclusion at RAN1#110b-e]

Agreement

* RAN1 to further study if the beam indication of candidate cell(s) L1/L2 mobility should be designed for a specific TCI framework below, and their potential RAN1 spec impact.
  + **Option A:**  Beam indication for Rel-18 L1/L2 mobility is designed based on Rel-17 TCI framework mechanism
  + **Option B:** Beam indication for Rel-18 L1/L2 mobility is designed based on Rel-15 TCI framework mechanism
  + **Option C:** Beam indication for Rel-18 L1/L2 mobility is designed based on both Rel-15 and Rel-17 TCI framework mechanisms

##### [Conclusion at RAN1#111]

Agreement

* The beam indication of candidate cell(s) for Rel-18 LTM should be designed based on the following:
  + Beam indication for Rel-18 LTM is designed based on Rel-17 unified TCI framework, if both serving cell and candidate cell support Rel-17 unified TCI framework
  + FFS: whether/how to design mechanism for Beam indication for Rel-18 LTM when at least one from serving cell and candidate cell supports only Rel-15 TCI framework.
  + Note: How and whether to indicate the new serving cell(s) and timing for beam indication are separately discussed

##### [Conclusion at RAN1#112]

Agreement

* At least for Rel-17 unified TCI framework based beam indication included in cell switch command (i.e. scenario 2), beam indication applies to signals/channels that follow or are configured to follow Rel-17 unified TCI at the target cell(s)
* FFS: beam indication for mTRP case

##### [Conclusion at RAN1#112bis-e]

Agreement

* Adopt Alt.2 for beam indication of target cell(s) and TCI state activation for candidate cell(s) (if supported) ,
  + Alt. 1: By indicating RS identifier, i.e. mapping between RS identifier and Rel-17 unified TCI state is done by a UE
  + Alt. 2: By indicating Rel-17 TCI state index

The following proposal was discussed during the email approval process, but it was not approved due to the concern provided by companies.

* For beam indication of target cell based on Rel-17 unified TCI framework applied to CORESET#0 and CORESETs (other than CORESET#0) associated with Type 0A/1/2-PDCCH CSS sets where no TCI state activation is provided, followUnifiedTCI-state is not enabled or not provided, the following alternatives are further studied, and one alternative will be down-selected at RAN1#113.
  + Alt.1: Follow the indicated TCI state until a new TCI state is configured or activated by the target cell
  + Alt.4: No new behaviour is introduced on top of Rel-17 unified TCI
    - ~~i.e. the network schedules transmission only based on the CORESET following Rel-17 unified TCI, and/or the corresponding beam information would be configured by the target cell after cell switch~~

Comments by companies are summarized below:

* Sub-bullet of Alt.4 is not Rel-17 behaviour
* Sub-bullet of Alt.4 should say “Network schedules transmission only based on the CORESET following Rel-17 unified TCI after cell switch.”
* Behaviour defined in section 10.1 of 38.213 is not clear, this may have an impact to CSS such as paging. In this case, neither of Alternatives may work.
  + *For a CORESET with index 0, the UE assumes that a DM-RS antenna port for PDCCH receptions in the CORESET is quasi co-located with*
    - *the one or more DL RS configured by a TCI state, where the TCI state is indicated by a MAC CE activation*
    - *command for the CORESET, if any, or a SS/PBCH block the UE identified during a most recent random access procedure not initiated by a PDCCH order that triggers a contention-free random access procedure, if no MAC CE activation command indicating a TCI state for the CORESET is received after the most recent random access procedure*
* Intention of Alt.4 needs clarification, e.g.
  + if the CSS is configured to follow the unified TCI state, it would follow the unified TCI state in the cell switch command, else, the CSS can’t be used until activated with a TCI state.

##### [Summary of contributions]

* ZTE
  + CORESET#0, CORESETs (other than CORESET#0) associated with Type 0A/1/2-PDCCH CSS sets should directly follow Rel-17 unified TCI state indication regardless of additional RRC parameter “followUnifiedTCIstate”.
  + Indicated TCI state should be applied till a new TCI state for target cell is indicated.
* Vivo
  + To avoid ambiguity of beam determination for PDCCH configured to not follow the unified TCI and scheduled PDSCH and reduce the number of UE blindly detecting PDCCH, it is expected that the network schedules transmission only based on the CORESET following Rel-17 unified TCI before the dedicated beam indication signaling for PDCCH configured to not follow the unified TCI and PDSCH scheduled by the PDCCH is received, i.e., Alt-2.
* Spreadtrum
  + The UE is not expected no TCI state activation is provided and followUnifiedTCI-state is not enabled or not provided for CORESET#0 and CORESETs (other than CORESET#0) associated with Type 0A/1/2-PDCCH CSS sets.
* CATT
  + For beam indication of target cell based on Rel-17 unified TCI framework applied to CORESET#0 and CORESETs (other than CORESET#0) associated with Type 0A/1/2-PDCCH CSS sets where no TCI state activation is provided, followUnifiedTCI-state is not enabled or not provided, support Alt. 4 as follows:
    - Alt.4: No new behaviour is introduced on top of Rel-17 unified TCI
      * + i.e. the network schedules transmission only based on the CORESET following Rel-17 unified TCI, and/or the corresponding beam information would be configured by the target cell after cell switch
* Fujitsu
  + For Scenario 2, to determine the beam for a CORESET which does not follow Rel-17 unified TCI and has no activated TCI state, either Alt.1 is supported or Alt.4 is supported with the clarification implying that the CORESET not following Rel-17 unified TCI cannot be used until any TCI state is activated for it.
    - Alt.1: Follow the indicated TCI state until a new TCI state is configured or activated by the target cell .
    - Alt.4: No new behavior is introduced on top of Rel-17 unified TCI.
* Ericsson
  + After execution of an LTM cell switch, for CORESETs associated with Type 0A/1/2-PDCCH CSS sets where no TCI state activation is provided and followUnifiedTCI-state is not provided, the UE follows the TCI state in the LTM cell switch command until a new TCI state is activated for the CORESETs.
  + After execution of an LTM cell switch, the UE determines the monitoring occasions for Type 0A/1/2-PDCCH CSS from the TCI state in the LTM cell switch command until a new TCI state is activated for the CORESETs.
* Xiaomi
  + The beam indicated in cell switch command should be used to all channel/signals before new TCI state is activated or indicated by the target cell.
* Nokia
  + For beam indication of target cell based on Rel-17 unified TCI framework applied to CORESET#0 and CORESETs (other than CORESET#0) associated with Type 0A/1/2-PDCCH CSS sets where no TCI state activation is provided and *followUnifiedTCI-state* is not enabled or not provided, the indicated TCI sate for the target cell can be used.
* Samsung
  + The CORESETs associated with CSS set other than Type3-PDCCH CSS set follow the unified TCI state of the target cell until configured a new TCI state.
  + An additional TCI state is signalled in the cell switch command for the CORESETs associated with CSS set other than Type3-PDCCH CSS set.
* DOCOMO
  + support either Alt1 or Alt4 below.
    - Alt.1: Follow the indicated TCI state until a new TCI state is configured or activated by the target cell.
    - Alt.4: No new behaviour is introduced on top of Rel-17 unified TCI.

##### [FL observation]

Even though many companies expressed their views on this issue, FL fails to find the majority for the alternatives made in the last meeting.

* For beam indication of target cell based on Rel-17 unified TCI framework applied to CORESET#0 and CORESETs (other than CORESET#0) associated with Type 0A/1/2-PDCCH CSS sets where no TCI state activation is provided, followUnifiedTCI-state is not enabled or not provided, the following alternatives are further studied, and one alternative will be down-selected at RAN1#113.
  + Alt.1: Follow the indicated TCI state until a new TCI state is configured or activated by the target cell
  + Alt.4: No new behaviour is introduced on top of Rel-17 unified TCI

On the other hand, it seems the companies’ proposals does not require any additional RRC parameters, so this issue wouldn’t be urgent (can be handled during the maintenance phase).

Given this analysis, FL would like to bring the same proposal again in this meeting. Then, check the companies’ preference during the offline discussion. If clear majority cannot be found, this proposal will be postponed to RAN1#113.

##### [FL Proposal 5-3-1-v1]

*FL note: check the number of supporting companies for each option offline*

* For beam indication of target cell based on Rel-17 unified TCI framework applied to CORESET#0 and CORESETs (other than CORESET#0) associated with Type 0A/1/2-PDCCH CSS sets where no TCI state activation is provided, followUnifiedTCI-state is not enabled or not provided, ~~the following alternatives are further studied, and one alternative will be down-selected at RAN1#113.~~
  + Alt.1: Follow the indicated TCI state until a new TCI state is configured or activated by the target cell
  + Alt.4: No new behaviour is introduced on top of Rel-17 unified TCI

##### [Comments to FL Proposal 5-3-1-v1]

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### [High] Configuration for TCI states based on Rel-17 unified TCI framework

##### [Conclusion at RAN1#110b-e]

Agreement

* RAN1 to further study if the beam indication of candidate cell(s) L1/L2 mobility should be designed for a specific TCI framework below, and their potential RAN1 spec impact.
  + **Option A:**  Beam indication for Rel-18 L1/L2 mobility is designed based on Rel-17 TCI framework mechanism
  + **Option B:** Beam indication for Rel-18 L1/L2 mobility is designed based on Rel-15 TCI framework mechanism
  + **Option C:** Beam indication for Rel-18 L1/L2 mobility is designed based on both Rel-15 and Rel-17 TCI framework mechanisms

##### [Conclusion at RAN1#111]

Agreement

* The beam indication of candidate cell(s) for Rel-18 LTM should be designed based on the following:
  + Beam indication for Rel-18 LTM is designed based on Rel-17 unified TCI framework, if both serving cell and candidate cell support Rel-17 unified TCI framework
  + FFS: whether/how to design mechanism for Beam indication for Rel-18 LTM when at least one from serving cell and candidate cell supports only Rel-15 TCI framework.
  + Note: How and whether to indicate the new serving cell(s) and timing for beam indication are separately discussed

##### [Conclusion at RAN1#112]

Agreement related to an LS to RAN2

* + The detailed design of RRC structure is up to RAN2, and send an LS to RAN2 to request to work on the RRC structure design on the measurement configuration.
    - Following RAN1 understanding will be provided in the LS
      * RAN1 has discussed the following configuration options for L1 measurement configurations for SSB till RAN1#112:
        + Option 1) Configurations for L1 measurement RS is provided under ServingCellConfig for the serving cells

is useful to reuses the mechanism for Rel-17 ICBM and necessary information to support inter-frequency measurement will be added there.

* + - * + Option 2) Configurations for L1 measurement RS is provided separately from ServingCellConfig for the serving cells and CellGroupConfig for the candidate cells

is useful to avoid the duplicated configurations for L1 measurement RSs, [and avoid UE to process configurations ~~for L1 measurement RS~~ provided under CellGroupConfig for the candidate cells]

* + - * + Option 3) Configurations for L1 measurement RS is provided under CellGroupConfig for the candidate cells

can achieve the similar benefit as Option 2) by directly referring to the candidate cell configurations.

* + - * Note RAN2 has a full flexibility to design the whole RRC structure design.
      * RAN1 believes this is RAN2 expert region, and respectfully asks RAN2 to finalize the RRC structure design after RAN1 finalizes the discussion on RRC parameters.
      * It is noted that RAN1 foresees the necessity of similar discussions on TCI state pool for candidate cells and L1 measurement report configurations.

##### [Conclusion at RAN1#112bis-e]

The following proposal was not agreed due to the lack of consensus.

* Similar as r17 TCI state mode indication with *unifiedTCI-StateType-r17*, Per candidate cell TCI state mode is provided before cell switch command to UE to determine the type of TCI state indication in the cell switch command

There were discussions on RRC configuration structure for TCI state configurations. However, majority companies saw no strong necessity.

