NG Fronthaul Network Requirements and Architecture

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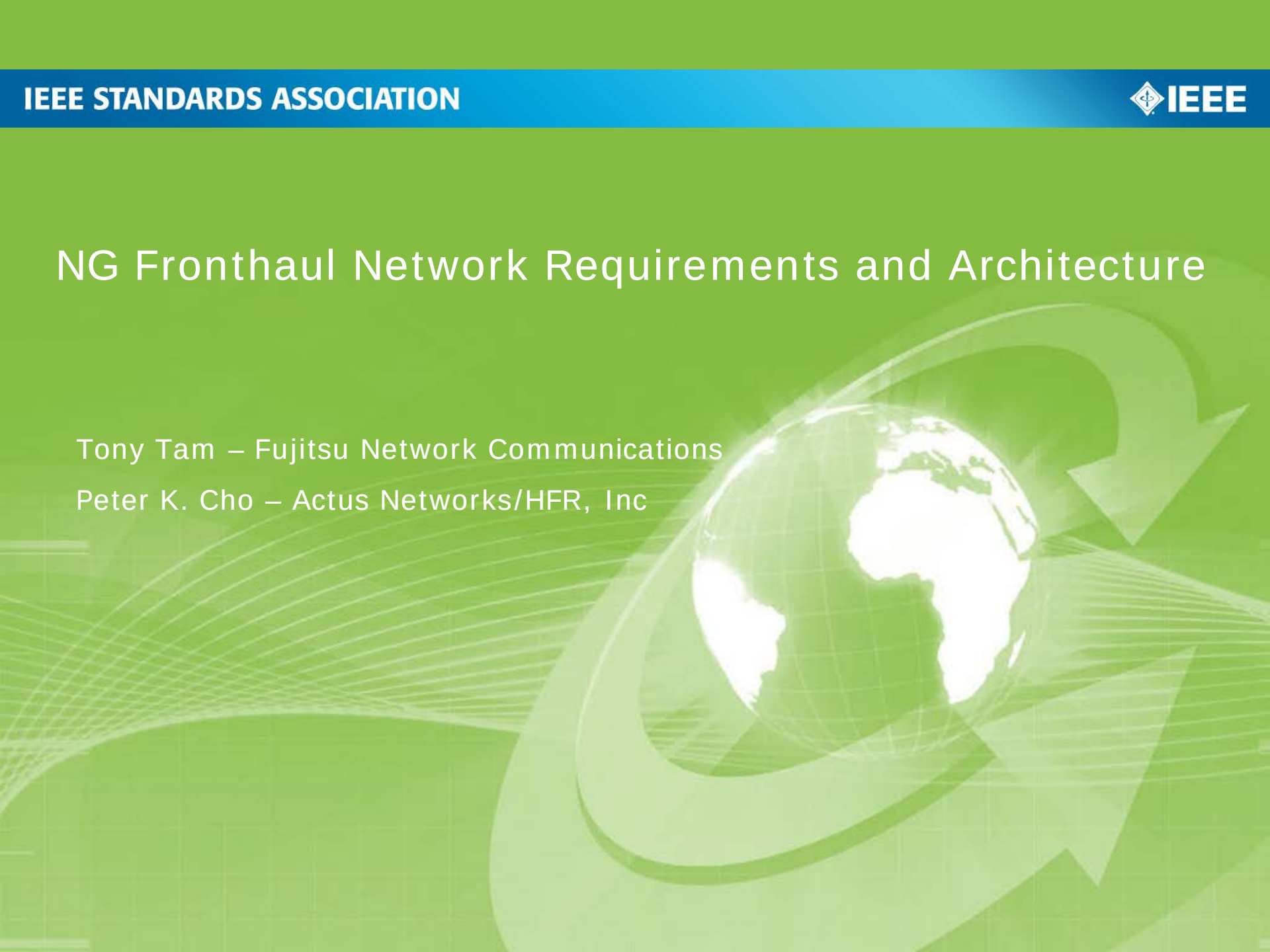

