Cloud-Ready RAN Evolution towards 5G

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11-08-2018

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Key Drivers

2

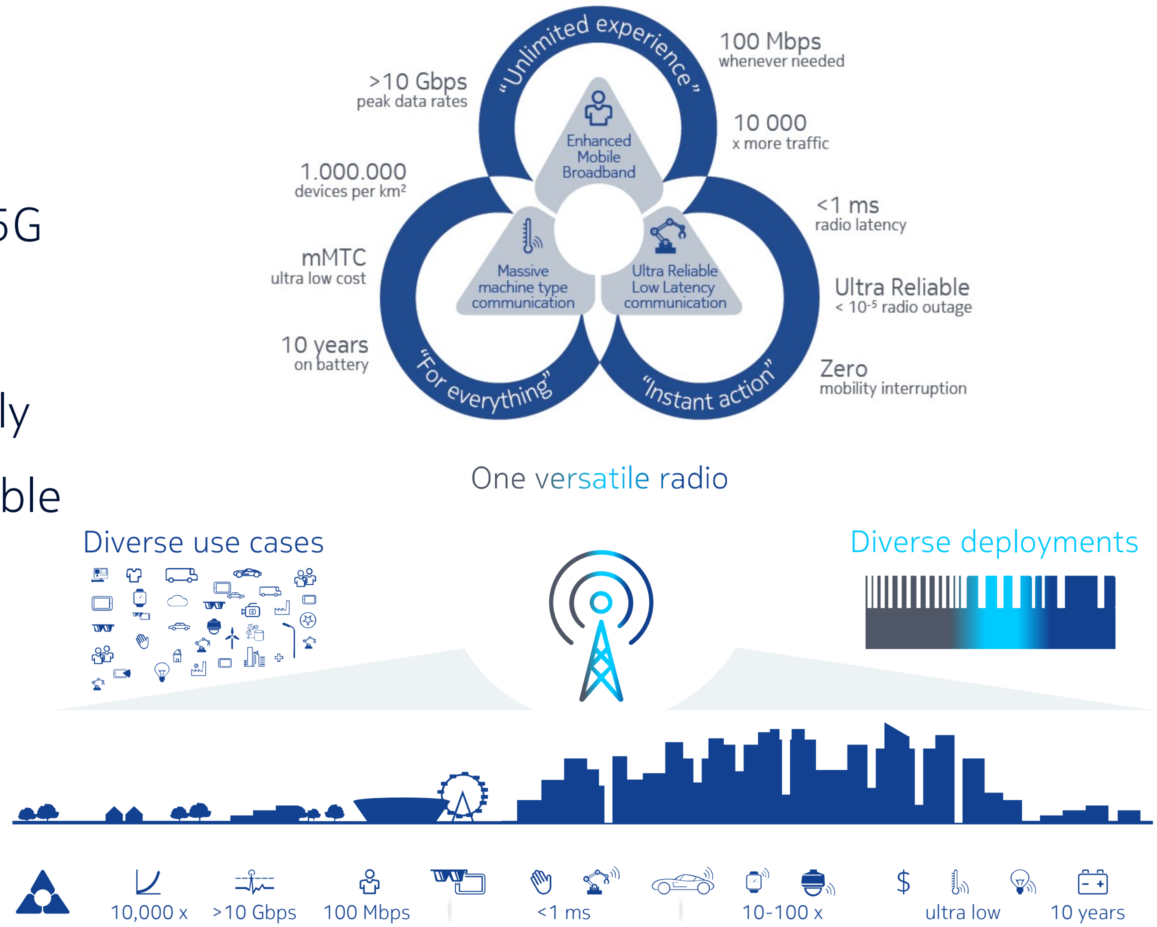
Challenges

3

Evolution

5G : At the cusp of network transformation
Explosion of Possibilities

- Networks are at the cusp of major transformation due to the advent of 5G technologies.
- A diverse set of use cases that can only be supported via seamless, fast, scalable and ultra reliable access networks.
- Achieve all these at lower costs of implementation !



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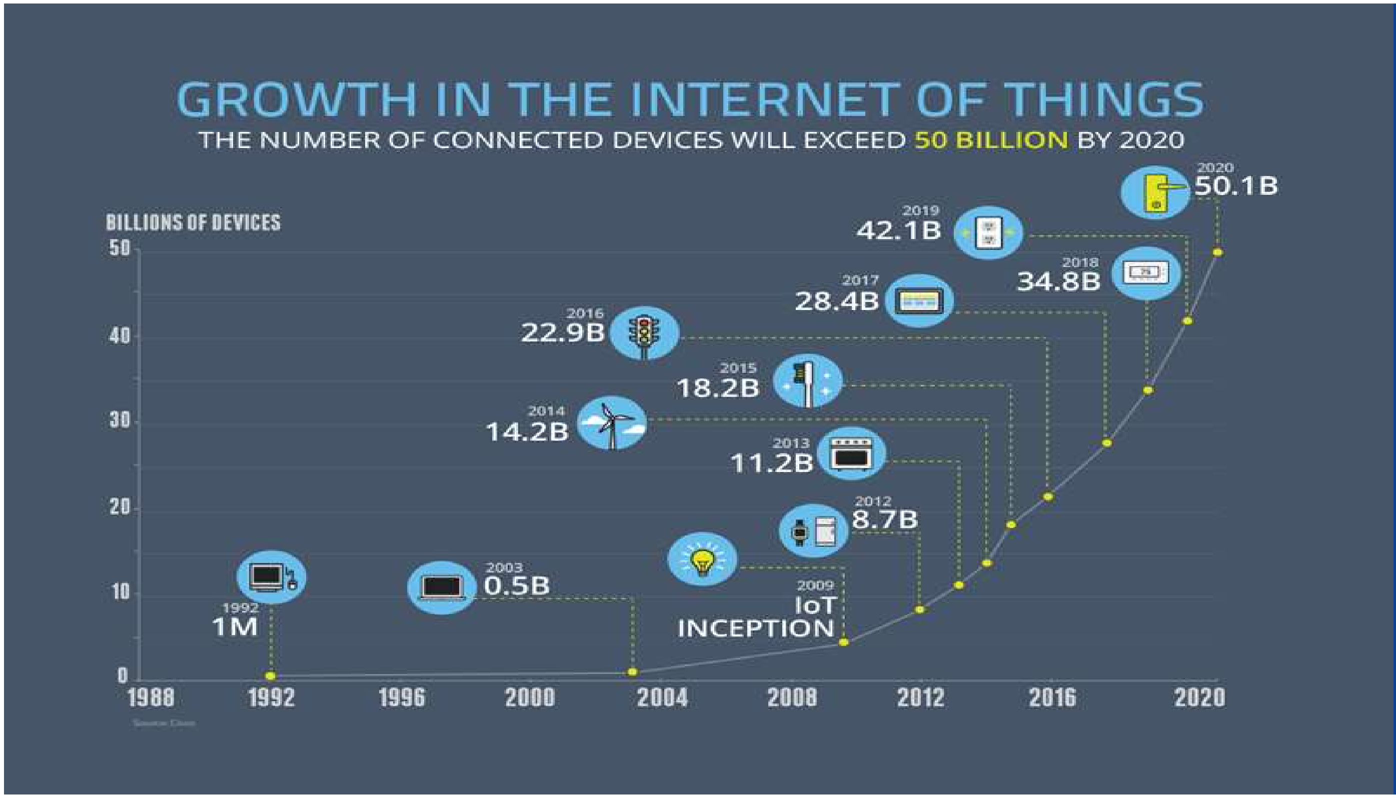
Impact of IOT

