4G to 5G: How Will It Happen?

Spectrum Futures 2017

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18th September 2017

Version 1.5
4G to 5G: Significant Network Evolution is Expected in 5G Networks

Transformation Towards a Software & Service Centric Architecture

- Bandwidth Pipe (n x LTE Carriers)
- Mobile Phones
- Call Flows or Procedures Centric
- Protocols
- Dedicated Hardware

Virtualized Network Functions

Physical Network ➔ Network Slice

Service Enabler Platform

Things

Services Centric

Application Programming Interfaces

Orchestration of Resources

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4G to 5G: Schedule and Key Aspects
3GPP Standardization Status Overview and the Key Aspects of 5G Networks

- Rel-14 freezing (completion of ALL items) at TSG#76
  - Some aspects continue (e.g. testing, legal intercept) but expected to conclude by 12.17

- Rel-15
  - Stage 1 freeze at TSG#76
  - Underway: Stage 2 5G Work on architecture, security, charging, management in SA, studies on 5G aspects of protocols, end-to-end aspects in CT, studies on RAN aspects

- Rel-16

5G Spectrum & Use Cases
RAN Centralization & RAN Virtualization
Control/User Plane Split in RAN & Core
Deterministic Networking in 5G
Network Virtualization
End-to-End Network Slicing
4G to 5G: Standards vs Open Sources (Part One)
Key Standards Development Organizations and Forums Charting the Path for 5G and Future Networks
4G to 5G: Standards vs Open Sources (Part Two)

Linux Foundation Unified Open Networking & Orchestration Architecture
4G to 5G: Realization of ETSI Multi-Access Edge Compute (MEC) Architecture
Real Time Payloads Processing • Network Data Analytics & Continuous Control
4G to 5G: Fixed 5G Services (Pre-5G) with mmWave Spectrum
Fixed Wireless Internet Access (FWIA) & Wireless Carrier Ethernet Services (W-CES) Made Possible with 5G NR (Standardization-in-Progress)

For Both Scenarios:
- 5G NR Cloud RAN does not connect back to a 5G Next-Gen Core User Plane Function (UPF). They connect directly into a Fixed Line Services Network.
- Such Fixed Line Equivalent Services are made possible due to a high amount of available spectrum in the Above 6GHz spectrum.
- Leverages 5G NR PDU capabilities (e.g. Ethernet, IPv4/IPv6 and Non-IP).
- Service Data Flow QoS is now fully accessible in the RAN due to the new SDAP sublayer introduced in the 5G NR RAN Stack.
4G to 5G: Mobile 5G Services with Sub-6GHz Spectrum

Significant Focus on Low Latency and High Reliability Communications Network to Deliver Mission Critical 5G Services

- **Smart Cities**
  (Massive Machine-Type Communications)
  Both IP-based & Non-IP based

- **Mobile Broadband**
  (Enhanced MBB)

- **Drone Operations**
  (Ultra-Reliable Low Latency Communications)

- **Cellular V2X**
  (Ultra-Reliable Low Latency Communications)
4G to 5G: Mobile 5G Services with Sub-6GHz Spectrum
Achieving Cell Densification with Multi-Hop Wireless Mesh Self-Backhaul Technologies

- **60 GHz Multi-Hop Wireless Mesh Self-Backhaul Concept**
  - Macro Cell
  - Pole Mount Node
  - Fiber Transport

**Optimal Wireless (60 GHz) Backhaul Route**

**Devices with Multi-Access Radio**

**Small Cell**
4G to 5G: Control/User Plane Split in RAN & Core
Future State Architecture for 5G NR RAN, 5G Next Gen Core and 5G Transport

Centralized Master Controller

- RAN DU-CP
- RAN CU-CP
- Transport Controller
- NG Core CP
- RAN DU-DP
- RAN CU-DP
- Transport UP
- NG Core UP

Open Interfaces

**Definitions:**
- **DU:** 5G NR Distributed Unit
- **CU:** 5G NR Centralized Unit
- **CP:** Control Plane
- **DP:** Data Plane
- **UP:** User Plane

**Locations:**
- **Edge Compute Data Center Site**
- **Regional Data Center Site**

**Notes:**
- **CP/DP Co-located**
- **CP/UP typically not co-located**
4G to 5G: Deployment Architecture of 5G NR and Co-existence with LTE

5G NR Non-Standalone (NSA) Mode vs 5G NR Standalone (SA) Mode

Legend:
NGC: Next Generation Core
gNB: 5G NodeB
eLTE: Evolved LTE
C-RAN with RAN Virtualization, Flexible Function Splits and CP/UP Separation

C-RAN and RAN Protocol Split with CPRI/RoE (LTE)

C-RAN with RAN Virtualization, Flexible Function Splits and CP/UP Separation

IEEE 1914.3 RoE Mapping

Wide Subcarrier (eMBB)

Narrow Subcarrier (mMTC)

Large CP (Broadcast)

Radio spectrum sliced based on use case

5G NR Spectrum Slicing (Resources Abstraction)

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4G to 5G: What Next Generation Networks Really Means

Thank You

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