Holistic View of NG Fronthaul Network Requirements and Architecture

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NG Fronthaul Network and Fog RAN			
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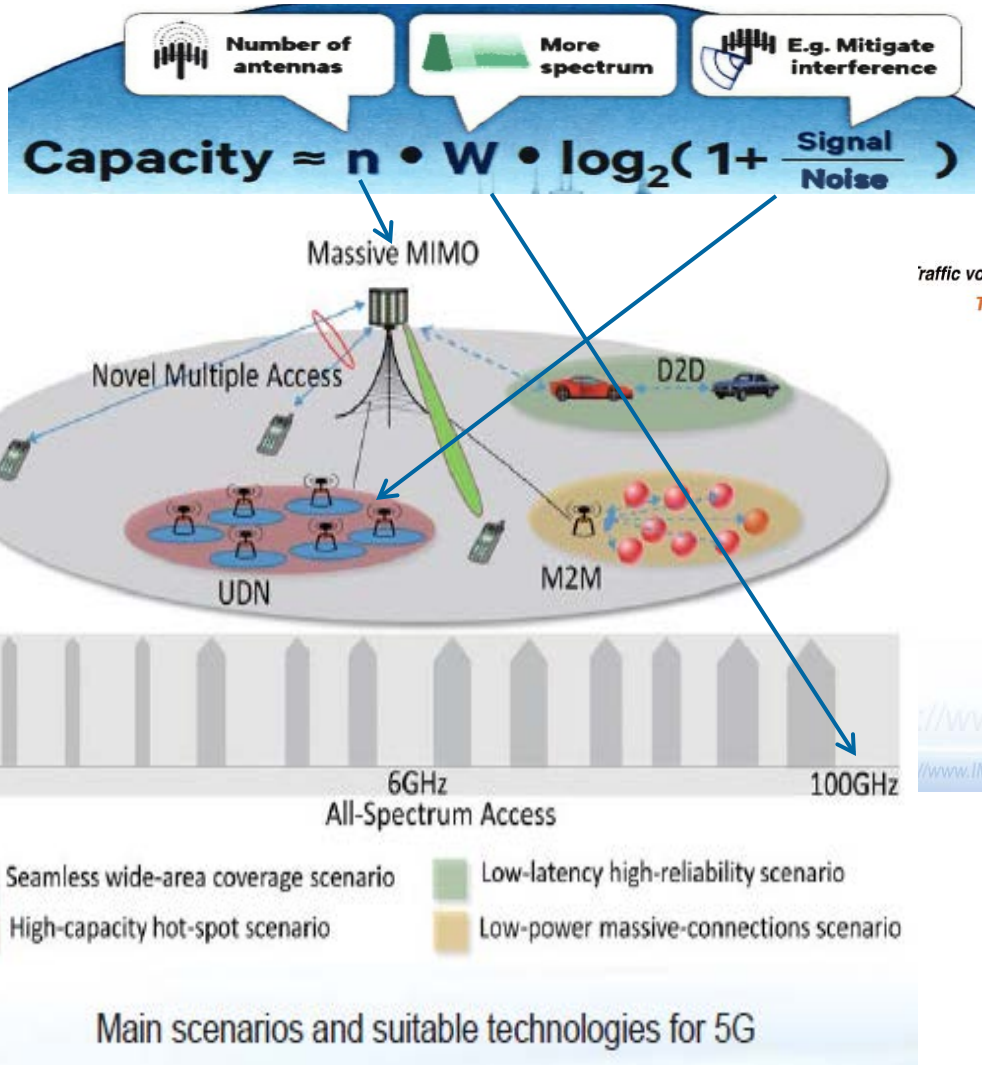
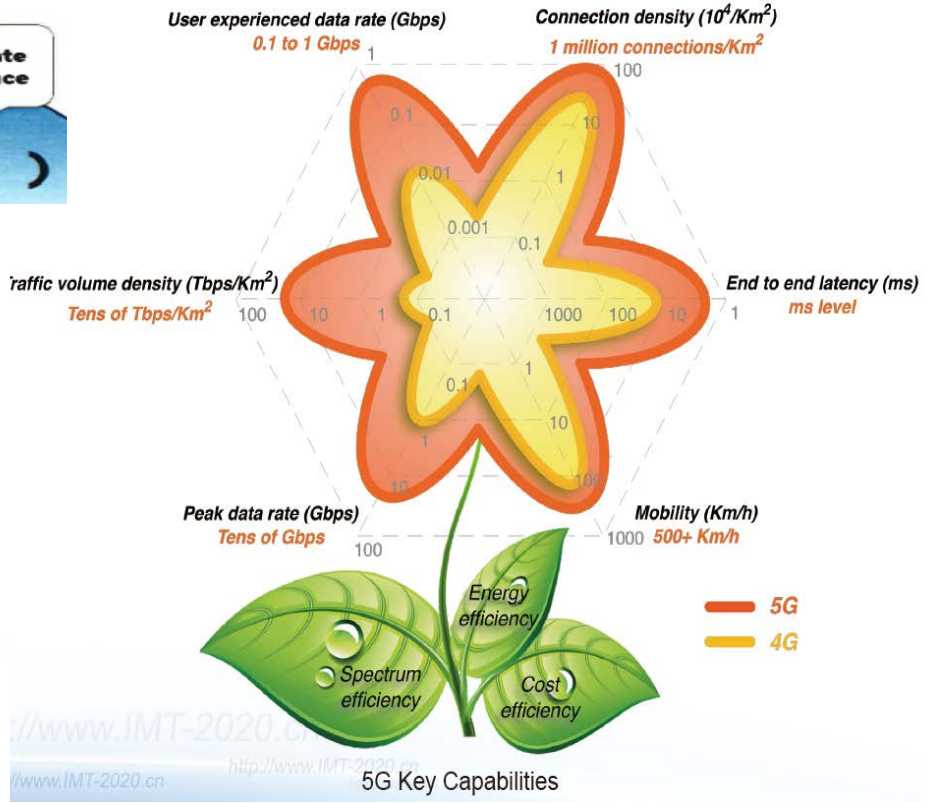
Agenda

