



Agenda Item : 4.0

Source : InterDigital

Title : InterDigital's Views on Rel-18 Scope for NR-Advanced

Document for : Discussion and Decision

5G-Advanced and Rel-18



Importance of Rel-18 going into 5G-Advanced

- PCG agreed that Rel-18 and onwards will have the marketing label '5G-Advanced'
- 5G-Advanced is expected to continue into Rel-19 and Rel-20.

High-level considerations for Rel-18 scope

- The overall scope of Rel-18 should include :
 - A limited number of Work Items of reasonable scope that continues and enhance existing features
 - A few items (WIs/SIs) that aims to enable some differentiation in terms of use case or performance
- The scope of individual WIs/SIs should limit the fragmentation of work in smaller items as much as possible

Key Focus for 5G-Advanced starting from Rel-18

- Improved support for **key 5G use cases** including XR, automotive and reduced capability devices
- More efficient use of **higher frequencies** up to 114.25 GHz for higher data rates considering power consumption
- Leveraging **link diversity** using combinations of Uu and Sidelink to enhance coverage and spectral efficiency
- Improved support for **new device architectures** and applications, including XR, wearables, and cloud gaming

Rel-18 Schedule



- 18-month Release Duration (assuming physical meetings only)
- Target start in Q1 2022
 - RAN1 starts in Q1 2022 with focus on few limited RAN1 new studies, in addition to Rel-17 corrections
 - Other WGs can start in Q2/Q3 2022 with a few topics. Q2 expected to focus mainly on Rel-17 corrections and Rel-17 ASN.1 freeze



R18 WIs/SIs for RAN1/2/3-led items



eMBB-driven Functional Evolution

- MIMO
- NR in higher frequencies
- NR Cross Division Duplex
- IAB *
- Multicast/Broadcast *

Non-eMBB-driven Functional Evolution

- RAN enhancements for XR
- Reduced capability devices
- Un-crewed Aerial Vehicles (UAV)
- V2X/Sidelink
- Sidelink Relay
- NTN
- URLLC/IIoT *
- Collaborative Terminals *

Cross-Functionalities for both eMBB and Non-eMBB Evolution

- Positioning enhancements
- Data collection for AI-enabled RAN
- AI/ML Study for PHY layer *

Continuation topic

New topic

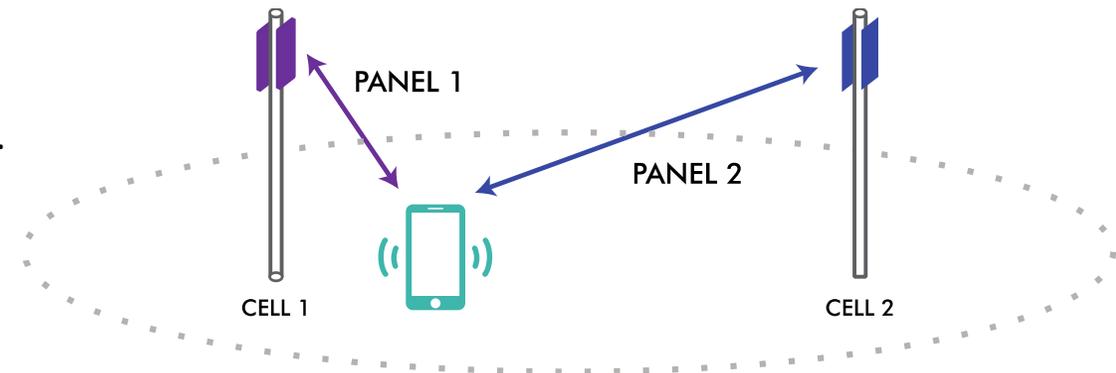
* These items should be in scope of R18 if overall workload permits

Justification

- Demand for higher UL throughput due to new device types (e.g., AR, VR)
 - Uplink MIMO performance has been limited to 4 layers, wideband precoding only, etc.
- Power consumption in FR2 has been an issue but no power saving solution targeted for FR2 beam management
- M-TRP operation in Rel-17 only supports synchronous network scenario but support of M-TRP operation in asynchronous network is more practical
- Rel-17 eURLLC WI only covers CSI enhancement for single TRP scenario

