NR OVERVIEW

Dr Stefan Parkvall
Principal Researcher, Ericsson Research

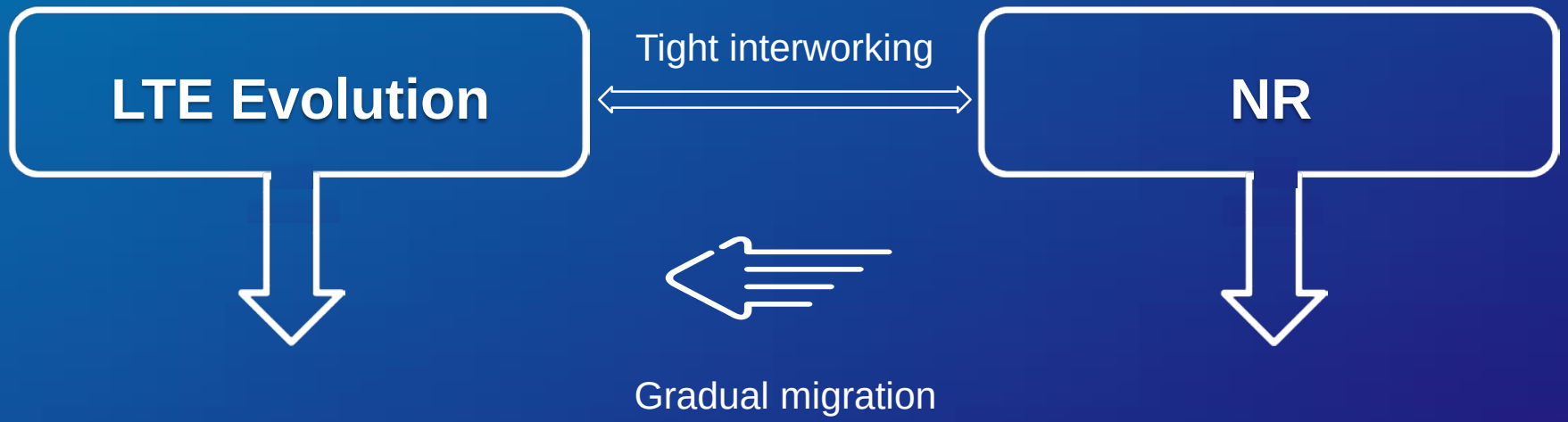
5G WIRELESS ACCESS

eMBB
High data rates, High traffic volumes

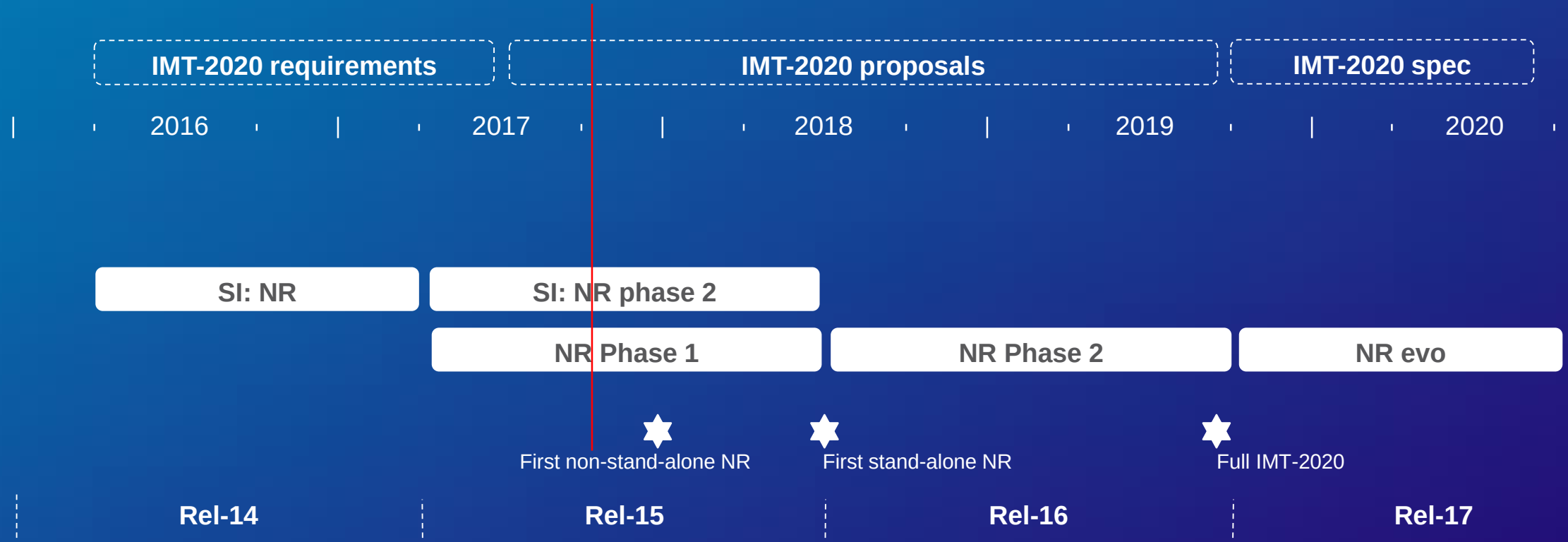
mMTC
Massive number of devices,
Low cost, low energy consumption

