RP-233864
3GPP RAN#102
Dec. 11th – 15th, 2023
AI: 9.1

Operator perspective on Rel-19 WI/SI package

December 2023

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General

- Perspective on proposals and time allocation for Rel-19
  - Rel-19 is becoming a **large 6G Study Item** with only a *limited* number of implementable features
    - Avoid Rel-19 being marginalized with a small delta for operator-driven features
    - Too much time allocated for various Study Items

- Views and priorities for Rel-19 SI/WI proposals
  - Further enhancements and downscoped items due to time constraints from Rel-18 WIs/SIs
  - New WIs/SIs based on **alignment** with, e.g., SA-led WIs/SIs
  - Clear, realistic, and fixed release timelines and internal WG milestones
  - Carefully and well-defined WIs to ensure completion in the Release timing

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RAN#102 Rel-19 WI/SI package (AT&T Priorities in BOLD)

RAN1-led items

- **AI/ML for air interface**
- **MIMO Enhancements**
- Evolution of NR Duplex Operation
- SI for Ambient IoT
- **Network Energy Savings (NES) enhancements**
- LP Wake Up Signal/Receiver
- **SI for Integrated Sensing and Communication (ISAC)**
  - **Start RAN plenary-led SI in 1Q followed by RAN1 SI**
- **SI for Channel Modeling for new spectrum**

RAN2-led items

- **SI for AI/ML for Air Interface (Mobility)**
- **Further XR enhancements**
- Mobility enhancements
- NTN evolution for NR/IoT
- **Further Sidelink enhancements**
  - **Multi-hop Relay enhancements**
  - **SL CA operation (RAN4)**
- ***Potential TEI-19 and/or revisit at RAN#105***
  - ***UAV enhancements***
  - ***NCR enhancements***
  - ***NR Positioning enhancements***
    - ***Sidelink positioning leftovers, e.g., SL-TDOA signaling***

RAN3-led items

- **SI + WI for AI/ML for NG-RAN**
- **Network reliability and efficiency enhancements**
  - **SON/MDT**
  - **SI + WI for Additional topological enhancements**
    - **Wireless Access Backhaul (WAB)**
    - **5G Femto**
    - **Mobile Integrated Access Backhaul (IAB) enhancements**

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Further Details on Select WI/SI Objectives

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MIMO

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RAN1-led WI: MIMO enhancements

Motivation and justification

- Rel. 18 specified multi-TRP CJT with ideal time/frequency synchronization. There needs to be a follow-on item that evaluates and specifies a more practical implementation of CJT towards a more distributed MIMO deployment
- There is a need to increase the number of supported CSI-RS ports per single transmission point to improve coverage and spectral efficiency, especially at upper FR1 bands. Type I codebook (not updated since Rel. 15) supports up to 32 CSI-RS ports. Hybrid beamforming support with multi-beam reporting is limited in NR.
- Beam management enhancements are still needed for improved beam acquisition and tracking building on Rel. 17/18 multi-beam operation enhancements

Key objectives

1. Specify UE reporting enhancements for multi-TRP CJT with non-ideal synchronization and backhaul, for both FDD and TDD
2. Specify CSI support for up to 128 CSI-RS ports, assuming legacy 32-port CSI-RS resources, and legacy codebook extensions. Specify extension of CRI-based CSI enhancements (CRI>1) to support hybrid beamforming
3. Specify enhancements to facilitate UE-initiated/event-driven beam reporting to reduce overhead and latency, assuming unified TCI framework

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Network Energy Savings enhancements