Networks need to scale to meet the increasing capacity demands

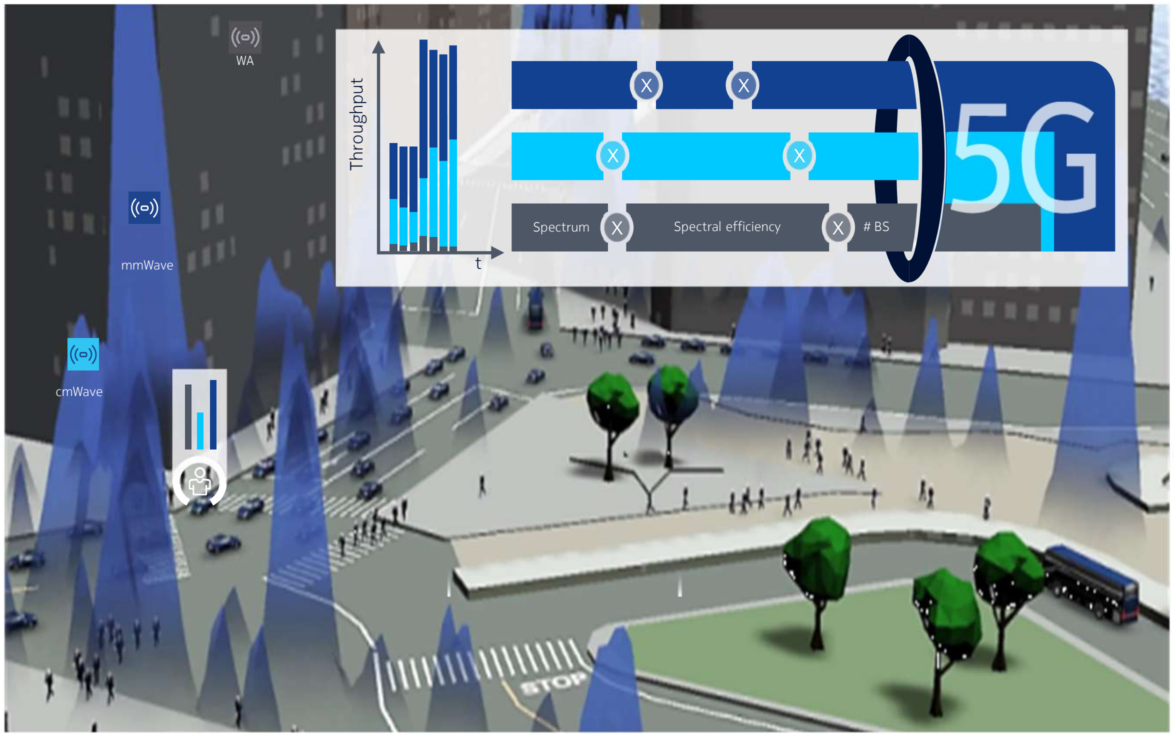


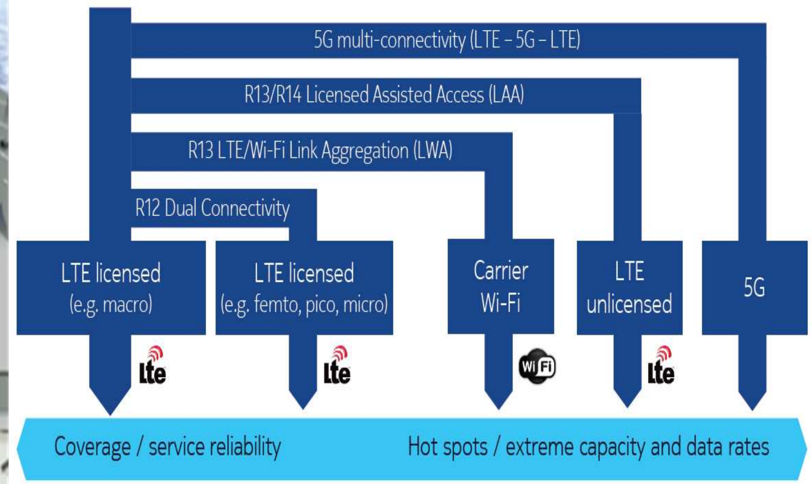
The number of IOT devices connecting to the network is expected to exceed 50B by 2020

Source : https://www.ncta.com/whats-new/behind-the-numbers-growth-in-the-internet-of-things

