3GPP TSG RAN Rel-19 Workshop

15th – 16th June 2023

RWS-230460

Overview of Rel-19 RAN4 content

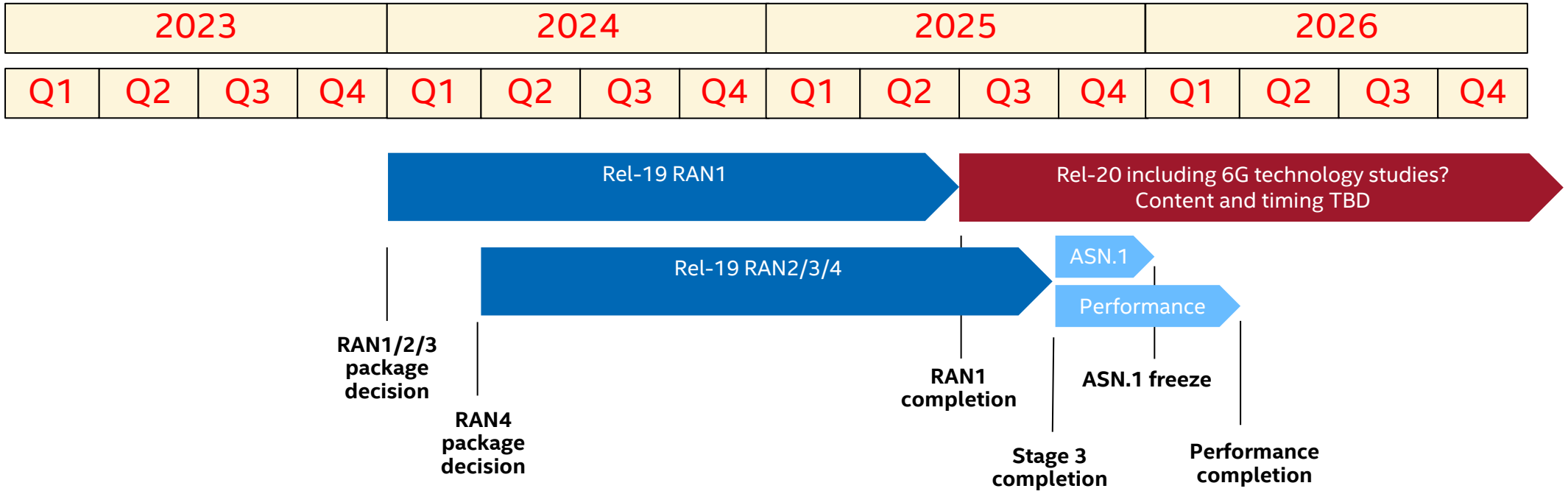
Agenda Item: 6

Source: Intel Corporation

Document for: Information

Rel-19 Timeline

- Rel-19 duration and timeline agreed at TSG#99
- 3GPP should aim to return to delivering to the agreed deadlines (following several releases disrupted by the pandemic)
- Rel-19 package scope dimensioned to fit the timeline



Candidate RAN4 Rel-19 Topics

- Evolved FR2 multi-panel UE
  - Multi-Rx panel: CA support; improved RF/RRM/Demod requirements; FR2-2
  - Multi-Tx panel: Baseline RF/RRM requirements
- Requirements to enable mTRP operation with RTD > CP
  - Extended set of UE RRM/Demod requirements for mTRP deployments operation with time difference beyond CP
- Measurement Gaps evolution
  - Pre-configured NCSG
  - Enhanced collision handling for concurrent MGs
- RRM requirements evolution
  - Enhanced TCI state switch requirements
  - URLLC-enabling requirements
  - Improved Beam switching requirements
- RF Evolution
  - Irregular Channel Bandwidth
- Demodulation Evolution
  - UE Soft IC receivers for DL SU-MIMO
  - UE Soft IC receivers for multi-DCI multi-TRP
  - BS MMSE-IRC for inter-cell interference

