3GPP TSG RAN Plenary Meeting #84
Newport Beach, USA: June 3-6, 2019

RP-190974

Agenda item: 8
Source: AT&T
Title: Release 17 Priorities & Proposals
Document for: Discussion/Decision

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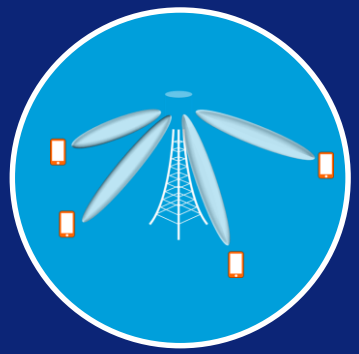
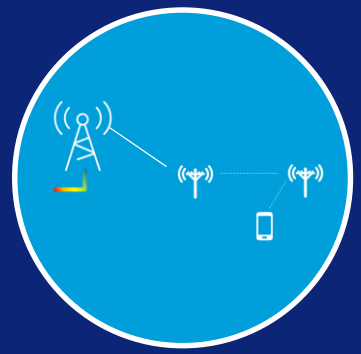
Key Areas of Focus



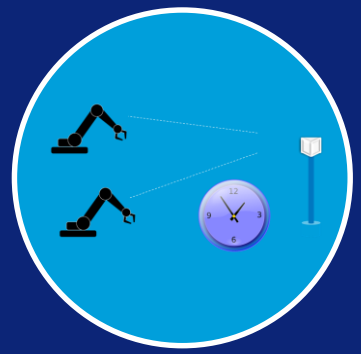
Performance Enhancements

- MIMO
- Control Channel Enhancements
- LTE NR CoEx



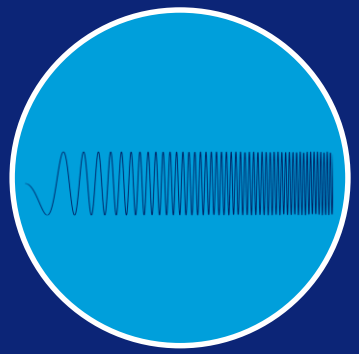
Architecture Enhancements

- Mobile IAB
- RAN Slicing for URLLC and Private Networks



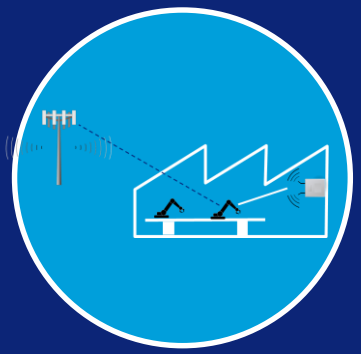
Reliability and URLLC

- Network Fountain Coding



Spectrum

- NR-U Enhancements
- NR Beyond 52GHz



Vertical and Use Cases

- NTN
- UAV
- Positioning and Sensing

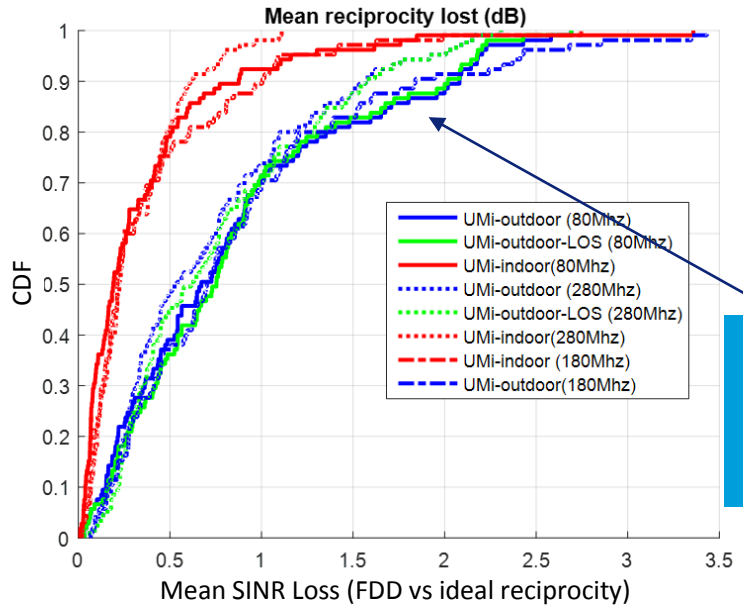
MIMO Enhancements

FDD MIMO Performance Enhancements:

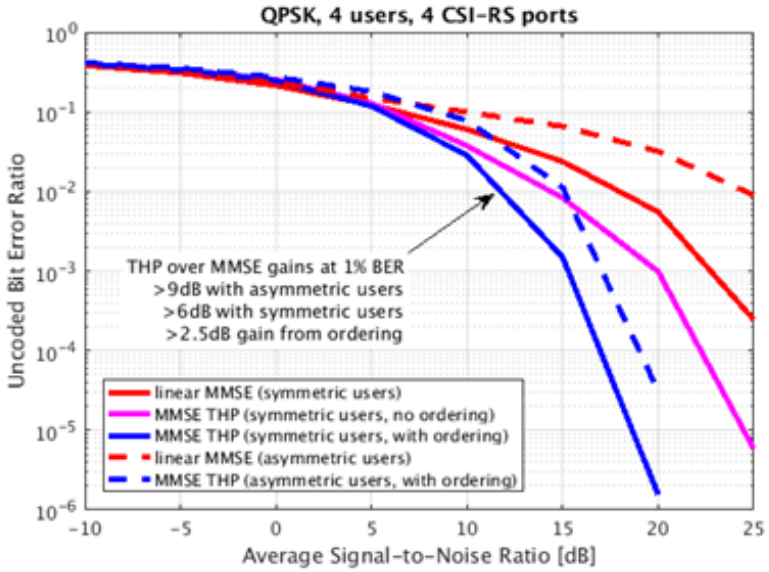
- Reciprocity based techniques for FDD
- Over the air calibration for FDD
- RS and compact feedback for FDD

Low Complexity Non Linear Precoding:

- Non linear precoding hold a lot of promise but complexity is an issue
- Develop low complexity non linear precoding
- CQI estimation for non linear receiver e.g. DMRS based CQI (studied in Reel 16 for URLLC)