Multi-Connectivity

Multiple radio technologies collaborating as one system





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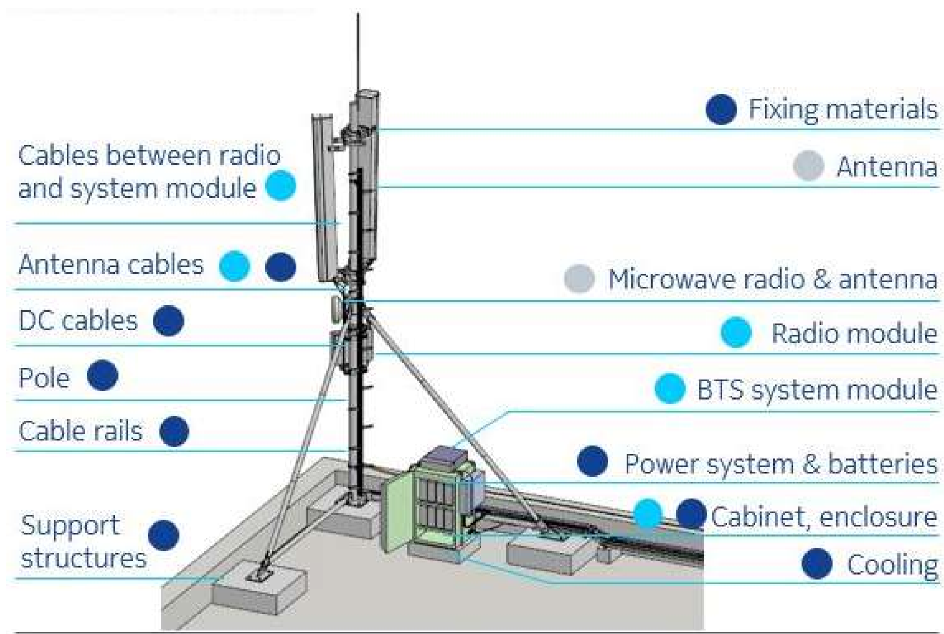
Where we start …

A Typical Integrated Base Station Site Deployment

- Each cell site has its own :
  - Dedicate Base Band Unit (BBU)
  - RF Modules
  - Power, Cooling and Routing Infrastructure
- Operational challenges for operator
  - CAPEX is high
  - Each site has to be engineered for peak capacity and hence underutilized during low loads
  - Site maintenance and upgrades are a time consuming and expensive affair



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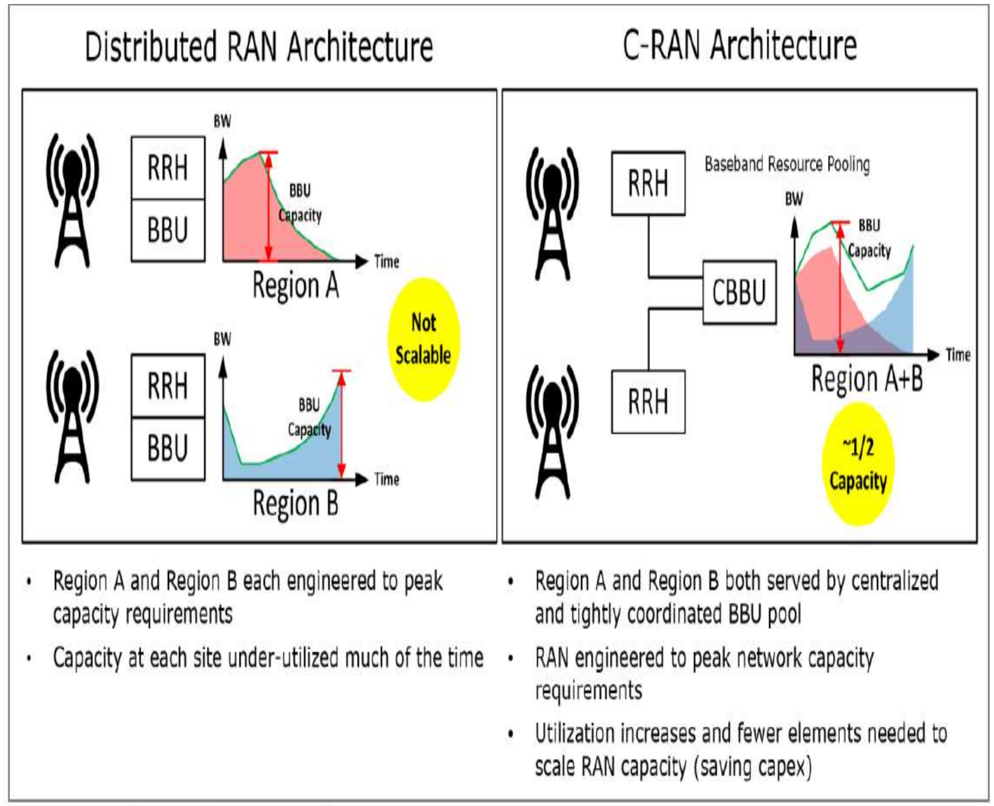
First Step towards Cloud-RAN

Benefits of Centralization

- Economics of scale :
  - Sharing of resources – Physical Space, Electricity Generators and Cooling
  - Better utilization of BB Pools leading to least amount of idle capacity and better scaling for demand
- Reduction of OPEX by :
  - Lesser site maintenance effort
  - Easier upgrades for baseband features
- Better Radio Performance
  - Increased co-ordination among cell sites leading to higher data rates.
  - Advanced features like COMP and Inter Site CA can be better supported
  - No Need for IPSEC since the BBs are co-located

