



3GPP RAN Rel-17

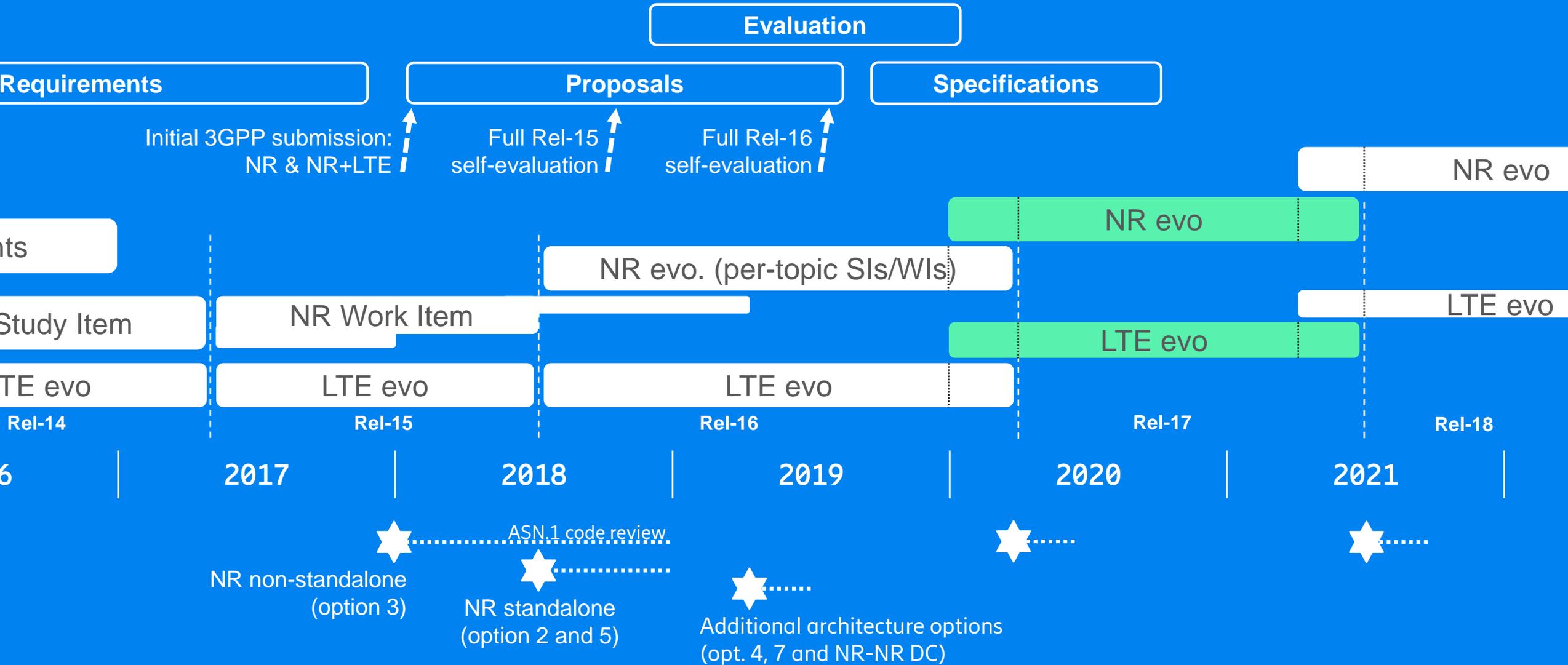
3GPP TSG-RAN Meeting #84
Newport Beach, CA, USA, 3 – 6 June 2019
Agenda item: 8

Overall 5G/NR vision



- Use case dimension:
 - Rel-15 started with eMBB and (selected) URLLC use cases
 - Rel-N++ add selected use cases (to allow the corresponding users to use the 3GPP eco system)
 - Rel-16 example use cases: Vehicle-to-X (V2X), Industrial Ethernet (TSN), non-public networks
 - Rel-17 example use cases: public safety, drones
 - End-goal: 3GPP NR to cover all relevant use cases (...everywhere, every time, everything connected)
- Feature dimension
 - Rel-N: start with basic support of a given use case, i.e., functionality addressing corresponding requirements
 - Rel-N++: evolve functionality by increasing efficiency/effectiveness as long as it is commercially justified
 - Example functionality: IAB for cost reduction, NR-LAA / MIMO for even higher data rates and capacity
- Common to both dimensions:
 - Ensure that NR continues to support all use cases from one platform and not split into NR-per-use case
 - Ensure forward compatibility and sufficient configurability and maximize simplicity
 - Specify functionality in a common way such that it can benefit multiple use cases

5G timeplan – IMT-2020 and 3GPP RAN



Topics for Rel-17



Continuations – mainly feature dimension

- NR >52.6GHz
- Non-terrestrial networks

- ...and further enhancements:
 - NR in unlicensed
 - Integrated Access Backhaul
 - MIMO
 - Positioning
 - URLLC/IIoT
 - SON/MDT
 - Sidelink (incl. non-V2V use cases)
 - LTE-M/NB-IoT
 - 1024QAM for FR1
 - Dynamic Spectrum Sharing

New topics – mainly use case dimension

- NR LITE for (indoor) industrial sensors
- NR enhancements for drones/UAVs
- NR multicast/broadcast
- Public Safety

Disclaimer

- Keep sufficient number of maintenance TUs for needed fixes identified in real life deployments

Ericsson priorities



Supportive – high prio

- NR LITE for (indoor) industrial sensors
- NR enhancements for drones/UAVs
- Dynamic Spectrum Sharing
- NR >52.6GHz
- NR in unlicensed 5-6GHz (no WI/SI needed?)
- Integrated Access Backhaul
- MIMO
- Public Safety (no dedicated SI/WI needed)
- URLLC/IIoT
- LTE-M/NB-IoT

Supportive – medium prio

- NR in unlicensed 60GHz (in Rel-17/18)
- Positioning
- NR multicast/broadcast
- SON/MDT
- 1024QAM for NR FR1

Neutral

- Non-terrestrial networks
- Sidelink

More details in order of..



eMBB

- NR >52.6GHz
- NR in unlicensed 60GHz
- NR in unlicensed 5-6GHz
- Integrated Access Backhaul
- MIMO
- Dynamic Spectrum Sharing
- 1024QAM for NR FR1

IoT

- URLLC/IIoT
- NR LITE for (indoor) industrial sensors
- LTE-M/NB-IoT

Other use cases

- Positioning
- Non-terrestrial networks
- Sidelink
- NR multicast/broadcast
- NR enhancements for drones/UAVs
- Public Safety

