

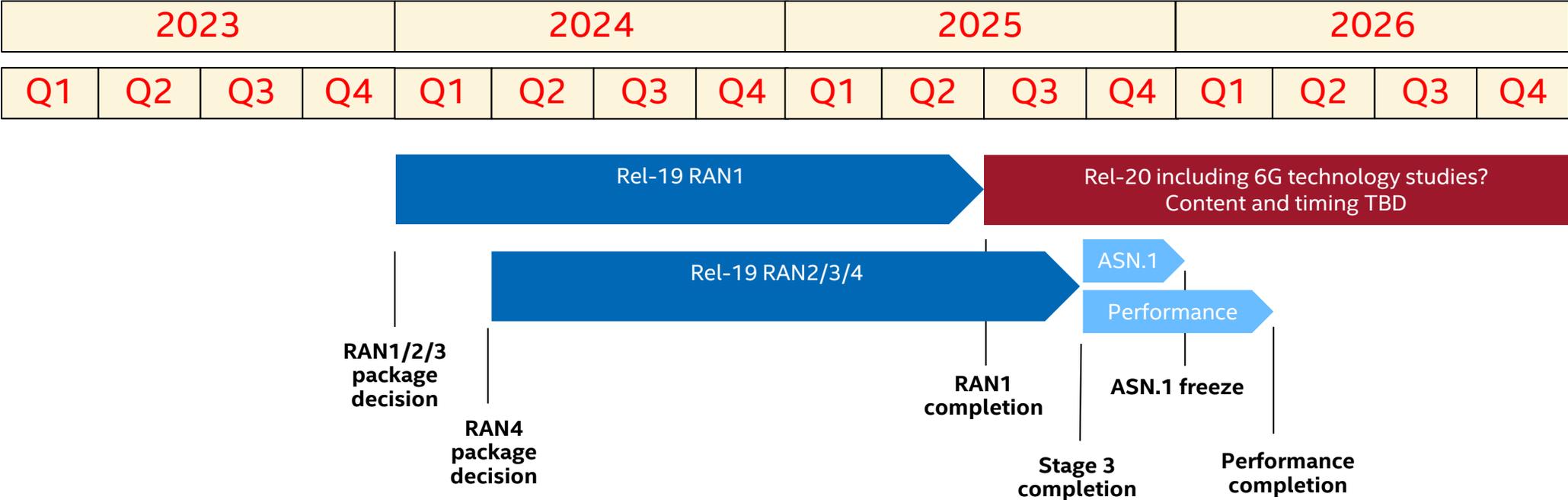
# Overview of Rel-19 RAN1/2/3 content

Agenda Item:	4
Source:	Intel Corporation
Document for:	Discussion



# Rel-19 Timeline

- Rel-19 duration and timeline agreed at TSG#99
- 3GPP should aim to return to delivering to the agreed deadlines (following several releases disrupted by the pandemic)
- Rel-19 package scope dimensioned to fit the timeline



# Release-19 - 2nd release of 5G Advanced

## Rel-18 – 5G Advanced

- Key new functionalities
  - Network energy saving, AI/ML for NG-RAN, Sidelink positioning
- Performance and capability enhancements
  - MIMO enhancements, XR enhancements
- Technology studies offering potential for significant improvements
  - AI/ML for air interface, Duplex evolution, LP-WUS



