**3GPP TSG-RAN WG4 Meeting #107 R4-2310045**

**Incheon, Korea, May 22 – 26, 2023**

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# Topic #1: L1/L2 triggered inter-cell mobility

## Sub-topic 1-1 DL synchronization before cell switch command

**Issue 1-1-4: Requirements of TCI state activation of neighbour cell before cell switch command**

* Proposals (CTC, OPPO, MTK, xiaomi, vivo): Discuss whether and how to define requirements for SSB based T/F fine tracking on neighbour cell
	+ Option 1 (MTK, xiaomi): Further discuss the impact due to T/F fine time tracking on candidate cells, e.g., impact on L1/L3 measurement.
		- Option 1a (MTK): For T/F fine tracking to the TCI state of a neighbour cell, at least one SSB is available at the UE during the last 160ms to satisfy transmit timing requirements.
			* Further discuss whether and how to leave a dedicated portion of SSB occasions and/or measurement gap occasions at least every 160ms.
	+ Option 2 (vivo): For the inter-frequency cell switch, if UE can perform T/F fine tracking before cell switch, RAN4 discuss and clarify whether the DL BWP of target cell is activated during downlink sync before the cell switch. If so, RAN4 discuss the delay/interruption requirements if needed.
* Recommended WF
	+ Further discuss how to define requirements for SSB based T/F fine tracking on neighbour cell.

**Discussion:**

E///: RAN1 is still working on it. Shall we hold the discussion until RAN1 finish their work. Some details are TBD.

MTK: RAN1 have concluded TCI state activation is part of the procedure. RAN4 can discuss based on existing RAN1 progress.

Nokia: this may not be that urgent to decide now. We can look into other topics,

Huawei: TCI state activation should have been agreed in RAN1.

MTK: this is important to start with since it may impact other topics.

Vivo:intra-frequench case should be covered by R17 requirements. We can focus on inter-frequency case.

QCOM: agree with Nokia. We should start with some framework discussion

Xiaomi: share the view as MTK that we should start with this issue.

MTK:we have got LS from RAN1 on PDCCH ordered RACH. T/F fine tracking should be part of it.

Nokia: we suggest start with topic 2.

E///:TCI activation should not be part of RAN4 reply to RAN1.

QCOM: same as E///

**Agreement:** For DL T/F ~~[fine]~~ tracking to the candidate cells ~~to the TCI state of a neighbour cell~~, at least one SSB is available at the UE during the last 160ms to satisfy transmit timing requirements.

## Sub-topic 1-2 UL synchronization before cell switch command

***For information:***

*RAN1 have defined some requirements for PDCCH order RACH for the serving cell as shown below, i.e., the delay to transmit PRACH after receiving PDCCH order and the scheduling restriction during PRACH transmission.*

|  |
| --- |
| **From 38.213**If a random access procedure is initiated by a PDCCH order, the UE, if requested by higher layers, transmits a PRACH in the selected PRACH occasion, as described in [11, TS 38.321], for which a time between the last symbol of the PDCCH order reception and the first symbol of the PRACH transmission is larger than or equal to $N\_{T,2}+ ∆\_{BWPSwitching}+∆\_{Delay}+T\_{switch}$ msec, where - $N\_{T,2}$ is a time duration of $N\_{2}$ symbols corresponding to a PUSCH preparation time for UE processing capability 1 [6, TS 38.214] assuming $μ$ corresponds to the smallest SCS configuration between the SCS configuration of the PDCCH order and the SCS configuration of the corresponding PRACH transmission - $∆\_{BWPSwitching}=0$ if the active UL BWP does not change and $∆\_{BWPSwitching}$ is defined in [10, TS 38.133] otherwise - $∆\_{Delay}=0.5$ msec for FR1 and $∆\_{Delay}=0.25$ msec for FR2- $T\_{switch}$ is a switching gap duration as defined in [6, TS 38.214] For a PRACH transmission using 1.25 kHz or 5 kHz SCS, the UE determines $N\_{2}$ assuming SCS configuration $μ=0$. |

**Issue 1-2-2-2: Basic assumption on DL synchronization before transmitting RACH**

* Proposals
	+ Option 1 (CATT, Apple): T/F fine tracking is necessary for UE to meet Te requirements for PDCCH ordered RACH before cell switch command.
	+ Option 2 (MTK, xiaomi, Huawei): RAN4 to reuse the existing condition to meet the Te requirement for PDCCH ordered RACH transmission for candidate cell(s), i.e., at least one SSB is available at the UE during the last 160ms.
* Recommended WF
	+ RAN4 to reuse the existing condition to meet the Te requirement for PDCCH ordered RACH transmission for candidate cell(s), i.e., at least one SSB is available (for T/F tracking) at the UE during the last 160ms, before transmitting msg1.