##### [Summary of contributions]

* Vivo
  + Support mixed state pool for LTM, i.e., some TCI states in the TCI state pool are associated with candidate cells.
* Spreadtrum
  + Support TCI configuration made by RAN2, the location of configurations of TCI states for the candidate cells (used before/at cell switch) is external to the ServingCellConfig(s) of current serving cells and external to the configuration of the LTM candidate cells
  + Similar as r17 TCI state mode indication with unifiedTCI-StateType-r17, per candidate cell TCI state mode is provided before cell switch command to UE to determine the type of TCI state indication in the cell switch command
* Huawei
  + Similar as Rel-17 TCI state mode indication with unifiedTCI-StateType-r17, per candidate cell TCI state mode is provided before cell switch command to UE to determine the type of TCI state indication in the cell switch command.
  + For a set of CCs (candidate Cells) configured in the same simultaneous TCI state update list, a common TCI state list associated with a reference cell can be provided. Otherwise, per cell TCI state list should be provided to UE before cell switch.
* Fujitsu
  + For Scenario 2, at least the following parameters are provided before the TCI state activation.
    - simultaneousU-TCI-UpdateList.
    - unifiedTCI-StateType .
* Ericsson
  + The UE is provided with an explicit mapping between a TCI state index and {DL carrier frequency, SSB SCS, PCI, SSB index}.
  + How to provide the mapping between a TCI state index and {DL carrier frequency, SSB SCS, PCI, SSB index} is up to RAN2.
* KDDI
  + Introduce separate TCI state pool for LTM.
* Nokia
  + Rel-17 unified TCI activation command can be used with an additional explicit or implicit indication to indicate the UE that for which of the two scenarios (LTM or intra/inter cell beam management) this activation command is applicable for.
  + TCI activation command for LTM candidate cell may indicate the LTM candidate cell and the associated TCI states to be activated.
    - FFS: whether/how to activate TCI states associated with multiple candidate cells using the same activation command
* Samsung
  + For beam indication for L1/L2 mobility, the dl-OrJoint-TCIStateList and ul-TCI-StateList are configured with TCI states having a source RS associated with the target cell.

It is also proposed regarding the management of activated TCI state

* Nokia
  + RAN1 to study the following options for the TCI activation and indication in Rel-18 LTM:
    - Alt-1: A combined list of activated TCI states including both for LTM and intra/inter-cell BM within the serving cell is maintained.
      * a beam indication for LTM, given either in the cell switch command (scenario 2), or in the DCI (before the cell switch command, scenario 1), can indicate an LTM specific TCI state from the combined list
    - Alt-2: a list of activated TCI states for LTM are maintained separately from the intra/inter-cell BM,
      * an additional indication (a flag or/and LTM candidate cell ID), specially for the scenario 1 (beam indication before the cell switch command if supported) may be given to the UE so that the UE may consider only LTM specific activated TCI states to map the given TCI code point as the beam indication
  + *FL view is that, if TCI state pool for LTM is managed separately from legacy TCI state pool, it is quite natural to adopt Alt-2. Meanwhile some exceptional case noted by Nokia can be addressed later.*
* Qualcomm
  + For TCI state activation for a candidate cell, support NW to inform the activated TCI state ID(s) of the candidate cell via a new MAC-CE
* IDC
  + Simultaneous operation of ICBM and LTM is supported with independent configuration and operation (e.g., separate TCI state pools).

##### [FL observation]

Given the proposal from companies, we can categorize the issues in this section as follows

* **RRC structure for configurations of TCI states**
  + Confirm the RAN2 assumption, i.e.
    - *RAN2 assumes that the location of configurations of TCI states for the candidate cells (used before/at cell switch) is external to the ServingCellConfig(s) of current serving cells and external to the configuration of the LTM candidate cells (same location as RS configuration).*
  + If this assumption is confirmed, it implies that the UE are configured with two TCI state list
    - 1) dl-OrJoint-TCIStateList and ul-TCI-StateList for Rel-17
    - 2) new TCI state list(s) for Rel-18 LTM
  + The question is whether both of two TCI state lists are valid for the UE, or 1) is overwritten by 2)
* **Management of activated TCI states**
  + The legacy TCI state activation is performed by MAC-CE. Thus, MAC-CE needs to be updated. The details depend on how the TCI state list for LTM is designed
    - The detailed design should be up to RAN2, but high level design by RAN1 is needed
* **Parameters included in configurations for TCI states**
  + unifiedTCI-StateType, which is common to all cells? Or different for each cell?
  + {DL carrier frequency, SSB SCS, PCI, SSB index} associated with TCI state
  + Note:simultaneousU-TCI-UpdateList is separately discussed under section 5.4

##### [FL Proposal 5-3-2-v1]

* Regarding the TCI state list for LTM,
  + RAN1 confirms the following RAN2 assumption,
    - *RAN2 assumes that the location of configurations of TCI states for the candidate cells (used before/at cell switch) is external to the ServingCellConfig(s) of current serving cells and external to the configuration of the LTM candidate cells (same location as RS configuration).*
  + For a UE configured with TCI state list(s) for LTM,
    - Alt 1: Both the legacy TCI state lists (i.e. dl-OrJoint-TCIStateList and ul-TCI-StateList for Rel-17) and the TCI state list(s) for LTM are valid, and the TCI states in these lists can be activated simultaneously
    - Alt 2: the legacy TCI state lists (i.e. dl-OrJoint-TCIStateList and ul-TCI-StateList for Rel-17) is overwritten by the new TCI state list(s) for LTM
      * i.e. dl-OrJoint-TCIStateList and ul-TCI-StateList for Rel-17 are not used for the UE
    - *FL note: discuss more which alt we take*
  + The configuration of the TCI state list includes the following information
    - *{DL carrier frequency, SSB SCS, PCI, SSB index} associated with TCI state*
    - Unified TCI-state type for each PCI
* The design of MAC-CE for TCI state activation for LTM is up to RAN2

##### [Comments to FL Proposal 5-3-2-v1]

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### [Closed] Beam indication mechanism applicable to gNBs not supporting Rel-17 TCI framework

##### [Conclusion at RAN1#110b-e]

Agreement

* RAN1 to further study if the beam indication of candidate cell(s) L1/L2 mobility should be designed for a specific TCI framework below, and their potential RAN1 spec impact.
  + **Option A:**  Beam indication for Rel-18 L1/L2 mobility is designed based on Rel-17 TCI framework mechanism
  + **Option B:** Beam indication for Rel-18 L1/L2 mobility is designed based on Rel-15 TCI framework mechanism
  + **Option C:** Beam indication for Rel-18 L1/L2 mobility is designed based on both Rel-15 and Rel-17 TCI framework mechanisms

##### [Conclusion at RAN1#111]

Agreement

* The beam indication of candidate cell(s) for Rel-18 LTM should be designed based on the following:
  + Beam indication for Rel-18 LTM is designed based on Rel-17 unified TCI framework, if both serving cell and candidate cell support Rel-17 unified TCI framework
  + FFS: whether/how to design mechanism for Beam indication for Rel-18 LTM when at least one from serving cell and candidate cell supports only Rel-15 TCI framework.
  + Note: How and whether to indicate the new serving cell(s) and timing for beam indication are separately discussed

##### [Conclusion at RAN1#112]

The following FL proposal was made, and no offline/online discussion was held at RAN1#112

* Interested companies are encouraged to check the proposal on by proponent companies, and to input their contribution to the future meeting as necessity.

##### [Conclusion at RAN1#112bis-e]

No time was spent in RAN#112bis-e for this issue because no time was available, which means RAN1 has not consensus yet whether/how to design mechanism for Beam indication for Rel-18 LTM when at least one from serving cell and candidate cell supports only Rel-15 TCI framework

##### [Summary of contributions]

* Support
  + NEC, Nokia
* Low priority
  + DOCOMO
* Not support
  + Futurewei, CATT, Intel, Google, Qualcomm, Samsung

##### [FL observation]

There are no strong supports from the companies to address this issue with high priority. This section is closed without FL proposal.

##### [Comments if any]

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### [Closed] Timing of beam indication – scenario 2 except TCI state activation

##### [Conclusion at RAN1#110b-e]

Agreement

* From RAN1 perspective, the following scenarios can be considered for Rel-18 L1/L2 mobility for beam indication timing. This will be updated depending on further RAN1 assessment and RAN2 decision on the time chart
  + Scenario 1: Beam indication before cell switch command
  + Scenario 2: Beam indication together with cell switch command
  + Scenario 3: Beam indication after cell switch command
* Interested companies are encouraged to further study the validity of the scenarios and the potential spec impact.

##### [Conclusion at RAN1#111]

Agreement

* For beam indication timing for Rel-18 LTM,
  + Support Scenario 2: Beam indication together with cell switch command,
    - For Rel-17 unified TCI framework,
      * Beam indication indicates TCI state for each target serving cell
  + FFS: Scenario 1: Beam indication before cell switch command
  + FFS: Scenario 3: Beam indication after cell switch command
* FFS: Activation of TCI state(s) of target serving and/or candidate cell(s).

##### [Conclusion at RAN1#112]

* Agreement
* RAN1 shares the same understanding as RAN2 on agreement:
  + The LTM mobility trigger information is conveyed in a MAC CE
* The same MAC CE is used for the LTM triggering.
* Agreement
* The agreement on scenario 2 (Beam indication together with cell switch command) at RAN1#111 is further clarified as the following:
  + Beam indication for the target cell(s) is conveyed in the MAC CE used for LTM triggering for scenario 2

##### [Conclusion at RAN1#112bis-e]

No issue was discussed.

##### [Summary of contributions]

No issue was raised.

##### [FL observation]

This section is closed without FL proposal.

### [Closed] Timing of beam indication – scenario 1 and/or 3

##### [Conclusion at RAN1#110b-e]

Agreement

* From RAN1 perspective, the following scenarios can be considered for Rel-18 L1/L2 mobility for beam indication timing. This will be updated depending on further RAN1 assessment and RAN2 decision on the time chart
  + Scenario 1: Beam indication before cell switch command
  + Scenario 2: Beam indication together with cell switch command
  + Scenario 3: Beam indication after cell switch command
* Interested companies are encouraged to further study the validity of the scenarios and the potential spec impact.

##### [Conclusion at RAN1#111]

Agreement

* For beam indication timing for Rel-18 LTM,
  + Support Scenario 2: Beam indication together with cell switch command,
    - For Rel-17 unified TCI framework,
      * Beam indication indicates TCI state for each target serving cell
  + FFS: Scenario 1: Beam indication before cell switch command
  + FFS: Scenario 3: Beam indication after cell switch command
* FFS: Activation of TCI state(s) of target serving and/or candidate cell(s).

##### [Conclusion at RAN1#112]

The following FL proposal was not discussed at RAN1#112 due to the lack of time.

* On scenario 1 for the timing of cell switch command, companies are encouraged to study further the following aspects:
  + which kind of enhancement is needed for scenario on top of the simultaneous operation of Rel-17 ICBM and Rel-18 LTM, and
  + the necessity of enhancements for scenario 1 when an activation procedure before cell switch command reception is introduced for scenario 2.

##### [Conclusion at RAN1#112bis-e]

The following FL proposal was postponed

* *Companies are encouraged to further study the spec impact when Rel-17 ICBM and Rel-18 LTM can be operated simultaneously, e.g.*
  + *TCI state pool for Rel-18 LTM can include or have any dependency of TCI states for Rel-17 ICBM operation*
  + *UE capability*

Also, there was no common understanding on the necessity of scenario 3, as a fall-back operation.

