Next Generation Wireless Technology for Digital Economy

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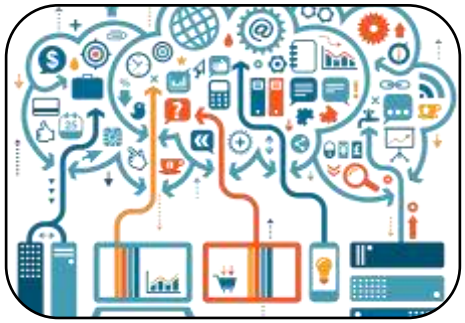
Agenda

- Key Global Digital Trends
- Market Trend
- Why Wireless Access
- Evolution of Wireless Access
- Prevailing Wireless Access Technologies
- Recent Development
- Next Generation Requirements
- 5G E2E Architecture
- Fixed Mobile Convergence
- Prevailing Challenges

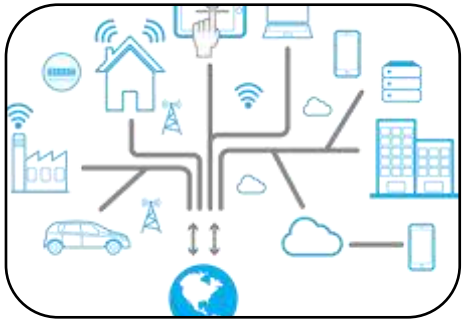
Key Global Digital Trends

OTT



Big Data

e-Payments



IoT/M2M

Mobile Advertising

Cloud Computing

Market Trend

- Prevailing Economy is being transformed to Digital Economy
- Digitalization applies to current business models to be transformed either through evolutionary or revolutionary path so that it will either be survived or flourished in the DX.
- Digitalization depletes the gap between service creation and consumption leading to a end-to-end transformation of structure and the dynamics of the Business Model.
- Wireless is the one of the largest digital carrier of data in DX

Global Wireless Market in 2020

- Global Annual IP traffic would reach 2.3 ZB
- Two third of IP traffic would be from Wireless and Mobile
- Smartphone traffic would exceed PC traffic
- 2.87 Billion people would be using Smartphones
- Estimated speed would range from 3.5 Gb/s to 10 Gb/s