**Discussion:**

E///: clarification is needed on the recommended WF

MTK: it impacts on how the existing Te requirement can apply.

QCOM: availability of SSB can be subject to interruption and/or measurement gap

**Agreement:**

* + RAN4 to reuse the existing condition to meet the Te requirement in section 7.1.2 in TS38.133 for PDCCH ordered RACH transmission for candidate cell(s), i.e., at least one SSB is available (for T/F tracking)
		- at the UE during the last 160ms before msg1 is transmitted, and
		- FFS:
			* after the random access is initiated by PDCCH order or other IE
			* other side condition

**Delay requirements for PDCCH ordered RACH before cell switch command**

*From all the submitted papers, moderator thinks the whole discussion can be divided into the following 4 sub-issues.*

*For information:*

|  |
| --- |
| **From R1-1805801 (Final\_Minutes\_report\_RAN1#92b\_v100)**Agreements:Modify the previous agreement with following updates:* For PDCCH ordered CFRA, the minimum timing gap between PDCCH order reception and Msg1 transmission is
	+ N2+ΔBWPSwitching+ ΔDelay,
		- If BWP switching is not required, ΔBWPSwitching=0; otherwise, ΔBWPSwitching is up to RAN4
		- N2 refers to the UE processing time value determined in the HARQ/scheduling session with front loaded plus additional DMRS and UE capability #1
		- N2 is dependent on the SCS of Msg1
			* Working assumption: For Msg1 with 1.25 kHz or 5 kHz SCS, calculation of N2 uses 15 kHz SCS.
		- ΔDelay includes at least MAC layer delay in initializing PRACH
			* ~~Value of Δ~~~~Delay~~ ~~is FFS (to be decided in RAN1)~~ ΔDelay = 250 us for FR2, ΔDelay = 500 us for FR1
 |

**Issue 1-2-2-3: Whether additional time for DL synchronization is needed in the delay requirements for PDCCH ordered RACH before cell switch command**

*The majority propose to add additional time for DL synchronization in some cases. In moderator’s view, RACH transmission on neighbour cell before cell switch is not urgent. For simplicity, moderator recommends agree on “additional time for DL synchronization should be added if target candidate cell is not a current active serving cell.”.*

* Proposals
	+ Option 1 (CATT, CMCC, MTK, xiaomi): Additional time for DL synchronization should be added in the legacy delay requirements specified for PDCCH ordered RACH transmission on serving cell in RAN1 for PDCCH ordered RACH transmission to neighbour cell,
		- CATT: The corresponding value is TΔ + Tmargin, where Tmargin = 2ms and TΔ should be determined in RAN4 after obtaining more details on scenarios for L1-RSRP measurement with gap and without gap.
	+ Option 2 (Apple, vivo, Ericsson): Additional time for DL synchronization should be added in some cases
		- Option 2a (Apple): additional latency is needed for fine time tracking if target candidate cell that is not a current serving cell.
		- Option 2b (vivo, Ericsson): If UE has not performed DL sync on the candidate cell before the PDCCH order triggering RACH on candidate cell, additional time for DL synchronization should be added.
	+ Option 3 (Huawei): How to guarantee PRACH transmission fulfil Te needs more discussion: additional uncertainty delay is added during the duration from reception of DCI command for PDCCH order to transmission PRACH, or SSB is required to be available within a 160ms window before PDCCH order.
* Recommended WF
	+ For PDCCH ordered RACH transmission to neighbour cell, additional time for DL synchronization should be added in the legacy delay requirements specified for PDCCH ordered RACH transmission on serving cell in RAN1 if target candidate cell is not current active serving cell.

**Discussion:**

MTK; fine with option 2a.

E///: take 2b as baseline and add additional side conditions

Nokia: take 2b as baseline

QCOM: for 2a, it should be limited to activated SCell or known deactivated SCell

CMCC: we can support to consider 2a and/or 2b

Huawei: support 2a and what QCOM just mentioned.

