3GPP TSG RAN Rel-19 Workshop
Taipei, Taiwan – June 15th – 16th, 2023

RWS-230107
Agenda Item 4

MediaTek Views on Rel-19

Balance between 5G-Advanced Evolution and Technology Exploration

MediaTek Inc.

Outline

- Rel-19 RAN Package and Snapshot
- RAN1-led proposals
- RAN2-led proposals
- RAN3-led proposals
- Misc.

General

MediaTek TDocs

TDoc	Title	Source
RWS-230107	MediaTek Views on RAN Rel-19	MediaTek Inc.
RWS-230108	MediaTek Views on RAN4 Rel-19	MediaTek Inc.
RWS-230109	[RAN-led] Study on Spectrum for Future Radio Access	MediaTek Inc.
RWS-230110	[RAN-led] Study on complementary reuse of terrestrial spectrum in satellite deployments	MediaTek Inc. et al.
RWS-230111	[RAN1-led] Device collaborative Tx and Rx	MediaTek Inc.
RWS-230112	[RAN1-led] Study on UE full duplex operation	MediaTek Inc.
RWS-230113	[RAN1-led] System Energy Efficiency Enhancement for NR (Low Power NR)	MediaTek Inc.
RWS-230114	[RAN1-led] Multi-Carrier Enhancements	MediaTek Inc.
RWS-230115	[RAN1-led] RedCap Multi-Carrier Switching	MediaTek Inc.
RWS-230116	[RAN1-led] NTN NR Enhancements	MediaTek Inc.
RWS-230117	[RAN1-led] MIMO Enhancements	MediaTek Inc.
RWS-230118	[RAN1-led] Study on next generation CSI	MediaTek Inc.

TDoc	Title	Source
RWS-230119	[RAN1-led] Coverage Enhancements	MediaTek Inc.
RWS-230120	[RAN1-led] Study on Channel Modeling for Integrated Sensing and Communication	MediaTek Inc.
RWS-230121	[RAN1-led] Sidelink Enhancements	MediaTek Inc.
RWS-230122	[RAN2-led] Mobility Enhancements	MediaTek Inc.
RWS-230123	[RAN2-led] Study on AI/ML Mobility	MediaTek Inc.
RWS-230124	[RAN2-led] Study on Lean Protocol Stack	MediaTek Inc.
RWS-230125	[RAN2-led] Further XR Enhancements	MediaTek Inc.
RWS-230126	[RAN2-led] SL Relay Enhancements	MediaTek Inc.
RWS-230127	[RAN3-led] NTN IoT further enhancements	MediaTek Inc.

NOTE: TU assessment is provided for each RAN1/RAN2/RAN3 item in the corresponding Tdoc
NOTE: MediaTek SA Rel-19 Views are in SWS-230025

Package Overview
incl. MediaTek and other proposals

SI: Study Item only in Rel-19
SI+WI: Study + Feature in Rel-19
WI: Feature in Rel-19
★: SA/CT dependencies

RAN-led items	RAN1-led items	RAN2-led items	RAN3-led items
SI Study on Spectrum for Future Radio Access [RWS-230109]	**SI+WI** Device-collaborative Tx Rx [RWS-230111]	**WI** Further Mobility Enhancements [RWS-230122]	**WI** IoT NTN Enhancements ★ [RWS-230127]
SI Study on complementary reuse of terrestrial spectrum in satellite deployments [RWS-230110]	**SI** Study on UE Full Duplex Operation [RWS-230112]	**SI** Study on AIML Mobility ★ [RWS-230123]	**WI** AIML NG-RAN
	WI gNB Sub-band Full Duplex	**SI** Study on Lean Protocol Stack [RWS-230124]	**WI** Timing as a Service (possibly RAN2-led)
	WI Low-Power NR (LPWUS+LPSSB) [RWS-230113]	**WI** AIML Framework ★	**WI** SON/MDT Enhancements
	WI Network Energy Efficiency	**WI** XR Enhancements ★ [RWS-230125]	
	WI Multi-Carrier Enhancements [RWS-230114]	**WI** SL Relay Enhancements ★[RWS-230126]	
	WI RedCap Multi-Carrier Switching [RWS-230115]	**WI** UAV Enhancements ★	
	WI Further NR NTN Enhancements ★ [RWS-230116]		
	WI Further MIMO Enhancements (incl. AIML) [RWS-230117]		
	SI Study on next generation CSI [RWS-230118]		
	WI Further Coverage Enh. [RWS-230119]		
	WI Further Positioning Enh. (incl. AIML) ★		
	WI Sidelink Enhancements [RWS-230121]		
	SI Study on Channel Models for Future Radio Access		
	SI Study on Channel Models for ISAC [RWS-230120]		
	SI Study on Ambient IoT ★		

Snapshot

(e)MBB

MIMO
- UE-init Beam Op.
- Tiered CSI feedback
- AI/ML

Study
- Next generation CSI

MC Enhancements
- 2-stage DCI
- Multi-carrier Cell

NTN NR ★
- DL Coverage
- Ku band
- 3MHz
- RedCap UE (RF req)
- Regen. arch. w/ISL ★

***Study* TN spectrum NTN**
- Complementary TN spectrum reuse in NTN deployment

IoT

RedCap
- Multi Carrier Switch

NTN IoT ★
- Store&Forward arch ★
- In-band/guardband coex NB-IoT with NR
- Overhead redux. mobility TN<>NTN

***Study* Ambient IoT ★**
- =f (RAN SID)
- NO 3GPP LPWA scenario/use case

Services

Study
- Lean UP Protocol Stack

XR enh. ★
- Multi-modal flow: 1UE
- 2Rx XR
- (Leftovers)

Positioning
- Uu/SL unlicensed
- AI/ML Pos
- Leftovers (Ranging) ★

Generic Perf. Boosters

Device collaborative Tx and Rx
- Rank augmentation
- Diversity augmentation

Study
- Full Duplex UE Op.

gNB SBFD
- =f(R18 SID result)

Coverage Enh.
- Site sharing enh: Further MPR reduction
- Extreme long range PUSCH
- (Msg5 PUSCH rep.)

Mobility
- LTM enh.
- Meas. efficiency

***Study* AI/ML Mobility ★**
- Data-driven mobility

AI/ML Framework ★

Energy Efficiency

Low-power NR
- LP-SSB x LP-WUS

Network Energy Eff.

Arch/Topology

Sidelink
- FR1 CA
- FR2 licensed [+ FR2 CA]
- Very low power

Sidelink Relay ★
- Multihop (U2U/U2N)
- Multipath continuity
- n3GPP

Migration

Study
- Spectrum: compatibility, coexist.