Scope for Rel-18

- UL performance enhancement
- E.g., higher order modulation, frequency selective precoding, etc.
- Power efficient beam management
- Inter-cell M-TRP operation in asynchronous networks
- M-TRP CSI enhancement for URLLC



NR in higher frequencies

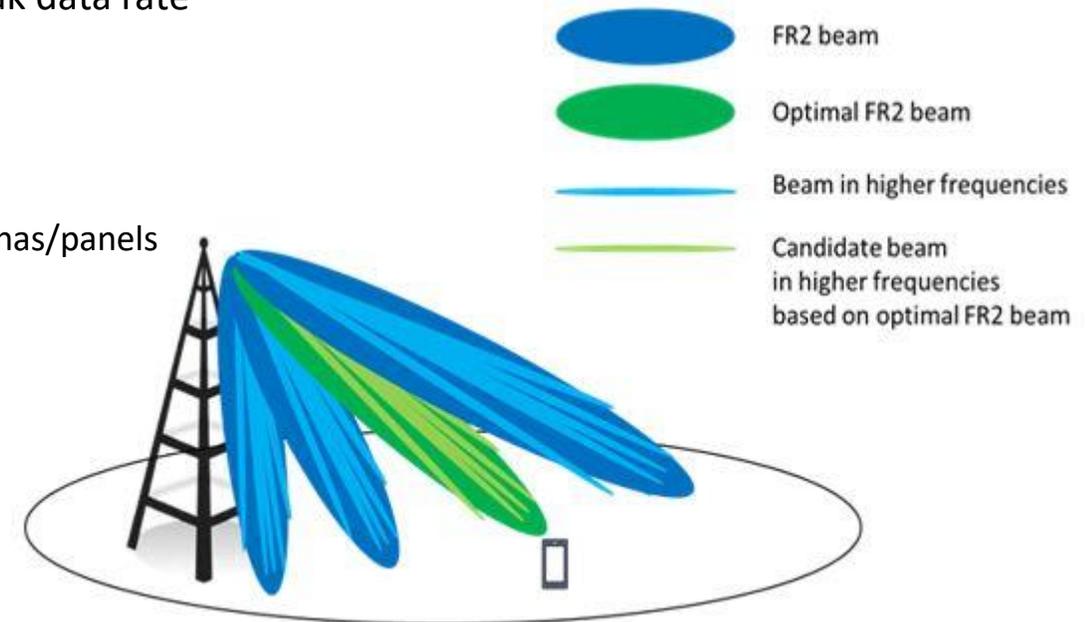


Justification

- Beam management in 52.6-71 GHz reuses existing FR2 BM operations, and optimization is necessary for higher frequency in Rel-17
- Support for SSB with 480/960kHz SCS for initial access in Rel-18 for better performance and robustness in higher frequency
- 52.6 – 71 GHz in Rel-17 focused on unlicensed operation, extension to licensed operation with wideband spectrum for higher frequency is beneficial for higher peak data rate

Scope for Rel-18 and onward

- Enhancement of NR in 52.6-71GHz
 - Beam management enhancement with larger number of beams/antennas/panels
 - 480/960kHz SCS for initial access if it is not supported in Rel-17
- Study necessary changes to extend NR for 71-114.25 GHz
- E.g., waveform, BM, DM-RS, PTRS, SCS, etc.