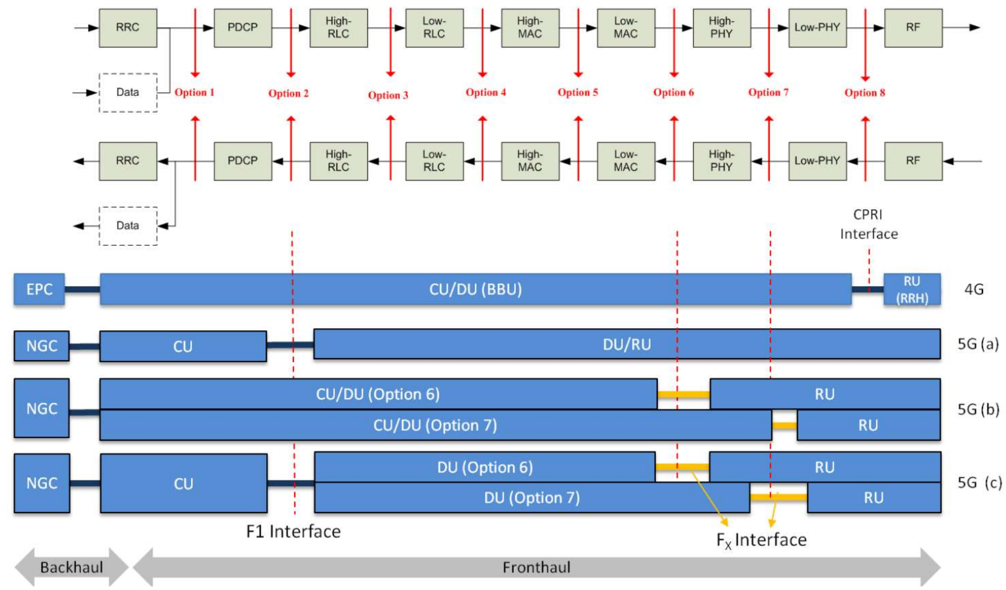


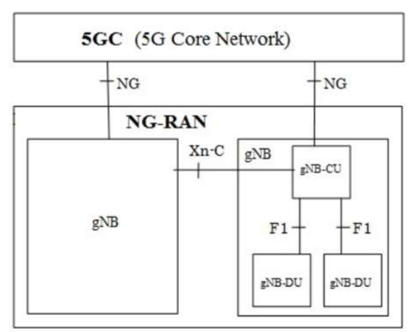
Source: Fujitsu & Heavy Reading

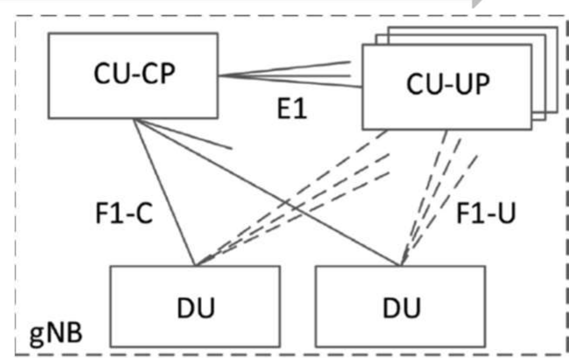
Functional Split for Centralization of RAN

3GPP Rel 15 Fronthaul Split

- Higher FH split at Option 2 (PDCP)
- Separation of Control and User Plane in CU
- Centralization of RRM allows capacity scaling
- Centralization of NRT User Plane at PDCP allows better Multi-connectivity
- Fronthaul for NRT (Mid haul) can have similar throughput requirements as backhaul







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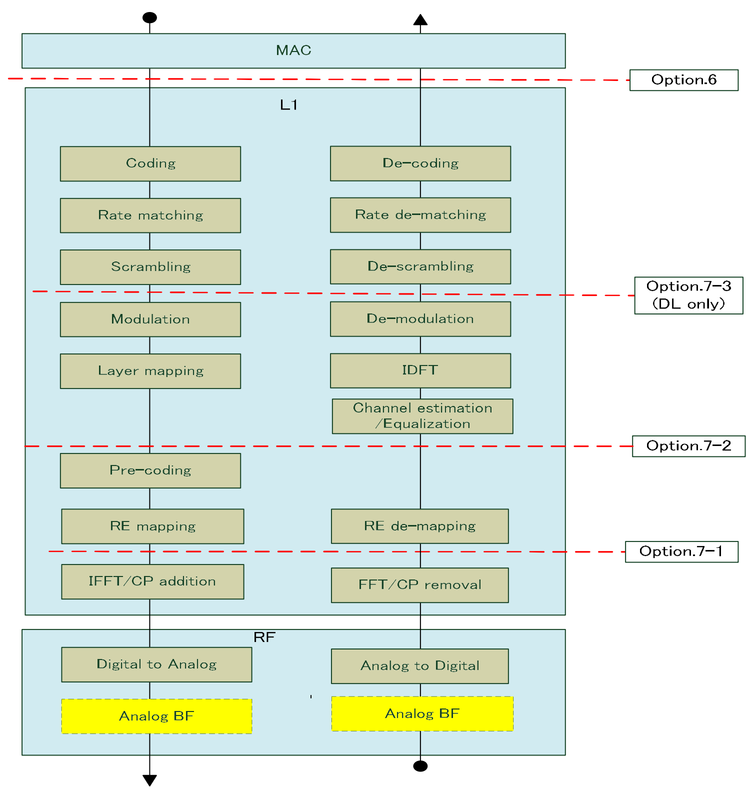
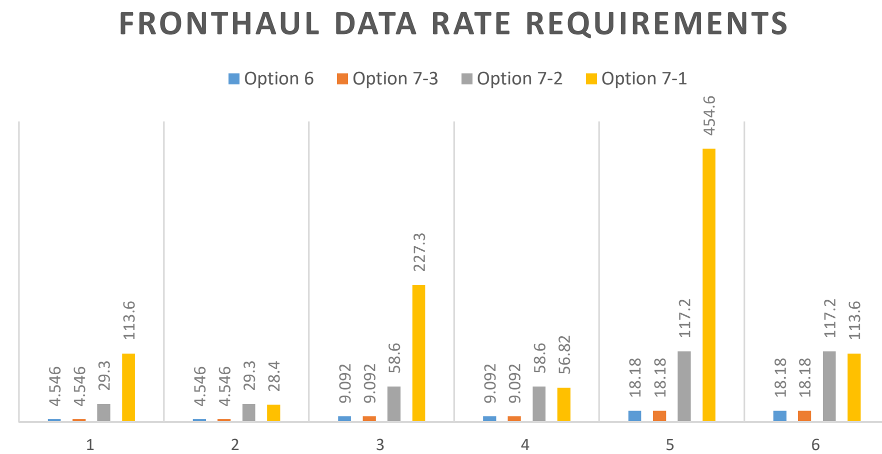
Fronthaul Split Options - RT

3GPP TR 38.816 : Study on CU-DU lower layer split for NR





<table>
<tr><th>Parameter set</th><th>Channel BW [MHz]</th><th>Modulation scheme</th><th>Number of MIMO layer</th><th>IQ bitwidth [bit]</th><th>Number of antenna ports</th></tr>
<tr><td>#1</td><td rowspan="2">100 (DL/UL)</td><td rowspan="6">256QAM (DL/UL)</td><td rowspan="6">DL:8
UL: 4</td><td rowspan="6">DL: 2x16
UL: 2x16</td><td>32 (DL/UL)</td></tr>
<tr><td>#2</td><td>8 (DL/UL)</td></tr>
<tr><td>#3</td><td rowspan="2">200 (DL/UL)</td><td>32 (DL/UL)</td></tr>
<tr><td>#4</td><td>8 (DL/UL)</td></tr>
<tr><td>#5</td><td rowspan="2">400 (DL/UL)</td><td>32 (DL/UL)</td></tr>
<tr><td>#6</td><td>8 (DL/UL)</td></tr>
</table>