Vivo:2a and 2b are not mutually exclusive but it may depend on UE capability

**Agreement:**

* + - On top of specified delay requirement in RAN1 as below,
			* *For PDCCH ordered CFRA, the minimum timing gap between PDCCH order reception and Msg1 transmission is*
				+ *N2+ΔBWPSwitching+ ΔDelay,*

additional latency may or may not be introduced subject to the following conditions

* + - * additional latency is not needed for fine time tracking if target candidate cell that is a current active serving cell or [known deactivated serving cell.]
			* If UE has not performed T/F tracking on the candidate cell before the PDCCH order triggered RACH occasion on candidate cell in the past 160ms, additional time for DL synchronization should be added.
				+ The defintion of ”perform T/F tracking” is FFS
			* If additional latency is needed, the exact value is TBD

**Issue 1-2-2-4: Time for RF re-tuning and the value**

* Proposals
	+ Option 1 (QC, CATT, MTK, Apple, [Huawei], vivo): RF re-tuning time is needed.
		- Option 1a (QC): FFS on the detailed values and granularity of the capability.
		- Option 1b (MTK): If RO of the target cell is not in the active UL BWP, RF retuning time is needed. Reuse the legacy value, i.e., 0.5ms for FR1 and 0.25ms for FR2.
* Recommended WF
	+ For PDCCH ordered RACH transmission to neighbour cell, RF re-tuning time is needed in the delay requirements
		- FFS: the detailed values.

**Discussion:**

**Agreement:**

**Issue 1-2-2-5: Time for baseband preparation time**

* Proposals
	+ Option 1 (CATT, MTK, Apple, xiaomi): Baseband preparation time is needed.
* Recommended WF
	+ For PDCCH ordered RACH transmission to neighbour cell, baseband preparation time is needed in the delay requirements
		- FFS: the detailed values.

**Discussion:**

**Agreement:**

**Issue 1-2-2-6: Whether to update the legacy components in the legacy delay requirements specified for PDCCH ordered RACH transmission on serving cell in RAN1**

* Proposals
	+ Option 1 (Huawei, vivo): keep the legacy components unchanged.
	+ Option 2 (MTK, Apple, xiaomi): BWP switching delay ( $∆\_{BWPSwitching}$) is not needed.
* Recommended WF
	+ Need more discussion.

**Discussion:**

**Agreement:**

## Sub-topic 2-5 Inter-frequency L1-RSRP measurement delay

**Issue 2-5-1-1: Type of inter-frequency L1-RSRP measurement to support**

*The proposals are not exclusive.*

* Proposals
	+ Proposal 1 (CAT, CTC, CMCC, MTK, Apple, xiaomi, Huawei, OPPO, Ericsson):
		- Define the requirement for inter-frequency L1-RSRP measurement with type 1 MG as a baseline.
	+ Proposal 2 (CAT, CTC, CMCC, MTK, Apple, Huawei, OPPO):
		- Consider Inter-frequency without gap (target SSB within DL active BWP) with UE capability.
	+ Proposal 3 (CATT, CMCC, MTK, xiaomi, Huawei):
		- Support inter-frequency L1-RSRP measurement with Type-2 MG in R18 LTM.
	+ Proposal 4 (Ericsson): FFS whether to support type 2 MG.
	+ Proposal 5 (CATT, CTC, Huawei): L1 inter-frequency with NCSG can be postponed.
	+ Proposal 6 (CTC, Huawei): L1 inter-frequency with NeedforGap can be postponed.
	+ Proposal 7 (vivo): For existing L1 measurement, NOT to define inter-frequency L1 measurement requirements. For new Type of L1 measurement if agreed in other WGs, inter-frequency requirements are specified for both the within gap case and outside gap case, and the legacy L3 measurement behaviour is re-used.
	+ Proposal 8 (Nokia): Inter-frequency L1-RSRP measurements with gap and without gap are defined after intra-frequency requirements
* Recommended WF
	+ Recommend agree on:
		- Define the requirement for inter-frequency L1-RSRP measurement with type 1 MG as a baseline.
		- Consider Inter-frequency without gap (target SSB within DL active BWP) with UE capability.
			* FFS: The details of the capability
		- Not consider L1 inter-frequency with NCSG in R18 LTM.
		- Not consider L1 inter-frequency with NeedforGap in R18 LTM.
		- FFS: whether to support type 2 MG in R18 LTM.