V2X and Sidelink

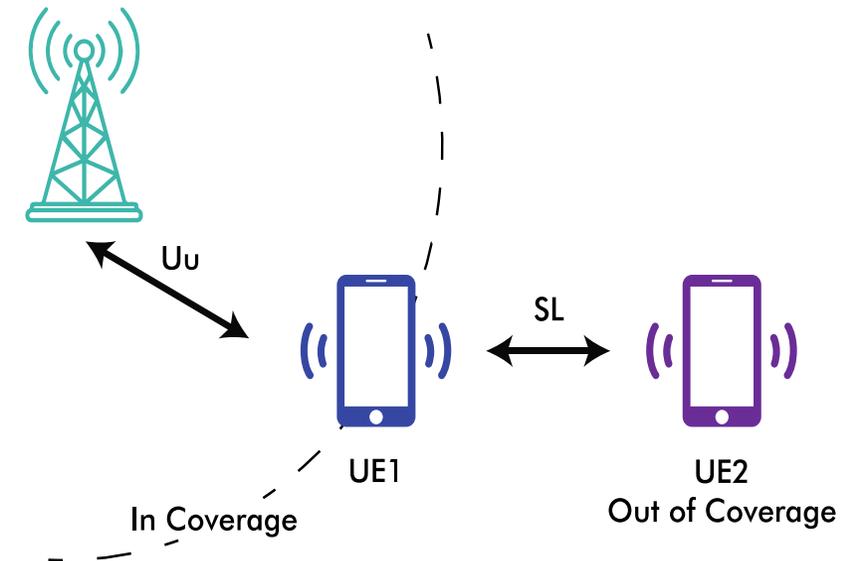
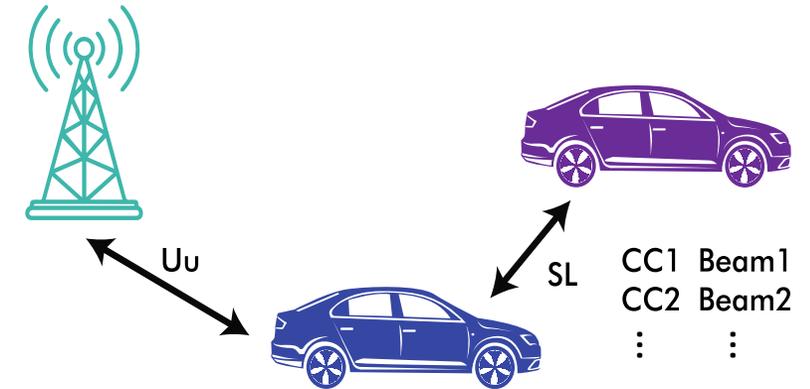


V2X/SL enhancements

- Justification
 - Support higher data rate, reliability, and lower latency to meet advanced V2X use cases
 - Support unlicensed spectrum, coverage enhancement, and additional power savings for new use cases (e.g., wearables)
- Scope for Rel-18 and onward
 - FR2 support for SL
 - SL multi-carrier/BWP operation
 - Power saving, coverage enhancement

Sidelink Relays

- Justification
 - SL relay should also target public safety use case
 - Power saving improvements
- Scope for Rel-18 and onward
 - UE to UE Relaying to support public safety cases, and continuation of critical services
 - Multi-connectivity and mobility enhancements for UE-to-NW relays
 - Power saving enhancements