Study
- Channel model 7-24GHz, (Sub-THz)

★: SA/CT dependencies

Proposals – RAN-led items

[RAN-led] Study on Spectrum for Future Radio Access SI

Motivation

- Channel Modeling for **midband 7-24GHz** and **potentially Sub-THz**
- This raises the questions ***a)*** **of a "clean-slate" radio access** in this spectrum and in turn ***b)*** **of compatibility and coexistence** between applicable radio access in this spectrum and also in existing spectrum i.e.
  - FR1 (licensed, unlicensed); FR2-1; FR2-2
  - New: 7-24GHz; New: (Sub-)THz
- **Important considerations** need to be addressed **in a timely manner, in Rel-19,** in order to aim at a **common understanding** that could frame potential future work in Rel-20 at least on
  - **Target use cases, usage scenarios** incl. associated deployment/operational challenges ***for these spectrum candidates***
  - **Regulatory aspects** incl. designations and regimes
  - **Intended radio configurations** involving a "clean-slate" radio access and other legacy access
  - **Coexistence needs** with incumbents (midband)

Proposal

- **Identify new spectrum candidates**
- **Identify target use cases / usage scenarios for identified spectrum candidates**
  - E.g. wide area, local area, coverage, capacity etc.
  - Deployment and operational challenges
  - NG-RAN architecture gap analysis vs. spectrum candidates requirements
- **Identify regulatory aspects** incl.
  - Designations/regimes for the identified spectrum candidates;
  - Coexistence needs with spectrum incumbents (7-24GHz spectrum candidate) incl. both co-ch and adj-ch coexistence
- **Identify intended radio configurations** involving a "clean-slate" radio access and other legacy access focusing on
  - Spectrum sharing schemes (e.g. DSS) with legacy radio
  - Joint connectivity with legacy radio
  - Standalone "clean-slate radio access" configurations

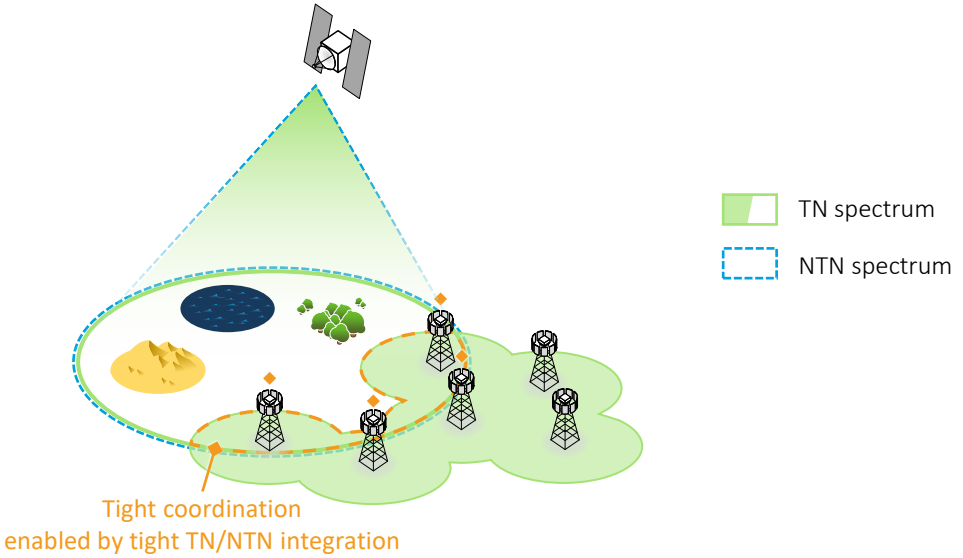
[RAN-led] Study on *complementary* reuse of Terrestrial SI spectrum in Satellite deployments

Motivation

- With the **convergence of terrestrial and satellite technologies** under a common platform, industry stakeholders have become open to the **possibility to allow spectrum allocated for terrestrial use to be used in a supplementary manner by satellite deployments in the same country** (see e.g. FCC 23-22 NPRM, March 2023).
- 3GPP TN+NTN integration: **3GPP unique position to identify**
  - **How *terrestrial* spectrum could be reused for satellite deployments**
  - **The potential associated opportunities and challenges, and possible techniques to address these**
- Reuse of TN spectrum in NTN deployments allows
  - **Growth of the NTN ecosystem** by increasing the spectrum capacity available for NTN users
  - **Adding value to TN and NTN stakeholders** as well as to **end users** e.g. consumers, verticals, etc. by
    - Allowing **TN operators to *fully* exploit their spectrum** assets in areas where traditional TN deployment is otherwise not cost-effective
    - **Augmenting the service availability and QoE over NTN** via higher capacity (i.e. NTN spectrum and TN spectrum)

Proposal

- Study the possibility to reuse *terrestrial* spectrum in Satellite deployments in a complementary manner, *in geographical areas where terrestrial connectivity for this spectrum is not available,* with initial focus on FR1
  - Outline the current regulatory status & ongoing activities
  - Identify the relevant operating scenarios, technical benefits and challenges
  - Highlight any potential techniques that may assist such operation

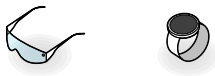


Proposals – RAN1-led items

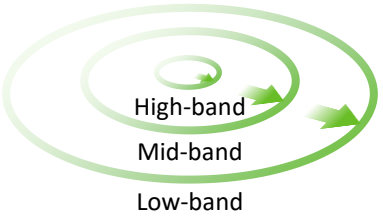
[RAN1-led] Device Collaborative Tx and Rx
SI+WI

Issues

- Device form-factor restrictions: Bottleneck of MIMO gain, due to physical limitations in the number of feasible Tx and Rx antennas



- Worse propagation/coverage properties in higher frequencies: Limit maximizing the MIMO gain *even when* more device antennas are feasible



Observation: More and more users carry a multiplicity of devices

- Such personal network of devices open some opportunity for collaboration that can address the above issues

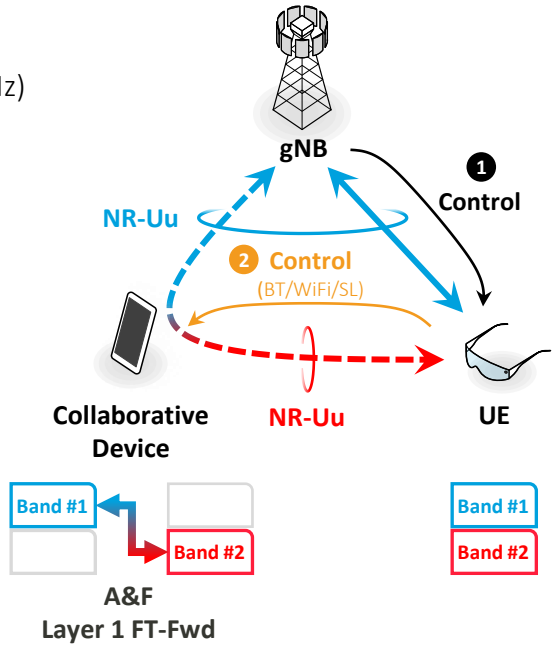
⇨ **The collective PHY capability of devices in close proximity can offer much greater performance than with a device alone.**

Proposal: UE to aggregate its own antenna capability with that of a collaborative device to obtain increased UL/DL MIMO performance

- Collaborative device = external antenna panel wirelessly connected to a UE
  - A&F with L1 Freq. Translation (Bands #1<>#2) with ~zero latency
  - Controlled by UE (under strict gNB constraints); Transparent to gNB
- Band#1: FR1 wide area (≤3.5GHz)
- Band #2: FR1 limited coverage (4.5/6GHz) (limited Tx power e.g. max 10dBm)
- Control: ❶ Side control info
  ❷ Layer 1 FT-Fwd control

⇨ **Path Combining – Higher Rank**
  - 35~50% higher UPT

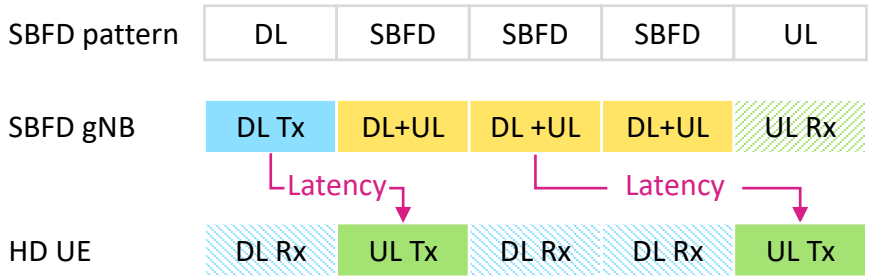
⇨ **Path Selection – Higher Diversity**
  - 15~30% higher UPT