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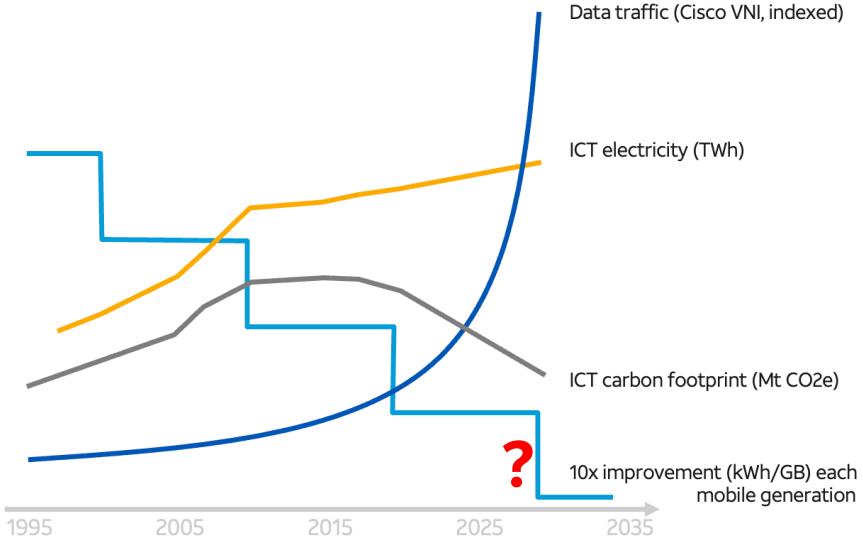
RAN1-led WI: Network Energy Savings Enhancements

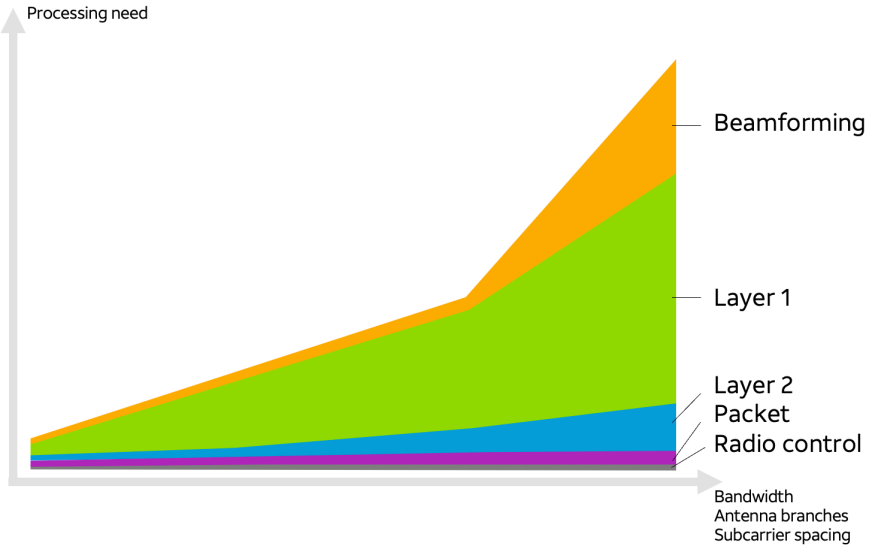
Justification and Motivation

- Despite the lean design of 5G, the radio continues to be one of the main drivers of energy consumption in the radio access network
- Power amplifiers (PAs) make up about half of the radio's energy consumption and together, PAs and front-ends incl. data conversion make up the bulk of the radio's energy consumption
- The "greenest" transmission is the one that never happened, but utmost dynamicity is not always feasible and practically realizable
- Rel-18 mainly focused on low-load scenarios, need to address med/high load



Key Objectives

1. Extend the "intra-carrier" 5G NR lean design into the frequency domain across carriers/cells
   - Multi-carrier energy savings enhancements incl. further overhead reductions in time and frequency domain
2. Complete the Rel. 18 study on power domain techniques for potential standardization
   - Over the air digital pre-distortion and UE post distortion
3. Continue to drive simplification into the 5G NR specifications, specifically as it relates to massive antenna deployments.



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SI for Integrated Sensing and Communications

(RAN Plenary and RAN1)

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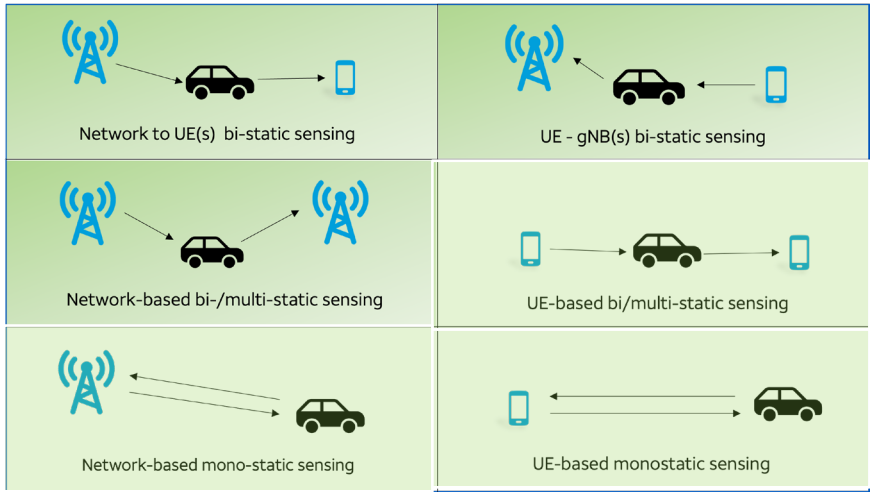
RAN Plenary and RAN1-led SI: Integrated Sensing and Communications (ISAC)