- 5G Network Requirements and Challenges
- A holistic view of Each Challenge and Solutions
- 5G Network Challenges and Solutions

5G Network Requirements



Main scenarios and suitable technologies for 5G



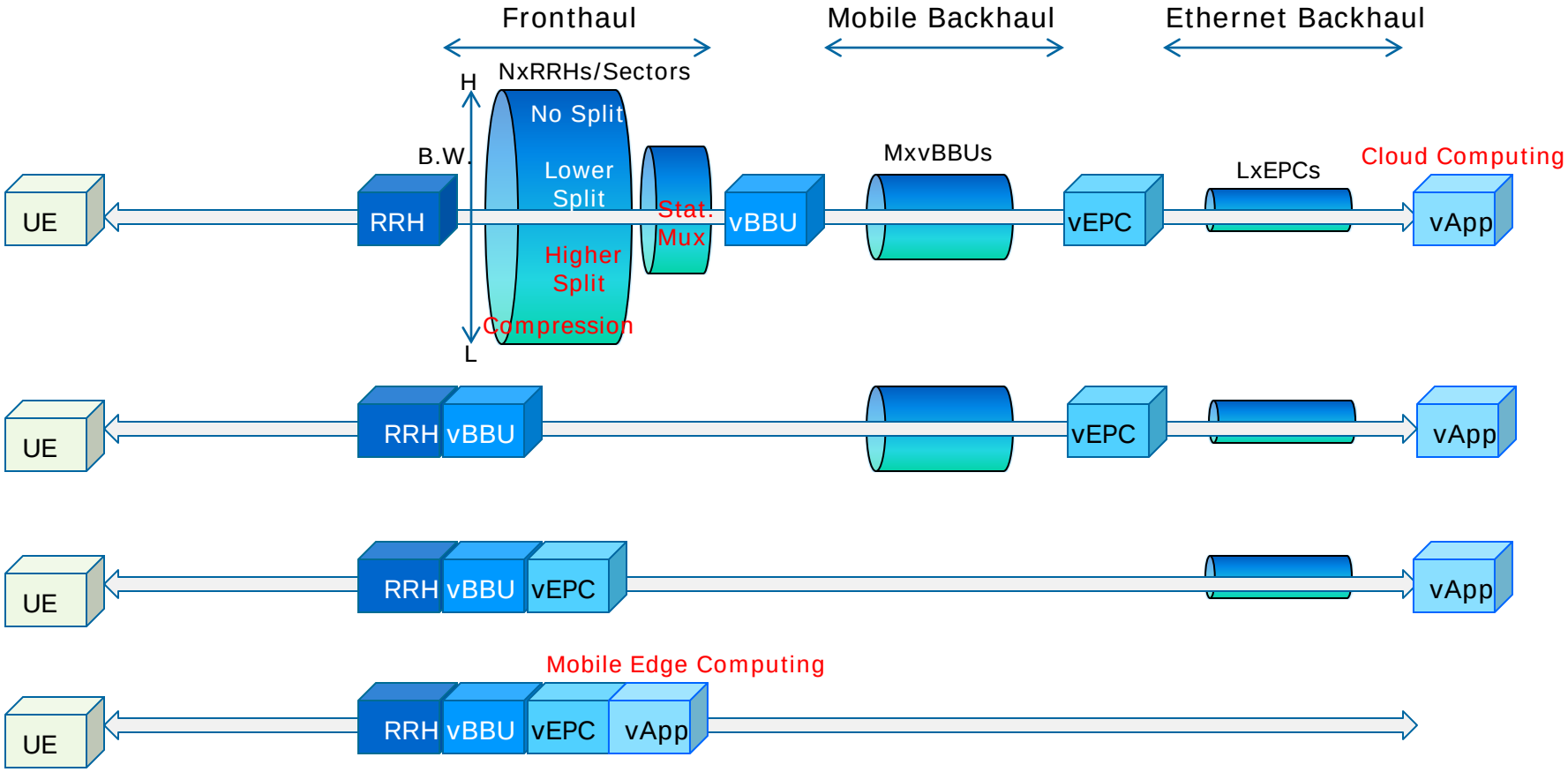
5G Key Capabilities

IMT 2020 5G Vision and Requirements
White Paper May 2014

5G Network Challenges

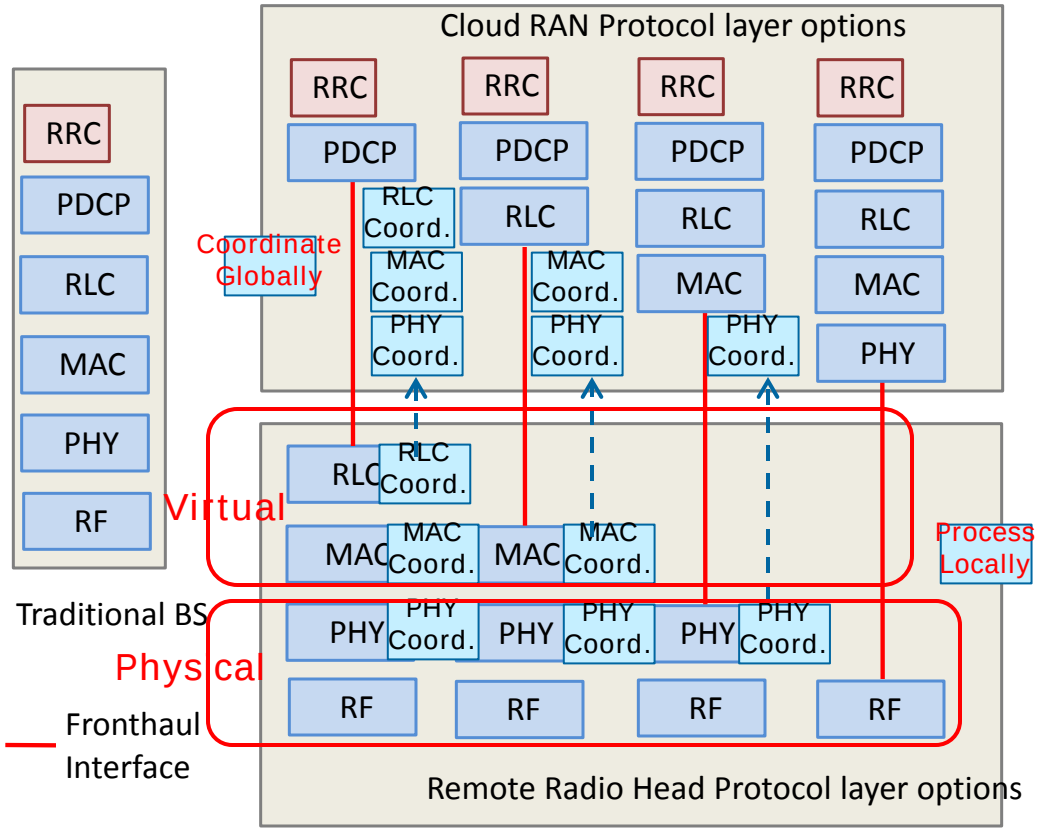
- 80x Fronthaul B.W. – 8xMIMO/20MHz -> 128xMIMO/100MHz
- Stringent E-2-E Delay 1ms – Vehicle and Tactile Internet
- Stringent RAN Delay – Interference Coordination in much denser network (<= 4ms)
- Mass Connection – 1M/km², Smart Digital World & IoT Network Underlay
- Tremendous Traffic Volume Density – Tens of TB/km²
- Ultra-Reliable Network
- Stringent 5G KPIs - 1 or 2 order of magnitude over 4G, often opposite end of each other

