3GPP TSG-RAN WG4 Meeting # 109
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Apple's view on R19 RAN4 enhancement

Rel-19 RRM enh-4 | NR RRM enhancement WI for R19

- Rel-19 RRM enhancement for NR and MR-DC is an umbrella WI for RRM enhancement, aiming to include:
  - Leftover RRM related topics/issues from Rel-18 and earlier release:
    - Further SCell activation and PSCell addition/change/activation enhancement based on R18 enhancement solutions
    - Requirement for SRS antenna port switching with full-slot SRS
    - HO with PSCell for new scenarios
    - Parallel measurement with NCSG
  - All newly identified RRM enhancement during Rel-18
    - FR2 RRM requirements delay reduction enhancements
    - A-TRS based RRM enhancements
    - Dynamic RTD/TTD status update
    - Other miscellaneous RRM features that are not in any other dedicated Rel-19 WI

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Rel-19 RRM enh-4 | Further SCell activation and PSCell addition/change/activation enhancement

- **Further SCell activation and PSCell addition/change/activation enhancement based on R18 enhancement solutions**
  - Background: in R18, the unknown SCell activation enhancements only focus on limited scenarios, but the similar solution can actually apply for other scenarios
  - The new scenarios for enhancement as illustrated below,

R18 enhancement for FR2 unknown SCell activation, including:
- Enh 1: Report of L3 measurement during activation,
- Enh 2: Beam sweeping factor reduction;
- Enh 3: Activation delay reduction by using SSB periodicity.

R19 SCell Activation enhancement, including:
- FR1 SCell activation enhancement using enh 1/3
- FR2-2 SCell activation enhancement using enh 1/2/3
- Direct SCell activation enhancement, including FR1, FR2-1 and FR2-2;

R19 PSCell addition/change enhancement, including:
- FR1 PSCell addition/change enhancement using enh 1/3；
- FR2-1 and FR2-2 PSCell addition/change enhancement using enh 1/2/3；

R19 SCG activation enhancement, including:
- FR1 SCG activation enhancement using enh 1/3；
- FR2-1 and FR2-2 SCG activation enhancement using enh 1/2/3；

Rel-19 RRM enh-4 | SRS antenna port switching with full-slot SRS

- **SRS antenna port switching with full-slot SRS**
  - Background
    - In Rel-17 FeRRM WI RRM requirements for SRS antenna port switching were introduced for SRS in last 6 symbols of slot
    - In Rel-16 RAN1 introduced feature start symbol for SRS transmission in any symbol

srs-StartAnyOFDM-Symbol-r16 Indicates whether the UE supports transmitting SRS starting in all symbols (0 to 13) of a slot. This capability is also applicable to a frequency band that does not require shared spectrum access.	Band	No	N/A	N/A

    - RRM requirements for full slot SRS transmission are not defined
  - Rel-19 Enhancement
    - Evaluate the scope of requirements for full slot SRS transmission
    - Define RRM requirements to support full slot SRS transmission

Rel-19 RRM enh-4 | HO with PSCell for new scenarios

- **HO with PSCell for new scenarios**
  - Requirement design for scenarios not covered in R17 RRM enhancement
    - from NR SA to NE-DC
    - from NR SA to NR-DC
    - from LTE SA to EN-DC

Supported in R17 FeRRM WI

Scenarios for new requirements

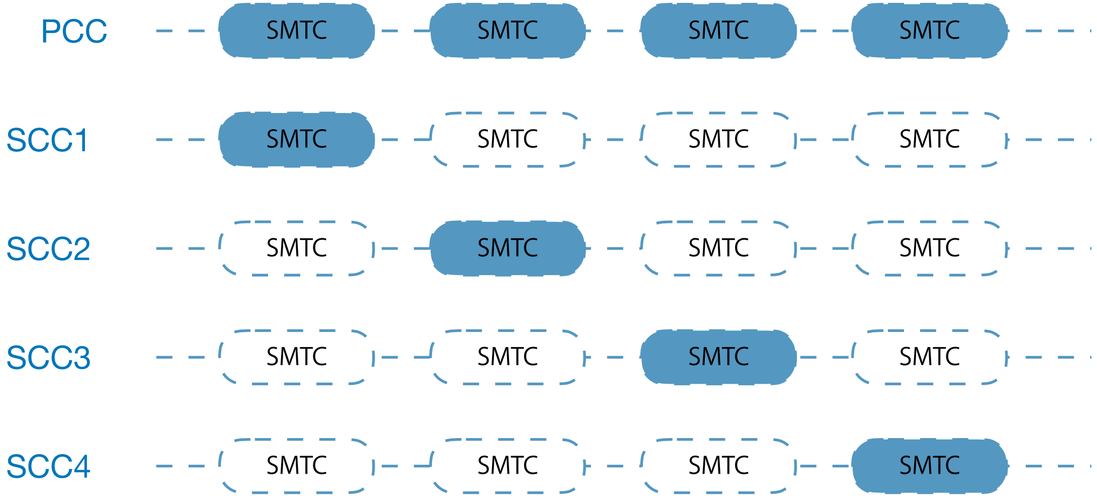
Table B-1: Supported MR-DC handover scenarios.