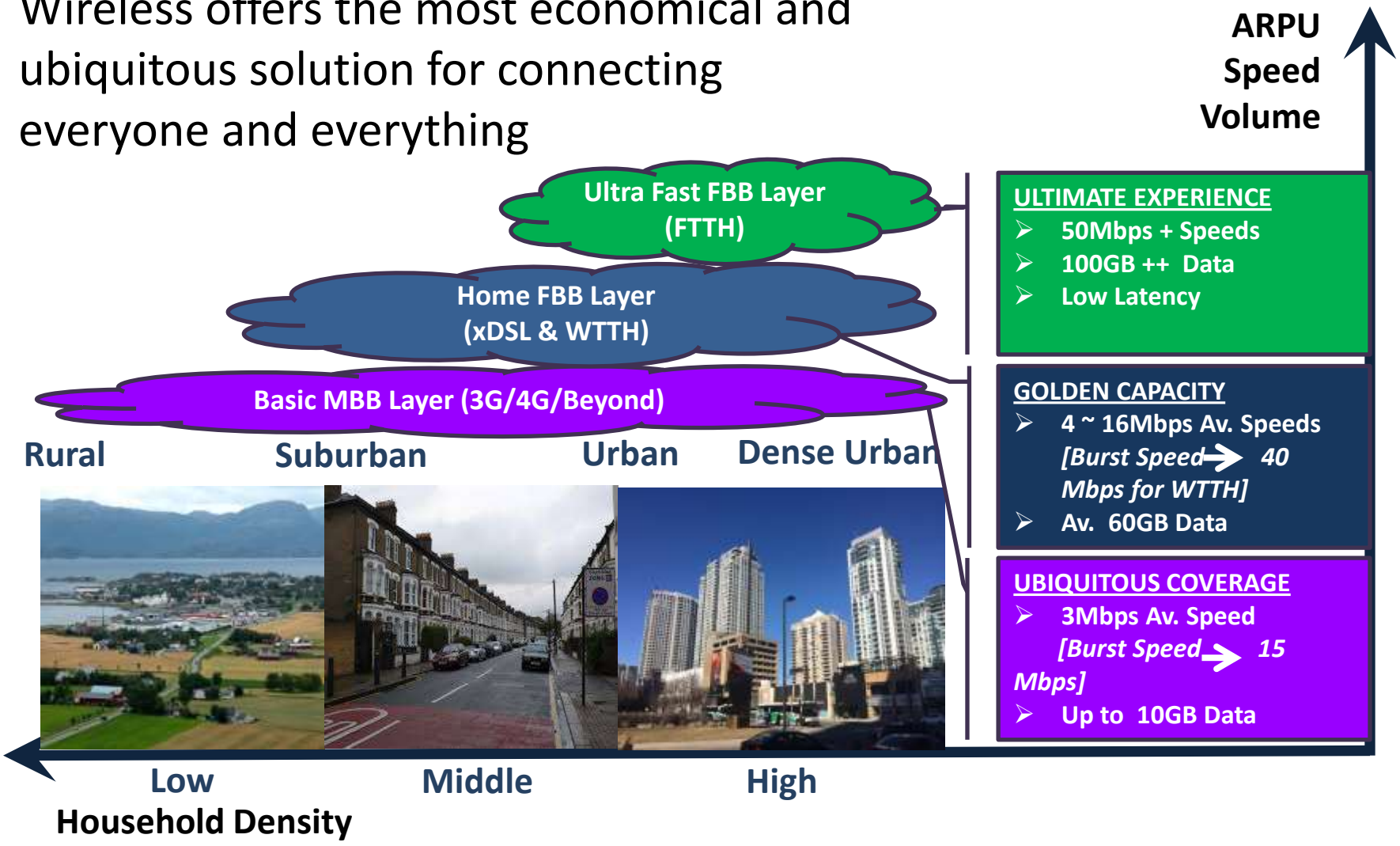
Why Wireless Access

Catalyst to digitalization at customer end, in terms of:

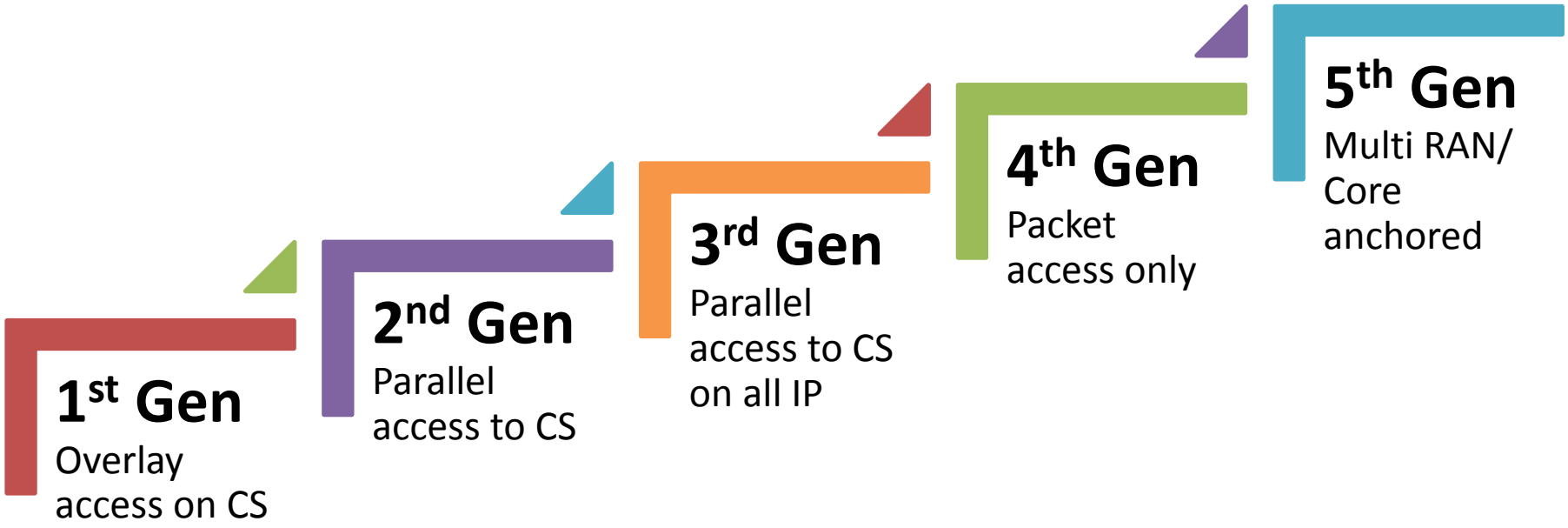
- Rich Personalized User Experience with Companion SMART devices with Context Awareness
- High Mobile Computational Power for General Purpose Applications
- Multi RAT – Proven ability to provide Ubiquitous coverage and Capacity
- Improved Security
- ROI
- Applicability in unknown use cases