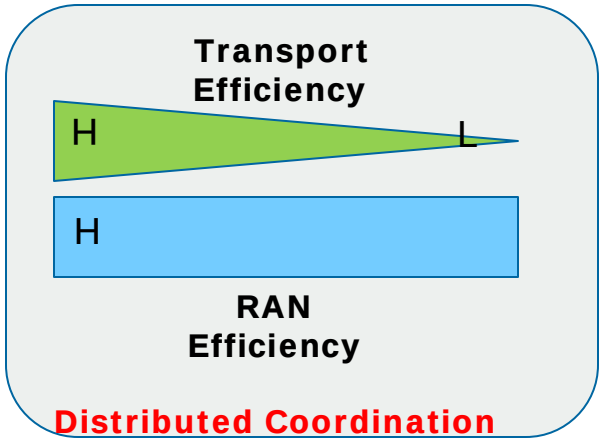
xHaul Bandwidth Profiles & Solutions

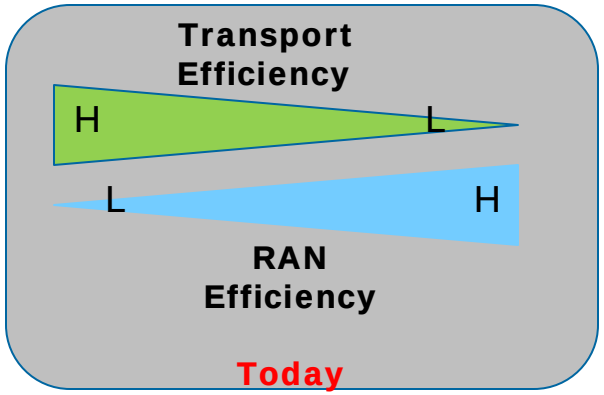


- FH the Higher the Split the Better, Compression & Stat. Muxing reduce it further
- BH B.W. lower than FH, the Earlier the Better
- Mobile Edge Computing reduce it to a minimum

