



**3GPP TSG RAN Meeting #103**

**Maastricht, Netherlands, March 18<sup>th</sup> – 22<sup>nd</sup>, 2024**

**RP-240491**

**Agenda item: 9.1.4.4**

**Source: Apple**

**Document for: Discussion**

# On RAN4 led RRM Enhancement in Rel-19

- Rel-19 RRM enhancement for NR and MR-DC is an umbrella WI for RRM enhancement, aiming to include:
  - FR2 L3/L1 measurement delay reduction: and/or CSSF enhancement
    - For Single-Rx capable UE: CSSF enhancement
    - For Multi-Rx capable UE: Rx beam sweeping number reduction and CSSF enhancement

FR2 L3/L1 measurement delay reduction

- **Enhancement for UE operating in multi-Rx simultaneous reception mode**

- L3 measurement delay reduction

- L3 measurement enhancements: intra/inter-freq. Measurement delay, scheduling restriction, support of simultaneous L1 and L3 measurements, and simultaneous L3 measurement and data/control
  - **L3 fast beam sweeping** capability based on UE implementation, similar to the L1 fast beam sweeping capability currently under discussion. Its applicability can be controlled by network for either L3 measurements in general or for L3 procedures such as handovers or PSCell addition/change.
  - **Scheduling restriction enhancement for L3 measurement** to support simultaneous L3 measurement and data/control reception

- L1 measurement delay reduction, including L1 measurements in L1-RSRP measurement, TCI switching and RLM/BFD

- **Dual TCI state switching based on R17/18 unified TCI framework**

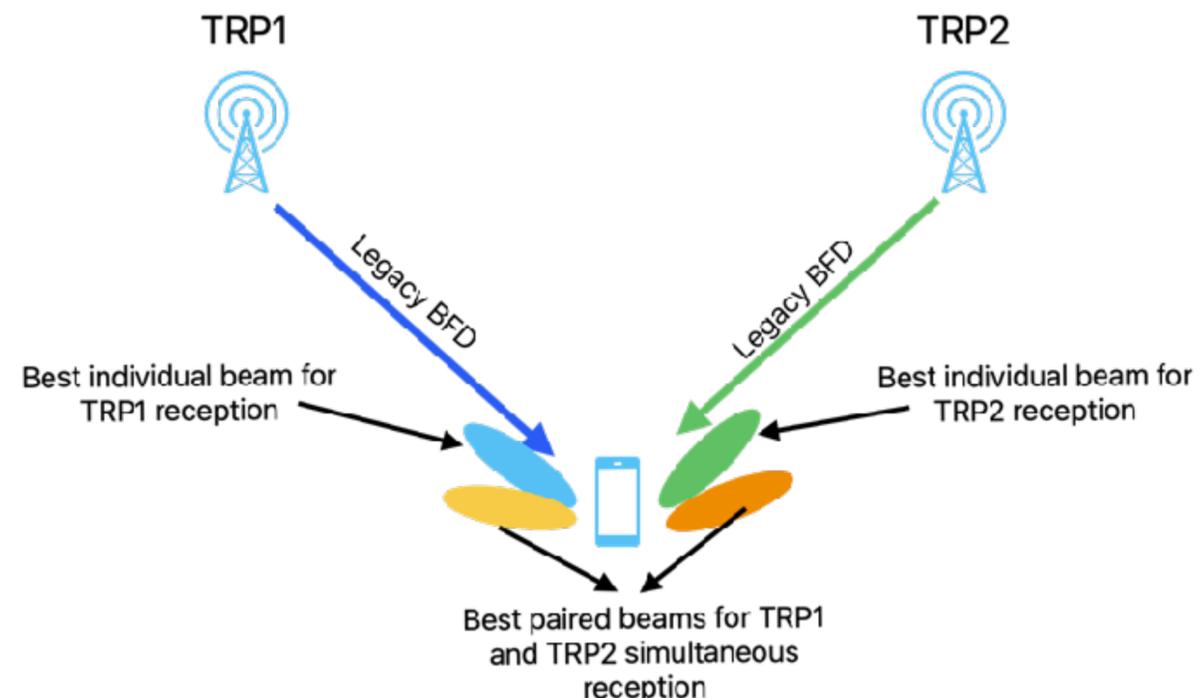
- Note that in R18, dual TCI state switching is specified based on R15/16 legacy TCI framework.

