3GPP TSG-RAN WG4 Meeting #111 R4-2410260

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**Agenda item:** 10.6.3

**Source:** Apple

**Title:** Way Forward for [111][228] NR\_RRM\_Ph5

**Document for:** Approval

# Topic #2: FR2-1 SSB based L3 measurement delay reduction for connected mode (10.6.2)

### Sub-topic 2-1 FR2-1 L3 measurement delay by optimizing Rx beam sweeping factor

**Abbreviation:**

* + BSF: beam sweeping factor
	+ FBS: fast beam sweeping

#### Issue 2-1-1: Applicability requirement of L3 measurement delay reduction by optimizing Rx BSF

**Applicability requirement:**

Agreement:

Baseline: L3 delay enhancements in Rel-19 by optimizing Rx BSF for UE supporting multi-rx simultaneous reception are applicable provided that:

* the target carrier(s) to be measured: only one carrier in the single FR2-1 band is configured for L3 SSB measurement and
* UE serving carrier(s): UE is configured with single carrier on FR2-1 band, i.e. FR2-1 PCell without CA/DC.

Note: The ‘other UE CA/DC modes (e.g., 1 or 2 FR2-1 bands CA, or FR1+FR2 CA/DC, or EN-DC)’ and/or the ‘other number of target to-be-measured carrier(s) on FR2-1 band’ can be FFS after concluding the baseline above. These extra FFS parts will NOT delay the WI completion.

**UE Power class:**

FFS the following options and moderator option:

* Option 1 (Apple, OPPO, LGE, vivo, HW, Samsung):
	+ RAN4 to consider UE supporting FR2-1 power class 3 as first priority.
	+ Option 1a (LGE):
		- but RAN4 should consider if other power classes could apply the outcome of the WI discussion
* Option 2 (CATT):
	+ It is proposed not to restrict the number of configured carriers and applied power class.
* Option 3 (Ericsson):
	+ We can have generic requirements for all power classes, maybe PC6 can be precluded, if no specific use cases for some power classes are pursued.
* Option 4 (Moderator)
	+ Baseline: RAN4 to consider UE supporting FR2-1 power class 3 as first priority.
	+ Note: whether other power classes could apply the outcome of the WI discussion can be FFS after concluding on PC3. These extra FFS parts will NOT delay the WI completion.

**Other clarification on WID:**

* FFS:
	+ “For UE supporting multiple-Rx simultaneous reception for L3 delay enhancement” means UE supporting “simultaneous reception of multiple SSBs from different directions of the same target frequency layer inside a SMTC window. But it does not mean “UE can process multiple SSBs from different directions of the target frequency in parallel.”

#### Issue 2-1-2: Conditions to apply L3 measurement delay reduction by optimizing Rx BSF

[Moderator note]: The condition here means in which case/condition/use-case/mode UE can apply the L3 measurement delay reduction by optimizing Rx BSF.

