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NR-Lite for Rel-17 Qualcomm views

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Table of content

- Overall background
  - Relationship of NR-Lite with eMBB, mMTC, URLLC
  - Use cases

- Areas of enhancements
  - HD-FDD
  - Reduced complexity PDCCH
  - Power consumption
  - Contention based Uplink
  - Relaying & sidelink

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Scope of NR-Lite

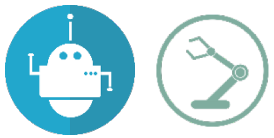
Expand the ecosystem

- What are Low Tier 5G UEs
  - Industrial sensors / video monitoring
  - Relaxed IOT devices
  - Wearables
  - May or may not be power constrained

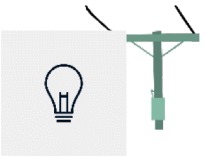
Healthcare

Smart cities

Transport and logistics

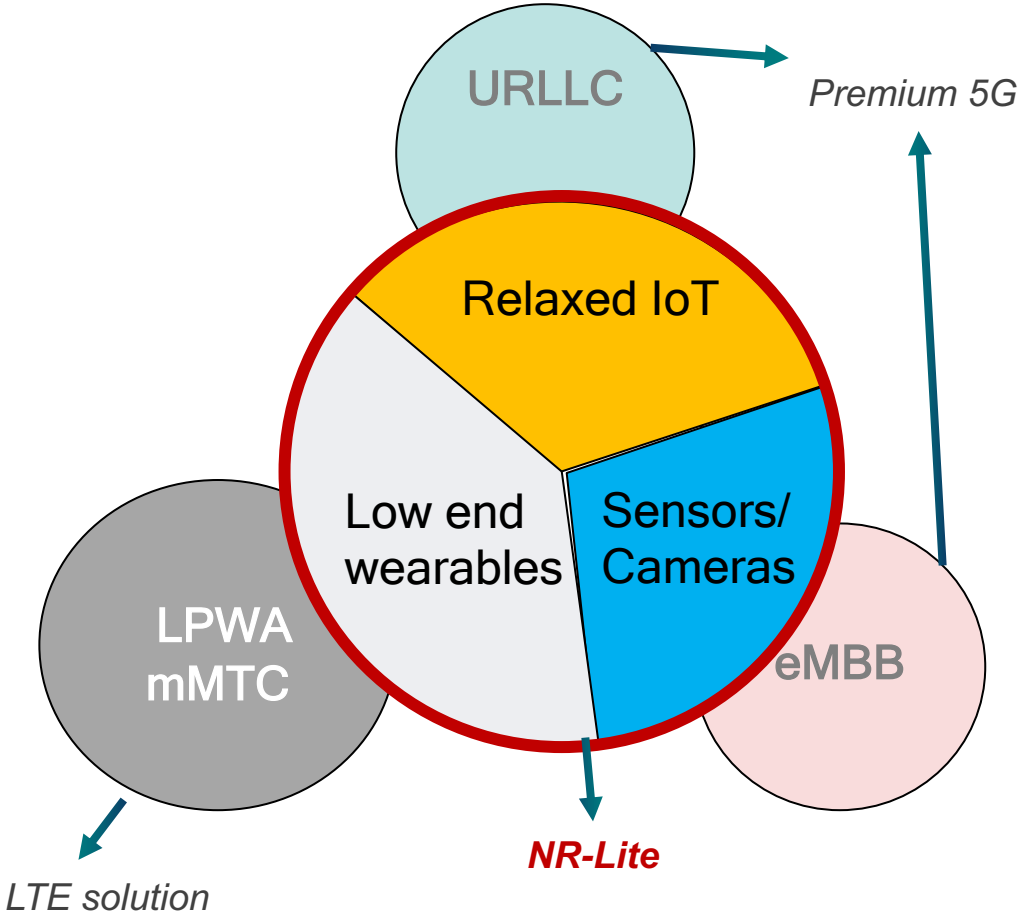


Process automation



Elec. distribution

Building automation



Characteristics	requirement
Latency	10-30ms
Reliability	1e-3/1e-4/1e-5
Data rate	10Mbps and below
Coverage	MCL=143dB

