5G RADIO ACCESS FOR NETWORKED SOCIETY

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OUTLINE

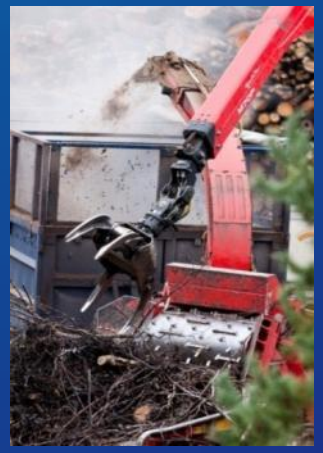
- 5G use cases
- Massive and critical communications
- 5G radio access
- Techniques for critical communication
  - Low latency
  - Reliability

5G USE CASES

Broadband experience everywhere anytime

Mass market personalized media and gaming

Meters and sensors, “Massive MTC”



Remote controlled machines

Smart Transport Infrastructure and vehicles

Human machine interaction

And much more

Multiple use-cases supported by a common network platform

WIDE RANGE OF REQUIREMENTS

MASSIVE MTC

SMART BUILDING

LOGISTICS, TRACKING AND FLEET MANAGEMENT

SMART METER

SMART AGRICULTURE

CAPILLARY NETWORKS

CRITICAL MTC

REMOTE HEALTH CARE

TRAFFIC SAFETY & CONTROL

INDUSTRIAL APPLICATION & CONTROL

REMOTE MANUFACTURING, TRAINING, SURGERY

LOW COST, LOW ENERGY
SMALL DATA VOLUMES
MASSIVE NUMBERS

ULTRA RELIABLE
VERY LOW LATENCY
VERY HIGH AVAILABILITY

5G RADIO ACCESS

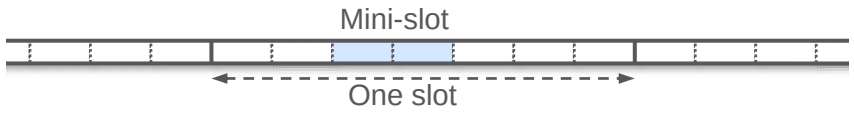
Evolution of existing technology + New radio-access technology

Targeting spectrum below 6 GHz

Targeting entire 5G spectrum range

NR – SELECTED DESIGN TARGETS

Low latency

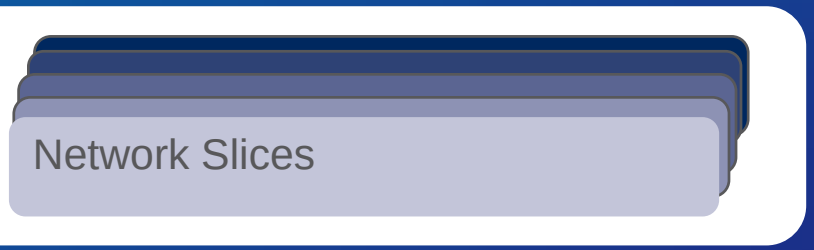


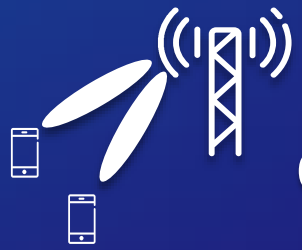
Ultra-lean

Minimize network transmissions
not directly related to user-data delivery

Forward compatibility

Multi-service



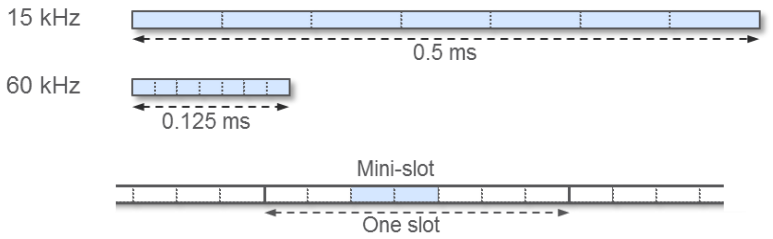


Beam centric

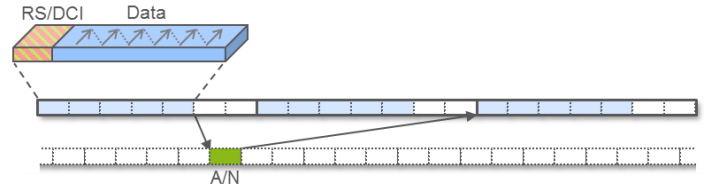
Multi-connectivity

NR – LOW LATENCY

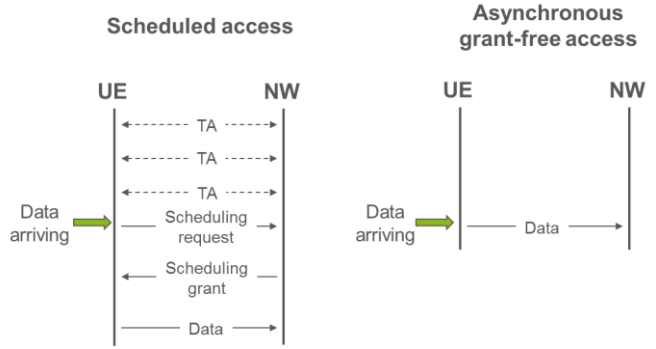
- Short scheduling units
  - Short regular slots – 125 μs at 60 kHz
  - "Mini slots" – Arbitrary starting point and length within a slot