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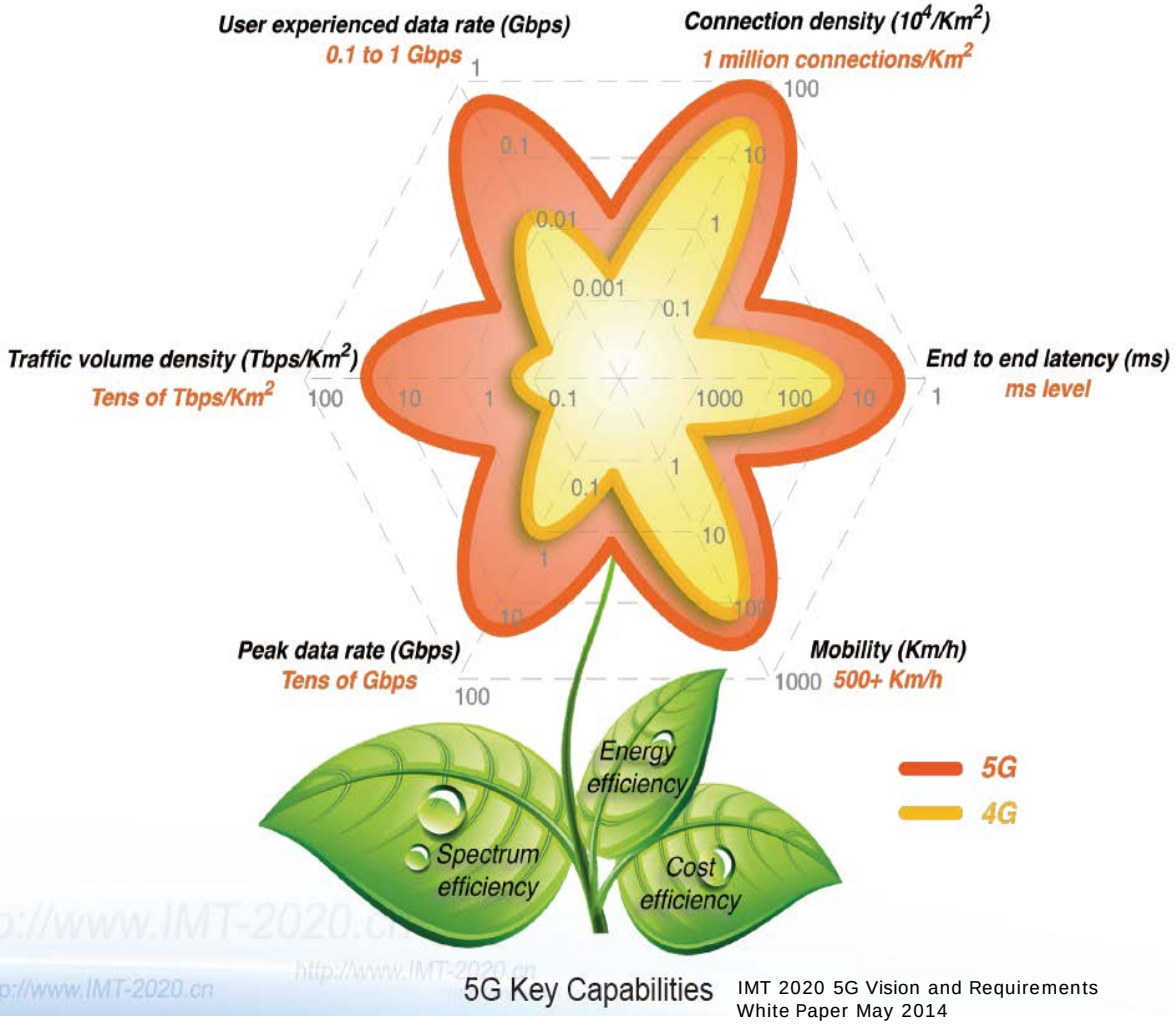
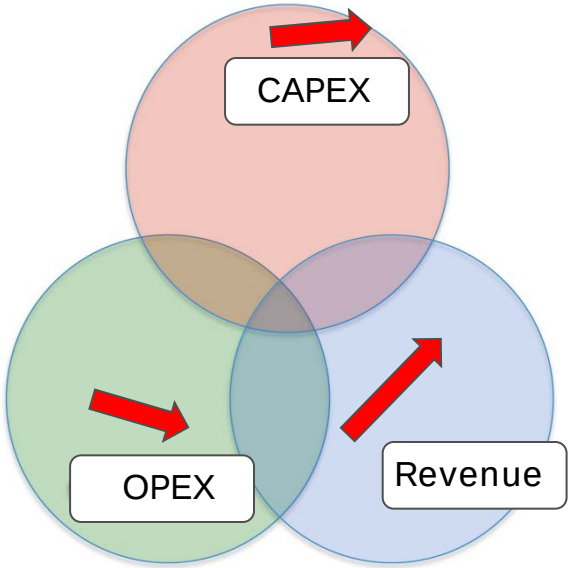
Agenda

- 5G RAN Requirements and Network Architecture
- NG Fronthaul Requirements and Network Architecture
- Radio over Ethernet

