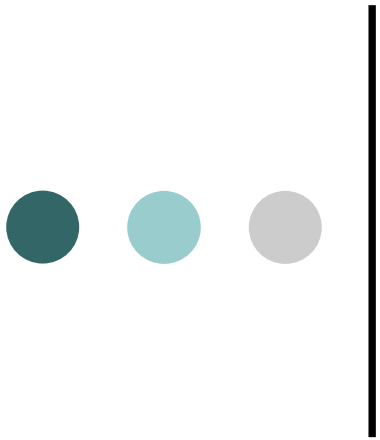

Lecture A

Source:

https://www.slideshare.net/kairosfox/cordcentral-office-rearchitected-as-a-datacenter

CORD
(Central Office Re-architected as a Datacenter)

Mobile Convergence LAB,

Department of Computer Engineering,

Kyung Hee University.

Sangyun Han

Five Requirements of CORD

- **Economies of Commodity Hardware**
- **Enable Innovative Services**
- **Extensible and Controllable**
- **Multi-Domain Security**
- **Operational Robustness**

CORD (Central Office Re-architecture as a DC)

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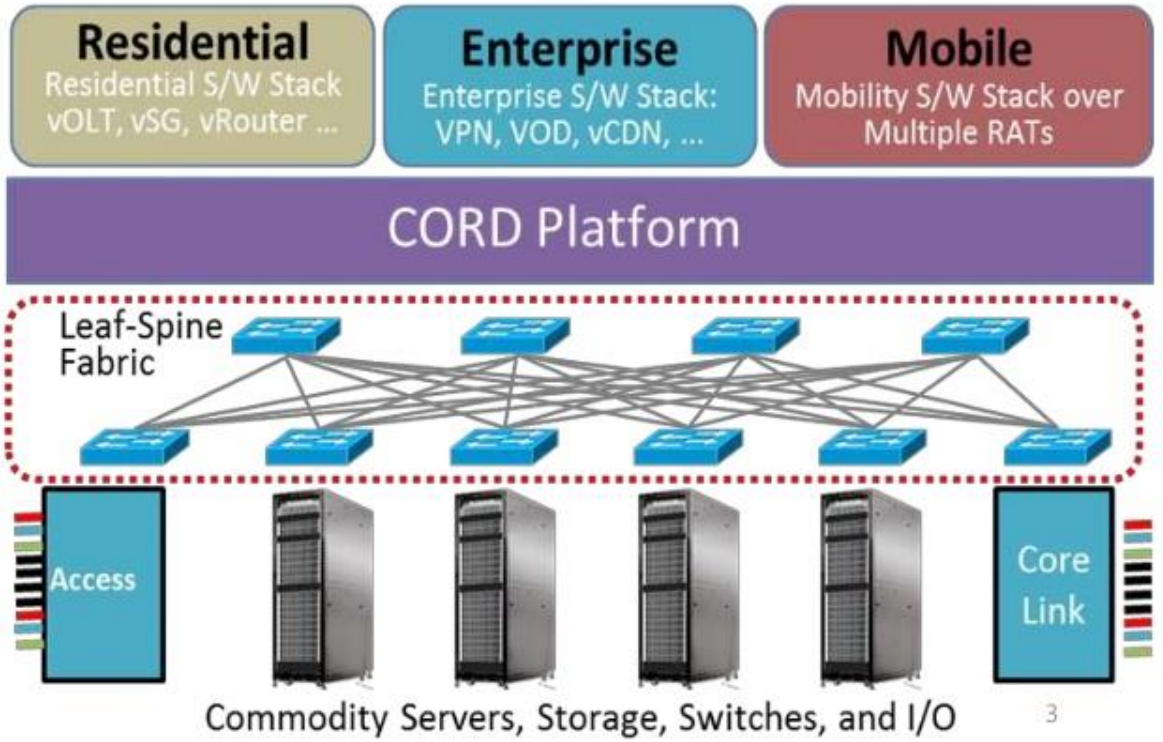
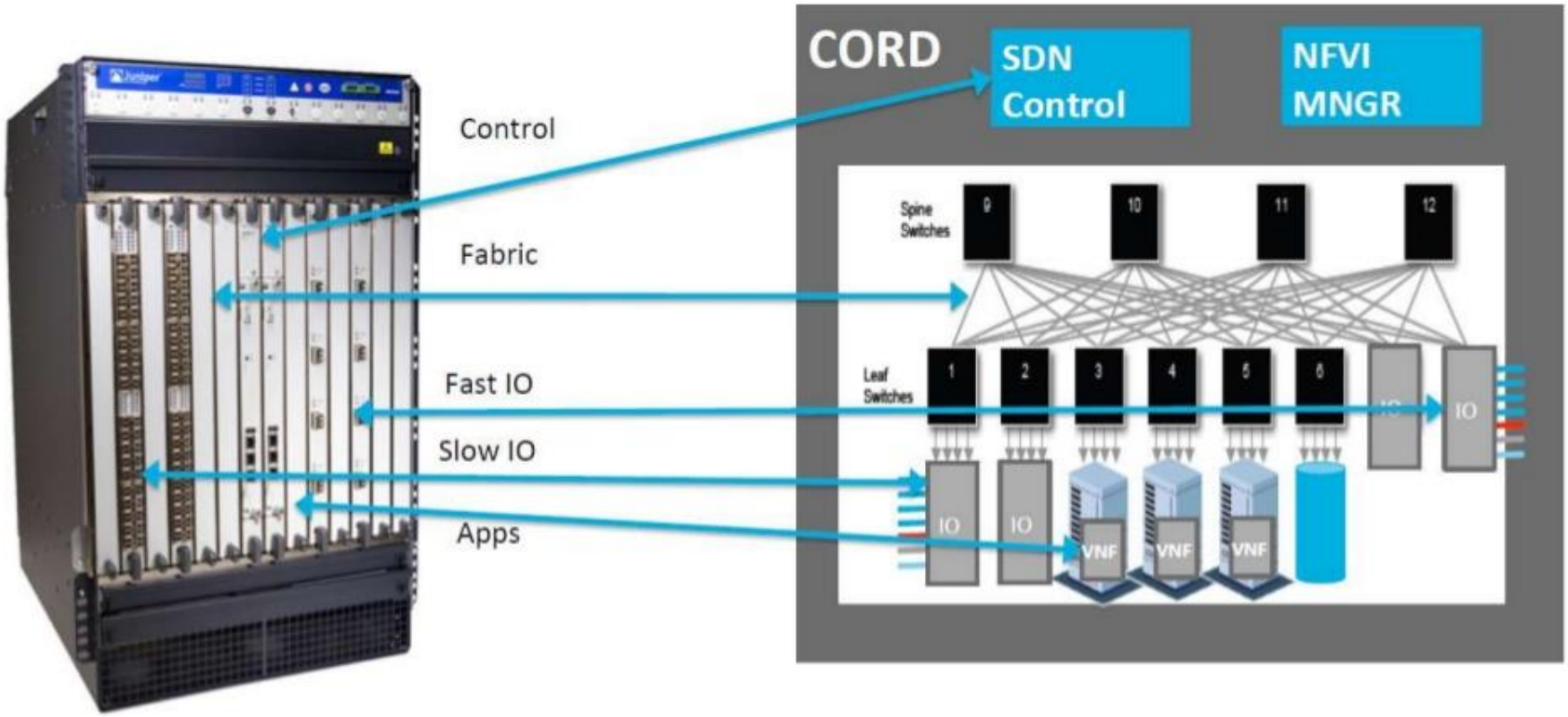
❖ **CORD is a platform that combines SDN, NFV and Cloud to deliver to Service Providers.**