Basic reciprocity can lead up to 3.5dB of SINR loss for FDD



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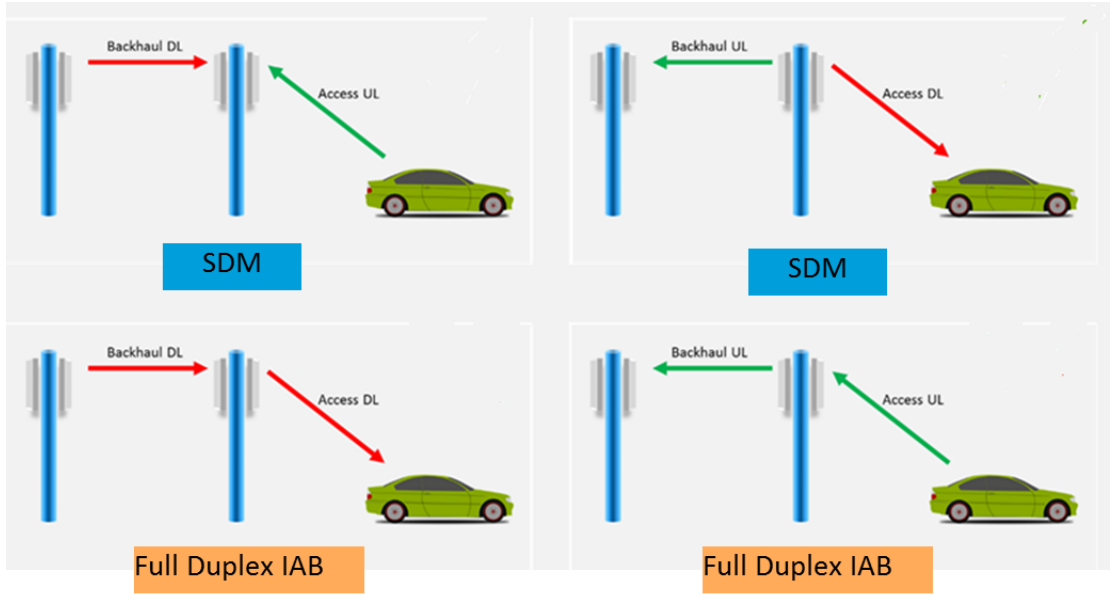
MIMO Enhancements

Multi-TRP Enhancements

- Single DCI enhancements for cases of large geometry difference between TRP
- Carry over items from Rel 16

Multi-Beam/Panel Enhancements

- Reliability and robustness enhancements
- Feedback overhead reduction
- Support simultaneous Tx and Rx from separate panels, useful for IAB use case:
  - SDM: Simultaneously Tx or Rx on backhaul and access links (see figure)
  - Full Duplex: Simultaneous Tx of backhaul and Rx on access / Simultaneous Rx on backhaul and Tx on access (see figure)



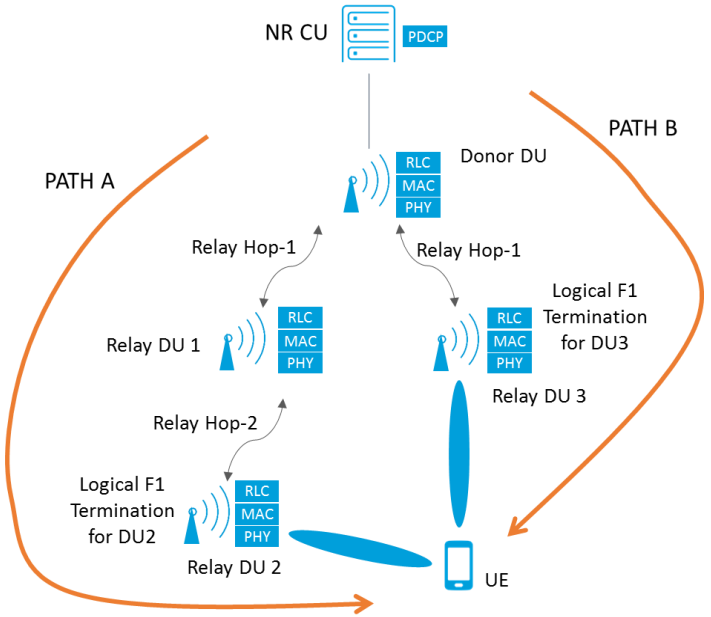
IAB Enhancements and Mobile IAB

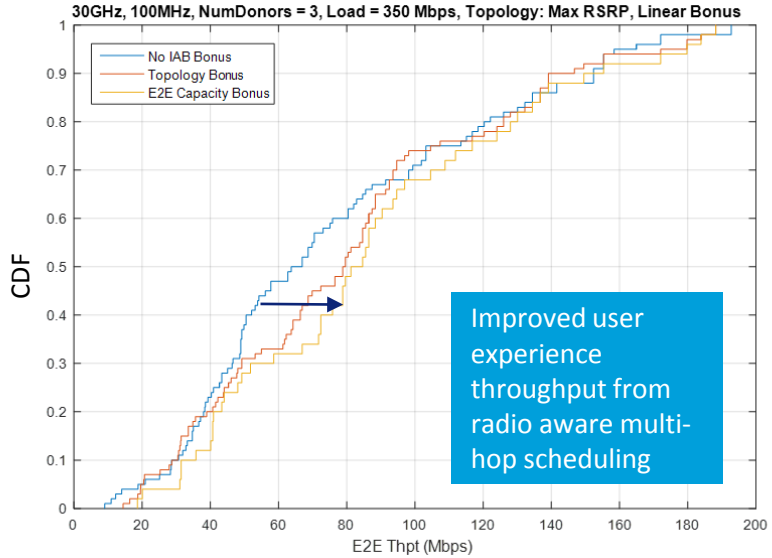
IAB Enhancement:

- **Topology Management:** topology adaptation of downstream relays between donor CUs, mesh-connectivity between IAB nodes for local control/user plane routing.
- **Protocol stack:** duplication over redundant routes, multi-hop scheduling enhancements, hop-by-hop flow control.
- **PHY/RF:** multiplexing beyond TDM (FDM/SDM/IAB node full duplex), case 6/7 timing alignment, DL power control optimization, built on a forward compatible Rel.16 design.

