5G NR Technology Components and Evolution

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Key Features of Rel-15 5G NR (1/3)

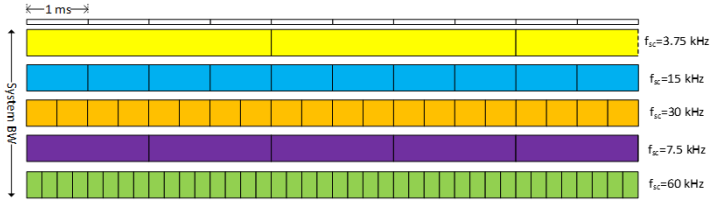
Support of higher & wider frequency band

- Rel-15 supports up to 52.6GHz (sub-1GHz, sub-6GHz, above 6GHz)
  - Much wider BW available in 24.5-39GHz bands, e.g., ~1GHz
- Support of wider BW per component carrier
  - up to 400 MHz in Rel-15 (note: LTE supports up to 20MHz per CC)
  - Reduced overhead to support wide band operation
  - Facilitate efficient implementation to support wide band operation

Support up to 400 MHz per component carrier in Rel-15

Scalable numerology

- Support multiple numerologies (subcarrier spacing, CP, slot length) with scaling (LTE: 15kHz subcarrier spacing only for MBB)
- Different choices of numerologies for different deployment scenarios;

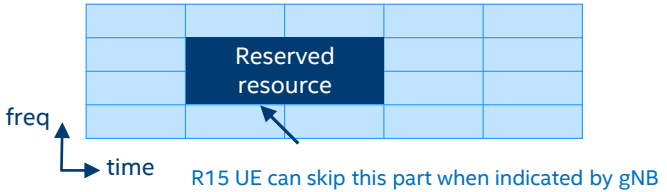


Frame structure to support fast HARQ feedback

- Immediate HARQ feedback in the same slot as data (possible under certain scenarios and UE capability)
- Performance benefits in latency and throughput
- Cleaner design by eliminating HARQ reTx related restrictions

Forward Compatibility

- Allow future evolution while minimally sacrificing efficiency
- Ex : support of reserved resources, scalable numerologies, block-wise flexible time/freq. resource allocation, network slicing, etc.



R15 UE can skip this part when indicated by gNB

Note : Details of features adopted in the spec may slightly vary

Key Features of Rel-15 5G NR (2/3)

Reduced power consumption

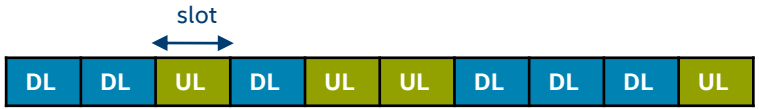
- UE
  - Small BW for control than data (UE often monitors control every slot)
  - Configurable number of PDCCH blind decoding attempts, e.g., by introducing channel/signal reducing necessity of PDCCH decoding
- Network (esp. beneficial in a densified scenario)
  - Reduction of always-on reference signals
  - Longer Sync signal and PBCH transmission periodicity

Advanced channel coding schemes

- LDPC for data and Polar code for control (for eMBB)
  - Efficient support of very high peak rates and lower latency
  - Better performance esp., for small packets for Polar
  - Flexible design in terms supported of block sizes and rates

Support for dynamic TDD

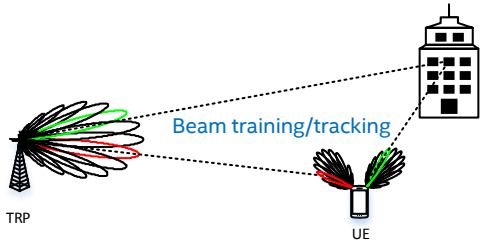
- Support of dynamical chance of DL/UL direction
  - More flexible usage of DL and UL resources
- Cross-link interference handling is a key challenge.



Can dynamically change DL/UL direction every slot

Enhanced multi-antenna techniques

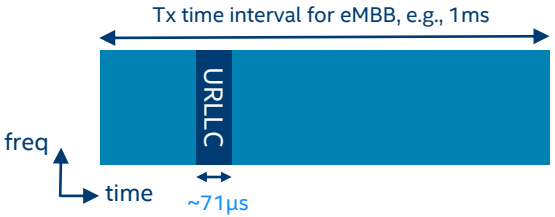
- Enhanced channel status feedback, MIMO layer mapping, precoding, etc.
- Improved beam management, e.g., fast beam training/tracking, decoupled DL and UL, etc.



Key Features of Rel-15 5G NR (3/3)

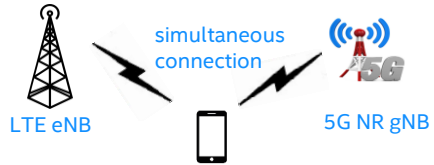
Support for low latency & high reliability

- Support 1ms end-to-end delay, e.g., via shorter Tx time interval
- Support for ultra-reliable transmission, e.g., 10^{-5} packet error rate via, e.g., via packet duplication from multiple transmission points.



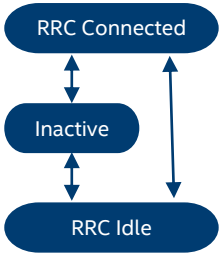
LTE-NR Dual connectivity

- UE is simultaneously connected to LTE eNB and NR gNB
- LTE provides coverage layer ensuring signalling reliability, while NR provides high data rates
- Reduced service interruption by quick fall back to LTE



Introduction of RRC Inactive state

- New UE power-efficient RRC state, "RRC Inactive" that is a RAN controlled "Idle" state
- Fast transition between Inactive and Connected with far less signalling
- "Paging" controlled by RAN: RAN-based notification area is managed by NR RAN



Other L1/L2 enhanced features compare to LTE

- Enhanced Initial Access
  - Sharp time/frequency detection of PSS
  - Improved cross-correlation property of SSS
  - Configurable synchronization signal periodicity
- Flexible scheduling and HARQ
  - Improved resources utilization via flexible timing between PDCCH and PDSCH, between PDCCH and PUSCH, between PDSCH and ACK
- Various uplink protocol enhancements for low latency & complexity
- New QoS model for 5G Core network: no end-to-end EPS bearers
- On demand system information (SIB)

Outlook on 5G+ and beyond

Continue enhancement on mobile broadband

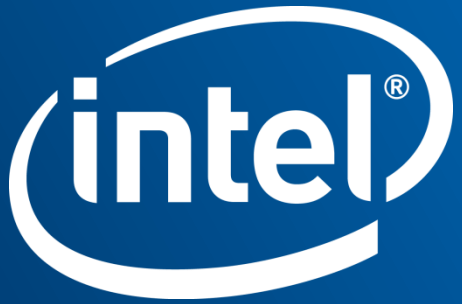
- Enhancement on peak data rate, spectral efficiency and resource utilization, coverage, latency, reliability, energy efficiency, number connections/density, etc.
- Explore high frequency band and unlicensed band

Network evolution from connecting people to connecting things

- New network slices and radio slices for new services, e.g., connected vehicles, industrial automation
- Local area network for local services

Computation and communication tight coupling

- Augment device capability by computation offloading to network edge
- E2E communication latency reduction by terminating traffic at network edge



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