- **Economies of a datacenter**
  - Infrastructure built with commodity buil ding blocks using open source software and white boxes
- **Agility of a cloud provider**
  - Software platforms that enable rapid cre ation of new services



CORD (Central Office Re-architecture as a DC)



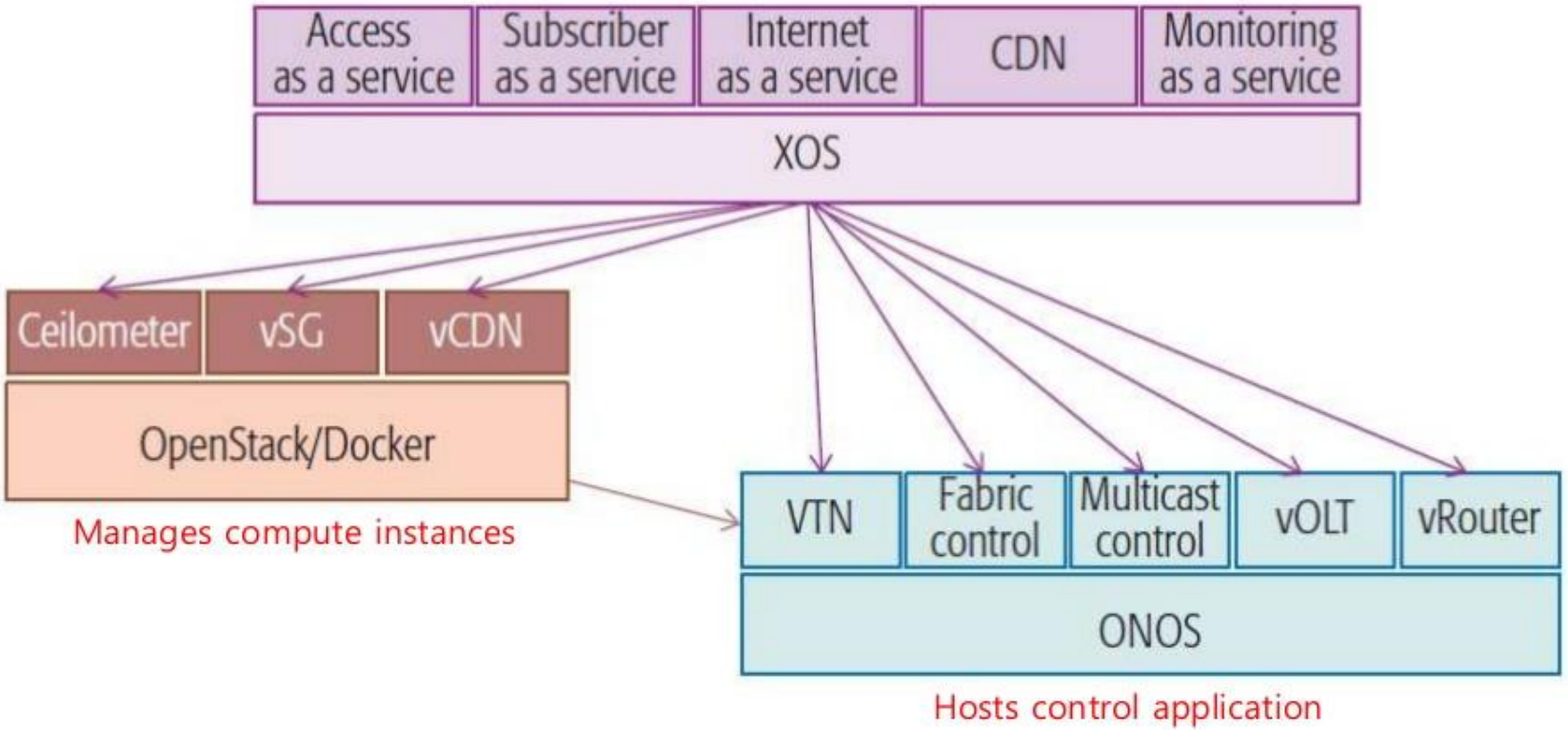
Two step of CORD

1. To disaggregate and virtualize the devices, turn each purpose-built hardware device into its software counterpart running on commodity hardware.

2. To provide a framework into which the resulting disaggregated elements can be plugged, producing a coherent end-to-end system.

❖ unifying abstraction that forge this collection of hardware and software elements into a scalable and agile system.

Open Source Components in CORD

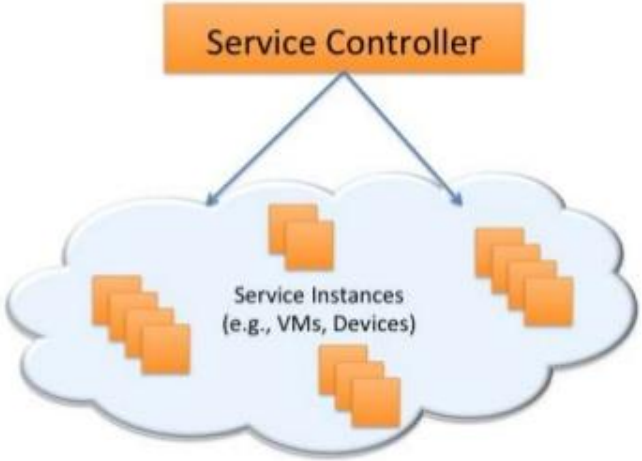


Software Building Block

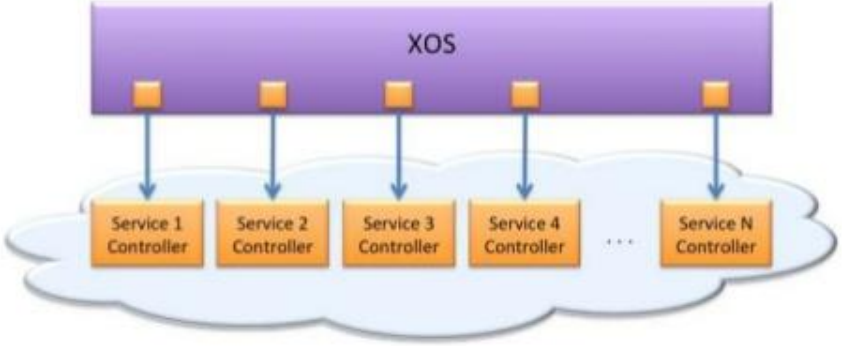
- **OpenStack**
  - Cluster management suite that provides the core Internet as a service(IaaS) and is responsible for creating and provisioning virtual machines and virtual networks
- **Docker**
  - Container-based means to deploy and interconnect services. It also plays a role in deploying CORD itself.(e.g., the other management elements are instantiated in Docker container)
- **ONOS**
  - It hosts a collection of control applications and manages both software switches and the physical switching fabric.
- **XOS**
  - Framework for assembling and composing services. It unifies infrastructure services(provided by OpenStack), control plane services(provided by ONOS), and any data plane or cloud services(running in VMs or containers)