Multi-Hop Scheduling:

- IAB system performance is significantly better if scheduling can be done with full or partial visibility of the conditions down the tree
- Exchange of some form of benefit metric can allow for radio aware scheduling of an intermediate relay node.

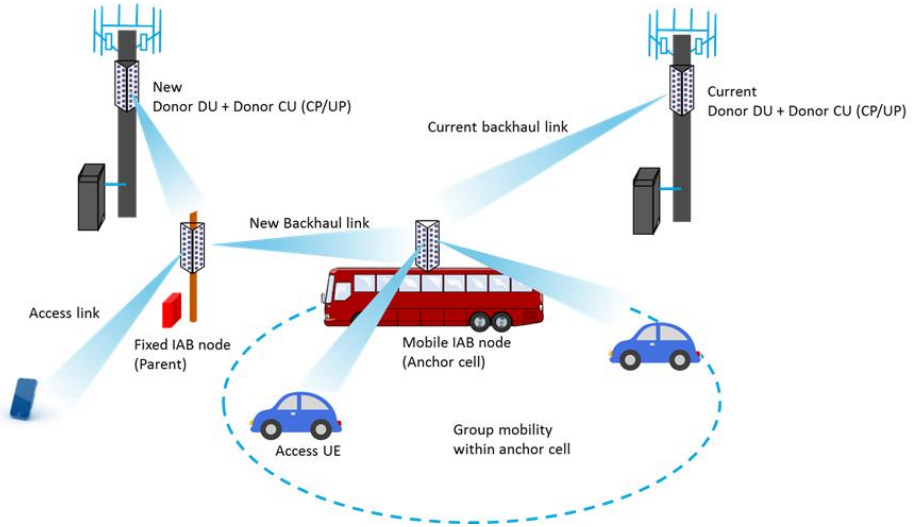


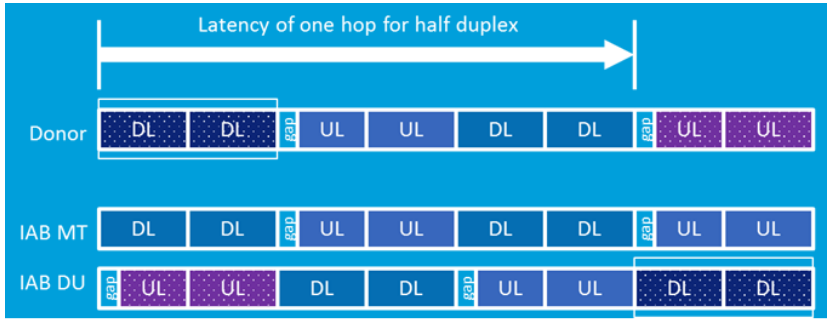


IAB Enhancements and Mobile IAB

Mobile IAB:

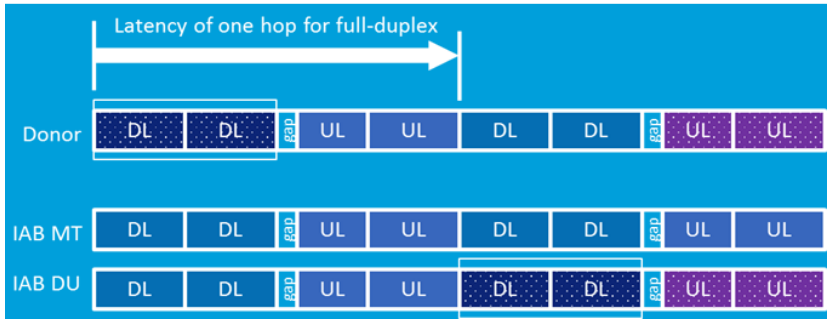
- Support for use cases that require mobility of IAB nodes, e.g. for group mobility
  - Regular (Rel 16) IAB nodes and Rel 17 mobile IAB nodes may be part of the same tree.
  - Separate CP and UP architecture
  - Reduces disruption and latency for downstream IAB in case of link failure
  - Access UE enhancements which support awareness of an IAB deployment and architecture can also be considered





Full Duplex IAB:

- Full-duplex on a per node basis may have limited standards impact
- However CLI issues will be worse compared to half-duplex, and full-duplex specific CLI characterization and mitigation enhancements should be studied



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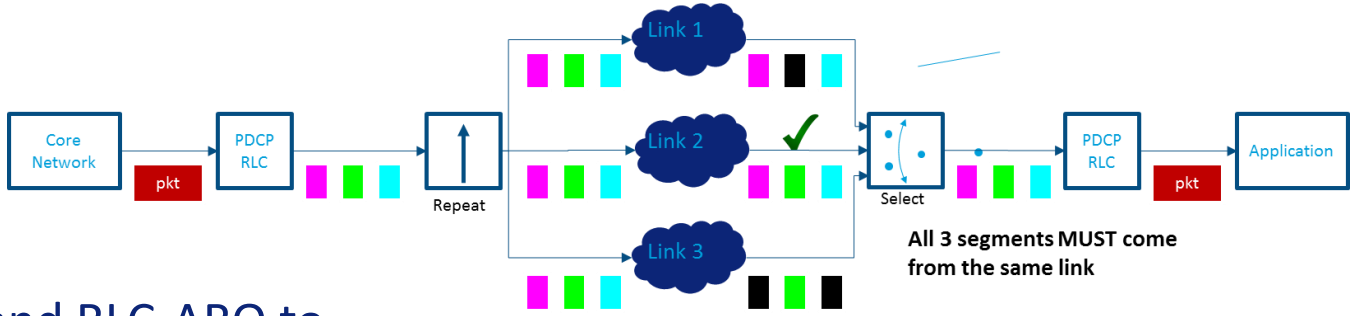
Network Fountain Coding

Reliability or Spectral Efficiency:

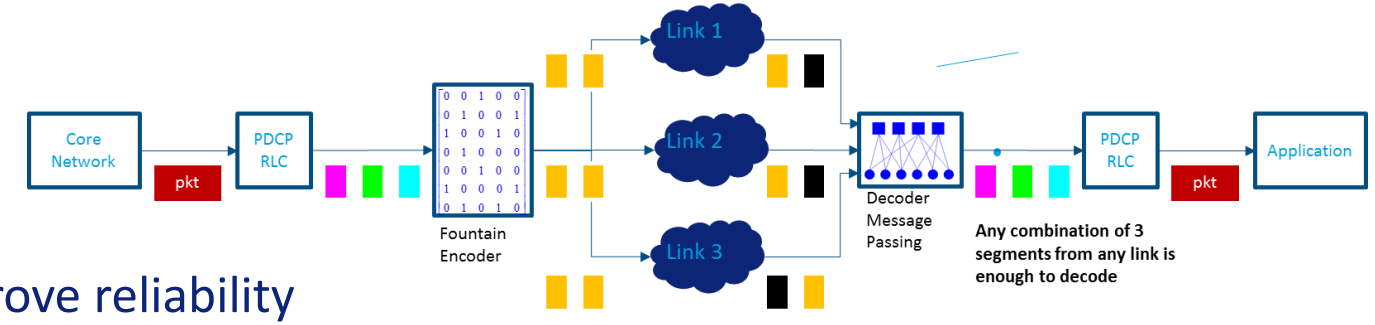
- For eMBB NR uses techniques such as HARQ and RLC-ARQ to achieve high reliability
  - [Latency  Spectral Efficiency ]
- For URLLC NR uses duplication at PDCP (higher layer)
  - [Latency  Spectral Efficiency ]



Duplication

Network Coding

- Fountain coding is a known technique to improve reliability when ARQ techniques are not usable (such as in broadcast)
- Network coding using fountain codes at higher layer can be used for improving spectral efficiency over simple duplication based technique



Network Coding

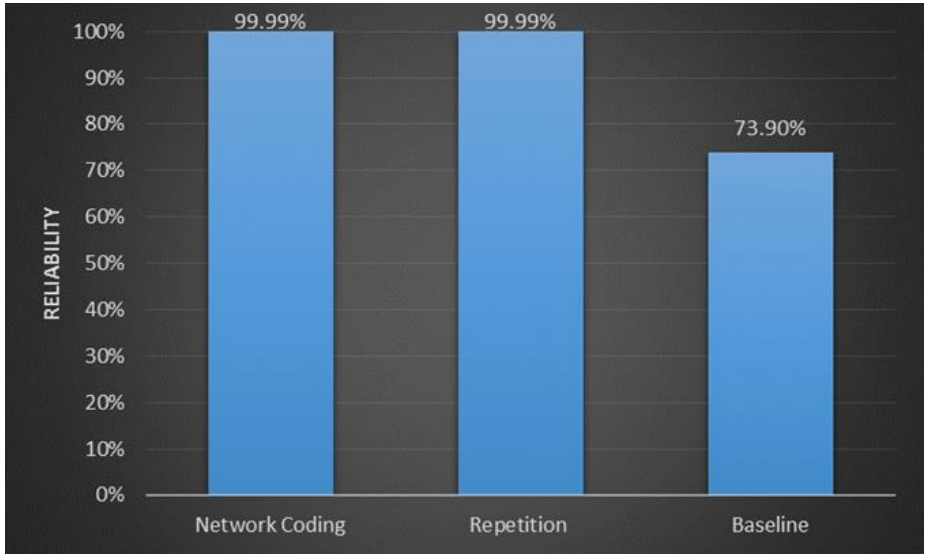
Network Fountain Coding

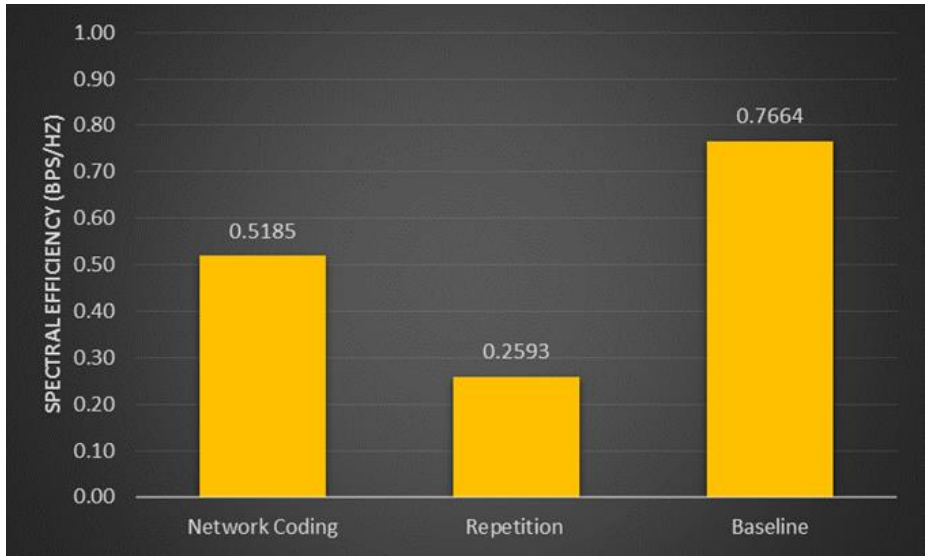
Compared to duplication network coding techniques with outer coding allow for a much higher spectral efficiency while achieving the same reliability

Network coding can be done above the MAC or above the RLC

A study item for network coding techniques:

- Study the optimal layer to perform outer coding
- Study different code designs for network coding
- Target 2x-3x improvement over packet duplication while achieving the same reliability





Parameter	Value	Parameter	Value
Frequency	2GHz	Num CC	1 for baseline, 4 for others
CC BW	10MHz	Packet Size	256 Bytes for long