Candidate RAN4 Rel-19 Topics

Evolved FR2 UE Simultaneous Multi-Panel Operation

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Simultaneous Multi-panel RX

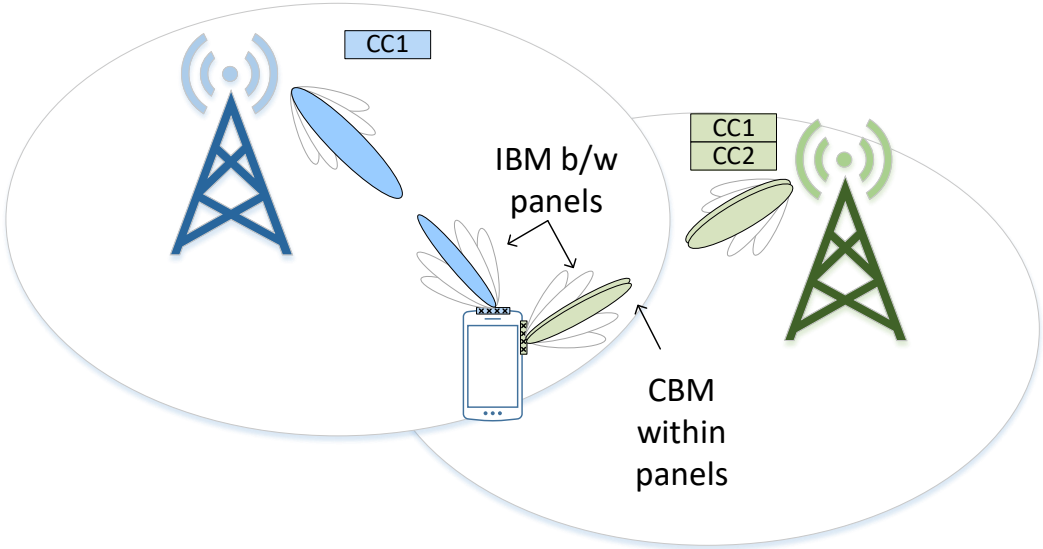
Motivation

- Support of FR2 simultaneous multi-Rx chain requirements is being introduced in Rel-18 NR_FR2_multiRX_DL WI. The Rel-18 requirements are limited to a single carrier scenario, and multiple potential enhancements were de-prioritized.
- Further evolution of Multi-Rx operation requirements is required to extract full benefits of advanced UE implementations

Candidate objectives/scope

- **DL CA multi-panel simultaneous RX:** Focus on intra-band CA and common beam management (CBM) within each panel. Introduce corresponding RF/RRM/Demod requirements and test methods.
- **Enhanced RRM requirements:** Rel-18 leftovers incl. L3 enhancements, inter-cell mTRP TCI state switch and beam management.
- **Enhanced demodulation requirements:** Joint processing of simultaneous mTRP signals.
- **Extension to FR2-2** (incl. RF/RRM/Demod requirements).
- **Extension to additional FR2 power classes** beyond PC3 including FWA/CPE devices.

Multi-RX CA operation framework



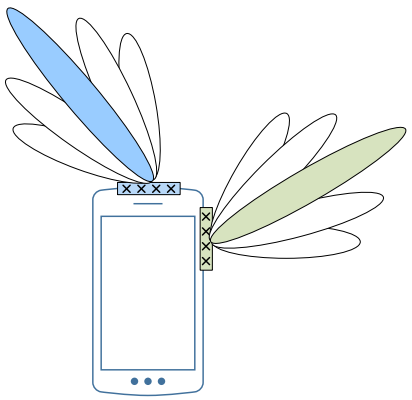
Note: several aspects are still under discussion in Rel-18 and the scope needs to be adjusted based on RAN4 progress

Evolved FR2 UE Simultaneous Multi-Panel Operation

Simultaneous Multi-panel TX

Motivation

- Simultaneous FR2 multi-panel transmission (STxMP) feature can improve FR2 UL performance including data rate and connection robustness
- Support of STxMP is introduced in Rel-18 FeMIMO WI. However, it is expected that a limited set of RAN4 requirements will be introduced. The potential Rel-18 scope does not include RF and FR2 Test Methods for STxMP. Extensive RAN4 studies work are needed to introduce the baseline requirements.



Candidate objectives/scope

- UE requirements to support single carrier STxMP operation including at least RF and RRM requirements.
- Limit to 2 Tx panels case, handheld and FWA/CPE UEs and single carrier STxMP operation.
- SRS multi-panel simultaneous Tx
- **RF requirements:** At least consider EIRP and new requirement concept based on spherical coverage
- **RRM requirements:** UL TCI state switch requirements, UL beam management procedures (e.g., beam selection)
- OTA test methods to enable STxMP testing

Note: several aspects are still under discussion in Rel-18 and the scope needs to be adjusted based on RAN4 progress