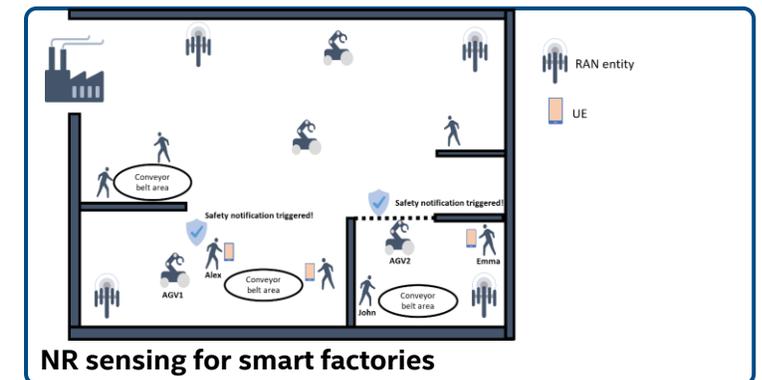
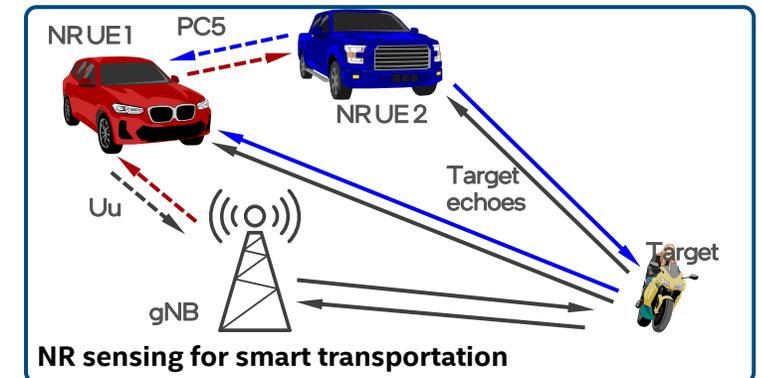
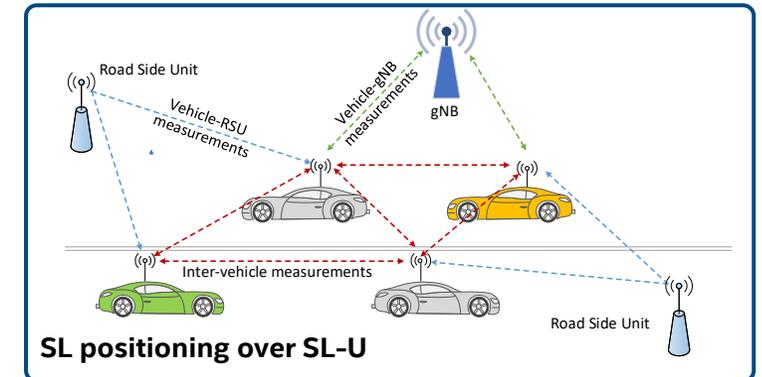
## Rel-19 – 2<sup>nd</sup> release of 5G Advanced

- Key new functionalities derived from the Rel-18 studies
  - AI/ML for air interface, SBFD, LP-WUS
- Further performance, capability and network operation improvements (capacity, coverage, energy, security, etc)
  - MIMO, Positioning, XR, NWES, RAN architectural enhancements, AI-ML in NG-RAN
- Technology studies in preparation for initiation of 6G
  - Joint Communication and Sensing

# RAN1-led: NR Positioning and Sensing in Rel-19

RWS-230453

- Expansion of existing NR-based localization features
  - DL and UL positioning in unlicensed spectrum
    - Current lack of support on unlicensed critical shortcoming for standalone NR-U
    - Design to be build on NR-U for data communication over DL/UL
  - SL positioning in unlicensed spectrum
    - Based on design of SL comm in unlicensed spectrum, enable SL positioning/ranging using unlicensed bands offering larger BWs
  - UL positioning in RRC\_IDLE state
    - To further facilitate LPHAP use-cases
- New Location-Based Services (LBS) leveraging on NR positioning framework
  - NR-based environment sensing
    - NR positioning features cover various methods over Uu and/or PC5 interfaces focusing on devices which transmit/receive NR signals
    - Wireless sensing capability is a natural evolution of the NR positioning framework, enabling environment sensing, presence detection, etc. in scenarios like smart transportation, IIoT, smart cities, and smart homes
    - New RAN features to include support of:
      - Localization of "device-free" targets (e.g., objects, humans, etc.) based on detection of NR signals reflected off such objects
      - Velocity estimation of targets using NR signals
    - Rel-19 study to cover use cases, scenarios, KPIs, channel model modifications, feasibility and performance evaluation, architecture and procedures



# RAN1-led: AI-ML for Air Interface Work Item

RWS-230454

## ■ CSI

- Two possible cases:
  - Autoencoder – potentially significant spec impact
  - Prediction - enhancements on top of Rel-18 MIMO prediction framework
- Model transfer/delivery
  - Proprietary model delivery based on pre-registered and vendor specific implementation
  - Model re-tuning with new data at the NW and Model transfer based on UE capability
- Model Life Cycle Management (LCM) for UE and/or two-sided models
  - Data collection
  - Model performance monitoring
  - Model update/switching/fall-back

## ■ Beam Management

- Spatial and temporal domain beam prediction with UE side and NW side models
- Model transfer and/or delivery
  - Models can be configured or downloaded based on UE capability
- Model Life Cycle Management (LCM)
  - Model update or re-tuning with new data collection
  - Model performance monitoring