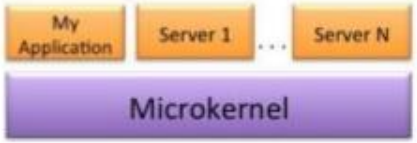
XOS : The CORD Controller

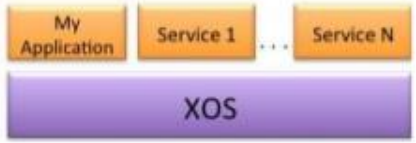
- **Everything-as-a-Service**
- **Controller for CORD**
- **Make CORD both extensible and controllable.**



- **It is not an independent open source project, it is managed under CORD's project governance.**







Two roles of ONOS in CORD

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- **Interconnects VMs**

  implementing virtual networks and managing flows across the switching fabric

- **Provides a platform for hosting control programs that implement CORD services.**

Type of CORD

- **M-CORD(Mobile CORD)**
- **E-CORD(Enterprise CORD)**
- **R-CORD(Residential CORD)**
- **A-CORD(Analytics for CORD)**

M-CORD

A New Future in Networking with Mobile Edge Mashing up SDN & NFV

Mobile CORD POC

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- Disaggregated and virtualized RAN
  - Simple programmable Remote Radio Heads
  - vBBU on commodity servers
- Disaggregated and virtualized EPC
  - Data plane management by ONOS
  - P-GW, S-GW, MME as “VNFs as a Service”
- Mobile edge service
  - Select EPC processing at the edge + eSON/A-CORD
  - Caching and other services from the edge
  - Customized for enterprises and applications

On-demand RAN/EPC deployment

Better user QoE

Efficient Resource Utilization

Programmable Infrastructure:
White Boxes + Open Source

M-CORD (Mobile CORD)

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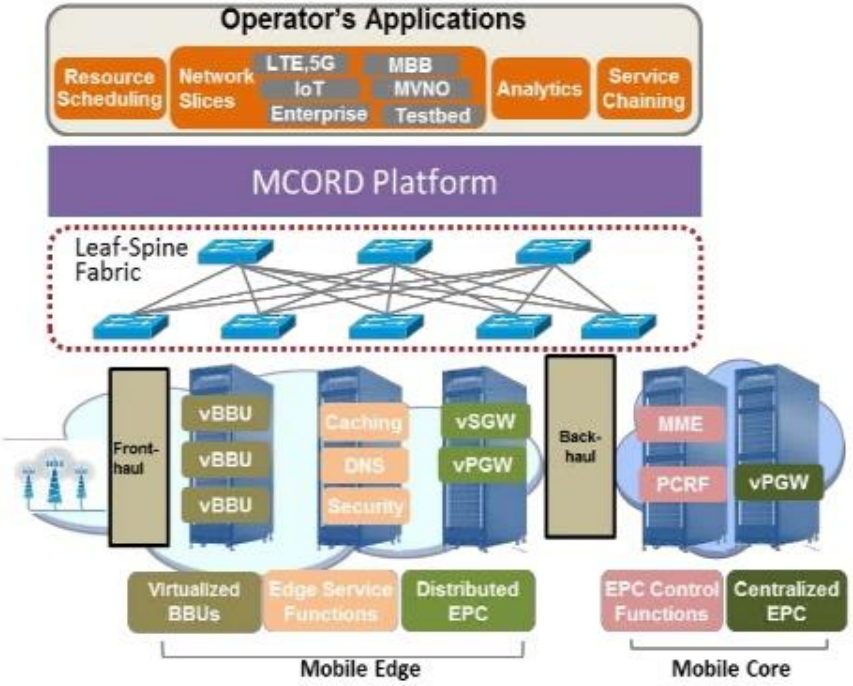
❖ **M-CORD is a CORD platform for Mobile Service Providers aim to deliver.**

- **Virtualization of Mobile Infrastructure: NFV**
  - Virtualize RAN and EPC using commodity components and open source software
  - Drive cost down and leverage IT's fast revolution
- **Disaggregation of Functions: SDN**
  - Decouple CP[Control Plane] from DP[Data Plane] of RAN and EPC for better Flexibility, Controllability and Scalability
  - Open interface for differentiated control applications
- **Mobile Edge Services**
  - On-demand deployment: 'Mobile edge as a Service'
  - Resource optimization and Increased capacity at Edge
  - Low latency for critical applications
  - Innovative and Customized service environment for new Revenue creation