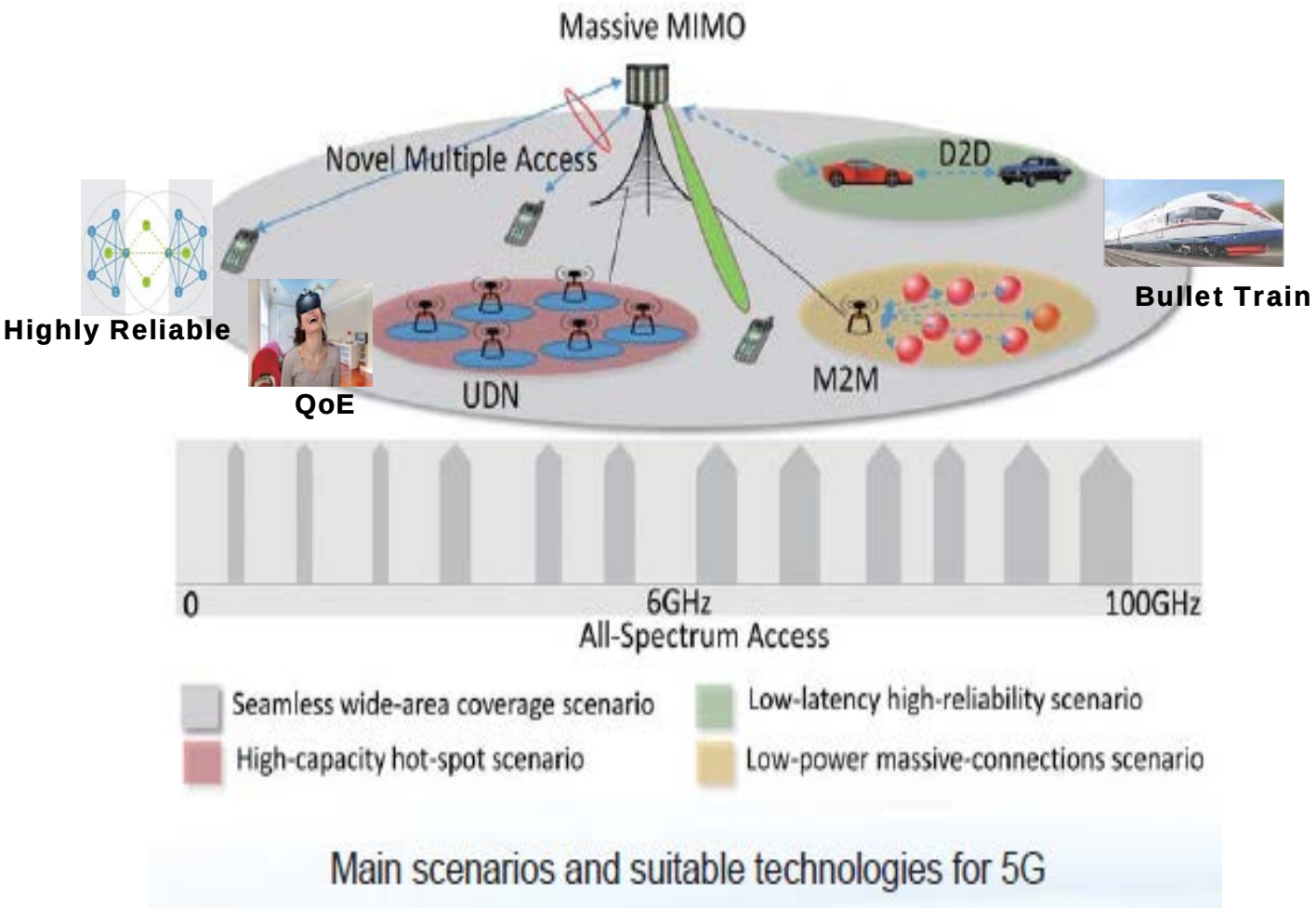
5G Network Requirements



IMT 2020 5G Vision and Requirements White Paper May 2014



5G RAN Network



Main scenarios and suitable technologies for 5G

IMT-2020 | IMT-2020 (5G) Promotion Group White Paper on 5G Concept

5G RAN Network – Network Slicing

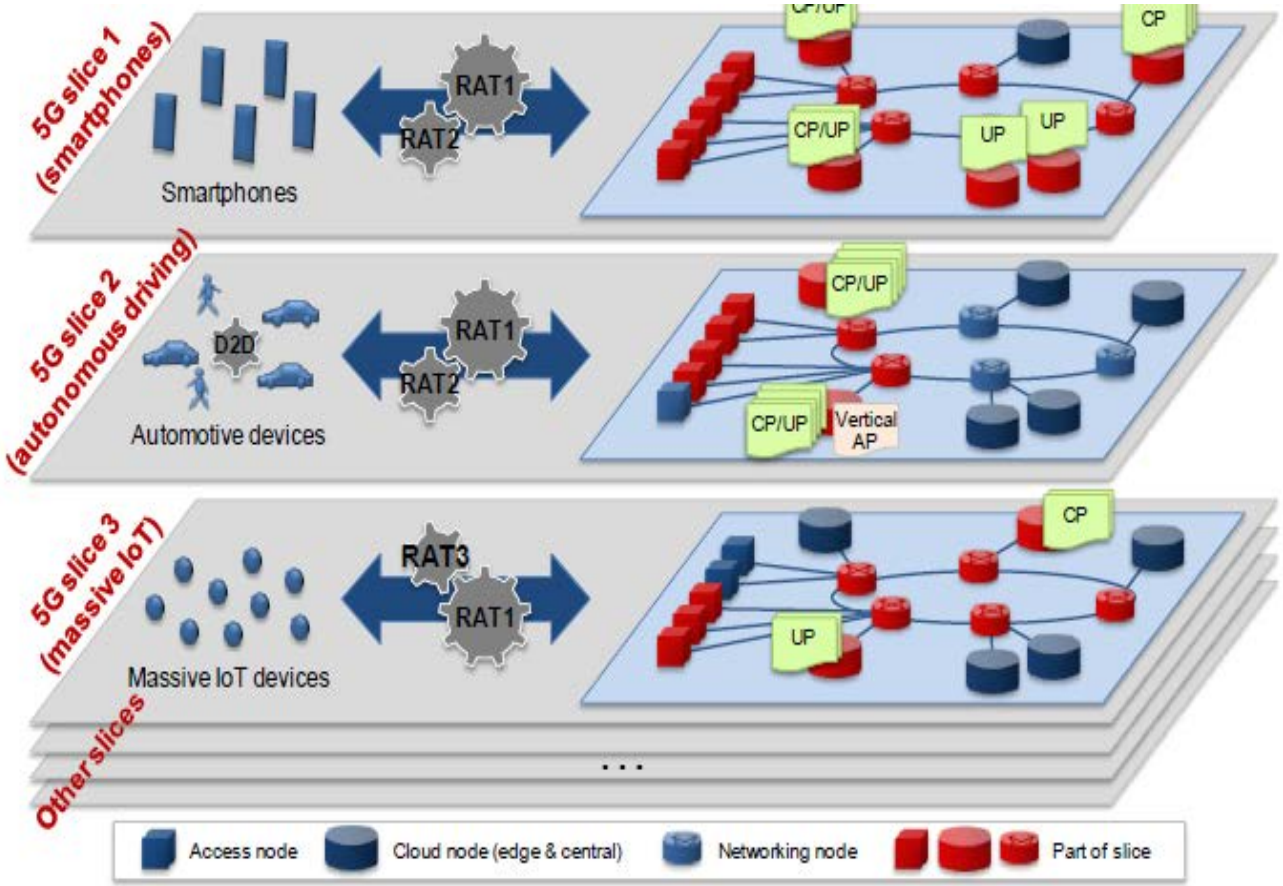


Figure 9: 5G network slices implemented on the same infrastructure NGMN 5G WHITE PAPER

