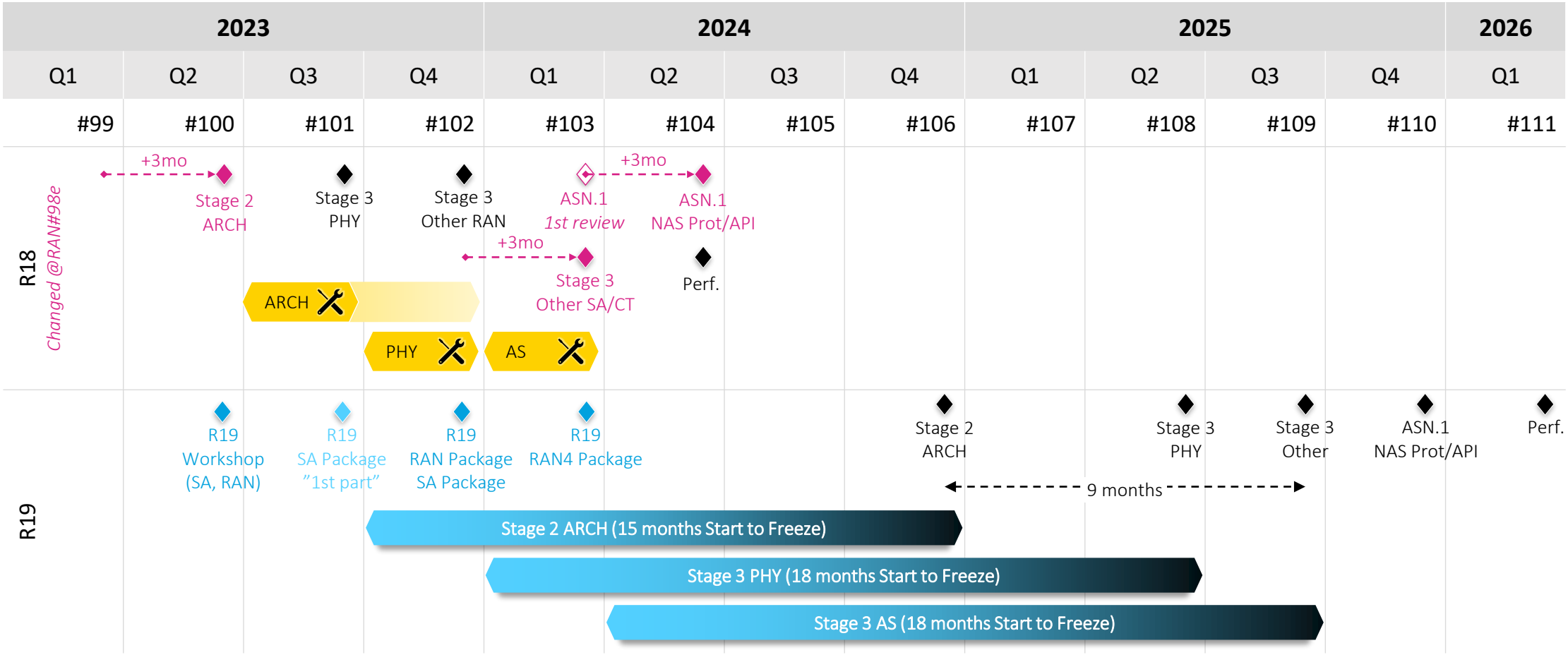
3GPP TSG RAN#99
March 20th – 23rd, 2023

RP-230650
Agenda Item 15

Rel-19 Proposals

MediaTek Inc.

Rel-19 Timeline (see RP-230650)



RAN#98e RAN planning: See RP-222730, RP-223528/SP-221317

Snapshot

(e)MBB

MIMO
- UE-init BM/Switch
- Tiered CSI feedback

Study
- MIMO: Scenario-dep. CSI

AI/ML
- CSI/BM

Mobility
- High #CCs / Bands

AI/ML Mobility *Study*
- Predictive mobility

MC Enhancements
- 2-stage DCI; MC Cell

NTN NR
- >10GHz

NTN NR + IoT - *Study*
- Spectrum re-use

IoT
Industry 4.0

RedCap
- Fast Carrier Switch

NTN IoT
- Full support for Store and Forward

Ambient IoT
- =f (RAN SID)