M-CORD = Best of Mobile + CORD

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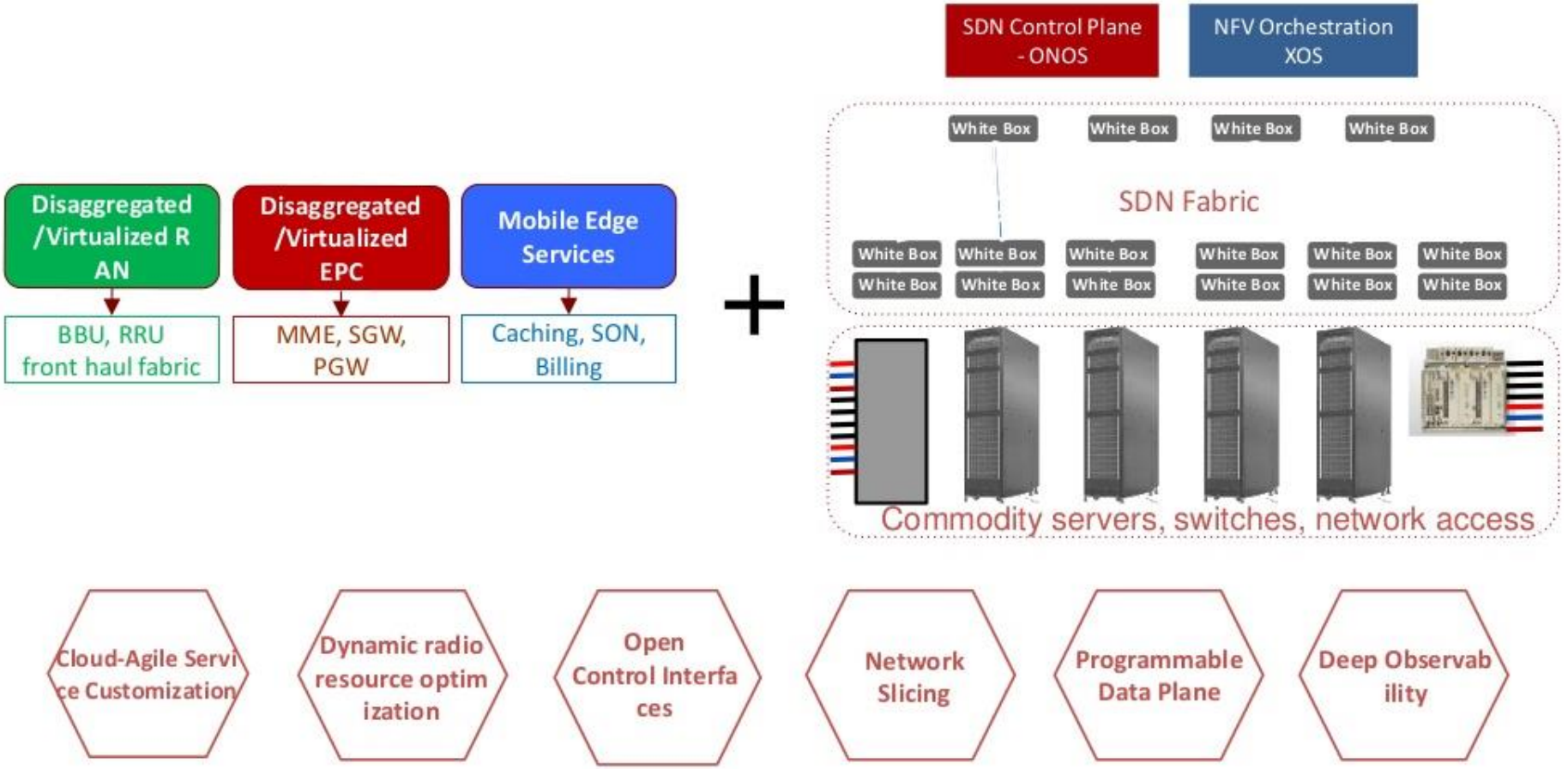
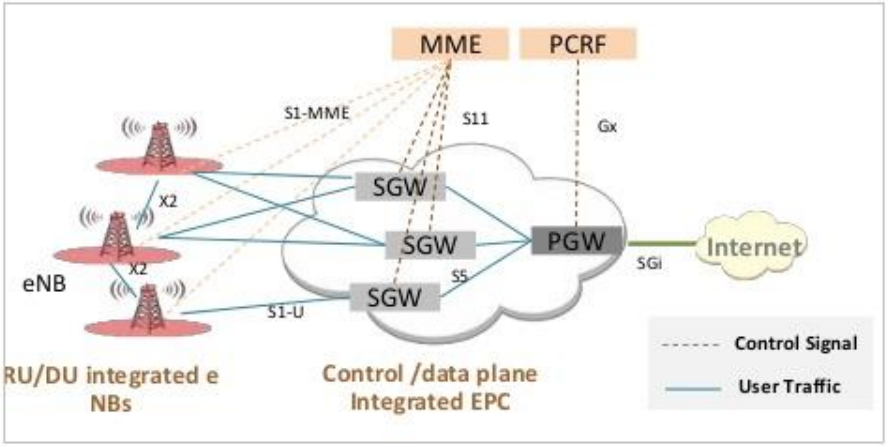


Disaggregated/Virtualized RAN and EPC

Traditional Architecture



with proprietary boxes & solutions

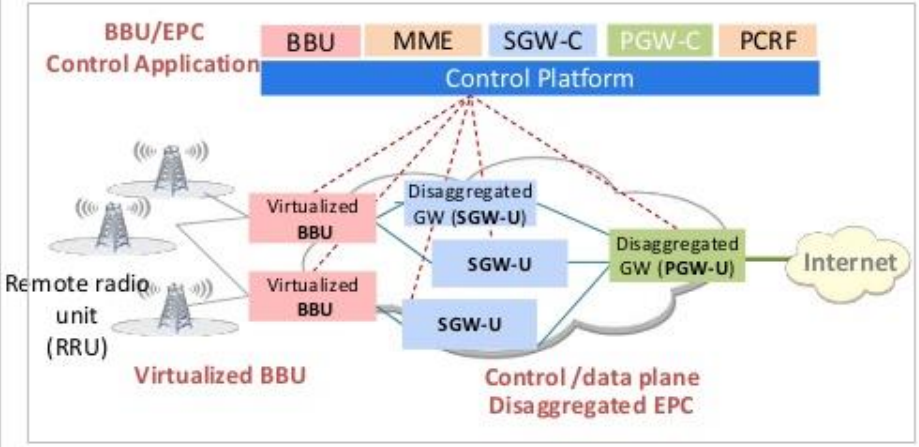
RU/DU integrated RAN

- Limited Scalability
- Inefficient coordination
- Sub-optimal spectrum usage
- High Cost

Control/data plane integrated EPC

- Limited scalability
- Discrete control
- Proprietary H/W for all-purpose
- High Cost

Target Architecture



with commodity H/W & open source/open API

Disaggregated & Virtualized RAN

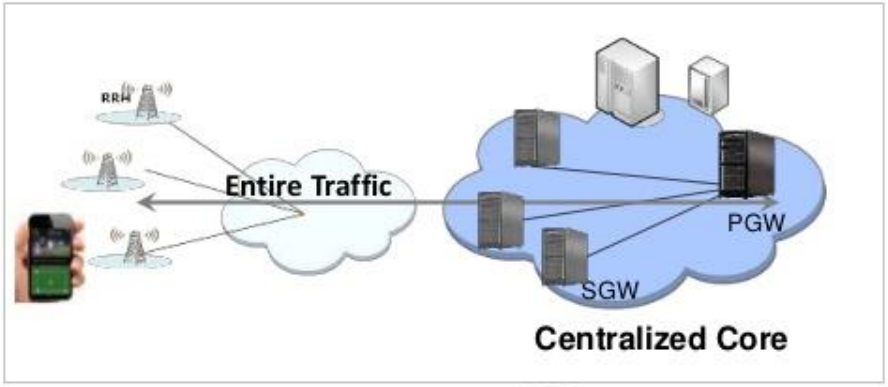
- High Flexibility & Scalability
- Centralized Coordination
- Spectrum usage optimization
- Reduced Cost

Disaggregated EPC

- Independent Scalability
- Centralized Control
- Choice of H/W best fits the SLA
- Reduced Cost