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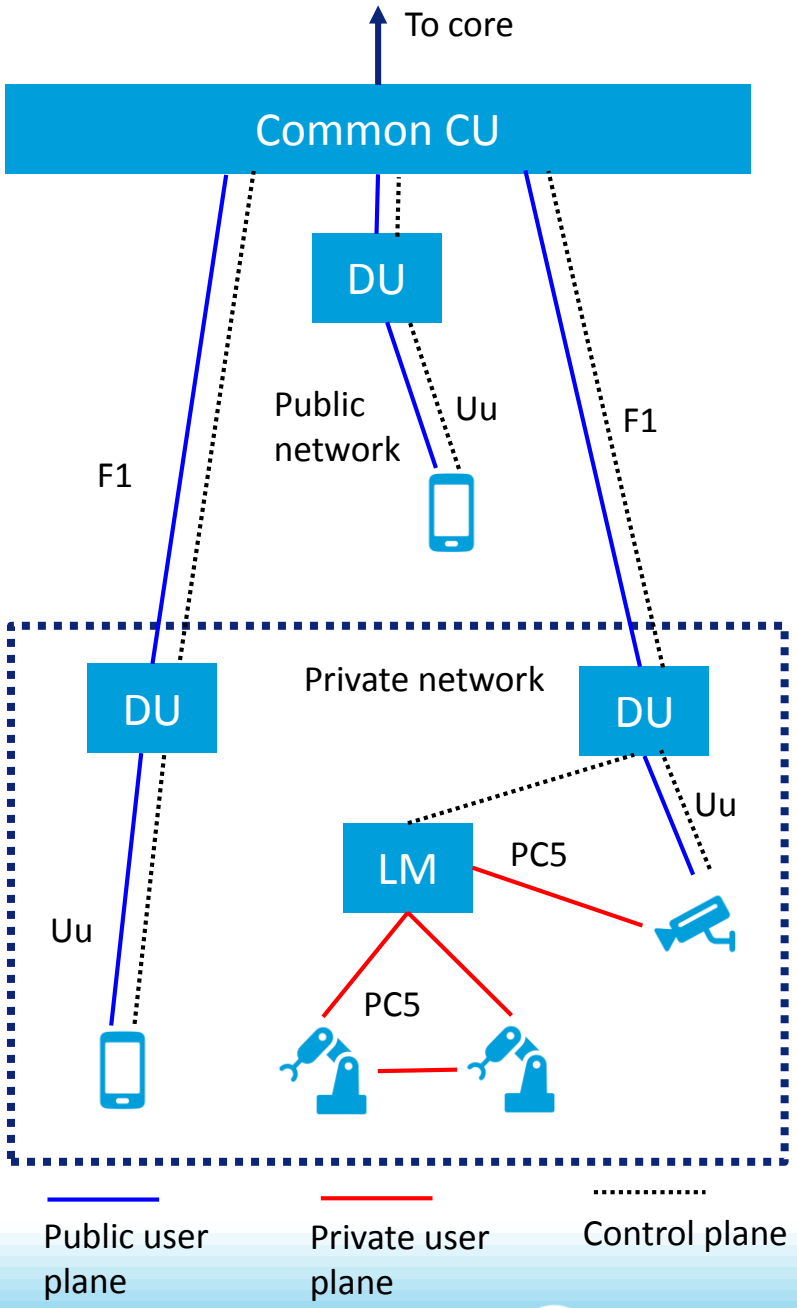
Architecture Enhancements for RAN Slicing

Private network are increasingly becoming the preferred option for many enterprise solution:

- Need to keep the user plane data in the premise (security) (e.g. local breakout)
- Requires heavy infrastructure deployment as private networks require full gNB on premise (e.g. a full CU and DU)

In Rel 17 allow RAN enhancements to allow for local breakout within the RAN:

- User plane contained in the enterprise
- Only DU's or Local Manager deployed in the enterprise
- CU deployed outside the enterprise
- Common CU and core for private and public networks
- PC5 interface can be used to allow for local breakout inside of the RAN



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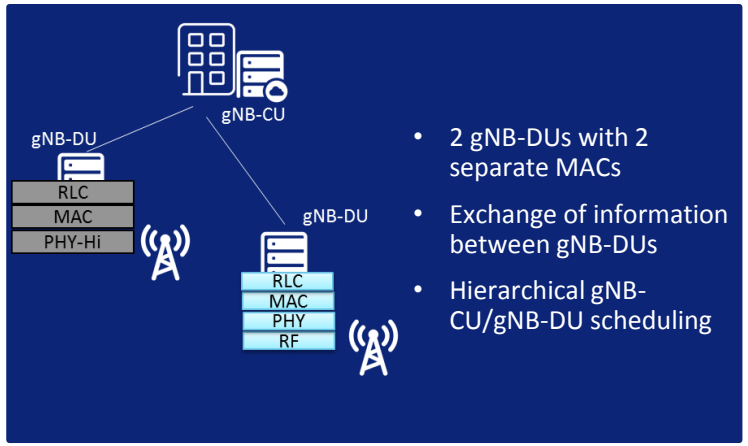
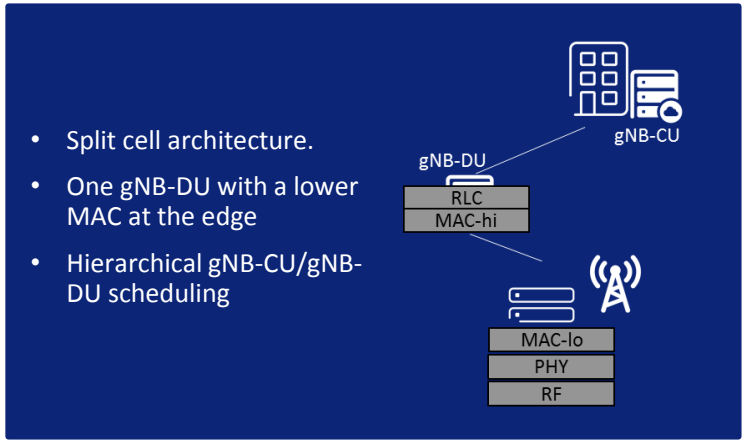
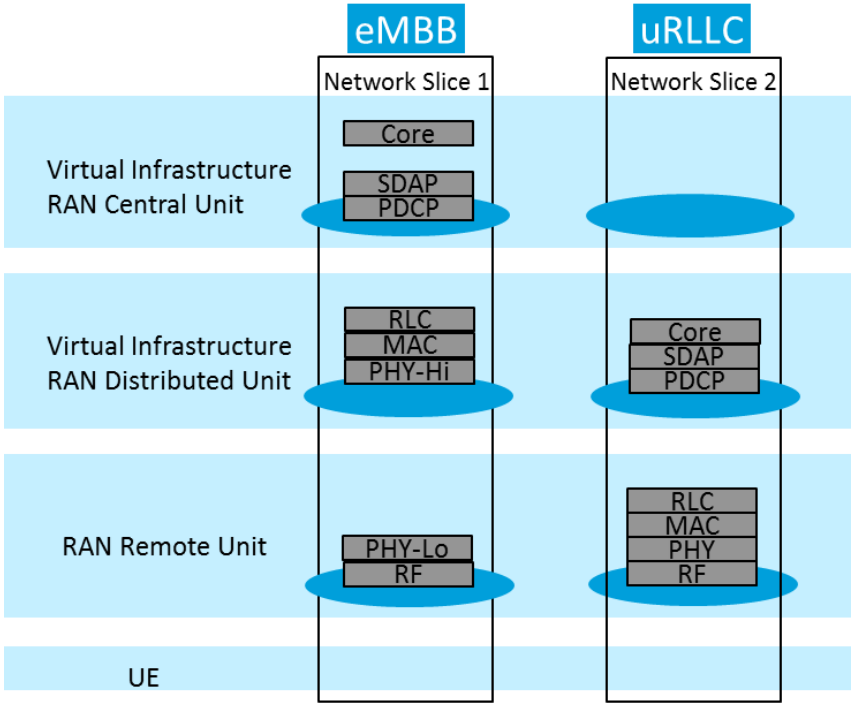
RAN Slicing Enhancements for URLLC Deployment