Network management

- SON/MDT

eMBB



NR > 52.6 GHz



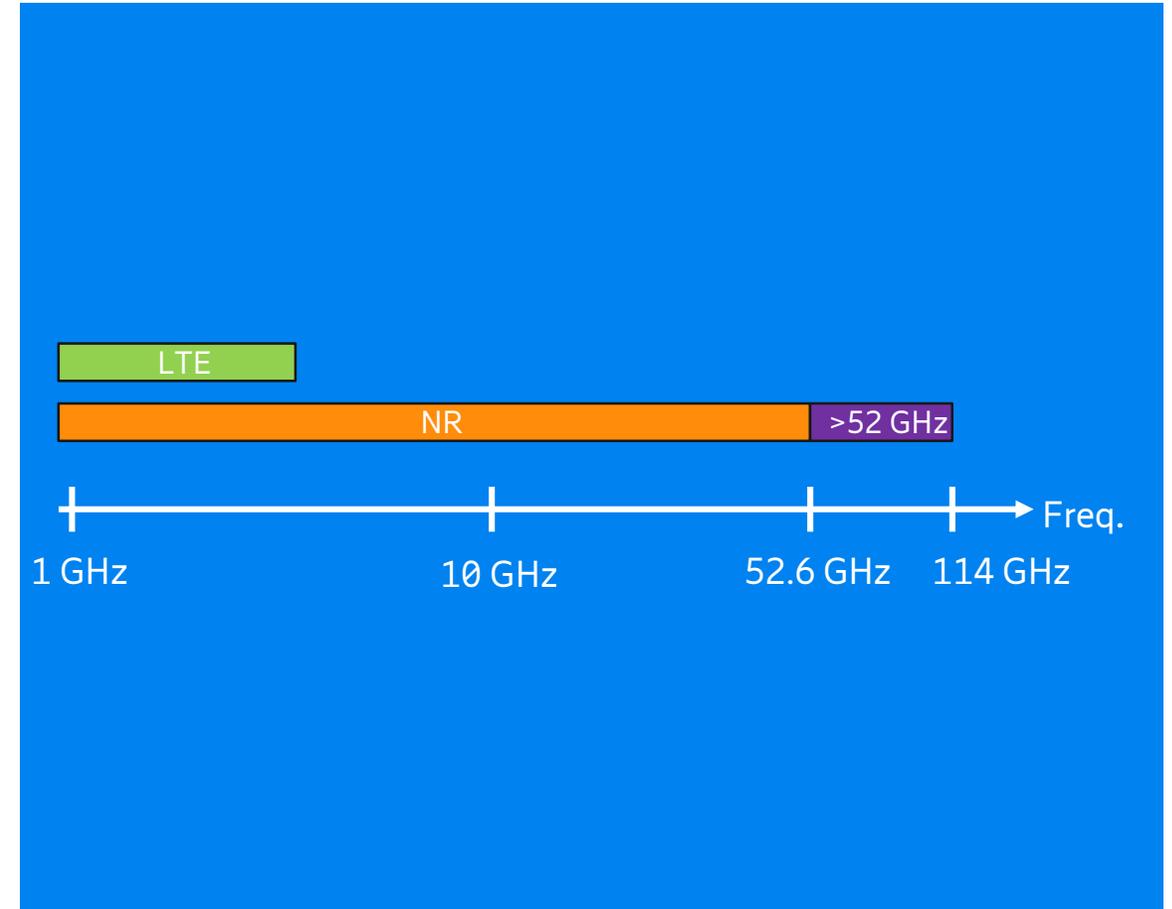
Justification

- Frequency range up to 114 GHz not in focus of Rel-15/16
 - Work re-started early but no commercial urgency
→ follow-up WI in Rel-18
- Possible use cases
 - Mobile broadband services (incl. integrated access/backhaul) for indoor and dense urban
 - Industrial internet of things (incl. positioning)
 - V2X

Study to which extend NR is applicable above 52.6 GHz

- Identify and study required modifications:
 - Baseline is OFDM for DL and OFDM/DFTS-OFDM for UL
 - Improvements need to be shown relative to this baseline
 - Performance boundary unlikely to be 52.6GHz
- Physical layer for licensed bands should be in focus first, followed then by unlicensed
- RAN4 analysis on adjacent channel coexistence scenarios

Note: Adopting a single-carrier waveform for NR would imply a completely new physical (and higher?) layer design as well as corresponding RAN4 work



NR Unlicensed 60 GHz



Unlicensed spectrum considered by cellular operators as a complementary tool to augment their service offering

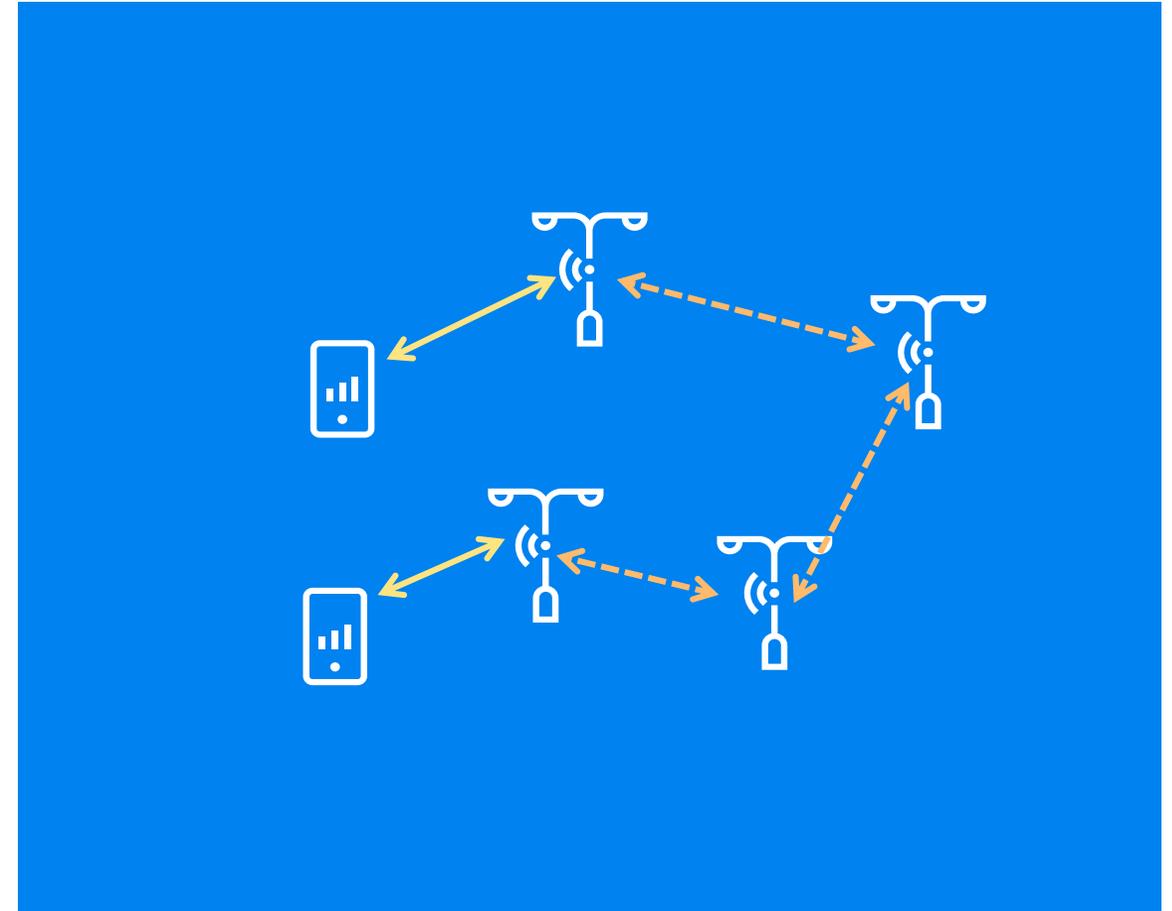
- Large amount of useable spectrum in the 60 GHz bands globally

Study use cases and scenarios

- Mobile broadband services (incl. integrated access/backhaul) for indoor and dense urban
- Industrial internet of things (incl. positioning)

Study NR-U 60 GHz system design based on findings from NR designs for above 52.6 GHz SI

- Start coex. and system design after conclusion on waveform
 - Mid/end of Rel-17 or beginning of Rel-18
- Overall NR-U 60 GHz designs should aim for similar or smaller incremental delta from NR designs for above 52.6 GHz as Rel-16 NR-U from Rel-15 NR
- Define a single global framework for channel access to the 60 GHz unlicensed bands



Enhanced NR Unlicensed (5 & 6 GHz)



Unlicensed spectrum considered by cellular operators as a complementary tool to augment their service offering

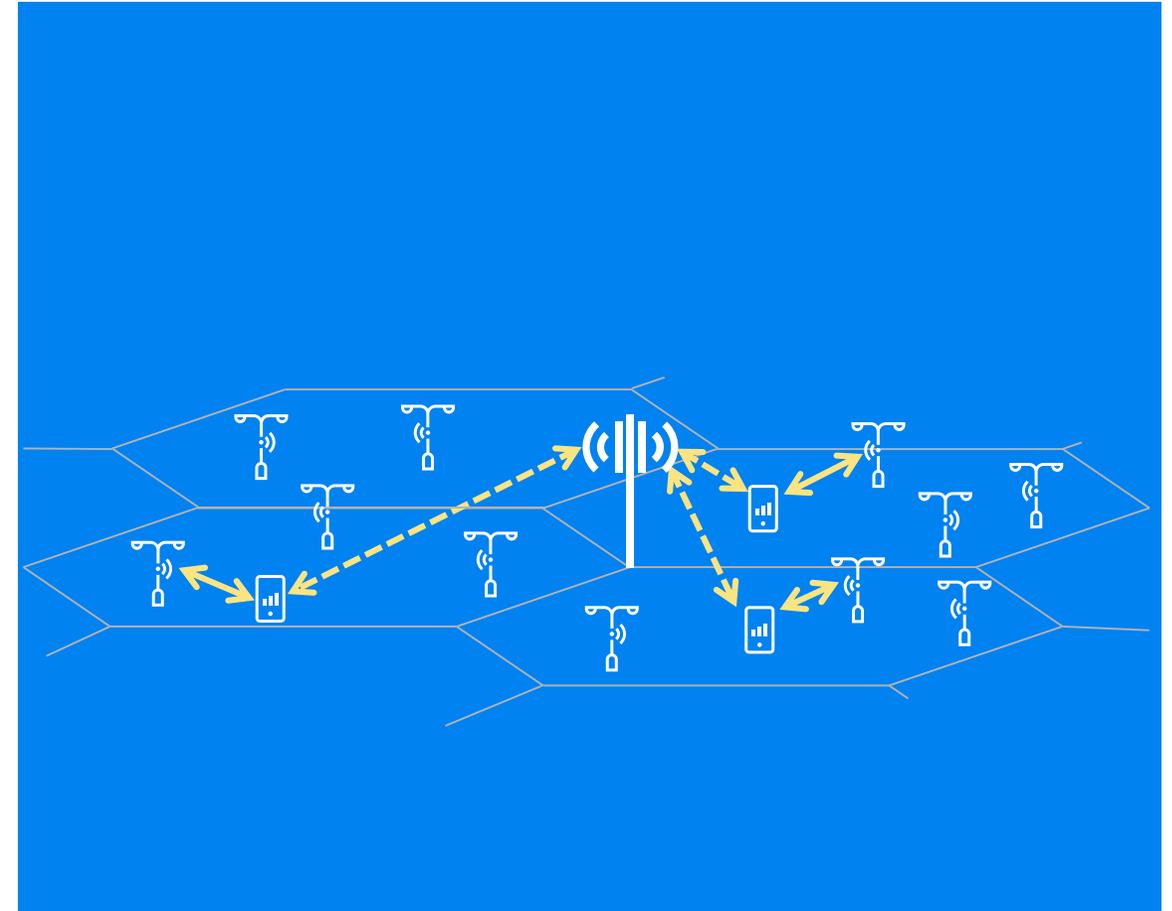
- Large amount of useable spectrum in the 5 and 6 GHz bands globally