Interference Coordination Profiles & Solutions

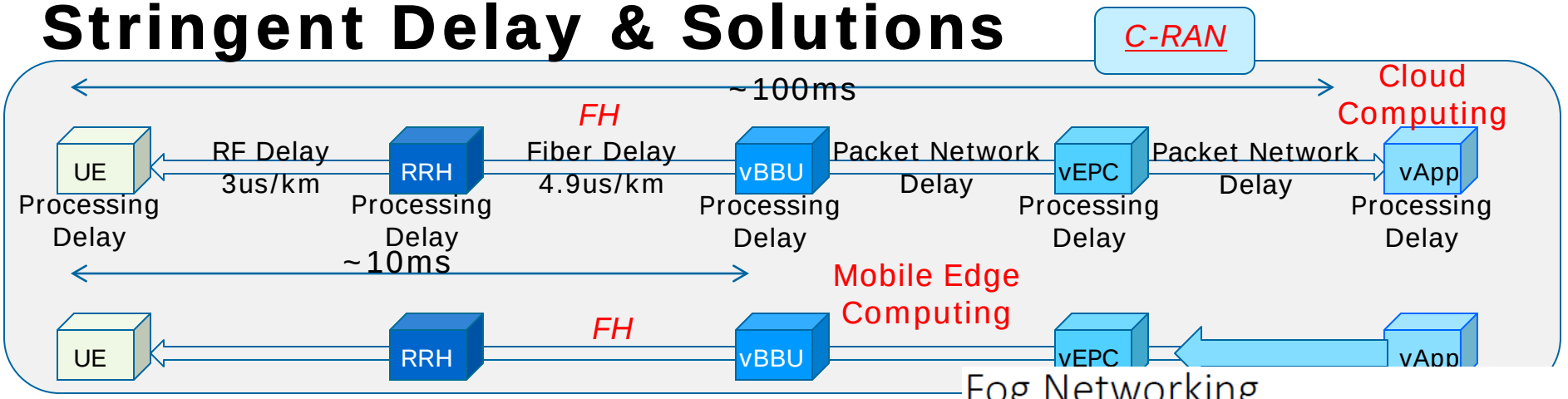


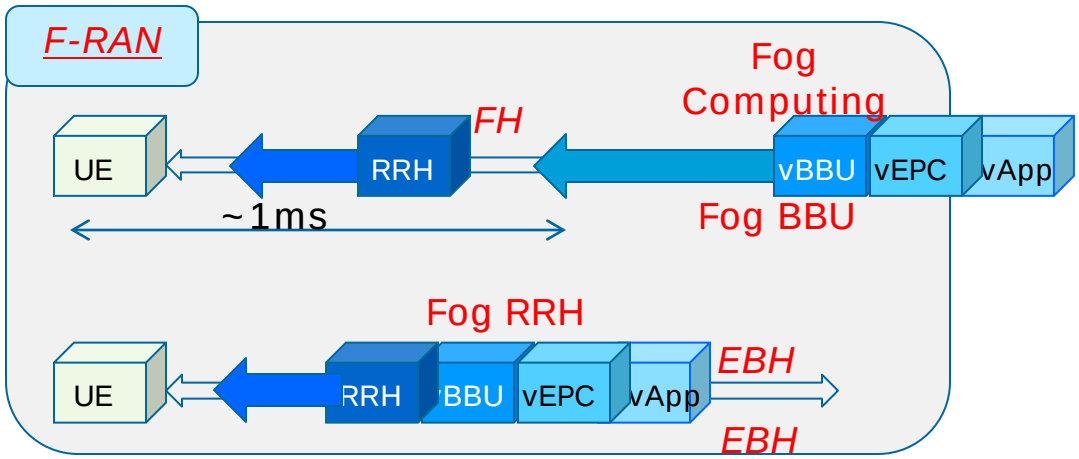




- The Less Layers at the BBU, The Worse The Coordination, The Better The FH Load
- Process coordination locally(<4ms) & Global one at BBU – achieve the Best for Both
- RAN Disaggregation – Keep RRH simple at Lower Layer & Virtualize Higher Layers

Stringent Delay & Solutions





Fog Networking

