

Overview of RAN4-led Rel-19 topics

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BS RF evolution and enhancements

- Study on more OTA requirements/options for BS type 1-H
 - > Motivation
 - Existing requirements for BS type 1-H include two OTA requirements: i.e. EIRP and EIS. Some conductive requirements may be over stringent without the verification the overall radiated performance.
 - > Objective
 - Evaluate possibilities for fixed or flexible selection of OTA TX and RX requirements for the new/evolved BS type 1-H.
- FR1 MB-BS requirements enhancement
 - > Motivation
 - In existing specification, for FR1 multi-band (common active RF components) BS, in the case where a single band is mapped on an antenna connector, some single-band requirements shall apply, such as transmitter spurious emissions, operating band unwanted emissions, ACLR. When the two bands are too close to each other, the applicable requirements are not clear, e.g. the limits for wanted signal leakage to the antenna connector for the other band.
 - > Objective
 - Study and specify the applicable requirements for the above case.

Further UE RF enhancements for FR1

- PC1.5 intra-band contiguous/non-contiguous CA
- 6Rx for handheld UE
- 4Tx enhancements for CA/DC
- PC3 CA, PC2 SC & CA low PAPR DMRS + power boosting

UE RF FR1

PC1.5 intra-band contiguous/non-contiguous CA

- Motivation

- > The band combination for PC1.5 intra-band contiguous/non-contiguous CA was already proposed in Rel-18, and it has impact on general requirement
- > Operators show interest for UE supporting this feature to accommodate the deployment demand
 - Example band combination could be n77C, n78C, n79C, n77(2A), n78(2A), n79(2A)

- Objective

- > Specify UE RF requirement for PC1.5 intra-band CA with 2Tx, including scenarios of
 - Intra-band contiguous CA w/ or w/o UL MIMO
 - Intra-band non-contiguous CA
 - Example band combinations: n77/78/79C, n77/78/79(2A)

UE RF FR1

6Rx for handheld UE

- Motivation

- > 6Rx for handheld UE was discussed extensively at the beginning of Rel-18 for RAN4 scope
- > Operators show strong interest to enable the feature for handheld UE

- Objective

- > Investigate and enable 6Rx on higher frequency bands targeting at support of smartphone (RAN4)
- > Investigate the feasibility whether 6Rx can be extended to the smartphone, and decide which UE type (smartphone and/or FWA/CPE) will be considered
 - Feasibility study includes performance gain and form factor
- > Consider NR TDD bands higher than 1.8GHz and example bands are n41, n77 and n78 (other bands to be introduced in the release independent way later)
- > Specify the requirements to support 6Rx subject to the conclusion of feasibility study
 - Specify the UE RF requirements to support 6Rx
 - Specify RLM test cases with 6Rx
 - Specify UE demodulation performance and CSI requirements to support 6Rx
 - Support at least up to 4 MIMO layers, FFS for layer larger than 4

UE RF FR1

4Tx for intra-band CA, CA+MIMO

- Motivation

- > 4Tx for SC was introduced in Rel-18 for CPE/FWA/vehicle/industrial devices
- > Further performance enhancement to enable intra-band CA for 4Tx

- Objective

- > Enable 4Tx on intra-band CA for CPE/FWA/vehicle/industrial devices
 - UE power class: PC1.5
 - PA configuration: Same as those for SC in Rel-18, i.e. 4x23dBm, 2x23+2x26dBm and 4x26dBm
 - Example bands: n41, n77/n78 for TDD; n1 for FDD

UE RF FR1

PC3 CA, PC2 SC & CA low PAPR DMRS + power boosting

- Motivation

- > PC3 power boosting for Pi/2 BPSK was supported from Rel-15
- > Lower PAPR DMRS was supported from Rel-16 but no enhancement for PC2 Pi/2 BPSK
- > Existing Pi/2 BPSK power enhancement is for SC only, not include intra-band CA

- Objective

- > Specify requirements to enable power enhancement for PC3 UE supporting Pi/2 BPSK with intra-band CA
- > Specify requirements to enable power enhancement for PC2 UE supporting Pi/2 BPSK w/ or w/o intra-band CA