[RAN1-led] Study on UE Full Duplex Operation
SI

Motivation

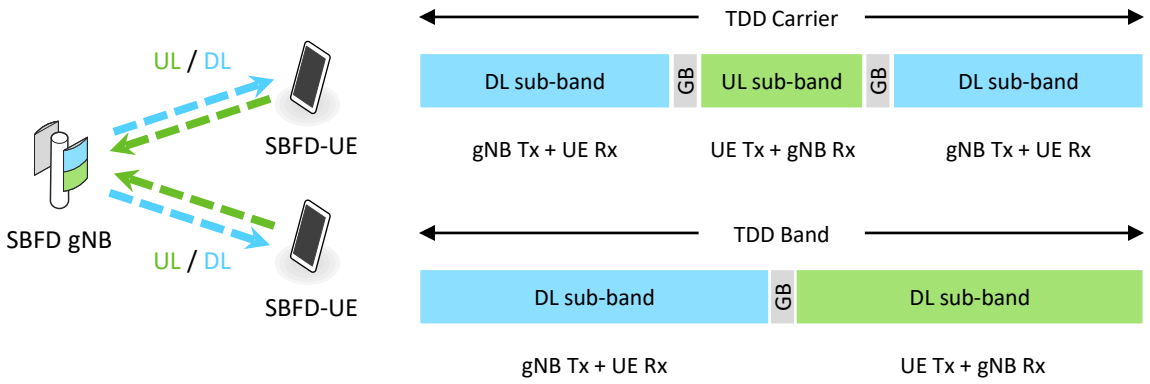
- TDD bands offer large bandwidth – essential to achieve high Tput and reliability
- **BUT** TDD patterns result in increased latency, and limited capacity and coverage
- **SBFD-gNB** alleviates the issue to some extent but **UE HD operation** remains the latency bottleneck due to non-simultaneous UL/DL UE operation



⇨ **Need to enable FDD-like low-latency in TDD bands, to improve capacity for latency-sensitive services, particularly important for the successes of XR**

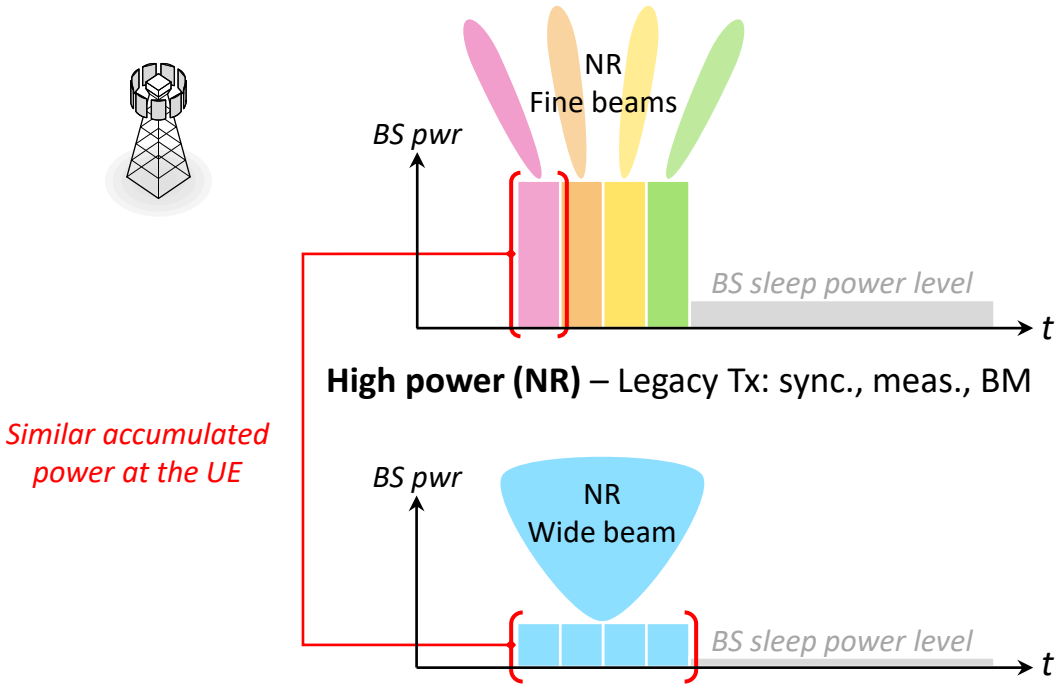
Proposal: Study full-duplex operation at UE

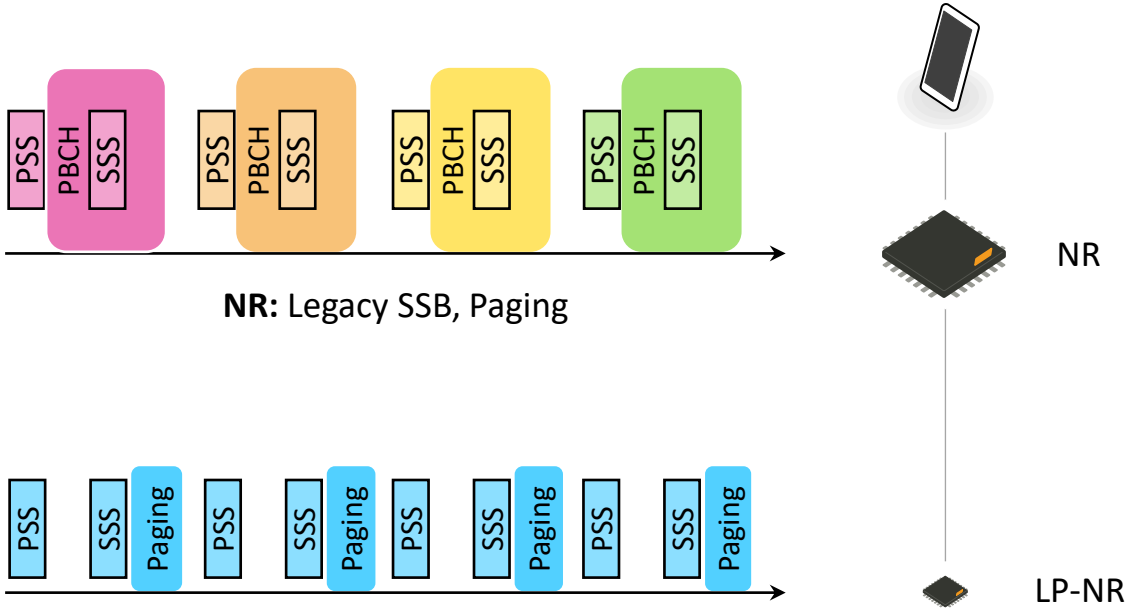
- Non-overlapped simultaneous transmission and reception
- Within a carrier or across different carriers (in intra-band CA)
- Investigate aspects to allow constraining UE complexity e.g. level of frequency separation (if needed) between Rx and Tx sub-bands, opportunistic operating conditions (e.g., UE Tx power level, inter-cell-interference level, UE Tx allocation, etc.), different device types.