Key components for NR-U design and channel access in Rel-16

- Consider only essential left-overs for Rel-17

Future evolution of NR-U to be naturally integrated in relevant feature WIs/SIs, e.g., IAB, IoT

- Minimize NR-U specific changes by maximizing synergies with normal NR



Integrated Access and Backhauling

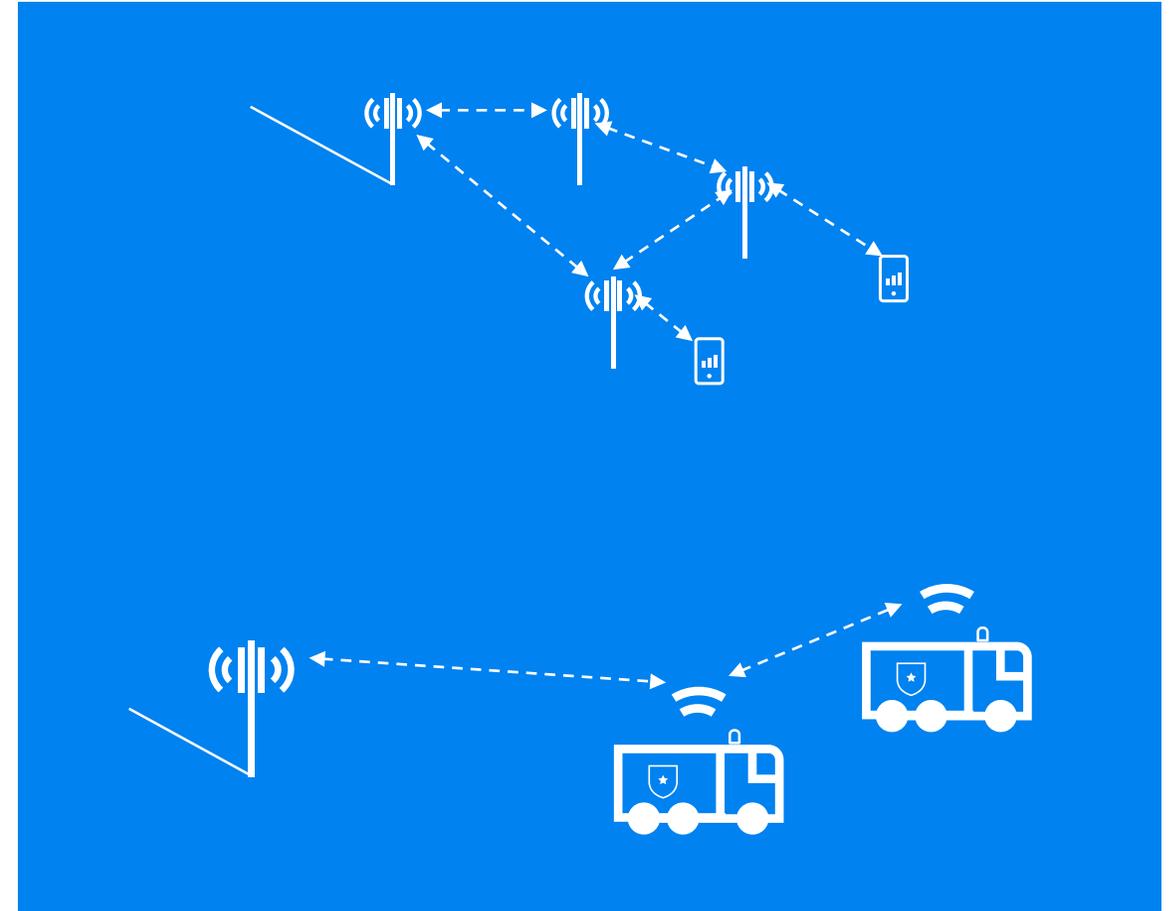


Justification

- Evolved IAB targeting increased efficiency
- Expand IAB usage to additional use cases, e.g., PS or IoT

Objectives

- Enable ad-hoc, temporary and portable/mobile IAB node deployments, e.g., IAB network for operation in disaster areas
- Enhancements to enable energy efficient operation, e.g., solar panel cell driven IAB nodes, e.g. RRC inactive
- Multi-connectivity backhauling enhancements
 - Enabling load balancing between paths, quick seamless fallback
 - Seamless handover at Radio Link Failure
- Multiplexing between different links of an IAB node (parent/child/access links)
 - Enhanced SDM between parent links and child links
 - May include new timing relations between links within the IAB node



MIMO

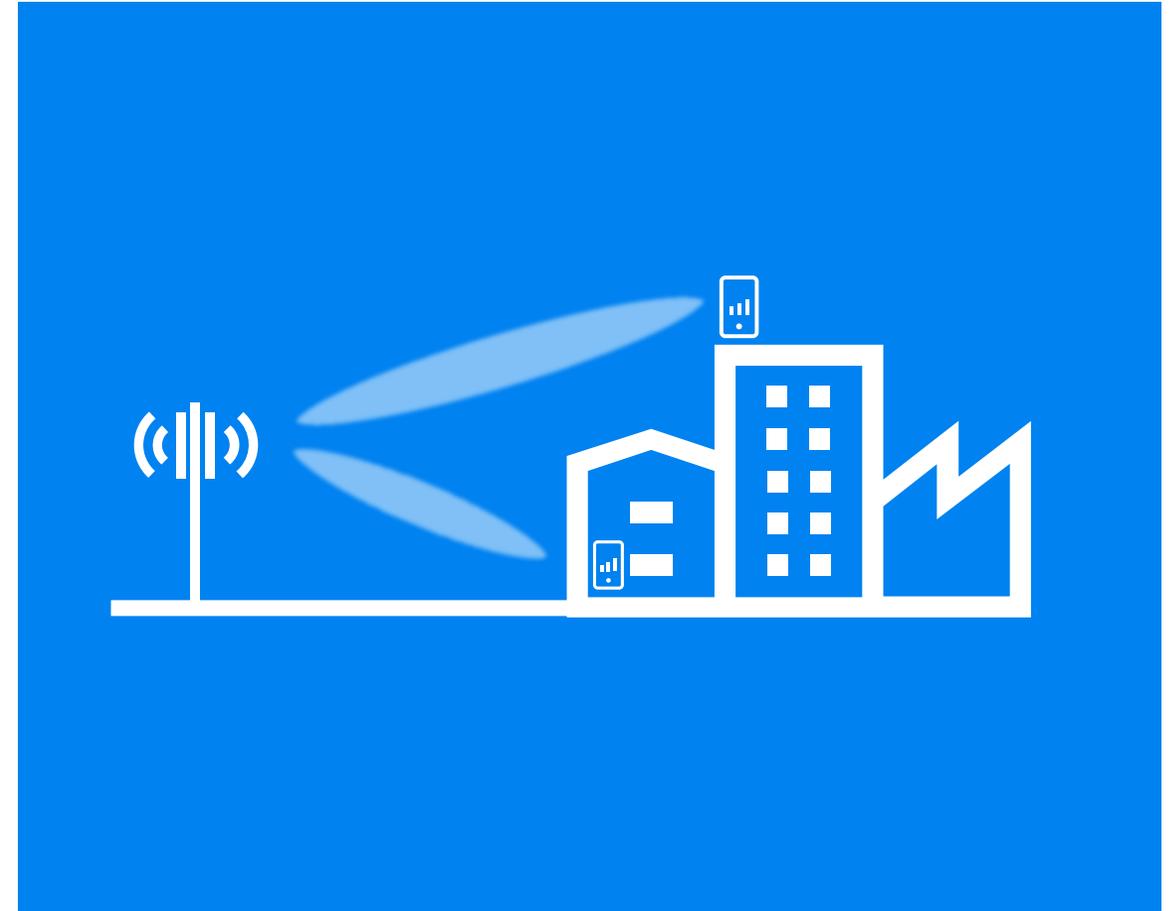


Increase MIMO efficiency in real operation

- Work item dedicated to fixing several bottlenecks learned from implementation, testing and real-life deployment
- Avoid creating gap between standards and real products (like in LTE)