NG Fronthaul Key Requirements

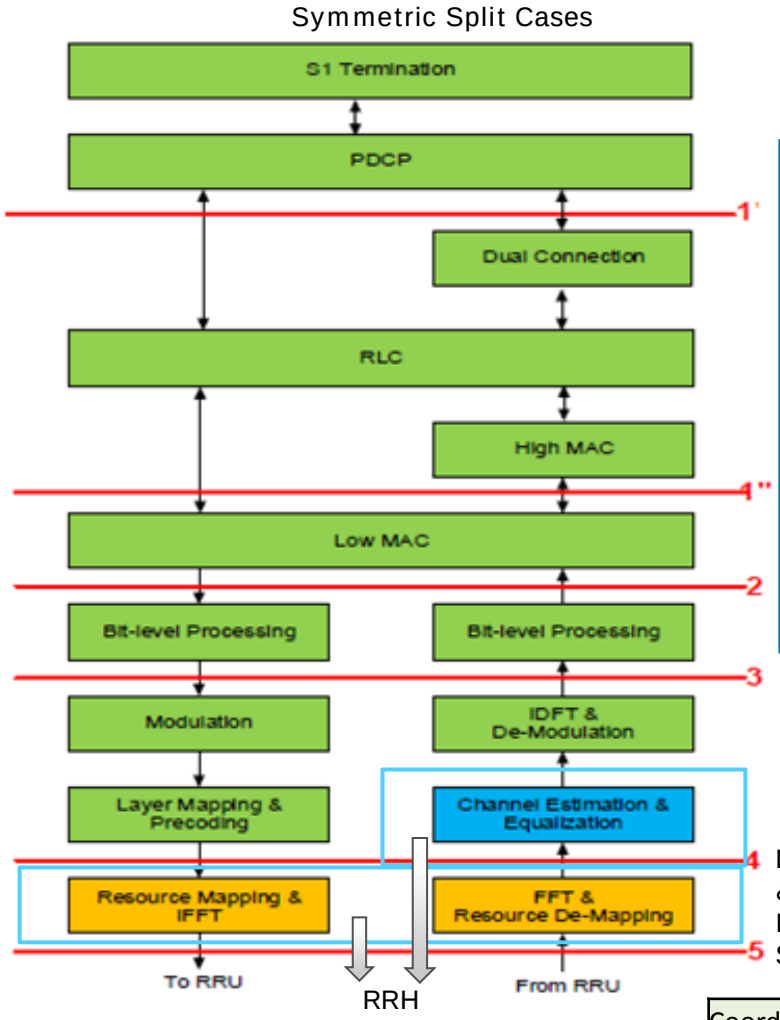
China Mobile NGFI Workshop June 2015

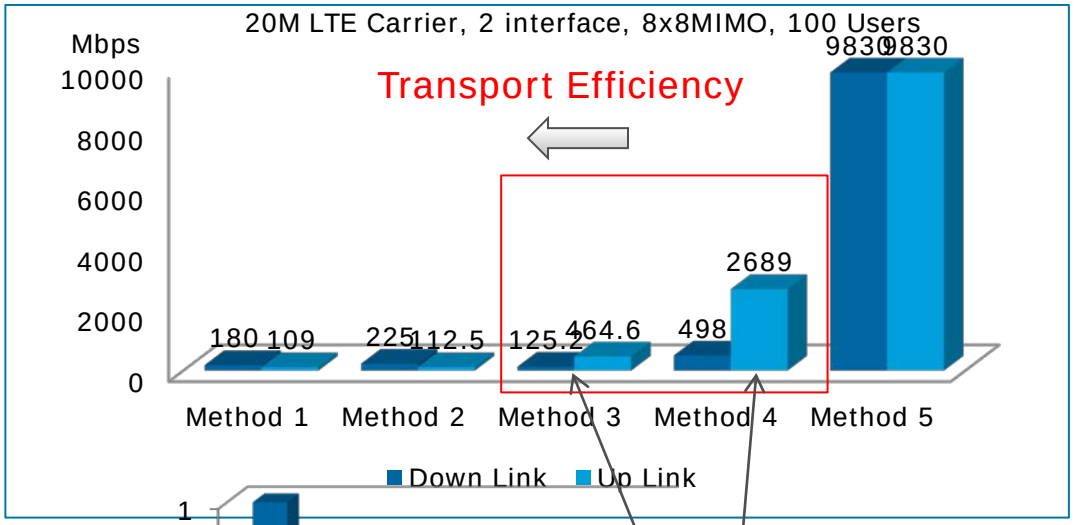
- **Transport Efficiency and Scalability**
  - Decouple MIMO Traffic - Massive MIMO processed at RRH to reduce transport bandwidth
  - Traffic Load Adaptation – Dynamic Transport Bandwidth adaptive to User Traffic Load
  - Statistical Multiplexing – Tidal effect over large scale of RRHs
- **RAN Network Efficiency**
  - Centralize RAN Coordination Functions as much as possible

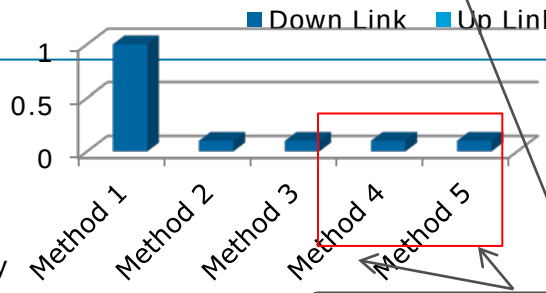
Tradeoff between Transport and RAN efficiency

- **RAN Networking and Virtualization**
  - Dynamic Networking – Mesh Network, Load Balancing and vBBU switching
- **RAN Interface Agnostic**
  - Support CPRI and Radio over Ethernet (NGFI Packet, RF over Packet)

Transport and RAN KPI Tradeoff – 4G LTE







Low Delay & Jitter
High Time Sync. Accuracy

Potential Choices

RAN Efficiency

Coordination	Method 1	Method 2	Method 3	Method 4	Method 5
Down Link	CS/CB	CS/CB	CS/CB, Non-coherent JT	CS/CB, JT	CS/CB, JT
Up Link	CS/CB	CS/CB	CS/CB, Soft Information JR	CS/CB, JR	CS/CB, JR