**Discussion:**

**Agreement:**

## Sub-topic 3-3 Detail of cell swith delay requirements for Pcell/PSCell

**Issue 3-3-3-2: Whether to define RACH-less cell switch delay requirements for unknown cell**

*Background: According to the discussion in last meeting, the majority prefer not to define RACH-based cell switch delay requirements for unknown cell case. Moderator suggests going to option 1.*

* Proposals
	+ Option 1 (CATT, MTK, vivo): Not define RACH-less cell switch delay requirements for unknown cell case.
* Recommended WF
	+ Not define RACH-less cell switch delay requirements for unknown cell case.

**Discussion:**

**Agreement:**

**Issue 3-3-3-1: Whether to define RACH-based cell switch delay requirements for unknown cell**

*Background: According to the discussion in last meeting, the majority prefer not to define RACH-based cell switch delay requirements for unknown cell case. Moderator suggests going to option 1.*

* Proposals
	+ Option 1 (CATT, MTK, vivo): Not define RACH-based cell switch delay requirements for unknown cell case.
* Recommended WF
	+ Not define RACH-based cell switch delay requirements for unknown cell case.

**Discussion:**

**Agreement:**

# Topic #2: Improvement on SCell/SCG setup delay

## Sub-topic 2-2 solutions based on existing measurement

**Issue 2-2-3: definition of ‘valid’ in solution based on existing measurement**

* Agreements in RAN4#106-bis-e:
	+ Candidate criteria for measurements validity definition
		- A) the measurement are performed within the last [X] seconds before it is reported
		- B) the reported measurement results satisfy measurement accuracy
		- C) variation of serving cell RSRP/RSRQ does not exceed [Y] dB
	+ FFS whether a single or several criteria should be used for measurements validity definition.
* Candidate solutions:
	+ Option A) the measurement are performed within the last [X] seconds before it is reported
		- Support: MTK, Apple, vivo, LG (A+B), ZTE (A+B or A+C), Xiaomi (A+C), HW, E/// (A+B)
		- Object: QC, Nokia
		- Others:
			* Further discuss whether to consider multiple [X] per UE mobility speed (CATT)
	+ Option B) the reported measurement results satisfy measurement accuracy
		- Support: CATT, LG (A+B), ZTE (A+B), E/// (A+B), QC, Nokia
		- Object: Apple
		- Others:
	+ Option C) variation of serving cell RSRP/RSRQ does not exceed [Y] dB
		- Support: vivo, LG, ZTE (A+C), Xiaomi (A+C)
		- Object: Apple, QC
		- Others:
			* How does the UE evaluate the variation should be further discussed (CATT)
			* FFS (Nokia)
* Recommended WF
	+ Continue discussion.

**Discussion:**

Nokia: we don’t think criterion A is valid. Support B

QCOM: Not support A. window X in A cannot guarantee B.

E///: timing window is important in A although 5s may not be suitable and can be visited

OPPO: agree with E///. A+B is good.

Nokia: the timing and accuracy may not be dependent all the time.

Huawei: support A. B is more test related. The cadence of serving cell and EMR measurement can be very different in C.

**Agreement:**

**Issue 2-2-5: indication of availability for UE configured with EMR**

* Candidate solutions:
	+ Option 1: it is necessary to introduce availability. (vivo, CATT?)
	+ Option 2: reuse existing idleMeasAvailable-r16 for UE configured with EMR. (Apple)
	+ Option 3: unnecessary (QC)
* Recommended WF
	+ Continue discussion.

**Discussion:**

**Agreement:**

**Issue 2-2-6: indication of validity for UE configured with EMR**

* Candidate solutions:
	+ Option 1: it is necessary to introduce validity. (vivo, CATT?)
	+ Option 1a: the validity information can be added in the existing EMR reporting structure. (Apple, ZTE, Xiaomi, E///)
	+ Option 2: unnecessary. (MTK, HW, OPPO, QC)
* Recommended WF
	+ Continue discussion.

**Discussion:**

**Agreement:**

**Issue 2-2-7: indication of availability for UE NOT capable/configured with EMR**

* Candidate solutions:
	+ Option 1: Regarding availability, whether a similar indication as ‘idleMeasAvailable-r16’ is necessary can be up to RAN2. (Apple)
	+ Option 2: introduce availability information. (vivo)
	+ Option 3: unnecessary (QC)
* Recommended WF
	+ Continue discussion.

