

NR-Lite for Industrial Sensors and Wearables



5G for Connected Industries

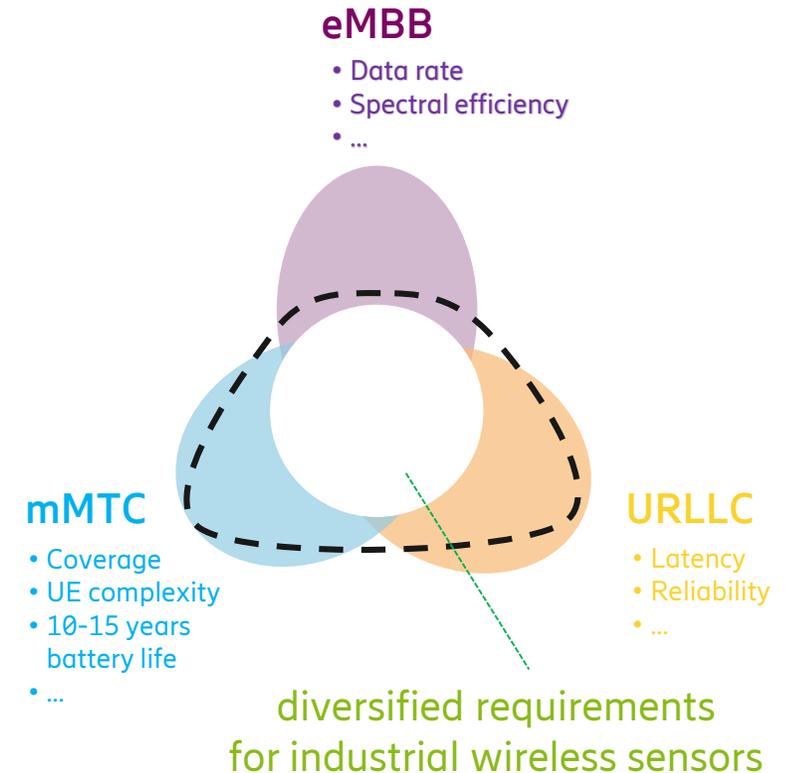


- One of 5G objectives is to enable connected industries
 - for digital transformation of the industries
 - for improved flexibility
 - for improved productivity and efficiency
 - for improved operational safety
- NR Rel-15 established a solid foundation and Rel-16 introduces further enhancements for better serving various industry verticals
 - Many on-going 3GPP SIs/WIs in Rel-16, in both SA and RAN
 - In RAN
 - NR V2X (RAN1-led): automotive industry, transport industry
 - NR eURLLC (RAN1-led) and NR-IIoT (RAN2-led): factory automation, transport industry, electrical power distribution
- NR-Lite would further strengthen NR for the industry verticals

Use Case Requirements for Connected Industries



- Wide range of use cases and connectivity requirements for industrial verticals
 - **cMTC type: remote driving, motion control for industrial automation, power distribution grid fault management**
 - **eMBB type: AR/VR for industrial automation**
 - **mMTC: LTE-M/NB-IoT for LPWA**
 - **IWSN: Industrial wireless sensor networks**
 - Broadly speaking, sensors with connectivity requirements that cannot be addressed
 - by NR Rel-16 in terms of
 - battery lifetime
 - form factor
 - complexity
 - nor by LTE-M/NB-IoT in terms of
 - data rate
 - reliability and latency
 - Examples: microphones, CO2 sensors, pressure sensors, humidity sensors, thermometers, cameras, video cameras, motion sensors, accelerometers, laser scanners, fluid-level sensors, inventory sensors, electric voltage meter, electric current meter, actuators



Rel-17 NR-Lite is NOT for LPWA Use Cases



- RAN#79 agreement ([RP-180581](#))
 - For Rel-16:
 - No NR based solution will be studied or specified for the LPWA use cases
 - LPWA use cases will continue to be addressed by evolving LTE-M(eMTC) and NB-IoT
- We see the considerations behind the above agreement still hold for Rel-17 and for next few years
- [Ericsson view: Rel-17 NR-Lite is not for LPWA use cases](#)