URLLC
Very low latency,
Very high reliability and availability

5G RADIO ACCESS ~2020

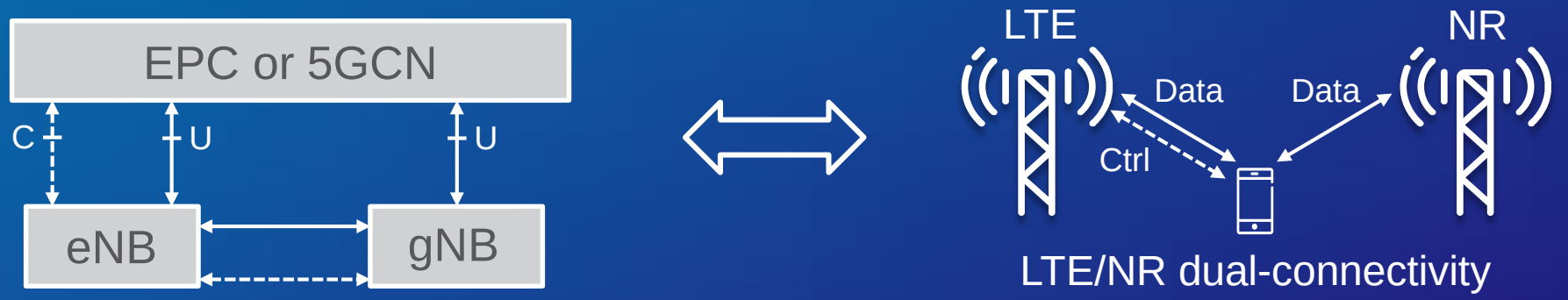


3GPP STANDARDIZATION



NR – ARCHITECTURE OPTIONS

Non-standalone operation with eNB (LTE) master (option 3/7)

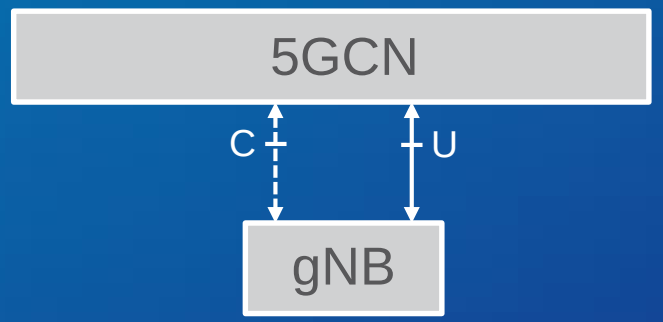


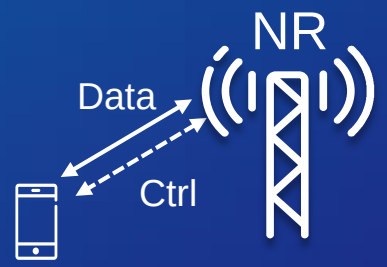
› Connectivity via EPC (option 3) or 5GCN (option 7)

› SCG bearer (opt. 3a/7a) or split bearer via eNB (opt. 3/7) or gNB (opt. 3x/7x)