Justification and Motivation

- Sensing provides valuable assistance information for communication to enable new use cases and scenarios
- 3GPP SA1 study on *many* use cases, scenarios, and requirements for integrated sensing and communication
- Current 3GPP channel model inadequate for use in identifying and characterizing sensing targets

Key Objectives

1. Identify representative sensing use cases and their corresponding KPIs out of the many SA identified use cases (RAN Plenary)
2. Prioritize network-based candidate sensing modes/topologies and scenarios (RAN Plenary)
3. Study modifications to the 3GPP SCM in 38.901 to support the identified use cases and sensing topologies including adding/modeling of the target and spatial consistency procedures for mobile targets. (RAN1-led SI)



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SI for Channel Modeling for New Spectrum

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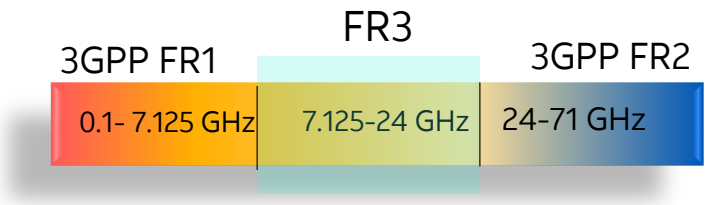
RAN1-led SI on Channel Modeling for New Spectrum

Justification and Motivation

- Upper mid-band spectrum expected to be key for 6G promising extremely high capacity and coverage
- 3GPP channel models claim to be valid for 0.1 – 100GHz, but hardly any field measurements were done for 7.125GHz-24GHz
- For US operators, the bulk of deployments have ISD>500m. Limited field measurements were conducted to develop the RMa channel model in 38.901. The RMa model is only valid for frequencies up to 7GHz



Key Objectives

- Validate through measurements and as necessary adapt the channel model in TR38.901 for 7.125-24GHz, including
  - Develop/validate model for RMa
  - Pathloss model, O2I penetration, new use cases deployments, frequency dependency of delay spread, angular spread, cluster delay and angular spread.
- Extend the channel model to include additional aspects, when applicable, such as near field propagation, antenna correlations, cluster ray blockages

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SI for Ambient IoT

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RAN1-led SI: Ambient IoT (SI *only* in Rel-19)

Justification and Motivation

- Follow-on WG-level Study Item that builds upon the recommendations and conclusions of the ongoing RAN-level "Study on Ambient IoT", TR 38.848, and TR 22.840 that is being developed by SA1 to capture use cases, traffic scenarios, device constraints of ambient power-enabled Internet of Things
- For enhanced support of public safety applications that require critical infrastructure sensors and monitors
- Target new "green" types of devices that are powered by energy that is provided through the harvesting of e.g., radio waves, light, motion, heat, including devices that are batteryless or have limited energy storage capabilities.
- **Generally, there will not be enough time to have both a SI phase and WI phase given the scope and uncertainties for device type/scenarios, architecture, PHY and upper layer signalling/design, etc.**

Key Objectives

1. Study a new type of IoT technology, independent from the existing 3GPP IoT technologies, e.g., NB-IoT, eMTC, RedCap, etc.
2. Evaluate device requirements, deployment scenarios, connectivity topologies and their characteristics, at least for the use cases/services agreed in SA1's "Study on Ambient power-enabled internet of Things" and those defined in TR 38.848.
3. Evaluation of potential target design characteristics and solutions for the relevant use cases, such as, power consumption, complexity, coverage, data rates, and positioning capabilities.
4. Define device categorization based on ambient power characteristics (e.g., energy source, energy storage capability, passive/active transmission, etc.)
5. Evaluation of higher layer solutions and protocols to support a new IoT device categorization