Latency requirements of URLLC and eMBB can imply the deployed architecture can be different:

- Its not desirable to have different network deployment for URLLC and eMBB
- Need to support different RAN architecture on the same HW via RAN slicing







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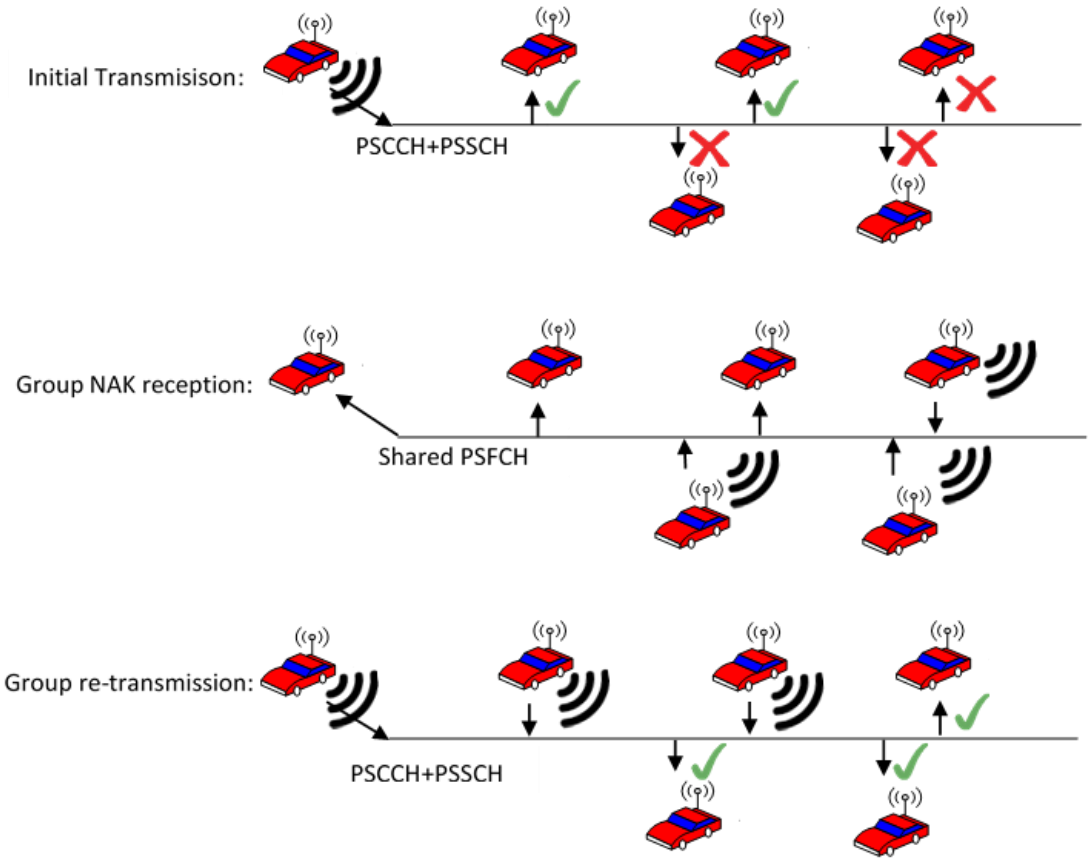
Sidelink Enhancements

Optimize sidelink for FR2 operation:

- Beam management and beam failure recovery

Sidelink Enhancements:

- Extend local manager based semi-static resource control on sidelink for other use cases besides Mode 2a (e.g Mode 2d)
- Depending on the latency requirement as well as other QoS requirement, scheduler may choose to activate high reliable HARQ retransmission for 2nd or 3rd retransmission
- Group based retransmission can significantly increase the successful rate of HARQ retransmission without requiring a centralized scheduler



Receiver Assisted LBT Benefits

NR Unlicensed Enhancements:

Closed Loop LBT (Receiver Assisted LBT)

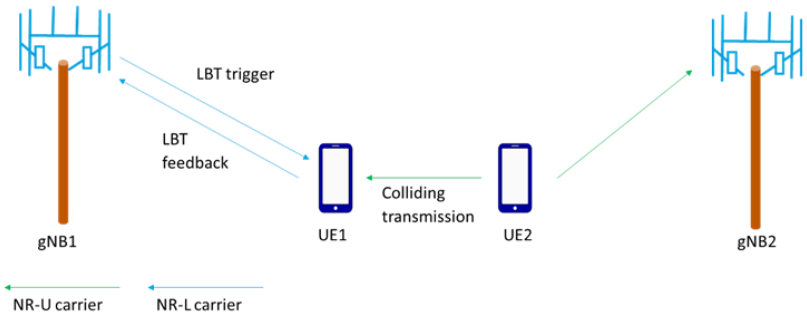
- Procedure can be message based (RTS/CTS-like), measurement based (CLI-like) or a combination thereof, e.g., message in DCI + measurement in UCI
- Procedure can be part of channel access mechanism (handshake must pass before COT starts) or can be separate (first transmission is best effort, feedback is received in COT)
- Procedure can work intra-operator, intra-RAT or inter-RAT
- Additional enhancements are possible with license-assisted access