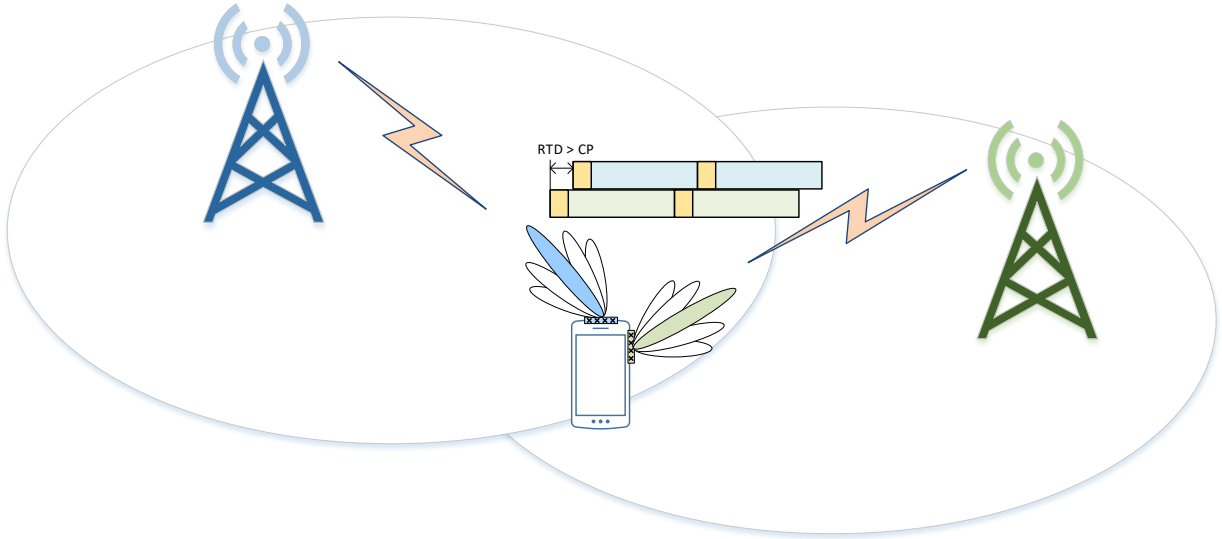
Candidate RAN4 Rel-19 Topics

Requirements to enable mTRP operation with RTD > CP

Requirements to enable mTRP operation with RTD > CP

Background

- In practical deployments it is challenging to guarantee that timing offsets between signals from different TRPs are within a CP, especially for FR2 operation with a high SCS, which limits the efficiency of mTRP operation
- Many existing baseline RRM/Demod requirements for mTRP scenarios are defined under an assumption that timing offsets between signals are less than CP



- Support of RTD > CP is being discussed under several Rel-18 work items, but a relatively limited support is expected to be introduced
  - **Rel-18 NR MIMO:** New UE capabilities are defined by RAN1 to enable Rx timing difference between the two DL reference timings > CP. FFS on the set of RAN4 requirements to be introduced. At least MRTD/MTTD requirements considered.
  - **Rel-18 NR FR2 HST:** RTD > CP planned to be supported for FR2 UE PC6. RRM requirements are limited to MRTD, and additional requirements are FFS. Demod requirements are FFS.
  - **Rel-18 NR FR2 Multi-Rx Chain:** RTD > CP scenario is de-prioritized at current stage.
  - **Rel-18 NR MobEnh:** RTD > CP support depends on UE capability. Separate RRM requirements are discussed corresponding to different UE capabilities.

Note: several aspects are still under discussion in Rel-18 and the scope needs to be adjusted based on RAN4 progress

Requirements to enable mTRP operation with RTD > CP

Motivation

- A systematic and generic approach is desirable to introduce the support of mTRP operation with time offsets larger than CP including RRM/Demod requirements to facilitate feature adoption for different device types
- At least the following RAN4 requirements are defined under an assumption of RTD < CP and limit mTRP operation
  - RRM
    - Inter-cell beam management
    - TCI state activation
    - LTM – L2 triggered mobility
    - CSI-RS based L3 measurements (intra-frequency)
  - Demodulation
    - Simultaneous demodulation of mTRP DL signals

Candidate objectives/scope

- Study and introduce UE requirements to enable mTRP operation with RTD > CP incl. DL/UL operation
- FR1 & FR2 scenarios
- Handheld, CPE/FWA and HST devices
- Consider both single carrier and CA scenarios
- UEs with and without simultaneous data reception capabilities
- Improved RRM requirements to enable RTD > CP
- Improved demodulation requirements to enable RTD > CP

Note: several aspects are still under discussion in Rel-18 and the scope needs to be adjusted based on RAN4 progress