To (column) / HO from (row)	E-UTRA with EPC	E-UTRA with 5GC	NR	GERAN or UTRAN	EN-DC	NGEN-DC	NE-DC	NR-DC
E-UTRA with EPC	YES	YES	YES	YES	YES	NO	NO	NO
E-UTRA with 5GC	YES	YES	YES	NO	NO	YES	NO	NO
NR	YES	YES	YES	NOTE 1	YES	NO	YES	YES
GERAN or UTRAN	YES	NO	NO	YES	NO	NO	NO	NO
EN-DC	YES	YES	YES	YES	YES	NO	NO	NO
NGEN-DC	YES	YES	YES	NO	NO	YES	NO	NO
NE-DC	YES	YES	YES	NOTE 1	NO	NO	YES	NO
NR-DC	YES	YES	YES	NOTE 1	NO	NO	NO	YES

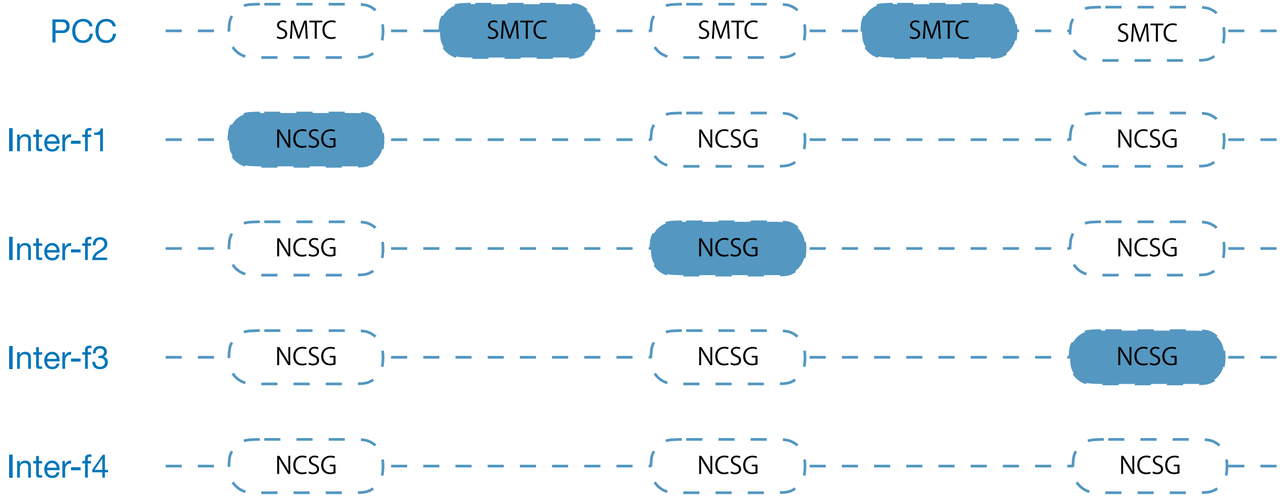
Note: Scenarios in above table are specified in TS37.340 Annex B

Rel-19 RRM enh-4 | Parallel measurement with NCSG

- **Parallel measurement with NCSG**
  - Background: existing RRM requirement is only for UE to measure one carrier within each NCSG occasion
  - R19 Enhancement:
    - RRM requirement for NCSG capable UE to support parallel measurement on at least two carriers simultaneously
    - RRM requirement for UE to support parallel measurement within legacy MG on at least two carriers simultaneously
      - Including UE which are not capable of NCSG or NFG.