Services
OTT enablers

XR enh.
- RAN<>APP: app rate control

Study
- Lean Protocol Stack

Generic

System Energy
- LP-SSB x LP-WUS

Study
- Duplex: SBFD UE

Positioning
- Uu/SL unlicensed
- AI/ML Pos

Arch/Topology
Sidelink

PAN Enhancements
- Device collab. for Rank and Diversity augmentation

Sidelink
- FR1 CA; 1024QAM
- FR2
- Mesh

Multi-Access

Migration

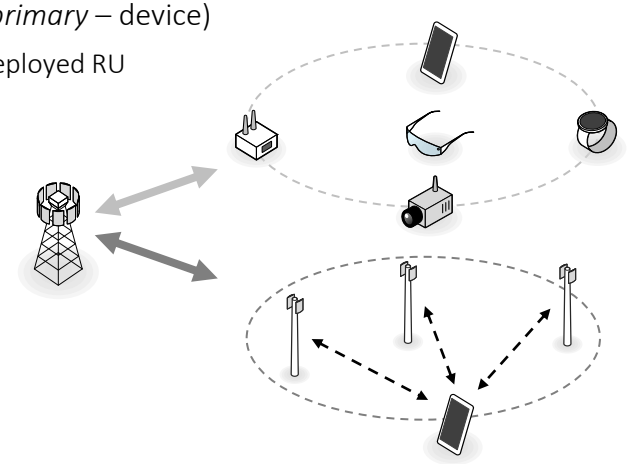
Study
- Spectrum: compatibility, coex

This is a preliminary snapshot.

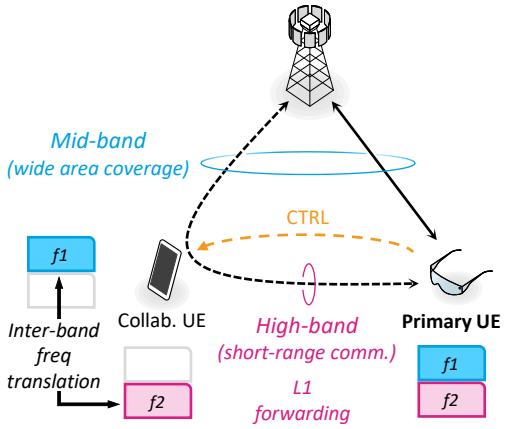
NOTE: Not all R19 items are indicated (e.g. ISAC)

[RAN1-led] Personal Area Networks Enhancements
Device Collaboration Tx/Rx

- Motivation
  - Most MIMO enh focus on NW-side, but physical limitation of UE-side device is a bottleneck for MIMO gain improvement
  - Enable PHY (**antenna**) capability sharing/aggregation among devices via L1-relay, to meet demanding latency and data rate req. (e.g. XR services)
  - Enable a more efficient way to extend 5G NR service by using different spectrums (e.g., mid-band, high-band) together
- Scenarios
  - PAN supporting XR-like services e.g. XR glasses + mobile/CPE
  - Public network: pole-mounted repeaters + mobile
  - A&F RU (controlled by end – *primary* – device)
    - Self-owned device; MNO-deployed RU



- Proposal: UE antenna capability augmentation for Diversity augmentation or Rank augmentation
  - Device-control path for exchange of critical info incl. CSI, repeater-mode enabling, power control etc. (over e.g. SL, WiFi)
  - A&F link: Inter-band frequency translation i.e. ~0-latency



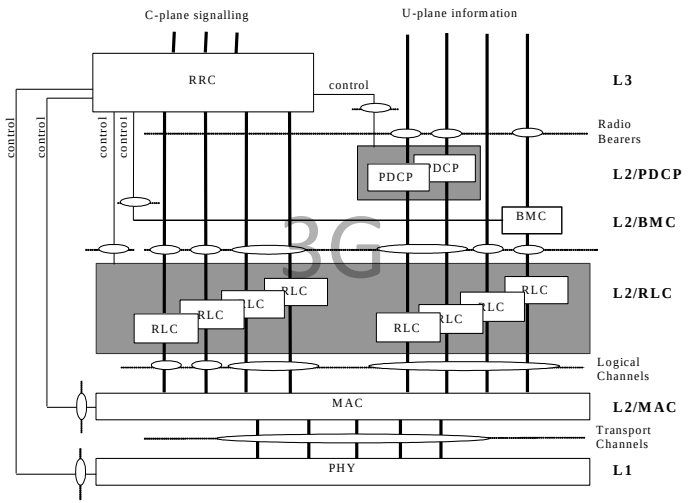
Diversity Augmentation
Path-select.:
- Mean DL UPT **+~14%**