- NOTE: This is a study only with no normative work targeted in Rel-19

[RAN1-led] System Energy Efficiency – Low Power NR WI





LP-NR @BS: Reduced #antenna for SSB and paging ***saves BS power***

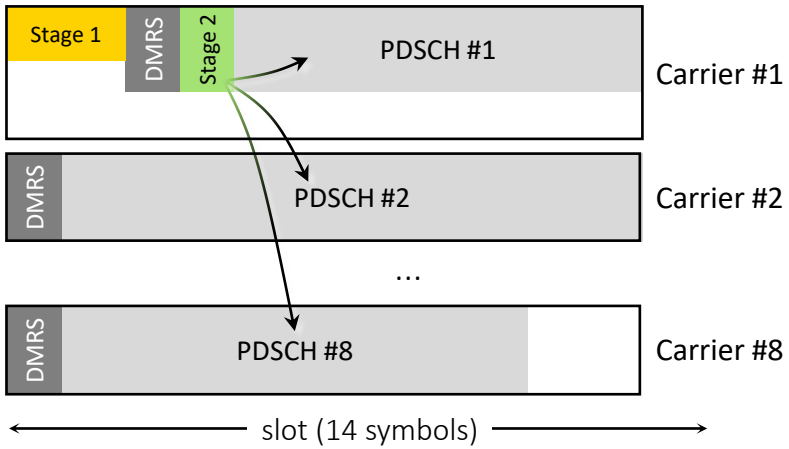
LP-NR @UE: Accumulating all TX occasions ***maintains coverage***

LP-NR @BS provides PSS, SSS and OOK indication

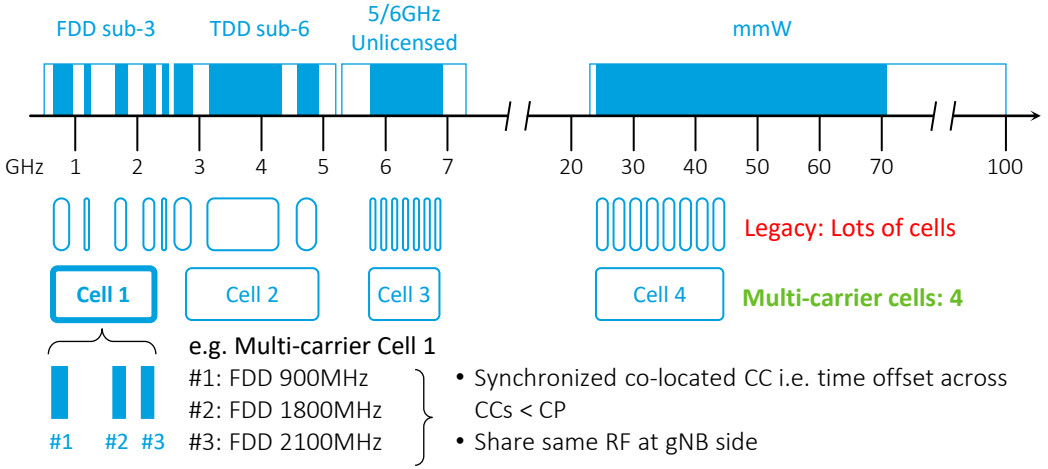
LP-NR @UE allows both more frequent signal reception/processing and reduced power consumption

[RAN1-led] Multi-Carrier Enhancements WI

- **Issue 1:** MC-DCI size is not scalable leading to PDCCH blocking
  - Redundant bits exist in DCI when scheduled CCs are fewer than the maximum RRC-configured aggregated CC number
  - Higher aggregation level for non-scalable DCI size adversely affects **PDCCH blocking rate and in turn user Throughput**
- **Proposal 1:** 2-stage DCI for better scheduling flexibility and minimal DCI overhead
  - Unified non-fallback DCI (1st stage) in PDCCH to schedule PDCCH or DCI-only PDSCH for aggregated DCIs across 4+ CCs (2nd stage)

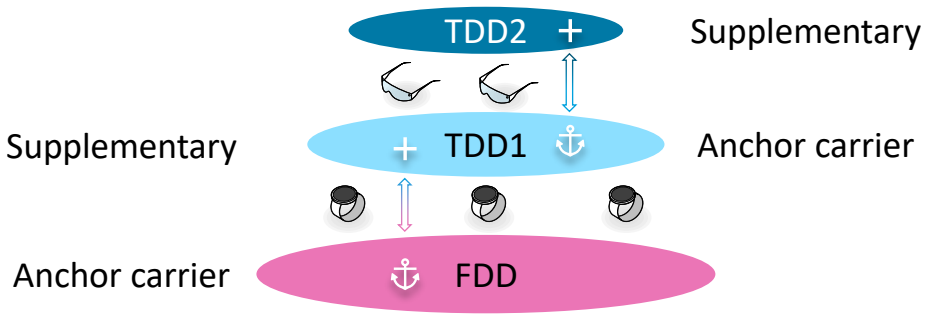


- **Issue 2:** CA inefficiencies
  - One carrier is associated with one cell. PHY/RRC complexity/overhead scales with cell number
  - X-carrier resource utilization is not efficient enough due to **Slow, inflexible Carrier activation/de-activation** and **Long HARQ latency for TDD**
- **Proposal 2:** Multi-Carrier Cell
  - Enable multiple CCs for a cell in both UL and DL
  - Enhanced HARQ operation addressing TDD latency bottlenecks
  - Fast carrier (de)activation within a cell
  - Joint RRC (re)configuration and L1/L3 processing operations for an MC Cell



[RAN1-led] RedCap Multi-Carrier Switching WI

- **Issue:** Lack of CA & 20MHz CBW prevents RedCap UE from using available resources to maximize data rate & latency performance
  - Available resource constraint, e.g., <20MHz in many FDD bands and no simultaneous DL + UL in TDD
  - FD-FDD capable UE may be unable to use its simultaneous 20 MHz DL + UL processing capability

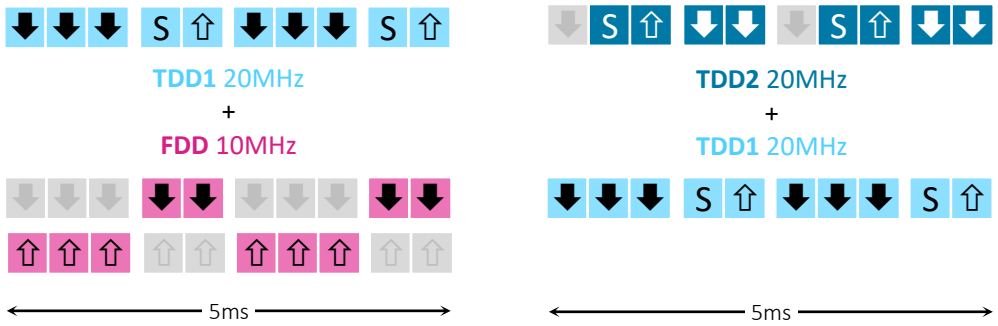


- **Proposal:** Redcap Multi-Carrier Switching would allow RedCap UE to:
  - Independently switch UE DL or UL to supplementary band to allow simultaneous **cross-band UL and DL operation**
  - Overcome available resource constraints in one FDD/TDD carrier

  NOTE: **Semi-static switching** configuration = no new L1 signalling overhead

  NOTE: Single TAG i.e. collocated carriers

  - **Enables greater use of available spectrum:**
    - to **improve RedCap UE throughput & latency**
    - while **maintaining the UE complexity envelope**