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Scope of NR-Lite

Premium design is not optimal for low tier UEs

Requirements & Characteristics	Premium 5G UEs		Low tier 5G UEs			Very low end
	eMBB	**URLLC**	**Industrial sensors / video monitoring**	**Low end wearables**	**Relaxed IoT**	**LPWA mMTC**
Latency	Low	Ultra Low	Medium	Medium	Low/medium	High
Reliability	High	Ultra high	Medium	Medium/High	High /ultra high	Low
Data rate	High	Low/High	Medium	Low -Medium	Low/medium	Low
Device complexity	High	High	Medium	Low	Low	Very low
Coverage	Normal	Normal	Normal	Normal	normal	Extreme
Battery life	Medium	Medium	Medium	Long	Low/Medium/NA	Very long
Connection density	Medium	Medium	Medium	High	High/very high	Very high
Bandwidth requirement	Wide	Wide	Medium	Medium	Medium	Narrow
Mobility	Yes	Yes	Yes	Yes	Yes	Nomadic

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Low Tier Half Duplex UE in FDD

Motivation and Design

- Complexity saving
  - Remove duplexer support per FDD band → significant savings with multi-bands
    - Smaller insertion loss by skipping a duplexer
    - Improved RF performance e.g., REFSENS (e.g., 0.8 dB improvement in LTE eMTC HD-FDD), max output power (MPR)
  - Reuse TDD baseband implementation
    - Minor impact to peak rate e.g. 17% - 25% reduction on DL due to flexible frame structure

- Specification impact
  - No spec change is expected to support the TDD-like operation in FDD
  - Need to introduce a new UE category for HD-FDD duplex mode (per band)
  - New Tx/Rx RF requirements e.g., maximum output power, aggregate power control tolerance, frequency error, REFSENS

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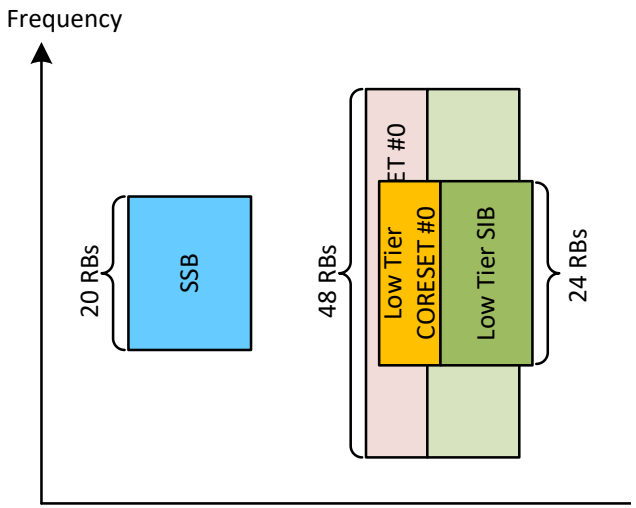
PDCCH Design for Low Tier UEs

Complexity reduction + capacity enhancement

- Low Tier UEs designed with smaller BW capabilities
  - R15 CORESET #0 max BW 17 MHz (i.e., 96RBs for SCS=15kHz, 48RBs for SCS=30kHz), can be larger than the max BW (i.e., 5MHz, 10MHz) targeted for the Low Tier UE
  - Proposal: Introduce single CORESET that contains one CSS set and one UESS set per BWP for Low Tier UE

- Consideration for reduced PDCCH monitoring for Low Tier UEs
  - E.g. reduce max number of BDs/CCEs per slot the UE needs to process