- Fast retransmissions
  - Two interlaces Retransmission within 250 μs (60 kHz numerology)
  - Enabled by front-loaded DMRS/DCI and frequency-first interleaving allowing for rapid data demodulation/decoding



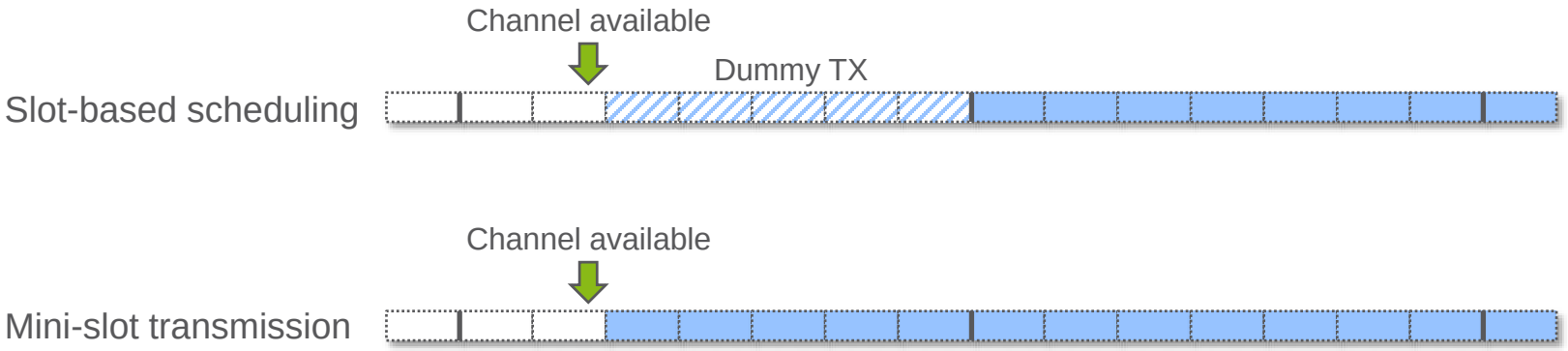
- Uplink grant-free transmission
  - Fast access to channel
  - Preferably avoiding explicit time alignment (asynchronous access)