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

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

[RAN1-led] NTN NR Enhancements WI

Focus efforts on enhancements that broaden the applicability of NR NTN, rather than specifying alternatives to existing 3GPP solutions

I. DL coverage enhancements [RAN1, RAN2, RAN4]

- **Issue:** deep shadowing not addressed in Rel-18
- **Proposal**
  - Rel-19 enhancements with a study phase to identify the DL SNR target.
  - Both FR1 and >10GHz
  - 2Rx UE, and for FR1 1Rx RedCap UE

II. RedCap UE support [RAN4]

- **Issue:** no UE RF requirements for 1Rx, or HD-FDD operation specified
- **Proposal:** RedCap UE with 1Rx antenna and FD-FDD as well as HD-FDD operation

III. >10GHz enhanced support [RAN4]

- Ka band was used as the baseline band for >10GHz operation
- Additional market value in specifying Ku band for NR NTN:
  - [DL:10.7–12.75 GHz; UL 12.75–13.25 GHz & 13.75–14.5 GHz]
- **Proposal:** Support for Ku band reusing req framework from Ka/FR1 band

IV. 3MHz channel bandwidth support [RAN4, RAN1]

- **Motivation:** The need for a narrower channel bandwidth than 5MHz has been identified when considering frequency reuse deployment scenario within a satellite spectrum block.
- **Proposal:** Support for 3MHz channel bandwidth in FR1 satellite bands (reusing work on NR_FR1_lessthan_5MHz_BW)

V. Regenerative payload with ISL [RAN3 (+SA2)]

- **Issue:** Rel-17~18 NR (and IoT) NTN only support transparent payload: this is a major limiting factor for NGSO NTN whereby coverage, service and QoS are reliant on the availability of a feeder link and its characteristics
- **Proposal:** introduce regenerative payload w/ ISL to address the above by
  - Lifting the reliance on the feeder link
  - Reducing latency
  - Increasing throughput
  - Increasing capacity

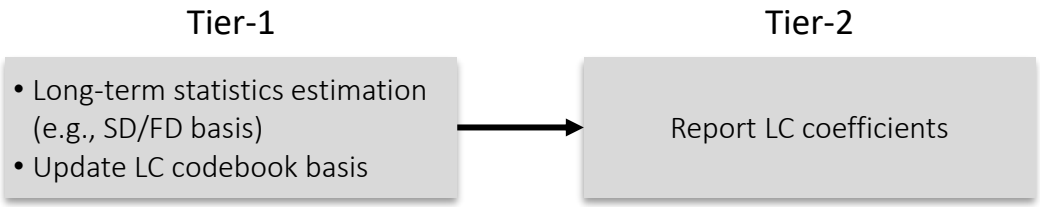
[RAN1-led] MIMO Enhancements
WI

Motivation

- [R18 enh. for high mobility] targets **time-domain CSI compression** as a means to **reduce reporting overhead while preserving MIMO performance** – however further overheard reduction is possible
- 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 ~without performance loss**

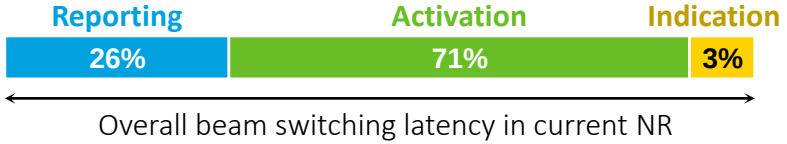
Proposal: Tiered CSI feedback with variable rates

- **Long-term report for slow-varying parameters**, e.g. time-frequency-spatial basis
- **Frequent report of fast-changing parameters**, e.g. linear combination coefficients
- **Expected Overhead reduction**: up to 20% depending on configuration



Motivation

- **Larger antenna array** is a key technique to enable cost-effective **mmWave**, but it suffers from **mobility issue** caused by **beam switching latency**
  - Smaller beam dwell time when increasing array size
  - NR mmWave performance degrades under larger antenna array due to large beam switching latency: **Previous enhancements focused on reducing latency for beam indication**
  - **The primary latency components are beam reporting and activation**



Proposal: UE-initiated beam operation

- **UE-initiated beam switching:** Define (configurable) systematic adoption of UE-reported beam(s) by the network to avoid beam activation latency
- **+ UE-initiated beam reporting:** Beam reporting according to pre-defined event(s) instead of a certain periodicity to reduce beam reporting latency
  - Most effective when combined with UE-initiated beam switching

[RAN1-led] Study on Next generation CSI SI

Issues

- UE CSI Feedback is in the form of precoder (PMI) with compression in space, frequency and time domains
  - Limitations in interference suppression in multi-user scenario
- CSI codebook is based on an ideal assumption of equidistant antenna elements – unrealistic in some deployments (e.g. mMIMO mTRP) where DFT-basis precoder synthesis is inefficient
- Varying compression efficiency (e.g. #paths < #Tx ports)
- Precoder not smooth across frequency sub-bands and time domain
- Strong(er) channel sparsity in higher frequency bands

Proposal: Study a unified framework for scenario-dependent CSI feedback

- **Study alternative basis to DFT-basis** for space/frequency/time domain compression
  - e.g. eigenvectors
  - Target a) better compression efficiency due to UE-specific basis and b) adaptability to different scenarios
- **Study and evaluate direct channel feedback i.e. direct feedback of parameterized MIMO channel**, to allow
  - Better compression efficiency than eType-II
    - Early results show 5%~10% over eType-II in MU-MIMO (with large room for improvement)
  - CSI interpolation/extrapolation in time/frequency/spatial domains
  - Straightforward exploitation of channel sparsity
  - Flexible TRP selection in mTRP C-JT without additional UE complexity
  - Pilot/feedback overhead not in direct proportion to the gNB array size
  - High resolution channel acquisition for sensing and positioning

PMI: Precoding Matrix Indicator

[RAN1-led] Coverage Enhancements
WI

Motivation

- Rel-18 UL Coverage Enh. focused on power domain improvements to further boost coverage and UL throughput for generic usage
- There may be certain network operating scenarios or conditions where UL power domain enhancements may be viable *without* incurring additional UE complexity

Proposal – Power domain improvements

- Study whether UL power domain enhancements may be viable without extra UE complexity in certain operating scenarios, and specify enhancements if justified

Motivation

- Extreme long-range requirements (Stage 1):
  ≤100km, low density ~2user/km^2, min UL 100kbps @cell edge

Proposal – PUSCH enhancements

- PUSCH Enhancements can be considered

Motivation

- Msg1 multiple PRACH Tx and Msg3 PUSCH repetitions specified
- Msg5 *may* be a coverage bottleneck @initial access in some cases

Proposal – Msg5 PUSCH repetitions

- Msg5 PUSCH repetitions can be considered if beneficial

[RAN1-led] Study on Channel Modeling for ISAC SI

Motivation

- Increasing interest for Integrated Sensing and Communication (TR22.837)
- The ISAC promise lies in the processing of *existing* radio communication signals[1] to deliver **value-adding sensing information** e.g. for radio network self-optimization; object detection; contact-free health monitoring etc.
- Prior designing technology for ISAC using 3GPP radio, **understanding how to model channels for sensing is fundamental**
  - Existing 3GPP channel models are defined only for radio communication
  - There is no existing 3GPP channel model considering the characteristics of communication and sensing