Why Wireless Access

Wireless offers the most economical and ubiquitous solution for connecting everyone and everything



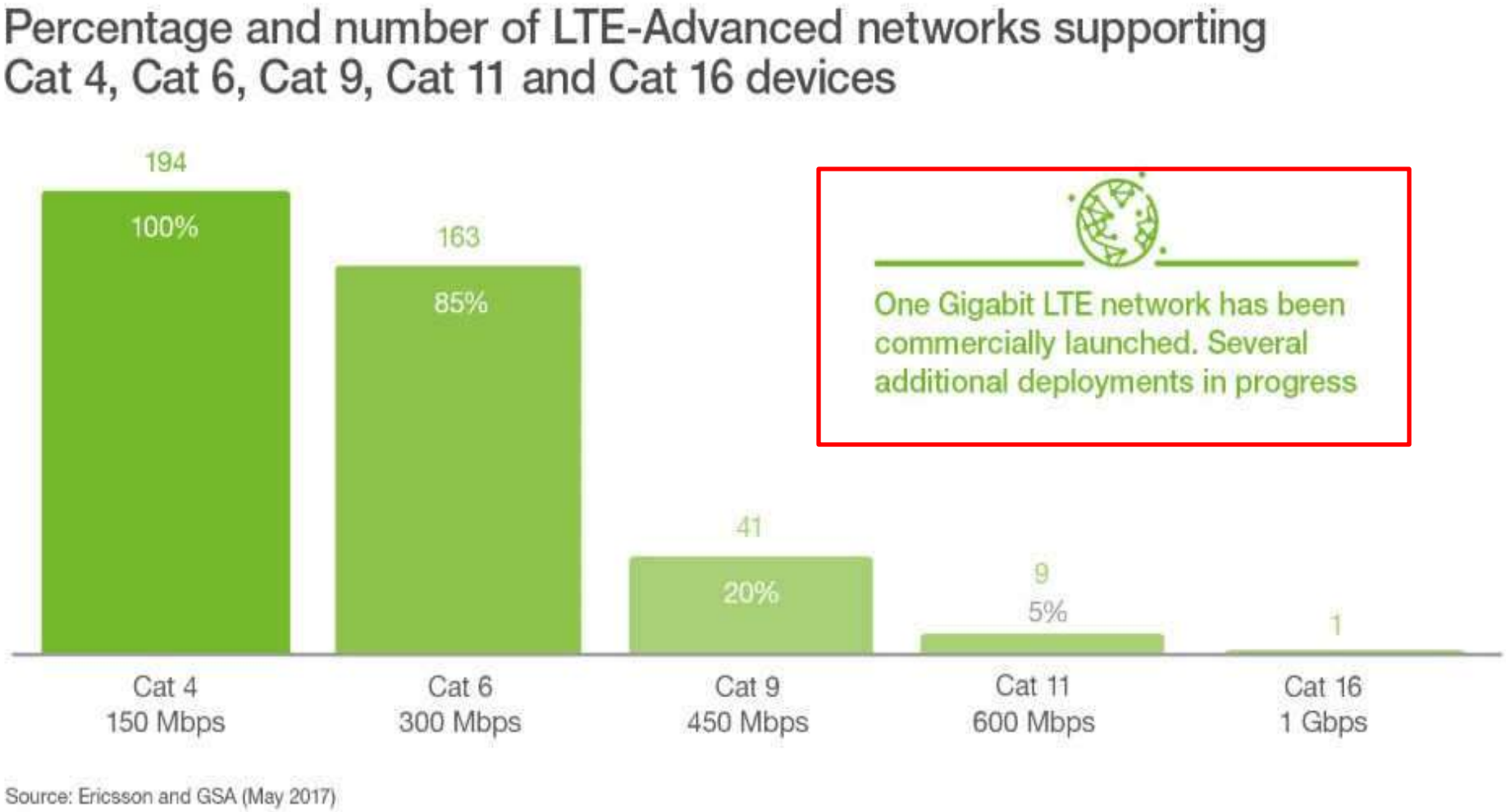
Evolution of PLMN Data Access



Prevailing Wireless Access Technologies

FDD LTE Data	**TDD LTE** Data	**WiMAX** Data
Wi-Fi Data	**3G (HSPA)** Parallel Data	**2G (GPRS)** Overlay Data
ZigBee IoT	**Bluetooth** PAN	**NB-IoT/eMTC** IOT

Capacity Progression of LTE – Multi-Gigabit



Source: Ericsson and GSA (May 2017)

