



3GPP TSG RAN Rel-18 workshop
Electronic Meeting, June 28 - July 2, 2021

RWS-210493

Mobility and Higher Frequency Range Enhancements for Rel-18

Apple Inc.

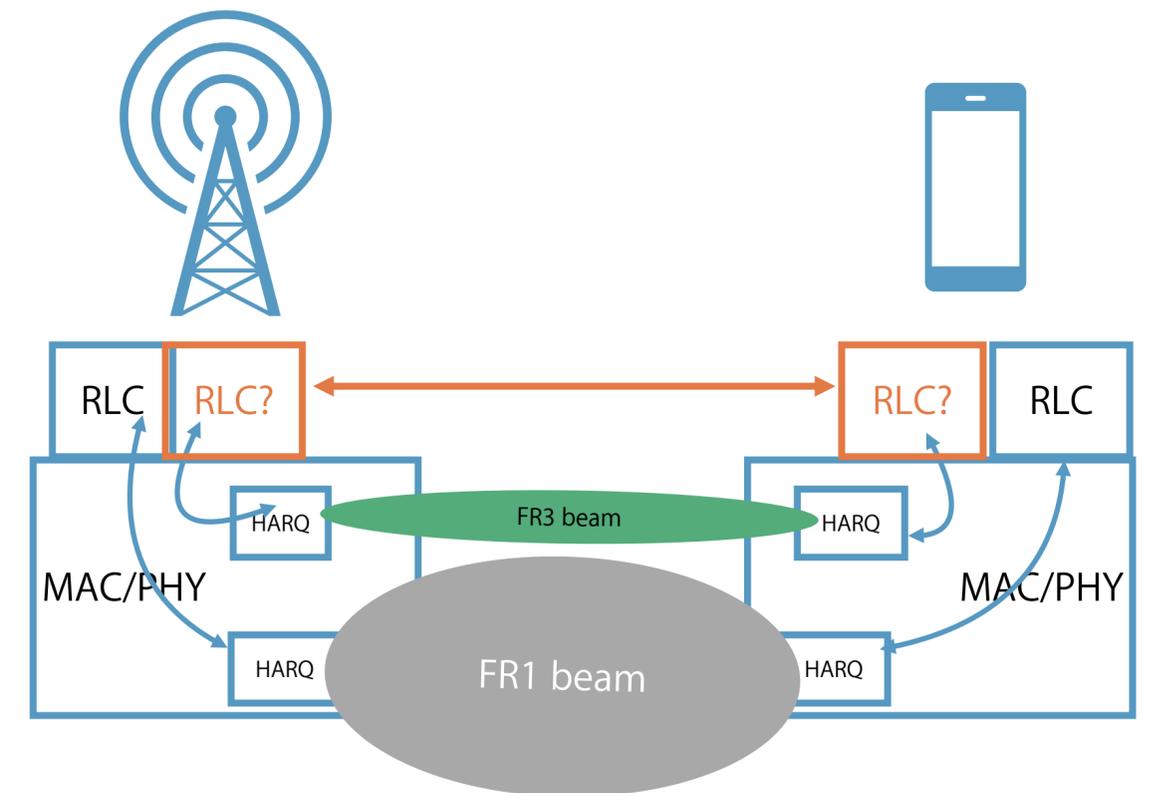
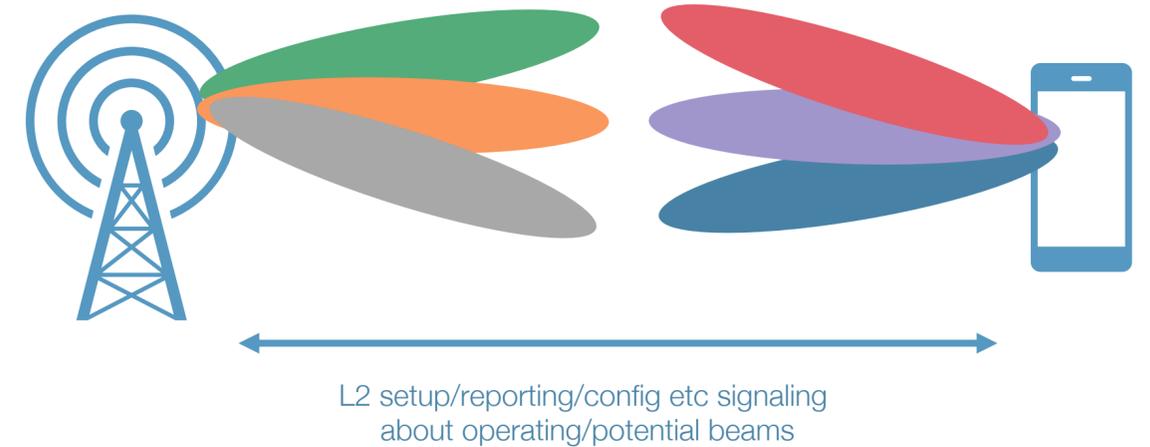
RAN2 Based Enhancements for FR2/2.x

