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NG Fronthaul Control plane Requirements and Architectures

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Next Generation Fronthaul Interface
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NGFI Network Requirements and Architecture			
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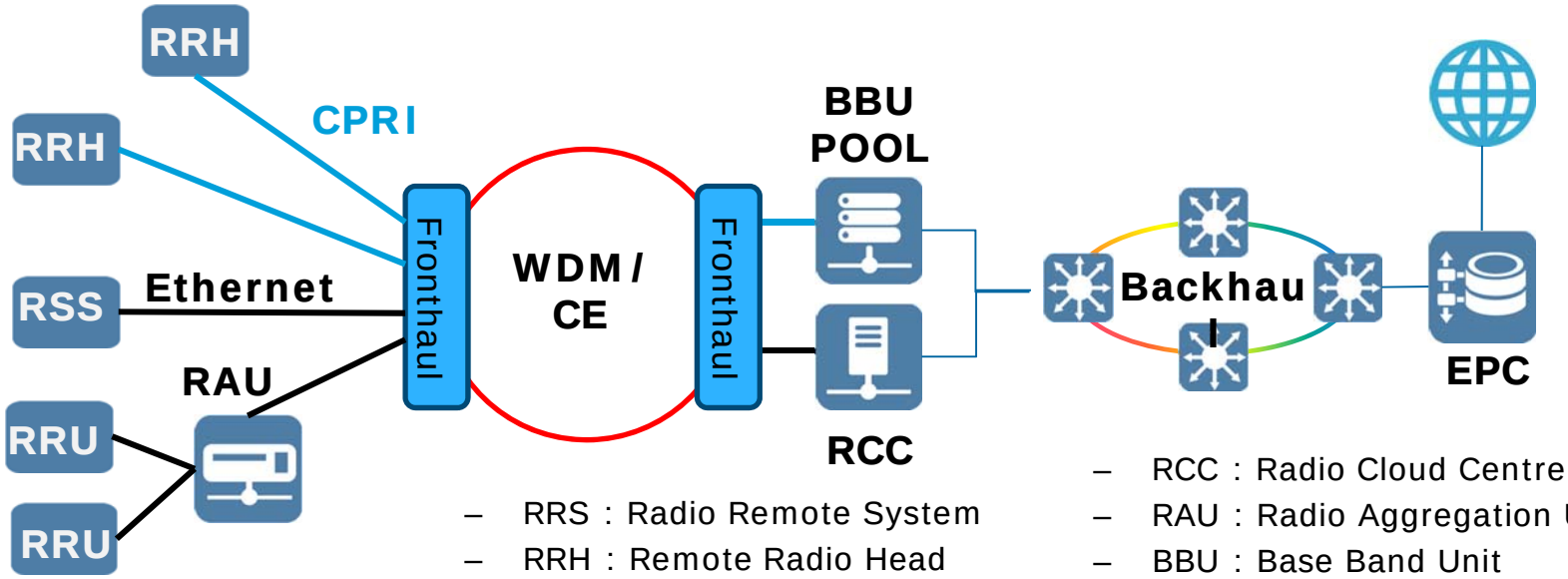
Agenda

- 5G RAN Architecture and Requirements
- Issues on Control Plane Requirements for NG Fronthaul
- Static vs. Dynamic
- In-band vs. Out-of-band
- Use cases: MPLS-TP vs. Software-defined Networking (Distributed Architecture and Centralized)

5G RAN Network Architecture :



- RRS : Radio Remote System
- RRH : Remote Radio Head
- RRU : Remote Radio Units
- RCC : Radio Cloud Centre
- RAU : Radio Aggregation Unit
- BBU : Base Band Unit
- DU : Digital Unit

5G RAN provides ~1-10 Gbps connections to mobile devices in the field

- Low-cost access technologies for higher data rates (e.g., Small cell, Multi-Radio access)

5G RAN provides various wireless access connectivity to mobile devices

- A collection of independent BSs (e.g., BBU pools for Various interface standards: 2/3/4/5G, WiFi, Wibro, WPAN,...)