##### [Summary of contributions]

* (Scenario1) Support simultaneous operation of Rel-17 ICBM and Rel-18 LTM
  + Support: Futurewei, CATT, Lenovo(?), CMCC, Samsung, DOCOMO, IDC
* (Scenario 1) Rel-17 ICBM mechanism is extended to support LTM
  + Support introducing a new beam application delay for unified TCI indication with serving cell change.
  + Support: Google
* (Scenario 1) Just sending beam indication before cell switch command and beam indication is not included in cell switch command.
  + Support: Nokia, Samsung, FGI
* Concern to consider/support scenario 1
  + Not support: Ericsson, Intel, Xiaomi, OPPO, MediaTek
  + Low priority: ZTE (can be discussed after scenario 2 is finalized)
* (Scenario 3)
  + Nokia
    - The UE can be indicated whether there is a beam indication is present or not in the cell switch command.
    - If no beam indication for the target cell is provided to the UE before/upon the cell switch, UE performs RACH-based LTM handover where the initial QCL assumption for the target cell can be acquired from the RACH procedure.
  + Not support: Ericsson, Intel, Xiaomi, OPPO

##### [FL observation]

For scenario 1, there is a moderate number of supporting companies for simultaneous operation of Rel-17 ICBM and Rel-18 LTM, FL sees that the analysis on spec impact is not enough. It is pointed out that both schemes can coexist if “TCI state pool and activation is separately managed”. FL thinks it is true, but the problem is that we have no such agreement so far.

For other use cases for scenario 1, there are companies who have concern on the benefit and spec impact as well.

For scenario 3, Nokia has point out an interesting situation that RAN2 still assume RACH-less LTM, which is a kind of fall-back operation. On the other hand, it is clear from the companies input in the last meeting and this meeting that companies have no common understanding on the necessity and use cases. FL’s understanding is that, if RACH procedure is still needed after cell switch command, beam determination can also be done after cell switch command. With this approach, network doesn’t need to exchange time sensitive information such as TA and TCI state. This aspect needs more discussion, but FL still see that scenario 2 still has higher priority.

Given these analyses, FL thinks we have nothing to discuss (except coffee break discussion) in this meeting as scenario 1 and 3 would be lower priority issue than scenario 2. Therefore, FL would like to comeback in the next meeting after overall system design becomes clear.

With this, the discussion of this section is closed.

**Action to the next meeting:**

* Check the spec impact of simultaneous operation of Rel-17 ICBM and Rel-18 LTM
* Discuss scenario 1 and 3 after scenario 2 can be finalized
  + Benefit and spec impact by introducing scenario 1 (except simultaneous operation of ICBM and LTM)
  + Necessity of fallback operation i.e. scenario 3, and its benefit.

##### [Comments if any]

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### [Mid] Beam application time

##### [Conclusion at RAN1#112]

The following FL proposal was made, but not discussed due to the lack of time

* Beam application time may be different from that for Rel-17 ICBM, FFS the exact value(s)

##### [Conclusion at RAN1#112bis-e]

Agreement

* Companies are encouraged to study the beam application time for Rel-18 LTM, which may be different from that without serving cell change
  + Definition of the beam application time
  + The exact value(s), condition and UE capability
  + Consider the interaction with the application of the candidate RRC configuration.

##### [Summary of contributions]

* ZTE:
  + In order to support inter-DU and inter-frequency cases for Rel-18 LTM, application time of TCI state to be applied for target cell needs to be defined or modified based on application time of beam indication specified in Rel-17 ICBM.
  + For the Rel-17 unified TCI based beam indication in Rel-18 LTM,
    - The reference to determine application time of TCI state indication for Rel-18 LTM can be last symbol of receiving TCI state indication or acknowledgement information corresponding to MAC CE carrying TCI state indication, which is similar to the definition logic of Rel-17 beam application time.
    - The time gap relative to the reference can be extended or scaled based on legacy time gap *(e.g., or BeamAppTime-r17)* or redefined.
* Vivo
  + When beam indication is received together with the cell switch command and uplink synchronization is achieved before the reception of cell switch command, the indicated TCI state can be applied in the first slot after X msec after the last symbol of acknowledgment of the cell switch command, where X is a sum of [3, RF retuning time, application time of the candidate RRC configuration].
* Spreadtrum
  + The time duration from CSC to the first data which can use the indicated beam, it contains the following parts
    - The legacy MAC CE application time starts at the first slot after:
    - The application time of the candidate RRC configuration and handover complete, which is up to RAN2
    - Rx beam retuning time
  + Huawei
    - The start point to count beam application time in LTM should reuse the legacy rule, i.e., the slot n where a PUCCH with HARQ-ACK information corresponding to the PDSCH carrying the cell switch command is transmitted.
    - Inputs from RAN2 and RAN4 on the latency of RRC reconfiguration and inter frequency beam switching are required to determine the beam application time in LTM.
  + CATT
    - For beam application time for Rel-18 LTM, TCI state(s) for the target cell is applied starting from the first slot that is Xms/slots after the ACK corresponding to the PDSCH carrying the cell switch command.
    - The beam application time can be indicated/determined dynamically corresponding to different scenarios.
  + Fujitsu
    - For Scenario 2, a separate beam application time from that of Rel-17 ICBM should be defined.
      * The starting time is after ACK for PDSCH conveying the cell switch command.
        + FFS: whether it is after the last symbol of ACK or after the slot of ACK
      * The ending time is determined by the cell switch command (MAC CE) application time and the application time depending on the UE capability.
    - The beam application time is the same for multiple cells in the same simultaneousU-TCI-UpdateList
  + Ericsson
    - The beam application time for LTM is defined by RAN4.
    - The reference for the beam application time for LTM is the time when the HARQ ACK for the corresponding PDSCH is sent.
  + Nokia
    - Reference time to apply the beam application time can be the first slot that is after the slot in which UE would transmit PUCCH with HARQ-ACK information corresponding to the PDSCH carrying the cell switch command
    - Coordinate with RAN4 to clarify:
      * whether the beam application time is considered as a part of the cell switch delay or not
        + If the beam application time is not considered as a part of the cell switch delay, then the final beam application time would be max (beam application time, cell switch delay).
  + Apple
    - The beam application time for beam information indicated in CSC command is defined as 3ms after UE sends the HARQ-ACK information for the CSC MAC-CE.
    - The application time of the RRC configuration for candidate cell is left to RAN2 as usual.
  + Qualcomm
    - Application time should be specified for the SpCell/CG update command
      * Application time can be different for previously activated and deactivated new SpCell/CG
  + OPPO
    - A application time the MAC CE cell switch command of LTM is defined and it can cover the beam application time of TCI state indication of the target cell and the application time of target cell RRC configuration.
  + Samsung
    - For Rel-18 LTM, the beam application time of a target cell is after the HARQ-ACK of the message containing the beam indication. The value of the beam application time of the target cell can be different from that of serving cell.
  + DOCOMO
    - Study following two options for the definition of the beam application time.
      * Option 1: the definition of the beam application time includes the cell switch application time.
      * Option 2: the beam application time is a separate/additional application time after cell switch.

In addition, timeline between TCI state activation and beam indication is proposed:

* Nokia
  + A beam indication in the cell switch command indicating one of the activated TCI state can be given starting from the first that is after slot n + 3, where slot n is the slot UE would transmit a PUCCH with HARQ-ACK corresponding to the PDSCH carrying the activation command for the beam indication.

##### [FL observation]

The proposal from companies can be summarized as follows:

* Most of the companies think the beam application time start from when the HARQ-ACK for the corresponding PDSCH, which carries beam indication for target cell, is sent.
* The following component needs to be considered for the beam application time
  + Legacy values, , BeamAppTime-r17
  + RRC reconfiguration (maybe RRC parameter switching time is correct? Because RRC reconfiguration is not performed) , which is up to RAN2
* The value of beam application time has a dependency with:
  + The cell switch is for intra-frequency or inter-frequency, i.e. due to RF retuning which is RAN4 issue
    - Including whether the target cell is previously activated or not
  + Whether beams for multiple cells are indicated, i.e. CA case.

FL understands RAN1 cannot conclude this issue without the input from RAN2 and RAN4. Thus in this meeting, we can focus on agreeing high level concept, and send an LS to RAN2 and RAN4.

It is also pointed out that there may be a necessity to define a timeline between TCI state activation and beam indication:

* Beam indication should be sent after slot n + 3, where
  + n is the slot UE would transmit a PUCCH with HARQ-ACK corresponding to the PDSCH carrying the activation command for the beam indication.

Since none has pointed out this issue so far. This issue can be back in the next meeting.

##### [FL Proposal 5-3-6-v1]

* For the beam application time for Rel-18 LTM,
  + The beam application time start from when the HARQ-ACK for the corresponding PDSCH, which carries MAC-CE containing beam indication for target cell, is sent
  + The following components are further considered to define the beam application time
    - Legacy values, i.e. and BeamAppTime-r17
    - Time to apply the RRC parameters for target cell(s). which is up to RAN2
    - RF retuning time when inter-cell switch is performed, which is up to RAN4
    - Whether the target cell is the previously activated cell
    - How to deal with beams for multiple target cells are indicated
* Send an LS to ask RAN2 and RAN4 feedback

##### [Comments to FL Proposal 5-3-6-v1]

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### void

Originally, this section is used to discuss Beam indication for multiple cells for CA. However, to ease the discussion, all the necessary discussion is moved to section 5.4.

[Conclusion at RAN1#112]

The following proposal was not discussed in RAN1#112 due to the lack of time.

* The existing mechanism, i.e. simultaneousTCI-UpdateList1 and simultaneousTCI-UpdateList2, is reused to indicate TCI states for multiple target cells

[Conclusion at RAN1#112bis-e]

The following FL proposal was postponed.

* For scenario 2, TCI state indication included in cell switch command indicates the TCI state(s) for SpCell of target cell(s)
* For scenario 2, a TCI state indicated in the cell switch command is applied to multiple cells included in the list of simultaneous TCI state of the indicated target cell (when the list is configured) when the cells indicated in the list are active after cell switch command, i.e. the same mechanism as simultaneousU-TCI-UpdateList is reused for Rel-18 LTM
  + FFS: when there are multiple (up to 4) simultaneousU-TCI-UpdateList configured for the [~~target~~ candidate] cells.
  + Note: RRC structures (i.e. under serving cell configuration or candidate cell configuration, etc) are up to RAN2

*FL note: FL suggestion is to differ the approval until the introduction of TCI state activation is decided.*

*FL note: regarding the note “when the cells indicated in the list are active“, the intention of the proponent is that we should avoid the misunderstanding that this list and beam indication can be used to indicate the use of CA (and indication of SCells) after LTM. Hope this clarifies the intention*

*FL note:” [~~target~~ candidate] cells.” FL believes this should be candidate cells as simultaneousU-TCI-UpdateList should be used in TCI state activation procedure.*

### [Closed] Beam indication for mTRP

##### [Conclusion at RAN1#112]

Agreement

* At least for Rel-17 unified TCI framework based beam indication included in cell switch command (i.e. scenario 2), beam indication applies to signals/channels that follow or are configured to follow Rel-17 unified TCI at the target cell(s)
* FFS: beam indication for mTRP case

##### [Conclusion at RAN1#112bis-e]

Even though some companies provided necessary discussion points for mTRP, two companies (operators) mentioned that this is a low-priority issue. Therefore, FL suggest closing the discussion in this meeting, and come back in the future meeting based on the companies’ contributions.

##### [Summary of contributions]

* CMCC
  + The beam indication for multiple TRP under LTM can be discussed later.
* OPPO
  + The TCI state(s) indicated through inter-cell beam management is applied to UE-specific PDCCH/PDSCH, PUSCH and PUCCH, as specified in Rel-17
  + The TCI state indicated in LTM cell switch is applied to UE-common PDCCH/PDSCH.

##### [FL observation]

Similar to the FL observation in the previous meeting. The level of companies’ interest is not high enough to trigger the discussion in this meeting, especially given the fact that we have only 2 meetings for RAN1 completion. With this, the discussion in this section is closed without FL proposal.