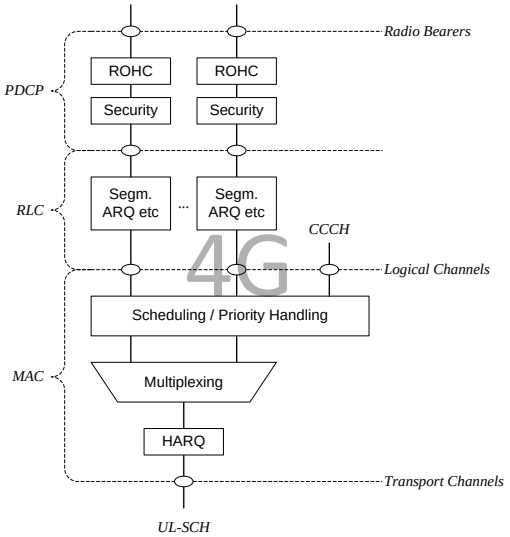
Path-select. + Rx BF at mobile:
- Mean DL UPT **+~28%**

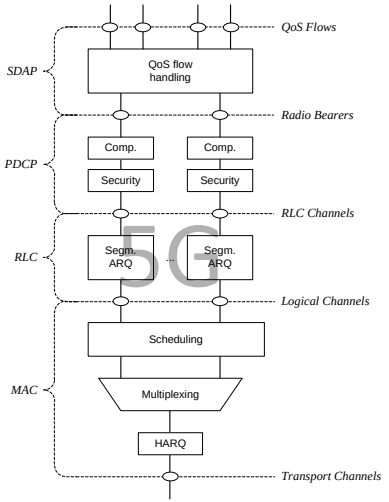
Rank Augmentation
DL: 4Rx → 4Rx + 4Rx:
- Mean DL UPT **+~37%**; 40% UEs with RI≥4

UL: 2Tx → 2Tx + 2Tx :
- Mean UL UPT **+~51%**; 90%UEs with RI>2

[RAN2-led] Study: Lean Protocol Stack







- Key issues
  - 3GPP protocol stack barely changed since 3G, while the world around us changed significantly (e.g. edge hosted apps, TCP-> QUIC)
  - Without an early UP architecture study, 3GPP is likely to yet again sleep-walk into the same stack design for 6G
  - L2 processing scales linearly with packet rate -> packet rate increase can result in processing and power consumption overhead in NW and UE

- Important to *study* solutions to the above issues incl.
  - Review/reconsider functionality needed of the L2 stack all the way down to the L1 interface, to meet highly demanding scenarios
  - Break linear relationship between packet rate and processing overhead (e.g. concatenation)
  - Focus on hardware-friendly L2 design and identify a sound baseline for future development

[RAN1-led] Study: Non-overlapping Full Duplex UE

- Motivation
  - With gNB-SBFD, HD-UE is the latency bottleneck i.e. low-system capacity for latency critical applications
  - Objective: FDD-like low-latency an coverage extended to TDD bands, without the FDD capacity limitations
    - Enabler for XR and latency applications in B5G and 6G

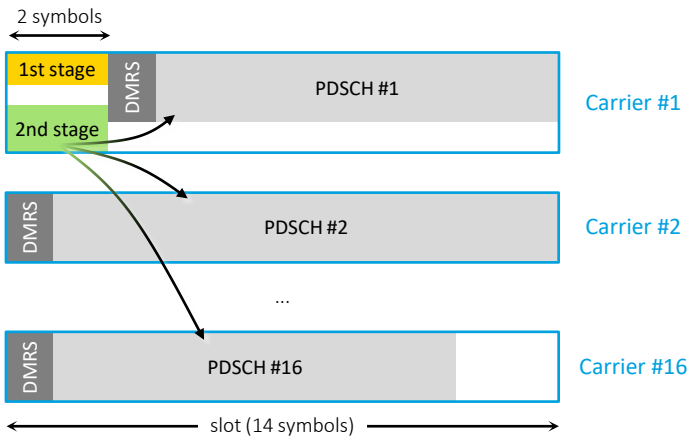
- Scope of the study
  - Identify possible schemes for non-overlapping full-duplex UE and evaluate their feasibility and performance:
    - Consider different types of devices; smartphones, compact devices for XR, CPE, etc.
    - Full-duplex operation: non-overlapped full-duplex on different subbands or carriers (intra-band)
    - Study the feasibility of UE-SBFD under different deployment scenarios
  - Identify specs' features to mitigate self-interference and enable acceptable SBFD-UE complexity
    - Frequency isolation between Rx and TX to minimize self-interference
    - Opportunistic activation of SBFD-UE mode in favourable conditions