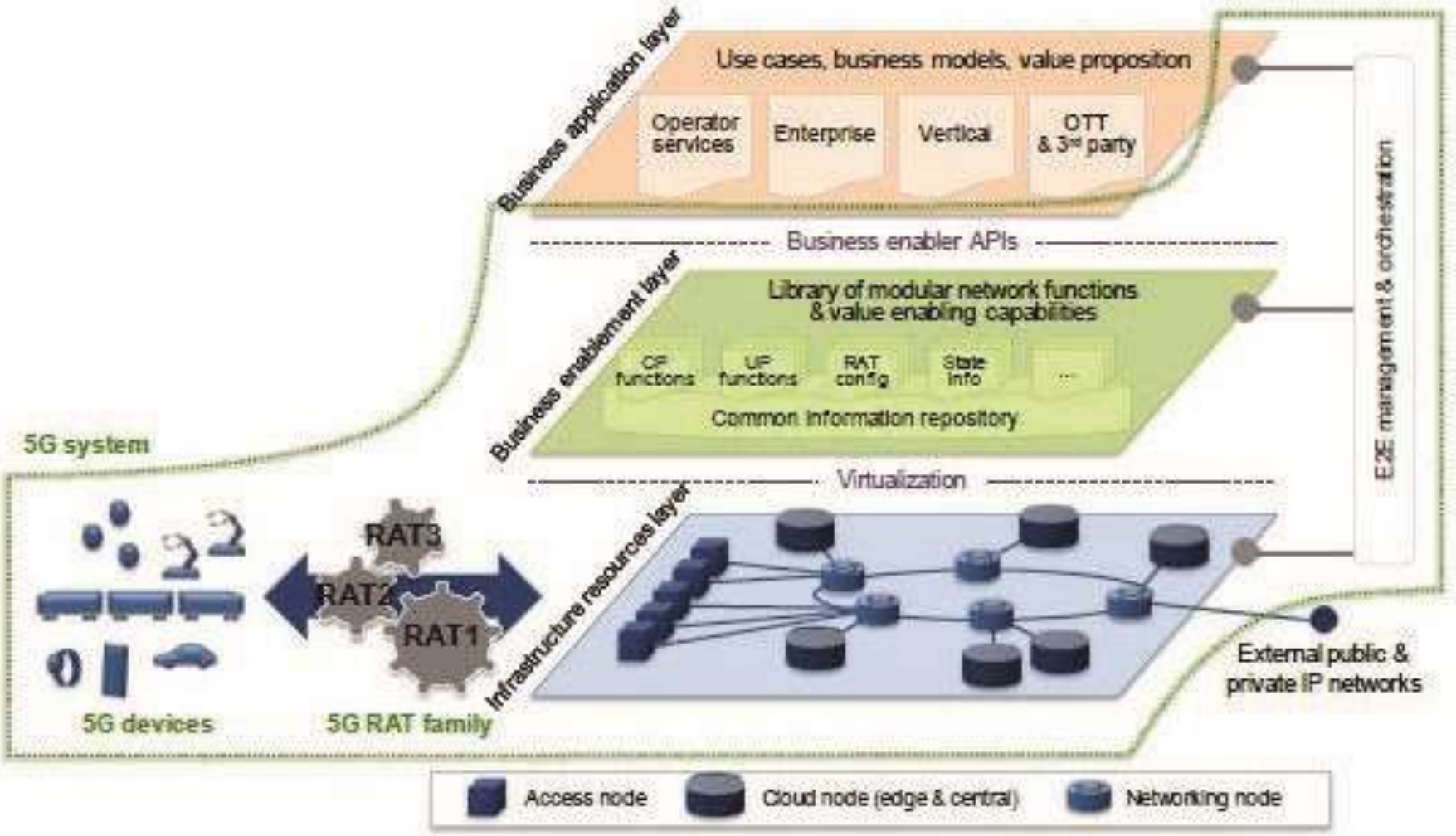
Glance at Recent Developments

- Beam forming - Coverage
- Massive MIMO – Capacity
- Channel Hardening /Channel Reciprocity - Reduced Latency
- Precoding – Simplify Receiver
- Inter eNodeB Carrier Aggregation & CoMP over X2 -Capacity
- eICIC - Capacity
- QCI – QoS Class Identifier
- Small Cell - Capacity
- C-RAN / D - RAN
- Evolved Multimedia Broadcast Multicast Services (eMBMS)
- VoLTE
- L2/L3 Services
- NFV - Core
- SDN ????
- PCC / UDC and OCS
- DRA/DEA
- CSC/MPLS

Next Generation Requirements

1. Enhanced mobile broadband (eMBB):
   - multi-gigabit per second (Gb/s) data rates
   - ability to support extensive data traffic growth
2. Ultra-Reliable Low Latency Communications(URRLC):
   - Very low latency (sub – 1 ms)
   - Very high availability, reliability and security
3. Massive machine-type communications (mIoT):
   - Massive number of low cost IoT connections with very long battery life
   - Wide coverage including inside buildings
4. Energy Efficient network and devices
5. Interoperability with existing wireless networks
6. Low device cost