RAN enhancements for XR

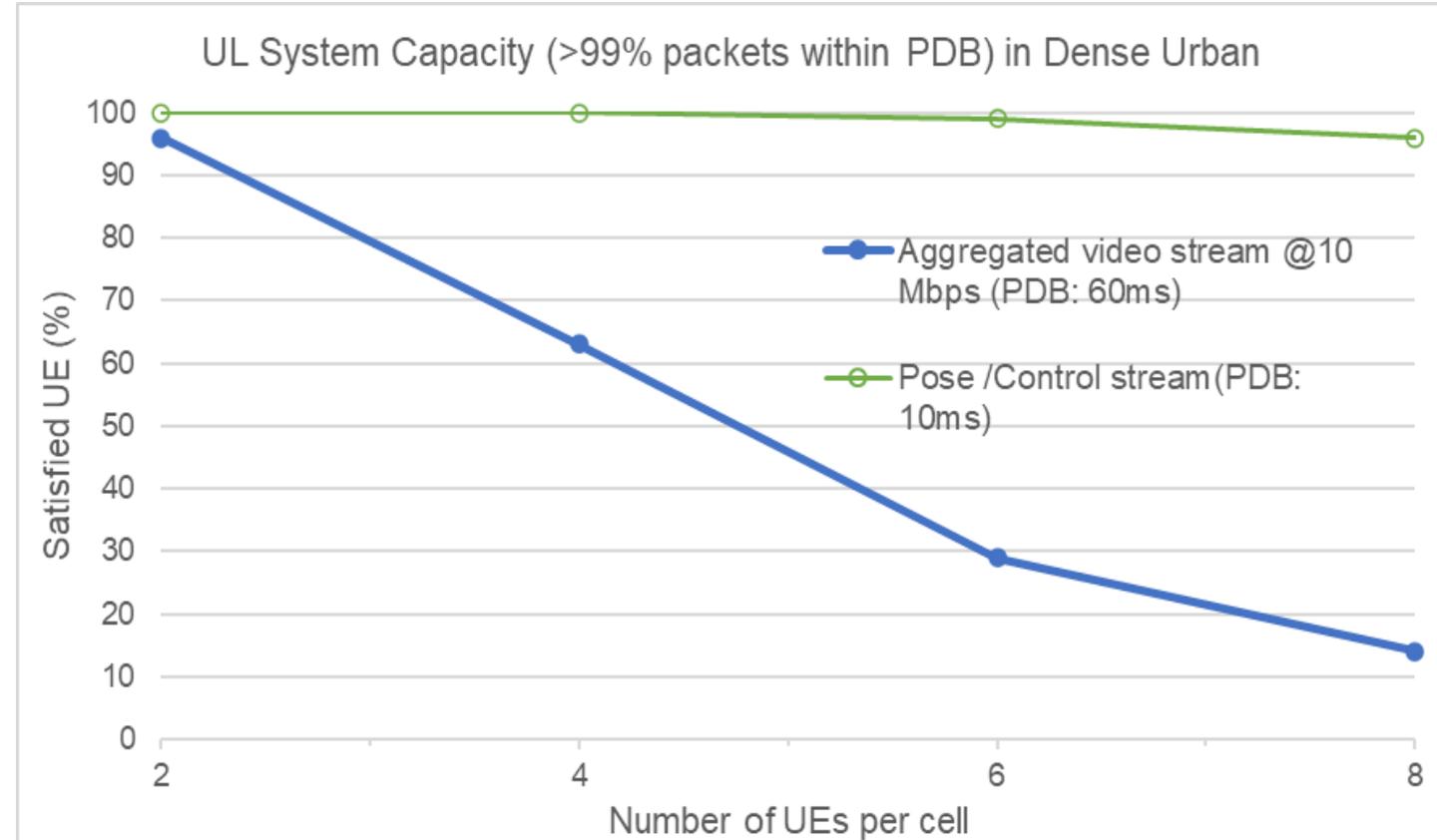


Justification

- Support for variety of XR applications, including VR, AR and Cloud Gaming

Scope for Rel-18

- Support for extended coverage, capacity, and mobility for XR
- XR device power efficiency improvement considering traffic pattern
- Granular QoS differentiation (e.g. per data stream, application data unit, or PDU)
- Synchronized transmission of multiple data streams per-application



In all deployment scenarios, the AR aggregated video stream (@10Mbps) is the bottleneck of the UL system capacity (in a multi-stream model)

Reduced Capability



Justification

- Further reduced complexity and power saving is beneficial for RedCap UE
 - FR2 specific enhancements are needed (e.g. beam management aspect)
- RedCap UE has coverage loss due to limited capability
 - One of the RedCap use cases is wearables with proximity to non-RedCap UEs
 - Collaborative transmission and reception with non-RedCap UE could compensate coverage loss

Scope for Rel-18 and onward

- FR2 enhancement for RedCap UE
 - Power efficient beam management
- Additional complexity reduction (e.g., CSI processing, reduced UE processing capability)
- Narrow band positioning
 - Positioning accuracy enhancement for bandwidth limited UE
- Sidelink operation for RedCap UE
 - Sidelink between RedCap and (non-)RedCap UEs