##### [Comments if any]

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## Cell switch command

### [High] Information included in Cell switch command

##### [Conclusion at RAN1#110b-e]

Agreement

* Interested companies are encouraged to perform technical analysis of the cell switch command from a RAN1 point of view, e.g.
  + Necessary information included in the command, which is relevant for RAN1 discussion
  + Necessary number of bits for the information
  + L1 impact or concern to use DCI or MAC CE for L1/L2 cell switch command

##### [Conclusion at RAN1#111]

Due to the lack of time, FL proposal 4-1-v4 was not discussed during the online session. Companies are encouraged to perform their analysis based on the final proposal in this meeting (which is FL proposal 4-1-v4 below).

* The following contents are further studied for the contents included in the cell switch command from layer 1 perspective. The bit number required for the contents and the condition of existence needs further discussion.
  + Cell identity / Cell group identity ~~– (ID or index?, what is the necessity from physical layer POV)~~
  + TCI state ID/Beam indication –FL note: the relationship with the timing discussion (i.e. beam indication before cell switch command) need to be discussed
  + DL/UL BWP indication
  + ~~Differentiation between Rel-17 ICBM and Rel-18 LTM (if the DCI for Rel-17 ICBM is reused for cell switch command)~~ FL note: RAN2 agreed to use MAC CE for cell switch triggering **on Tuesday in this meeting**
  + TA value and/or TA acquisition indication
  + ~~[UL resource indication for sending acknowledgement of LTM (if RAN1 identify the necessity from L1 point of view) ]~~
  + Triggered aperiodic CSI-RS resource indice(s)/ CSI-RS resource set ID/CSI report setting ID
    - e.g. for gNB/UE beam refinement, TRS tracking after cell switch command
  + Triggered aperiodic SRS resource set ID

*FL note: it was agreed in RAN2 that MAC CE is used for triggering cell switch. ~~This means that this discussion is not urgent in this meeting.~~*

* *The MAC CE agreed to carry LTM related information for cell switch is used for LTM triggering of the cell switch.*
* *LTM cell switch is supervised by a timer*
* *UE arrival in the target cell need to be indicated (somehow)*

##### [Conclusion at RAN1#112]

The following proposal was not treated at RAN1#112 because of the lack of time.

* From RAN1 point of view, at least the following information needs to be included in the cell switch command, which is conveyed by MAC CE
  + Information to identify the target cell(s)
    - The details including bit number are designed by RAN2
  + FFS: TA related information (up to the discussion in A.I. 9.12.2)
  + Beam Indication for the target SpCell
  + ID of the active DL and UL BWPs for the target SpCell
* [Study further the necessity/effectuality and benefit of the following field and corresponding UE procedure]
  + Triggering of aperiodic TRS transmitted from the target cell
  + Triggering the CSI acquisition of the target cell and reporting to the target cell
  + Triggering of aperiodic SRS transmission to the target cell
* FFS: the presence of each field (i.e. always present or configurable)
* FFS: the bit size of each field, or can be felt to RAN2

*FL note: yellow part can be removed if we can achieve the consensus during offline discussion*

##### [Conclusion at RAN1#112bis-e]

Agreement

* From RAN1 point of view, at least the following information can be included in the cell switch command, which is conveyed by MAC CE
  + Information to identify the target cell(s)
    - The details including bit number are designed by RAN2
  + TA related information (details up to the discussion in A.I. 9.10.2)
  + 1 joint or 1 pair of UL and DL unified TCI State index for the target Cell
    - Note: discussion on target SpCell is not precluded
  + Active DL and UL BWPs for the target cell
  + FFS: Triggering of aperiodic TRS transmitted from the target cell
  + FFS: Triggering the CSI acquisition of the target cell and reporting to the target cell
  + FFS: Triggering of aperiodic SRS transmission to the target cell
  + FFS: C-RNTI
* FFS: the presence of each field (i.e. always present or configurable)

Working Assumption

On the presence of beam indication within cell switch command, at least for scenario 2, following is supported:

* A field to indicate 1 joint or 1 pair of UL and DL unified TCI State index for the target cell field is always present in the cell switch command.

Note: If scenarios 1 and 3 are agreed to be supported in R18 LTM other solutions may be considered.

##### [Open Issues]

The main content of cell switch command has been agreed on in RAN-112bis, however, there are few items left to be finalized, including triggering of AP SRS, AP CSI-RS (ACQ) and AP TRS. Number of companies discussed whether they see these fields are necessary within R18 LTM cell switch command or not. Companies seem to be divided on whether these fields are needs. Proponents of these fields claim that existence of these fields can lead to lower overall latency, while the opponents believe the benefits of such AP triggering can not be materialized while it can lead to higher UE complexity.

Another main issue remaining for the last meeting, is how the beam indication field will be used for CA cases, i.e., where we have SpCell beam indication. Very limited companies considered this issue, and believe single active beam indication should also be considered for SpCell cell switch cases, at least for intra band CC, where the indicated beam can be applied to all CCs.

##### [FL Proposal 5-4-1-v1]

**FL Proposal 1**: Support having the following optional fields in the cell switch command conveyed by MAC-CE command, subject to UE capability:

* + Triggering of aperiodic TRS transmitted from the target cell
  + Triggering the CSI acquisition of the target cell and reporting to the target cell
  + Triggering of aperiodic SRS transmission to the target cell

**FFS:** UE capability details.

**FL Proposal 2:** Whether C-RNTI needs to be included within the MAC-CE containing cell switch command will be left to RAN2 decision.

Confirm the working assumption achieved in RAN1-112bis with the following addition:

**FL Proposal 3:** On the presence of beam indication within cell switch command, at least for scenario 2, following is supported:

* When beam indication and activation is not performed jointly, a field to indicate 1 joint or 1 pair of UL and DL unified TCI State index for the target cell field is always present in the cell switch command.
* When beam activation command is received before the cell switch command, a codepoint index to indicate an activated TCI codepoint included in the cell switch command is always present to determine the TCI state of the target cell

**Note:** If scenarios 1 and 3 are agreed to be supported in R18 LTM other solutions may be considered.

**FL Proposal 4:** On the beam indication fieldin thecell switch command conveyed by MAC-CE, for target SpCell, i.e., CA scenarios:

* Only the beam indication for target SpCell is included in the cell switch command, and the beam indication can be applied to a set of intra-band CCs, which are included in the same list of simultaneous TCI state updating as that including target SpCell.

**FL Proposal 5:** It will be left to RAN2 decision whether the following fields are always present or not in the cell switch command:

* Active DL and UL BWPs for the target cell
* TA related information

**FL Proposal 6:** The beam indicated in cell switch command should be used for reception of all channels (PDCCH/PDSCH for DL and PUSCH/PUCCH for UL) on target cell before new TCI state is activated or indicated.

##### [Comments to FL Proposal 5-4-1-v1]

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## Preparation for LTM before reception of cell switch command

### [High] Details on DL synchronization to candidate cell(s)

##### [Conclusion at RAN1#110b-e]

Agreement

* RAN1 to further study the potential RAN1 enhancements and spec impact to perform at least the following procedures prior to the reception of L1/L2 cell switch command aiming at the reduction of handover delay / interruption
  + DL synchronization for candidate cell(s)
  + TRS tracking for candidate cell(s)
  + CSI acquisition for candidate cell(s)
  + Activation/Selection of TCI states for candidate cell(s), if feasible
  + Note: Uplink synchronization aspect will not be discussed under this A.I.
  + FFS: Whether the above procedures prior to the reception of L1/L2 cell switch command can be performed on candidate cell when it is deactivated Scell (if defined in RAN2)
* Detailed discussion will be commenced after receiving RAN2 LS.

##### [Conclusion at RAN1#111]

Agreement

* Regarding the potential RAN1 enhancements to reduce the handover delay / interruption for Rel-18 LTM
  + Support at least DL synchronization for candidate cell(s) based on at least SSB before cell switch command
    - Further study the necessary mechanism, e.g. signaling and UE capability

##### [Conclusion at RAN1#112]

The following FL proposal was made and discussed:

* Companies are encouraged to study the following aspects related to the DL synchronization and TCI state activation when Rel-17 unified TCI is used for LTM beam indication:
  + Timing to perform DL synchronization
    - Alt.1 Two-step DL synchronization procedure
      * UE maintains DL synchronization (to find frame boundary and for TA management) with SSB after L1 measurement and then
      * gNB activates TCI state(s), and then the UE starts DL synchronization (for PDSCH/PDCCH reception) with the QCL source of the TCI states
    - Alt.2-1 One-step DL synchronization procedure
      * UE maintains DL synchronization with SSB after L1 measurement
    - Alt.2-2 One-step DL synchronization procedure
      * gNB activates TCI state(s), and then UE starts DL synchronization with the QCL source of the TCI states
  + Necessity for DL synchronization for TA: whether and how DL synchronized is performed before TA
  + Applicability of CSI-RS (if agreed) in addition to SSB
  + RAN1 spec impact (UE capability, configuration, activation etc)
  + Timing of TCI state activation, i.e. whether TCI state activation is performed before TCI state indication or together with TCI state indication.

The important aspects for the next meeting are clarified during the session as follows:

* Alternatives are just for study, and other alternatives are not precluded
* DL synchronization in alt 2-1 is to find frame boundary and for TA management
* RAN1 spec impact includes, e.g. gNB indication of the cell(s) to maintain DL synchronization
* Agreement on this proposal is not necessary as the list of alternatives is not well formulated. Instead, it can be captured in the FL summary and used for the discussion in the next meeting.

##### [Conclusion at RAN1#112bis-e]

**Agreement**

For the Rel-17 unified TCI based beam indication in Rel-18 LTM, at least Alt 1 is supported:

* **Alt 1:** TCI state activation of a candidate cell is received before the reception of beam indication of the candidate cell,
* **Alt 2:** TCI state activation of a candidate cell is received together with the reception of beam indication of the candidate cell
  + FFS: signalling details for TCI state indication, if both activation and indication are done in the same MAC CE message carrying switch command
* **Alt 3:** Alt 1 and/or Alt 2 can be supported based on the UE capability

**FFS:** signalling details for TCI state activation

**FFS:** For Alt 1, whether/how TCI state activation for candidate cell(s) is allowed

**Note:** If scenarios 1 and 3 are to be supported other beam indication/TCI activation timing relationships are not precluded.

##### [Open Issues]

It was agreed in RAN1-112bis that at least beam activation before beam indication is supported in R18 LTM, however, companies identified one main issue which needs to be further discussed when considering this scenario, which is how to handle/signal the case where single active TCI is supported.

Furthermore, companies are all aligned that UE may have limited capability in terms of tracking/maintaining DL synchronization with multiple candidate cells. Hence, the need for UE capability reporting, where the UE reports the maximal number of active TCI states across candidate cell(s) it can support.

Majority of the companies also agree that Alt 1 (i.e., beam activation prior to beam indication in cell switch command) is sufficient to support in R18 LTM, and Alt 2 does not need to be considered.

Furthermore, given it has been previously agreed that in R18 LTM that DL synchronization for candidate cell(s) based on at least SSB before cell switch command should be supported, majority of the companies would like to define this SSB down-selection and related capabilities discussed and defined in RAN1.

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

**FL Proposal 1:** For R18 LTM, for TCI activation of candidate cell before cell switch, down select one Alt:

* **Alt 1:** UE is expected to perform and maintain DL synchronization (of activated TCI states) once it receives the TCI activation of candidate cell.
* **Alt 2:** DL synchronization for candidate cells before cell switch command is UE capability

**FL Proposal 2:** For TCI activation of candidate cell before cell switch, total number activated TCI states across serving cell(s) and candidate cell(s) is a UE capability.