- **Parallel L1+L3 measurement without delay scaling (Kp factor in current TS38.133)**

- Study and if feasible, specify enhancement of parallel L1+L3 measurement based on UE multi-Rx capability

- **Enhancement for UE operating in multi-Rx simultaneous reception mode (cont.)**

- L1 measurement delay reduction, including L1 measurements in L1-RSRP measurement, TCI switching and RLM/BFD (cont.)
  - Paired RLM or BFD for multi-Rx capable UE in multi-TRP scenario
    - Justification:
      - Legacy RLM/BFD only can evaluate the best individual Rx beam to receive data/control from one or both TRP(s)
      - Paired RLM/BFD can evaluate the quality of paired Rx beams for data/control reception in multi-TRP scenario
    - Study and if feasible, specify RLM/BFD evaluation on a paired RSs (RS1 and RS2), and RS1 and RS2 are transmitted from different TRPs



- **Enhancement for UE operating in multi-Rx simultaneous reception mode (cont.)**

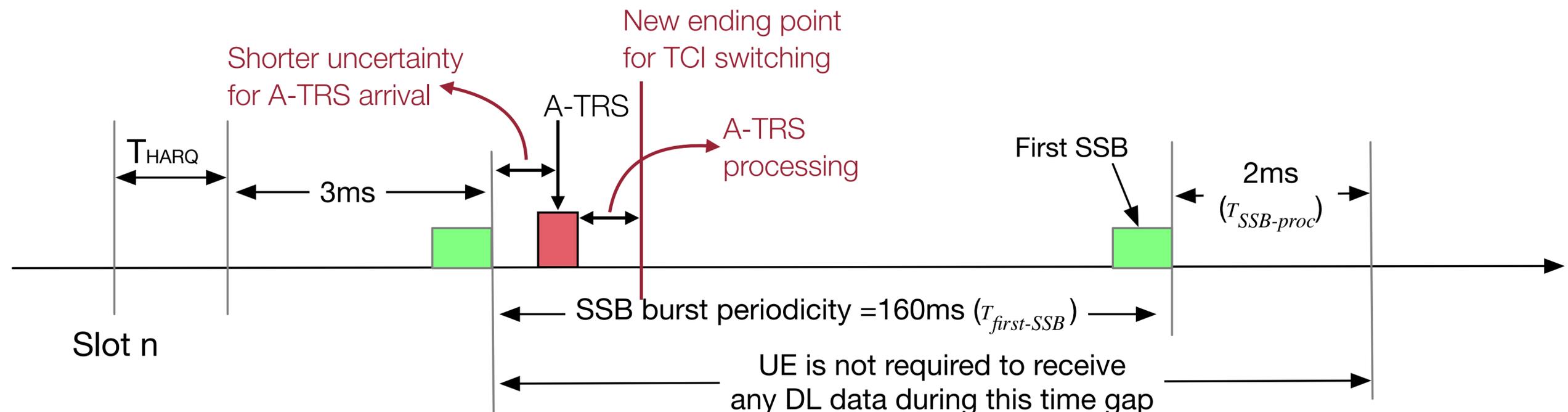
- L1 measurement delay reduction, including L1 measurements in L1-RSRP measurement, TCI switching and RLM/BFD (cont.)

- A-TRS based L1 measurement/tracking reduction for following scenarios

- HO (incl. LTM),

- TCI switching,

- Example: In legacy TCI switching requirement, there was a time gap from “slot  $n + T_{HARQ} + (3 \text{ ms}) / \text{NR slot length}$ ” to “slot  $n + T_{HARQ} + (3 \text{ ms} + T_{OK} * (T_{\text{first-SSB}} + T_{\text{SSB-proc}})) / \text{NR slot length}$ ”. Since UE is not required to receive DL data during this time gap, it will probably impact the throughput performance in case the first SSB arrives 160ms later (analyzed in R4-2006616).



## ■ Enhancement for UE operating in multi-Rx simultaneous reception mode (cont.)

- L1 measurement delay reduction, including L1 measurements in L1-RSRP measurement, TCI switching and RLM/BFD (cont.)
  - A-TRS based L1 measurement/tracking reduction for following scenarios (cont.)
    - SCell activation,
    - PSCell addition/change,
    - SCG activation

### 8.9.2 PSCell Addition Delay Requirement

The requirements in this clause shall apply for the UE configured with only PCell in FR1.