NG Fronthaul Key Requirements

ref: 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)

New radio access technologies in NG Fronthaul

5G can be realized using a combination of

Converged access control

- Combination of various access technologies (e.g., Small cell, Multi-Radio access, massive MIMO) for high spectral efficiency
- Low-cost technologies for higher data rates (e.g., multiple wavelengths, Ethernet)

Flexible & reconfigurable network resources (

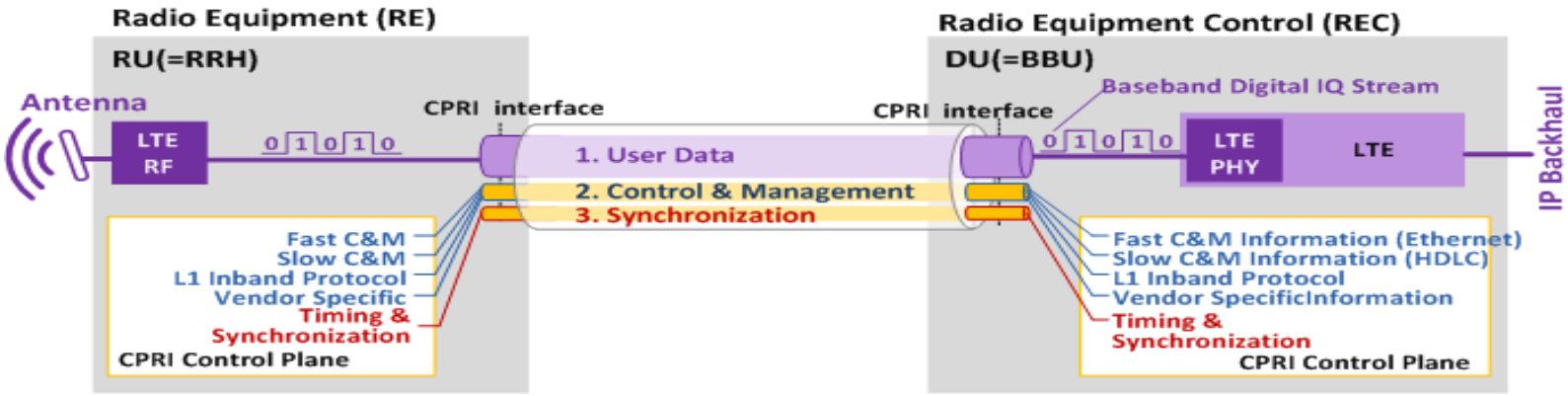
- Coordination for Radio Resource Allocation in the access network (e.g., time-variant statistical multiplexing, network on-demand)
- Dynamic configuration for spectrum and infrastructure sharing (i.e., coordinated multipoint and massive MIMO, heterogeneous radio networks)

Open architecture (suitable for multiple operators)

- Edge Computing and Cloud Access Network
- network virtualization (VLAN) enables infrastructure sharing
- Generic operation and maintenance (i.e., a control/data separation architecture **, Open Access, Cloud, SDN, Virtualization)**

1. Issues: How to transport both the Control Plane and the User Plane between RRH and BBU?

- User Plane: D-RAN to C-RAN to Virtual RAN
  - Encapsulation/Mapping
  - Function split
  - Network slicing