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AI/ML

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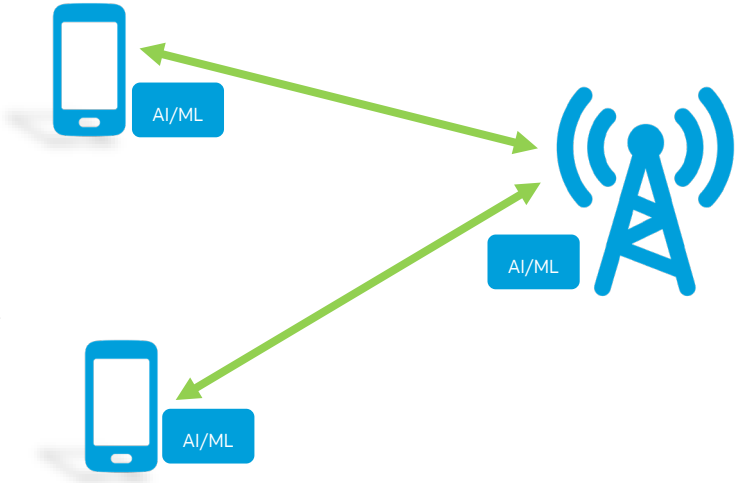
AI/ML for NR Air Interface (RAN1-led)

Background and Motivation

- There are still various aspects of the general framework in Rel. 18 that were not well discussed and/or were not agreed
- A common framework was recommended, whenever possible, across AI/ML use cases
- Two-sided models are crucial to specify for AI/ML for air interface, including several aspects studied in the general framework
- CSI prediction was considerably down-scoped in Rel. 18. Limited LCM and specification impact aspects were considered

Key Objectives

- Support of single sided models for,
  - Beam management for DL Tx prediction in both UE-sided and NW-sided models
  - Positioning, with down-selection of some of the positioning use cases
- Support of two-sided models for CSI compression
- Support single sided model for CSI prediction, with full LCM and specification impact
- Support the necessary/recommended LCM components for selected sub-use cases
- Support non-3GPP transparent mechanisms for data collection and model transfer/delivery
- Support a common framework (when needed) across AI/ML use cases
- Consider general framework aspects that were not finalized in Rel. 18
- Consider RAN4 requirements and test cases for AI/ML enabled features



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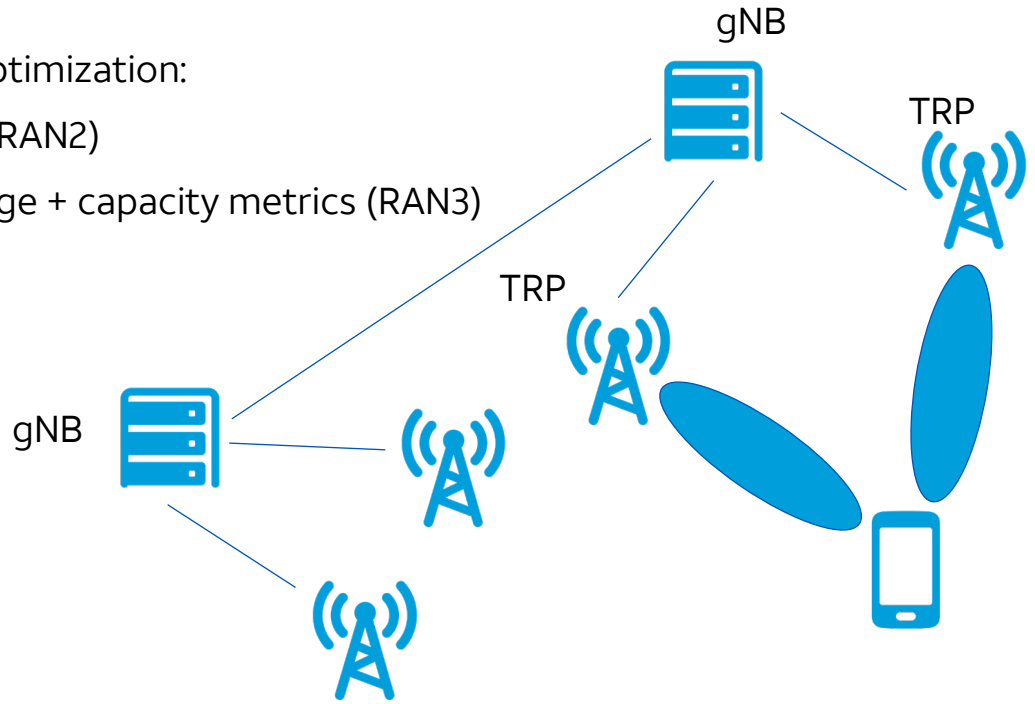
AI/ML for NG-RAN (RAN3-led)