Proposed enhancements

- Reciprocity-based operation in TDD
 - Extend triggering flexibility for SRS and CSI-RS to avoid PDCCH congestion
 - Increase sounding efficiency for reciprocity-based operation
- Operation flexibility and overhead reduction
 - Extend the QCL framework so that also UL measurements can be used for indicating an RX beam for the UE
- Latency reduction for enabling MIMO transmission
 - Obtain MIMO related CSI measurements already at connection setup to reduce MIMO activation latency
- URLLC aspects of multi-TRP (if not in Rel-16)



Dynamic Spectrum Sharing

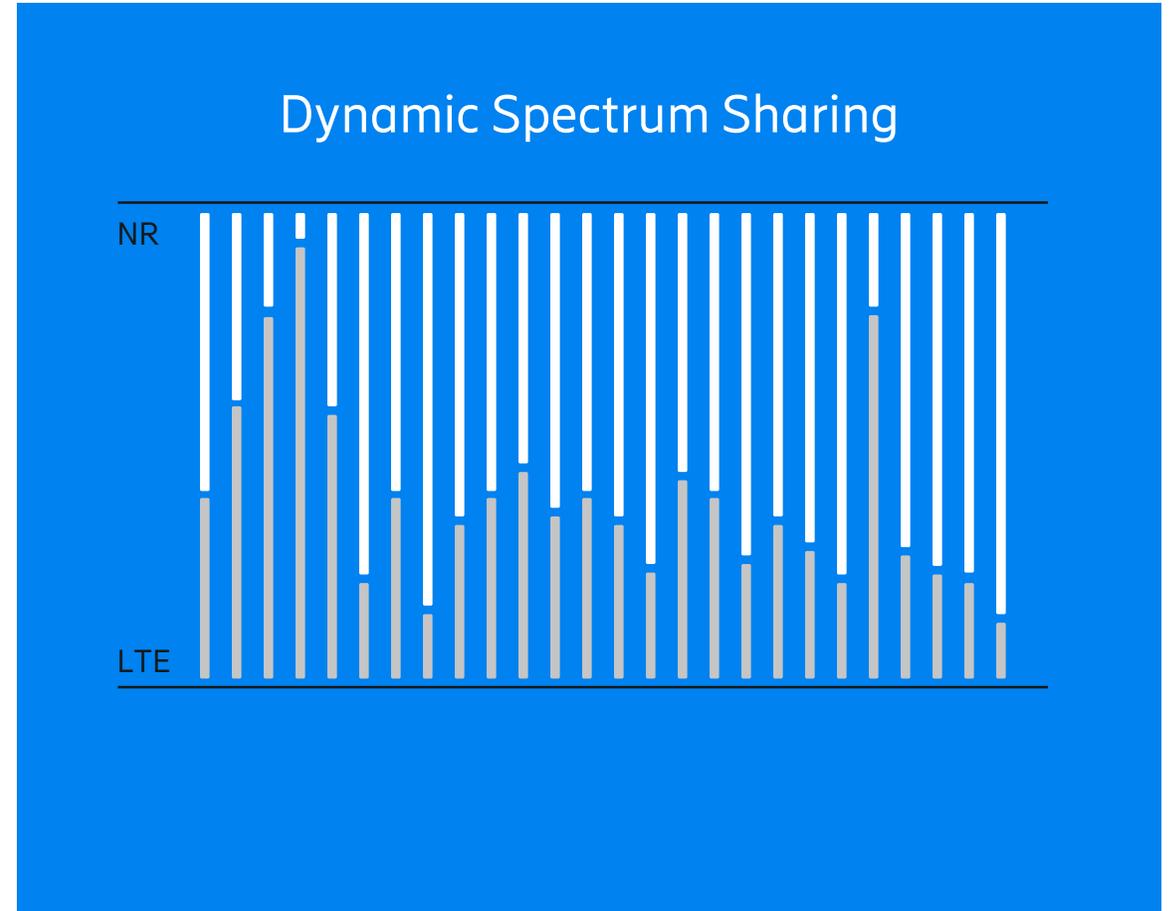


Enhanced cross carrier scheduling

- Allow, in addition to self scheduling also NR PDCCH on SCell to schedule NR data on PCell/PSCell