Proposal

- Identify target use cases
- Study the impact of sensing mode (monostatic, bistatic) and sensing type (active/passive) on channel modeling
- Study whether and how TR38.901 channel models can be enhanced
  - Incl. gap analysis
- Both FR1 and FR2

gNB monostatic | UE monostatic | gNB-gNB bistatic | gNB-UE bistatic | UE-gNB bistatic | UE-UE bistatic

NOTE 1: e.g. reflected, refracted, diffracted or scattered

[RAN1-led] Sidelink Enhancements
WI

Motivation

- Some imbalance between Uu and SL performance (e.g. Tput, Latency) can lead to
  - forced perf. degradation for Relay-based coverage extension
  - unnecessarily restrict services/application running over SL
- Very low power operation in unlicensed spectrum introduced or being introduced by regulations in some regions/countries
  - i.e. very low Tx power, incl. without LBT (e.g. China)
- SL FR2 (licensed) studied in Rel-18

Proposal – Specify SL support as follows

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

NOTE 1: e.g. reflected, refracted, diffracted or scattered

Proposals – RAN2-led items

[RAN2-led] Further Mobility Enhancements WI

Motivation – LTM

- LTM procedure is triggered by network command
  - Issues of Robustness (loss of HO CMD) and Signaling overhead (more frequent L1 measurement report)
- LTM: significantly shorter ToS and more frequent cell switches than with legacy HO
  - Data loss rate caused by HARQ reset at cell switch is x1%
- LTM: only supported intra-CU
  - Low-interruption HO cannot be achieved in all scenarios

Proposal – LTM Enhancements

- Conditional LTM: UE-triggered LTM based on network config. Conditions. RACH-less (as in Rel-18)
- HARQ Continuation in target cell: same HARQ ID for new Tx / ReTx of a TB in both source and target cells
- Inter-CU LTM (w/o inter-DU interface)

Motivation – Measurement efficiency

- Unnecessary measurements, inefficient measurement and reporting
  - Each candidate treated with equal priority by the UE – less preferred targets may be reported first resulting in perf. loss
  - L1 measurement of an LTM Target wastes resources if the corresponding quality of L3 measurement is low
  - Meas. of all freq. expected to be of the same quality is inefficient

Proposal – Measurement efficiency improvements

- **Conditional L3 meas. based on a Pilot Frequency** in a Freq. Group (network-configured): UE skips measuring frequencies in a group if the strongest cell in the pilot frequency is lower than a Threshold
- **L1 LTM meas. conditional to L3 meas.** being higher than a threshold
- **Weighted measurements** (Connected mode) based on nw-controlled priorities: high priority freq weighted higher
- **New reporting criterion:** report a low priority freq. if the measurement quality of a higher priority freq. is lower than a threshold

ToS: Time of Stay

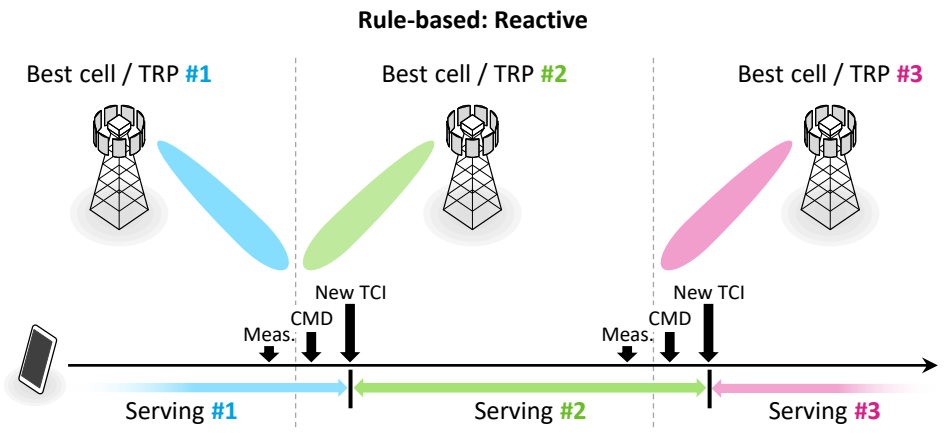
[RAN2-led] Study on AI/ML Mobility SI

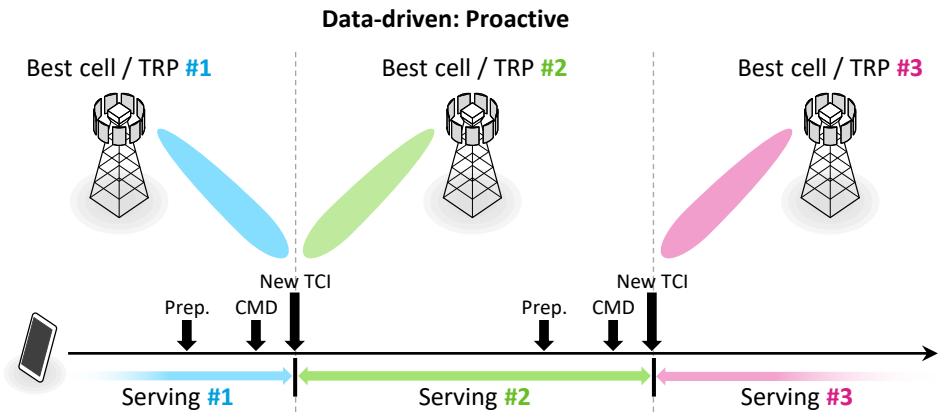
Motivation – Limitations of Rule-based mobility

- Cannot achieve optimum perf. in extreme scenarios (FR2, high mobility)
- Reactive by-design i.e. not fast enough to adapt for extreme mobility
- High complexity, high measurement effort and high signaling overhead
- New capacity-hungry services e.g. XR (high Tput, low latency) need reliable mobility
- Need for optimum mobility perf. with min. overhead in FR1 and FR2

Proposal – Proactive data-driven mobility

- Better mobility perf.; reduced meas. effort, signalling OH and latency
- **Use Case #1:** AI-based target cell prediction (HO execution)
  - Accurately predict *when* to HO to *which* cell/beam
- **Use Case #2:** AI-assisted RRM measurement
  - Accurately predict RRM measurement e.g. RSRP to reduce measurement effort and need for measurement gaps
- **Study required:** use cases, performance benefits, specification impact





OH: Overhead

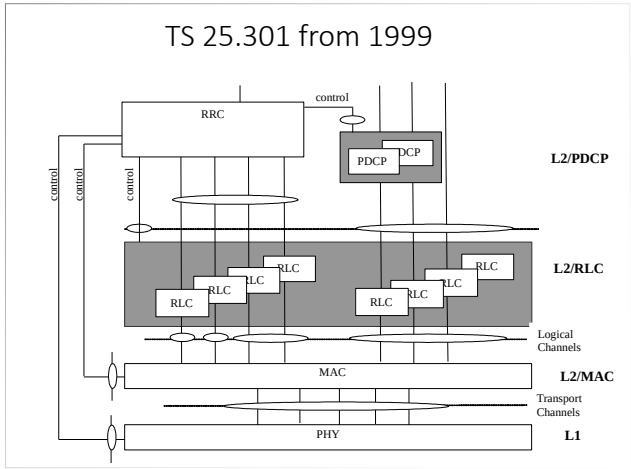
[RAN2-led] Study on Lean Protocol Stack
SI