Justification and Motivation

- AI/ML algorithms embedded in the RAN to enable (near) real-time decisions with distributed data
- Interface enhancements to support training and LCM with fallback in multi-vendor deployments
- SI-phase for new use cases going beyond Rel-18

Key Objectives

1. Further enhancements for Rel-18 use cases to support more dynamic optimization:
   - AI/ML based mobility enhancement: Support for LTM and CHO (RAN3/RAN2)
   - AI/ML based load balancing: Extend to CA/DC scenarios, DL/UL coverage + capacity metrics (RAN3)
2. Dynamic cell-shaping with multi-cell/OAM coordination (RAN3/RAN1)
3. User-clustering based scheduling and RRM (RAN3/RAN2)
4. AI/ML based network slice management (RAN3)



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Network-Controlled Repeaters (NCR)

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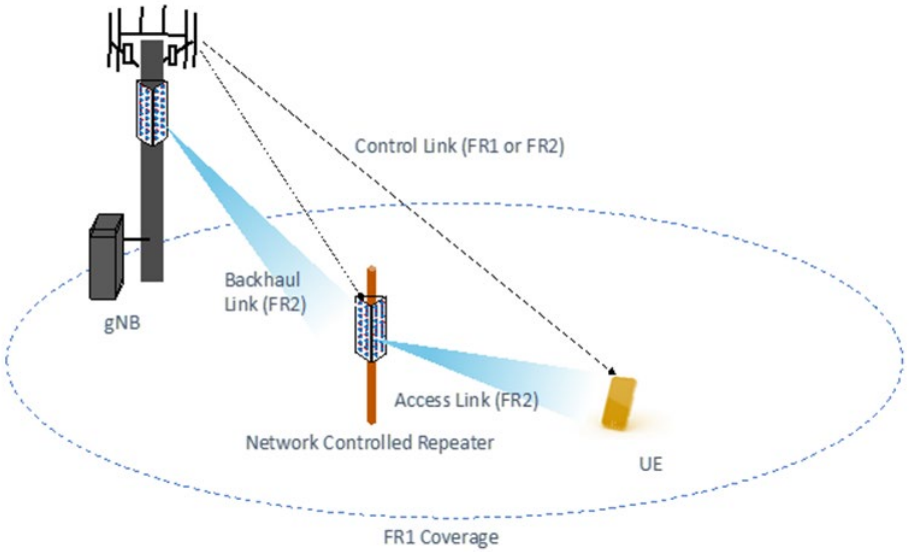
Network-Controlled Repeaters (NCR) enhancements

Justification and Motivation

- NCR portability: Public Safety and special-event use cases
- Deployment flexibility: Scalable and user-deployed (e.g., in-building NCR)



Small but essential objectives (RAN1 and RAN2)

1. CONNECTED mode RRM measurement reports for NCR
2. OTA access/backhaul power control signalling
3. Multi-frequency support for NCR-MT (e.g., NR-DC/EN-DC/CA)

Due to perceived lack of available time in the Rel-19 scope, NCR enhancements seem unlikely to be a part of the initial Rel-19 package.

NCR enhancements to be revisited in Rel-19 as either:

1. TEI-19 proposals given enhancements that are small in scope, but essential for commercial deployments
2. Revisit a potential WID for NCR enhancements in 3Q2024 (RAN#105)

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Further Sidelink (Relay) Enhancements

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WI Further Sidelink (Relay) Enhancements (RAN2-led)