- Consider also how to increase PDCCH capacity



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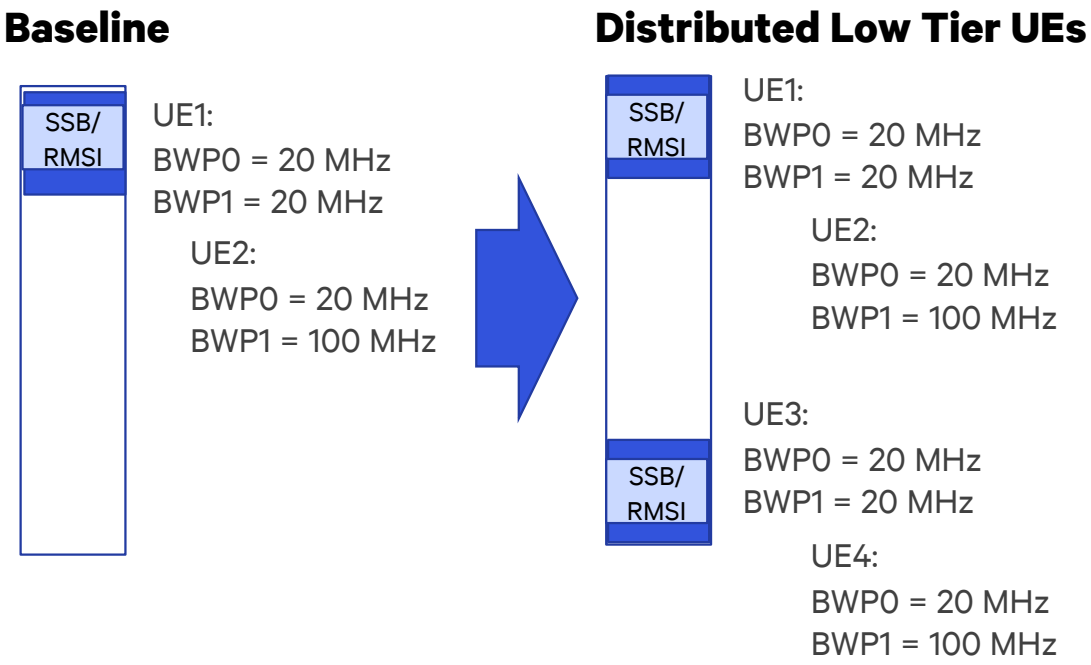
Co-existence of Premium and Low Tier UEs

- Rel-15/16 support for reduced BW UEs tend to congregate users around the SSB/RMSI frequency
- Techniques to support distributing low tier UEs across frequency
  - E.g. Multiple SSB/RMSI distributed across frequency
- Consider how to support efficient multiplexing of resources between low tier and high tier UEs
  - E.g. new configuration scheme for PDCCH resources to minimize CORESET fragmentation and/or blocking for PDCCH resources



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Peak Power and Battery Life Optimization

- Battery saving design is critical for wearables
  - Peak power requirement is dominant factor affecting battery design
  - Lower peak power → smaller / less expensive battery (and form factor)

- Enhancements for peak power optimization compared with Premium UEs
  - High efficiency Tx: Potential waveform / RF spec impact
  - Repetition in time for RS and channels, overhead reduction

- Enhancements for battery life optimization
  - *Note: some may be addressed as part of other agendas e.g. UE power saving, Small data for NR*
  - RRC_IDLE/INACTIVE power savings show great impact to battery life for wearables use cases
    - Additional RS for RRM
    - WUS for idle mode paging
  - Small data transmission in RRC_INACTIVE
    - RRC connection setup overhead reduction
  - Seamless fallback to PAN (including other RAT such as Bluetooth) for wearables
    - Minimize connection interruption during WAN and PAN switching