Upon receiving PSCell addition in subframe  $n$ , the UE shall be capable to transmit PRACH preamble towards PSCell in FR1 or FR2 no later than in subframe  $n + T_{\text{config\_PSCell}}$ . Upon receiving PSCell addition in subframe  $n$ , the UE shall be capable to transmit PRACH preamble towards PSCell in FR2 no later than in slot  $n + \frac{T_{\text{config\_PSCell}}}{NR \text{ slot length}}$ .

where:

$$T_{\text{config\_PSCell}} = T_{\text{RRC\_delay}} + T_{\text{processing}} + T_{\text{search}} + T_{\Delta} + T_{\text{PSCell\_DU}} + 2 \text{ ms}$$

$T_{\text{RRC\_delay}}$  is the RRC procedure delay as specified in TS 38.331 [2].

$T_{\text{processing}}$  is the SW processing time needed by UE, including RF warm up period.  $T_{\text{processing}} = 20\text{ms}$  when target cell is in FR1 and  $T_{\text{processing}} = 40 \text{ ms}$  when target cell is in FR2.

$T_{\text{search}}$  is the time for AGC settling and PSS/SSS detection. If the target cell is known,  $T_{\text{search}} = 0 \text{ ms}$ . If the target cell is unknown and the target cell  $\hat{E}_s/I_{ot} \geq -2\text{dB}$ ,  $T_{\text{search}} = 3 * N * T_{\text{Trs}} \text{ ms}$ .  $N = 1$  when target cell is in FR1,  $N = 8$  when the target cell is in FR2-1, and  $N = 12$  when the target cell is in FR2-2

$T_{\Delta}$  is time for fine time tracking and acquiring full timing information of the target cell.  $T_{\Delta} = 1 * T_{\text{Trs}} \text{ ms}$  for a known or unknown PSCell.

In PSCell addition the Trs based L1 T/F tracking delay can be reduced by using A-TRS



- **Enhancement for UE operating in single-Rx or multi-Rx reception mode**

- CSSF enhancement:

- With larger number of serving CCs in FR2, it would result into FR2 with huge long measurement/detection delay to degrade mobility performance based on CSSF factor without MG.

**Table 9.2.5.1-13: Time period for PSS/SSS detection, deactivated PSCell (FR2)**

DRX cycle	$T_{PSS/SSS\_sync\_intra}$
No DRX	$\text{Ceil}(M_{pss/sss\_sync\_w/o\_gaps} \times K_p) \times \text{measCyclePSCell} \times \text{CSSF}_{intra}$
DRX cycle $\leq$ 320ms	$\text{Ceil}(M_{pss/sss\_sync\_w/o\_gaps} \times K_p) \times \max(\text{measCyclePSCell}, 1.5 \times \text{DRX cycle}) \times \text{CSSF}_{intra}$
DRX cycle $>$ 320ms	$\text{Ceil}(M_{pss/sss\_sync\_w/o\_gaps} \times K_p) \times \max(\text{measCyclePSCell}, \text{DRX cycle}) \times \text{CSSF}_{intra}$

### 3.6.2.1 Number of serving carriers for SA

Requirements for standalone NR with NR PCell are applicable for the UE configured with the following number of serving NR CCs:

- up to 16 NR DL CCs in total, with 1 UL (or 2 UL if SUL is configured) in PCell and up to 8 UL (or 9 UL if SUL is configured) in total for SCells.
- SUL may be configured together with one of the UL

For instance,

CSSF = 15 if 16 CCs are configured as CA (15 SCC share one searcher), and SCell measurement delay:  $15 \times 5 = 75$  SMTC period (Kp=1 for simplicity)

- SMTC periodicity = 160ms, the total measurement delay can be up to 12000ms

- For FR2, the measurement delay is defined as  $\max(600\text{ms}, \text{ceil}(M_{pss/sss\_sync\_w/o\_gaps} \times K_{FR} \times K_p \times K_{layer1\_measurement}) \times \text{SMTC}_{period}) \times \text{CSSF}_{intra}$ , without DRX. In the field, such delay can be easily exceeding 1000ms.

- R19 enhancement:

- Study and if feasible, specify CSSF reduction for L3 measurement on FR2 frequency layers