## ■ Positioning

- Many possible sub-cases in Rel-18 SI: (prefer scoping for normative work)
  - Direct AI/ML positioning (fingerprinting)
  - AI-ML assisted positioning
  - UE side model, NW side model

# RAN1-led: MIMO evolution

- CSI/CSI-RS: Larger arrays for sub-6 and mid-band – part study
  - Support for larger number of ports - 64, up to 128 ports
  - Support for large size sub-array (for coverage)
    - Beam sweeping to account for sub-array beams
    - UE CSI feedback on multiple sub-array beams
- Multi-TRP evolution
  - Enhanced asynchronous operation targeting FR2
    - Delay > CP
    - Single DCI operation (DL and UL)
    - Panel specific CSI, inter-panel isolation/interference feedback to support panel specific DL reception
- Beam-management
  - Faster beam acquisition: L1-measurement burden increasing due to multi-cell, L1/L2 mobility etc. SSB correlation information can be used for faster beam acquisition
  - Reporting overhead reduction by UE triggered reporting
  - Study UE initiated beam management
- Uplink
  - Evolution of STxMP (collision, multiplexing of channels, residuals)
  - Uplink only TRP support ( coverage for FR2)
- Study near-field LOS MIMO
  - Spherical wave consideration for predominantly LOS channels (very little to no scattering/reflection)
  - Indoor deployments with large antenna arrays and large spacings (lap-top, TVs)

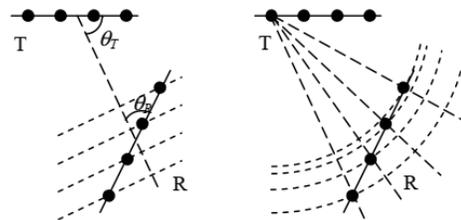


Figure 1: (a) Point-source model. (b) Distributed-source model.

Ref: J. Jiang and M. A. Ingram, "Distributed Source Model for Short-Range MIMO"

# RAN1-led: Network energy saving enhancements

- Promising potential enhancements from Rel-18 SI were not considered for Rel-18 WI
- For Rel-19, some further enhancements from Rel-18 SI TR38.864 may be considered
- **SSB-related enhancements**
  - Simplified SSB transmissions, longer periodicities than 160ms, skipping SSB transmissions etc.
  - Adaptation of SSB/SIB1 with longer periodicity
    - Including skipping of SSB/SIB1 which UE is informed
  - On demand SSB/SIB1 transmissions based on UE WUS
- **Paging enhancements**
  - Concatenate paging frame/occasion into consecutive frames or slots while maintaining the same paging occasion density
  - Similar enhancements to PRACH expected to be feasible
- **Wakeup signal to wake up cell in deep sleep**
  - Also act as on-demand SIB1 request
- **Cell reselection enhancement**
  - Enable NES-capable UE to prioritize/down-prioritize a specific NES cell or NES cells on a specific frequency
- **Cell on/off in CU-DU split deployment**
  - Option 1: CU-DU sync on detailed energy consumption information over F1 and CU decides cell on/off
  - Option 2: DU autonomy on cell on/off and informs CU

# Other RAN1-led

## Duplex evolution

- Normative specification work to support non-overlapped SBFDF-based FD operation at gNB based on outcome of Rel-18 studies on SBFDF.
- Normative specification work for enhancements for more effective mitigation of cross-link interference between gNBs and between UEs based on outcome of Rel-18 studies on dynamic/flexible TDD.
- For a given NR carrier with SBFDF and/or enhanced dynamic/flexible TDD operation, the specified solutions should ensure support of all UE types:
  - Pre-Rel-19 UEs (“legacy UEs”)
  - Rel-19 UEs that support Rel-19 SBFDF and/or features for enhanced dynamic/flexible TDD operation
  - Rel-19 UEs that do not support Rel-19 SBFDF and/or features for enhanced dynamic/flexible TDD operation

## LP-WUS/WUR

- Depending on the outcome of SI for LP-WUS
- Specify the signal design of LP-WUS
  - Potential LP synchronization signal in addition to LP-WUS. Prefer to use same waveform/modulation as LP-WUS if supported
  - Potential two-part time structure for LP-WUS
  - Suitable BW of LP-WUS
- Specify the L1 procedure for LP-WUS
  - Duty-cycle based operation
  - Specify the information (paging group, sub-group, UE-ID, reason for paging, etc.) carried by LP-WUS and the related procedures
- Related performance impacts, including RRM impact
- RRC state applicable for LP-WUS operation