Motivation – The World has changed, not so much the UP stack

- 3GPP Uu UP stack has remained ~unchanged since UMTS R99...
- ...yet significant changes have occured outside 3GPP
  - Increasing data rate expectations (from kbps to Gbps)
  - Shrinking delay expectations (from seconds to <20ms)
  - Services migration to the edge
  - Changing transport layer protocols (from TCP to RTP, QUIC)
  - Wireless access has become the norm
- Known gaps (examples)
  - Processing overhead in UE and gNB
    - *N* downlink data packets ⇨ *N* uplink ack packets
    - UL data rate << DL data rate, but UL processing ≈ DL processing
  - UL scheduling delays
    - DG: 2 RTTs delay (SR+BSR) for an appropriately sized grant
    - CG: Reduced delay, unused resources leads to capacity loss
- Known gaps (examples) (cont'd)
  - Reliability for delay-constrained traffic
    - HARQ: good delay perf. but faces reliability issues (e.g. feedback unreliability)
    - ARQ: high reliability, poor delay performance (e.g. window stalls)

Proposal

- A holistic study of the current NR UP stack performance and its gaps is needed to enable lean and responsive UP operation, in terms of
  - Throughput
  - Delay
  - Reliability



CG: Configured Grant
DG: Dynamic Grant

[RAN2-led] XR Enhancements WI

Motivation

- (Potential Rel-18 leftovers on capacity and power-saving)
- Multi-modal XR (single UE)
  - Incl. haptics, sensors etc.
  - (Synchronized) multi-flow traffic with high capacity, data rate and low latency requirements: potential efficiency improvements in terms of synchronization and scheduling/RRM coordination between different flows of one UE may be needed
  - NOTE: no value identified across multiple UEs
- 2Rx XR
  - Clear demand to introduce 2Rx support for XR device in bands where 4Rx are currently mandated has been voiced – discussions are ongoing in Rel-18
  - This should be introduced in Rel-19 if not in Rel-18

Proposal

- Measurement Gap enhancement
- PDCCH monitoring resumption after NACK (if not in Rel-18)
- C-DRX enhancements to reduce active time for power saving
- Support of 2Rx for XR device with 100MHz channel bandwidth and optional CA support (if not in Rel-18)

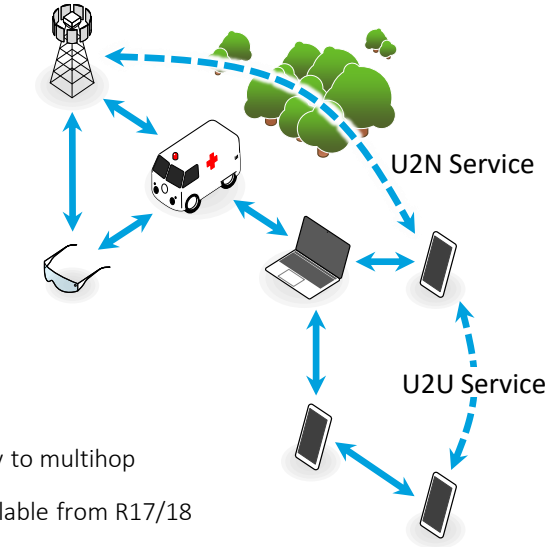
- Multi-modal XR – single UE only
  - Synchronization and coordination between multiple flows
  - Scheduling enhancements (if justified)

[RAN2-led] Sidelink Relay Enhancements WI

Motivation

- U2N/U2U relaying models for services from anywhere to anywhere
  - Multihop combining U2N and U2U
  - Service continuity in all scenarios
  - Integration of non-3GPP transport
- More dramatic coverage extension via multihop
  - Public safety, IoT, etc.
- Devices can extend services to distant peers e.g.
  - Shared XR activities

  - V2X: vehicles sharing environment/sensor info



- NOTES:
  - Rel-18 considers U2U fwd compatibility to multihop
  - Service continuity for U2N Relay is available from R17/18

Proposal

- Specify support for multihop U2U Relaying
  - remote UE ⇔ relay UE ⇔ relay UE ⇔ remote UE
  - SRAP, discovery, and (re)selection enhancements to support multihop routing
  - Service continuity (change of relay UE)
- Specify support for multihop U2N Relaying
  - network ⇔ relay UE ⇔ relay UE ⇔ remote UE
  - SRAP, discovery, and (re)selection enhancements to support multihop routing
  - Service continuity (change of relay UE, [gNB])
- U2N service continuity to multipath
- U2U, U2N relay with non-3GPP transport
  - Non-3GPP <SRAP> 3GPP higher layers

Proposals – RAN3-led items

[RAN3-led] NTN IoT Enhancements WI

Focus efforts on enhancements that broaden the applicability of IoT NTN, rather than specifying alternatives to existing 3GPP solutions

I. Regenerative payload with Store and Forward [RAN3 (+SA2)]

- **Issue:** Rel-17~18 IoT (and NR) NTN only support transparent payload: this is a major limiting factor for NGSO NTN whereby coverage, service are reliant on the availability of a feeder link and its characteristics
- IoT data (and data sent using 3GPP IoT) are inherently delay-tolerant: E.g. for emergency messaging, data delivery is critical, with delay-tolerance compatible with 3GPP IoT
- **Proposal:** regenerative payload w/ Store & Forward addresses the above by
  - Lifting the reliance on the feeder link
  - Allowing data transmission and storage in absence of a feeder link, and data delivery when the feeder link resumes
  - NO ISL

II. High Power UE [RAN4]

- **Motivation:** Interest was expressed for high-power IoT NTN UE
- **Proposal:** Support for high-power UE (PC TBD, Freq bands TBD)

III. In-band, guardband coexistence of NB-IoT with NR [RAN4]

- **Motivation:**
  - Current RAN4 requirements assume no inband or guardband operation for NB-IoT in an NR channel operated from the same SAN, although **UE RF req already provide flexibility for this**.
  - Stakeholder interest was expressed for this scenario
- **Proposal:** SAN requirements for in-band, guardband coexistence of NB-IoT with NR

IV. Overhead reduction during NTN/TN mobility [RAN3, (RAN2) (+SA2)]

- **Issue:** Change of UE capabilities between TN/NTN triggers TAU or retrieval of capabilities from the UE, leading to additional overhead esp. with discontinuous coverage. Avoiding/reducing overhead is needed[2]. Work is expected to start from SA2
- **Proposal:** means to reduce or avoid signaling overhead at TN/NTN mobility (under coordination with SA2)

Misc.