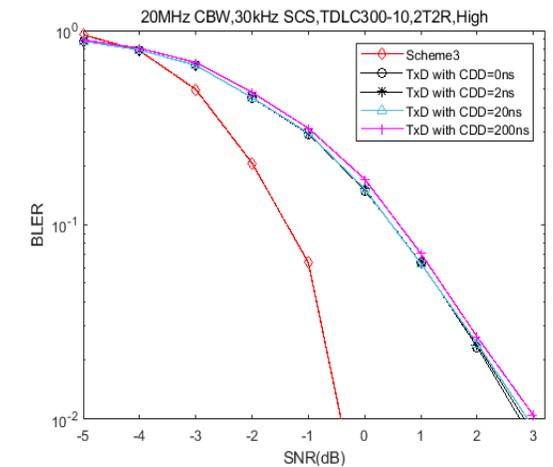
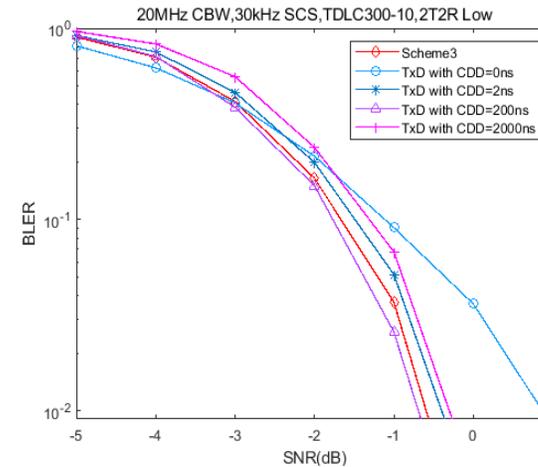
Further UL enhancement via UE RF evolution

- Robust uplink transmission diversity.
- MPR reduction via UL transmission with uneven PSD
- 1Tx-1Tx UL Tx switching

Robust uplink transmission diversity (TxD)

- Motivation

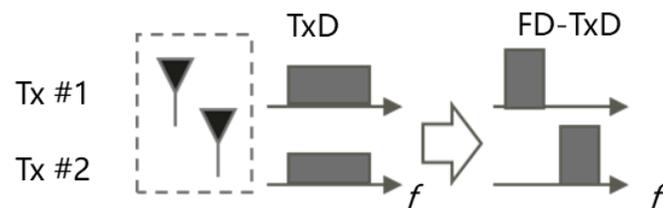
- > TxD is widely used for high power UE, e.g., power class 1.5 (29dBm), and single port uplink transmission for cell edge UE
- > Issues for existing TxD:
 - Timing offset between 2 Tx would degrade TxD performance
- > New TxD scheme whose performance is not sensitive to Timing offset between 2Tx is needed
 - Robust TxD performance
 - Enabling less power back-off



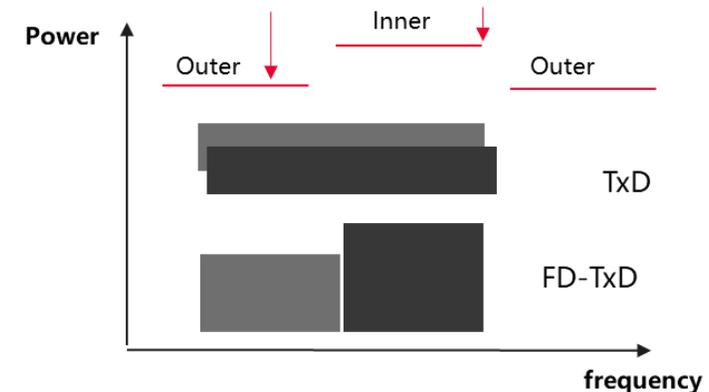
Benefit #1: More robust diversity performance: not sensitive to timing offset

- Objective

- > Enable the robust frequency-division 2Tx transmission diversity scheme (FD-TxD)



Frequency division 2Tx TxD



Benefit #2: Less power back-off (potential reduced MPR)

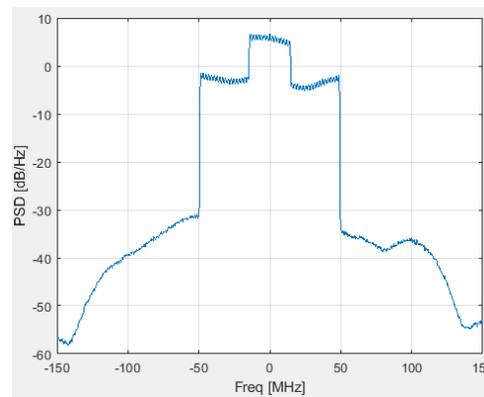
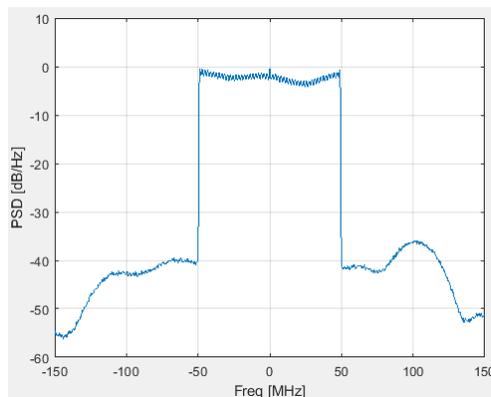
MPR reduction via UL transmission with uneven PSD