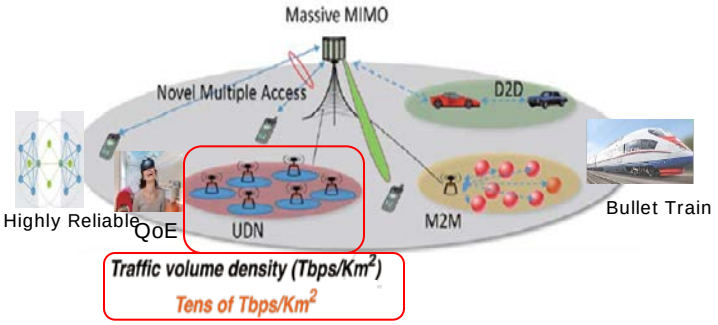
5G Transport and RAN KPI Tradeoff

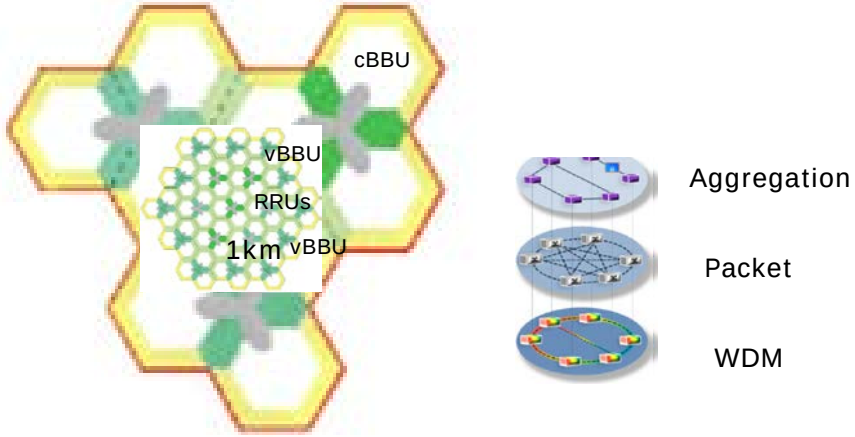
Dimensioning

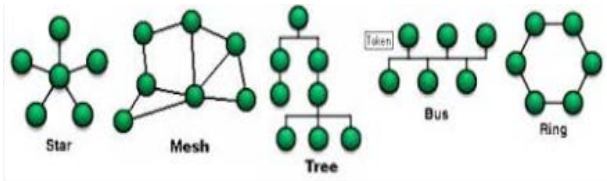
TBD

5G Transport Network - UDN

- Fiber Rich within 1 km²
- vBBUs locally to cap FH capacity locally
- Easier to meet 5G RAN KPIs
- Packet DAS option
- Less Constraint on Transport Network Topology
- Transport Layers depending on Traffic Load

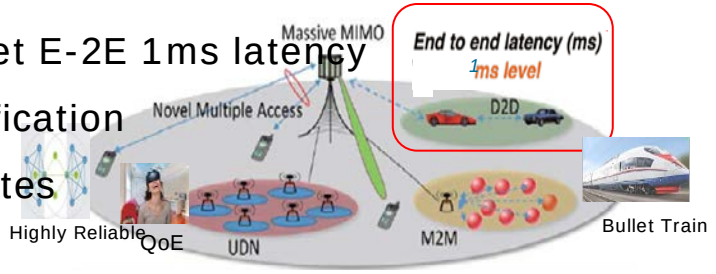


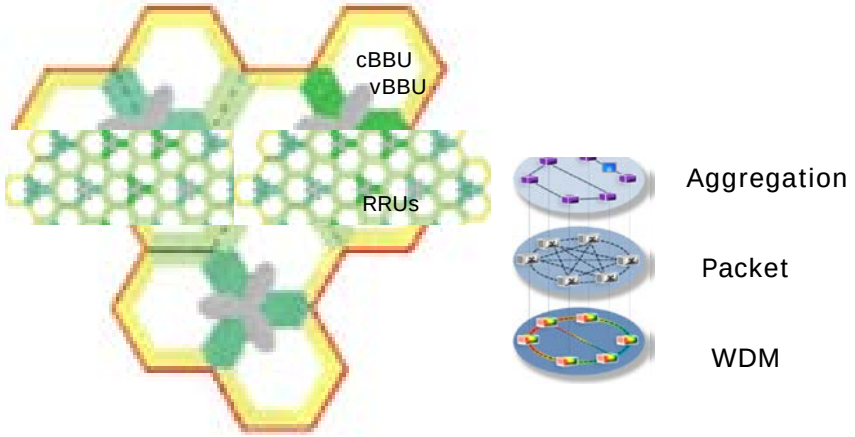


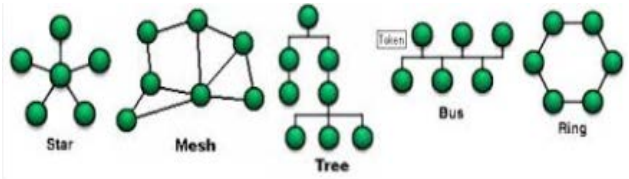


5G Transport Network – Low Latency

- vBBU at C-BBU site (FH Fiber 100us latency) meet E-2E 1ms latency
- Overlay over C-RAN topology with 5G RRU densification
- Transport Network Topology limited by Fiber Routes
- Transport Layers depending on Traffic Load