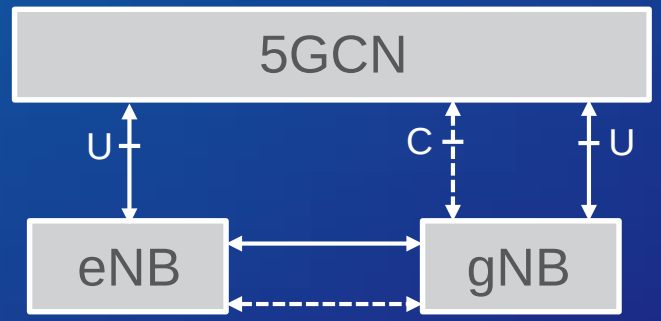
NR – ARCHITECTURE OPTIONS

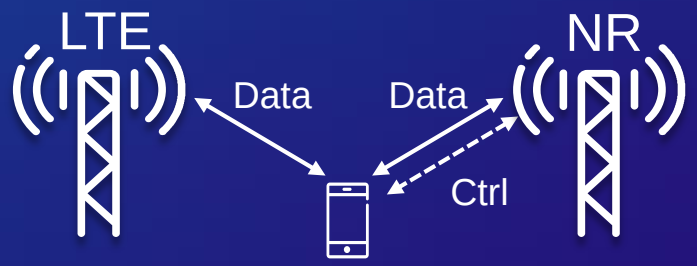
Standalone operation or NR master (option 2/4)





Option 2





NR/LTE dual-connectivity

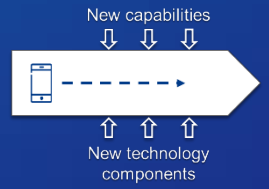
Option 4/4a

NR KEY BENEFITS

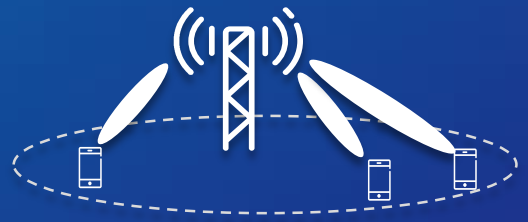
Ultra-lean

Wide spectrum range

Forward compatibility



Multi-antenna

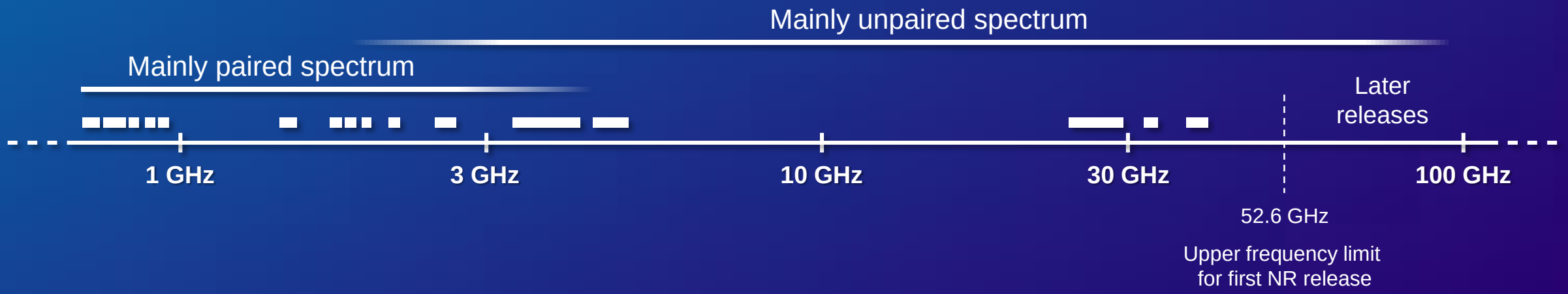


Low latency

5G – SPECTRUM

- From below 1 GHz to beyond 30 GHz
- Paired and unpaired spectrum

- NR-LTE coexistence
  - high-band NR downlink in separate spectrum
  - low-band NR uplink shared with LTE spectrum



MM-WAVE CHALLENGES

Propagation

Diffraction

Outdoor-to-indoor penetration

Rain/atmospheric attenuation

(Less of an issue for small cells)