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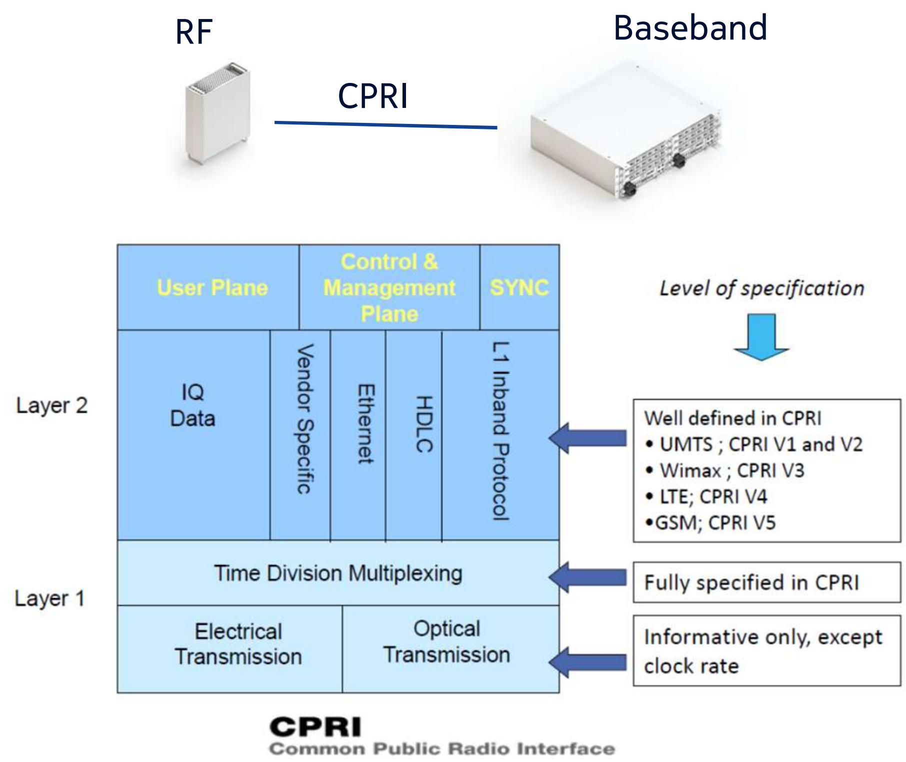
Fronthaul Interface & Synchronization

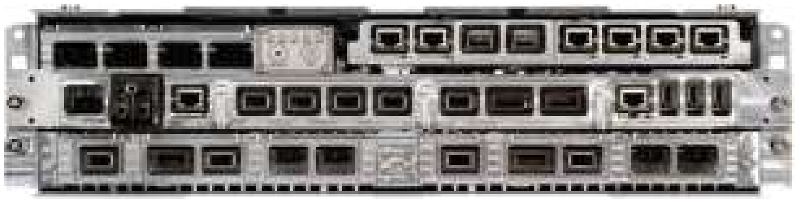
- A digital interface standard to transport antenna samples between Radio Equipment (RE) and Radio Equipment Controller (REC).
- CPRI v7.0 bit rates range from 614 Mbit/s (Rate 1) up to 24330 Mbit/s (Rate 10)
- Originally specified for point-to-point topology
- Provide time and synchronization information for the Radio Air Interface
- Interoperability limited to the low layers covered by the specification



Source : http://www.cpri.info/

RT Baseband - Software Transformation

- Custom built hardware => COTS
- Data Locality => Statelessness
- FPGAs / HW Accelerators => Software Imp
- Latency / Performance at Scale
- Monolith to Microservices



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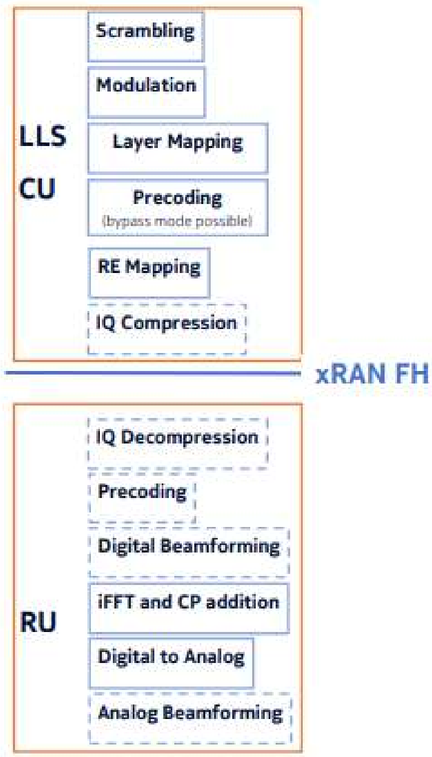
Fronthaul Split for PHY- XRAN
XRAN-FH.CUS.0-v02.00



Processing blocks with dotted blocks are not mandatory for all RU categories. Precoding operation for certain RU categories can be done within the RU and in this case precoding in LLS-CU can be bypassed.

RU Category A

Non-precoding radio unit. Precoding in radio is not supported.

Digital and Analog beamforming optional

RU Category B

Precoding radio unit. Precoding in radio is supported.