# Other RAN1-led

## Ambient IoT study for Rel-19

- Evaluation of the identified use cases and deployment scenarios agreed in RAN SI, at least considering
  - Different UE types of 1) passive transmission w/o energy storage, 2) passive transmission w/ energy storage, 3) active transmission with energy storage
  - Different topologies of gNB, Ambient IoT device, UE (monostatic and bistatic )
- Study on possible specification impacts
  - A new physical frame structure, waveform, modulation, channel coding, etc. may be considered
  - Potential impact from network point of view, e.g., how to handle massive number of devices, collision control, lightweight protocol that has fewer message exchanges and signalling overhead, with/without CN connection etc.
  - Co-existence with NR
- Study for entire Rel-19

## Sidelink enhancements

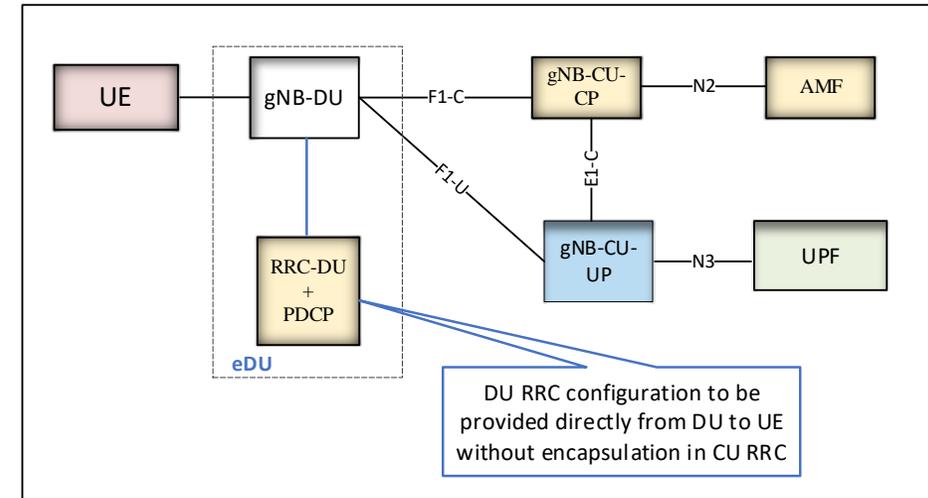
- Sidelink Carrier Aggregation
  - Further enhancements - some of the restrictions imposed in Rel-18 could be lifted to increase the value of such feature for more general use cases.
- Sidelink Enhancements for FR2 Operation
  - This is in study only in Rel-18. Potential benefits to specify in Rel-19:
    - Mitigate limitations in terms of bandwidth in the ITS band
    - Enable use cases requiring very high data rate, such as advanced sensors sharing
  - Only licensed spectrum is in the scope of the study in Rel-18, while there is a large portion of unlicensed spectrum available in FR2-2 (i.e., 52.6 GHz– 71 GHz) which could be considered.
- Industrial IoT
  - Cooperative Carrying Robots use cases (in RP-223475 / 5G-ACIA / TS 22.104 / RP-230724)
    - More precise synchronization
    - Further improved latency and reliability

# RAN2-led: RAN architectural enhancements

RWS-230457

## Direct RRC signalling from DU to UE

- Current RAN architecture prevents fast, secure and reliable signalling of lower layer configurations
  - Longer delay in configuration by DU generated signalling sent via CU
  - Security risk from using MAC CEs to avoid RRC delay
  - Less reliable transmission (no RLC) for MAC CEs
- Potential enhancement:
  - Support direct transfer of RRC messages generated at DU (e.g. CellGroupConfig) to the UE without transferring to CU
  - Support a PDCP termination at DU for security.
  - Reduced RRC processing delay for the “simpler” RRC messages (similar configuration contents as MAC CEs) generated at DU



## Multiple distributed CU-UP termination points

- Single security termination point for User plane termination point restricts deployment flexibility
- Enhancement to enable multiple distributed CU-UP termination points with separate security key handling