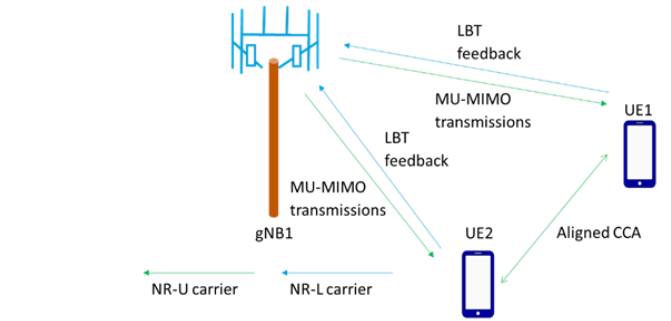
Directional LBT

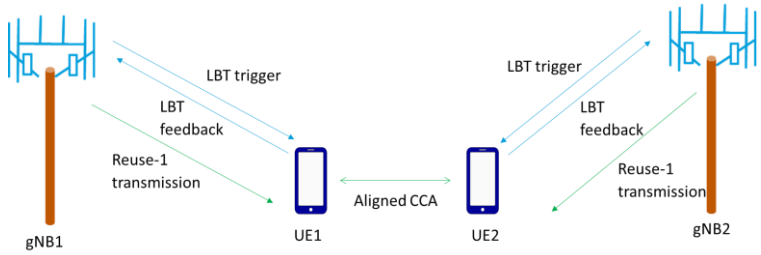
- Directional LBT can increase spatial reuse with MU-MIMO and also alleviate the hidden node problem if designed properly

NR-U for new bands above 52.6GHz

- Waveform agnostic channel access mechanism in new NR Unlicensed bands
- Allow for no LBT for fixed backhaul links in IAB
- Allow for directional LBT and particularly soft listening with variable LBT threshold to incentivize directional LBT







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NR Beyond 52.6GHz: Overall Considerations

System BW Requirement:

- Target CC bandwidth up to 3GHz (still fits the RAN1/2 design by scaling up SCS to 960). A lower value is also acceptable as along as >= 1GHz is addressed

System Gain (max coupling loss):

- Target same system gain for all channels as FR2 **assuming same occupied BW**.

Antenna Array:

- Much larger antenna aperture (relative to wavelength) than FR2. Typically up to 1024 antenna elements.
- Due to HW limitations we might need to consider multi-aperture antennas and multi-RF to one baseband design.

Standalone System:

- Should support standalone operation which in this case means supporting a >52GHz system w/o any FR1/FR2 components for use cases where it makes sense.

Waveform Selection:

- Strive for a single waveform in DL and single waveform for UL in any given frequency range
- The 52.6 – 114 GHz could be divided in to multiple frequency ranges if a single waveform is not suitable

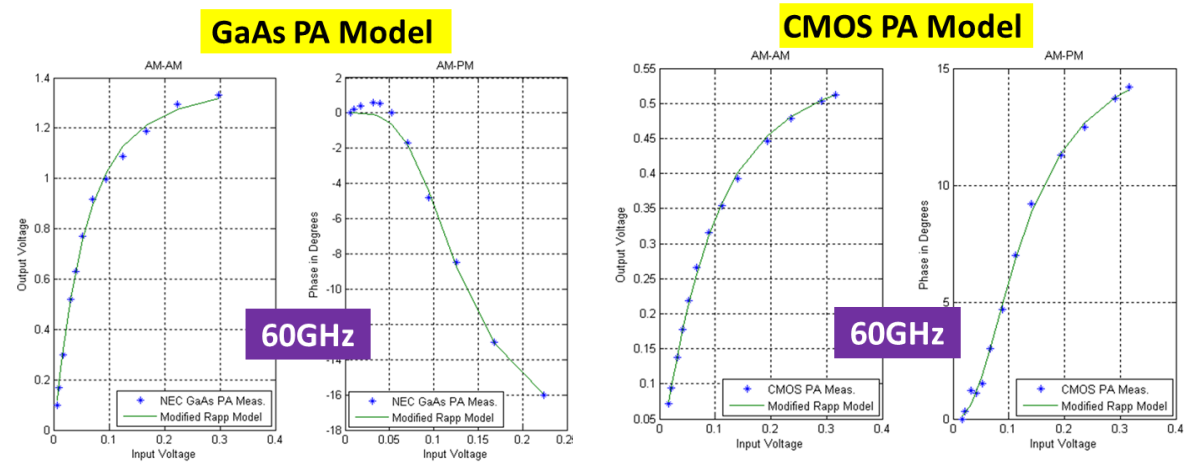
NR Beyond 52.6GHz: Waveform Design

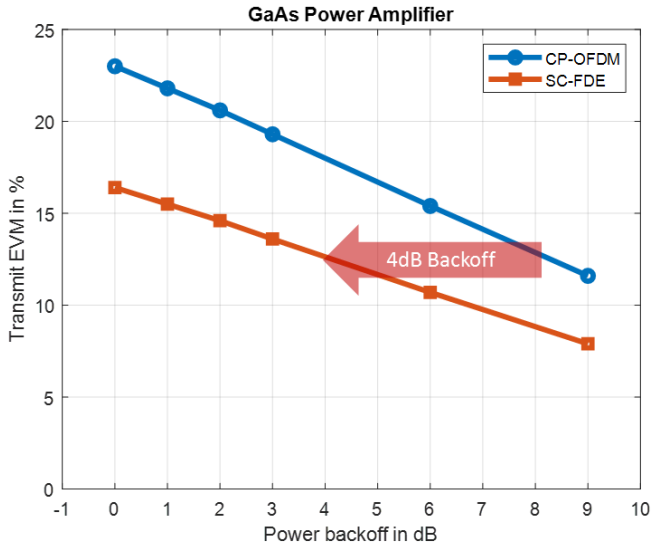
RF Impairment Consideration during waveform selection:

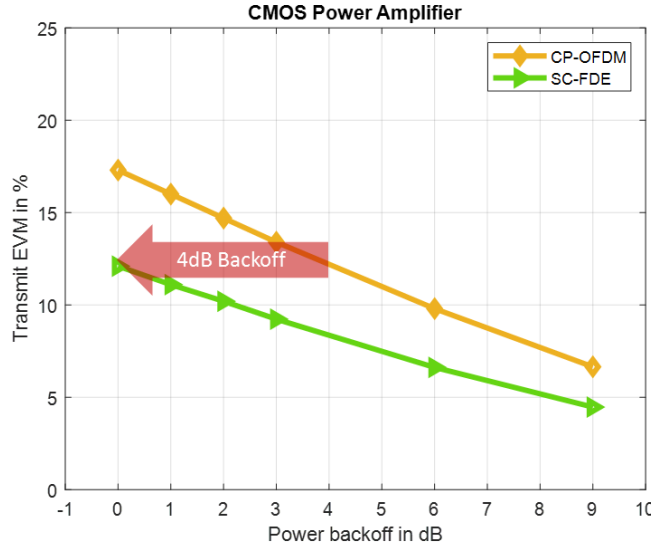
- Various RF impairments such as PA non-linearity, phase noise, IQ impairments should be taken in to consideration while selecting a waveform in a given frequency range
- Develop models based on measurements for all of the RF impairment as a part of the Rel 17 SI

Waveform selection criteria:

- Various factors such as power back off, EVM, ACLR, Spectral Emissions Mask etc should ALL be taken in to consideration while selecting a waveform
- For example: Single carrier based waveform seem to provide a distinct advantage from a power back-off point of view







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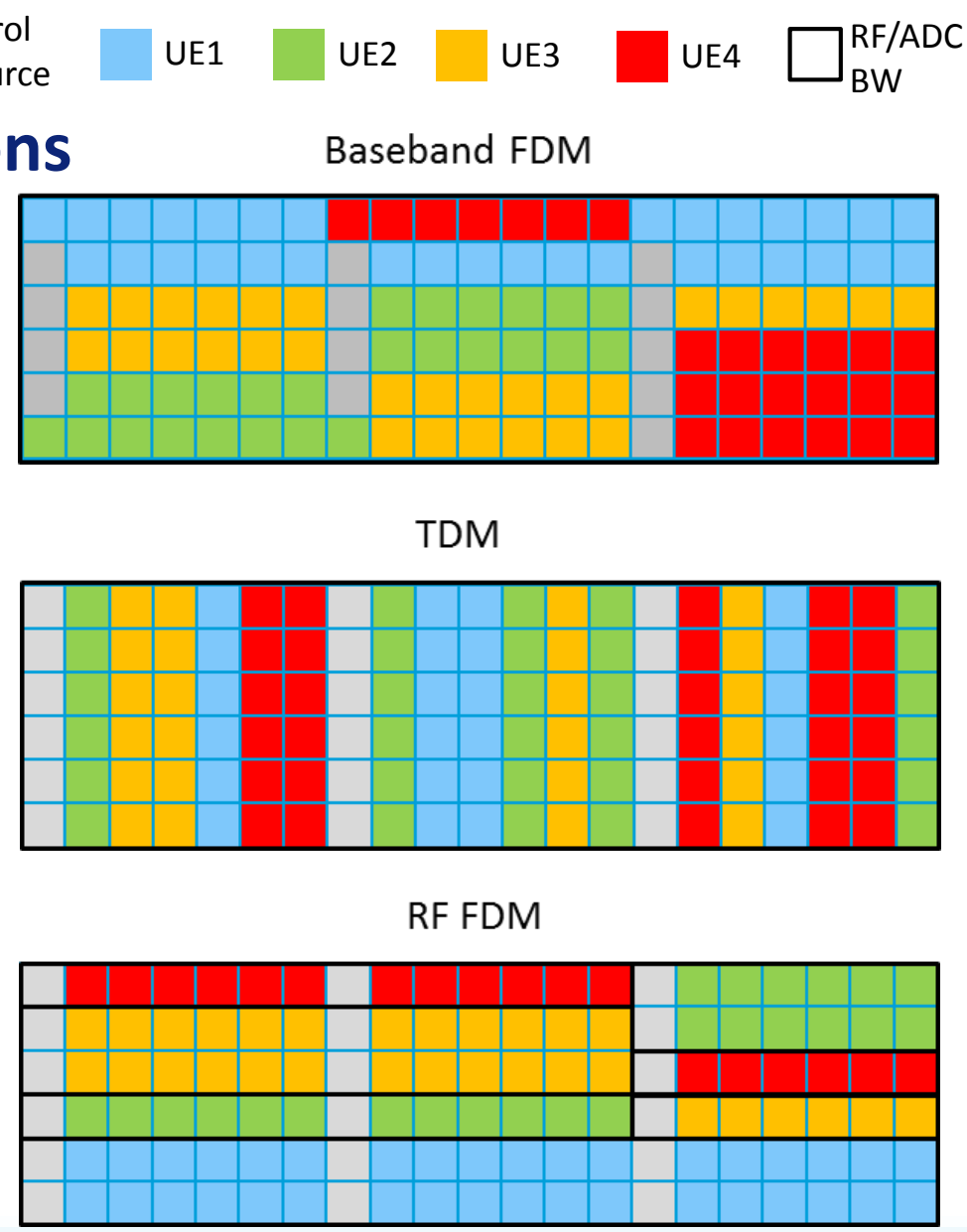
NR Beyond 52.6GHz: Other Design Considerations

Beam Managements and Initial Access:

- Larger antenna aperture implies narrower beams (higher gain) (more beams)
- The beam management design needs to be carefully evaluated to ensure that we still have a robust system at these high bands
- The initial access design (such as the design of PSS/SSS, RACH procedure) needs to be carefully designed to keep the system access time to a minimum

User Multiplexing:

- User multiplexing and MAC design should be designed to achieve a good balance between spectral efficiency and power efficiency (UE battery life):
  - Control channel monitoring periodicity, Blind decode complexity
  - ADC BW in RRC Connected and RRC Idle mode



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LTE NR Co-Existence

- 5G systems requires Lower spectrum deployments for wide area coverage
- Release 15 standardized dynamic partitioning of spectrum between LTE and NR
  - Very beneficial as the full bandwidth can be used for NR
  - Based traffic conditions we can assign the spectrum between LTE and NR
  - eMBB use case only
- Release 17 Enhancements
  - Mixed numerology: NR numerology is different compared to that of LTE
  - PDCCH enhancements to increase the capacity of NR PDCCH
  - CSI enhancements to feedback the correct CSI under LNC operation
  - URLLC and eURLLC use cases


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