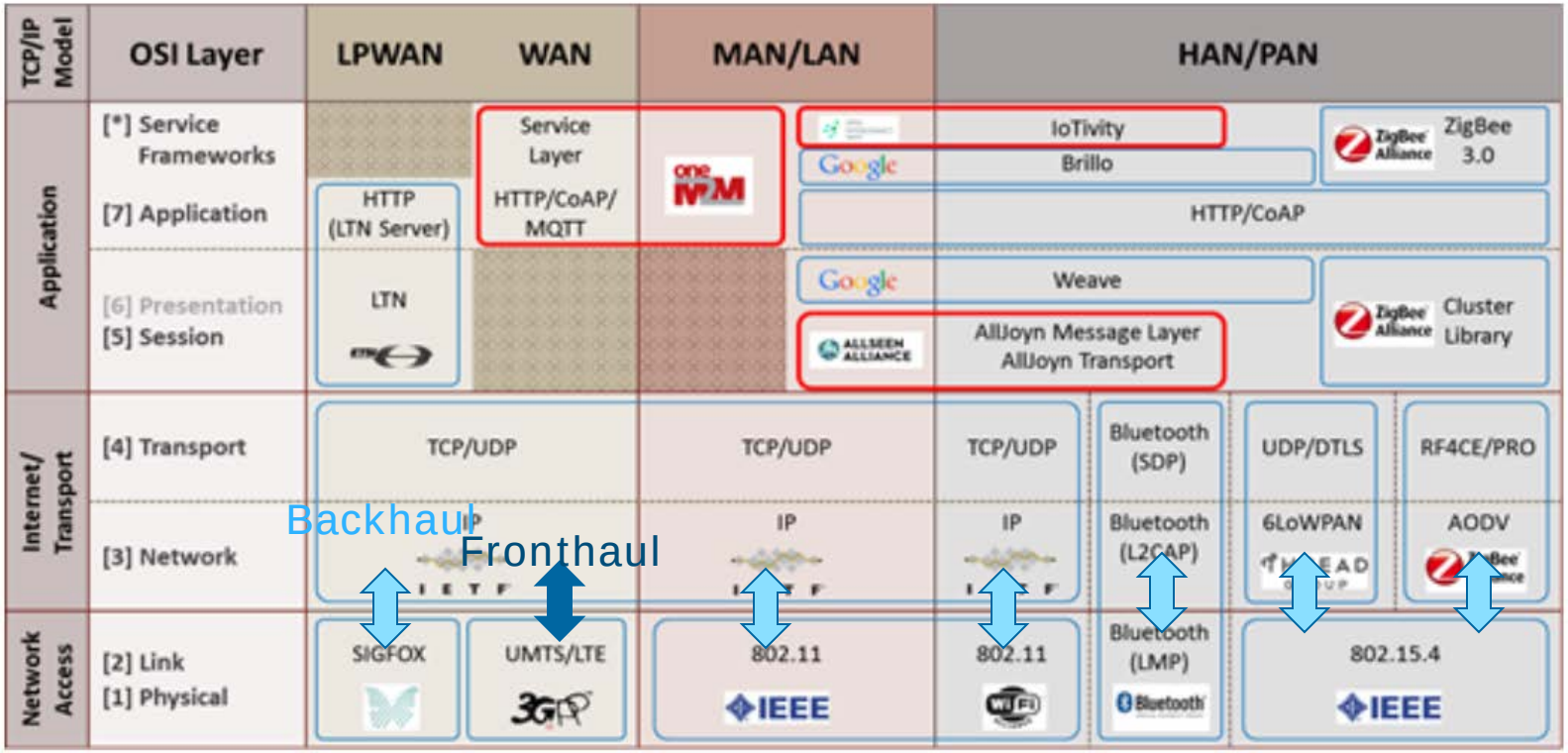
" A network architecture that uses one or a collaborative multitude of **end-user clients** or **near-user edge devices** to carry out a substantial amount of storage (rather than stored primarily in cloud data centers), communication (rather than routed over backbone networks), and control, configuration, measurement, and management (rather than controlled primarily by network gateways such as those in LTE core) "