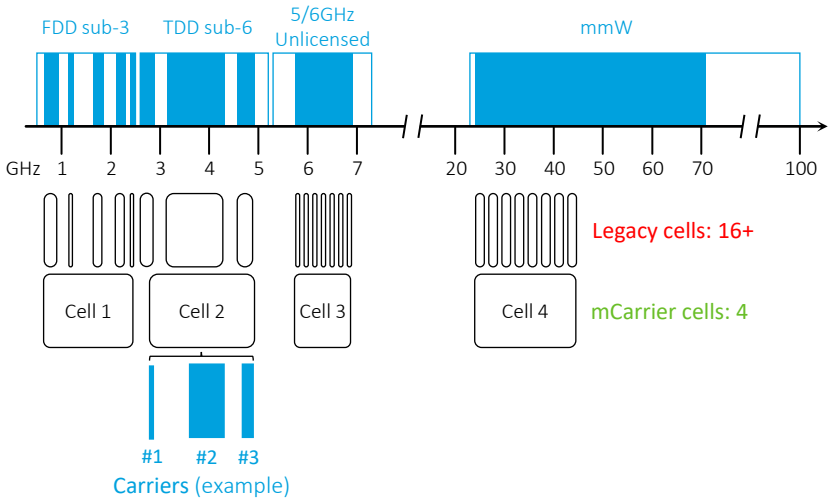
[RAN-led] Study: Spectrum for a "future radio" access

- Besides channel modeling activities for new spectrum, early sandbox study on compatibility and coexistence between misc. applicable radio access (incl. 4G, 5G NR and "future radio" access) in existing and new spectrum
- Spectrum candidates for future radio access (existing NR spectrum and new spectrum)
  - FR1 (licensed, unlicensed)
  - FR2-1
  - FR2-2
  - New: 7-24GHz
  - New: (Sub-)THz
- Identify target use cases / usage scenario for identified spectrum candidates
  - e.g. wide area, local area, hyperlocal area, coverage, capacity, offload, D2D, etc.
- Identify target candidate regime(s) and regulatory aspects (new spectrum)
- Identify intended "future radio" access configurations
  - Spectrum sharing (e.g. DSS) with legacy radio
  - Joint connectivity with legacy radio
  - Standalone "future radio" configurations
- Identify coexistence needs with incumbents (7-24GHz)
  - Incl. adjacent channel and co-channel