- ## Justification and Motivation
  - For enhanced support of applications and use cases requiring sidelink, further enhancements are necessary in order to introduce the solutions identified during the Rel-17 RAN FS_NR_SL_relay study item and ProSe phase 2 in SA investigating further 5G system enhancements to support Proximity Services.
    - Additionally, remaining items down-scoped from NR sidelink evolution (NR_SL_enh2), e.g., SL CA, Power Saving enhancements, etc.
  - Support of UE-to-UE multi-hop relay is essential for the sidelink coverage and reliability improvements without relying on the use of uplink and downlink.
  - Service continuity enhancements in UE-to-Network multi-path relay are necessary to cover the mobility scenarios not currently supported, provide higher data rate and higher reliability.
  - Support of carrier aggregation facilitates the efficient use of fragmented SL frequency spectrum
    - Enables larger bandwidths allowing for improved data rates and reliability, enabling public safety and commercial services.
- ## Key Objectives
  1. Specify mechanisms to support multi-hop Layer-2 UE-to-UE relay (and possibly L3)
  2. Specify mechanisms to enhance service continuity for multi-path/hop Layer-2 UE-to-Network relay
  3. Specify mechanisms to support NR sidelink CA operation based on LTE sidelink CA operation for at least intra and inter-band CA for FR1 licensed spectrum (RAN4-led)
  4. Specify mechanisms for Power saving techniques, e.g., SL DRX enhancements, WUS and BWP adaptation for SL.
  5. Accuracy, latency, and reliability improvements for SL positioning and ranging* *if not addressed by TEI or NR Pos WI*

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XR enhancements

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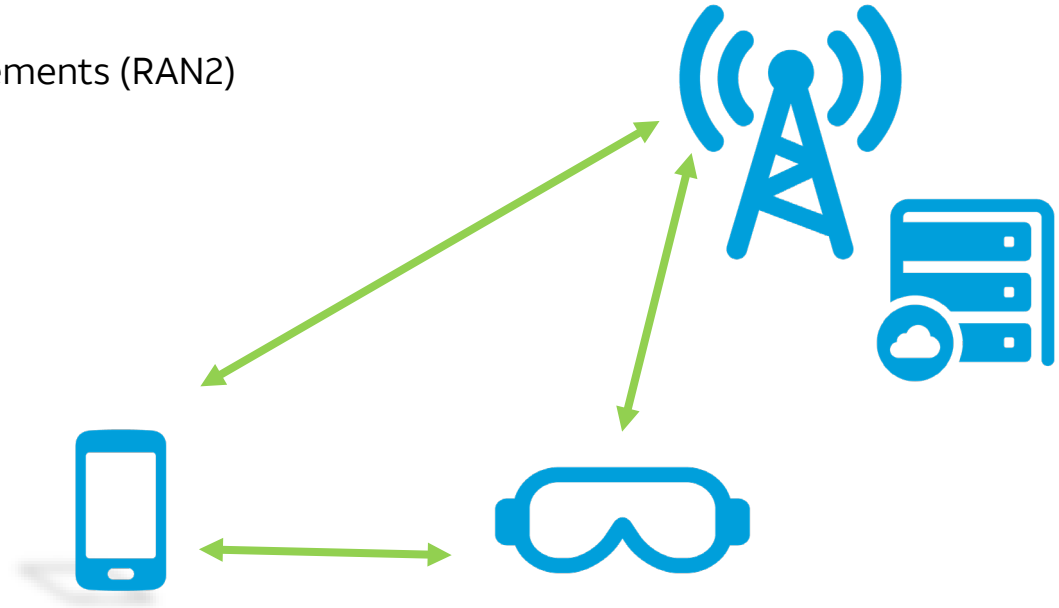
RAN2-led WI: XR

Justification and Motivation

- Multi-device interactions and user mobility make XR traffic scalability challenging
- E2E QoE combines spatial, temporal and interactivity measures as a function of network KPIs
- Significant opportunities for cross-layer App/RAN optimizations to improve E2E QoE and network scalability

Key Objectives

1. Paired/tethered device status and user-context XR-awareness enhancements (RAN2)
2. Real-time QoE monitoring within the RAN and/or UEs (RAN2)
3. Multi-carrier scheduling and power savings enhancements (RAN1)