Enhanced NR ZP-CSI-RS to enable efficient rate matching of LTE CSI-RS

- Adjustments for DC carrier handling of LTE



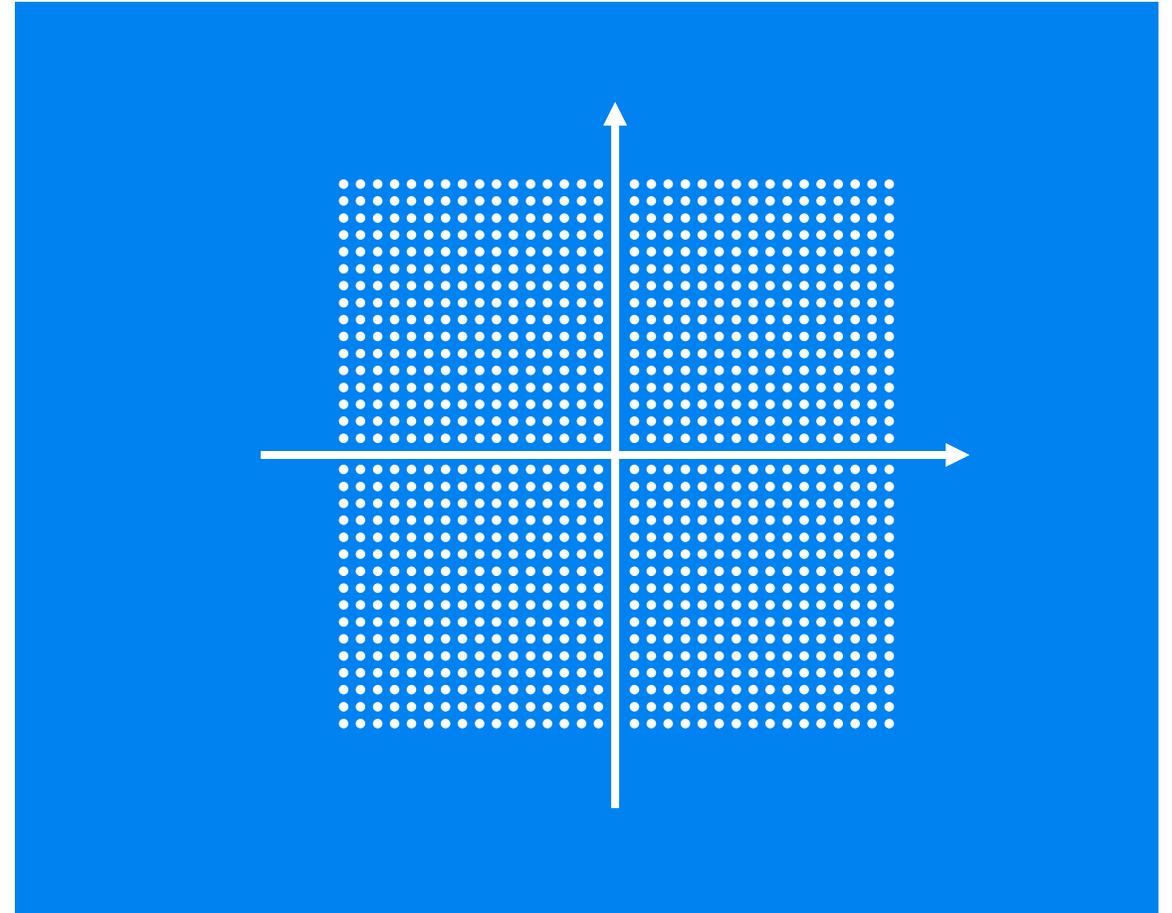
DL 1024 QAM for FR1



High DL data rate under high SNR conditions

- Small cells / indoor / FWA
- Beamforming
- NR competitive with LTE / Wi-Fi

Work Item focussing on DL FR1 only



IoT



Industrial IoT / URLLC

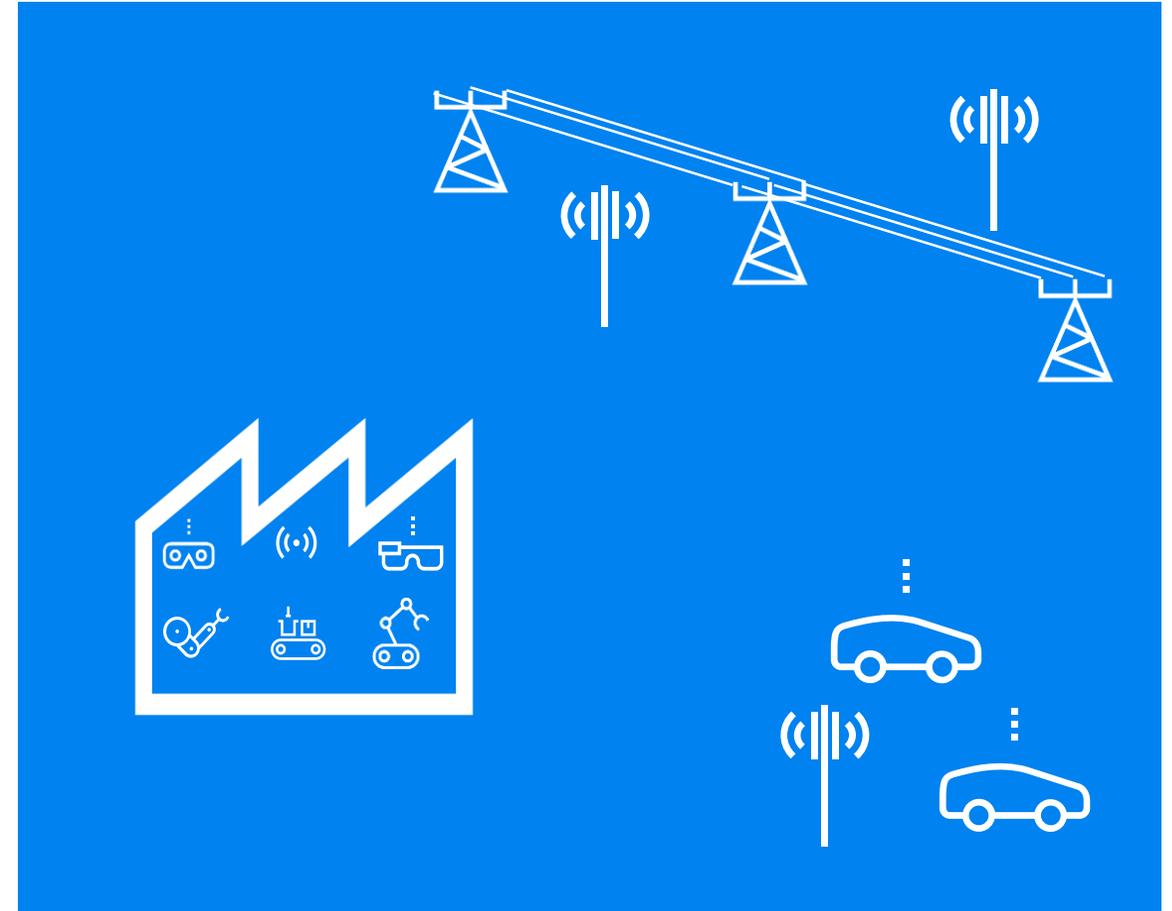


Background

- Rel-15/16 URLLC work provides solid support for critical IoT use cases, especially with dedicated deployments
 - Improvement potential for wide area deployments
- Keep max. synergies with NR and carefully justify URLLC specific changes (especially on lower layers)

Rel-17 enhancements

- For higher layers focus on solutions needed to support SA2 features for Ethernet and TSN integration, and time synchronization
- For lower layers, focus on enhancements, especially wrt spectral efficiency and capacity
 - eMBB/URLLC multiplexing (preferred in Rel-16)
 - Faster UE processing times
 - IOT offload to unlicensed spectrum
- Consider further enhancements for mmWave bands



NR LITE

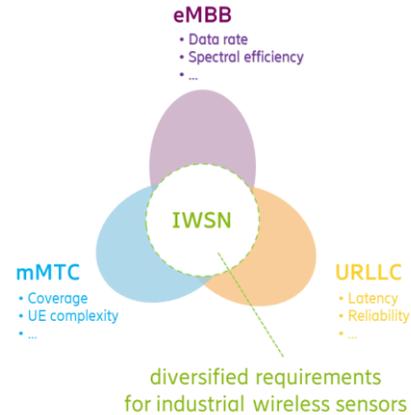


Industrial wireless sensor network (IWSN)

- “Mid-end” IOT use cases
 - Coexisting with URLLC services
- (Similar requirements as wearables)

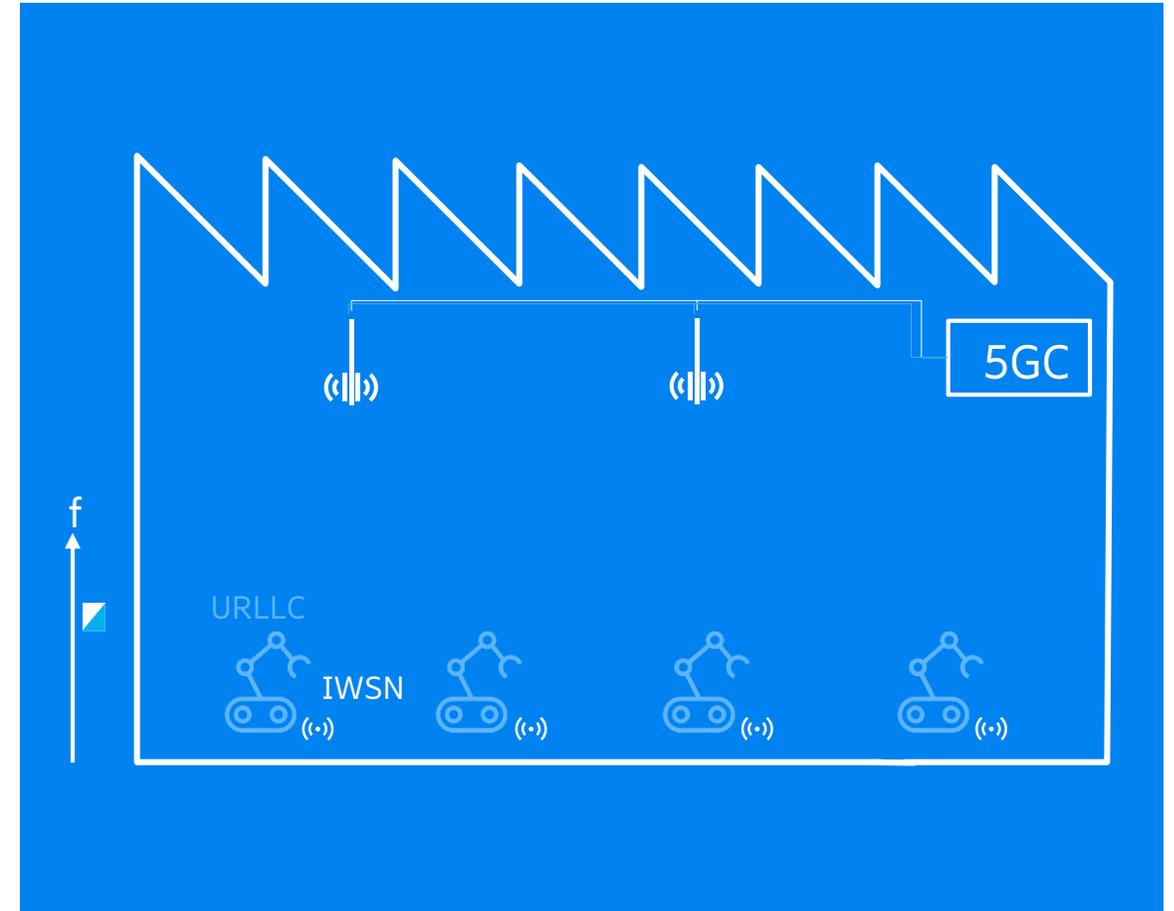
Inherit basic NR building blocks

- NR flexible numerology
- NR beam management and beamforming
- NR TDD configurations
- Reuse NR SSB of ~5 and 10MHz