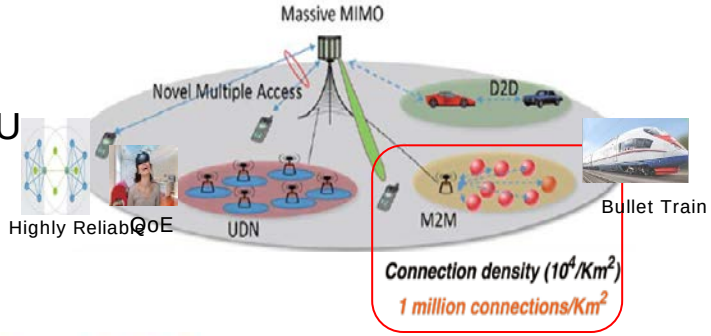


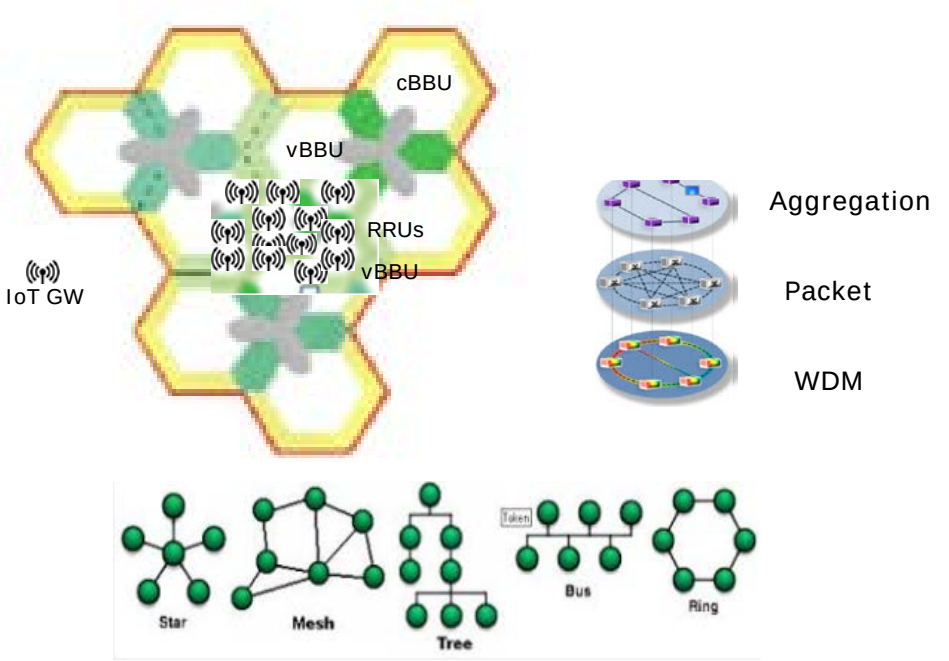




5G Transport Network – Dense M2M Network

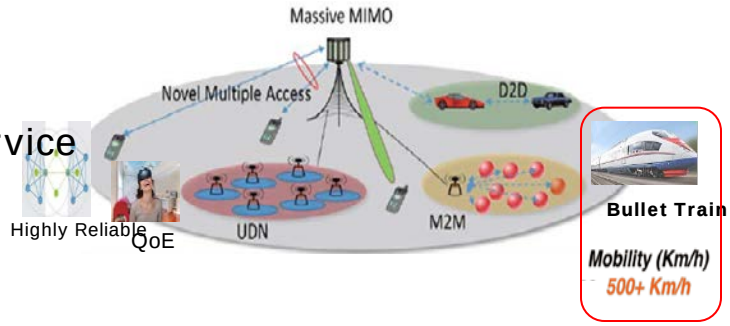
- vBBU may be locally due to dense devices & smaller cells
- IoT Gateways needed to aggregate dense IoT devices to RRU
- Transport Network Topology may be limited by Fiber Routes
- Transport Layers depending on Traffic Load

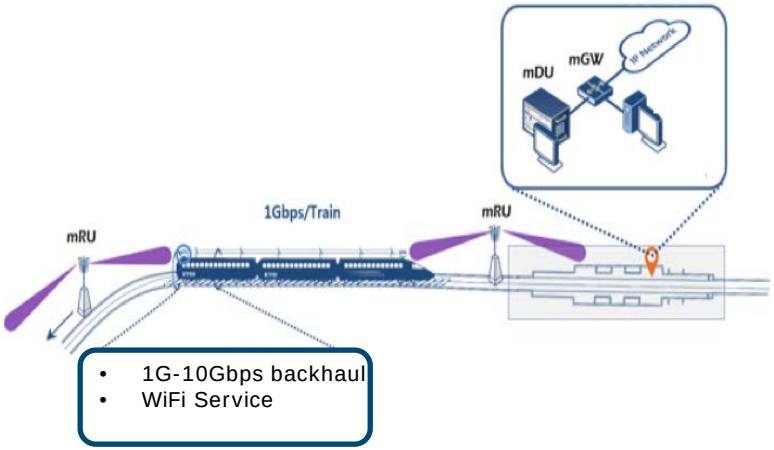




5G Transport Network – 500+km/hour

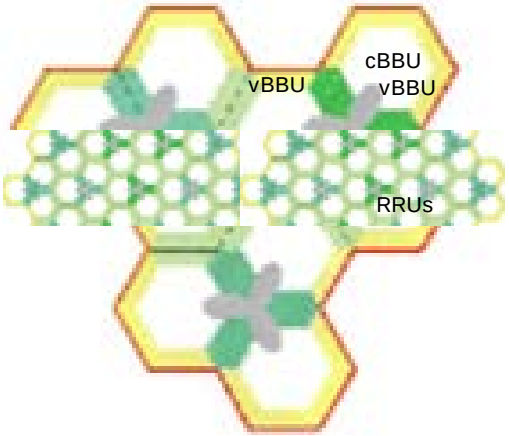
- 5G network as WiFi backhaul
- mmWave frequency
- Backhaul for high speed train and Broadband service
- 1G to 10Gbps Backhaul speed