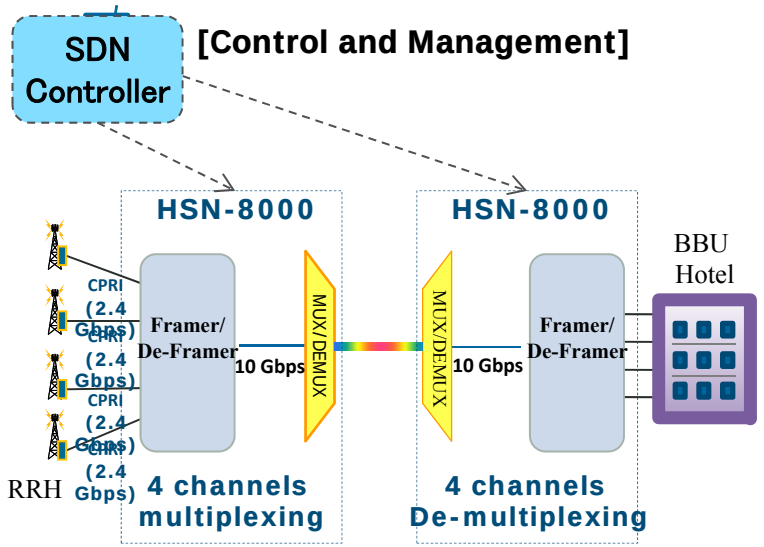


2. Issues: How to transport both the Control Plane and the User Plane between RRH and BBU?

- **Control Plane**: Need a Control and Management Frameworks
  1. Dynamic Topology discovery/Configuration/Provisioning (on-demand transport)
  2. OAM (i.e., connectivity (QoS) monitoring, Failure protection, TE requirement, Reliability, Synchronization, and manageability)
  3. Virtualization (i.e., flexible bandwidth assignment, Edge computing, Cloud computing, load balancing,)
  4. Coordination for Radio resource allocation (Cooperative interference management, Self-configuration, Self-optimization)

2.1 5G RAN Network – Dynamic bandwidth allocation / Configuration / Provisioning

- Decoupled control plane
  - time-variant statistical multiplexing
  - Rapid and dynamic provisioning
  - Optimizing resource utilization
  - Rapid scale-out of service capacity
  - Automation of network configuration



- **Dynamic wavelength / VLAN assignment**
- **performance of configuration**
- **Color conversing for CWDM and DWDM**

Source : www.hfrnet.com, www.netmanias.com

2.2.1 5G RAN Network – OAM

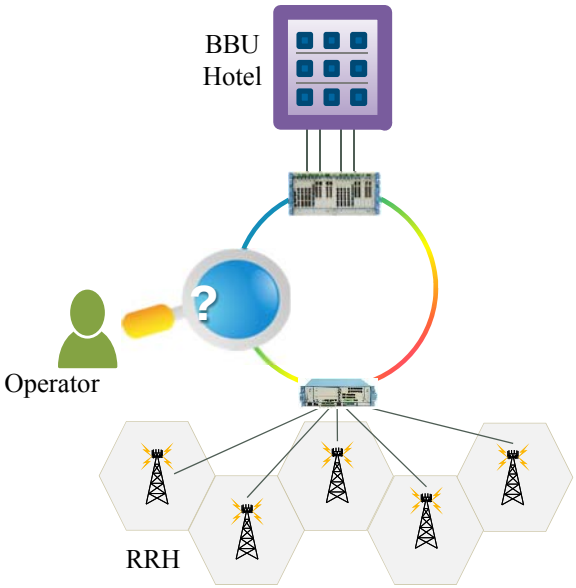
- Functions
  - Fault Detection (e.g., connectivity check)
  - Fault Localization (e.g., loopback, lock)
  - Performance monitoring (e.g., delay, loss)

- Tools (Existing Tool Extended)
  - Bidirectional forwarding detection (BFD))
  - LSP Ping/Trace
  - CCM

Source : www.hfrnet.com, www.netmanias.com

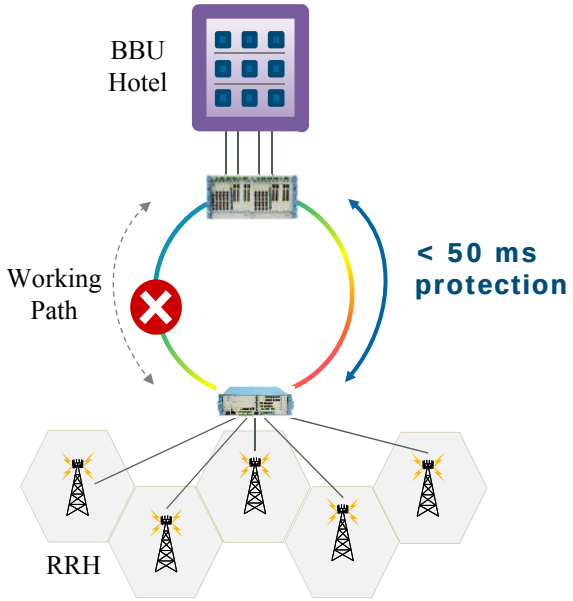
2.2.2 5G RAN Network – QOS monitoring and protection

[Quality Monitoring]



- Channel quality measurement (Code violation, LOF , etc)
- Fiber monitoring (LOS, AIS, Delay)
- Loop-back test to pinpointing problem
- Fiber distance checking

[Failure Protection]