Mung Chiang, Princeton University

Total Delay = RF Delay + Fiber Delays + Processing Delays + Packet Network Delays

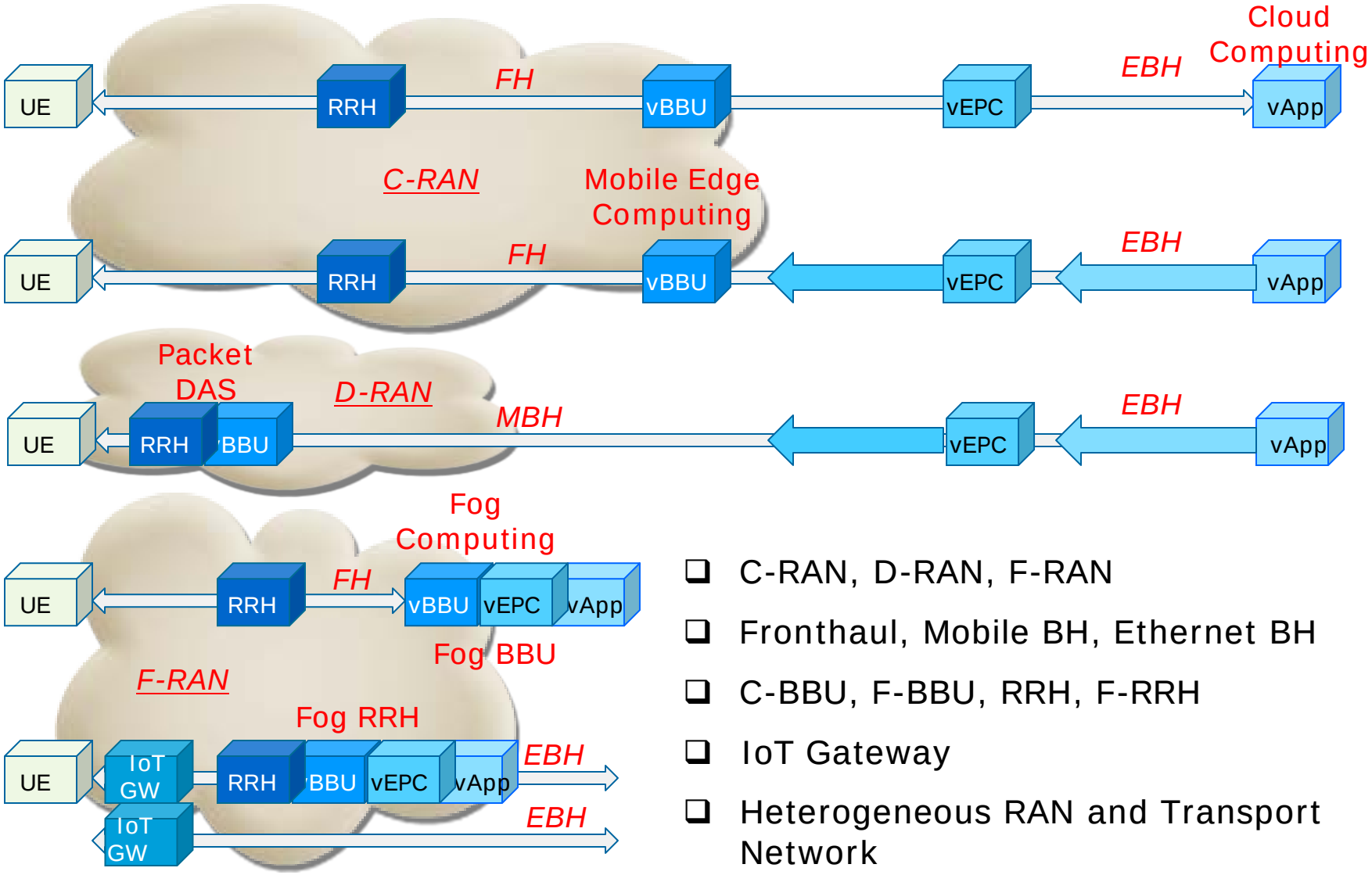
- ❑ Eliminate or Minimize Packet Network Delay – Node Collapsing or Time Sensitive Ethernet
- ❑ Eliminate or Minimize Fiber Delay – Node Collapsing or Shorter Distance
- ❑ Minimize Processing Delay – High Power Processor
- ❑ Minimize RF Delay – Shorter Distance