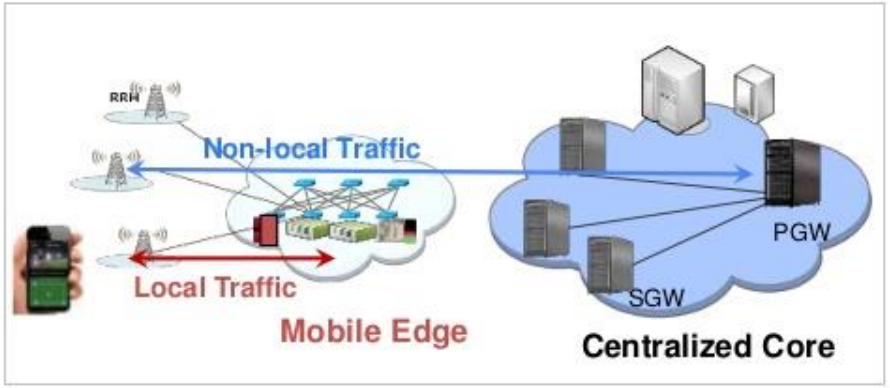
Mobile Edge

Traditional Mobile Service Processing



- Overload on backhaul, transport and core EPC
- Inefficient use of network resources
- Deterioration on QoE of the users
- Overprovisioning to handle peak traffic

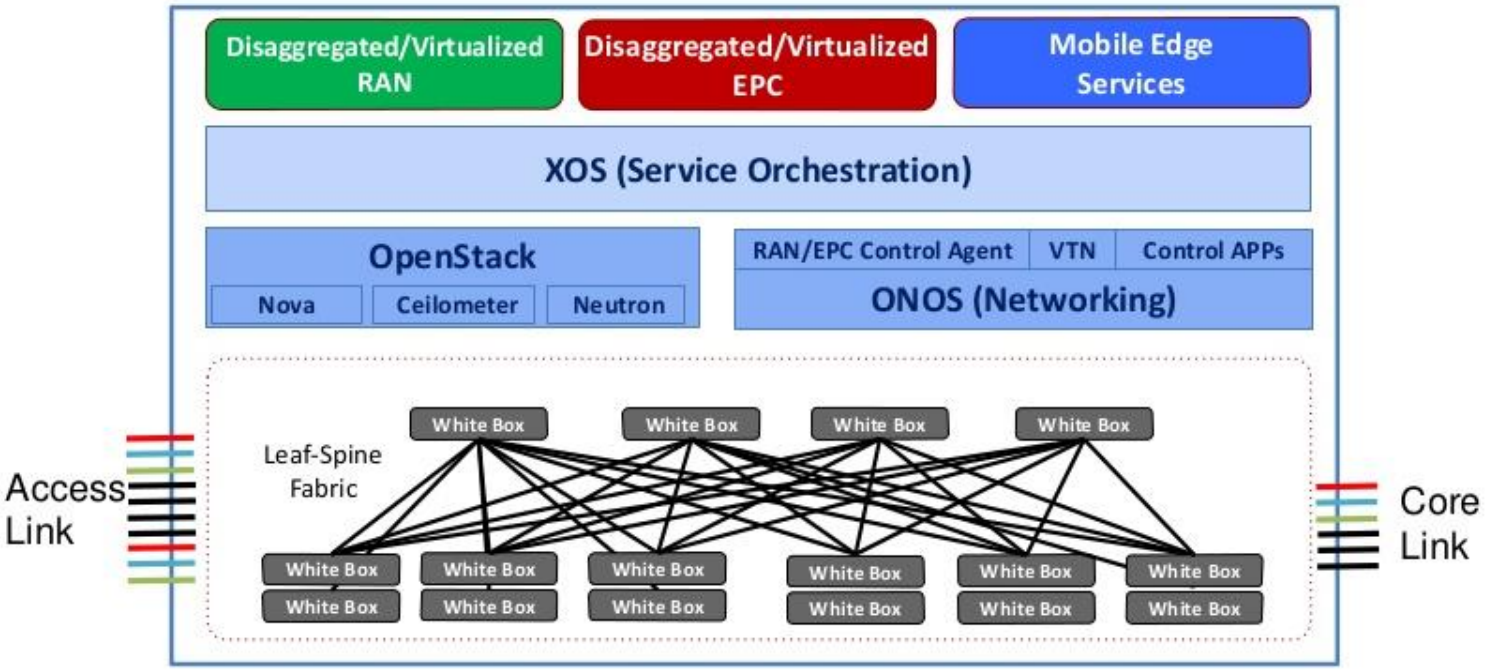
Mobile Edge Service Processing



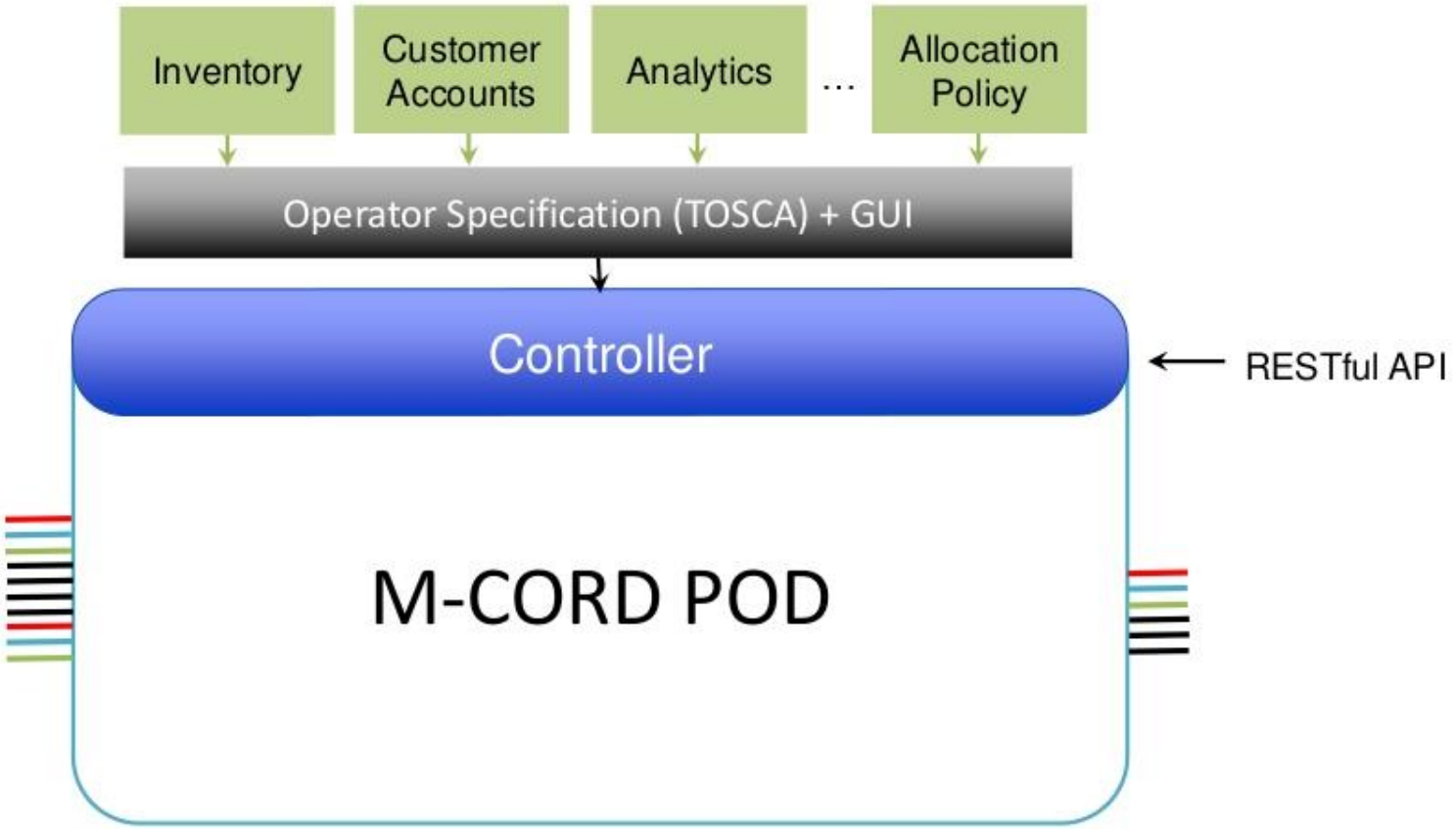
"Mobile edge, where operators can leverage their core competencies to overcome their limitations"