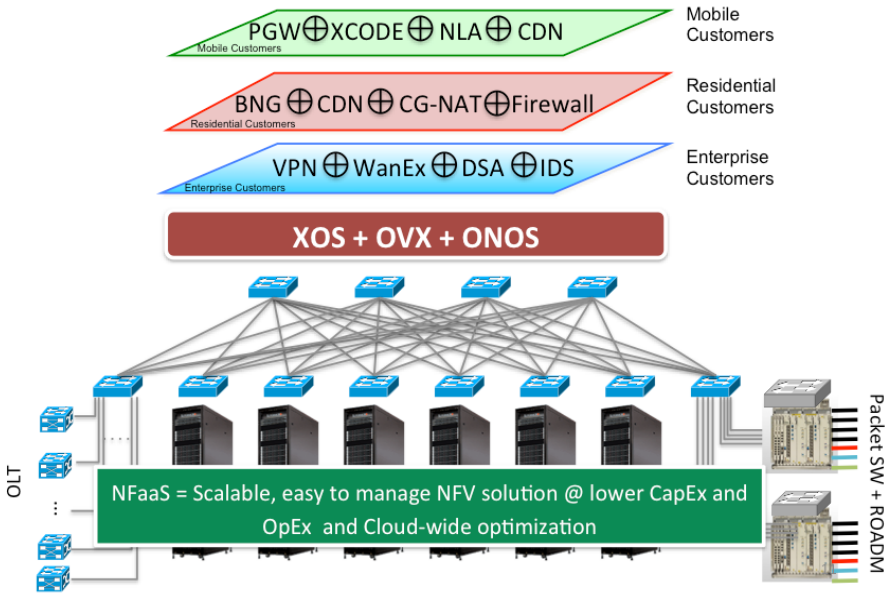


- Sub-50ms failure protection
- Automatic revertible and non-revertible protection switching
- Delay Equalization

Source : www.hfrnet.com, www.netmanias.com

2.3 5G RAN Network –virtualization

- Simplified architecture
  - Specialized middle boxes are replaced with common hardware i.e. uniform infrastructure
- Reduced CapEx
  - Specialized components are replaced by common hardware and open source software
- Decreased OpEx
  - Through automation
- Flexibility
  - Through infrastructure virtualization and the ability to manage functions (flexible bandwidth assignment) at the service level