Enhancements to meet IWSN requirements

- Reduced device BW and fewer antennas (cf. eMBB)
 - Ultra-low UE power class
 - All NR bands (both FR1 & FR2, FDD & TDD)
 - UE energy efficiency (1-3 years battery life)
 - Early Data Transmission to reduce latency and power consumption
- *Neither coverage enhancement nor ultra-narrow (GSM-like) bandwidth*
— *NR LITE to complement 5G mMTC/LPWA solutions NB-IoT & LTE-M!*



LTE-M & NB-IoT continue to address LPWA use cases in 5G era

- Network roll-outs and device uptake have just started to take off
- Careful selection of new features with commercial interest while keeping complexity low

Enhancements areas:

- **Improved DL scheduling flexibility for high spectral efficiency**
 - Additional (M/N)PDCCH time offsets and scheduling delays
 - Support higher PDSCH code rates for Cat-M1
- **Minimization of interference and resource waste in UL**
 - Avoid (N)PRACH CE level ramping for UE at high (N)RSRP
 - UL power control and PHR in connected mode in NB-IoT
- **Further UE power saving through efficient procedures**
 - Reduce UE activity due to paging escalation of other UEs
 - Support system information update in connected mode



Other use cases



Positioning

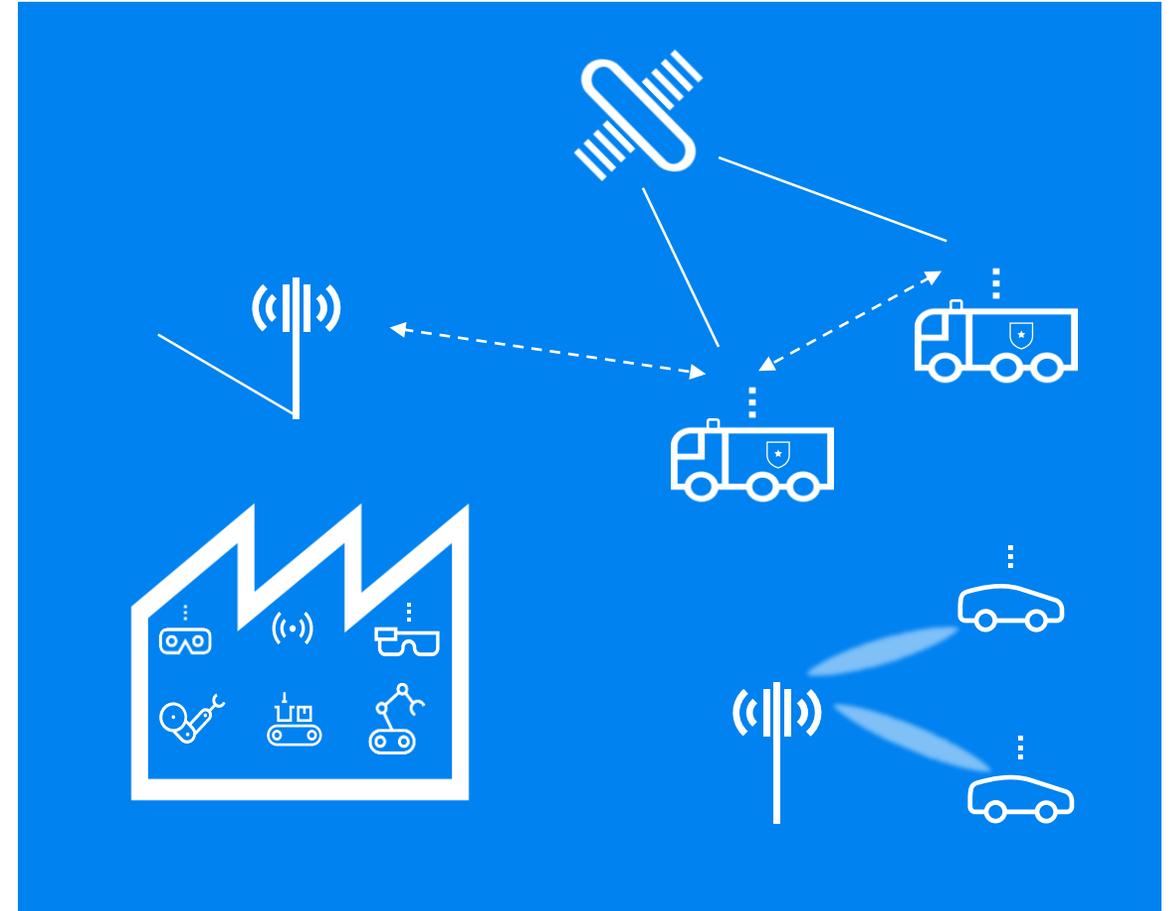


Background

- Rel-16 is the first release to address positioning based on NR signals, measurements and procedures
- Rel-16 addresses regulatory requirements and general purpose positioning
- Rel-16 IIoT study item on industrial use case channel modelling has positioning specific parameters

Rel-17

- Addressing use case specific requirements for industrial, automotive/V2X, public safety and IoT use cases
 - Appropriate positioning accuracy, velocity accuracy, latency, availability, uncertainty, etc. levels
 - Support for both fixed and temporary deployment options
- GNSS integrity support to address compliance with automotive safety integrity levels other applications benefitting from integrity assessments



Non-terrestrial networks



Follow up Rel-16 NTN SI to introduce the basic set of features to enable NR to support satellite communications

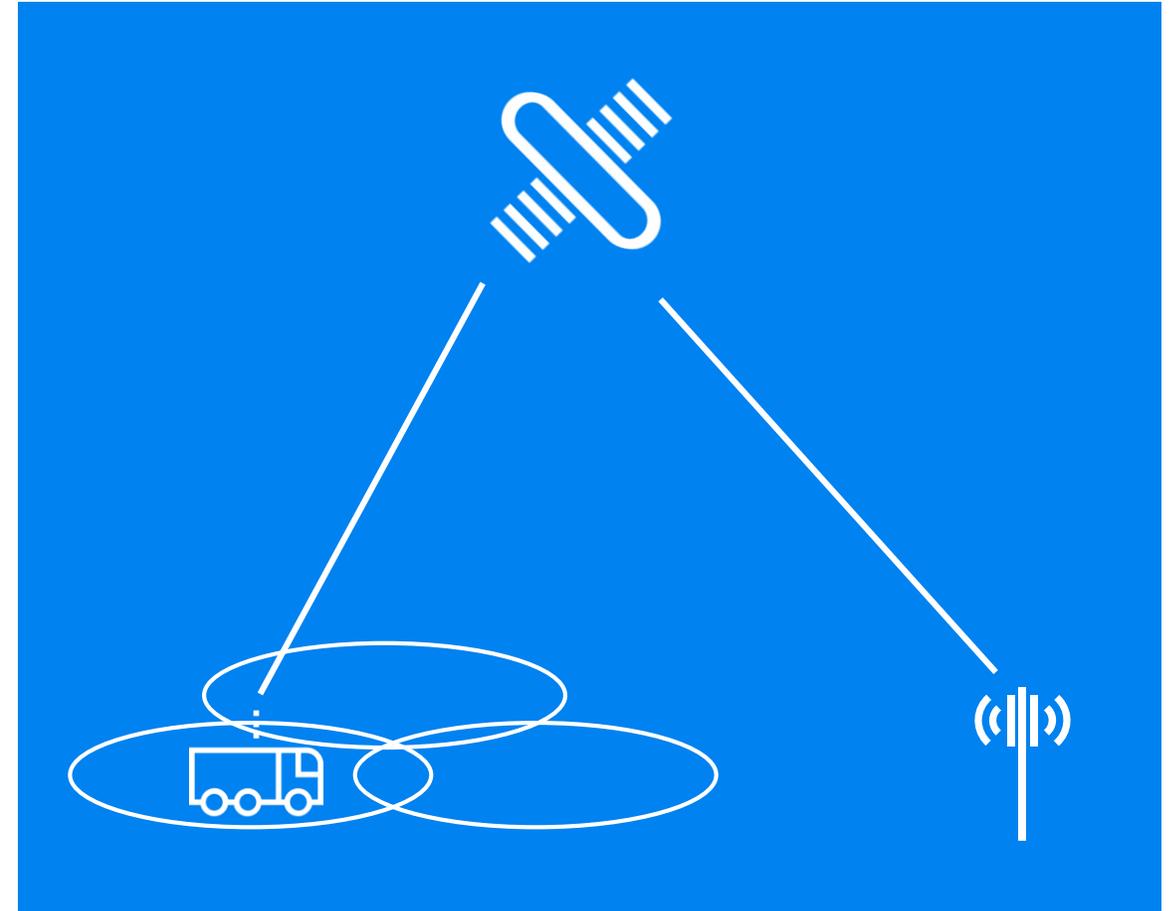
- Aim to maximize synergies with existing NR features for terrestrial mobile networks → minimize changes
- Relevant enhancements can be used in other scenarios such as HAPS or very large cells