**Conditions for UE to apply L3 measurement delay reduction by optimizing Rx BSF:**

* + FFS: multi-Rx simultaneous reception of UE is in active mode, which is expected to follow the one specified in Rel-18 for multi-Rx simultaneous reception feature
		- Option 1 (Apple, CATT, ZTE, vivo, CTC, Intel): multi-Rx simultaneous reception of UE is in active mode, which is expected to follow the one specified in Rel-18 for multi-Rx simultaneous reception feature.
			* Option 1a (ZTE): The UE is in multi-Rx operation if following condition is met: UE is configured with group-based beam reporting (GBBR) report
			* Option 1b (Intel): The UE is considered activated in multi-Rx simultaneous reception mode when the UE is configured with group-based beam reporting. The UE is considered activated for L3 reporting when the GBBR is configured not long prior to the expected L3 reporting.
		- Option 2 (LGE): The L3 measurement delay enhancement requirements for UE supporting multi-Rx simultaneous reception can apply if multiple panels are activate and SSBs in a SMTC window can be measured with multiple beams.
		- Option 3 (CMCC): the conditions for UE to apply L3 measurement delay reduction by optimizing Rx BSF is that multi-Rx simultaneous reception of UE is in active mode, as for whether the condition is same as that for Rel-18 multi-Rx simultaneous reception can be further discussed.
		- Option 4 (HW, Nokia, Ericsson): Do not reuse the same applicable conditions specified in Rel-18 multi-Rx
	+ Option 4a (QC) : R19 Rx BSF is independent to R18 multi-Rx simultaneous reception feature includes conditions and requirement.
		- Option 5 (MTK): The conditions in R18 multi-Rx WI do not limit the discussion on having further conditions in R19 for UE supporting multi-Rx to enhance FR2-1 SSB based L3 measurement delay
	+ FFS: UE’s mobility status, e.g., whether HST is precluded or not
		- Option 1 (Apple, ZTE(preclude HST), vivo, CTC, Samsung(preclude HST)): low mobility status, i.e., preclude HST
		- Option 2 (CATT, CMCC): enhanced BSF can also be used for HST
		- Option 3 (Ericsson): no scenario restriction (e.g., low mobility) is needed
		- Option 4 (MTK): For UE with high mobility
	+ FFS: RRM measurement with two panels activated, two searchers are occupied by this single carrier
		- Option 1 (Apple): the legacy searcher assumption and legacy CSSF shall still be applied for L3 RRM measurement with two panels activated
		- Option 1a (Ericsson):
			* The WI shall prioritize the use case of the same receiver for search and measurement processing on one carrier simultaneously received from multiple panels, e.g. a single searcher receives and processes the same carrier on multiple panels.
		- Option 2 (vivo, HW): RRM measurement with two panels activated, two searchers are occupied by this single carrier
	+ FFS: SSB processing delay/time for processing multiple beams received in a SMTC
		- Option 1 (vivo, QC, Intel, Apple): needs SSB processing delay/time for processing multiple beams received in a SMTC
	+ FFS: Power consumption issue
		- Option1 (Apple): considering power consumption, BSF reduction of L3 measurement will not trigger UE to activate multi-Rx.
		- Option 2 (LGE): For power consumption of multi-Rx operation, Rel-18 UAI ‘multiRx-PreferenceFR2’ for power saving can be considered as starting point.
		- Option 3 (Ericsson): To avoid unnecessary power consumption and computation load, enabling/disabling the parallel L3 measurement on multiple panels (if it is one of solutions addressing L3 measurement delay) may be determined by at the least one of the below options:
* Option 3-1: NW indicates UE enabling parallel L3 measurement on multiple panels for serving L3 measurement delay reduction through L3 or lower layers signalings.
* Option 3-2: UE determines to apply parallel L3 measurement on multiple panels for serving L3 measurement delay reduction, and enable it after acknowledged by NW.
* Option 3-3: UE determines to apply parallel L3 measurement on multiple panels for serving L3 measurement delay reduction if a condition is fulfilled, e.g., at cell edge. NW may be aware of it by sending a ‘allowance’ signalling or not aware of it.
	+ - Option 4 (Nokia): Discuss FBS triggering conditions among the following options:
			* Option 4-1: Network configuration of FBS (similar as option 3-1)
			* Option 4-2: Mobility Event triggering FBS
			* Option 4-3: Conditional Handover configuration
	+ FFS: UE has prior knowledge on the cell to be measured
		- Option 1 (CATT): on top of the UE capability of supporting Multi-Rx, no additional conditions of prior knowledge for target cell is needed
		- Option 2 (vivo, CTC, MTK): UE needs prior knowledge on the cell to be measured
			* Option 2a (CTC): It’s proposed to consider conditions of prior knowledge on the cell to be measured and discuss whether the conditions of prior knowledge are applicable
		- Option 3 (Ericsson): UE may only measure part of spatial directions with one panel out of multiple panels. It reduces L3 measurement delay as well, upon acquiring prior knowledge on the cell to be measured, e.g.,
			* The UE has measured the cell before in a time period.
			* The UE has knowledge on the absolute/relative location of the cell to be measured.
			* The UE has knowledge on its moving state (including rotation).
	+ FFS: Rel-19 L3 measurement with multi-Rx DL reception is irrelevant to multi-TRP operation deployment
		- Option 1 (vivo, Samsung): Rel-19 L3 measurement with multi-Rx DL reception is irrelevant to multi-TRP operation deployment
	+ FFS: cell-centre UE or cell-edge UE
		- Option 1 (Nokia, MTK): RAN4 to consider L3 FBS targeting cell edge scenarios
	+ FFS: DRX is configured or not (newly added issue in this meeting based on Xiaomi’s proposal)
		- Option 1 (Xiaomi): SSB based L3 measurement delay reduction with DRX shall be deprioritized
	+ FFS: Simultaneous operation between L3 and L1 measurements
		- Option 1 (ZTE): Simultaneous operation between L3 and L1 measurements by optimizing Rx BSF, simultaneous operation between L3 measurement and data reception by optimizing Rx BSF
		- Option 2 (Ericsson): Scenario where L3 measurement is reduced using reduced beam sweeping and scenario where L1 measurement is reduced using multiple-reception from multi-TRP for DL measurement/data are different scenarios and not expected to operate simultaneously.
			* L3 measurement delay reduction may be influenced by L1 measurement/data transmission scheme, wherein L1 measurement may be:
				+ Legacy requirements or,
				+ Enhanced requirements for Multi-Rx in Rel-18
			* We prefer legacy requirements between them. Once L1 measurement is chosen, we shall further check L1/L3 sharing scheme.
	+ FFS: UE is in RRC CONNECTED mode (newly added issue in this meeting based on ZTE’s proposal)
* Agreement: Only support multi-Rx L3 measurement for CONNECTED UE