In CA, UE is required to measure 2 CC in each occasion



In NCSG, UE is required to measure only one CC in NCSG

Rel-19 RRM enh-4 | FR2 RRM requirements delay reduction

- **FR2 RRM requirements delay reduction enhancements**
  - Background: With larger number of serving CCs in FR2, it would result into huge long measurement/ detection delay to degrade mobility performance based on CSSF factor without MG.

Table 9.2.5.2-1: Measurement period for intra-frequency measurements without gaps(FR1)

DRX cycle	$T_{SSB_measurement_period_intra}$
No DRX	max(200ms, ceil(5 x K_p) x SMTC period)[Note 1] x $CSSF_{intra}$
DRX cycle≤ 320ms	max(200ms, ceil(1.5x 5 x K_p) x max(SMTC period,DRX cycle)) x $CSSF_{intra}$
DRX cycle>320ms	ceil(5 x K_p) x DRX cycle x $CSSF_{intra}$
NOTE 1: If different SMTC periodicities are configured for different cells, the SMTC period in the requirement is the one used by the cell being identified	

2.1 Number of serving carriers for SA

irements for standalone NR with NR PCell are applicable for the UE configured with the following number of ng 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,

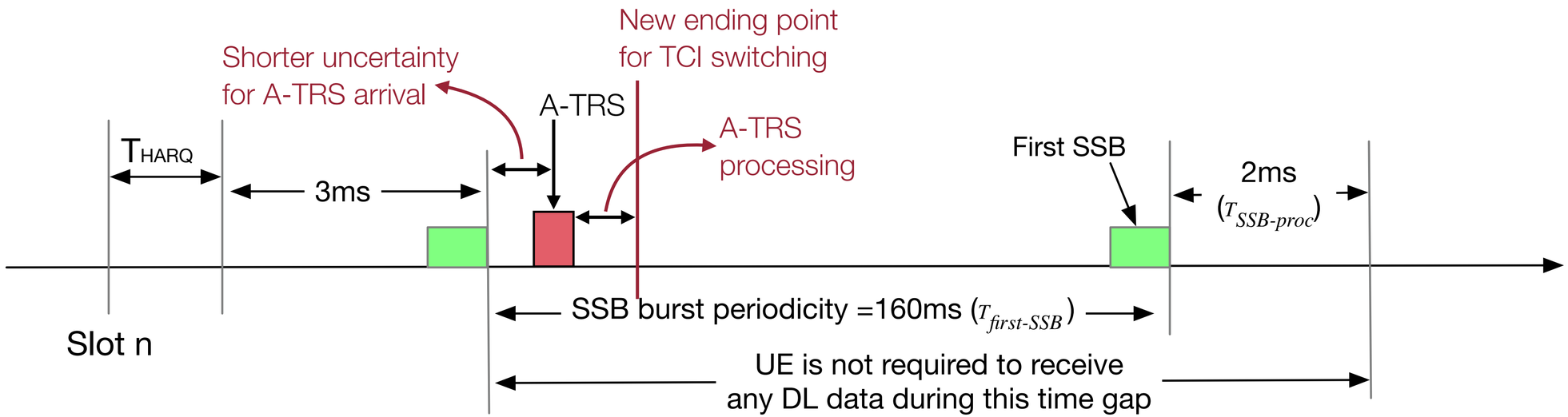
CSSF = 15 if 16 CCs are configured as CA (15 SCC share one searcher), and Scell measurement delay: 15*5=75 SMTC period (Kp=1 for simplicity)

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

  - R19 enhancement: Cell identification and measurement delay reduction in FR2 CA with large serving CC number

Rel-19 RRM enh-4 | A-TRS based RRM enhancement

- **Background:**
  - In current spec, periodical RS (e.g., SSB) is mainly used for AGC and T/F tracking during RRM procedures, e.g., HO, TCI switching, SCell activation, and PSCell addition/change.
  - RAN4 can explore a general solution of utilizing A-TRS for the enhancement to the above UE activities.
- **TCI switching enhancement (as an example)**
  - Background: In legacy TCI switching requirement, there was a time gap from "*slot n+ T_{HARQ} +(3 ms) / NR slot length*" to "*slot n+ T_{HARQ} +(3 ms +TO_k*($T_{first\text{-}SSB}$ + $T_{SSB\text{-}proc}$)) / 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).
  - R19 enhancement: enhancement to use A-TRS for TCI T/F tracking to shorten the total switching delay.