Industrial Wireless Sensor Radio Requirements



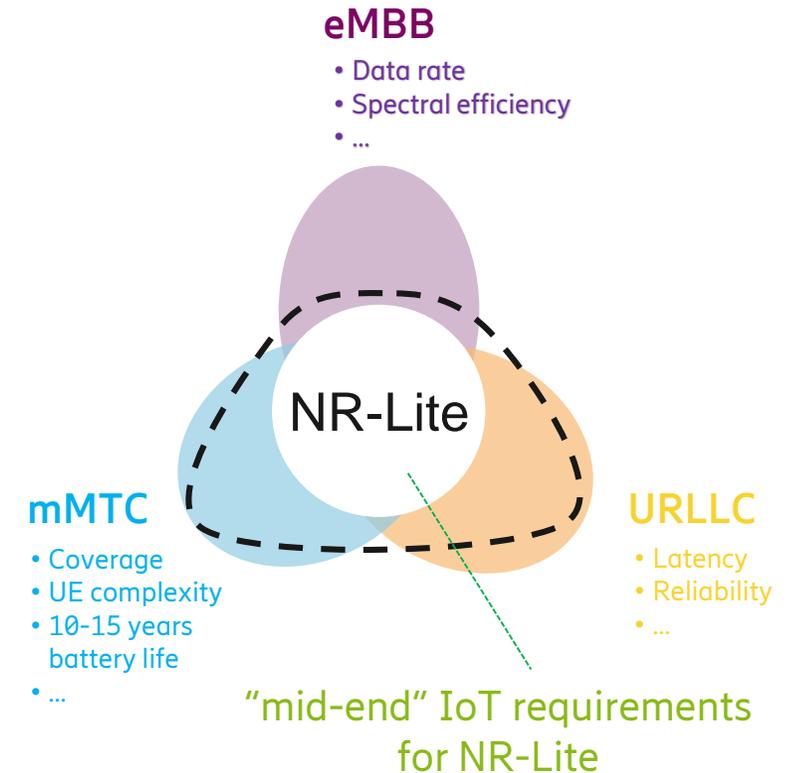
- The majority of the industrial wireless sensors do not need to achieve the extreme KPIs of eMBB, mMTC, and URLLC.
- Release 17 study item can start with study and address the requirement space between these extremes.

	LPWA	IWSN	URLLC
Solution:	LTE-M, NB-IoT, EC-GSM-IoT	NR-Lite	LTE and NR URLLC
Latency:	< 10s	5-10ms for safety related monitoring 50ms – 1s for non-safety related monitoring	0.5 to 1 ms
Connection density:	1,000,000 per km ² (= 1 per m ²)	0.05 - 1 per m ²	-
Range and coverage:	164 dB MCL	<30m; mainly indoor deployment*	-
Device cost:	Ultra-low*	Low*, Ultra-low transmit power	High
UE battery lifetime:	10-15 years	1-3 years battery life	-
Data rate:	> 160 bps	Up to 100 Mbps (based on Table 5.3.8.6 of TR22.804)	-
Reliability:	-	Need to work in extremely harsh environment	Up to 99.9999%

Additional Use Cases



- Many use cases shared similar requirements as industrial wireless sensors
 - Requirements not yet best served by eMBB, URLLC, LTE-M, NB-IoT
 - NR-Lite can be designed to address these wide-area use cases such as wearables
- Example: Wearables
 - Small form factor
 - Data rate not as high as eMBB, but higher than LTE-M/NB-IoT
 - Latency not as tight as URLLC, but tighter than LTE-M/NB-IoT
 - Battery lifetime does not need to be 10-15 years, but need to be much longer than typical recharging cycles of smartphones



Rel-17 NR-Lite



Introduce NR-Lite to support industrial wireless sensor network (IWSN) and wearables

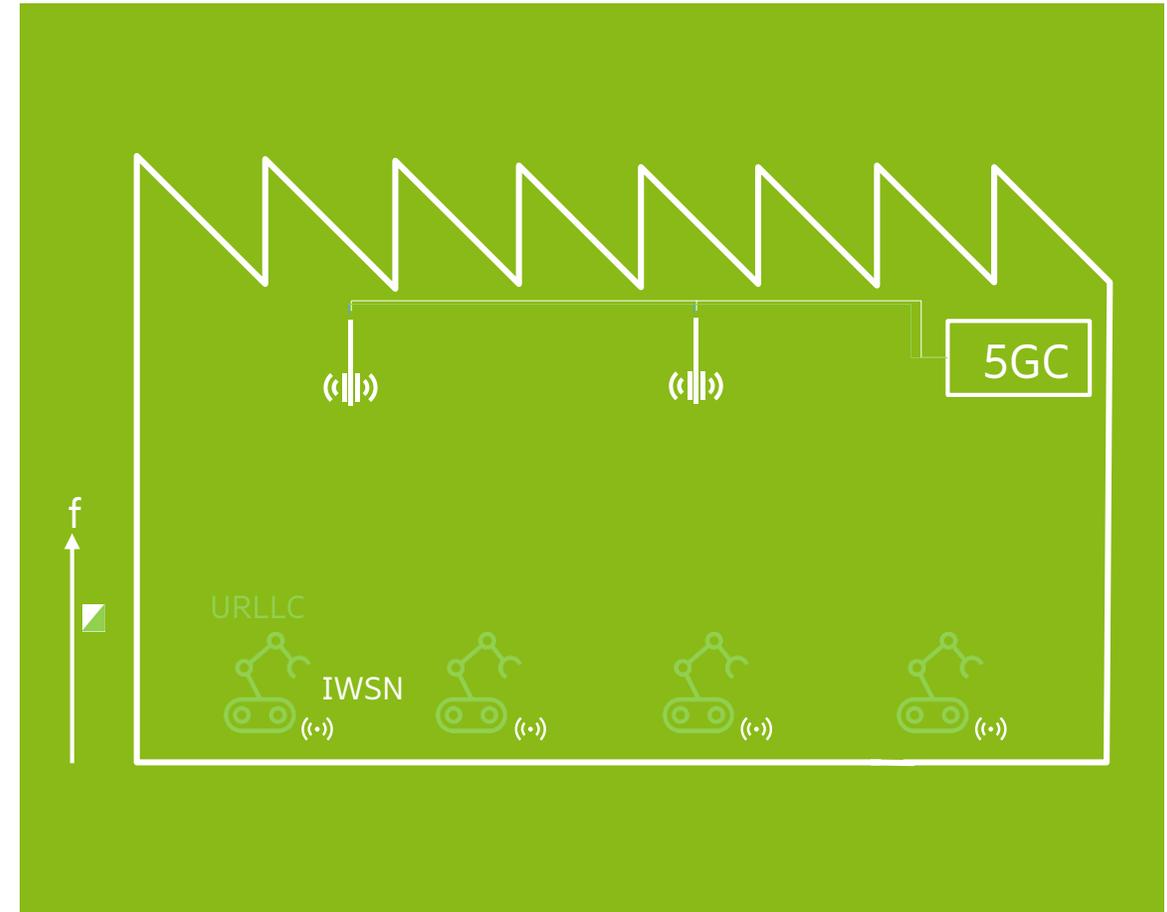
- Complementing the 5G mMTC/LPWA solutions NB-IoT & LTE-M
- Smaller UE form factor
- Spectrum availability (IMT-2020, TDD bands)
- Better coexistence with URLLC (especially TDD)
- (No need for Coverage Enhancements in Rel-17)