* FFS UE capability details (to be discussed in UE capability session)

**FL Proposal 3:** For TCI activation of candidate cell before cell switch command, if UE supports single active TCI, down select one Alt:

* **Alt 1:** TCI activation and indication is received jointly in cell switch command
* **Alt 2:** TCI activation is still performed prior to cell switch command; however, the beam indication field will not be present in the cell switch command (since a single TCI is activated)
* **Alt 3:** TCI activation is still performed prior to cell switch command; however, the beam indication field will always point to codepoint 0 in the cell switch command

**FL Proposal 4:** For R18 LTM, at least for multiple active TCI for candidate cell case, do not support joint TCI state activation and beam indication of the candidate cell in the same MAC-CE message.

* **FFS:** if this procedure will be used for single active TCI scenario

**FL Proposal 5:** for R18 LTM, introduce a mechanism to enable the UE to select a subset of the SSBs, based on UE capability, to maintain DL synchronization timing information.

* FFS: details of SSB down-selection, possible solutions:
  + **Alt 1:** SSBs are selected in the following order:
    1. SSBs for which the TCI states are activated (if any),
    2. Strongest SSBs based on the measurement results
  + **Alt 2:** SSBs are selected in the following order:
    1. SSBs for which the TCI states are activated (if any)
    2. SSBs for which at least one PDCCH order has been received,
    3. Strongest SSBs based on the measurement results
* Maximum number of SSBs for early DL synchronization maintenance is a UE capability

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

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### [Mid] Other procedures to reduce handover latency/interruption time

##### [Conclusion at RAN1#110b-e]

Agreement

* RAN1 to further study the potential RAN1 enhancements and spec impact to perform at least the following procedures prior to the reception of L1/L2 cell switch command aiming at the reduction of handover delay / interruption
  + DL synchronization for candidate cell(s)
  + TRS tracking for candidate cell(s)
  + CSI acquisition for candidate cell(s)
  + Activation/Selection of TCI states for candidate cell(s), if feasible
  + Note: Uplink synchronization aspect will not be discussed under this A.I.
  + FFS: Whether the above procedures prior to the reception of L1/L2 cell switch command can be performed on candidate cell when it is deactivated SCell (if defined in RAN2)
* Detailed discussion will be commenced after receiving RAN2 LS.

##### [Conclusion at RAN1#111]

Agreement

* Regarding the potential RAN1 enhancements to reduce the handover delay / interruption for Rel-18 LTM
  + Support at least DL synchronization for candidate cell(s) based on at least SSB before cell switch command
    - Further study the necessary mechanism, e.g. signaling and UE capability

##### [Conclusion at RAN1#112]

The following proposal was not treated due to the lack of time.

* TRS tracking for candidate cells before the reception of cell switch command is supported
* CSI acquisition for candidate before reception of cell switch command is supported

*FL note: before going to the proposal, it is suggested checking the companies’ view on the criticality of this functionality for LTM. FL’s understanding is that these techniques requires non-negligible spec impact (especially for CSI acquisition), and hence this topic is handled on best effort basis.*

##### [Conclusion at RAN1#112bis-e]

No consensus

##### [Open Issues]

Number of contributions did consider the topic of triggering CSI acquisition and TRS tracking prior to cell switch command. The companies were divided in opinion on whether these two mechanisms should be introduced part of Rel-18 LTM. Companies in favor of enabling these features discussed how TRS tracking for candidate cell(s) is necessary to get QCL-typeA information for demodulation and the benefits in terms of ensuring quality of PDxCH reception specially in scenarios where frequent handovers are likely to take place. In addition, the benefits of CSI acquisition for candidate cells were discussed where it will allow enabling appropriate MCS choice based on the UE reported CQI.

The proponents of these enhancements discussed how the same similar latency reduction can be achieved by having CSI acquisition and tracking triggering through cell switch command and furthermore raised concern on the workload introducing these procedures will lead to.

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

**FL Proposal 1:** There is **no consensus** to support the following procedures prior to the reception of L1/L2 cell switch command aiming at the reduction of handover delay/interruption in Rel-18 LTM

* TRS tracking for candidate cells before the reception of cell switch command
* CSI acquisition for candidate before reception of cell switch command

Note: At least for the candidate cells which are current serving cells, the CSI acquisition and TRS tracking prior to cell switch command will be supported

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

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| Company | Comment |
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## Cross A.I. issue

### void

## LS

### [Paused] LS to RAN2,3 and 4

##### [FL observation]

As usual, it would be helpful for RAN2, 3 and 4 to know the RAN1 agreements in RAN1#113. The final decision will be made at the final online session is concluded.

##### [FL proposal 5-7-1-v1]

* Send an LS to RAN2,3,4 on the RAN1 agreements in this meeting
  + All agreements in AI 9.10.1 and 9.10.2 in RAN1#113 are included

## Other topics

UL arrival

* + Huawei
    - UE could be configured with SRS/PUSCH/PUCCH resource in the target cell before cell switch command is issued. FFS: beam application, timing, power control etc.

LTM farilure and recovery

* + Huawei
    - UE can additionally determine the LTM failure according to L1 measurement of DL RS and success of UL transmission on preconfigured resource in the target cell. UE can recover the link with source cell when LTM failure is detected without waiting for expiration of T304.

What UE should do after cell switch

* + Nokia
    - RAN1 to select one or more of the following alternatives on the UE assumption for activated TCI states upon the cell switch.
      * Alt-1: Upon the cell switch to the target cell, UE may consider the TCI states of the target cell activated before the cell switch as valid for intra/inter-cell beam management within the target cell (new serving cell). For all other candidate cells, the TCI states are not considered to be active anymore.
      * Alt-2: Upon the cell switch, UE may retain all the activated TCI states given before the cell switch.
      * Alt-3: The UE may be configured (e.g., in RRC or in the cell switch command) whether the activated TCI states are to be maintained/retained after the cell switch. The configuration can be cell specific.
  + Huawei
    - To achieve the low latency of potential subsequent LTM, at least TA and L1 measurement results can be kept for original serving cell and part of candidate cells configured when UE is associated with original serving cell.
  + Nokia
    - In Rel-18 LTM, at least a TCI state or a QCL source RS associated with the target cell can also be provided as a beam indication before the cell switch.
      * UE can determine a DL RS via the provided TCI state or the QCL source RS for monitoring at least one DL channel and/or transmission of at least one UL channel of the target cell after the cell switch until it receives a new activation/beam indication from the new target cell.
      * The UE can be configured to consider that once it has completed the RRC reconfiguration (i.e., the handover is complete), it has not been provided with an indication of a TCI state or has not received activation for any TCI state in relation to the target cell.

Further latency reduction

* + Qualcomm
    - In case of inter-DU LTM, study mechanism to reduce the latency for target DU to prepare the indicated beam after the cell switch command is sent

UE initiated LTM

* + Samsung
    - For L1/L2 mobility enhancements, study UE-initiated dynamic cell switch.

LTM failure

* + IDC
    - Support beam failure recovery on resources of non-serving cell.

# Annex

# WID in RP-222332

The detailed objective of this work item is captured below:

1. To specify mechanism and procedures of L1/L2 based inter-cell mobility for mobility latency reduction:

* Configuration and maintenance for multiple candidate cells to allow fast application of configurations for candidate cells [RAN2, RAN3]
* Dynamic switch mechanism among candidate serving cells (including SpCell and SCell) for the potential applicable scenarios based on L1/L2 signalling [RAN2, RAN1]
* L1 enhancements for inter-cell beam management, including L1 measurement and reporting, and beam indication [RAN1, RAN2]
  + *Note 1: Early RAN2 involvement is necessary, including the possibility of further clarifying the interaction between this bullet with the previous bullet*
* Timing Advance management [RAN1, RAN2]
* CU-DU interface signaling to support L1/L2 mobility, if needed [RAN3]

*Note 2: FR2 specific enhancements are not precluded, if any.*

*Note 3: The procedure of L1/L2 based inter-cell mobility are applicable to the following scenarios:*

* + - *Standalone, CA and NR-DC case with serving cell change within one CG*
    - *Intra-DU case and intra-CU inter-DU case (applicable for Standalone and CA: no new RAN interfaces are expected)*
    - *Both intra-frequency and inter-frequency*
    - *Both FR1 and FR2*
    - *Source and target cells may be synchronized or non-synchronized*

1. To specify mechanism and procedures of NR-DC with selective activation of the cell groups (at least for SCG) via L3 enhancements:

* To allow subsequent cell group change after changing CG without reconfiguration and re-initiation of CPC/CPA [RAN2, RAN3, RAN4]

*Note 4: A harmonized* RRC modelling approach for objectives 1 and 2 could be considered to minimize the workload in RAN2.

1. To specify data forwarding optimizations for CHO including target MCG and target SCG in NR-DC [RAN3].
2. To specify CHO including target MCG and candidate SCGs for CPC/CPA in NR-DC [RAN3, RAN2]

* CHO including target MCG and target SCG is used as the baseline

1. To specify RRM core requirements for the following, as necessary [RAN4]:

* L1/L2-based inter-cell mobility
* Enhanced CHO configurations addressed by this WI

1. To specify RF requirements to cover inter-frequency L1/L2-based mobility, as necessary [RAN4].
2. To study the following, with completion targeted by RAN#98 meeting [RAN4]:

* The impact of FR2 RRM mobility measurement acquisition and reporting on FR2 SCell/SCG setup/resume delay for a UE connecting from idle/inactive mode.
* The level of feasible improvement in FR2 SCell/SCG setup delay from defining new UE measurement procedures and RRM core requirements, and whether additional information from the network would help the UE to perform those measurements effectively. The following sequence of events should be assumed.
  + - The UE initiates and performs improved measurements when it requests RRC connection setup/resume.
    - After acquiring those improved measurements, the UE subsequently reports those measurements to the network to support SCell/SCG setup.

# TU allocation



# Agreements at RAN1#112bis-e

Agreement

* Adopt Alt.2 for beam indication of target cell(s) and TCI state activation for candidate cell(s) (if supported) ,
  + Alt. 1: By indicating RS identifier, i.e. mapping between RS identifier and Rel-17 unified TCI state is done by a UE
  + Alt. 2: By indicating Rel-17 TCI state index

Agreement

From RAN1 point of view, at least the following information can be included in the cell switch command, which is conveyed by MAC CE

* + Information to identify the target cell(s)
    - The details including bit number are designed by RAN2
  + TA related information (details up to the discussion in A.I. 9.10.2)
  + 1 joint or 1 pair of UL and DL unified TCI State index for the target Cell
    - Note: discussion on target SpCell is not precluded
  + Active DL and UL BWPs for the target cell
  + FFS: Triggering of aperiodic TRS transmitted from the target cell
  + FFS: Triggering the CSI acquisition of the target cell and reporting to the target cell
  + FFS: Triggering of aperiodic SRS transmission to the target cell
  + FFS: C-RNTI
* FFS: the presence of each field (i.e. always present or configurable)

Agreement

For the beam selection for SSB based L1-RSRP measurement report,

* Beam selection is performed across the L cells from configured (or activated, if introduced) cells, i.e. M beams for each of the L cells
  + FFS: How to select the L cells and M beams per cells is up to UE
* M x L beams are reported in a single report instance
  + Max values of M and L are based on UE capability, and at least M x L=4 is supported as a UE capability, other UE capabilities are FFS
    - FFS if UE is allowed to report less than M x L beams
  + The values of M and L are configured to the UE in the reporting configuration
* FFS: The following configurability is introduced in the report configuration
  + 1) Whether serving cell is always selected in the L cell selection performed by the UE, and applicable when a UE is configured with L>=2
  + 2) at least one of the inter-frequency cells is always selected in the L cell selection performed by the UE, and applicable when a UE is configured with L>=2 and at least one cell in inter-frequency

Agreement

For the Rel-17 unified TCI based beam indication in Rel-18 LTM, at least Alt 1 is supported:

* **Alt 1:** TCI state activation of a candidate cell is received before the reception of beam indication of the candidate cell,
* **Alt 2:** TCI state activation of a candidate cell is received together with the reception of beam indication of the candidate cell
  + FFS: signalling details for TCI state indication, if both activation and indication are done in the same MAC CE message carrying switch command
* **Alt 3:** Alt 1 and/or Alt 2 can be supported based on the UE capability

**FFS:** signalling details for TCI state activation

**FFS:** For Alt 1, whether/how TCI state activation for candidate cell(s) is allowed

**Note:** If scenarios 1 and 3 are to be supported other beam indication/TCI activation timing relationships are not precluded.