5G – Next Generation of Wireless



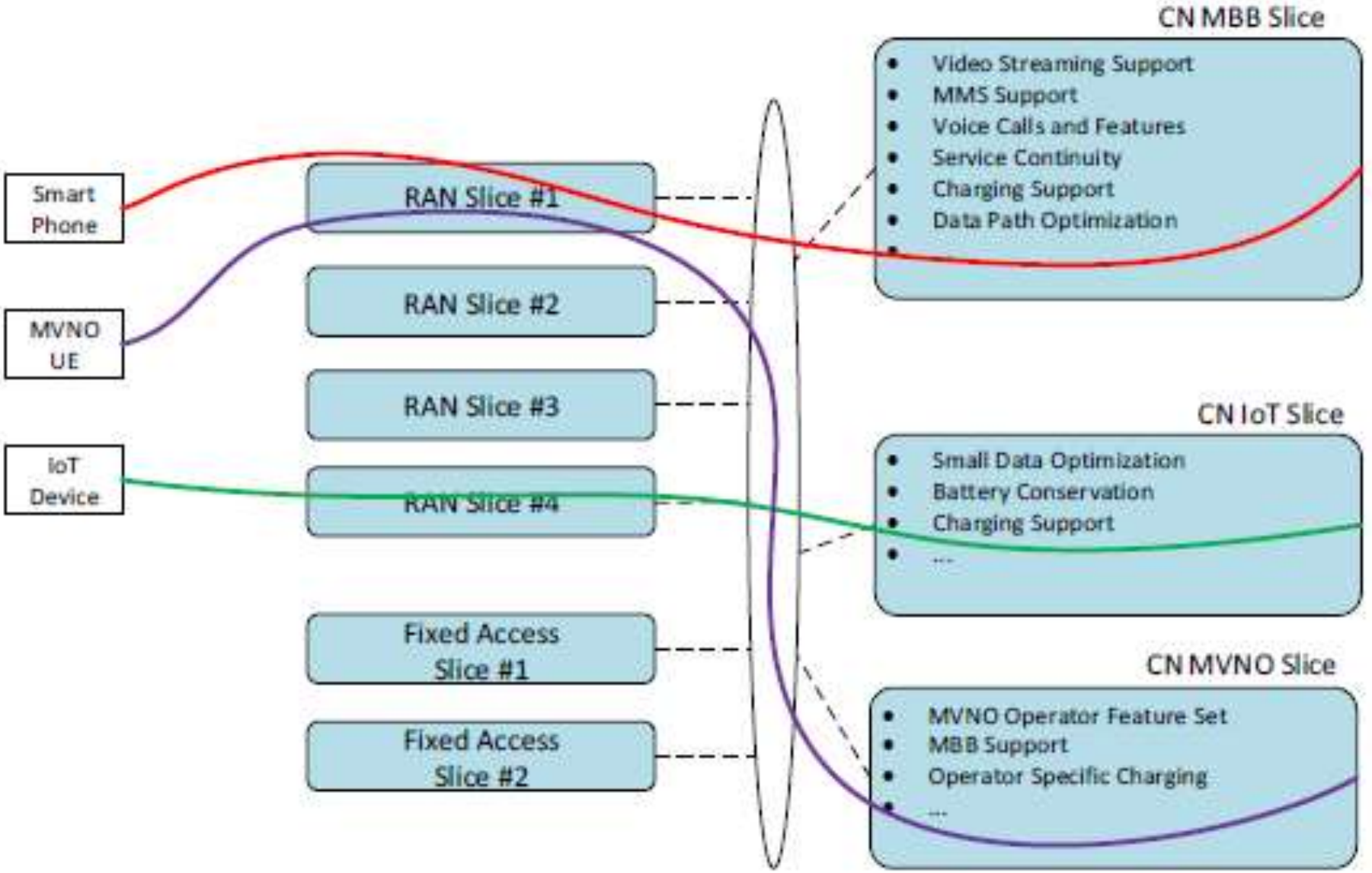
Source: NGM E2E Architecture

Virtualization and 5G

SDN and NFV enables the programmability and agility of the Network Core Architecture

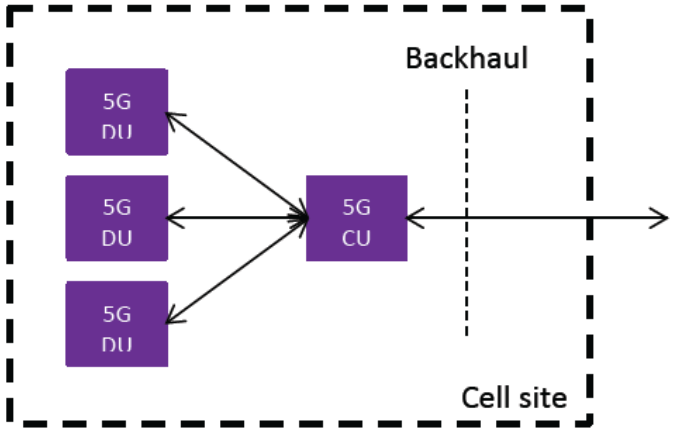
- Cloud enabled core
  - Core network function can be placed dynamically along with the access network functions to achieve KPIs
- Network slicing
  - Divides a network into multiple slices
  - Each slice comprised with isolated (Control, Management, User planes)
  - Slice can be optimized based on use case (Latency, Capacity, Throughput, Speed)
- Management and orchestration