[Moderator]: Option 1 is agreeable, it’s already clearly stated in WID. Will be removed in the formal version.

#### Issue 2-1-3: Scenarios to use L3 measurement delay reduction by optimizing Rx BSF

[Moderator note]: The scenarios here means which UE behavior/activity/procedure(s) would be improved with this feature or which corresponding requirements in the existing RRM spec will be enhanced to accommodate this feature.

**FFS on the justifications to decide which of the following scenarios shall be considered.**

* Encourage companies to discuss the expected benefit to considering BSF reduction for the following scenarios.
* ~~Option 1 (QC) : RAN4 needs to discuss a solution and scenarios as a package before deciding each scenario.~~
	+ ~~FFS on whether NW needs to know whether UE is operating L3 Rx BSF~~

**FFS on following scenarios to decide which ones are considered to use L3 measurement delay reduction by optimizing Rx BSF:**

* + Scenario 1: SSB based Intra-frequency measurement without MG, including TPSS/SSS\_sync\_intra and TSSB\_measurement\_period\_intra
		- Option 1(Apple, NTT DCM, CATT, Xiaomi, OPPO, LGE, CMCC, ZTE, CTC, HW, Ericsson): Yes
		- Option 1a (OPPO): For deactivated SCell and PSCell in FR2-1, the enhancement of TPSS/SSS\_sync and TSSB\_measurement\_period can also apply.
		- Option 2: No
	+ Scenario 2: SSB based Intra-frequency measurement with MG, including TPSS/SSS\_sync\_intra and TSSB\_measurement\_period\_intra
		- Option 1(Apple, NTT DCM, CATT, Xiaomi, OPPO, LGE, CMCC, ZTE, CTC, HW, Ericsson): Yes
		- Option 2: No
	+ Scenario 3: SSB based Inter-frequency measurement without MG, including TPSS/SSS\_sync\_inter, TSSB\_time\_index\_inter and TSSB\_measurement\_period\_inter
		- Option 1(Apple, NTT DCM, CATT, Xiaomi, OPPO, LGE, CMCC, ZTE, CTC, HW, Ericsson): Yes
* Option 1a (OPPO): For deactivated SCell and PSCell in FR2-1, the enhancement of TPSS/SSS\_sync and TSSB\_measurement\_period can also apply.
	+ - Option 2: No
	+ Scenario 4: SSB based Inter-frequency measurement with MG, including TPSS/SSS\_sync\_inter, TSSB\_time\_index\_inter and TSSB\_measurement\_period\_inter
		- Option 1(Apple, NTT DCM, CATT, Xiaomi, OPPO, LGE, CMCC, ZTE, CTC, HW, Ericsson): Yes
		- Option 2: No
	+ Scenario 5: Handover
		- Option 1(NTT DCM, CATT, CMCC, ZTE, CTC, Ericsson, MTK): Yes
		- Option 2(vivo): No
		- Option 3 (Apple, Xiaomi, OPPO): After RAN4 has conclusion(s) on the solution(s) of L3 measurement delay reduction for the above baseline scenarios 1/2/3/4, the solutions(s) can be extended to this scenario
	+ Scenario 6: PSCell addition
		- Option 1(NTT DCM, ZTE, MTK): Yes
		- Option 2(vivo): No
		- Option 3 (Apple, CATT, OPPO): After RAN4 has conclusion(s) on the solution(s) of L3 measurement delay reduction for the above baseline scenarios 1/2/3/4, the solutions(s) can be extended to this scenario
	+ Scenario 7: RRC Re-establishment/RRC Connection Release with Redirection
		- Option 1(NTT DCM, ZTE): Yes
		- Option 2(vivo): No