**Agreement**

* RRC parameter ss-PBCH-BlockPower for candidate cells is included in the LTM configuration.
  + UE needs the parameter to (at least) perform RACH towards candidate cells
  + Note: how to capture this parameter and RRC structure are up to RAN2

**Agreement**

* Companies are encouraged to study the beam application time for Rel-18 LTM, which may be different from that without serving cell change
  + Definition of the beam application time
  + The exact value(s), condition and UE capability
  + Consider the interaction with the application of the candidate RRC configuration.

Conclusion

* Whether active DL and UL BWP of the target Cell/SpCell field, within the cell switch command, is always present or not is left to RAN2 decision.

Working Assumption

On the presence of beam indication within cell switch command, at least for scenario 2, following is supported:

* A field to indicate 1 joint or 1 pair of UL and DL unified TCI State index for the target cell field is always present in the cell switch command.

Note: If scenarios 1 and 3 are agreed to be supported in R18 LTM other solutions may be considered.

**Agreement**

* Periodic and semi-persistent report on PUCCH are also supported for gNB scheduled L1-measurement reporting.

# Agreements at RAN1#112

Agreement

* RAN1 shares the same understanding as RAN2 on agreement:
  + The LTM mobility trigger information is conveyed in a MAC CE
* The same MAC CE is used for the LTM triggering.

Agreement

* The agreement on scenario 2 (Beam indication together with cell switch command) at RAN1#111 is further clarified as the following:
  + Beam indication for the target cell(s) is conveyed in the MAC CE used for LTM triggering for scenario 2

Agreement

* For L1-RSRP measurement RS configuration
  + For SSB based L1-RSRP measurement:
    - As a starting point, at least the following information needs to be provided to a UE, e.g.
      * For intra- and inter- frequency: PCI or logical ID (e.g., as being defined in R17 ICBM), time domain (e.g. SMTC or periodicity and SSB position in burst)
      * For inter-frequency: frequency domain location (e.g. center frequency), SCS
      * FFS: transmission power (for pathloss calculation)
    - Note: other parameters included in the configuration can be further discussed
    - Including above agreement into the LS
  + The detailed design of RRC structure is up to RAN2, and send an LS to RAN2 to request to work on the RRC structure design on the measurement configuration.
    - Following RAN1 understanding will be provided in the LS
      * RAN1 has discussed the following configuration options for L1 measurement configurations for SSB till RAN1#112:
        + Option 1) Configurations for L1 measurement RS is provided under ServingCellConfig for the serving cells

is useful to reuses the mechanism for Rel-17 ICBM and necessary information to support inter-frequency measurement will be added there.

* + - * + Option 2) Configurations for L1 measurement RS is provided separately from ServingCellConfig for the serving cells and CellGroupConfig for the candidate cells

is useful to avoid the duplicated configurations for L1 measurement RSs, [and avoid UE to process configurations ~~for L1 measurement RS~~ provided under CellGroupConfig for the candidate cells]

* + - * + Option 3) Configurations for L1 measurement RS is provided under CellGroupConfig for the candidate cells

can achieve the similar benefit as Option 2) by directly referring to the candidate cell configurations.

* + - * Note RAN2 has a full flexibility to design the whole RRC structure design.
      * RAN1 believes this is RAN2 expert region, and respectfully asks RAN2 to finalize the RRC structure design after RAN1 finalizes the discussion on RRC parameters.
      * It is noted that RAN1 foresees the necessity of similar discussions on TCI state pool for candidate cells and L1 measurement report configurations.

Agreement

* Send an LS to RAN2,3,4 on the RAN1 agreements in this meeting
  + All agreements in AI 9.12.1 and 9.12.2 in RAN1#112 are included
  + The LS contents agreed in AI 9.12.1 (on L1 measurement configuration) and AI 9.12.2 (on RAR) are also included

Agreement

* At least for Rel-17 unified TCI framework based beam indication included in cell switch command (i.e. scenario 2), beam indication applies to signals/channels that follow or are configured to follow Rel-17 unified TCI at the target cell(s)
* FFS: beam indication for mTRP case

Agreement

Draft LS R1-2302193 is endorsed in principle by appending latest agreements.

Agreement

Final LS R1-2302194 is endorsed.

# Agreements at RAN1#111

Agreement

* For Rel-18 LTM, L1 inter-frequency measurement is supported from RAN1 point of view.

Agreement

* Regarding the potential RAN1 enhancements to reduce the handover delay / interruption for Rel-18 LTM
  + Support at least DL synchronization for candidate cell(s) based on at least SSB before cell switch command
    - Further study the necessary mechanism, e.g. signaling and UE capability

Agreement

* For L1 measurement report for Rel-18 L1/L2 mobility, if UE event triggered report for L1 measurement is supported based on further study
  + At least the following aspects may be considered
    - How to define UE event and exact definition of events,
    - Report container
    - Resource allocation/assignment for UE event triggered report
    - Necessity of indication to gNB when the condition UE event is met, and how
    - Necessity to define the condition to start/stop the reporting,
    - Contents of the report/reporting format, PCI, RS ID, measurement result etc.
    - The interaction with filtered L1 measurement results (if supported)
    - Support of simultaneous configuration of both UE event triggered and any of periodic/semi-persistence/aperiodic reporting, and solutions when both of them are configured.
    - Report destination, whether the report is sent to serving cell only or can be sent to one or more candidate cell(s).
    - Benefit when L3 measurement is involved

Agreement

* For candidate cell measurement for Rel-18 LTM,
  + SSB based L1-RSRP is supported for intra-frequency measurement
  + SSB based L1-RSRP is supported for inter-frequency measurement from RAN1 point of view
  + FFS: L1-SINR, CSI-RS based L1-RSRP

Agreement

* The beam indication of candidate cell(s) for Rel-18 LTM should be designed based on the following:
  + Beam indication for Rel-18 LTM is designed based on Rel-17 unified TCI framework, if both serving cell and candidate cell support Rel-17 unified TCI framework
  + FFS: whether/how to design mechanism for Beam indication for Rel-18 LTM when at least one from serving cell and candidate cell supports only Rel-15 TCI framework.
  + Note: How and whether to indicate the new serving cell(s) and timing for beam indication are separately discussed

Agreement

* For gNB scheduled L1 measurement report for Rel-18 LTM, report as UCI is supported
  + Semi-persistent report on PUSCH, and aperiodic report on PUSCH are supported
    - FFS: periodic and semi-persistent PUCCH
  + In a single report instance, report for serving cell and candidate cell(s) for intra-frequency and/or inter-frequency can be included.

Agreement

* For beam indication timing for Rel-18 LTM,
  + Support Scenario 2: Beam indication together with cell switch command,
    - For Rel-17 unified TCI framework,
      * Beam indication indicates TCI state for each target serving cell
  + FFS: Scenario 1: Beam indication before cell switch command
  + FFS: Scenario 3: Beam indication after cell switch command
* FFS: Activation of TCI state(s) of target serving and/or candidate cell(s).

Agreement

On mechanism to acquire TA of the candidate cell(s) in Rel-18 LTM, at least support PDCCH ordered RACH.

* The PDCCH order is only triggered by source cell
* FFS: the details including content of DCI, RACH resource configuration, RAR transmission mechanism, etc.
* Note: any other RACH-based solutions are for discussion separately

Agreement (Made in RAN1#110b-e)

Support TA acquisition of candidate cell(s) before cell switch command is received in L1/L2 based mobility.

* FFS: whether this can be applied to candidate cell when it is deactivated SCell (if defined in RAN2)

Agreement

For PDCCH ordered RACH in LTM, at least the following enhancements are supported

* Introduce indication of candidate cell and/or RO of candidate cell in DCI
* configuration of RACH resource for candidate cell(s) is provided prior to the PDCCH order
* FFS: whether/how to transmit RAR

 Agreement

On whether RAR is needed for PDCCH ordered RACH for a candidate cell in LTM, the following alternatives are considered for further study

* Alt 1: RAR is needed
* Alt 2: RAR is not needed
  + Note: If Alt 2 is supported, TA value of candidate cell is indicated in cell switch command
* Alt 3: whether RAR is needed can be configured

Agreement

* TA updating (i.e. re-acquisition of TA) for candidate cell can be triggered by NW.
  + same triggering mechanism reuse the initial TA acquisition, i.e., PDCCH order triggered RACH in a candidate cell

# Agreements at RAN1#110b-e

Agreement

* For Rel-18 L1/L2 mobility, L1 intra-frequency measurement for candidate cell is supported
  + At least the following aspects are for RAN1 further study:
    - RAN1 assumes Rel-17 ICBM CSI measurement as starting point.
    - Whether and how to apply relaxation for the restrictions imposed on the Rel-17 intra-frequency L1 non-serving cell measurement defined in 9.13.2 of TS38.133, where RAN4 impact is foreseen, e.g.
      * SFN offset alignment compared with serving cell
      * BWP setting, i.e. non-serving cell SSB should be covered by serving cell active BWP
      * Introduction of symbol level gap or SMTC for larger Rx timing difference (i.e. larger than CP length)
    - Commonality with intra-frequency L3 measurement
    - Commonality with L1 inter-frequency measurement for measurement configuration
* Send an LS to RAN4 (CC RAN2)
  + RAN1 to ask RAN4 if the restriction on e.g., SFN offset alignment, BWP setting and Rx timing difference, etc, described in 9.13.2 of TS38.133 for intra-frequency L1 non-serving measurement can be relaxed or not.
  + RAN1 assumes Rel-17 ICBM CSI measurement as starting point.

Agreement

* For Rel-18 L1/L2 mobility,
  + SSB is supported for L1 intra-frequency measurement
  + SSB is supported for L1 inter-frequency measurement if inter-frequency L1 measurements are supported
* Further study the following L1 measurement RS for candidate cell
  + CSI-RS for tracking, beam management, CSI and mobility, CSI-IM, which is for L1 intra-frequency and L1 inter-frequency (if supported)

Agreement

* For candidate cell measurement for Rel-18 L1/L2 mobility,
  + L1-RSRP is supported for intra-frequency candidate cell measurement.
  + Further study the following measurement quantities for candidate cell measurement
    - L1-RSRP for inter-frequency (if supported)
    - L1-SINR for intra-frequency and inter-frequency (if supported)
* FFS: to assess the use case and the benefit of UL measurement instead of/in addition to DL L1 measurement, which includes:
  + How the UL measurement result is used, e.g. handover decision
  + Signals/channels used for UL measurement, e.g. SRS
  + Spec impact including other WGs, e.g. definition of gNB measurement, interface to transfer RS configuration or measurement results
  + Note: The next discussion will take place based on companies’ contribution in future meeting.