Illustrative Network Slicing

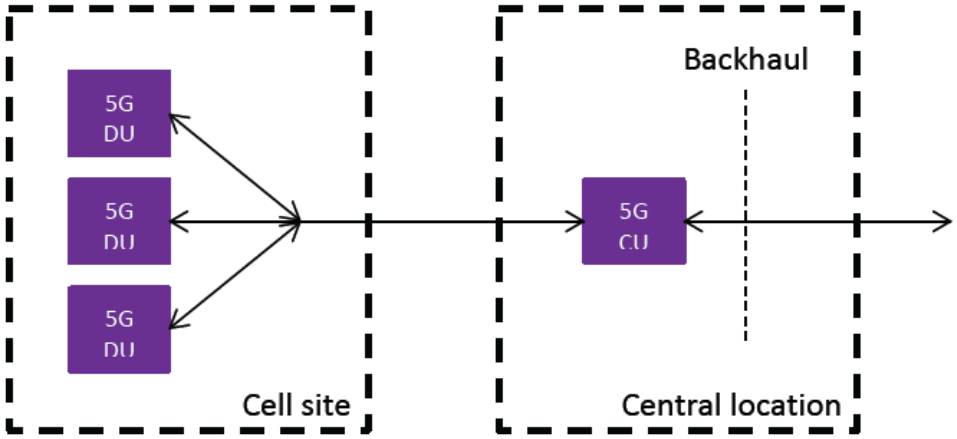


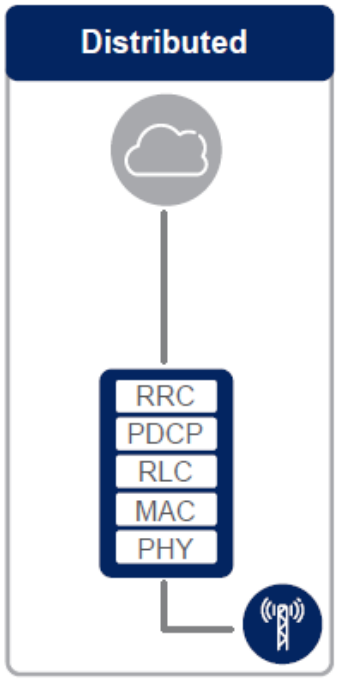
Cloudification of RAN

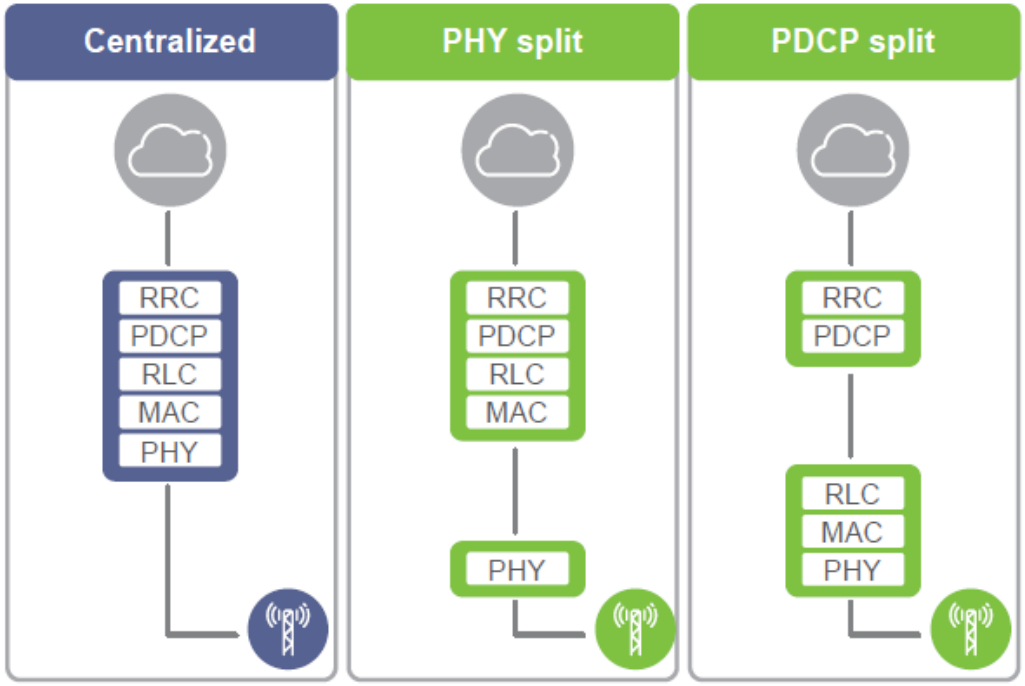
D-RAN /Flat Architecture



Cloud-RAN / Selective Centralization







Multi RAN Support

- Fixed Broadband Access Network
  - Take advantage of static placement of CPE
  - Higher QoE with better channel characteristics
  - Lower Signaling overhead
- Wi-Fi Access Network
  - Non-3GPP Access
  - 802.11 **ac/ad** (ax/ay)
  - SON Features for Orchestration and management
- Small Cells
  - Seamless Integration
  - High capacity solution for Hotspot
  - SON Features for Orchestration and management
  - demand Effective Interference cancellation techniques