Positioning

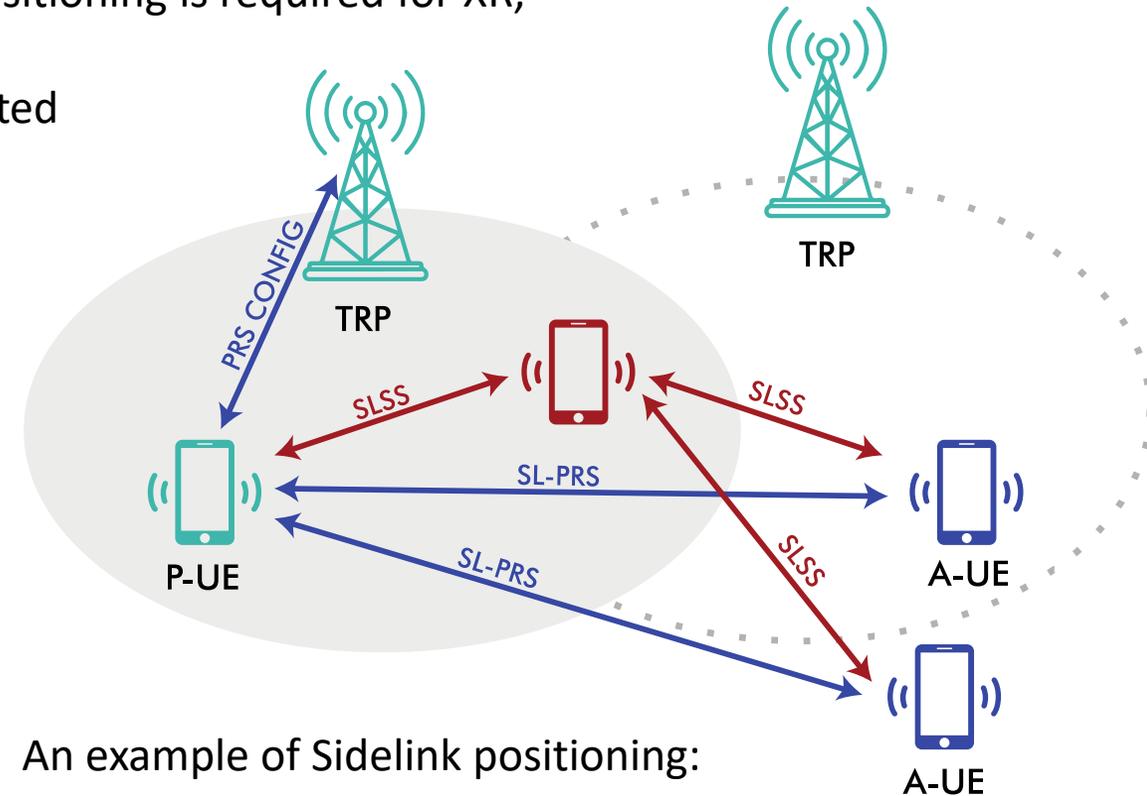


Justification

- Higher accuracy and lower latency absolute/relative positioning is required for XR, V2X and Industrial IoT devices
- Reliable positioning for high mobility should be supported

Scope for Rel-18 and onward

- Support higher frequency (e.g., >52.6 GHz)
- Positioning during handover
- Integrity for RAT dependent positioning
- Unlicensed band assisted positioning
- Phase difference-based positioning