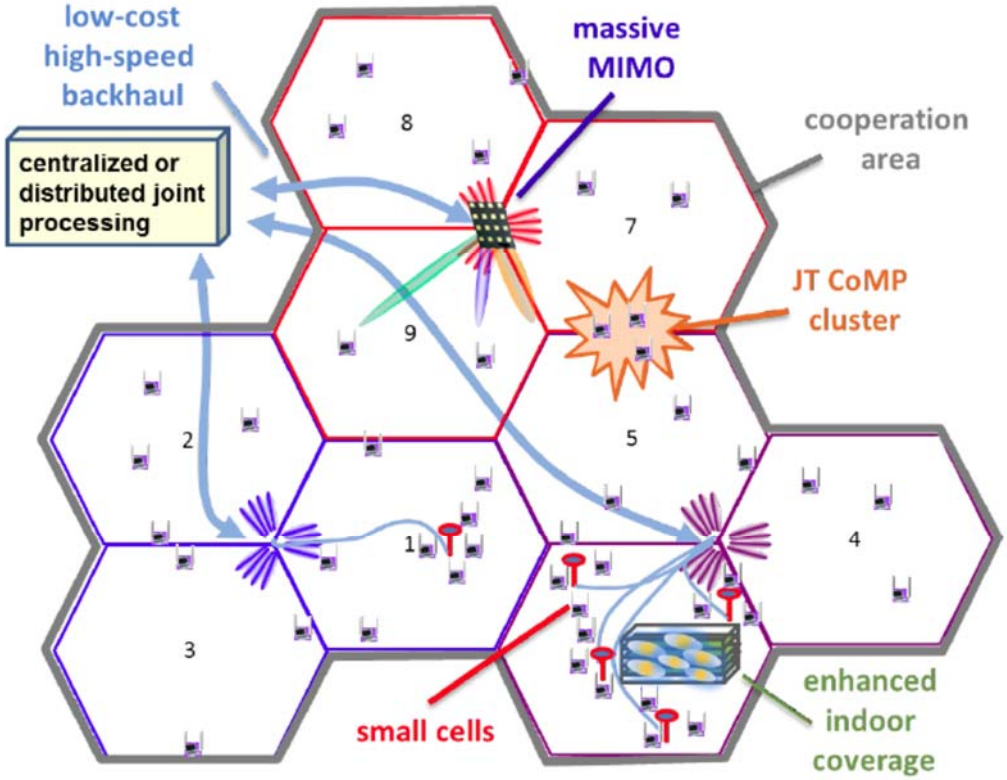


2.4 5G RAN Network – Coordination for Radio resource allocation

Combination of small cells/enhanced indoor WLAN, coordinated multipoint and massive MIMO is proposed for high spectral efficiency