Agreement

* For Rel-18 L1/L2 mobility, further study the potential RAN1 spec impact of L1 inter-frequency measurement
  + The definition and scenarios of L1 inter-frequency measurement is determined by RAN4, and RAN1 assumes at least the following until receiving their confirmation
    - The scenarios not included in intra-frequency are regarded as inter-frequency, which includes at least the following scenarios:
      * The frequency of the measured RS not covered by any of the active BWPs of SpCell and Scells configured for a UE, but covered by some of the configured BWPs of SpCell and Scells configured for a UE.
      * The frequency of the measured RS not covered by any of the configured BWPs of SpCell and Scells configured for a UE
  + At least the following aspect is studied:
    - Commonality with L1 intra-frequency measurement for measurement configuration
* Send an LS to RAN4 (CC RAN2)
  + RAN1 would like to confirm our understanding that the supported scenarios not included in intra-frequency are regarded as inter-frequency, which includes at least the following scenarios:
    - The frequency of the measured RS not covered by any of the active BWPs of SpCell and Scells configured for a UE, but covered by some of the configured BWPs of SpCell and Scells configured for a UE.
    - The frequency of the measured RS not covered by any of the configured BWPs of SpCell and Scells configured for a UE
  + It is RAN1 understanding that the introduction of measurement gap and SMTC for L1 inter-frequency measurement, if any, is expected to be a RAN4 issue
  + Note: this content is included in the LS agreed for intra-frequency L1 measurement

Agreement

* For L1 measurement report for Rel-18 L1/L2 mobility, further study the following mechanisms:
  + Report as UCI on PUCCH or PUSCH
    - Periodic report on PUCCH, semi-persistent report on PUCCH/PUSCH, and aperiodic report on PUSCH
    - Potential enhancements to Rel-17 ICBM report format to accommodate Rel-18 scenarios, e.g.
      * Inter-frequency measurement, if supported
      * Increasing the maximum number of reported beams, which is 4 for Rel-17 ICBM
      * Flexible size beam report, e.g., two-part UCI (e.g., the 1st part contains the best beam/cell and the number (e.g., N) of reported beams/cells, the 2nd part contains the rest (N-1) beams/cells
      * Reducing the reporting overhead by e.g. choosing beams/cells per frequency or across frequencies to report (FFS how)
  + Report on MAC CE
    - Both gNB scheduled and/or UE initiated (if supported) report are studied

Agreement

* RAN1 to further study if the beam indication of candidate cell(s) L1/L2 mobility should be designed for a specific TCI framework below, and their potential RAN1 spec impact.
  + **Option A:**  Beam indication for Rel-18 L1/L2 mobility is designed based on Rel-17 TCI framework mechanism
  + **Option B:** Beam indication for Rel-18 L1/L2 mobility is designed based on Rel-15 TCI framework mechanism
  + **Option C:** Beam indication for Rel-18 L1/L2 mobility is designed based on both Rel-15 and Rel-17 TCI framework mechanisms

Agreement

-  Send an LS to RAN2/RAN3 asking the clarification on intra-/inter-DU scenario:

-      RAN1 has started the discussion on the configuration for L1 measurement and TCI states for candidate cells. Regarding the following RAN2 agreements captured in RAN2 LS (R1-2208331/R2-2209257), it is not clear for RAN1 which kind of information/configuration for candidate cell(s) are available at a serving cell for inter-DU case for Rel-18 L1/L2 mobility. Thus, companies have different understanding on the implication of the sentence “as much commonality as reasonable” in the LS.

-      *The design for intra-DU and inter-DU L1/L2-based mobility should share as much commonality as reasonable. FFS which aspects need to be different.*

-  RAN1 respectfully asks RAN2 and RAN3 if the serving DU knows the measurement RS configuration and TCI state configuration of cells served by another DU

Agreement

* Send an LS to RAN2, 3 and 4 to inform them of the agreements under A.I 9.12.1 and A.I. 9.12.2
* If the LS related proposal under A.I 9.12.1 and 9.12.2 are agreed, the contents are also included.

Agreement

* RAN1 to further study the potential RAN1 enhancements and spec impact to perform at least the following procedures prior to the reception of L1/L2 cell switch command aiming at the reduction of handover delay / interruption
  + DL synchronization for candidate cell(s)
  + TRS tracking for candidate cell(s)
  + CSI acquisition for candidate cell(s)
  + Activation/Selection of TCI states for candidate cell(s), if feasible
  + Note: Uplink synchronization aspect will not be discussed under this A.I.
  + FFS: Whether the above procedures prior to the reception of L1/L2 cell switch command can be performed on candidate cell when it is deactivated SCell (if defined in RAN2)
* Detailed discussion will be commenced after receiving RAN2 LS.

Agreement

* From RAN1 perspective, the following scenarios can be considered for Rel-18 L1/L2 mobility for beam indication timing. This will be updated depending on further RAN1 assessment and RAN2 decision on the time chart
  + Scenario 1: Beam indication before cell switch command
  + Scenario 2: Beam indication together with cell switch command
  + Scenario 3: Beam indication after cell switch command
* Interested companies are encouraged to further study the validity of the scenarios and the potential spec impact.

Agreement

* Interested companies are encouraged to perform technical analysis of the cell switch command from a RAN1 point of view, e.g.
  + Necessary information included in the command, which is relevant for RAN1 discussion
  + Necessary number of bits for the information
  + L1 impact or concern to use DCI or MAC CE for L1/L2 cell switch command

**Agreement**

Support TA acquisition of candidate cell(s) before cell switch command is received in L1/L2 based mobility.

* FFS: whether this can be applied to candidate cell when it is deactivated SCell (if defined in RAN2)

**Agreement**

On mechanism to acquire TA of the candidate cells, the following solutions can be further studied:

•         RACH-based solutions

e.g., PDCCH ordered RACH, UE-triggered RACH, higher layer triggered RACH from NW other than L3 HO cmd

•         RACH-less solutions

e.g., SRS based TA acquisition, Rx timing difference based, RACH-less mechanism as in LTE, UE based TA measurement (including UE based TA measurement with one TAC from serving cell)

Agreement

For TA acquisition of a candidate cell before cell switch command is received, study at least the following alternatives of associating TA/TAG to candidate cell:

* Alt1: Associate TA/TAG and candidate cell implicitly, e.g.,
* the association between TA/TAG and TCI states can be configured
* Alt2: Associate TA/TAG and candidate cell explicitly, e.g.,
* the association is provided as a part of candidate cell(s) configuration
* the association between TA/TAG and SSB(s)/TRS(s) is provided as a part of candidate cell(s) configuration

# Agreements at RAN2#121bis-e

* Current Contents is agreeable as is. Include also agreements regarding L1 measurements for information (copy-past of agreements part), revise the title to be *Reply LS on L1 measurement RS configuration and PDCCH ordered RACH for LTM*
* The revised LS out is approved unseen in R2-2304553
* From RAN2 perspective, to enable shared preamble resource among multiple UEs, it is beneficial that the information that identifies the allocated CFRA resource (i.e., SS/PBCH index, RACH occasion, and Random Access Preamble index) can be indicated in the PDCCH order (as legacy intra-cell PDCCH order).
* RRC RACH configuration for early TA acquisition (e.g., including whether RAR needs to be received) is specific per target cell and is signalled separately (separate IEs) from the candidate cell configuration (the part that need to be applied at cell switch).
* R2 assumes that Early TA RACH option 3 (with RAR from candidate cell) is not needed in Rel-18.
* With the assumption that the UE will skip RACH in the target cell if a TA value is given in the cell switch command: It is FFS if the following TA values can be given to the UE:

- Value 0,

- Value indicating that the UE shall apply the TA of one source cell.

* R2 assumes RRCReconfigurationComplete message is always sent at each LTM execution.
* In RACH-based LTM, the target cell is aware of the UE’s arrival based on the reception of preamble in CFRA and on the reception of Msg3/MsgA in CBRA, like the legacy HO.
* In RACH-less LTM, the target cell is aware of the UE’s arrival based on reception of the first UL transmission from this UE
* In RACH-less LTM, RRCReconfigurationComplete can be the content of the first UL MAC PDU/transmission to indicate UE arrival, i.e. no need to introduce any new signaling to indicate UE arrival (for the MCG-switch case)
* For RACH-based LTM, the UE considers that LTM execution procedure is successfully completed when the RACH is successfully completed.
* For RACH-less LTM, the UE considers that LTM execution procedure is successfully complete when the UE determines the NW has successfully received its first UL data.
* Following behaviors of LTM supervisor timer are agreed:

- 1: The UE starts the LTM supervisor timer, upon reception of the LTM cell switch MAC CE;

- 2: The UE stops the LTM supervisor timer, upon successful completion of LTM cell switch;

- 3: If the LTM supervisor timer for MCG expires, as baseline, the UE considers LTM failure and initiates RRC re-establishment. (SCG switch case FFS)

* LTM supervisor timer is RRC layer timer.
* At RLF or LTM execution failure (for MCG), RAN2 intend to support fast recovery to a candidate cell by LTM execution.
* While configured with LTM candidate cells, the UE can also execute any L3 handover command sent by the network. R2 assumes that is could be up to the network to avoid any issue due to the race condition between LTM execution and RRC Reconfiguration (e.g. L3 HO cmd), e.g. avoid sending LTM switch cmd and L3 HO cmd in the same TB.
* Discuss terminology for the TS in the RRC stage-3 discussions when/if needed (not at current meeting).
* Whether the Reference configuration is a complete configuration or not is up to the network implementation.
* Reference configuration + LTM candidate configuration (in combination) has to be a complete configuration.
* The reference configuration is always explicitly signalled (not automatically derived from any other config, e.g. current).
* Confirm that only the replacement procedure (the “full config without L2 reset”) is supported for Execution of LTM cell switch.
* The UE may perform early decoding and early validity check. FFS whether Early validity check triggers early re-establishment. FFS the possible timing, FFS subset of cells, FFS if need to specify anything or just up to UE impl, FFS if other signalling to notify network is needed.

Initial agreements, from RAN2 point of view (may be dep on RAN1 progress).

* The location of RS configuration for SSB-based measurements of candidate cells is external to the ServingCellConfig(s) of current serving cells and external to the configuration of the LTM candidate cells. The RS configuration, per RAN1 agreement, can include PCI or logical ID, SMTC location, frequency location, and SCS.
* RAN2 assumes that the location of configurations of TCI states for the candidate cells (used before/at cell switch) is external to the ServingCellConfig(s) of current serving cells and external to the configuration of the LTM candidate cells (same location as RS configuration).
* RAN2 assumes that For L1 measurements of LTM candidate cells, the reporting configuration is placed inside the ServingCellConfig of current serving cell(s).

*Chair: the agreements above may need to be further evaluated, e.g. wrt subsequent LTM switches.*

* RAN2 assumes that whether filtering, hysteresis, and time-to-trigger are needed for LTM specific L1 measurements is up to RAN1.
* FFS if the LTM specific L1 measurements of an LTM candidate SCell is independent of its activation status.
* Whether to assume L1/L2 signaling to control or change L1 measurement/reporting for LTM needs further discussion (parts may be discussed in RAN1). RAN2 assumes that such control would be limited to certain aspect that need frequent update and restricted by RRC configuration.

# Agreements at RAN2#121

**Agreed: Usage of reference configuration:**

**- Candidate delta configuration is applied on top of the reference configuration to form a complete candidate configuration (FFS if done at cell switch or before the cell switch)**

**- The complete candidate configuration is applied and replacing the current UE configuration (at the time of reconfiguration execution/cell switch), by a RRC reconfiguration procedure that makes replacements of configuration but doesn’t necessarily reset RLC or PDCP.**

**- To support reconfigurations that requires reset of RLC PDCP, this should be possible (in principle same a full config)**

**- FFS if more than RLC PDCP should be kept and how much of “replacing” need to be specified.**

**- FFS if the reference configuration can be derived from the current UE configuration at some point of time.**

**Potentially: R2 assumes that LTM without a separate reference configuration (if agreed) could work something like this:**

- **Alt A: The candidate configuration (which need to be complete) is applied and replacing the current UE configuration (at the time of reconfiguration execution/cell switch), by a RRC reconfiguration procedure that makes replacements of configuration but doesn’t necessarily reset RLC or PDCP. (Same procedure as above)**

**- Alt B: The candidate configuration (which can be a delta config) is applied to the current UE configuration (at the time of reconfiguration execution/cell switch), by legacy RRC reconfiguration procedure (it is assumed that the network need to coordinate if subsequent reconfigurations shall work, FFS feasibility).**

**agree to use Model 1: One *RRCReconfiguration* message for each candidate target configuration *RRCReconfiguration* to configure target candidate cells**

**Reference config can be empty**

**In the RRC procedures, the candidate delta configuration is applied on top of the reference configuration to form a complete candidate configuration when the UE receives the LTM configuration (before the LTM cell switch). UE implementation can postpone that step to the reception of the LTM cell switch command. FFS Discuss early vs late compliance check.**

**In the RRC procedures, the complete candidate configuration is applied and replacing the current UE configuration (at the time of reconfiguration execution/cell switch), by a RRC reconfiguration procedure that makes replacements of configuration but doesn’t necessarily reset MAC, RLC or PDCP. FFS whether we can rely on a modified version of the reconfiguration procedure with fullconfig flag set. FFS how to make sure the procedures work in case the LTM candidate configuration is a complete configuration.**

* No consensus to support HARQ continuation (and in order to resume discussion some new input may be needed, e.g. quantitative evidence of a serious problem).
* To determine if to reset L2 or not is based on RRC configuration (e.g. set of cells. FFS if separate for RLC, MAC, PDCP).