[RAN1-led] Multi-Carrier Enhancements

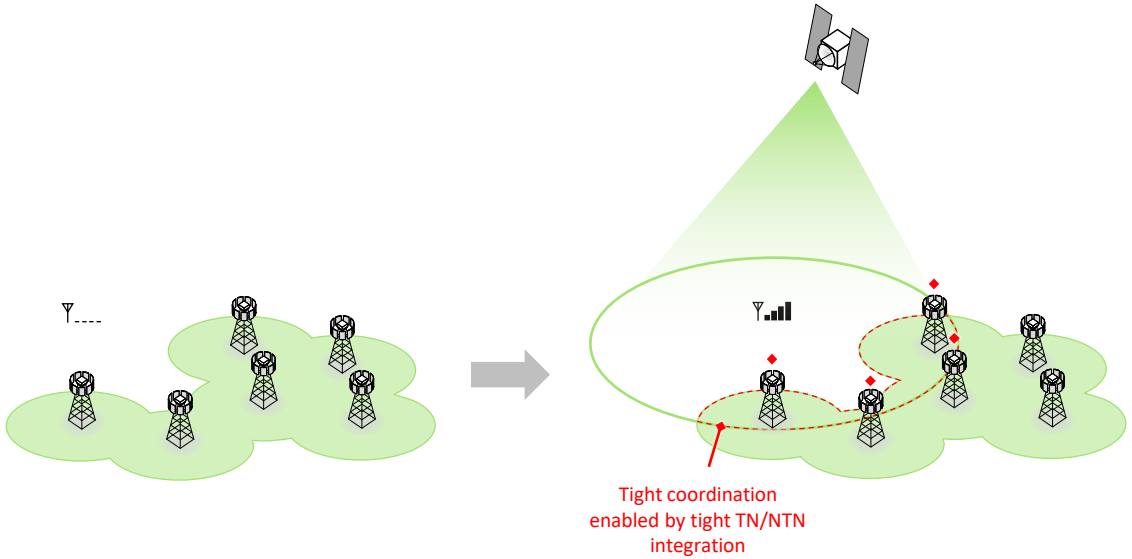
- Motivation
  - **Use case:** CA of sub-3GHz FDD, mid-band TDD (3-7GHz) and mmW
  - **Legacy PDCCH design:**
    - Scheduling blocking rate and DCI overhead scales with the aggregated cell number, *instead of data rate*, for CA of 5-16 cells, *assuming* legacy UE blind decoding capability (e.g. up to a total BD amount of 4 cells)
  - **Legacy CA framework:**
    - Overhead of RRC configuration & L1 measurement report and UE complexity scales with aggregated cell number, *instead of data rate*, while most cells do operate jointly (e.g. FR2)
- Best efficiency for "massive CA"
  - **2-Stage DCI:** From 4 DCI sizes per cell to 1 fallback DCI + 1 unified non-fallback DCI per cell
    - Unified non-fallback DCI (1st stage) in PDCCH to schedule PDCCH or DCI-only PDSCH for aggregated DCIs across 4+ cells (2nd stage)
  - **Cell BW and CBW decoupling:** Multiple CCs for a cell, applies in UL and DL
    - Efficient BWP, HARQ operation and L1 measurements across the multiple CCs



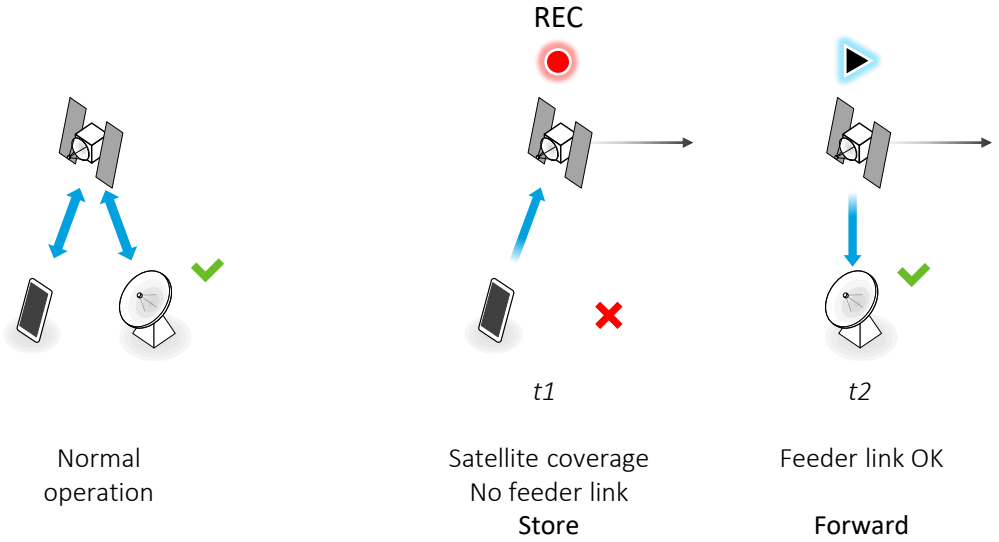


NTN

- **[RAN/4-led] Study:** TN/NTN Spectrum Re-use
  - Leverage 3GPP TN/NTN integration to enable tight, coordinated NTN re-use of TN spectrum in areas with no/low TN coverage
  - Early study on a spectrum reuse scenario where the same spectrum can be used in a complementary manner for satellite where not deployed for terrestrial, and vice-versa



- [SA/CT-led] IoT NTN Store and Forward
  - Min: NAS protocol adaptation to prevent NAS failure and escalating UE back-off (some synergies with discontinuous coverage)