Focus on most common bent-pipe architecture, where gNB functionality is on the ground

- Regenerative architecture (incl. inter-satellite communication), where satellite hosts gNB functionality, should be down-prioritized from Rel-17

Key design considerations include long propagation delay, large Doppler, and moving cells, with the main technical areas being

- PRACH and random access procedure adaptations for uplink timing and frequency control
- Retransmission mechanisms, e.g. deactivate HARQ
- Connected/idle mode mobility enhancements
- MAC/RLC/PDCP timer adaptation



Sidelink

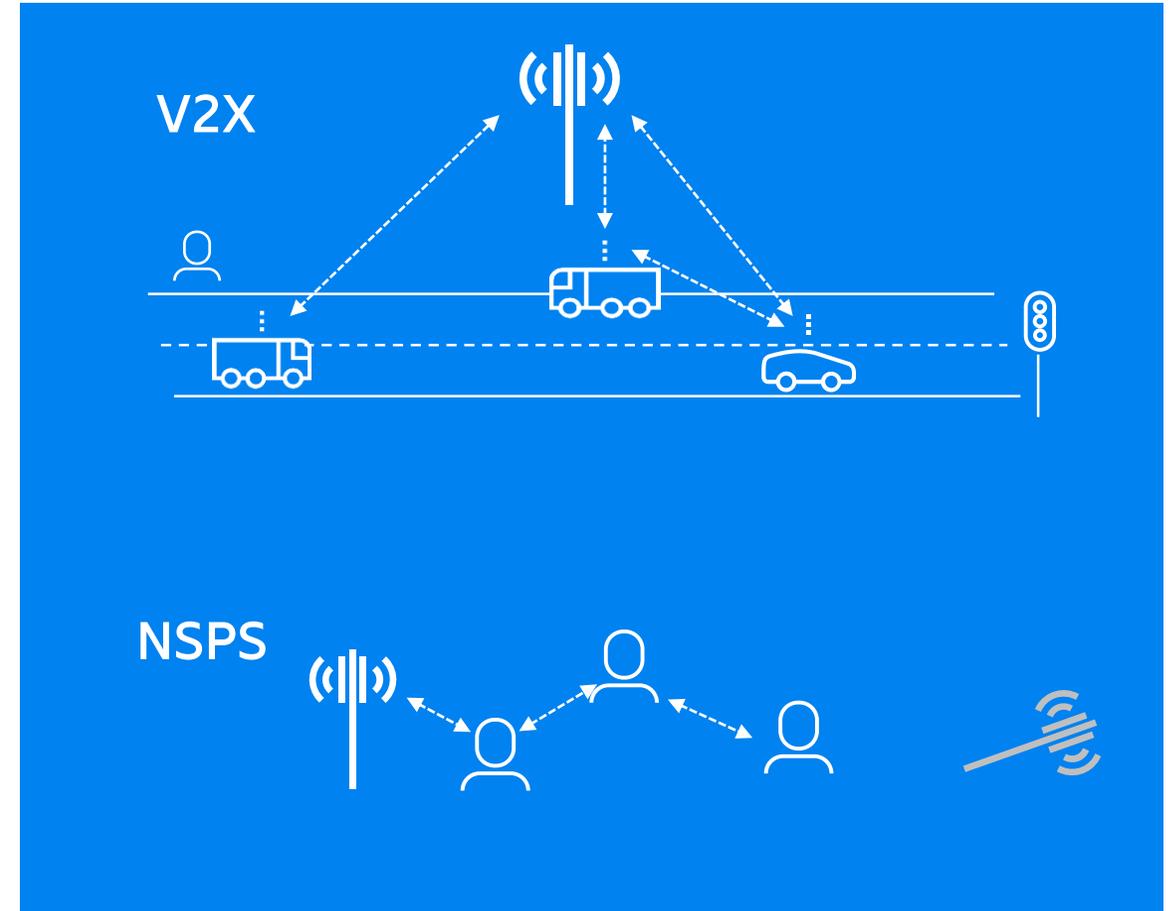


V2X use cases

- Key components for V2V in Rel-16?!
 - No continuous evolution of sidelink technology for commercialized (broadcast-based) application/use cases possible

Public Safety use case

- Enable 5G to meet the PS requirements
 - Sidelink as building block for out-of-coverage use cases
 - UE-to-UE relaying for out-of-coverage
- Standardize Rel-17 NR sidelink for PS (based on future NR V2V eco system)
 - Maximize synergies with NR V2V → minimize PS specific changes



Broadcast / Multicast

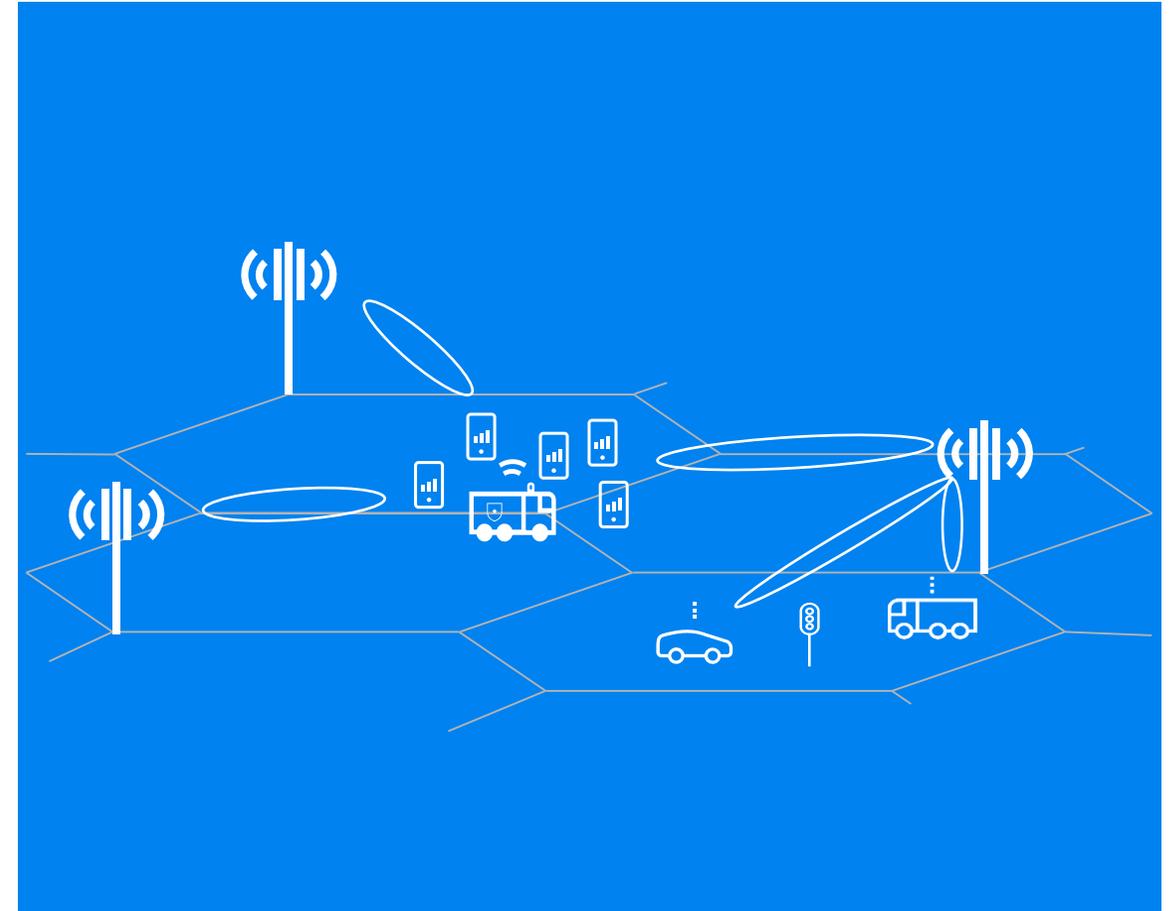


Broadcast / multicast for efficient content delivery

- Public Safety, e.g. group call, group video
- ITS, e.g., distribution of road conditions, traffic sign/light status, etc.