MINI-SLOT TRANSMISSION

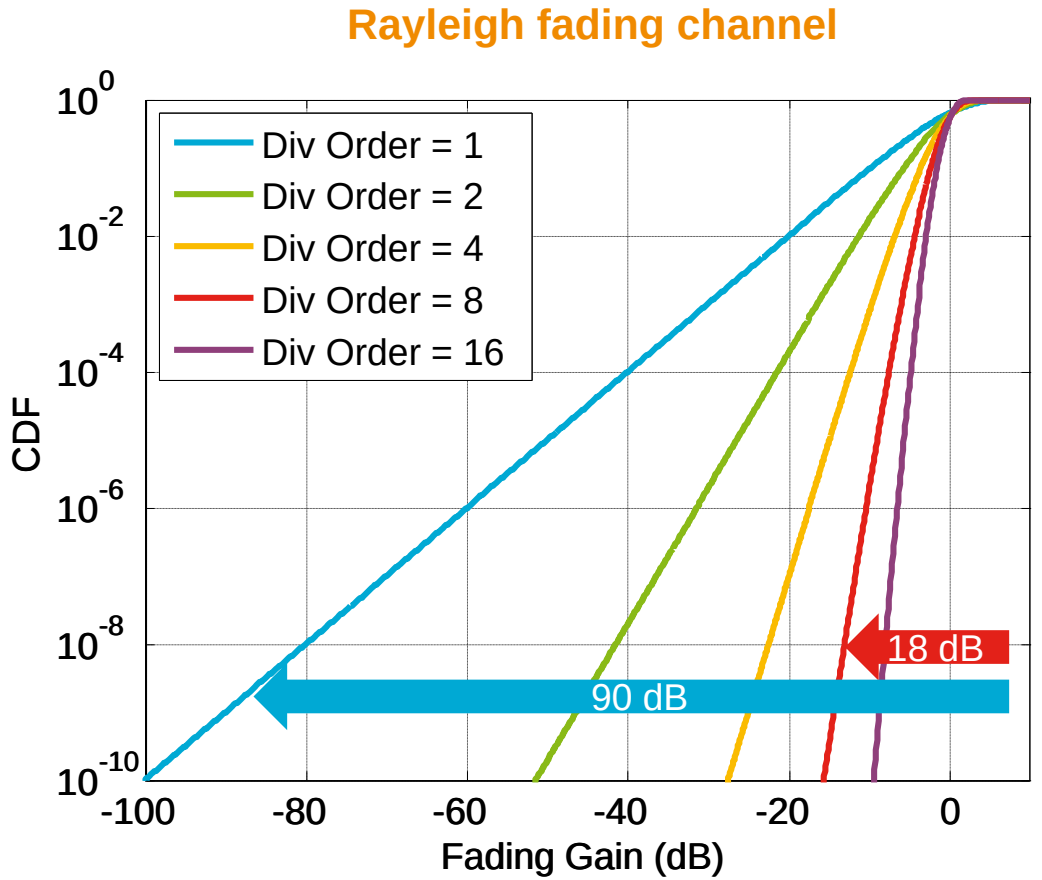
Unlicensed operation

- Unlicensed transmissions should follow LBT “rule”
  - Do not start transmission until channel is available
  - Occupy channel as soon as it is available
- Slot-based scheduling: Dummy transmission until start of slot
- Mini-slot transmission: Rapid occupation of channel with useful data transmission



REDUNDANCY THROUGH DIVERSITY

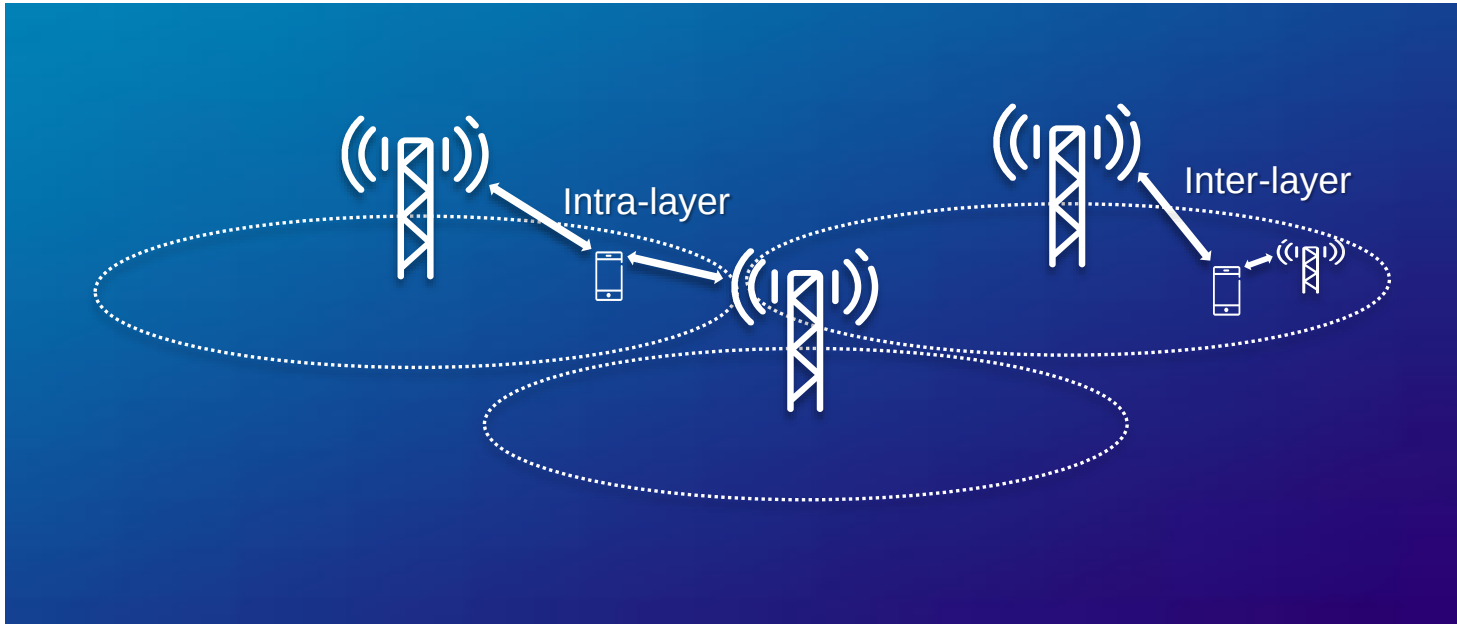
- Diversity may be obtained through
  - spatial diversity, and
  - frequency diversity
- Time diversity difficult due to latency constraint
- Coding needed to fully exploit frequency and transmit diversity