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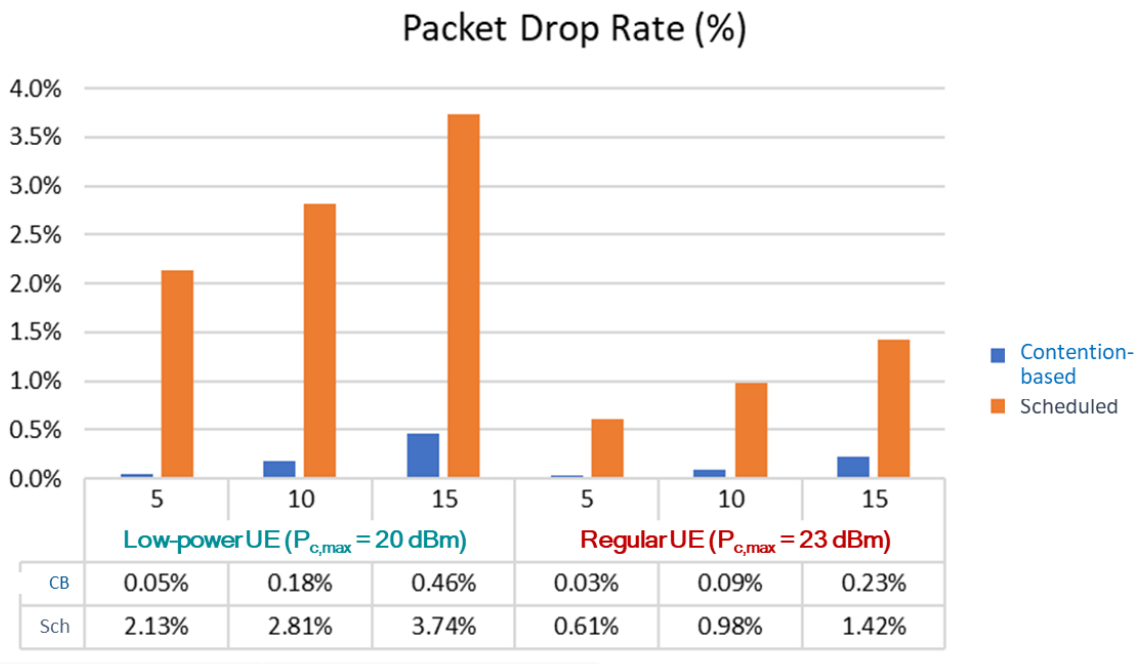
Contention-Based UL for Small Data Transmission

- PHY design to support UL small data transfer for low-power UE in RRC_INACTIVE and RRC_IDLE states
  - Shortened queuing delay
  - Reduced signaling overhead

- Rel-17 enhancements can be based on Rel-16 two-step RACH designs, targeting lower latency and higher resource utilization efficiency
  - e.g. flexible and scalable resource sharing, procedure enhancement, interference cancellation



	Low-power UE ($P_{c,max}$ = 20 dBm)			Regular UE ($P_{c,max}$ = 23 dBm)		
	5	10	15	5	10	15
CB	0.05%	0.18%	0.46%	0.03%	0.09%	0.23%
Sch	2.13%	2.81%	3.74%	0.61%	0.98%	1.42%

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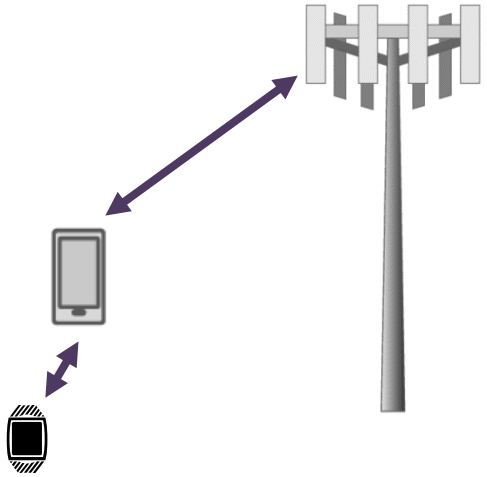
Relaying for Wearable and Mesh for Relaxed IoT

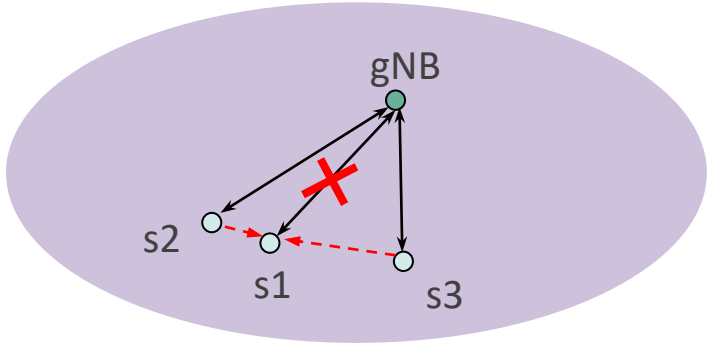
- Coverage extension
  - Fewer antennas
  - Lower power budget
  - Longer battery life due to uplink energy saving

- Relaying – possible approaches
  - Uu based
  - PC5 based (sidelink)

- *Note: this item may be addressed as part of other agenda e.g. sidelink*



Relaying for wearable coverage extention



Mesh for relaxed IOT coverage and reliability

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