Candidate RAN4 Rel-19 Topics

Measurement Gaps Evolution

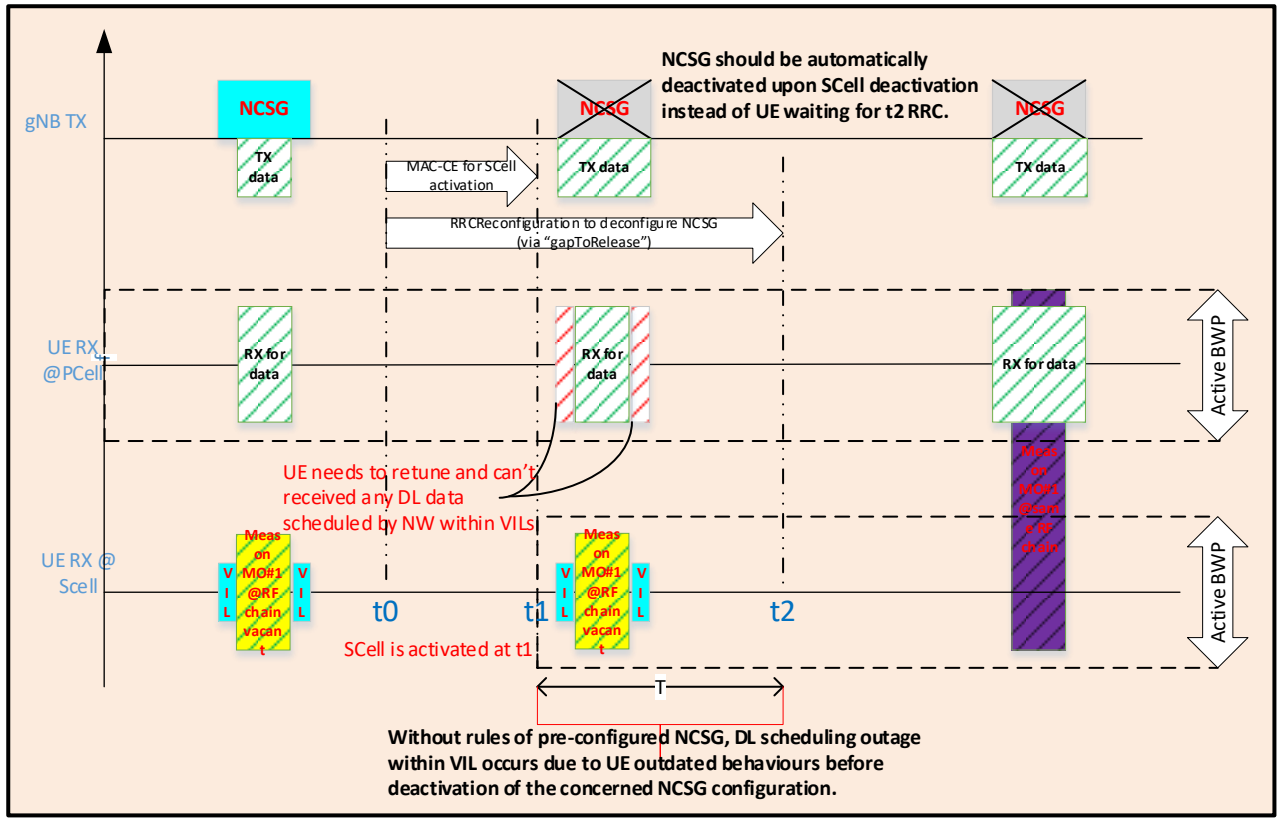
Measurement Gaps Evolution
Pre-configured NCSG

Motivation

- The combination of pre-configured MG and NCSG features was de-prioritized in Rel-18 timeframe.
- For CA SCell, since UE can perform measurement on SCell by either within NCSG or outside of gap depending on SCell activation status (if we assumed SSBs in SCell are within UE's active BWP), some problems were observed under cases below.
  - Case 1: SCell activation. DL scheduled data could be lost because of RRC processing to release associated NCSG.
  - Case 2: SCell deactivation. UE cannot perform measurements on the SSBs on the deactivated SCell before UE completes RRC processing for the new NCSG or MG. The measurement latency will be extended due to UE RRC processing time.

Candidate objectives/scope:

- Pre-configured NCSG
  - Mechanism to configure the pre-configured NCSG
  - Activation/deactivation procedure
  - UE capability