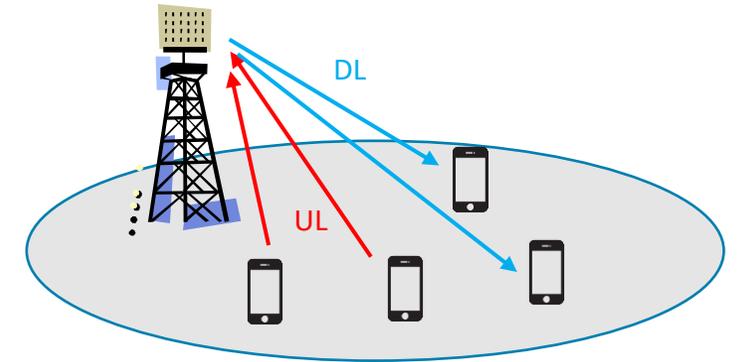
An example of Sidelink positioning:
P-UE: Positioning UE, A-UE: Assistant UE,
SL-PRS: Sidelink PRS, SL-SS : Sidelink synchronization signal

NR Cross Division Duplex



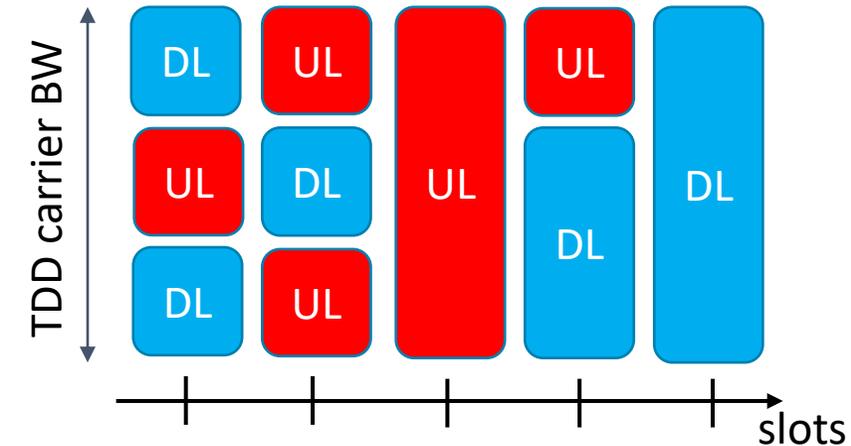
Justification

- Full duplex becomes feasible with an improved spatial isolation using separate Tx/Rx panel, beams, and frequency
- Sub-band level full duplex in TDD using non-overlapped frequency resources could enable dynamic UL/DL resource adaptation based on the traffic load in each direction
- With more bandwidth available at higher frequencies, UL and DL can operate simultaneously in the same carrier while benefiting from extended time domain continuity to overcome adverse pathloss at such frequencies



Scope for Rel-18

- Study sub-band level full duplex in TDD in terms of performance, feasibility, required specification impacts, etc.
 - Consider cross division duplex capability at gNB only in Rel-18



Un-crewed Aerial Vehicles (UAV)

