The 5G Evolution:
3GPP Releases 16 — 17
Global 5G Commercial Deployments
Reported by TeleGeography, Dec 2019
3GPP Releases 15, 16 & 17

NR Rel-15
2017

NR Rel-16
2018

NR Rel-17
2019

IMT-2020 in ITU & 3GPP Submission

ITU
2014<br>Visions
2015<br>Requirements
2016<br>Proposals
2017<br>Evaluation
2018<br>Specification
2019
2020

3GPP
NR Rel-15
NR Rel-16
Remote Interference by Ducting

- Hydrometeor scatter
- Elevated layer reflection/refraction
- Ducting
- Line of sight with multipath enhancements
Propagation Delay & Downlink Transmission

Single of aggressor cell arriving delayed at victim cell such that downlink aggressor cell interferes with uplink of victim cell.
Migration Towards 5G Target Architecture

Current Industry Plans:
- Option 1
  - EPC
  - LTE
- Options 1, 3
  - EPC
  - LTE
  - NR
  - NSA

Target Architecture:
- Option 2 (1, 3)
  - EPC
  - 5G Core
  - LTE
  - NR
  - NSA
  - SA
  - Legacy
  - SA
Migration to 5G using LTE, NSA NR & SA NR

**EPC-5GC Tight Interworking**
- 5G Core features also for LTE access
- Smooth LTE – NR mobility

**Spectrum Sharing**
- Efficient use of pooled resources
- Soft spectrum re-farming

**NR Carrier Aggregation**
- Increased coverage & full peak rates
- Less UE complexity

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**Diagram**

- **5GC w/ tight interworking + CUPS**
  - PCF
  - NEF
  - CHF
  - UDR
  - UPF
  - SGW-C
  - SGW-U
  - MME

- **Existing EPC**
  - 5G
  - 4G & 5G shared
  - 4G

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**New TDD bands**
- 1-3GHz
- <1GHz
2-STEP & 4-STEP

CONTENTION-BASED RANDOM ACCESS PROCEDURES

UE

A

MsgA: Preamble + Data
Msg1 + Msg3

MsgB: RA Response
Msg2 + Msg4

B

gNB

1
Random Access Preamble

2
Random Access Response

3
Scheduled Transmission

4
Contention Resolution

gNB
V2X SUPPORT

LTE-NR Dual Connectivity

- eNB
- gNB
- EPC
- NR V2X SL
- LTE V2X SL

Standalone NR

- gNB
- 5GC
- NR V2X SL
- LTE V2X SL
NR
RAT-dependent positioning schemes

Location Server

Measurements for
UL AoA
UL RSRP
UL RTOA
gNB Rx-Tx time difference

Measurements for
DL RSRP per beam/gNB
DL RSTD
UE Rx-Tx time difference

PRS/SRS
LPP
IAB → Integrated Access & Backhaul
Can provide coverage to isolated coverage gaps
MIMO Enhancements

Support of single PDCCH & multiple PDCCH for Multi-TRP transmission

Multi-TRP for enhancing URLLC operation