Preconfigured NCSG de-activation

Measurement Gaps Evolution

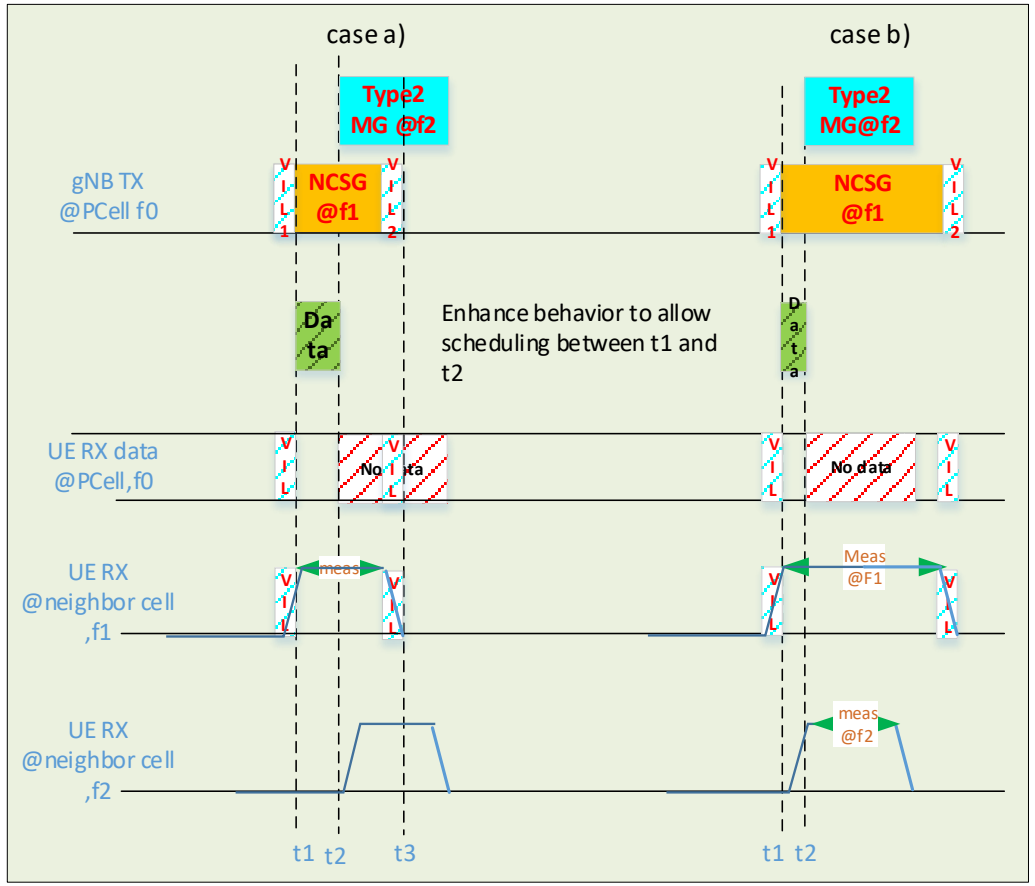
Enhanced collision handling for concurrent MGs

Motivation

- Based on current design for concurrent MGs with NCSG, UE needs to drop one of the gap instances when they are collided for intra-band measurements or inter-band measurements (e.g., both (f0+f1) and (f1+f2) band combinations).
- UEs with vacant RF chain(s) can utilize them for parallel measurements for the multiple gaps no matter they are collided or not. The enhanced dropping rule can be beneficial to increase overall both UE and NW efficiency.

Candidate objectives/scope:

- Enhanced UE behavior upon gap collisions
  - Optimized dropping rules when NCSGs are within concurrent MGs



NCSG collision handling

Candidate RAN4 Rel-19 Topics

RRM Evolution

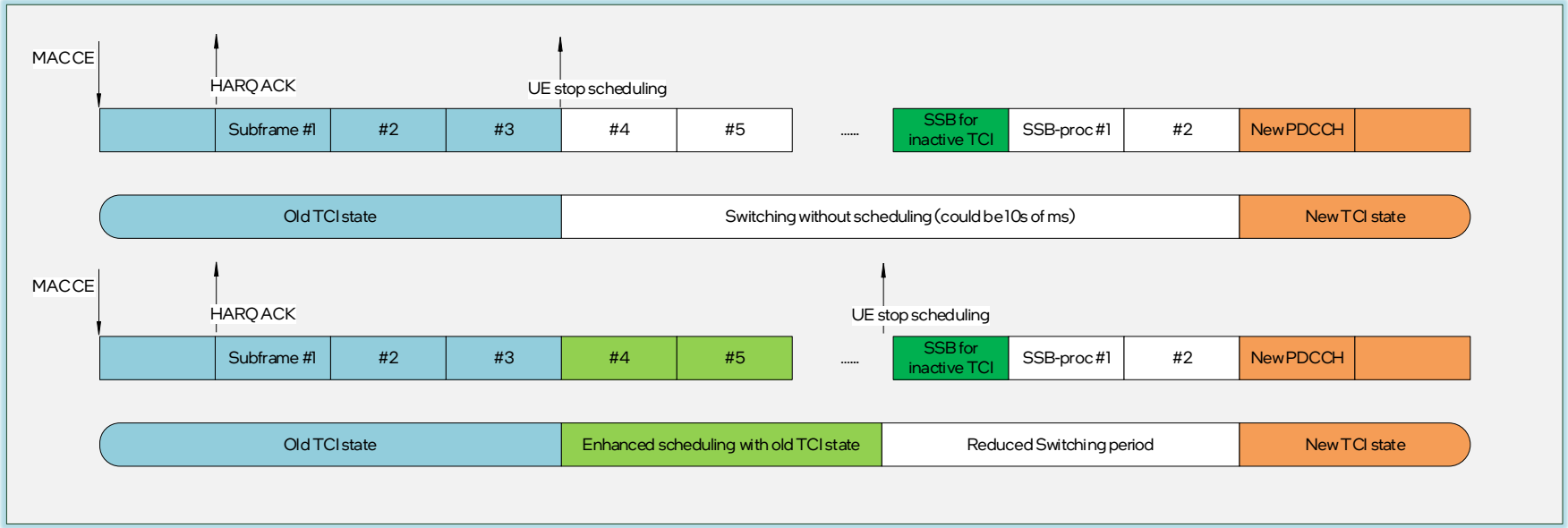
RRM Evolution
Enhanced TCI state switch requirements