		- Option 3 (Apple, CATT, OPPO): After RAN4 has conclusion(s) on the solution(s) of L3 measurement delay reduction for the above baseline scenarios 1/2/3/4, the solutions(s) can be extended to this scenario
	+ Scenario 8: SCell activation
		- Option 1(MTK): Yes
		- Option 2(vivo): No
		- Option 3 (Apple, CATT, OPPO): After RAN4 has conclusion(s) on the solution(s) of L3 measurement delay reduction for the above baseline scenarios 1/2/3/4, the solutions(s) can be extended to this scenario
	+ Scenario 9: SCG activation
		- Option 1(ZTE, MTK): Yes
		- Option 2(vivo): No
		- Option 3 (Apple, CATT, OPPO): After RAN4 has conclusion(s) on the solution(s) of L3 measurement delay reduction for the above baseline scenarios 1/2/3/4, the solutions(s) can be extended to this scenario
	+ Scenario 10: CGI identification
		- Option 1 (NTT DCM, ZTE): Yes
		- Option 2(vivo): No
		- Option 3 (Apple, CATT, OPPO): After RAN4 has conclusion(s) on the solution(s) of L3 measurement delay reduction for the above baseline scenarios 1/2/3/4, the solutions(s) can be extended to this scenario.
	+ Scenario 11: CSI-RS based intra-/inter-frequency measurements, the CSI-RS is configured *associatedSSB*. The discussion on CSI-RS configured with associatedSSB could be revisited if SSB based L3 measurement delay reduction is concluded.
		- Option 1: Yes
		- Option 2(vivo): No
		- Option 3 (Apple, CATT, OPPO): After RAN4 has conclusion(s) on the solution(s) of L3 measurement delay reduction for the above baseline scenarios 1/2/3/4, the solutions(s) can be extended to this scenario

#### Issue 2-1-5: measurement performance requirement when apply L3 measurement delay reduction by optimizing Rx BSF

* Agreement:
	+ RAN4 is not to change existing measurement performance requirement when consider optimization of Rx BSF in L3 measurement delay reduction.
* ~~FFS:~~
	+ ~~The accuracy test requirement for Rx BSF optimization in L3 measurement delay reduction can be FFS.~~

### Sub-topic 2-2 FR2-1 L3 measurement delay by optimizing CSSF outside gap in CA/DC

#### Issue 2-2-1: Clarification on the bullets in WID for this CSSF optimization

FFS:

* Option 1 (Apple): Rel-19 CSSF optimization applies for the both cases: (1)UE is not capable of Rel-18 multi-Rx simultaneous reception, (2)UE is capable of Rel-18 multi-Rx simultaneous reception but work in single-Rx currently.
* Option 2 (ZTE): Besides the case UE is not capable of R18 multi-Rx simultaneous reception, R19 CSSF optimization is also applied to the case that UE is capable of multi-Rx but not configured with GBBR report.
* Option 3 (Ericsson): Clarify whether ‘the case UE is capable of Rel-18 multi-Rx simultaneous reception but work in single-Rx currently’.
	+ Does it indicate that the UE only can use a single panel (and subsequent receiver including baseband) out of multiple panels for reception and measurement? If so, is there any degradation of reception and measurement from measuring on a single panel?
* Option 4 (Nokia): Rel-19 discussion on the scenarios for CSSF optimization will be considered in CA/DC scenarios, independently of the UE support of multi-Rx capabilities.