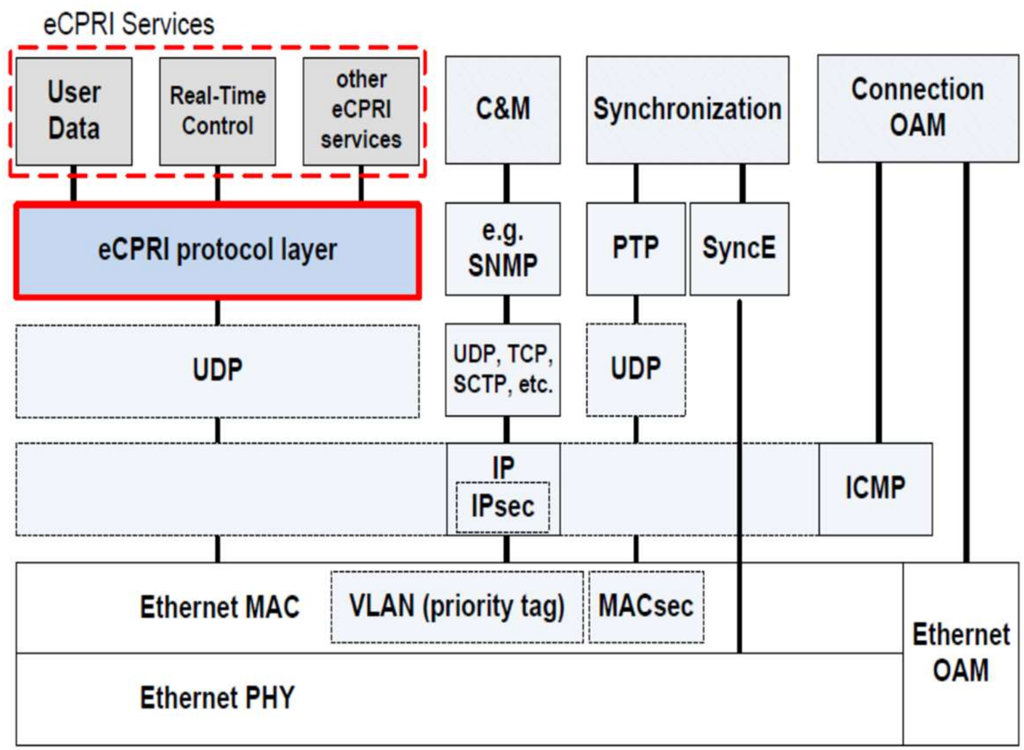
Allows support for modulation compression.

Digital and Analog beamforming optional

Source : http://www.xran.org/resources/

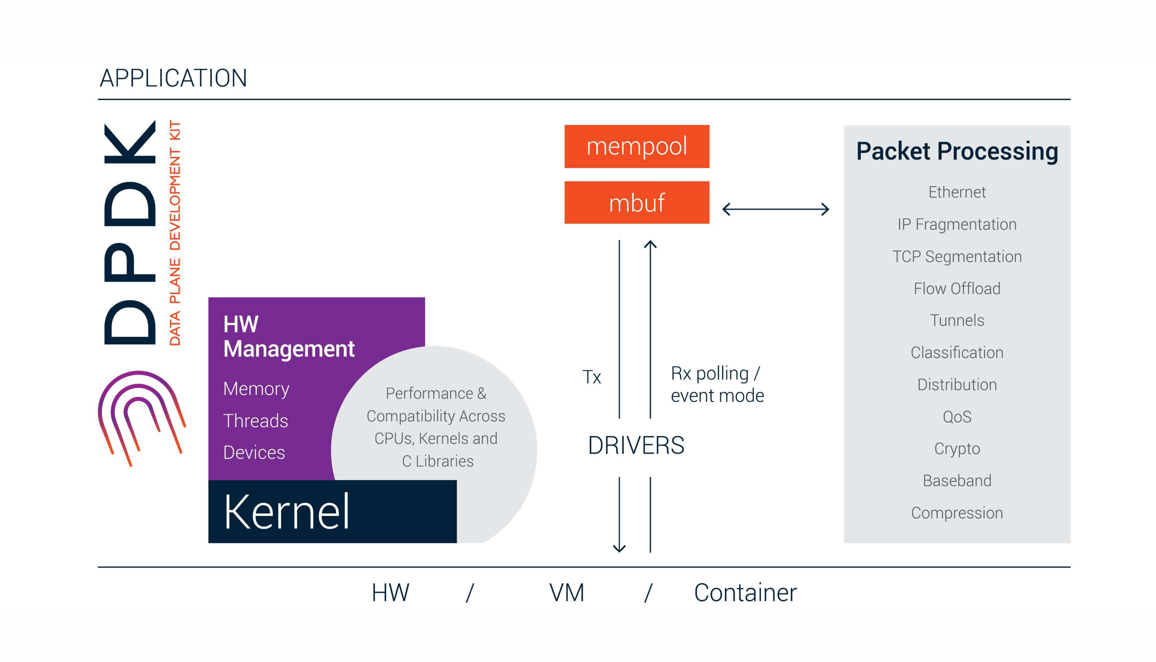
eCPRI – Fronthaul Interface evolution
eCPRI spec v1.1

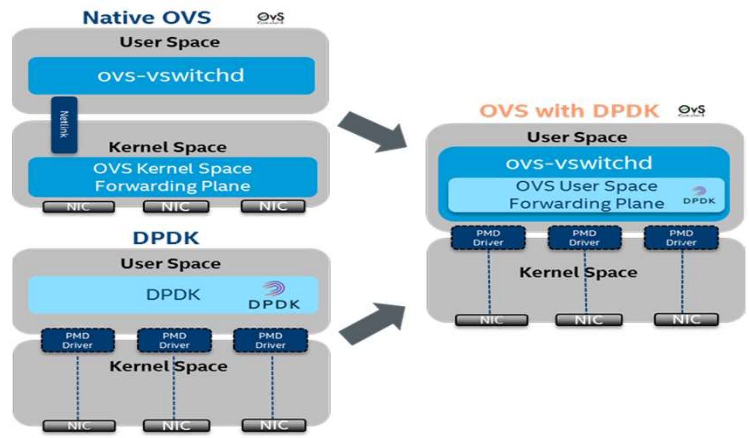
- Supports use of IP / Ethernet for transport
- Allows User plane data apart from IQ samples to be sent
- Allows independent Synchronization mechanisms using either PTP or SyncE or both

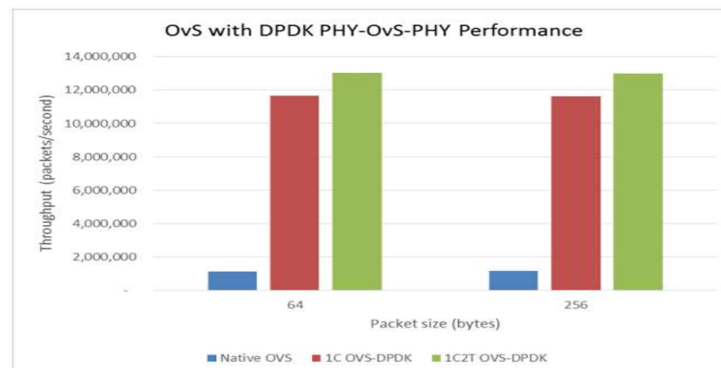


Source : http://www.cpri.info/

Data Plane Packet Processing







Source : https://www.dpdk.org/
https://software.intel.com/en-us/articles/open-vswitch-with-dpdk-overview