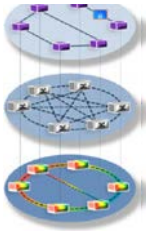




5G Transport Network – Highly Reliable

- Redundant vBBUs are the Norm
- Ring or Redundant Paths at the core Fronthaul network
- RRU-vBBU Switching
- Dual Node Interworking across two Rings at the optical layer
- Multi-Chassis LAG across two Rings at the packet layer
- Sub-50ms protection at the Optical Layer
- Sub-50ms protection at the Packet Layer

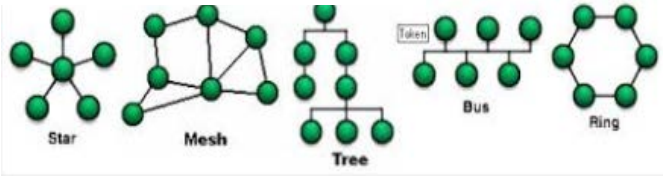




Aggregation

Packet

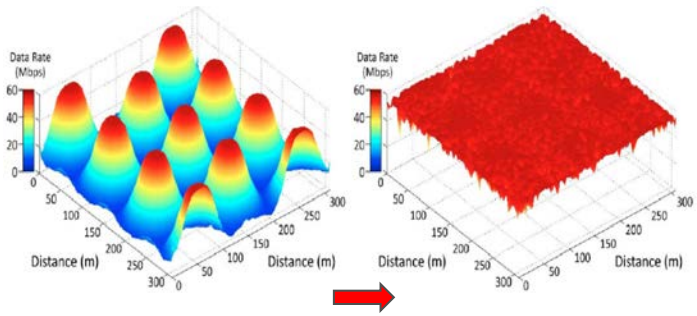
WDM

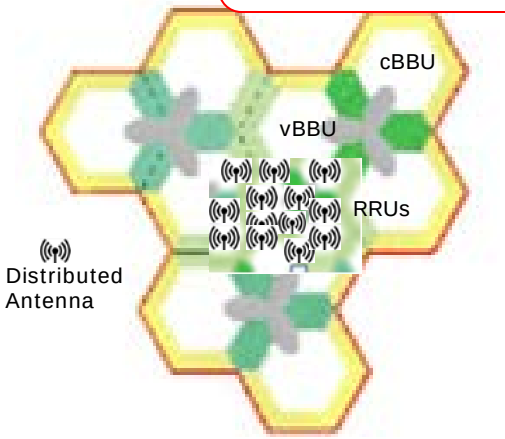


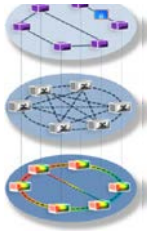
5G Transport Network – QoE

- Massive Network MIMO raises the throughput effectively
- Massive MIMO on the RRU can be distributed to achieve it
- Similar to Outdoor Packet DAS Model
- Digital RF over Ethernet from Distributed Antenna to RRU

User experienced data rate (Gbps)
0.1 to 1 Gbps
Peak data rate (Gbps)
Tens of Gbps



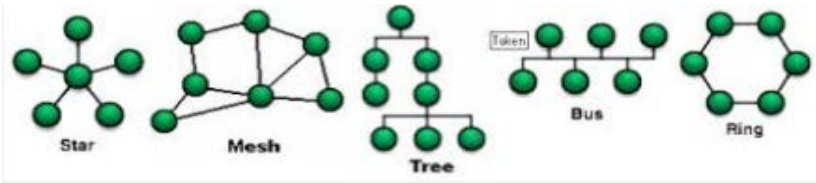




Aggregatio

Packet

WDM



5G Transport Network – Network Slicing

- Radio Frames ID visibility under SON Server Guidance
- Slices are assigned to V-LANs and Groups
- Each Slice can traverse different FH path
- Each Slice can traverse different BH path
- Protection Switching based on Each Slice