#### Issue 2-2-2: UE measurement procedure to use L3 measurement delay reduction by optimizing CSSF

FFS:

* Option 1: the following scenarios in CA/DC to use L3 measurement delay reduction by optimizing CSSF shall be prioritized:
	+ SSB based Intra-frequency measurement without MG (Apple, CATT, CMCC, vivo, CTC, HW, Nokia, MTK)
		- Alt1: including TPSS/SSS\_sync\_intra and TSSB\_measurement\_period\_intra
		- Alt2: including TPSS/SSS\_sync\_intra, TSSB\_time\_index\_intra and TSSB\_measurement\_period\_intra
	+ SSB based Inter-frequency measurement without MG, (Apple, CATT, CMCC, vivo, CTC, HW, Nokia, MTK)
		- Alt1: including TPSS/SSS\_sync\_inter and TSSB\_measurement\_period\_inter
		- Alt2: including TPSS/SSS\_sync\_inter, TSSB\_time\_index\_inter and TSSB\_measurement\_period\_inter
	+ Inter-RAT SSB measurement without MG (CMCC, Ericsson)
	+ NeedForGaps measurement without MG, including both with and without interruption (Ericsson)
	+ NCSG measurement without MG without interruption (Ericsson)

#### Issue 2-2-3: Applicability requirement of L3 measurement delay reduction by optimizing CSSF

FFS:

* Option 1 (Apple, CATT, OPPO, CMCC, ZTE): RAN4 to consider following CA/DC mode for L3 measurement delay reduction by optimizing CSSFoutside\_gap,i
	+ EN-DC (Apple, CATT, OPPO, CMCC, ZTE, Ericsson):
		- Intel proposed to deprioritize EN-DC
	+ NE-DC (Apple, CATT, OPPO, CMCC, ZTE, Intel, Ericsson):
	+ SA (Apple, CATT, OPPO, CMCC, ZTE, CTC, Intel, HW):
		- FR2+FR2 CA (HW), FR1+FR2 CA (HW, Ericsson), FR2 only intra band CA (Ericsson), FR2 only inter band CA (Ericsson)
	+ NR-DC (Apple, CATT, OPPO, CMCC, ZTE, CTC, Intel)
		- FR1+FR2 NR-DC (HW, Ericsson)

#### Issue 2-2-6: measurement performance requirement when apply L3 measurement delay reduction by optimizing CSSF

* Agreement:
	+ RAN4 is not to change existing measurement performance requirement when consider optimization of CSSF in L3 measurement delay reduction.

### Sub-topic 2-3 Common aspects for L3 measurement delay reduction

*Sub-topic description:*

*Open issues and candidate options before f2f meeting:*

#### Issue 2-3-1: whether and/or which previous release feature shall also be considered in “FR2-1 SSB based L3 measurement delay reduction for connected mode”

FFS:

* Option 1 (Apple):
	+ for “FR2-1 SSB based L3 measurement delay reduction for connected mode” by optimizing Rx beam sweeping factor, R18 feature of FR2 multi-Rx reception shall be considered
	+ for “FR2-1 SSB based L3 measurement delay reduction for connected mode” by optimizing CSSF outside gap, both R16 inter-frequency measurement without MG and R18 inter-RAT measurement without MG shall be considered.
* Option 2 (LGE, QC):
	+ RAN4 not to consider SSB based L3 measurement delay enhancement with previous release features.
	+ R19 L3 measurement enhancement for both fast beam sweeping and CSSF optimization is independent to R18 multi-Rx feature. (QC)
* Option 3 (Ericsson):
	+ Only Rel-18 multi-Rx scenario should be assumed, and we should not assume that the UE is also supporting other features.