- Mobile edge's best advantage is 'Proximity to End Users'
- Services can be processed at mobile edge
- Suitable for customized services to target customers
- Net Result: Better efficiencies for operators and better QoE for users

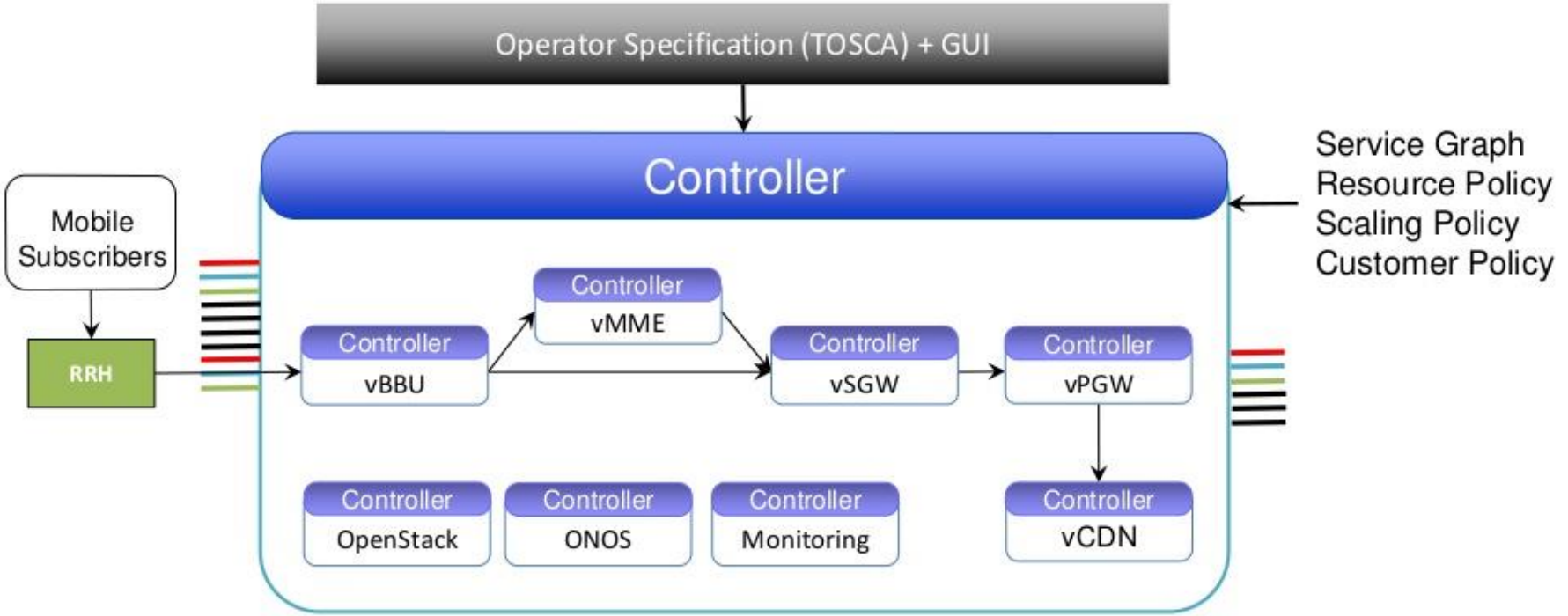
M-CORD Architecture Framework



M-CORD : External view

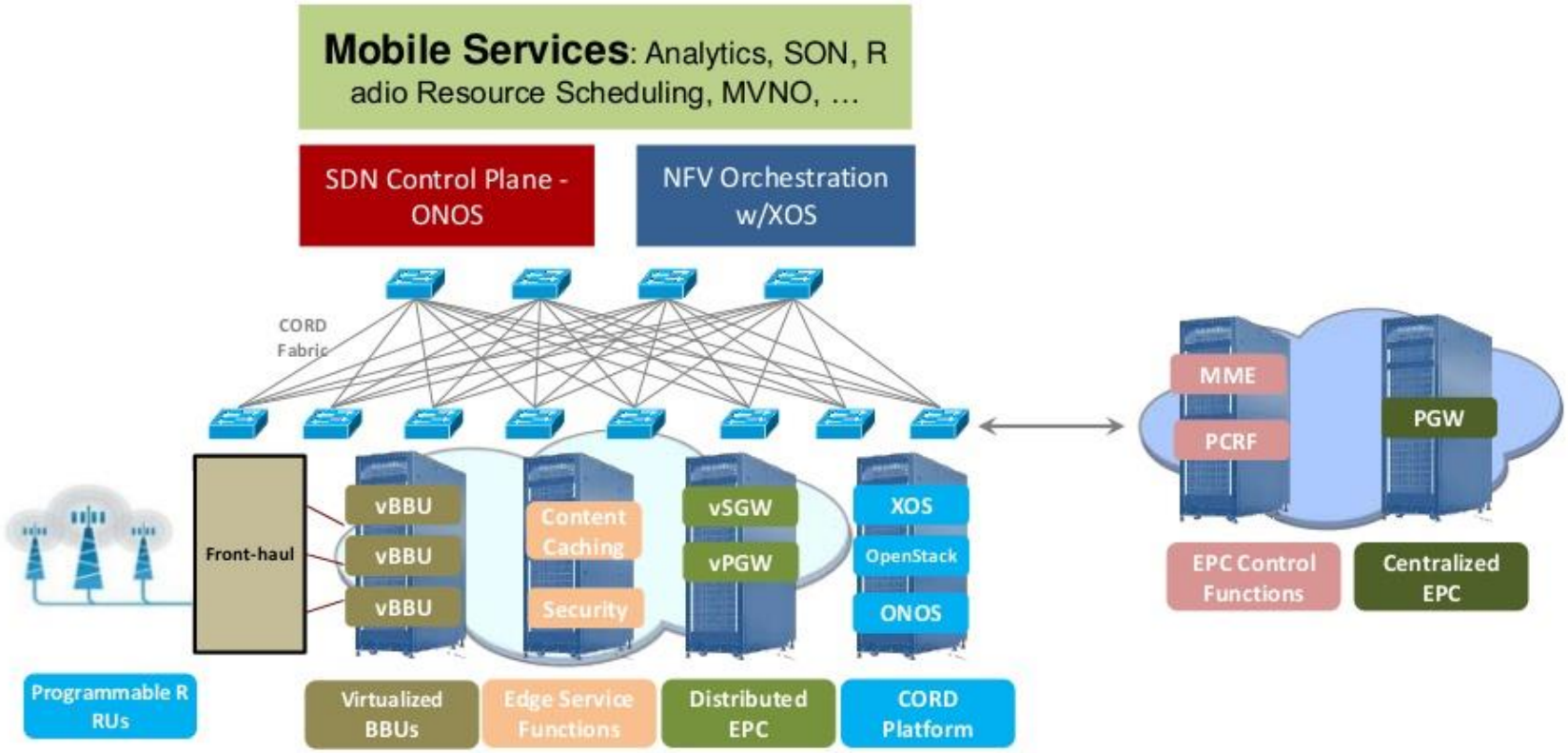


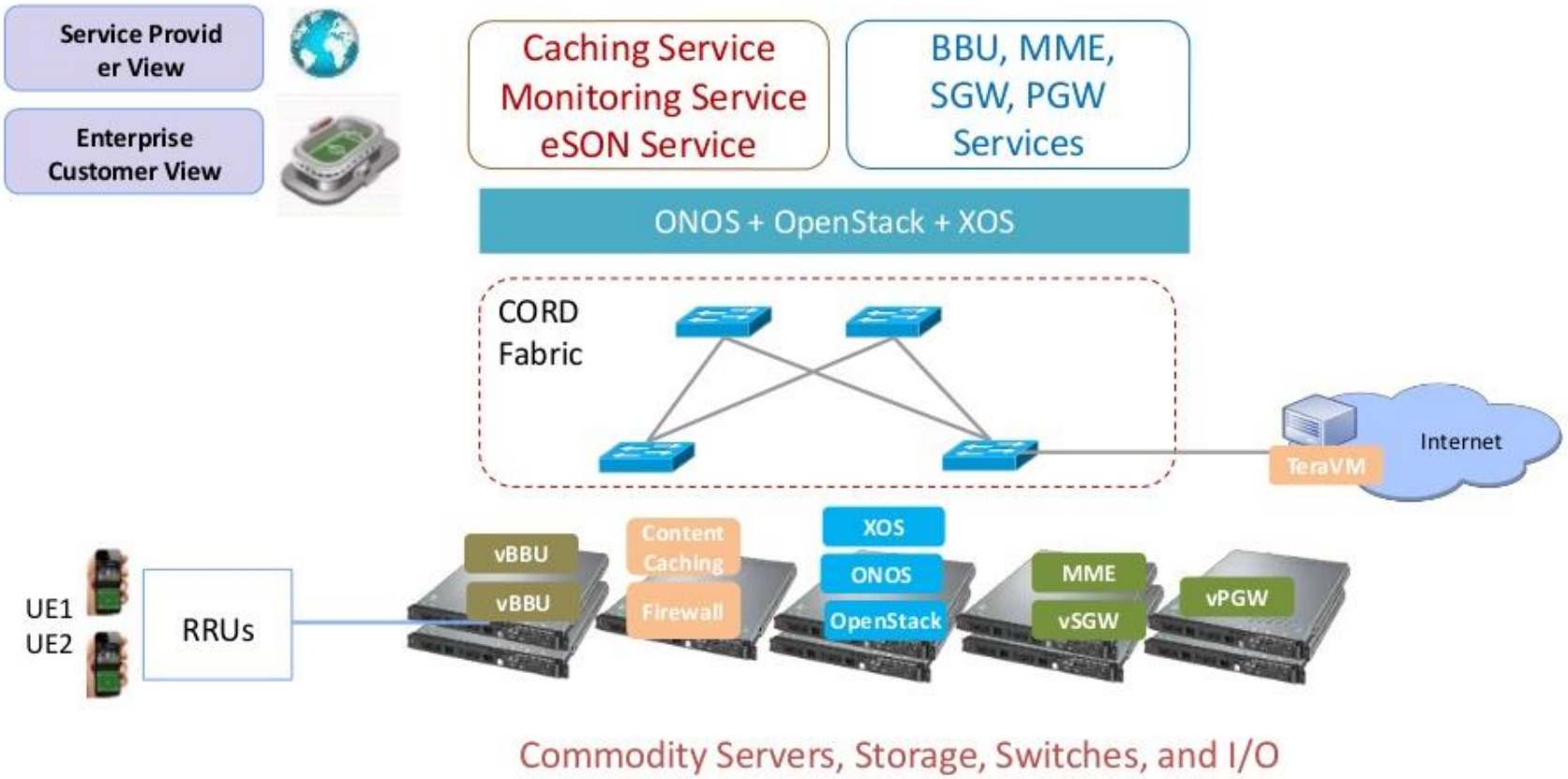
M-CORD : Internal view



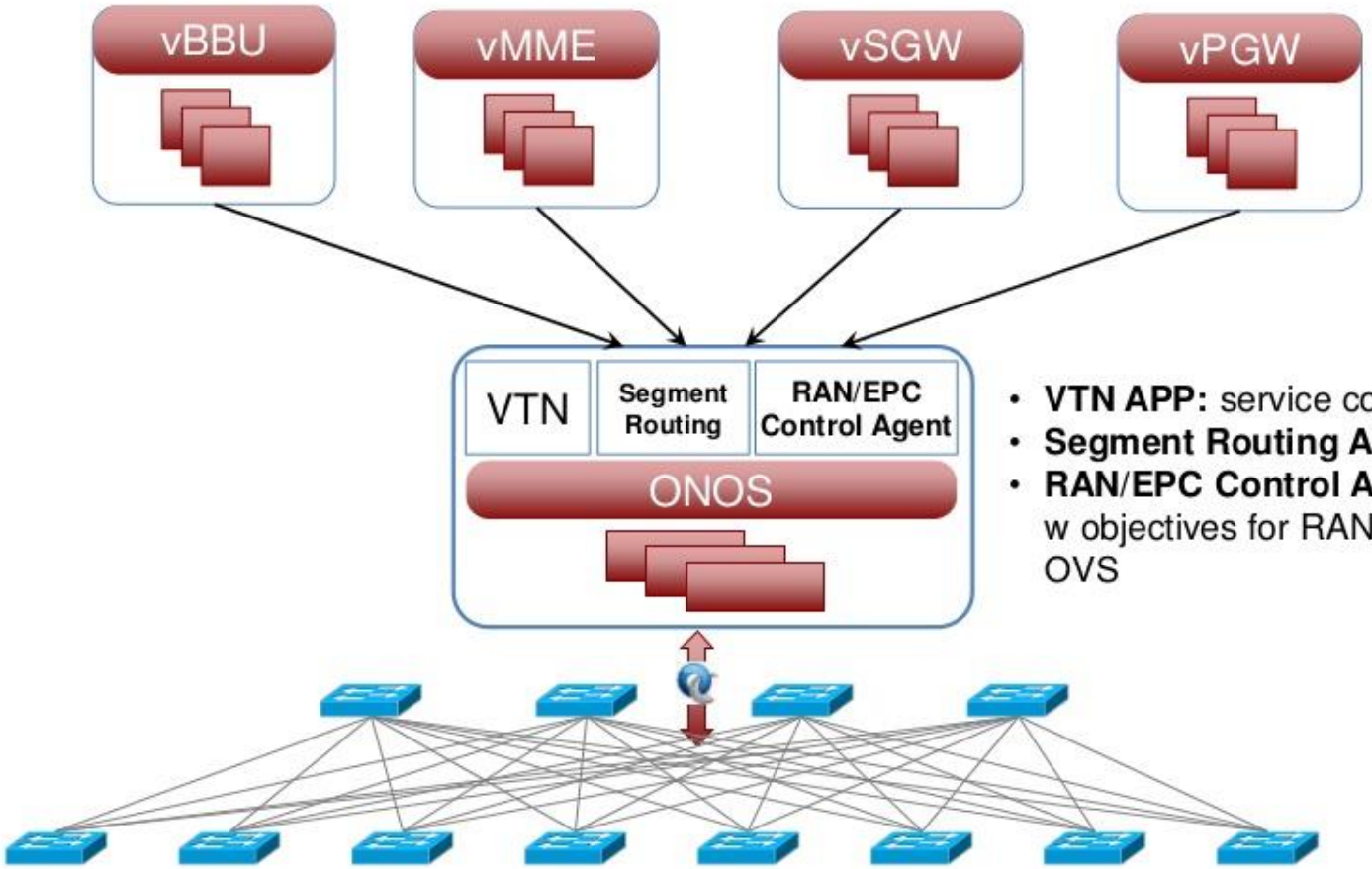