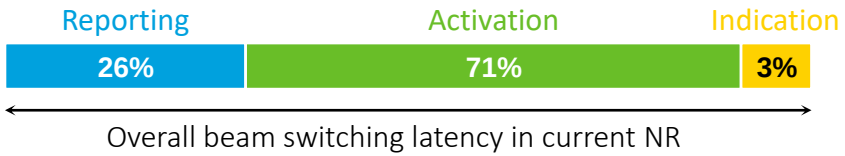


[RAN1-led] MIMO

[1/2]

- Motivation (CSI)
  - [R18 enh. for high mobility] Negligible performance loss from *increasing* feedback periodicity of slow-varying basis (report the same [R1-2204691] W_1, W_f) while keeping that of the linear combination coefficients
    - I.e. overhead can be reduced with negligible performance loss
  - *See next slide for further forward-looking proposal*
- Proposal: 2-tier CSI feedback
  - Tiered CSI feedback with variable rates
  - Long-term report for slow-varying parameters
    - e.g. time-frequency-spatial basis
  - Frequent report of fast-changing parameters
    - e.g. linear combination coefficients

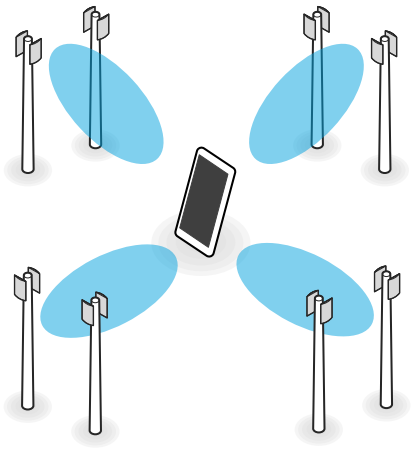
- Motivation (Procedure)
  - [R17/R18] FR2 perf hindered by beam reporting / beam switching latency
  - Field observation: wide NW adoption of UE-reported beams
- Proposal: UE-initiated beam switching / beam reporting
  - **UE-initiated Beam Switching:** Define (configurable) systematic adoption of UE-reported beam(s) by the network
    - Significant reduction of delay between beam reporting & beam switching
    - 70% beam-switching latency reduction expected (if UE switches to new beam w/o the beam activation delay)
  - **UE-initiated Beam Reporting:** A good trade-off between latency reduction and UL resource overhead
    - More attractive if beam switching is initiated by UE
    - 23% beam-switching latency reduction expected



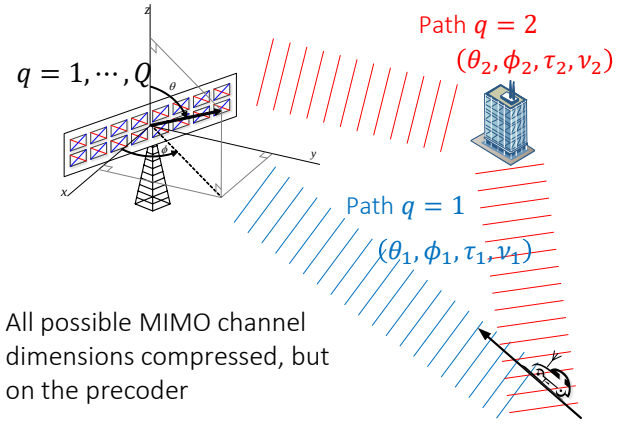
[RAN1-led] Study: MIMO

[1/2]

- Motivation
  - Improve flexibility of current CSI framework for better scenario-dependent adaptation
- Proposal: Study alternative basis for non-uniform antenna scenario
  - Non-uniform antenna scenario: DFT basis not efficient for synthesizing precoder