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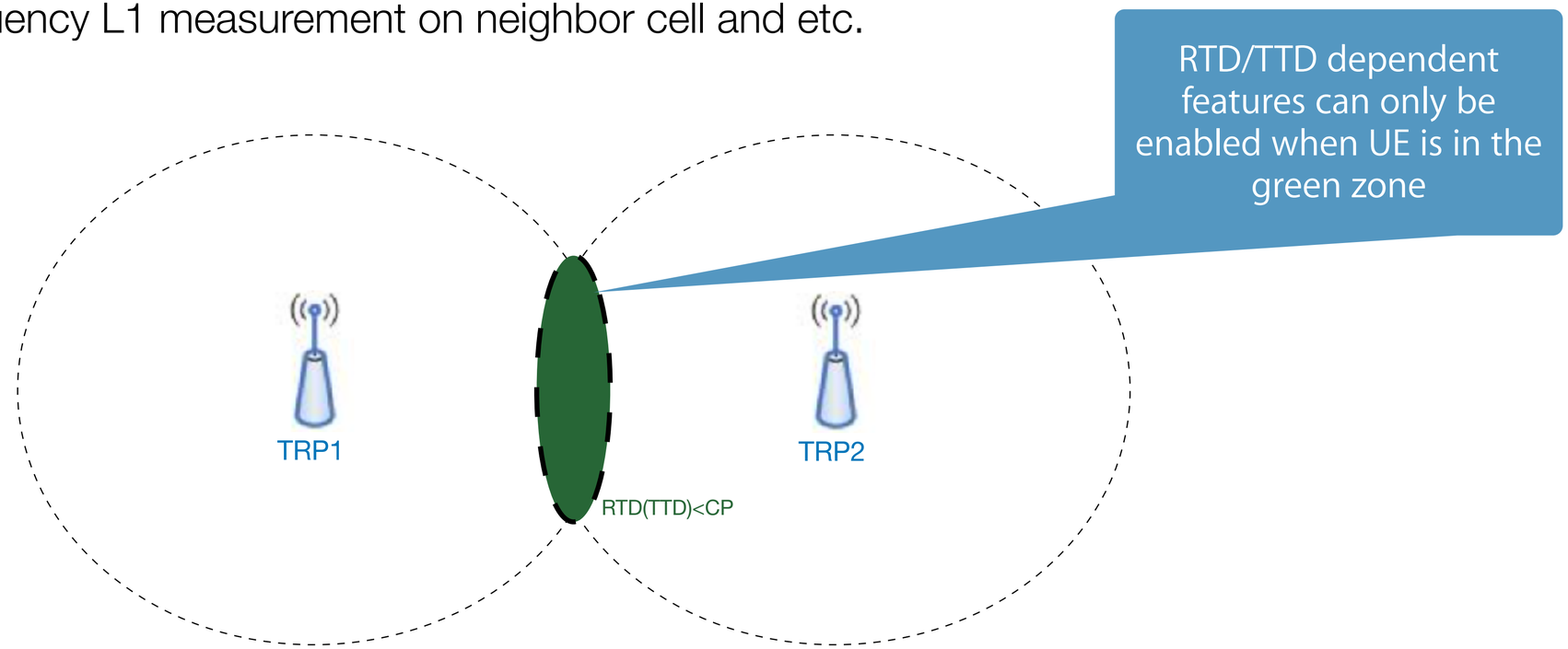
Rel-19 RRM enh-4 | Dynamic RTD/TTD status update

- **Dynamic RTD/TTD status update**
  - More and more RAN4 requirements are RTD/TTD dependent, such as RRM requirements applicability of multi-Rx, multi-TRP with dual TAGs, intra-frequency L1 measurement on neighbor cell and etc.



- Example of multi-TRP with 2TAs :
  - Step 1: UE indicates its category to NW after access NW (baseline UE or advanced UE).
  - Step 2: Network configures UE to monitor RTD between the two TRPs.
  - Step 3: UE monitors the RTD consistently, and report to network when status changes (into or out of green zone)
  - Step 4: Upon receiving RTD status change from UE, network can update configuration accordingly (e.g. fallback to single TAG or enable 2 TAs).

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