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UAV enhancements

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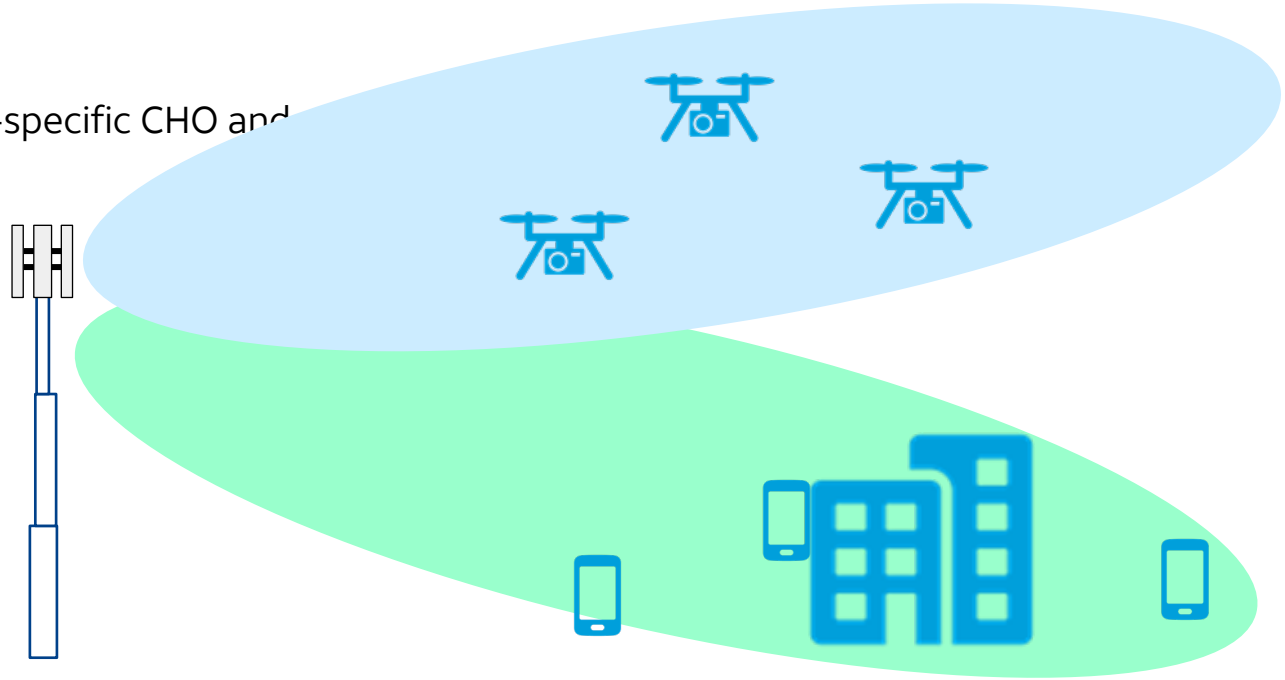
RAN2-led WI: UAV enhancements

Justification and Motivation

- To enhance support for advanced UAS/UAV verticals
  - Advanced application support, e.g., UAV-to-UAV communication,
- Remaining items down-scoped from earlier releases
- ***Potentially TEI-19 could be used for some specific enhancements rather than a new Rel-19 WI (or a small WI at RAN#105)***

Key Objectives …

- RAN2 objectives
  - Ongoing mobility enhancements potentially including UAV-specific CHO and flight-path reporting / prediction
  - Refinement of measurement report triggering
  - Enablement for airborne IAB
  - PC5-based U2X
- Additionally, from RAN1 perspective: Further study and specify UL interference mitigation solutions for UAVs, taking into consideration, e.g., beam-related information and capabilities.



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Additional Topological Enhancements

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RAN3-led SI/WI: Additional Topological Enhancements

5G Femto

Justification

- On-going need for femto-scale deployments

Objectives

- Study integration of 5G Femto with the 5G RAN architecture.
- Study how to define the 5G access control mechanism
  - Reuse existing CAG functionality
  - Identify and specify needed enhancements if required.
- Requirements specification during WI phase

Wireless Backhaul (IAB/WAB)

Justification

- Public Safety/Mission Critical use cases including UAV use cases
- Efficient 5G access for high-mobility UEs (onboard aircraft, high-speed trains, etc.)
- NTN-based backhaul
- Edge networks

Objectives

- **WAB**: Study impact of mobile gNBs within a stationary network
  - Study signaling enhancements to support authorization and resource multiplexing
  - Study QoS enhancements for backhaul
  - Study RAN-impact for supporting co-located UPF
- **IAB**: Study enhancements under a single-donor IAB topology
  - Robustness enhancements for multi-hop IAB routing
  - Multi-frequency/DC support for IAB-node mobility

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Thanks!