Objectives

- Common framework for single- and multi-cell (SFN) broadcast
 - Building on Rel-15 NR unicast as much as possible
 - Keep Rel-15 numerology
 - Forward compatible to larger SFN broadcast
- Dynamic adaptation of broadcast/multicast/unicast
 - Adaptive SFN cluster to instantaneous demand
- HARQ retransmissions
- Small cell cluster synchronization and coordination handled by RAN without 5GC support



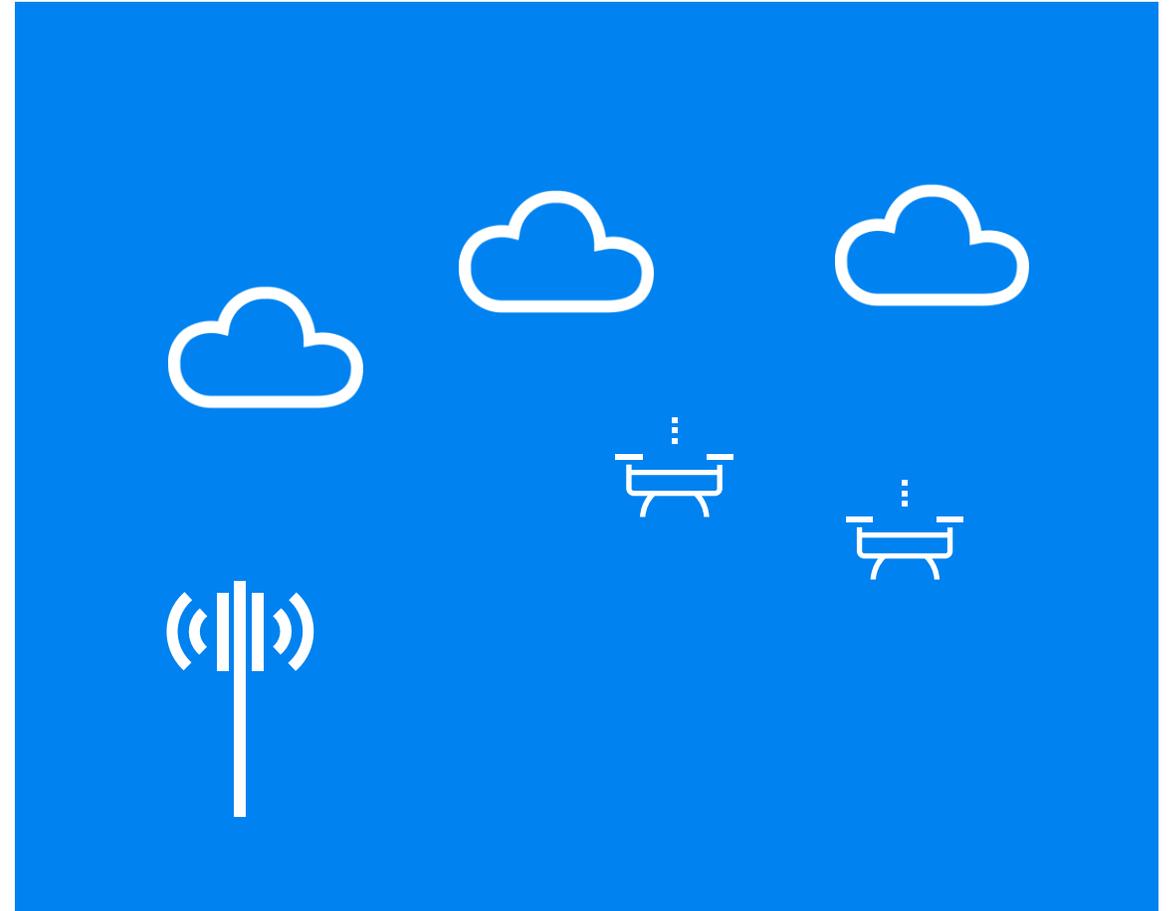
Drones / Unmanned Aerial Vehicles



Rel-15 study on connected drones identified beneficial drone-specific enhancements [3GPP TR 36.777]

Focus on RAN2 improvements that have also been discussed/introduced in Rel-15 LTE

- Height, location, and flight path reporting
- Flexible configuration adjustment due to drone height
- Idle mode mobility enhancements
- Means to avoid frequent measurement reporting



Public safety

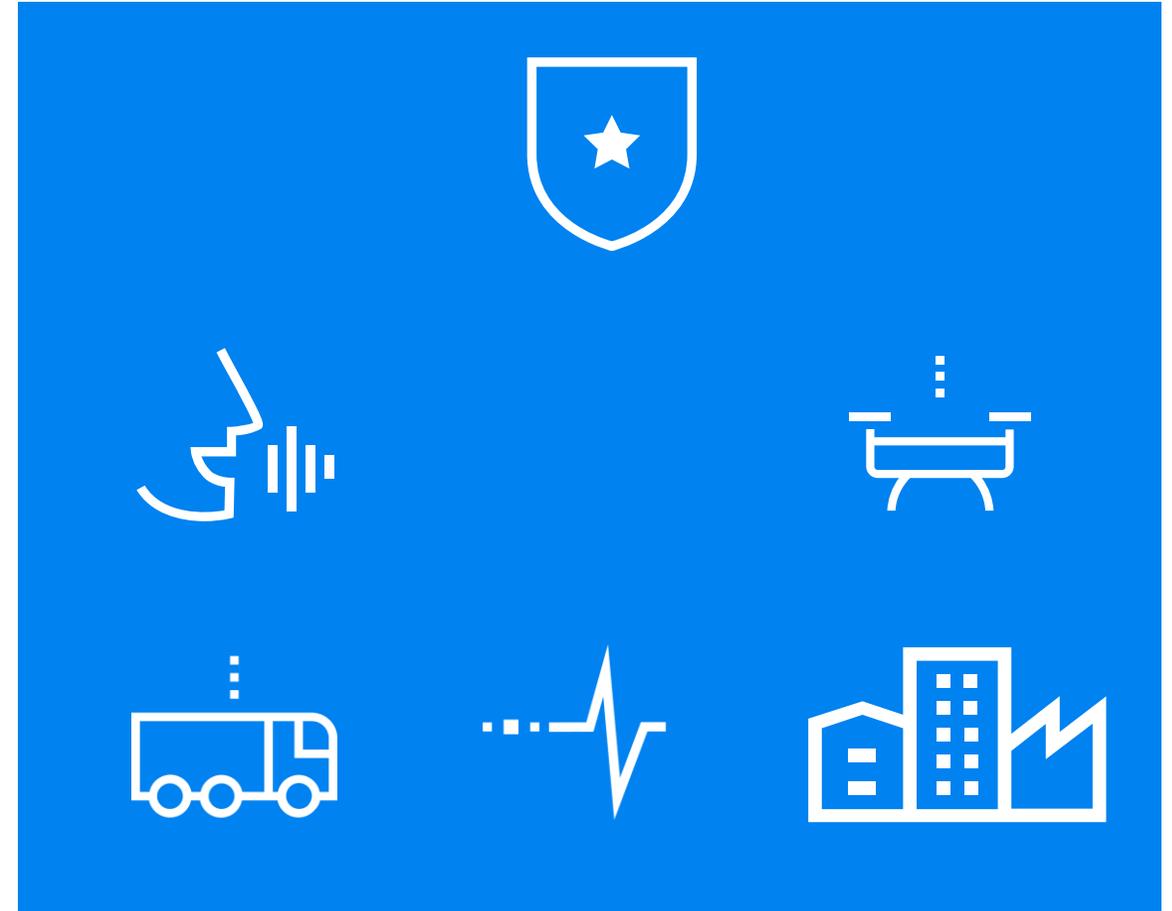


3GPP to support the public safety system

- Leverage on as many synergies as possible with MBB to support the public safety use case

Necessary components covered in separat items

- Sidelink
 - For out-of-coverage communication
- Broadcast
 - For efficient group call/video
 - (No additional RAN impact for group communication)
- Mobile IAB nodes
 - For “cells on wheels” or adhoc/temporary networks
- Drones



Network Management



Self Optimizing Networks (SON)



Background

- SON functions in Rel-16 will be 'LTE-like'
- MDT is expected to be completed in Rel-16
- Configuration/optimization issues identified based on NR specific parameter and/or the first NR deployments are not handled in Rel-16

Rel-17

- Standardize NR specific configuration and optimization features, e.g.,
 - Synchronization signal configuration optimization
- Local RRM policy container
- Enhanced coverage and capacity optimization
- Continue to align with the ONAP related development





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