Background

- In TCI state switching requirements, there is a time gap where UE is not required to receive or transmit data
- The gap has an impact on the throughput performance in case the first SSB arrives relatively late for DL TCI state switching and in case the first PL-RS arrives late for UL TCI state switching
- UE behavior can be enhanced to receive and transmit data during the time gap of Tfirst-SSB for DL TCI state switching or during the Tfirst_target-PL-RS

Candidate objectives

- Enhancements to maintain the UE reception and transmission during the period (or part of period) of DL, UL and joint DL/UL active TCI state switching



Current MAC CE based TCI state switch timeline

Enhanced MAC CE based TCI state switch timeline

Example of MAC-CE based downlink TCI state switch

RRM Evolution
URLLC-enabling requirements

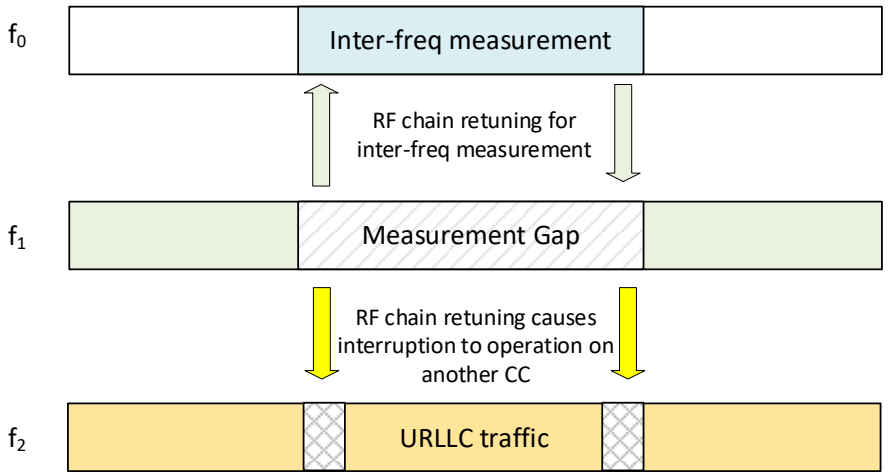
Background

- URLLC is one of key applications for 5G/5G-A.
- From RRM requirements perspective URLLC data is no different to eMBB in terms of allowed disruptions in data, which is not well fulfilling URLLC service requirements regarding mission criticality. RRM procedures such as measurements, interruptions due to RF retuning, SCell activation, etc. may affect URLLC traffic
- Further enhancements to RRM requirements and UE capabilities can be considered to minimize disruptions on URLLC traffic.

Candidate objectives

- Study and specify enhancements for protection of carriers with URLLC traffic from RRM-related disruptions
  - Identify the cases, where disruptions on carriers with URLLC traffic may occur
  - Enhancement to reduce the allowed interruption length on carriers with URLLC traffic
  - Mechanisms for interruption protection on carriers with URLLC traffic
  - Additional UE capabilities for interruption free RF chains dedicated for carriers with URLLC traffic

Note: The same set of enhancements can be applied to other time-sensitive or reliability-sensitive types of services incl. XR.