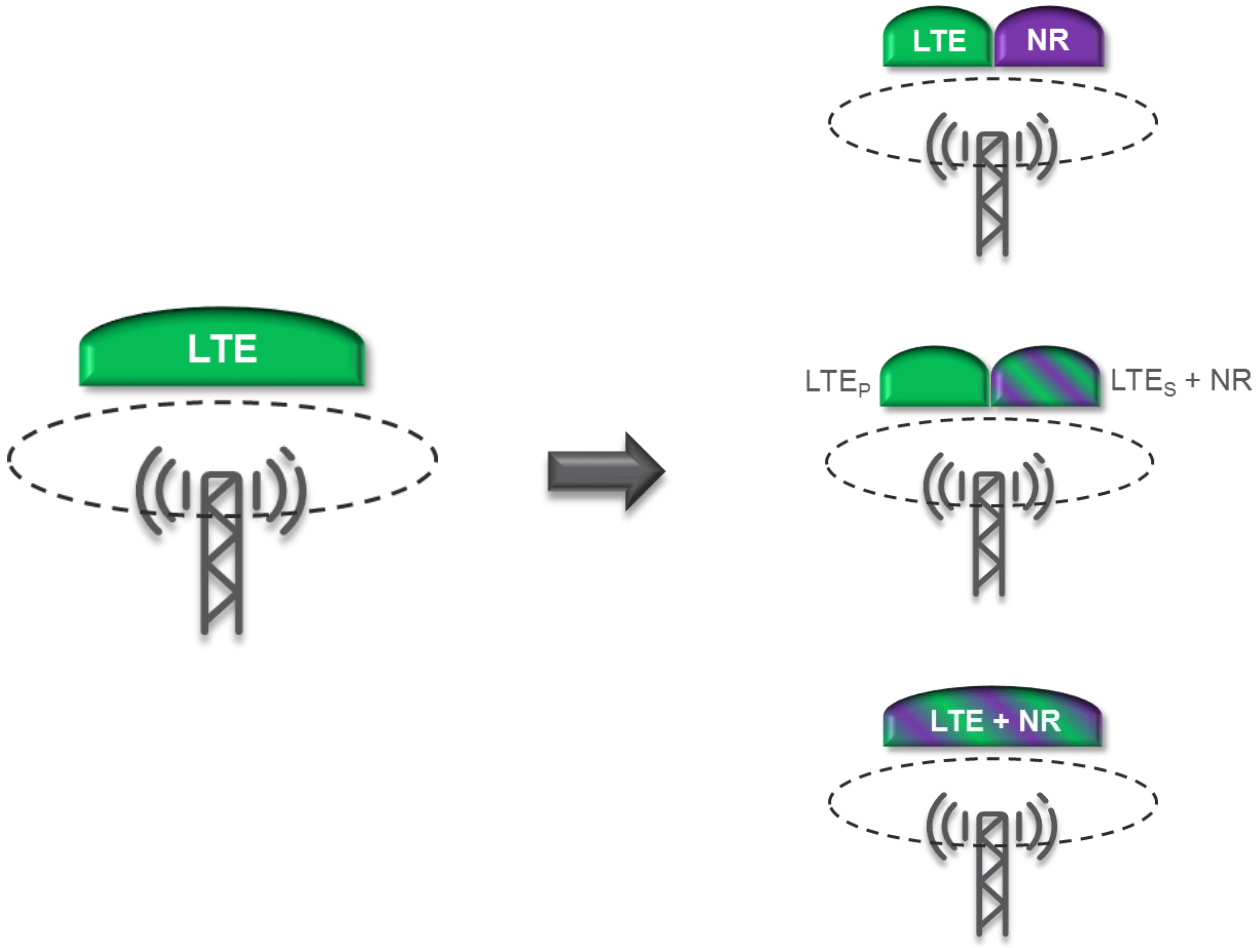
Diversity is key for ultra-reliable communications

MULTI-CONNECTIVITY

- Joint connectivity to multiple sites or multiple systems
- Intra-layer connectivity
  - Joint transmission/reception: Enhanced coverage
  - Distributed MIMO: Higher peak data rates
- Inter-layer connectivity
  - Enhanced connectivity robustness
  - Intra-RAT or inter-RAT (LTE+NR)



LTE/NR COEXISTENCE



Frequency multiplexing

NR overlaid on LTE sCell

NR overlaid on LTE pCell

- NR in LTE MBSFN subframes
- NR unused LTE UL subframes
- …

SUMMARY

- 5G designed for new use cases from the beginning
- 5G = LTE evolution + NR
- Key technologies for critical communication include
  - Mini-slots for lower latency
  - Multi-connectivity for increased reliability

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