Body loss

Regulation

Additional Tx power limitations above 6 GHz

Implementation

Efficiency, dynamic range, output power, …

BASIC TECHNOLOGIES

› Many technologies in common with LTE…

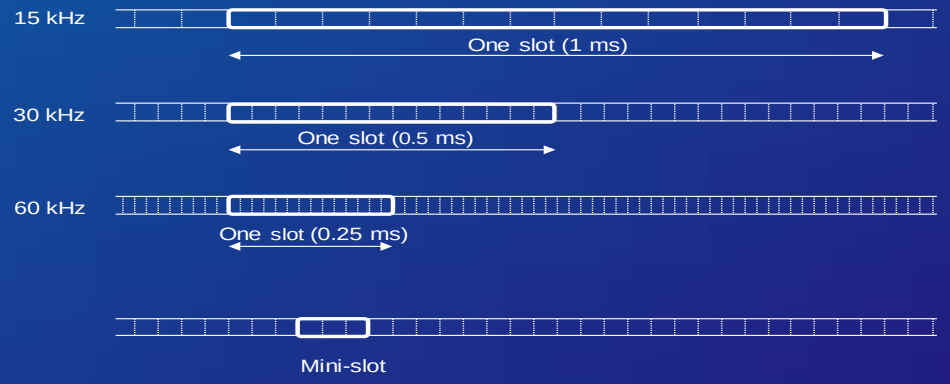
› OFDM-based air interface
  – Scalable numerology

› Scheduling, hybrid-ARQ, …

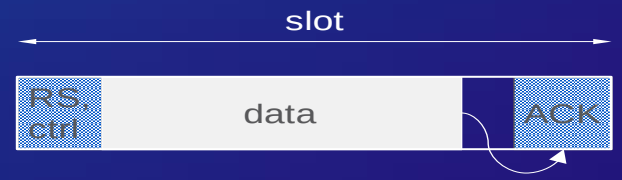
› …but clean-slate design allows for optimizations and enhancements

LOW LATENCY OPERATION

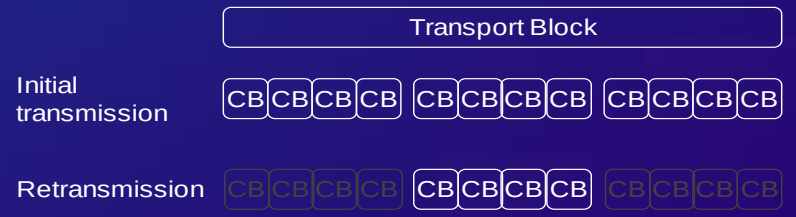
› Latency-friendly frame structure
  – Mini-slots – may preempt ongoing transmissions



› Fast processing time
  – ACK a few symbols after data ends
  – Latency-friendly mapping – front-loaded RS



› CBG-based retransmission
  – To handle bursty interference

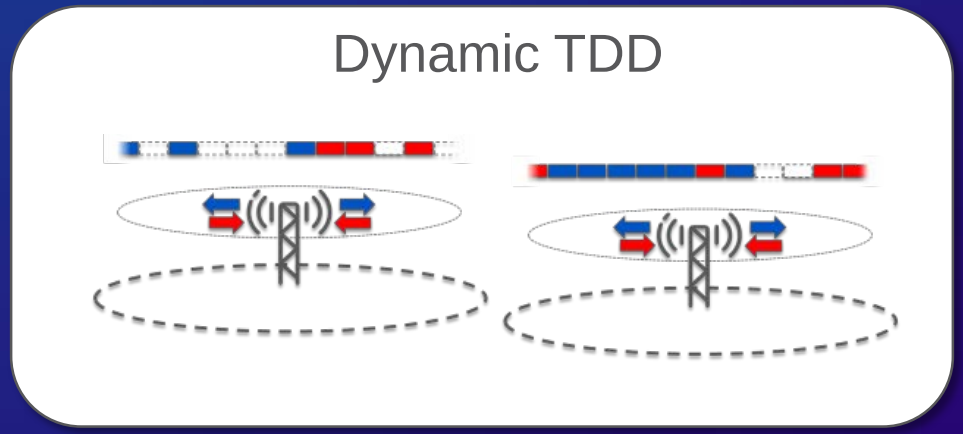


DYNAMIC TDD

- Allow for dynamic assignment of resources to downlink and uplink
  - UE listens/receives on downlink unless explicitly or implicitly scheduled to transmit on uplink
  - Possible to inform the UE about a semi-static uplink/downlink allocation