Core Network

- Multi RAN Support including Non-3GPP Access
- Dynamic selection/ attachment UP/ CP Termination at core based on
  - Location
  - Mobility
  - Service requirement
- Simultaneous multipoint attachment
  - Per device
  - Per service flow
- Facilitate network discovery and selection based on
  - User experience
  - Reliability & Availability demand of

eSGiLAN

- VNF Based Network Function
  - Firewall
  - Load balancers
  - DDOS
  - WAF
  - ADC
- VNF Based Application Function
  - IMS
  - SBC
- SDN Controlled Packet Transport

Fixed-Mobile Convergence in Ecosystem

Entire Communication Service Provider Architecture supports both Fixed and Mobile Broadband Users and their Applications.

- Device Convergence
- Network Convergence
- Core Convergence
- Control Layer Convergence
- Application Layer Convergence
- API Layer Convergence
- OSS/BSS Convergence

Spectrum Resource

$f_c < 1$ GHz	1 GHz < f_c < 6 GHz	6 GHz < f_c
Coverage	Coverage + Capacity	Capacity

Support widespread coverage across urban, suburban and rural areas and help support Internet of Things (IoT) services

Mixture of coverage and capacity benefits, including spectrum within the 3.3-3.8 GHz range
Forms the basis of many initial 5G services

Meet the ultra-high broadband speeds envisioned for 5G
Focus on bands > 24 GHz including growing interest in the 24 GHz and/or 28 GHz bands which could be easily implemented together in a single device
Interest in exploring bands in the 6-24 GHz range

Licensed and Unlicensed Bands

- Licensed spectrum should remain in the core of 5G spectrum management model
  - Guarantee Long-term vital investment
  - High Quality of service levels
- Unlicensed bands can play a complementary role
  - Offloading for complementary improvements in price/ performance
- High potential for the coexistence of 5G and other wireless services in higher frequency bands.
  - Satellite
  - fixed links/TML

Government & Regulator Support

- Contribution for widely harmonized mobile spectrum
- Adoption of regulation to issue technology neutral spectrum licenses.
  - Bands used for present mobile technologies can be easily reframed for 5G thus ensuring spectrum is used most efficiently.
- Need to adopt national policy measures to encourage long-term heavy investments in 5G networks.
  - Network Slicing
  - Speed of Rollout
  - Quality of Service

Possible National Landscape

- Producing harmonized National Broadband Plan encompassing 5G which details activities and timeframes.
- Creating a spectrum roadmap
- Supporting exclusive, long-term 5G mobile licenses with a predictable renewal process
- Ensuring all mobile licenses are technology and service neutral to encourage 5G upgrades
- Avoiding artificially high 5G spectrum prices

Prevailing Challenges - Industry

- Diminishing Yield
- Brisk Technology Progression
- eMBMS Support
- Continuous Trend in Commoditization of Telecommunication Infrastructure, Platforms, Services and Applications
- Exponential Proliferation of Devices and demand for throughput
- Higher Agility in the Wireless Market and Customer Expectations
- Utility Infrastructure - Operation and Maintenance

Prevailing Challenges - Corporate

- Regulatory Regime
- Strategizing Virtualization and Cloudification to address Wireless Use cases
- Agility and Volatility in Wireless Enabled Business Models / Business Cases
- Customer retention – Wireless Access technology obsoleteness – ARPU
- Building agile ecosystems

Prevailing Challenges - Network

- Identification of Clear Access Network Roadmap
- Selection of Best Access Network Deployments Strategy
- Selection of Best Architectural Options
- Multi Access Profile Users – Cost Disparity – Supplier Strategies
- Changes - Vendor Locking – Investment Protection

Prevailing Challenges - Consumer

- Availability of Access Technologies
- Market driven reachability
- Application Security
- Feature Enhancements