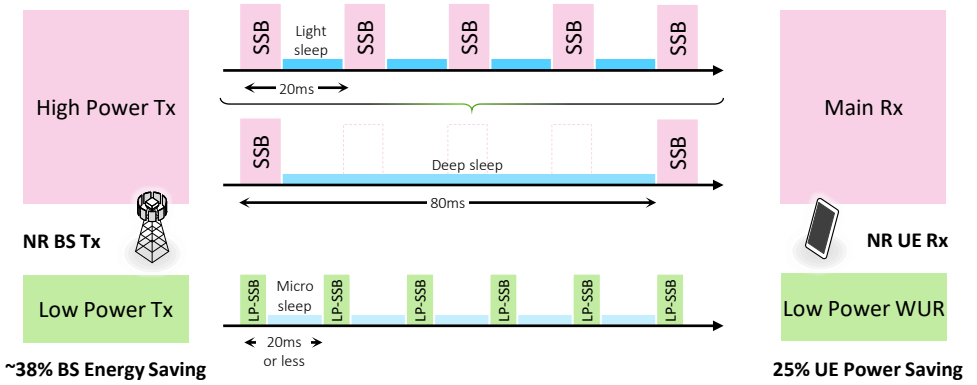
- Proposal: Study Direct Channel Feedback
  - Allows more flexible precoder design for MU-MIMO and other usage such as sensing and positioning



[RAN1-led] System Energy Efficiency

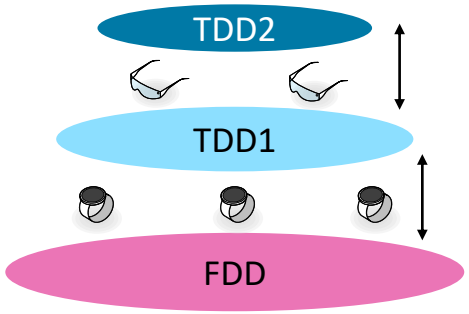
- Motivation
  - Further BS energy saving, e.g., reducing SSB power consumption, should avoid performance impact (e.g. keeping SSS periodicity for UE mobility)
  - Low-power wake-up receiver (LP-WUR) improves both UE power saving and BS scheduling flexibility but should avoid BS energy consumption impact
  - **Need for a joint design** to ensure energy saving and performance KPIs for both BS and UE
- Scenarios
  - **Low data activity:** To reduce BS SSB TX energy w/o UE mobility impact
  - **Higher data activity:** UE energy saving with better BS scheduling flexibility

- **BS: Low-power SSB (LP-SSB)** to minimize UE mobility impact
  - LP-SSB + Legacy SSB of longer periodicity where:
  - LP-SSB: PSS & SSS transmitted with reduced #antennas for RRM and sync only
  - Legacy SSB of longer periodicity: Legacy UE operations
- **UE: LP-WUR** enabling DRX-less scheduling and reduced meas. gaps
- **Integrated LP-WUS and LP-SSB**
  - Reduced PDCCH monitoring and SSB meas. w/ LP-WUR assist.
  - DRX-less scheduling and reduced meas. Gaps
  - LP-SSB redundancy / repetition to compensate for coverage loss

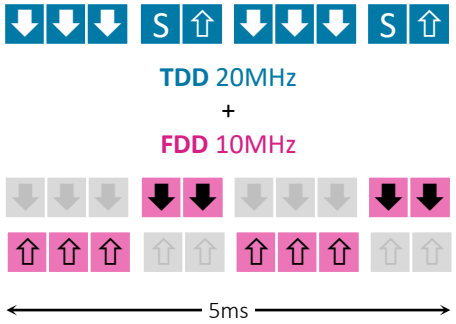


[RAN1-led] RedCap

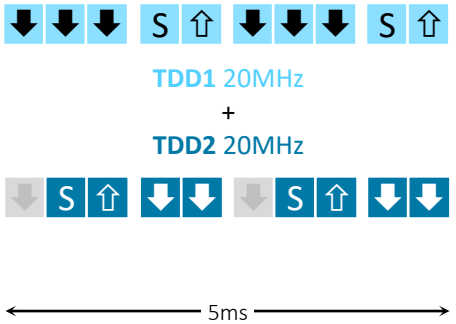
- Motivation
  - Expansion of the RedCap market will require a more efficient use of all available spectrum resources due to increasing #RedCap UEs in the field
  - For RedCap UEs to utilize different frequency resources, only handover and RRC reconfiguration are available that can cause long data interruption and increased signalling load
  - Dynamic utilization of frequency bands for RedCap UEs with single-CC processing capability
- Scenarios
  - TDD bands for RedCap UEs
    - Large BW; inferior coverage, latency
    - Utilize complementary TDD to improve latency and UPT
  - FDD bands for RedCap UEs
    - Good coverage and latency; small BW
    - Utilize TDD band for offloading