- Motivation

- > Further reduction of power back-off is desirable to improve the PA efficiency and thus uplink performance
- > Issues of existing power back-off (MPR)
 - Apply one power back-off (MPR) for uplink transmission
- > There is room to further improve the PA efficiency

- Objective

- > Apply different power back-off values to RE-s depending on their locations
- > Specify the new MPR table



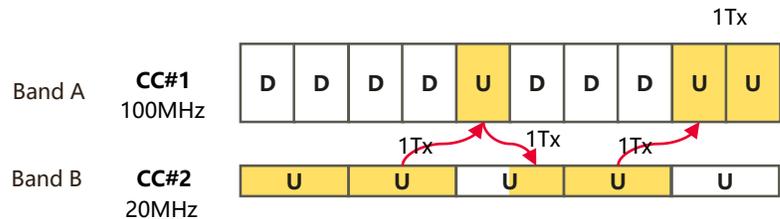
UL transmission with uneven PSD

- Transmit the center PRB with less MPR than the existing specification
- Keep the EVM and out-band emissions unchanged

1Tx-1Tx UL Tx switching

- Motivation

- > Enable low-end UEs equipped with 1Tx to support UL Tx switching
 - Since Rel-16, 2Tx chain based UL Tx switching with non-zero switching period is specified.
 - ✓ 1Tx to 2Tx UL switching between band A and band B
 - ✓ 2Tx to 2Tx UL switching between band A and band B
 - In Rel-18, 2Tx chain based UL Tx switching with non-zero switching period among 3 or 4 bands are specified.
 - The low-end NR UE may be just equipped with 1Tx chain. Its uplink performance can be significantly improved, if the UL Tx switching with non-zero switching period is enabled for it.



Peak data rate enhancement for 2 band example on left

1Tx fixed on Band A	1Tx fixed on Band B	1Tx-1Tx UL Tx switching
~310Mbps	~120Mbps	~430Mbps

- Objective

- > Enable 1Tx based UL Tx switching with minimum spec impacts
 - 1Tx to 1Tx UL Tx switching between band A and band B
 - 1Tx to 1Tx UL Tx switching among 3 or 4 bands
 - Leverage the existing RAN1/RAN2 specifications for 2Tx based UL switching feature and multi-carrier operation feature as much as possible.

Further RRM enhancements

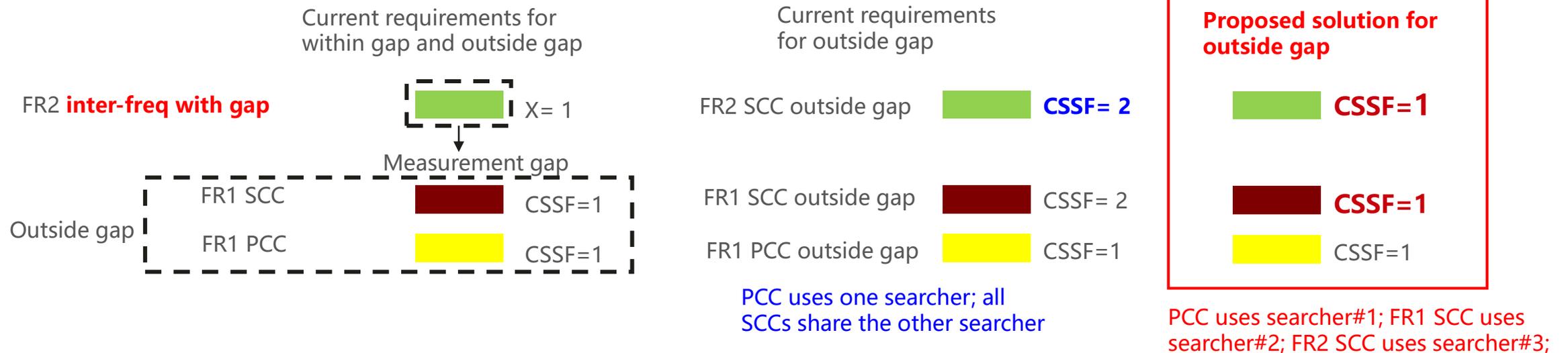
- L3 Measurement enhancement for FR1+FR2
- Interruptions at NR SRS antenna port switching
- L1/L2 mobility inter-frequency measurement enhancement
- BWP switch enhancement

Further RRM enhancements

L3 Measurement enhancement for FR1+FR2

- Motivation

- > Current status: Delay requirements for measurement outside gap are defined based on 2 searchers assumption for total CCs in FR1 and FR2
- > Observation: In FR1+FR2 scenario, a UE supporting **per-FR gap** shall support totally 3 searchers to meet the requirements for measurement **within gap** in FR2 and **outside gap** in FR1
- > Potential enhancement: when no gap is needed, the searcher within gap can be **borrowed** for outside gap, then 3 searchers are used for measurement outside gap.