Radio Coordination

- radio coordination capabilities
- antennas for multi-user MIMO and beamforming

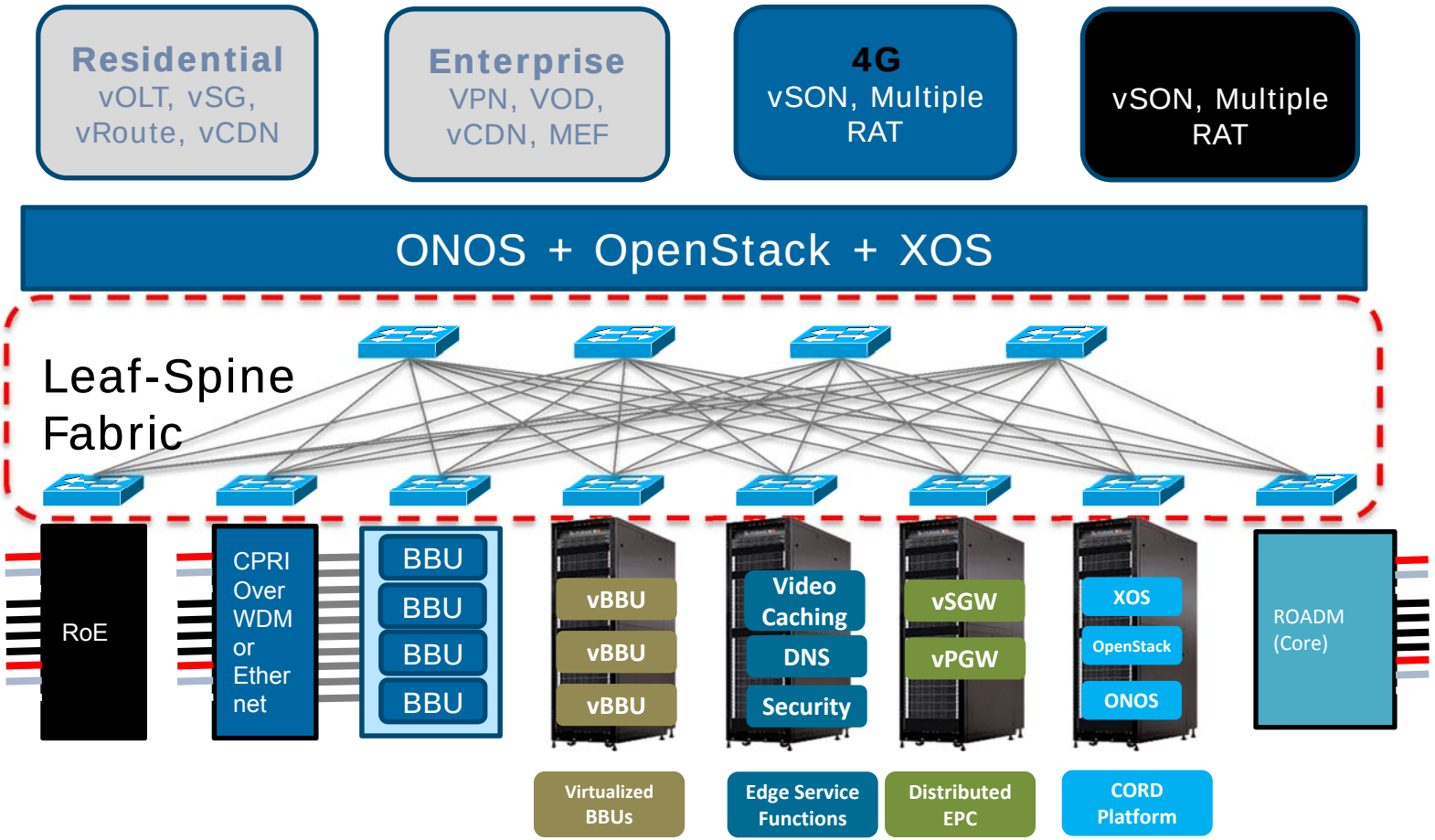


NG Fronthaul Key Technologies- Control and management framework

- **Topology and Resource Discovery**
  - Automatic discovery of Switches including RRH and BBU
- **Configuration / Provisioning / Virtualization**
  - Self-Organizing Network (SON) vs. Software-Defined Network (SDN)
- **OAM and Protection**
  - In-Band vs. Out-of-Band
- **Coordination for Radio resource allocation**
  - Centralize RAN Coordination Functions as much as possible

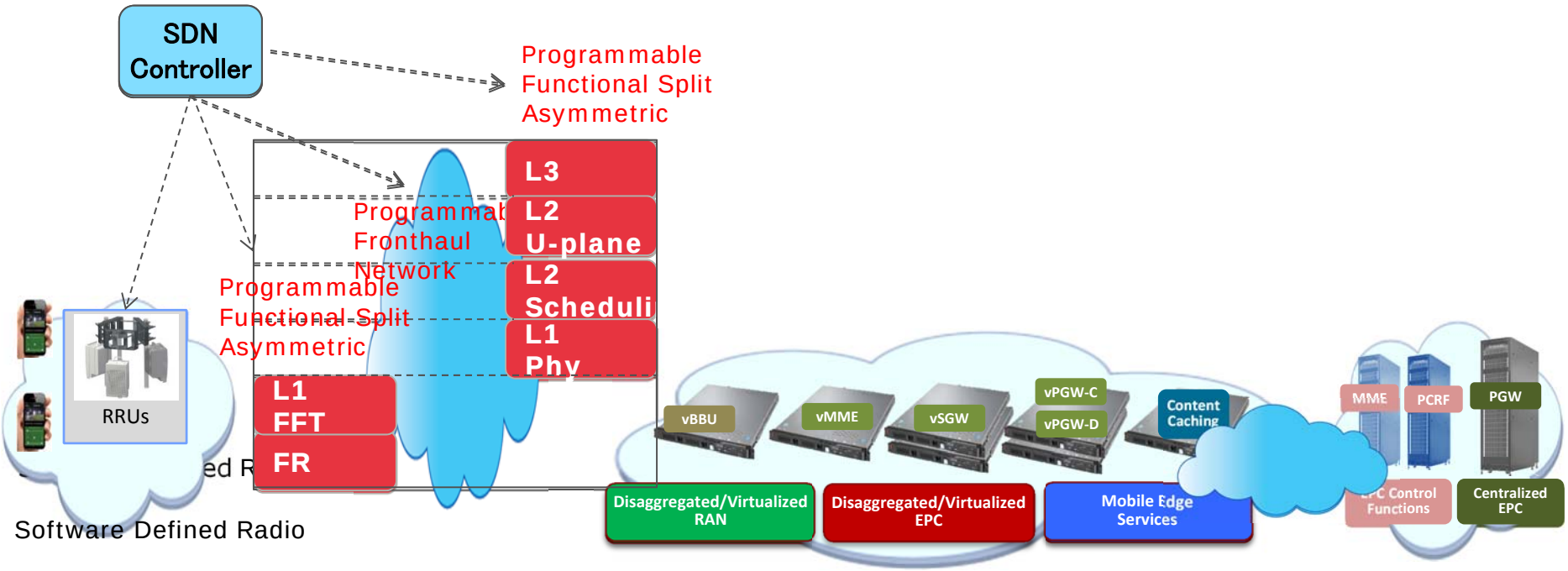
Use Cases: M-CORD

CORD(Central Office Re-architected as a Data Center) by ONOS



Use Cases: SDN overlay model

- New Gen. RRU and BBU will support L1 to L3 functional split options symmetrically & asymmetrical upon demand
- Fronthaul Network will adapt to topology change and bandwidth demand dynamically upon SDN control



Ref: Tony Tam – Fujitsu Network Communications

Thanks

Questions?