■ Justification

- mmW and >52GHz require enhanced beam management and faster co-ordination between the UE and gNB. Additional exchange of control and feedback information of the channel/beam and the UE state is required to enhancement the beam-based operation.
- RAN2 protocols were largely agnostic to beam-specific operations in signaling design.
- At least in the uplink, **further** L2 based control information/feedback can help with effective beam management
- Increased data-rate from higher frequency operation requires better data-plane protocol handling (**leftover from Rel-17**)
 - Handling increased data-rate
 - Handling even higher asymmetric data-rates from FR1 and FR2/2.x

■ Proposals

- RAN2 to evaluate communication on further minimization of beam specific configuration/transition/operation delays in FR2/2.x
 - Approaches like enhancements to L2/L3 signaling, additional logic in L2 (eg., timer based handling etc.)
- RAN2 to evaluate the enhancements to L2/L3 data-plane protocols for FR2.x and higher frequencies.



Further Mobility Enhancements

- Justification

- With beam based operation in mmW/>52GHz, along with beam management, link control from L3 perspective needs enhancements.
 - Frequent link changes inherent from beams require re-visiting the L3 link control logic (re-establishment procedures etc.). RAN2 already added conditional handover (CHO) as part of mobility enhancements in Rel-16, and similar enhancements can help with link control based on beams.
- Even for non-beam based and FR1 mobility, enhancements on link control from L2 level itself can avoid latencies associated with L3 control. RAN2/RAN1 are discussing L1/L2 centric mobility in Rel-17, and leftover as well as additional enhancements (for eg., faster cell change with the same DU) related to this can help with UE mobility in rel-18.

- Proposals

- RAN2 to evaluate procedures that enhance link control/re-establishment from L3 for FR1 and higher FR (beam) based mobility
- RAN2 to also evaluate enhancements based on L2 mobility starting with the Rel-17 as baseline.



RAN4 Based Enhancement for FR2/2.x (1)

■ Justification

- FR2 Coverage Enhancement and MPE requirements

- At UE side, both Tx power (P-MPR) and UL duty cycle (maxUplinkDutyCycle-FR2) can be leveraged to comply with MPE requirements.
 - P-MPR can be flexibly decided and updated at UE side
 - maxUplinkDutyCycle-FR2 is static
- In R17, FR2 UL gap is discussed to facilitate proximity sensing
 - When human body is not proximate, unnecessary power backoff (P-MPR) can be avoided
 - However, unnecessary UL duty cycle limitation still applies
 - When human body is proximate, P-MPR is the only degree of freedom to meeting MPE requirements.
 - UL duty cycle enhancement can help to reduce power backoff in case of power limited scenario.
- Flexible tradeoff between power and UL duty cycle can enable better FR2 coverage and/or performance
 - Rel-16/17 status
 - Does not cover dynamic or semi-static signaling of changes at the UE side that impact P-MPR or uplink duty cycle.

- Harmonization for RLM and BFD/CBD

- Existing RLM and BFD/CBD have many commonalities, but they are configured independently
 - Independent RS could be configured for RLM and BFD/CBD
 - Independent evaluation procedure for RLM and BFD/CBD
- Scope for reduction in complexity and in saving resource consumption for both the UE and the network.