Interruption impact on carriers with URLLC traffic

RRM Evolution

Improved UE Rx Beam switching requirements

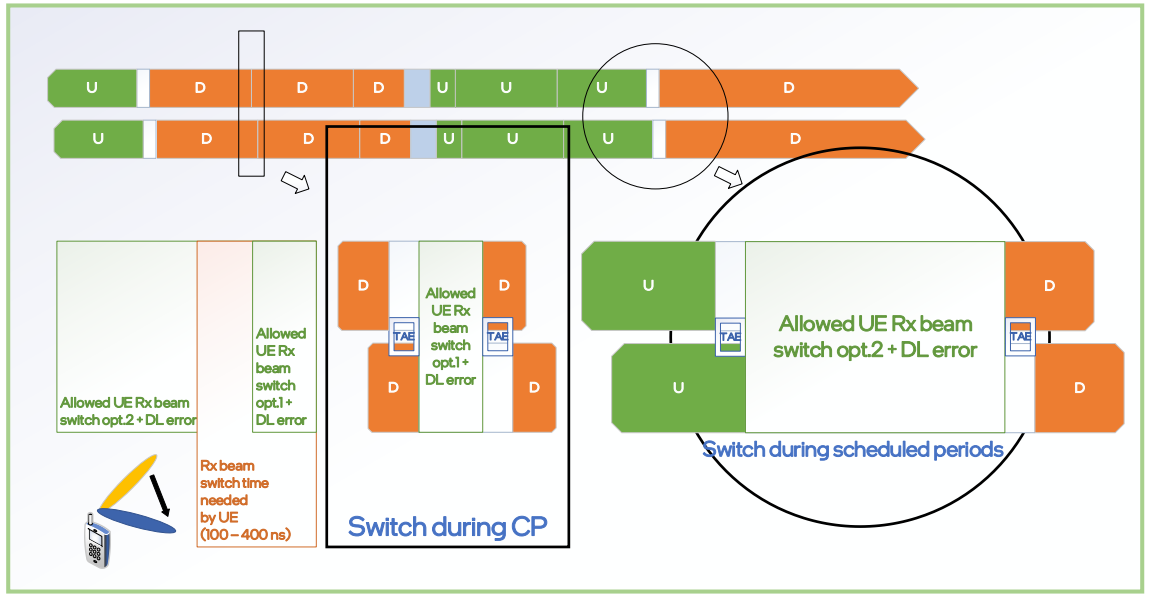
Background

- In FR2, there are cases where the CP length cannot accommodate the switching time of UE Rx beam switching properly, therefore causing interruptions on scheduling every time the UE switches its Rx beam.
- Performance degradation is expected on the serving cell for both single carrier and CA scenarios with CBM.
- Dedicated scheduled time periods or guard periods between UL and DL symbols for beam switching can be used to avoid performance loss

Candidate objectives

- Enhancement to schedule time periods for FR2 UE Rx beam switching

SCS	CP length	TAE for Contiguous CA	DL timing error
120kHz	580ns	130ns	~33ns
480kHz	146ns	32.5ns	~8ns
960kHz	73ns	32.5ns	~4ns
Note: UE Rx beam switching time ranges from 100 to 400 ns.			



Comparison between switching during CP and during scheduled periods

Candidate RAN4 Rel-19 Topics

RF Evolution

RF Evolution
Irregular Channel Bandwidth

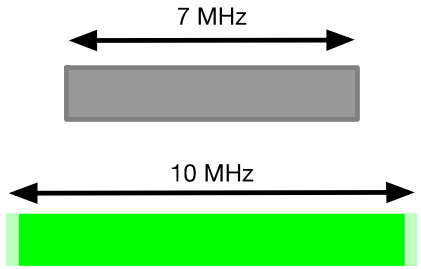
Motivation

- Increase spectrum utilization by allowing operators to flexibly use available spectrum blocks of any RB granularity instead of only traditional BW sizes at multiples of 5MHz.
- Several solutions were identified in the Rel-18 NR Irregular CBW SI (TR 38.844), but no follow up WI was approved

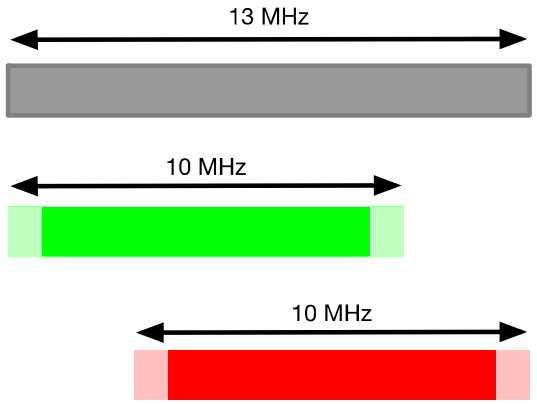
Candidate objectives

- Introduce specification support for the following irregular CBW methods
  - Larger Channel BW than licensed BW
  - Overlapping UE CBW from Network Perspective
- Address potential issues with initial access for irregular channel BW less that 10MHz

TR 38.844: Larger channel bandwidth (example for 7MHz)



TR 38.844: Overlapping carriers (example for 13MHz)