# Agreements at RAN2#120 (From RAN2 chair notes)

[R2-2211201](file:///C:\Users\johan\OneDrive\Dokument\3GPP\tsg_ran\WG2_RL2\RAN2\Docs\R2-2211201.zip) Discussion on RAN1 LS on measurement and configurations for L1L2-based inter-cell mobility CATT, Fujitsu discussion Rel-18 NR\_Mob\_enh2-Core

* RAN2 assumes that LTM (intra DU and inter DU) is network-controlled mobility where the control is from the source, i.e. measurements (L1 measurements) are configured in the UE from the source Cell, and the decision to switch cell is by the source cell, and enhancements considered for LTM before cell switch, e.g. pre-synchronization, TA handling, target beam mgmt (to the extent it is supported) may be by the source cell. RAN2 understands that this may require cooperation source DU CU target DU and/or OAM coord. RAN2 don’t see any blocking issue to share information between DUs but the support of this is in RAN3 domain. RAN2 see no necessity for a direct inter-DU-interface to support this.

[R2-2213332](file:///C:\Users\johan\OneDrive\Dokument\3GPP\tsg_ran\WG2_RL2\RAN2\Docs\R2-2213332.zip) 38.300 running CR for introduction of NR further mobility enhancements MediaTek Inc. draftCR Rel-18 38.300 17.2.0 B NR\_Mob\_enh2-Core

* Endorsed as baseline for further update

[R2-2211202](file:///C:\Users\johan\OneDrive\Dokument\3GPP\tsg_ran\WG2_RL2\RAN2\Docs\R2-2211202.zip) On Procedure Descriptions CATT discussion Rel-18 NR\_Mob\_enh2-Core

DISCUSSION

* Include a procedure in the MTK stage-2 offline (e.g. acc to proposal and comments)

[R2-2212438](file:///C:\Users\johan\OneDrive\Dokument\3GPP\tsg_ran\WG2_RL2\RAN2\Docs\R2-2212438.zip) Qualitative analysis on what to include in the RRC model for LTM Ericsson discussion Rel-18 NR\_Mob\_enh2-Core

* P1 RAN2 to confirm that the CellGroupConfig IE is (mandatory) needed within an LTM candidate cell configuration.
* P3 The RadioBearerConfig IE can be optionally supported in an LTM candidate configuration
* P5 The MeasConfig IE can be optionally supported in an LTM candidate configuration.
* P8 The OtherConfig IE is not required to be part of the LTM candidate cell configuration.
* P9 The LTM candidate cell configuration should be designed as a To AddMod/ToRelease structure.
* P10 The LTM candidate cell configuration ASN.1 structure comprises at least a CellGroupConfig IE and a configuration ID.

[R2-2211456](file:///C:\Users\johan\OneDrive\Dokument\3GPP\tsg_ran\WG2_RL2\RAN2\Docs\R2-2211456.zip) Discussion on configurations for multiple candidate cells of L1 L2 mobility Intel Corporation discussion Rel-18 NR\_Mob\_enh2-Core

DISCUSSION

**On Delta Configuration**

* A UE stores the reference configuration as a separate configuration.
* The reference configuration is managed separately

[R2-2211487](file:///C:\Users\johan\OneDrive\Dokument\3GPP\tsg_ran\WG2_RL2\RAN2\Docs\R2-2211487.zip) Trigger and Execution of LTM vivo discussion Rel-18 NR\_Mob\_enh2-Core

* The MAC CE agreed to carry LTM related information for cell switch is used for LTM triggering of the cell switch.
* LTM cell switch is supervised by a timer
* UE arrival in the target cell need to be indicated (somehow)

[R2-2213335](file:///C:\Users\johan\OneDrive\Dokument\3GPP\tsg_ran\WG2_RL2\RAN2\Docs\R2-2213335.zip) Report of #033 on Partial MAC reset for intra-DU LTM vivo discussion Rel-18 NR\_Mob\_enh2-Core

* RAN2 to have the mindset to have a common design for partial MAC reset for different cell change cases in intra-DU scenario (as far as reasonable)

[R2-2213336](file:///C:\Users\johan\OneDrive\Dokument\3GPP\tsg_ran\WG2_RL2\RAN2\Docs\R2-2213336.zip) Potential Partial MAC Reset for intra-DU LTM vivo, MediaTek, Xiaomi discussion Rel-18

* Noted
* The summary in [R2-2213336] could be considered as the starting point for partial reset in intra-DU.

[R2-2212865](file:///C:\Users\johan\OneDrive\Dokument\3GPP\tsg_ran\WG2_RL2\RAN2\Docs\R2-2212865.zip) Discussion on security issue in cell switch NTT DOCOMO INC. discussion Rel-18

* Permanent Identities such as PCI will not be used in L1 L2 signalling, instead L1 L2 signalling will use temporary identities configured by RRC.

# Agreements at RAN2#119b-e(R2-2211061)

Terminology

* RAN2 to use “LTM” as term for the L1/L2-triggered mobility.
* Use the term “cell switch” for the procedure of triggering change of cells via the LTM feature
* Use the term “Subsequent” LTM for the case when cell switch between L1/L2 mobility candidates is done without RRC reconfiguration in between.

Target performance enhancements

* No security update support in Rel-18 with L1/L2 based mobility.
* FFS whether ASN.1 decoding and validity/compliance check of candidate cell configuration are performed upon reception of the candidate cells configuration. FFS if this need to be specified.
* For UE processing, the following (not exhaustive) is assumed to be performed after receiving the cell switch command:

MAC/RLC reset (when configured)

RF retuning (e.g. needed for inter-frequency), baseband retuning

* R2 assumes that the following items may be discussed by RAN1 and RAN4 (and may be scenario specific):

- Whether to perform DL synchronization to candidate/target cell before receiving the cell switch command. R2 assumes this is feasible at least for the case that the target cell is already an active serving cell.

- Whether to support of performing TRS tracking and CSI measurement of candidate/target cell before/by cell switch command

* L1L2 based mobility supports the following CA scenarios:

PCell change without SCell change

PCell change with SCell change

* Support NR-DC scenario in L1L2 based mobility, at least for the PSCell change without MN involvement case, i.e. intra-SN.

L1 measurements and beam indication

* RAN2 assumes that RAN1 will drive discussions on L1 measurement enhancements, if any. If RAN1 identifies the need for e.g. event reporting, filtering etc, RAN2 can then be involved if needed.
* Inter-freq L1L2 mobility: R2 Confirms that For L1L2 mobility inter-freq scenarios in general should be supported (including mobility to inter-frequency cell that is not a current serving cell), including the support of inter-frequency L1 measurements, if feasible by R4 and R1.
* RAN2 assumes that whether to use the unified TCI framework as the baseline for beam indication for L1L2 mobility is up to RAN1 (RAN2 observes that L1/L2 mobility need to support inter-freq cases).

RRC

* A L1/L2 inter-cell mobility candidate (target) configuration is received within an RRC message before the L1/L2 dynamic switch is triggered.
* For L1L2 mobility, Target Pcell/SCell can be current SCell/PCell, i.e., current SCell/PCell can be configured as candidates.
* RAN2 assumes that sequential L1L2 cell change between Candidates without RRC reconfiguration can be supported.

Dynamic cell switching

* RAN2 assumes L1/2 mobility trigger information is conveyed in a MAC CE, FFS if the MAC CE or a DCI is used for the actual triggering.
* RAN2 assumes the MAC CE for L1/2 mobility trigger contains at least a candidate configuration index.
* FFS if it should be possible to perform SCell activation/deactivation (amongst SCells associated with the candidate configuration) simultaneously with L1 L2 mobility trigger MAC CE (if so, FFS how this is determined).
* RAN2 assumes that both RACH-based (CFRA, CBRA) and RACH-less procedures for L1 L2 mobility switch may be supported. RACH-less if the UE doesn’t need to acquire TA during the cell switch. RAN2 understands that the feasibility of RACH-less may depend on RAN1, and expect that RAN1 is working on this.
* RAN2 assumes RACH resource for CFRA for L1 L2 dynamic switch may be provided in RRC configuration (or potentially by MAC CE FFS).
* FFS if the MAC CE can indicate TCI state(s) (or other beam info) to activate for the target Cell(s), dep on RAN1 progress.
* R2 assumes that at L1L2 cell switch: Whether the UE performs partial or full MAC reset (FFS what partial reset is, e.g. to avoid data loss), re-establish RLC, perform data recovery with PDCP is explicitly controlled by the network. R2 assumes that this can be configured by RRC. FFS if MAC CE indication(s) is/are needed.

# Agreements at RAN2#119-e (R1-2208331/ R2-2209257)

* Assumption: HO interruption time for L1/L2-based inter-cell mobility is the time from UE receives the cell switch command to UE performs the first DL/UL reception/transmission on the indicated beam of the target cell. FFS if TRS tracking after HO and CSI RS measurement should also be included, i.e. the time to use a high-performance beam (can be clarified further).
* Assumption: To reduce HO interruption time, investigate e.g. solutions to reduce the time for UE reconfiguration (already in the WID), downlink and uplink synchronization after handover decision (other parts of dynamic switch not precluded).
* Confirm to Support L1/L2-based inter-cell mobility for inter-DU scenario (as well as intra-DU scenarios).
* The design for intra-DU and inter-DU L1/L2-based mobility should share as much commonality as reasonable. FFS which aspects need to be different.
* R2 assumes that L2 is continued whenever possible (e.g. intra-DU), without Reset, with the target to avoid data loss, and the additional delay of data recovery.
* ICBM is one scenario considered for L1L2 mobility, but is not the only one, and is not a prerequisite for using L1L2 mobility.
* RAN2 to consider preparation of target cell configurations capable of dynamic switching without need for full configuration.
* Measurement delay can/may be considered in this work
* Assume that we rely on L1 measurements to trigger L1L2 mobility (still measurement for preparation could be L3, FFS)
* R2 will initially focus on PCell mobility.
* R2 assumption: Rel-18 L1/L2 mobility includes both non-CA (PCell only) and CA scenarios (PCell and SCell). This includes the following cases

a) the target PCell/target SCell(s) is not a current serving cell (CA 🡪 CA scenario with PCell change)

b) FFS the target PCell is a current SCell

c) FFS the target SCell is the current PCell.

* DC scenarios are FFS (e.g. PSCell mobility may be a low hanging fruit FFS).
* Current options on the table: to configure a L1/L2 inter-cell mobility candidate cell:

a. One RRCReconfiguration message for candidate target cell

b. One CellGroupConfig IE for each candidate target cell

c. One SpCellConfig IE for each candidate target cell

* Will send an LS to RAN1 and RAN3 on the progress of this meeting.