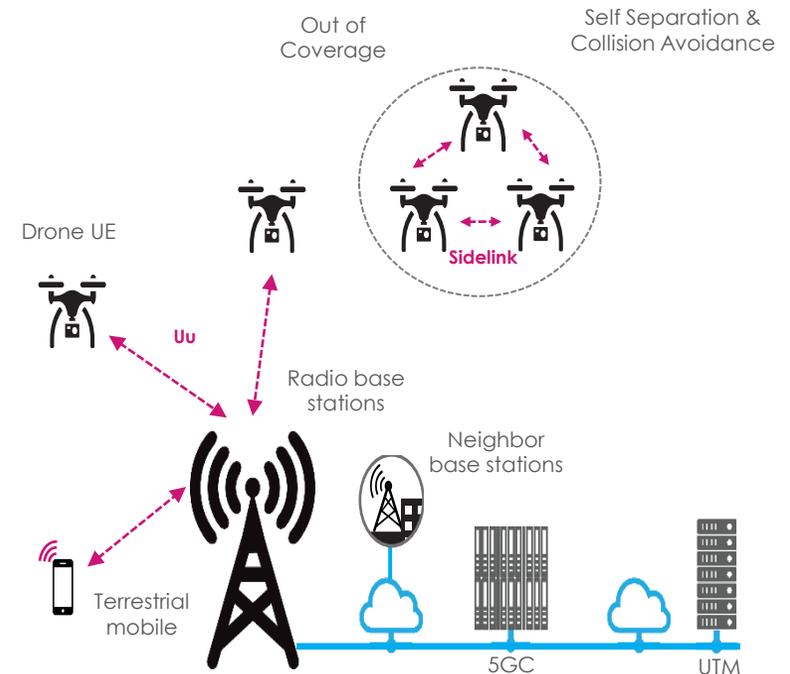


Justification

- Address Uu interference and mobility challenges for UAV (as for LTE in R15)
- Commercial regulations under development require anti-collision and situational awareness features implemented for Drones
- Support direct UAV-UAV communication to meet latency budgets and to provide a scalable solution

Scope for Rel-18

- UE indication of flight path to gNB
- Measurement report triggering based on UE height
- Detection and mitigation of UL and DL interference by resource allocation, beamforming and UL power control enhancements
- SL PC5 broadcast between UAVs, e.g. in a UAV swarm.
 - A UAV can be connected to RAN via Uu, SL, or both

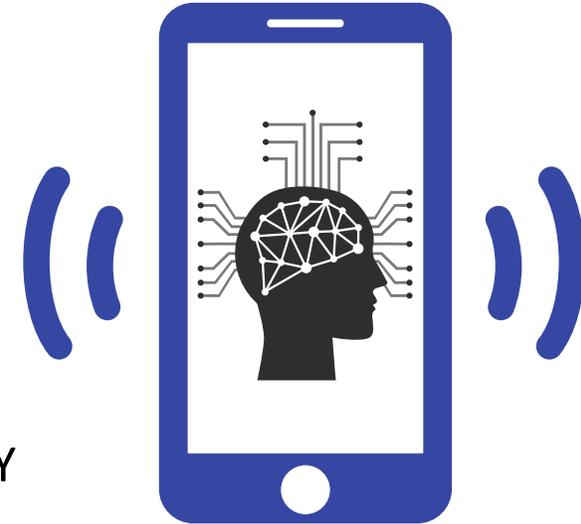


Study on AI/ML in PHY Layer



Justification

- AI/ML can be a useful tool to address specific optimizations
 - Example use cases include
 - MIMO CSI feedback
 - RS overhead reduction
 - Mobility/beam management optimizations
 - Positioning enhancements e.g., for NLOS
- RAN does not have a methodology to evaluate and enable AI/ML in PHY



Possible Objectives for Rel-18

- Identify relevant use cases and scenarios for deployment of AI/ML.
- Study and define an evaluation methodology for AI-based PHY enhancements
 - To enable characterization of a baseline legacy performance for any given use case
 - To enable comparable benchmarking of different AI/ML solutions
 - To evaluate the benefits of different AI/ML solutions for a given use case
- Study characterization and signaling of UE capabilities w.r.t AI processing



Justification

- Extend work for URLLC to high data rate use cases (e.g. XR)
 - This could also be addressed within XR WI
- URLLC latency requirement cannot be met from Inactive modes
 - For any URLLC data arrival in Inactive, the UE must first perform initial/random access, which consumes most of the latency budget.
- LBT failures can considerably delay preamble or data transmissions, especially in wider band unlicensed carriers

Scope for Rel-18 and onward

- Support of URLLC in INACTIVE mode
 - Control plane latency reduction (e.g. mobility, paging, etc.)
 - URLLC data transmission in INACTIVE
- Support of URLLC with high data rates (e.g. XR)
- Other User plane latency reduction
 - Leftover Rel-17 items (i.e. topics that couldn't complete in Rel-17 due to lack of time)
 - Enhanced Type-B repetition over multi-TTI PUSCH grants
 - URLLC operation in LBE and FBE considering LBT, incl. initial access and operation in wideband carriers.
 - Improved reliability by network Coding/coded redundancy over multiple paths/transmissions