Inherit basic NR building blocks

- NR flexible numerology
- NR beam management and beamforming features
- NR TDD configurations
- Reuse NR SSB²

Enhancements to meet IWSN requirements

- Enable lower complexity UEs compared to NR eMBB UEs*
- Ultra-low UE power class
- UE energy efficiency (up to 1-3 years battery life)
- Enhancements RRC Inactive for longer sleep cycles
- Work in all NR bands
- Early Data Transmission to reduce latency and power consumption.



Rel-17 NR-Lite SI Objectives (1/3)



- NR performance and service requirements for NR-Lite use cases:
 - Identify services and requirements suitable for IWSN and wearables, and not already covered by URLLC and mMTC [RAN2 lead, RAN1]
 - Study TS 22.104 "*Service requirements for cyber-physical control applications in vertical domains*" and TS 22.261 "*Service requirements for the 5G system and identify requirements*" suitable for NR IWSN.
 - Map the identified set of service requirements to radio requirements relevant for TSG RAN including at least requirements on UE battery life, UE form factor, latency, reliability, connection density, data rate, and UE complexity. [RAN2 lead, RAN1]

Rel-17 NR-Lite SI Objectives (2/3)



- Study and identify features for supporting NR-Lite use cases :
 - Enable energy efficient operation in UE to ensure a sufficiently long battery life for IWSN and wearables use cases. [RAN2]
 - Study enhancements to RRC_INACTIVE mode, i.e. longer sleep cycles and efficient RAN handling thereof. [RAN2]
 - Based on existing NR SSB and CORESET 0 designs, study and identify suitable UE bandwidth(s) for meeting the data rate, latency, and reliability requirements of IWSN and wearables
 - Study if any physical layer changes are required to support UE bandwidth reduction compared to eMBB devices. [RAN1]
 - Study the feasibility of ultra-low UE power class, and/or reduced number of antennas, for smaller UE form factor. [RAN1 lead, RAN2]
 - Study Early Data Transmission for NR for latency reduction and energy efficient improvement beneficial to IWSN and wearable UEs. [RAN2]
 - Study whether there is a benefit of introducing HD-FDD [RAN1]
 - Ensure efficient co-existence with URLLC. [RAN1]
 - Study suitable frequency bands, consider both FR1 and FR2. [RAN4 lead, RAN1]
 - Specify additional NR features if necessary (in addition to those listed above) to support the identified IWSN and wearables use case. [RAN2 lead, RAN1]

Rel-17 NR-Lite SI Objectives (3/3)



- Study and identify NR UE features and parameters suitable for NR-Lite use cases using *TS 38.306 "UE radio access capabilities"* as a baseline:
 - Study UE feature list relevant for IWSN and wearables. [RAN1 lead, RAN2]
 - Based on the identified use cases, performance and service requirements, identify NR features and parameters (e.g. soft buffer size, number of MIMO layers, number of receive antennas, highest modulation order, etc.) that should be supported by NR IWSN and wearables UEs.
 - Balance UE complexity with sufficient performance.