**Discussion:**

**Agreement:**

**Issue 2-2-8: indication of validity for UE NOT capable/configured with EMR**

* Candidate solutions:
	+ Option 1: how/when to report the result and the validity information can be up to RAN2. (Apple)
	+ Option 2: unnecessary. (MTK, HW, OPPO, QC)
	+ Option 3: UE reports the indication of valid cell reselection measurement results in *RRCResumeComplete* message or *UEInformationResponse* message. (Xiaomi)
* Recommended WF
	+ Continue discussion.

**Discussion:**

**Agreement:**

## Sub-topic 2-3 solutions based on enhanced measurement

**Issue 2-3-5: starting point of the enhanced measurement**

* Candidate solutions:
	+ Option 1: (Apple, vivo, ZTE)
		- For MT originating call, UE starts to perform additional measurement after paging reception.
		- for MO call, UE starts to perform additional measurement after first RACH preamble transmission, i.e. Msg1.
	+ Option 2: RAN4 can consider defining unified delay requirement for both MT and MO call, starting from after Msg1 transmission. (QC)
	+ Option 3: Validation of available IDLE/INACTIVE mode measurements may start at RRC connection setup/resume. (Nokia)
* Recommended WF
	+ Continue discussion.

**Discussion:**

**Agreement:**

**Issue 2-3-6: ending point of the enhanced measurement**

* Candidate solutions:
	+ Option 1: When UE sends RRCResumeComplete or SecurityModeComplete (CMCC, vivo, Apple)
	+ Option 2: no later than MO configuration (Apple, ZTE, E///)
	+ Option 3: RAN4 shall define measurement delay requirement instead of defining measurement ending point. (QC)
	+ Option 3a: No need to define an explicit ending point for validation measurements. Enhanced measurements end when the UE has finished the measurements and reported the results. This may be before or after the CONNECTED mode measurement configuration. (Nokia)
* Recommended WF
	+ Continue discussion.

**Discussion:**

**Agreement:**

**Issue 2-3-7: UE measurement behavior after receiving MO configuration in connected mode**

* Candidate solutions:
	+ Option 1: requirements of existing measurement in connected mode shall not be impacted by enhanced measurement. UE is not expected to support parallel measurement of enhanced measurement and legacy connected mode measurement. (Apple)
	+ Option 2: NW expect the UE continues performing measurement even after RRC CONNECTED, if NW provide explicit measurement information for enhanced measurement, NW configure MO at RRC CONNECTED state for the same target frequency that UE is performing from RRC IDLE/INACTIVE. (QC)
* Recommended WF
	+ Continue discussion.

**Discussion:**

**Agreement:**

**Issue 2-3-10: number of samples, including whether Rx beam sweeping is needed**

* Candidate solutions:
	+ Option 1: To guarantee the measurement accuracy, the measurement samples are not supposed to be reduced. Not to reduce the scaling factor of Rx beam sweeping during the RRC connection setup/resume procedure. (Apple, HW)
	+ Option 1a: As baseline, RAN4 shall not reduce the scaling factor of Rx beam sweeping when defining requirements for the new measurement during RRC connection setup/resume. (Xiaomi, QC)
	+ Option 2: For the case that the carrier for mobility is in the same band with the carriers for improved measurement, the beam information from cell reselection measurement can be utilized to reduce the Rx beam sweeping factor in improved measurement. For other cases, to introduce UE capability for lower Rx beam sweeping factor like Rel-17 positioning. (vivo)
	+ Option 3: During the additional measurement, for the further validity check, reduced samples and (or) reduced beam sweeping factors can be considered for the results obtained within the last [Y] seconds. Reduced samples or reduced beam sweeping factors may not be considered for results obtained more than [Y] seconds ago. Also, for the results obtained within the last [X] (Y>X) seconds, it can be treated as valid results without additional measurements. (LG)
	+ Option 4: During re-evaluation/validation measurements, UE is not expected to perform full beam-sweeping and hence, the scaling factor associated with the beam sweeping can be reduced. (Nokia)
* Recommended WF
	+ Continue discussion.

**Discussion:**

**Agreement:**

**Issue 2-3-12: measurement period**

* Candidate solutions:
	+ Option 1: RAN4 consider SSB period for the enhanced measurement. The measurement period requirements can be defined as (8 + [X]) TSSB ms. (QC)
	+ Option 2: Enhanced measurement period can be based on SSB period instead of SMTC. (Nokia)
* Recommended WF
	+ Continue discussion.

**Discussion:**

**Agreement:**