MBS and Data collection



Multicast/Broadcast

- Justification:
 - Rel-17 will achieve support for MBS in stand-alone scenarios. Further investigation is necessary to determine if MBS features can work in DC scenarios (e.g. can MRB be a split bearer between an MN and SN)
 - MBS operation under mobility scenarios are not yet addressed due to time limitation.
- Scope for Rel-18:
 - MBS support in DC and MR-DC deployments
 - Mobility enhancements, including considerations on service continuity
 - MBS support in INACTIVE

Enh. Data Collection for AI-enabled RAN

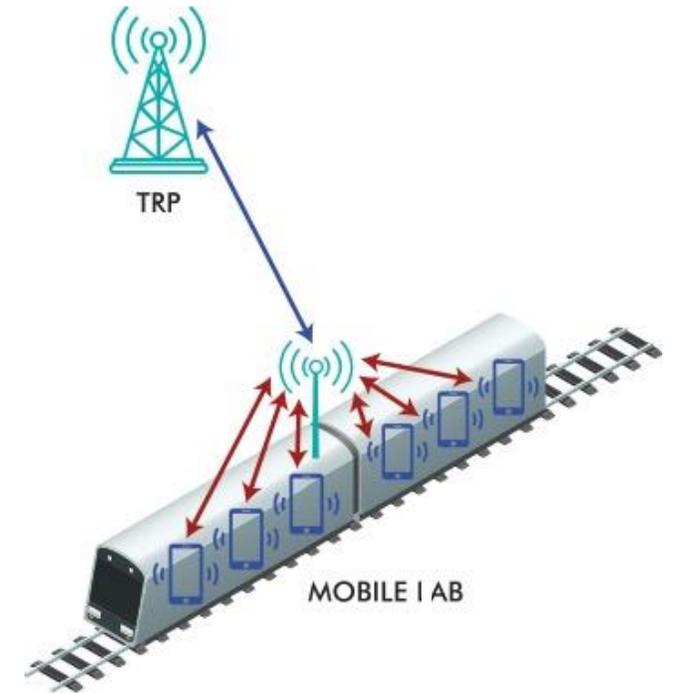
- Continuation in RAN3 to further enhance data collection for MDT, mobility path optimization, and load balancing, energy efficiency, and RAN optimization (e.g. RS allocation).
- RAN AI-enabled enhancements can be useful tool to address specific problems or optimizations, e.g. MIMO CSI feedback, RS allocation, mobility and beam management optimizations, positioning enhancements.

IAB and NTN



IAB

- Justification:
 - Mobile IAB can enable train/vehicle mounted relays flexible deployments. This is related SI in SA1 on Vehicle Mounted Relays (VMR).
- Scope for Rel-18:
 - Support for mobile IAB deployment, including related mobility DAPS and CHO enhancements
 - Enhanced fairness, latency enforcement, and congestion mitigation
 - DC enhancements, including connectivity to multiple parents
 - IAB operation in unlicensed spectrum



NTN

- Justification:
 - Extended coverage and connectivity can be achieved by dual connectivity between LEO and GEO
 - Continuous and periodic acquisition of GNSS positioning can be power consuming for NTN devices
- Scope for Rel-18:
 - DC between LEO and GEO satellites for service continuity
 - Enhanced power saving in NTN and IoT-NTN
 - Support of some NTN features in IoT-NTN devices

Collaborative Terminals



Justification

- Multiple UEs or peripherals can be associated with the same end user, and potentially connected to each other via SL and to the network using a Uu connection.
- Depending on the application (XR, IIoT, or a V2X/UAV platoon), services and transmissions can be switched, split, or coordinated between the inter-connected UEs to increase reliability, data rate, or radio connection diversity.
- SI scope can follow progress in SA studies, if agreed. Relevant aspects including VMR, enh. ProSe, and coordinated comm of multiple UEs have been proposed in SA.

Scope for Rel-18

- Service switching and continuity upon switching Uu from one device to another
- Service splitting and coordination between multiple inter-connected UEs
- Collaborative transmission and reception by sharing MIMO layer, power, carriers
- Transmission and reception of control information on an anchor UE and between interconnected devices
- Fast discovery/selection, configuration of devices in proximity, and dynamic group creation