# RAN2/3-led: AI/ML in NG-RAN

- Rel-18 work item targeted normative work to support network energy saving, load balancing and mobility optimization, especially over Xn interface.
- Potential enhancements and new use cases can be further considered for Rel-19
- **AI/ML in NG-RAN for NR-DC**
  - Rel-18 focused on standalone - NR-DC deployment scenario also important to consider
  - Supported use cases to include (but not limit to): NWES, load balancing, mobility optimization
- **Support model inference at gNB-DU**
  - Rel-18 only considered model inference at gNB-CU but application within DU offers potential for further resource optimization
  - Supported use cases include (but not limit to): NWES, load balancing
- **Data/Model sharing among NG-RANs (gNBs)**
  - Rel-18 assumption was for separately trained AI/ML models in different network entities
  - Fast and distributed data/model sharing between NG-RANs
  - Joint network optimization between NG-RANs
  - Support interoperability
- **Study of AI/ML for mobility use case**
  - AI/ML applied to mobility may offer benefits to handover reliability, service interruption, signaling overhead, UE power consumption, etc
  - Potential applications:
    - To predict UE mobility/trajectory/measurements and trigger HO based on predictions
    - To dynamically select the HO parameters based on multiple factors, e.g. UE location, etc.

# RAN2-led: Enhancements to XR operation

RWS-230459

- In Rel-18 XR WI, RAN and UE are enhanced to consider XR specific information
- Promising potential enhancements from Rel-18 SI but not pursued in Rel-18 WI are worthy of consideration for Rel-19
- SA1 Rel-19 TR 22.856 captures Metaverse use cases (which are a super set of XR).

Rel-18

Discard operation for intra-PDU set

BSR enhancements considering XR characteristics and including delay reporting of UL buffered data

C-DRX support of XR traffic with non-integer periodicities

Multiple CG PUSCH transmission occasions in a period of a CG PUSCH configuration

Retransmission-less CG enhancement for XR

Rel-19

Differentiated handling (e.g., reliability, prioritization) of different PDU set importance in a given QoS flow

Support of Multi-Modal XR data (i.e., different streams of an application) e.g., synchronization of related streams, multiple C-DRX active simultaneously

PDU set discard enhancements due to inter-PDU set dependencies

Measurement gap enhancements to mitigate the impact on the XR traffic

# RAN2-led: Small Data Transmission (SDT) Operation



Background: SDT operation allows a UE in RRC\_INACTIVE to perform data exchange in DL and/or UL in any RB previously configured for SDT

- Rel-17: UE can initiate resume via RACH or CG resources configured for SDT
- Rel-18: Network can trigger resume for MT SDT

Rel-19 proposed areas: recovery mechanism from an abrupt termination of SDT session and RRC-less enhancement for CG-SDT operation

# Other RAN2/3 led

## Further Mobility enhancements

- Large scope for R19 mobility enhancements not necessary
  - Recent releases already specified many mobility enhancements:
    - Handover enhancements: DAPS and CHO in R16, LTM in R18
    - SCG mobility enhancements: intra-SN CPC in R16, SCG deactivation, CPA and inter-SN CPC in R17, and selective activation of SCG in R18
- Potential enhancements for complementing work already started in Rel-18
  - Co-existence of LTM and L3 handover:
    - How to coordinate CU and DU to make proper handover decision, since LTM is decided by source DU and legacy L3 handover is decided by source CU.
  - Inter-CU LTM
    - PDCP reconfiguration/re-establishment is involved
    - Security key handling in case of dynamic switch without RRC reconfiguration

## Enhancements for UAV

- To improve performance and HO for UAV, Conditional Handover in Rel 16 can be further enhanced.
- Existing Triggering conditions:
  - Event A3, A5 was introduced in Rel-16
  - Event A4, D1 and T1 were introduced in Rel-17 for NTN CHO enhancement
    - D1 and T1 are always combined with A3, A4 or A5.
- Enhanced UAV specific CHO
  - Event D1 and T1 can be reused for UAV
  - Adding triggering condition for height and/or speed (Event H1/H2, S1/S2)
  - Three condition events would need to be combined (measurement, height/ location and speed)

# Other RAN2/3 led

## NTN evolution

- Potential enhancements to further supplement Rel-18 include:
  - R18 leftovers, e.g., handover optimization for hard feeder link switch including how to address the service gap
  - Other vertical features applied in NTN, e.g., MBS or RedCap
  - To address higher performance, e.g., support CA/DC in NTN scenario for higher data rates

## IAB evolution

- Potential further evolution of IAB functionality
  - IAB node with backhaul link via NTN
  - Simultaneous connectivity of mobile IAB-nodes to multiple donor nodes
  - Enhancements for mobile IAB node mounted in aerial vehicle to provide coverage to UEs travelling within the vehicle

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