- Fast carrier-switching to exploit freq. resources in different bands
  - Short data interruption (~210 µs) for semi-static carrier switching
  - No change to RedCap UE complexity envelop
- FDD-TDD carrier switching operation
  - Mobility in FDD + data offloading in TDD
- TDD-TDD carrier switching operation
  - Exploit complementary TDD D/U resources



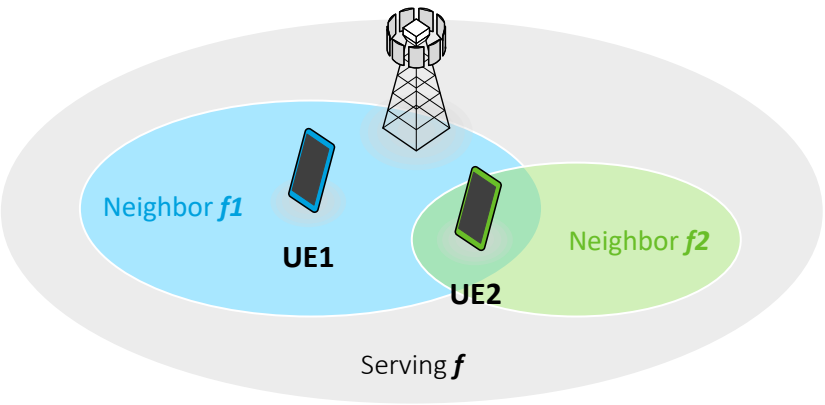
DL: 162.42Mbps (+19%)
UL: 48.41Mbps (+33%)
Fast switch: 210µs gap



DL: 188.74Mbps (+38%)
UL: 57.51Mbps (+58%)
Fast switch: 210µs gap

[RAN2-led] Mobility Enhancements

- Measurement priorities for inter-freq or reporting control
  - Current UE measurement and reporting treat all inter-freq layers with *equal priority*.
  - With increasing number of bands used by MNOs, **more precise control on UE measurement behavior** (e.g. prioritize FR2 over FR1) is desired i.e.
    - **Proposal 1:** RRM measurement requirement based on **NW-configured weighting**
    - **Proposal 2: Additional reporting criterion** for early reporting of high priority frequencies
      - e.g. low priority frequency is only reported if the measurement quality of high priority frequency is lower than a threshold.
- Freq-group based measurement
  - Key Issue: *long* FR2 measurement delay
  - **Proposal:** UE to measure only one **pilot** frequency (configured by NW) in an FR2 band and to assume other freq. in the same band have similar quality
    - MNO/NW define the **pilot** freq. according to its deployment
    - Targeted for *unsuitability* determination

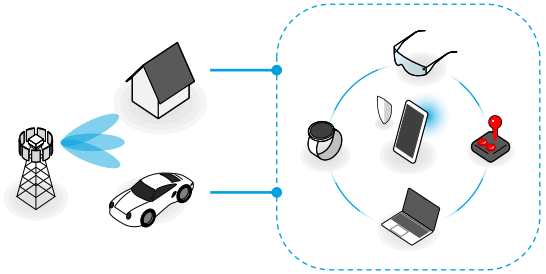


- Current Serving Frequency
- Neighbor Freq 1 (*f1*): (low prio.)
- Neighbor Freq 2 (*f2*): (high prio.)

  - Intended behavior
    - UE2 to report *f2* first
    - UE1 to report *f1*

[RAN1-led] Sidelink

- Motivation
  - Some imbalance between Uu and SL performance (e.g. Tput, Latency) can lead to:
    - forced perf. degradation for Relay-based coverage extension; and
    - unnecessarily restrict services/application running over SL
  - 1-hop SL Relay unnecessarily limits PAN use cases i.e. mesh
  - Increasing interest and demand for proximity communication between devices incl. tethering, collaborative computing
  - SL FR2 (licensed) study in R18
- Scenarios
  - Incl. indoor, in-car
  - Proximity network incl.
    - Wearable devices
    - In-car communication
    - Collaborative computing
  - SL tethering XR
    - SP to XR headset rendering



- Proposal
  - SL FR1
    - CA
      - licensed+ licensed (pending in R18)
      - Licensed + unlicensed
      - Unlicensed + unlicenced
    - 1024QAM (targeted for indoor scenario)
  - SL FR2 (licensed)
    - Beam: initial pairing, management, recovery, etc.
    - Cast type: broadcast/unicast
  - [RAN2-led] mHop relay

Thank You!