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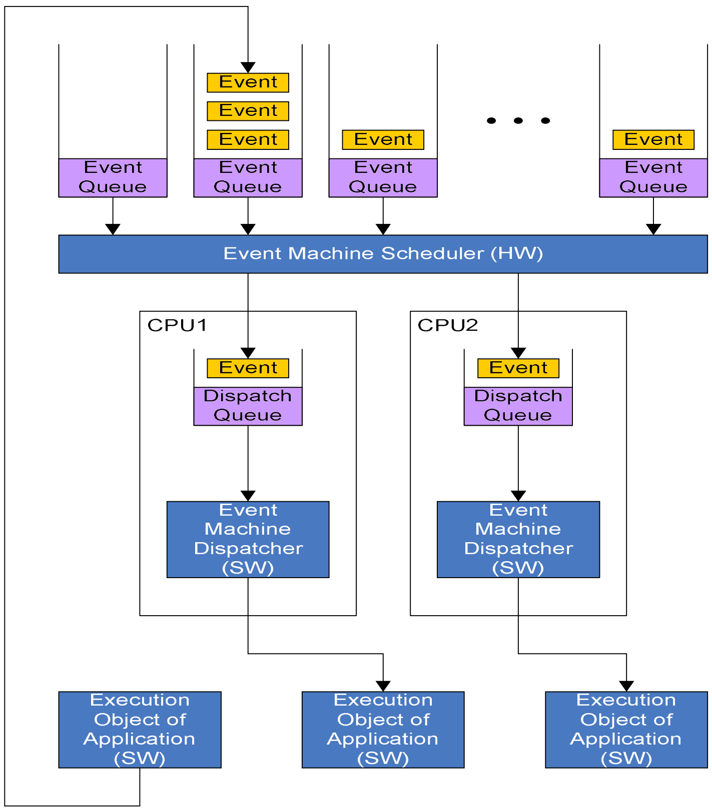
Software Architecture Models – Open Event Machine

Data Plane Processing

- Open Event Machine (OpenEM or EM) is an architectural abstraction and framework of an event driven multicore optimized processing concept originally developed for networking. Open sourced by Nokia. [https://sourceforge.net/projects/eventmachine/]

- Provides a run to completion model that can be used for scaling data plane applications



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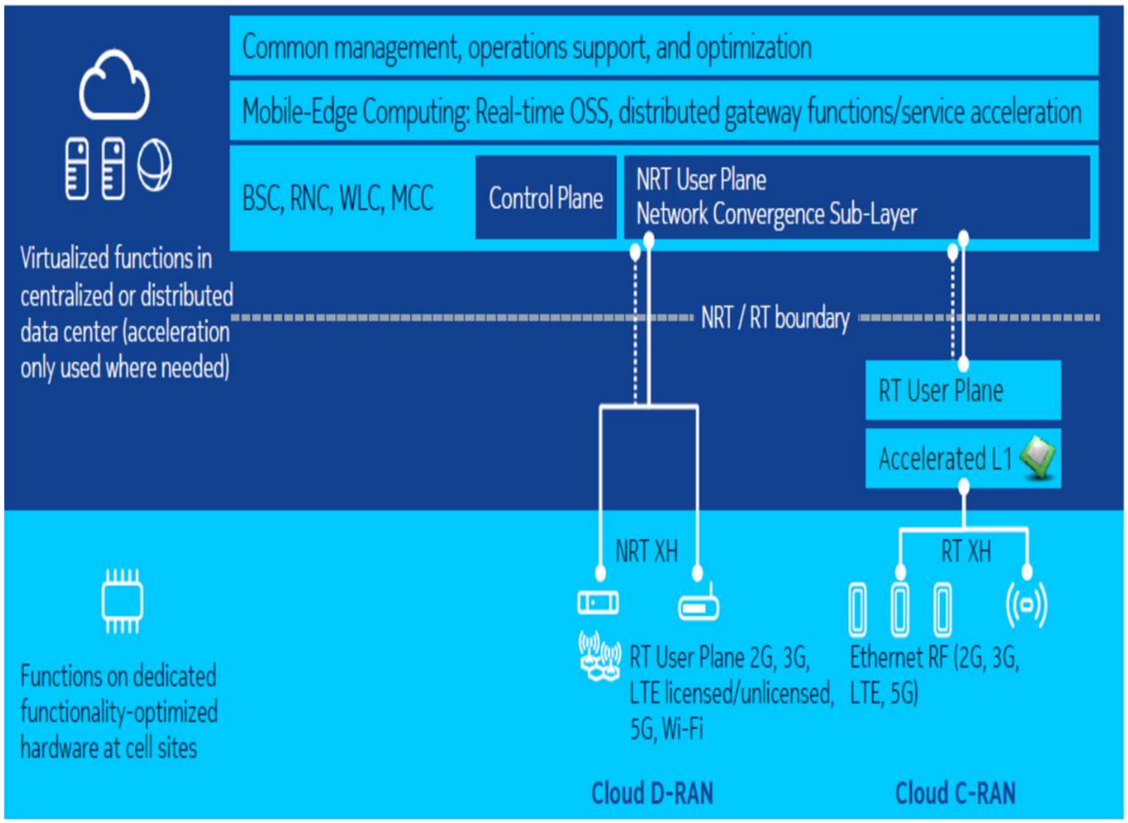
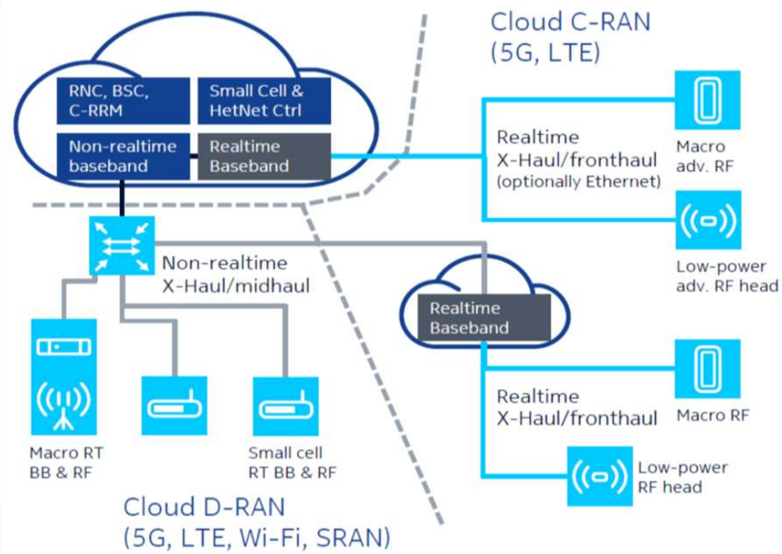
Meeting the demands of Multi-Connectivity
Multi-layer RAN