- "Macro" deployment – semi-static operation
  - Less dynamic traffic variations
  - Important to avoid TDD-specific interference

- "Small-cell" deployments – dynamic operation
  - More dynamic traffic variations
  - TDD-specific interference less critical

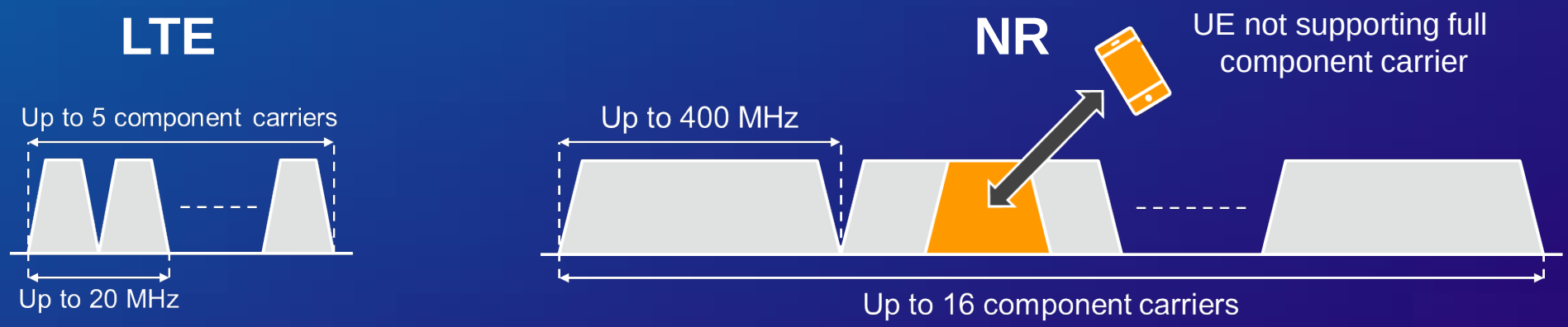


BANDWIDTHS

› Up to 400 MHz component-carrier bandwidth (20 MHz for LTE)

› Up to 16 component carriers
  – Overall bandwidth depends on frequency band

› Not all devices must support the full network carrier bandwidth

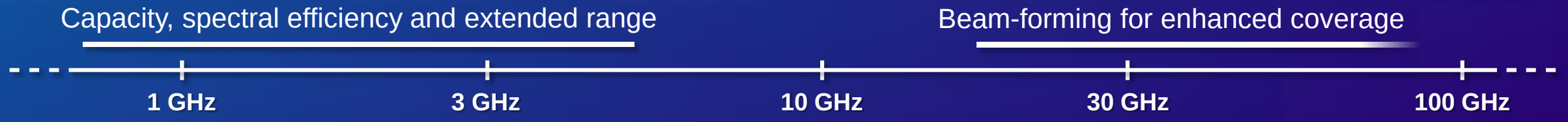


MULTI-ANTENNA TRANSMISSION

Common toolbox – but different tools suitable for different frequency ranges

› Lower frequencies (“sub-6 GHz)
  - Similar to LTE but enhanced
  - Up to to ≈10 antenna elements
  - Capacity, end-user data throughput