■ Proposals

- RAN4 to investigate and introduce dynamic or semi-static signaling to enable the adaptation of maximum UL duty cycle or other MPE-complied means to enable better FR2 coverage and/or performance that are visible to the network.
- RAN4 to investigate and introduce a harmonized link monitoring/recovery mechanism to unify the RLM and BFD/CBD within single UE procedure

RAN4 Based Enhancement for FR2/2.x (2)

■ Justification

- FR2 and FR2.x UE antenna scaling

- As a technique to reduce the power consumption of FR2(and beyond) UEs, a procedure to enable/disable antennaelements with corresponding RF chains can be employed(antenna scaling)
- When the UE scales antenna arrays, its analog beam formingcodebook undergoes an instantaneous change, and NW performance is impacted
 - If the UE performs antenna scaling autonomously (as can already be done in currently available FR2 devices), then NW performance losses are possible
 - Power and throughput gains relative to current device behavior are possible if the network can be aware of UE antenna scaling operation
- A RAN4-led study into this topic can quantify the impact on network performance
 - E.g. UE scales from 4x1 to 2x1 and from 2x1 to 4x1
 - UE may determine different antenna switching points based on Rx signal strength, Rx signal quality, Tx output power level, or Tx power headroom
 - Optimal allocation of the number of UE antenna elements to meet desired downlink and uplink coverage can be different
- The study should identify potential solutions to mitigate impact on NW performance
 - Including quantifying the benefit to the NW being aware of the UE antenna switching capability and/or operation
- The study should also identify the impact of UE antenna scaling on UE RF requirements (e.g. TPC, max input level) and the associated testability

- UL Power Control Simplification for FR2.x

- UE UL dynamic range is seen decreasing over increasing operation frequency; in FR2.x the UE may always operate at PCMAX in order to achieve the desired SNR at gNB receiver
- It would not make much sense to downscale the UL channel BW and lower the SNR target at gNB receiver just for the sake of allowing UE to back off its UL power which however may have the benefit of power saving.
- Having UE operating at PCMAX with maximum available channel BW over a short burst time could save more power than using narrower channel BW at a back-off power over a longer burst time as PA efficiency usually peaks at maximum output power.
- There is an opportunity for NR network operation at 60 GHz and above frequency ranges without the need of UL TPC which could bring substantial benefits on simplifying network operation for UL radio control as well as reducing UE transmitter design complexity.
- Or at least open loop power control can be replaced with PCMAX as current FR2 requirement with large tolerance is rather not useful where the intended power level could swing both ways to either PCMAX or low enough for not being able to reach base station.

■ Proposals

- RAN4 to investigate the impact of UE antenna scaling in FR2 and FR2.x on NW performance and to identify potential solutions to mitigate impact on NW performance
- RAN4 to investigate methods to simplify UL power control for FR2.x and identify potential solutions

Summary

■ Proposals

- RAN2 to evaluate communication on further minimization of beam specific configuration/transition/operation delays in FR2/2.x
 - Approaches like enhancements to L2/L3 signaling, additional logic in L2 (eg., timer based handling etc.)
- RAN2 to evaluate the enhancements to L2/L3 data-plane protocols for FR2.x and higher frequencies.
- RAN2 to evaluate procedures that enhance link control/re-establishment from L3 for FR1 and higher FR (beam) based mobility
- RAN2 to also evaluate enhancements based on L2 mobility starting with the Rel-17 as baseline.
- RAN4 to investigate and introduce dynamic or semi-static signaling to enable the adaptation of maximum UL duty cycle or other MPE-complied means to enable better FR2 coverage and/or performance that are visible to the network.
- RAN4 to investigate and introduce a harmonized link monitoring/recovery mechanism to unify the RLM and BFD/CBD within single UE procedure
- RAN4 to investigate the impact of UE antenna scaling in FR2 and FR2.x on NW performance and to identify potential solutions to mitigate impact on NW performance
- RAN4 to investigate methods to simplify UL power control for FR2.x and identify potential solutions