Handling of AI/ML Normative work

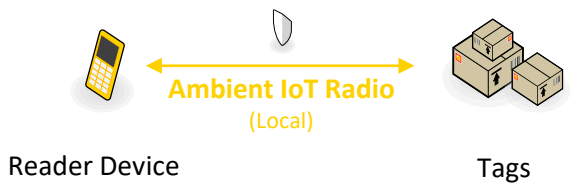
Motivation

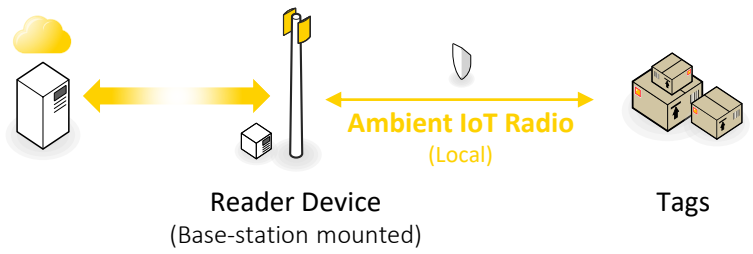
- A single Rel-18 Study on AI/ML was created focusing on
  - **Use Cases:** CSI Compression, Beam Management, Positioning
  - **Framework**
- Should normative work proceed for one or more of the above use cases – it is important the work be carried out with the corresponding expertise

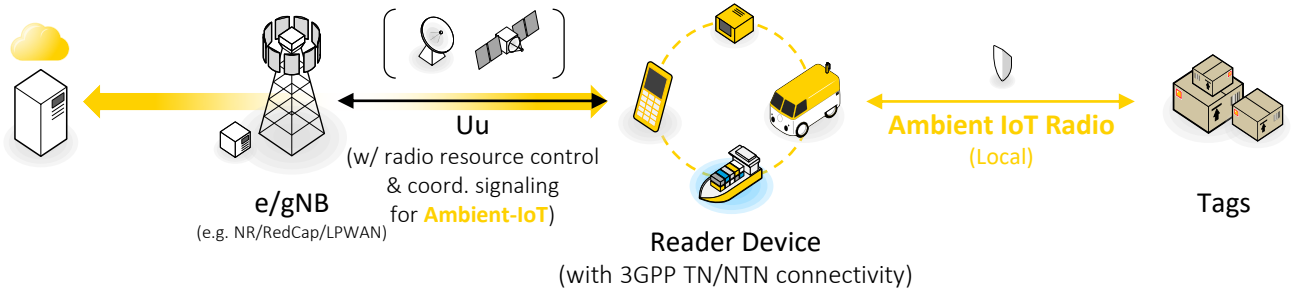
- **Proposal**
  - Handle AI/ML normative work on a given use case in the corresponding Work Item i.e.
    - CSI and Beam Management in MIMO enhancements
    - Positioning in Positioning enhancements
    - Only use cases with positive SI conclusion should proceed
  - Work on the Framework should be handled under a single WI led by RAN2

[RAN1-led] Ambient IoT
SI

- All scenarios and use cases readily achievable with existing 3GPP LPWA ***shall*** remain out of scope
- **Proposal:** Ambient IoT to ensure
  - Tags remain *as simple as possible* i.e.
    - **behavior agnostic to the deployment scenario** itself: Tag only interacts with a Reader Device (embedded in a UE or base station mounted)
    - **Tags are not UEs** i.e. tags have no SIM, and operate in a connection-less manner only to receive/transmit data
  - Deployments remain as simple as possible i.e. with minimal system impact
  - Ambient IoT RAT operates *only* between Reader Device and Tag
  - **All radio resources for Ambient IoT are under full control of the network**
  - **The above secures added value to MNOs with**
    - **minimal impact to infrastructure**
    - **minimal impact to devices**
    - **minimal Tag complexity**







[RAN1-led] Positioning Enhancements WI

- **Motivation**
  - Positioning was the biggest item in Rel-18 – it should be reduced significantly in Rel-19
  - The main leftover is support for unlicensed spectrum
  - (Possible SL Pos/Ranging leftovers)
- **Proposal:**
  - Support for unlicensed spectrum (Uu, SL)
  - Support for AI/ML (if concluded accordingly in the Rel-18 study)
  - SL Positioning / Ranging leftovers

TU Baseline Estimate

TU Baseline
RAN1, RAN2, RAN3

RAN1 TU Baseline	Q1 2024	Q2 2024	Q3 2024	Q4 2024	Q1 2025	Q2 2025	Q3 2025	Q4 2025	Q1 2026	TOTAL
Total TU available	**31**	**62**	**31**	**62**	**31**	**62**				**279**
Maintenance (nominal TUs)	4	8	4	8	4	8				36
Maintenance (additional TUs)	11	4	4	0	0	0				19
Reserved TUs ([5%-15%] capacity)		4	2	4	2	4				16
Rel-19 TEIs				2	1	2				5
Impacts from other WGs TSGs		2	1	4	2	4				13
Total TU SI WI	**16**	**44**	**20**	**44**	**22**	**44**	0	0	0	**190**

RAN2 TU Baseline	Q1 2024	Q2 2024	Q3 2024	Q4 2024	Q1 2025	Q2 2025	Q3 2025	Q4 2025	Q1 2026	TOTAL
Total TU available		**80**	**40**	**80**	**40**	**80**	**40**			**360**
Maintenance (nominal TUs)		26	13	26	13	26	13			117
Maintenance (additional TUs)		13	13	3	2	0	0			31
Reserved TUs ([5%-15%] capacity)			3	6	3	6	3			21
Rel-19 TEIs					1	2	1			4
Impacts from other WGs TSGs		1	1	3	2	4	2			13
Total TU SI WI	0	**40**	**10**	**42**	**19**	**42**	**21**	0	0	**174**

RAN3 TU Baseline	Q1 2024	Q2 2024	Q3 2024	Q4 2024	Q1 2025	Q2 2025	Q3 2025	Q4 2025	Q1 2026	TOTAL
Total TU available		**38**	**19**	**38**	**19**	**38**	**19**			**171**
Comebacks		6	3	6	3	6	3			27
Maintenance, LS, TEI (nominal TUs)		8	4	8	4	8	4			36
Maintenance, LS, TEI (additional TUs)		1	1	1	1	1	1			6
Reserved TUs ([5%-15%] capacity)		2	1	2	1	2	1			9
Total TU SI WI	0	**21**	**10**	**21**	**10**	**21**	**10**	0	0	**93**

TU Baseline
RAN4

		RAN4 Core Part					RAN4 Perf Part			
RAN4 TU Baseline	**Q1 2024**	**Q2 2024**	**Q3 2024**	**Q4 2024**	**Q1 2025**	**Q2 2025**	**Q3 2025**	**Q4 2025**	**Q1 2026**	**TOTAL (Core)**
Total TU available		**90**	**45**	**90**	**45**	**90**	**45**	*90*	*45*	**405**
Total TU available RF		**49**	**24.5**	**49**	**24.5**	**49**	**24.5**	*49*	*24.5*	**220.5**
Total TU available RD		**41**	**20.5**	**41**	**20.5**	**41**	**20.5**	*41*	*20.5*	**184.5**
Maintenance (nominal TUs)		9	5	6	3	4	2			29
Maintenance (additional TUs)		0	0	0	0	0	0			0
Reserved TUs ([5%-15%] capacity)		2	1	2	1	2	1			9
Rel-18 perf part	**?**	**?**								0
Rel-19 TEIs										0
Impacts from other WGs TSGs		2	1	2	1					6
Reserved for Spectrum Items		13	6.5	13	6.5	13	6.5			58.5
Total RF TU SI WI		**23**	**11**	**26**	**13**	**30**	**15**	*49*	*24.5*	**118**
Maintenance (nominal TUs)		10	7	4	2	4	2			29
Maintenance (additional TUs)		0	0	0	0	0	0			0
Reserved TUs ([5%-15%] capacity)		2	1	2	1	2	1			9
Rel-18 perf part	**?**	**?**								0
Rel-19 TEIs										0
Impacts from other WGs TSGs		2	1	2	1					6
Reserved for Spectrum Items		0.25	0.25	0.5	0.25	0.5	0.25			2
Total RD TU SI WI		**26.75**	**11.25**	**32.5**	**16.25**	**34.5**	**17.25**	*41*	*20.5*	**138.5**
Leftover (Total)	0	**49.75**	**22.25**	**58.5**	**29.25**	**64.5**	**32.25**	*90*	*45*	**256.5**

Thank you!