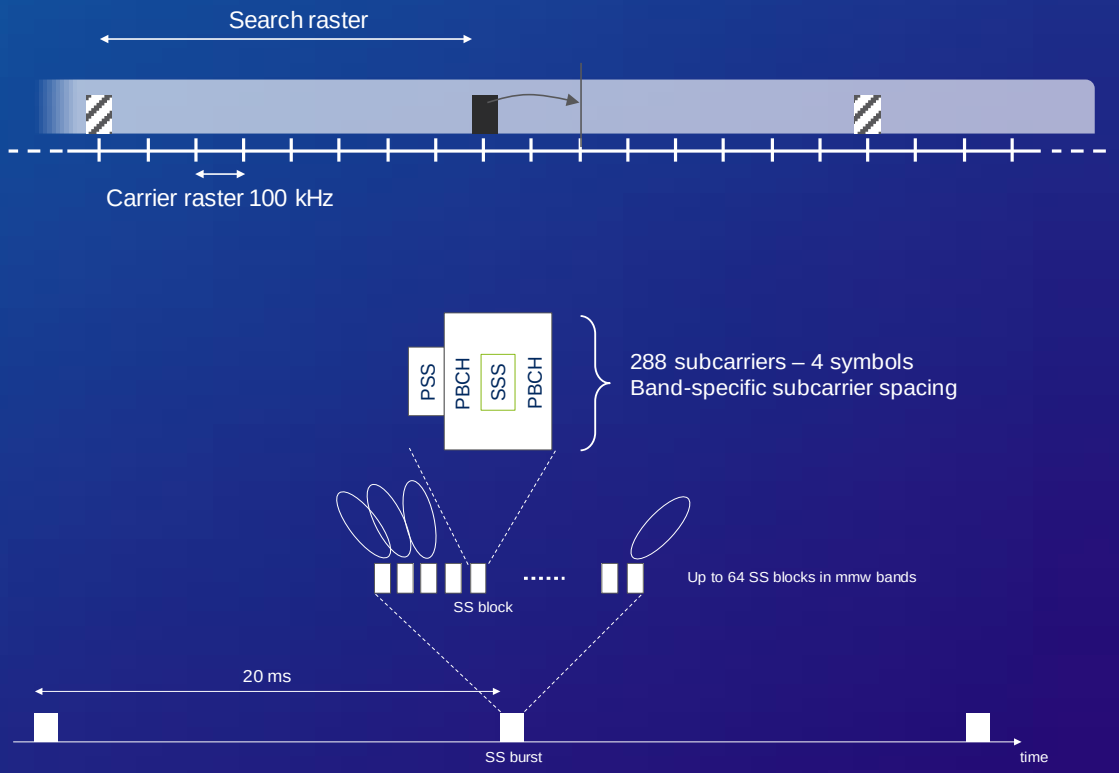
› Higher frequencies (“mmw”)
  - Up to several hundred antenna elements (“Massive MIMO”)
  - Focus on beam-forming for coverage



INITIAL ACCESS

- Sparse search raster – reduced search effort
  - Sync not necessarily at carrier center (unlike LTE)

- Beamforming-friendly mobility/initial access



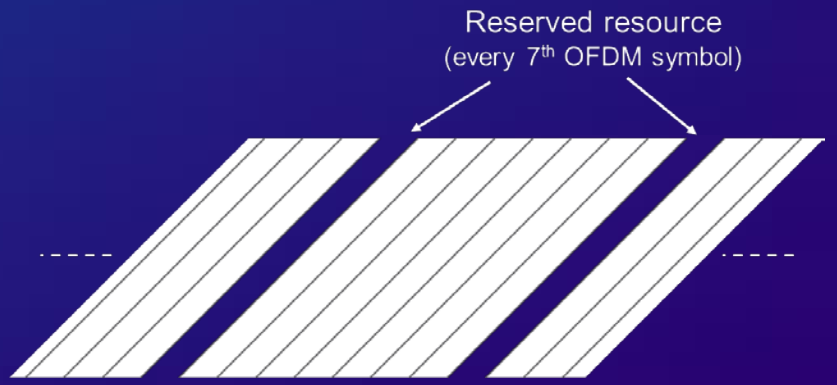
FORWARD COMPATIBILITY

› NR allows for configuration of “reserved resources” on uplink and downlink

› Release 15 UEs should not
  – expect and transmission on downlink reserved resources
  – transmit on uplink reserved resources

⇨ New Rel-15+ functionality can use reserved resources without impact to Rel-15 UE

› Can also be used for LTE/NR co-existence
  – Configure NR reserved resources corresponding to critical LTE transmissions

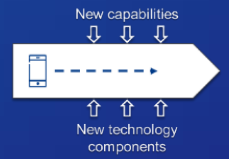


SUMMARY

› NR – first release December 2017

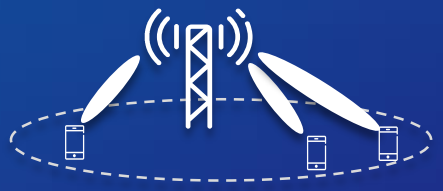
Ultra-lean

Forward compatibility



Wide spectrum range

Beam-centric



Low latency

ERICSSON