- Objective (R19 Proposal)

- > Enhance CSSF (carrier-specific scaling factor) for L3 measurement outside gap in the above case

- Gain

- > Shorter measurement delay for serving cell measurement (which is typically measured outside gap)

Further RRM enhancements

Interruptions at NR SRS antenna port switching

- Motivation

- > In current RRM spec, it is assumed that SRS resource for SRS antenna switching is allocated at the last 6 symbols of a slot. However, SRS starting in any symbol within a slot is already supported since Rel-16. Thus, some SRS antenna port switching scenarios are not covered by current RAN4 requirements.
- > In Rel-17 interruption requirements at NR SRS antenna port switching, following scenarios are considered:
 - *Scenario 1: when $X=1$ SRS symbol is configured in a slot for SRS antenna port switching*
 - *Scenario 2: otherwise, using $X=6$ SRS symbols in a slot as assumption of SRS transmission time*

Symbol level interruption requirement is only considered for scenario 1 for synchronized case. For all other cases, interruption requirement is defined in number of **slots**, which may be much longer than the actual interruption length.

- Objective

- > Interruption requirements at NR SRS antenna port switching when SRS starting in any symbol of a slot
- > Finer granularity of interruption requirements at NR SRS antenna port switching (i.e. symbol level interruption length for more applicable scenarios)

Further RRM enhancements

L1/L2 mobility inter-frequency measurement enhancement

- Motivation
 - > According to current R18 LTM progress, only L1/L2 inter-frequency measurement with Type 1 gap is specified in R18.
- Objective
 - > L1/L2 inter-frequency measurement with NCSG (Network Controlled Small Gap)
 - In FR1, SSB based L1-RSRP measurement can be performed simultaneously with L3-RSRP measurement;
 - In FR2, SSB based L1-RSRP measurement is to be shared with L3 measurement with one NCSG, Or define a dedicated NCSG for L1-RSRP measurement
- Gain
 - > For UE who supports NCSG, during measurement occasion UE is expected to transmit and receive data on the corresponding serving carrier(s).

Further RRM enhancements - BWP switch enhancement

- Motivation

- > For RedCap UE, when UE switch from CD-SSB to NCD-SSB when **only center-frequency is changed**, BWP switching delay can be reduced.

	NR Slot length (ms)	BWP switch delay $T_{\text{BWPswitchDelay}}$ (slots)	
		Type 1 ^{Note 1}	Type 2 ^{Note 1}
0	1	1	3
1 μ	0.5	2	5
2	0.25	3	9
3	0.125	6	18

Note 1: Depends on UE capability.
Note 2: If the BWP switch involves changing of SCS, the BWP switch delay is determined by the smaller SCS between the SCS before BWP switch and the SCS after BWP switch.

- Objective

- > Enhance BWP switching delay both in FR1 and in FR2

Spectrum/basket WI

- Spectrum/Band combination basket WIs should be further considered after approval of non-spectrum WI/SIs as Rel-18 after March 2024
- Clear boundary on the general requirements between non-spectrum and spectrum WI proposals
 - > General requirements are supposed to be specified under non-spectrum WIs
 - > Exception could be considered for spectrum WI only for limited exemplary bands/combinations
 - No more band/band combinations could be added later for spectrum WI including general requirements
 - > Basket WIs are strictly limited to band/band combination specific requirements

Initial considerations for R19

RAN4 BS RF

OTA requirements enhancement

- Study on more OTA requirements/options for BS type 1-H

MB-BS requirements enhancement

- Study on the exclusions for multi-band BS when single-band requirements apply

RAN4 UE RF

UE RF FR1

- PC1.5 intra-band C/NC CA
- 6Rx for handheld UE
- 4Tx for intra-band CA, CA+MIMO
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Further UL enhancement via UE RF evolution

- Robust uplink transmission diversity
- MPR reduction via UL transmission with uneven PSD
- 1Tx-1Tx UL Tx switching

RAN4 spectrum/basket WIs

Follow similar approach as Rel-18

- Clear boundary on general requirements between non-spectrum & spectrum WIs
- Not considered as a package with non-spectrum WI/SI proposals

RAN4 RRM

Measurement enhancement for FR1+FR2

- Enhance CCSF (carrier-specific scaling factor) for measurement outside gap

Interruptions at NR SRS antenna port switching

- Interruption requirements at NR SRS antenna port switching when SRS starting in any symbol of a slot
- Finer granularity of interruption requirements at NR SRS antenna port switching

L1/L2 mobility inter-frequency measurement enhancement

- L1/L2 inter-frequency measurement with NCSG (Network Controlled Small Gap)

BWP switch enhancement

- Enhance BWP switching delay both in FR1 and in FR2