IoT Network



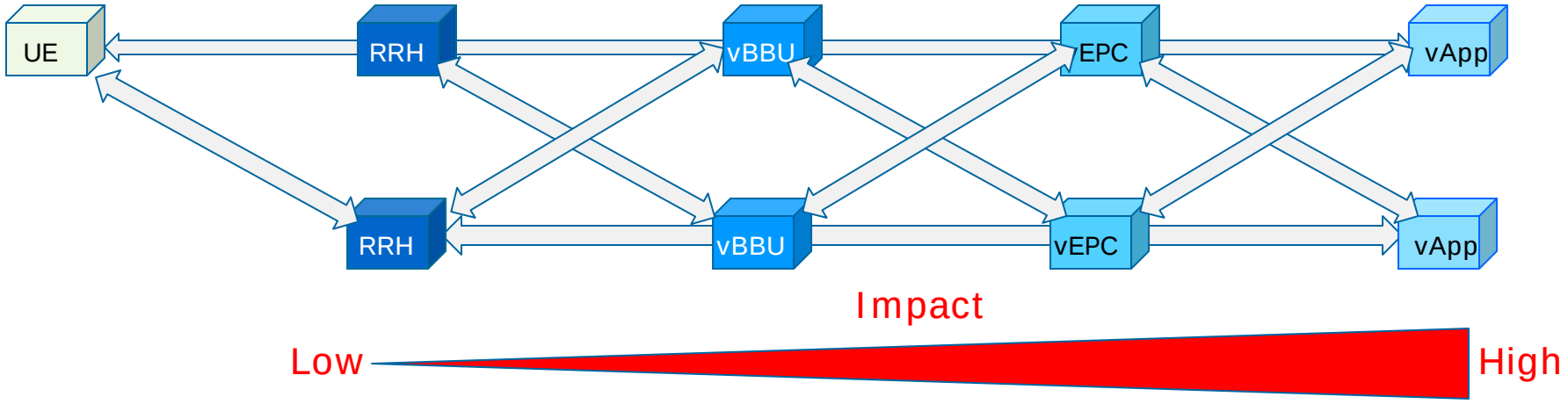
- IoT Networking either via 3GPP NB-IoT or standalone other means
- FH – 3GPP NB-IoT, BH – Other means
- IoT Gateway aggregates UE to minimize the mass connection to the FH/BH Network
- IoT Network Traffic – North-South and East-West

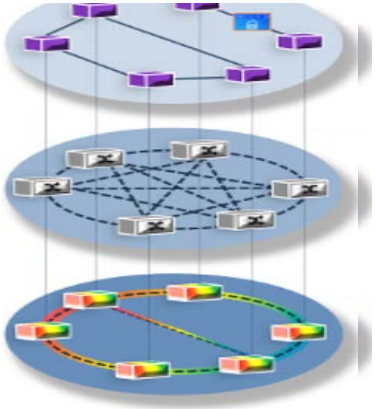
X-RAN & X-Haul Network



- C-RAN, D-RAN, F-RAN
- Fronthaul, Mobile BH, Ethernet BH
- C-BBU, F-BBU, RRH, F-RRH
- IoT Gateway
- Heterogeneous RAN and Transport Network