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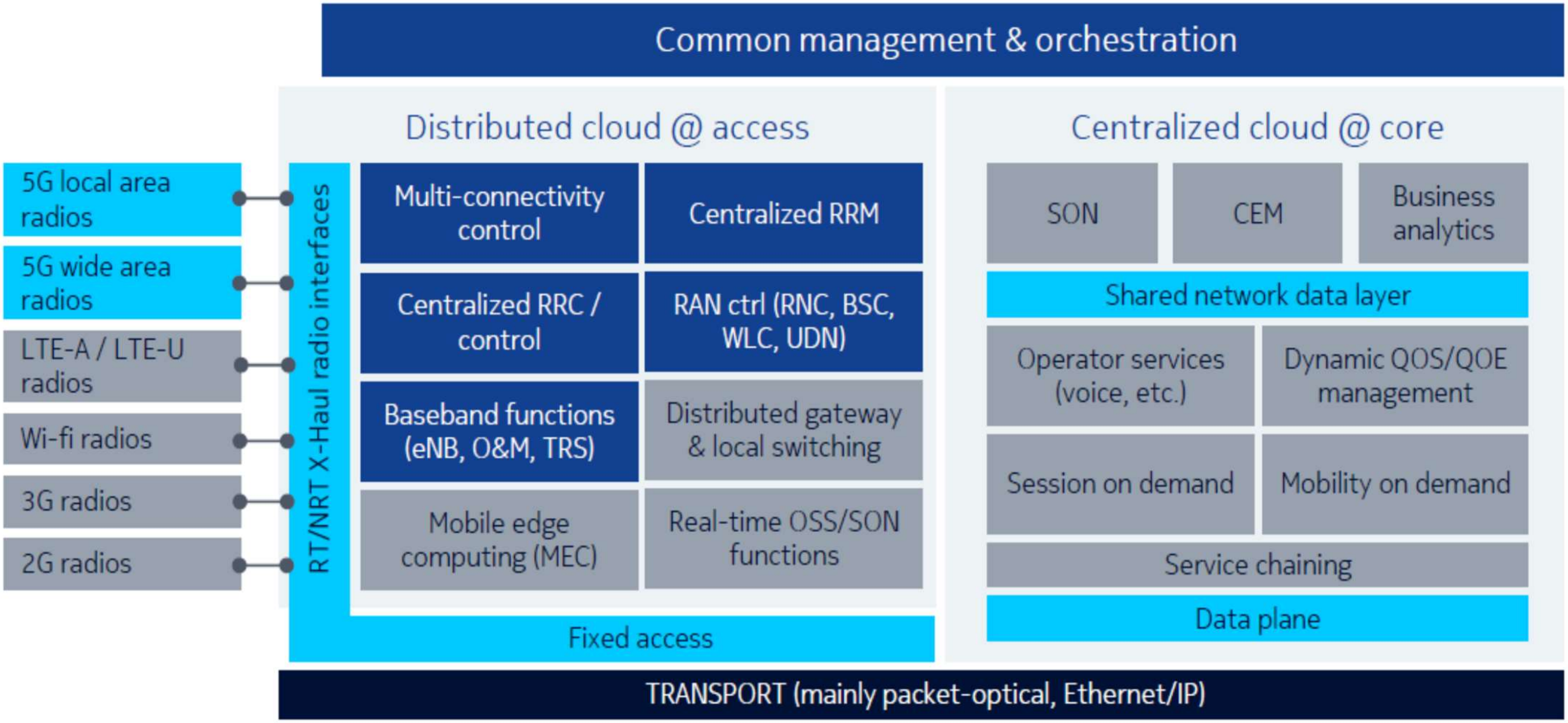
Multi-layer Telco Cloud for Cloud-RAN



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Verizon Wireless and Nokia collaborate on virtualized RAN [Link]

Nokia Cloud BTS on air on Verizon Virtual Cloud Platform in Oklahoma City trial

Verizon target

- Cloud migration to reduce network CAPEX and OPEX
- Increase in number of users per cell leading to lower cost per user
- Flexible and scalable capacity
- Continuous software delivery

Solution

- Nokia and Verizon demonstrated successful trial operation of Nokia AirScale Cloud BTS on Verizon's Virtual Cloud Platform (VCP edge) infrastructure for Verizon's VRAN 1.0 architecture in Oklahoma City trial
- Nokia and Intel jointly working with Verizon to develop Verizon VRAN 2.0 architecture including technology demonstrations and trials
- VRAN 2.0 Cloud RAN architecture puts RAN real-time functions in cloud, enabling a software defined and hardware agnostic solution

"Verizon is committed to furthering innovation within the ecosystem by ensuring deployment flexibility. Verizon's Intelligent Edge Network, which maximizes this flexibility, will allow faster upgrades, allowing our customers access to the latest technology as quickly as possible."

Bill Stone, Vice President, Technology Development & Planning, Verizon

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RAN : Evolution to Cloud

- Key Drivers:
    - Diverse Use Cases
    - Costs of Deployment
    - Multi-connectivity – Network of Networks
- Challenges
    - BB RT Cloudification
    - Front haul and Synchronization for 5G
- Cloud RAN :
    - Multi Layered, Integrated to Telco Cloud
    - Centralized RAN functions for NRT at Edge Data Centers
    - RT Baseband at Far Edge / Site

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