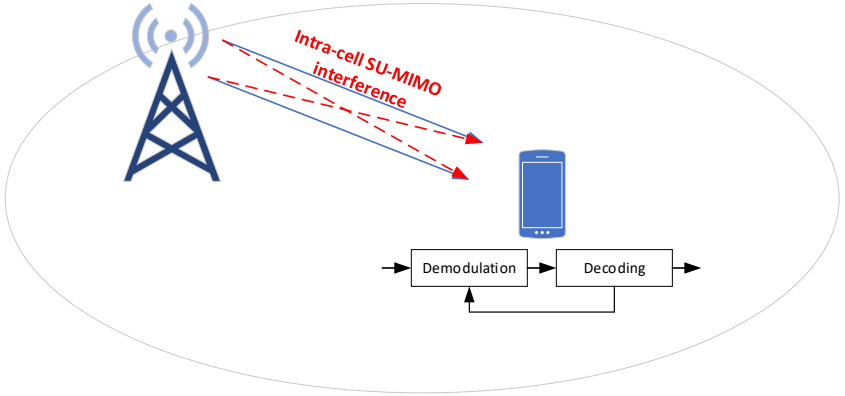
Candidate RAN4 Rel-19 Topics

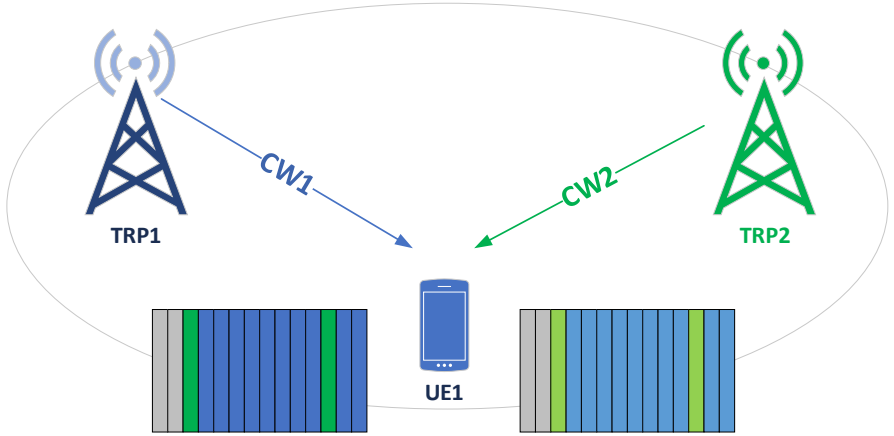
Demodulation Evolution

UE Advanced Receivers
Soft IC receivers

Soft IC receivers for DL SU-MIMO

- Motivation: DL SU-MIMO requirements are defined for MMSE-IRC and R-ML receivers. Further possible performance enhancement are possible in case of using of IC receivers.
- Candidate objectives: Study performance benefits and specify UE requirements for **Soft IC receiver for DL SU-MIMO scenario**





Soft IC receivers for DL multi-TRP

- Motivation: Rel-16 eMIMO requirements for multi-DCI multi TRP scenario are defined for scenarios with non-overlapping PDSCH allocation and MMSE-IRC receiver. IC receiver can be used to improve PDSCH performance for multi-DCI multi TRP scenario with overlapping or partially overlapping PDSCH allocations.
- Candidate objectives: Study performance benefits and specify UE requirements for **Soft IC receiver for multi-DCI multi TRP scenario**

BS Demodulation
MMSE-IRC for inter-cell interference

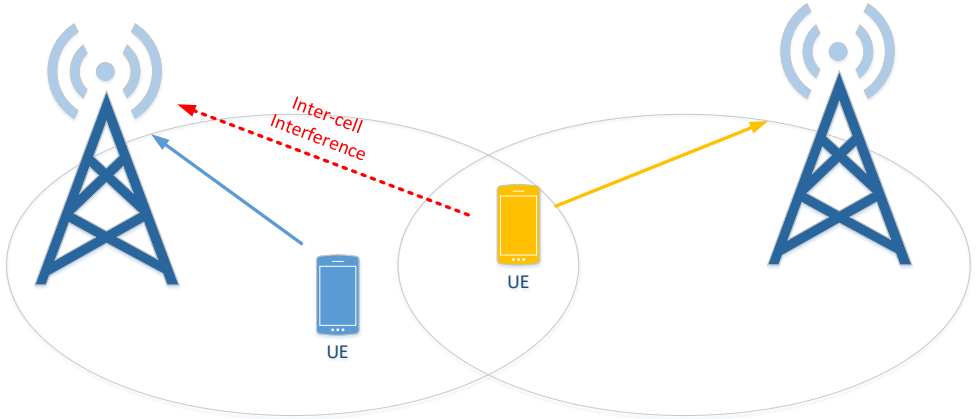
Motivation

- Existing BS requirements are defined for noise limited conditions and do not allow verification of BS interference rejection capabilities under practical conditions
- Interference-limited conditions are quite typical for 5G deployments and support of MMSE-IRC processing is important to guarantee good performance in the field (see typical LTE profiles on the right)

Candidate objectives

- Study NR UL inter-cell interference profiles
- Define BS MMSE-IRC demodulation requirements for inter-cell interference scenarios for SU-MIMO cases

UL inter-cell interference



Typical UL DIP/INR values
for 85% DIP CDF based on TR 36.884

	HomoNet		HetNet	
	DIP	INR	DIP	INR
Interf UE1	-1.11	7.29	-0.43	12.38
Interf UE2	-10.91	-2.51	-13.78	-0.97

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