Ultra-Reliable Network





Aggregation

Packet

WDM

- Redundant Path at each Layer
- Ring and/or Path Protection Switching
- Network Rerouting
- Dual Homing
- Multi-Layer Protection and Restoration

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
- Each Slice based on a distinct set of KPIs
- Each Slice varies across RF/FH/BH w/ Mobile Edge & Fog Computing options

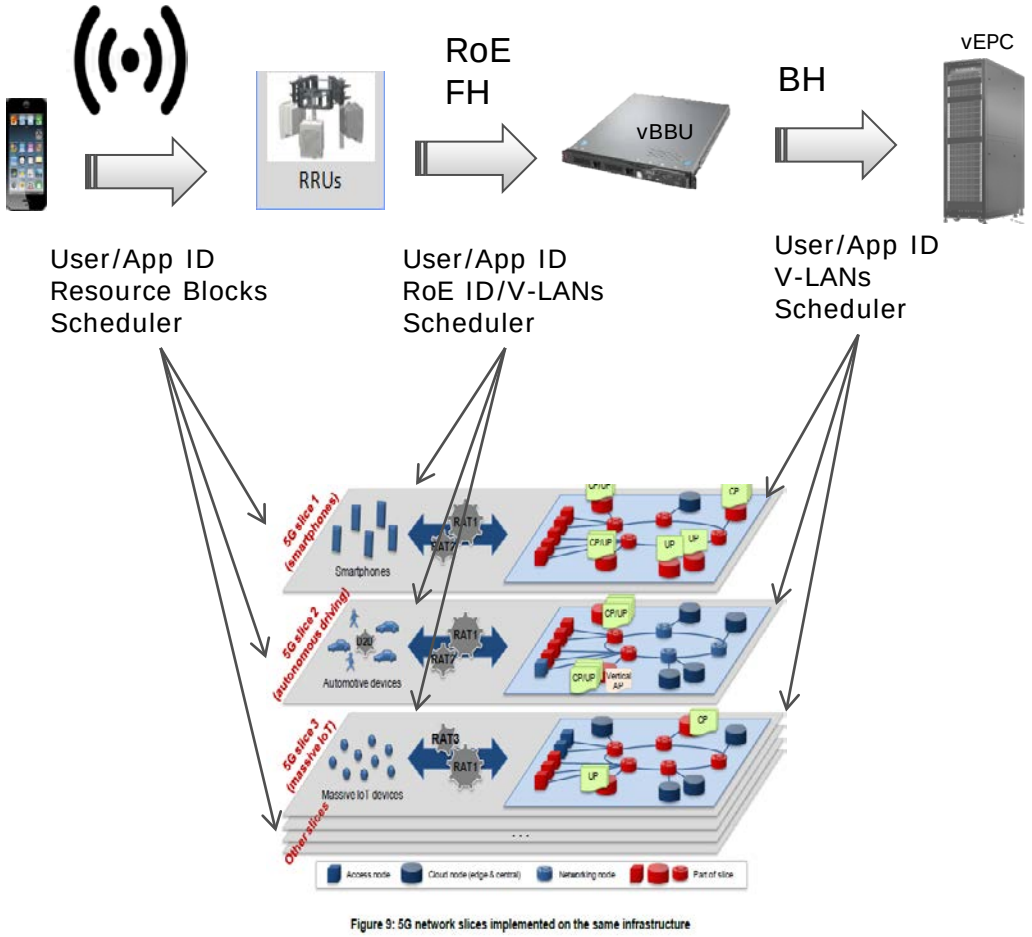


Figure 9: 5G network slices implemented on the same infrastructure

5G Network Challenges & Solutions

- 80x Fronthaul B.W. – 8xMIMO/20MHz -> 128xMIMO/100MHz
  - *Higher Functional Split/Compression/Stat. Muxing*
- Stringent E-2-E Delay 1ms – Vehicle and Tactile Internet
  - *Mobile Edge & Fog Computing*
- Stringent RAN Delay – Interference Coordination in much denser network (<= 4ms)
  - *Process coordination locally & coordinate globally at BBU while allowing higher functional split*
- Mass Connection – 1M/km², a Smart Digital World & IoT Network Underlay
  - *IoT Gateway and Network underlay*
- Tremendous Traffic Volume Density – Tens of TB/km²
  - *Mobile Edge & Fog Computing*
- Ultra-Reliable Network
  - *Redundancy at every layer and Junction*
- Stringent 5G KPIs- 1/2 order of magnitude over 4G, often opposite end of each other
  - *Network Slicing based on KPIs*
- *A New Paradigm – X-RAN and X-Haul Heterogeneous Network*