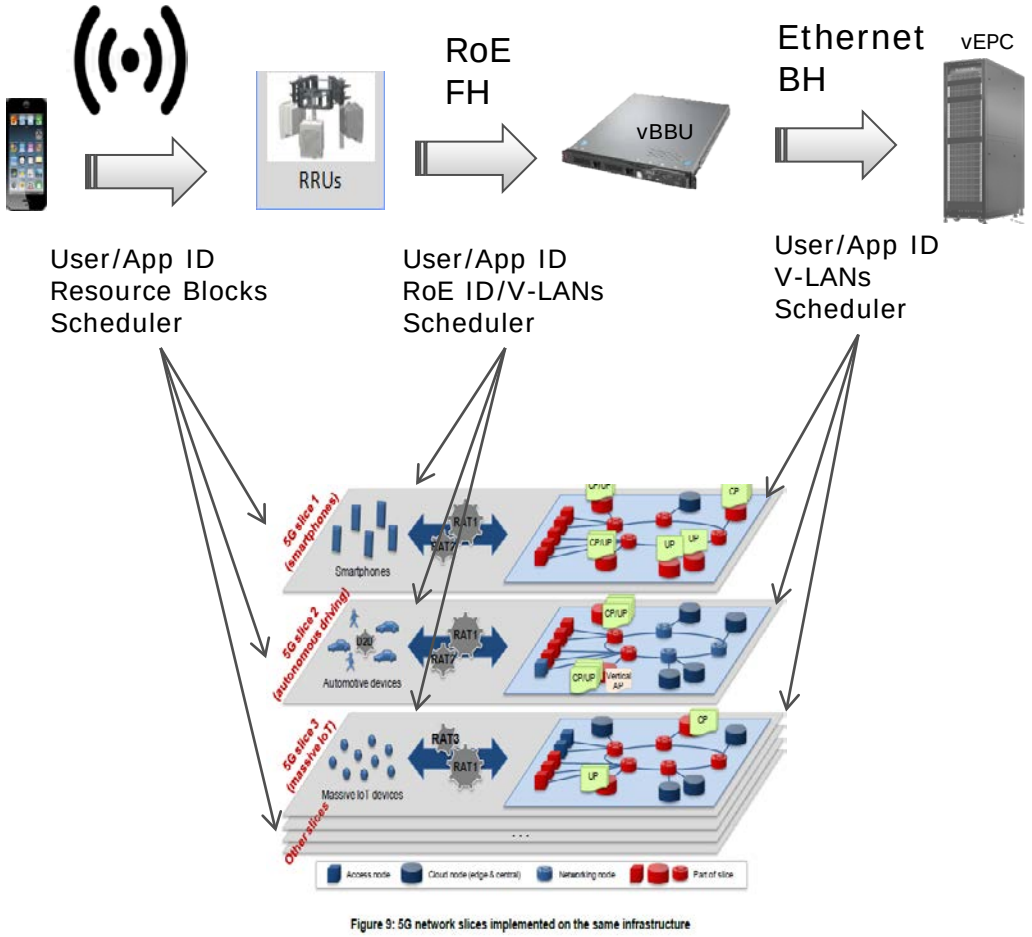
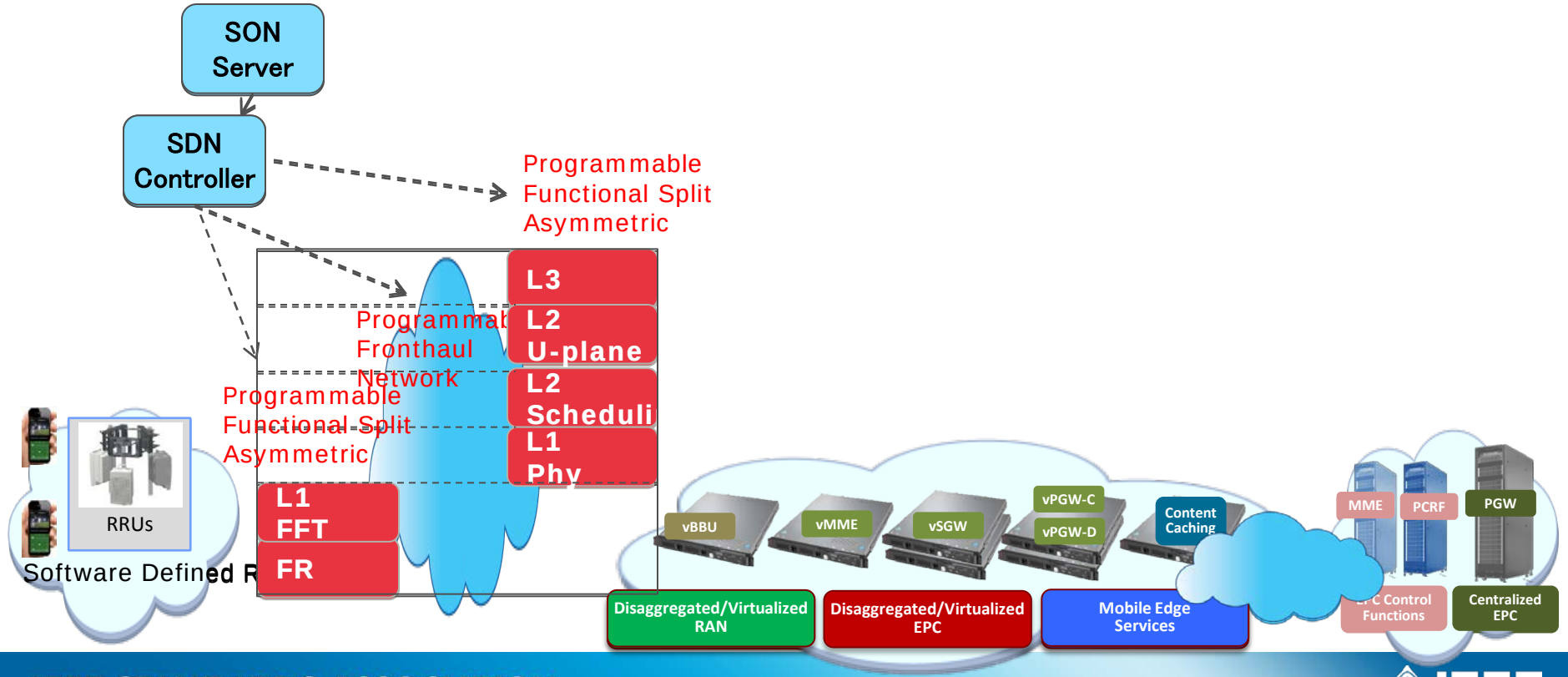


Figure 9: 5G network slices implemented on the same infrastructure

V-RAN

- New Gen. RRU and BBU will support L1 to L3 functional split options symmetrically & asymmetrical upon demand
- RRU may home to different vBBU and some RRU may be shutdown during off hour especially indoor
- Fronthaul Network will adapt to topology change and bandwidth demand dynamically upon SDN control



Radio over Ethernet

- From TDM to Statistical Multiplexing
- Agnostic to Air I/F Technology
- Low Delay & Jitter
- Higher Time Sync Accuracy
  (1588v2 ns time accuracy)

IEEE 8021.CM Profiles based on the following standards

- 802.1ASbt Precise Timing Protocol Gen 2 (gPTP Gen 2)
- 802.1Qbu Preemption (collaborating w/ 802.3br Interspersing Express Traffic)
- 802.1Qbv Time Aware Shaper (TAS) – Scheduled Traffic
- 802.1Qca Shortest Path Control & Reservations
- 802.1CB Frame Replication & Elimination
- 802.1Qcc Stream Reservation Protocol Gen 1.1