Everything-as-a-Service (XaaS) / Micro-Services Architecture

M-CORD Implementation




Service Provider View
Enterprise Customer View
Caching Service
Monitoring Service
eSON Service
BBU, MME, SGW, PGW Services
ONOS + OpenStack + XOS
CORD Fabric
Internet
TeraVM
UE1
UE2
RRUs
vBBU
vBBU
Content Caching
Firewall
XOS
ONOS
OpenStack
MME
vSGW
vPGW
Commodity Servers, Storage, Switches, and I/O

Role of ONOS



- **VTN APP:** service connectivity
- **Segment Routing APP:** fabric management
- **RAN/EPC Control Agent APP:** compose flow objectives for RAN/EPC data plane inside OVS

E-CORD

Enterprise WAN connectivity and innovative carrier grade services

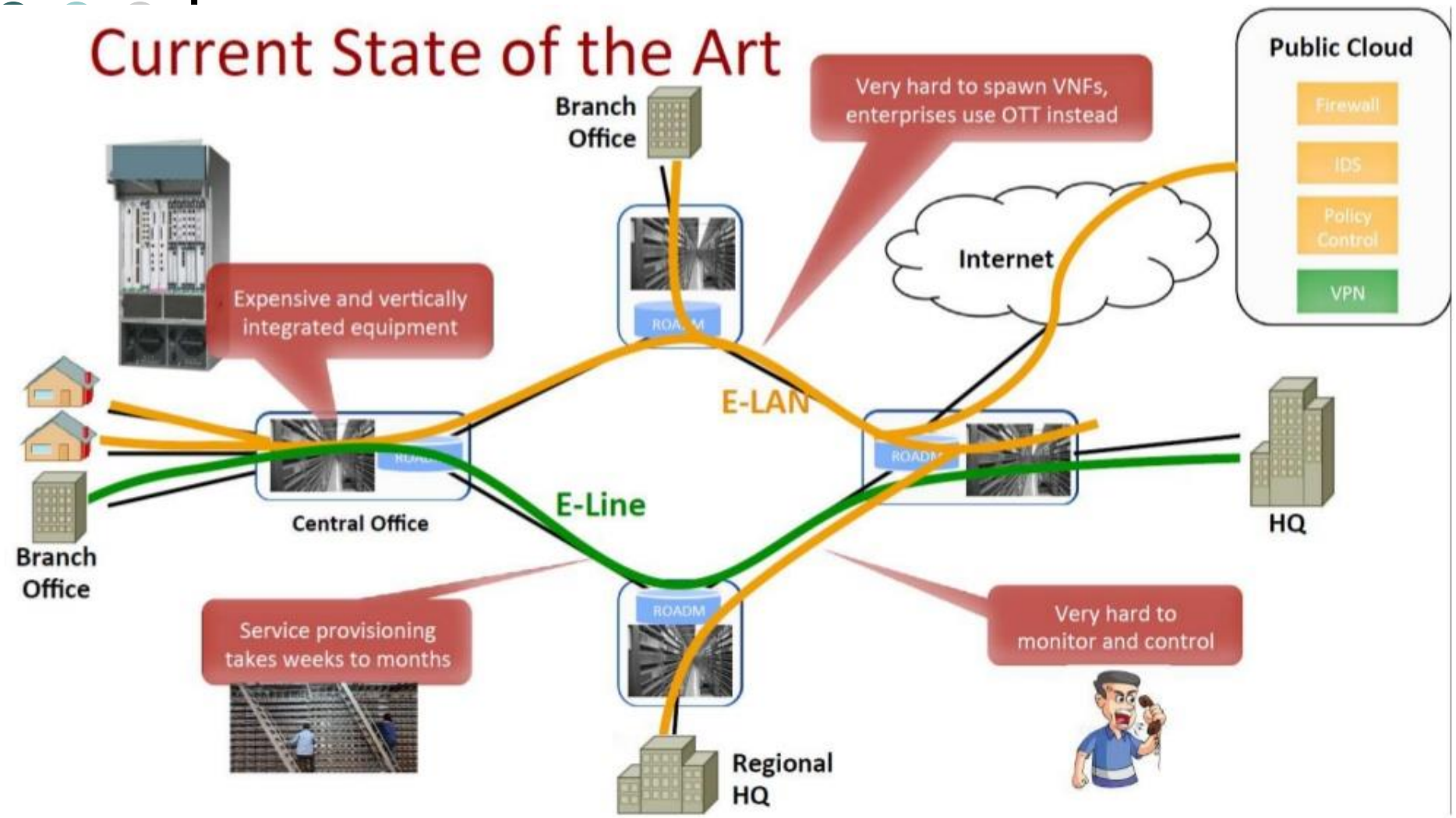
E-CORD

- **Enterprise connectivity services over metro and wide area networks**
- **Built on commodity HW and open source software**
  - Disaggregated ROADM(Re-configurable Optical Add-Drop Multiplexer)
- **SDN/NFV-based elasticity of commodity clouds to bring datacenter economics and cloud agility to the Telco Central Office.**

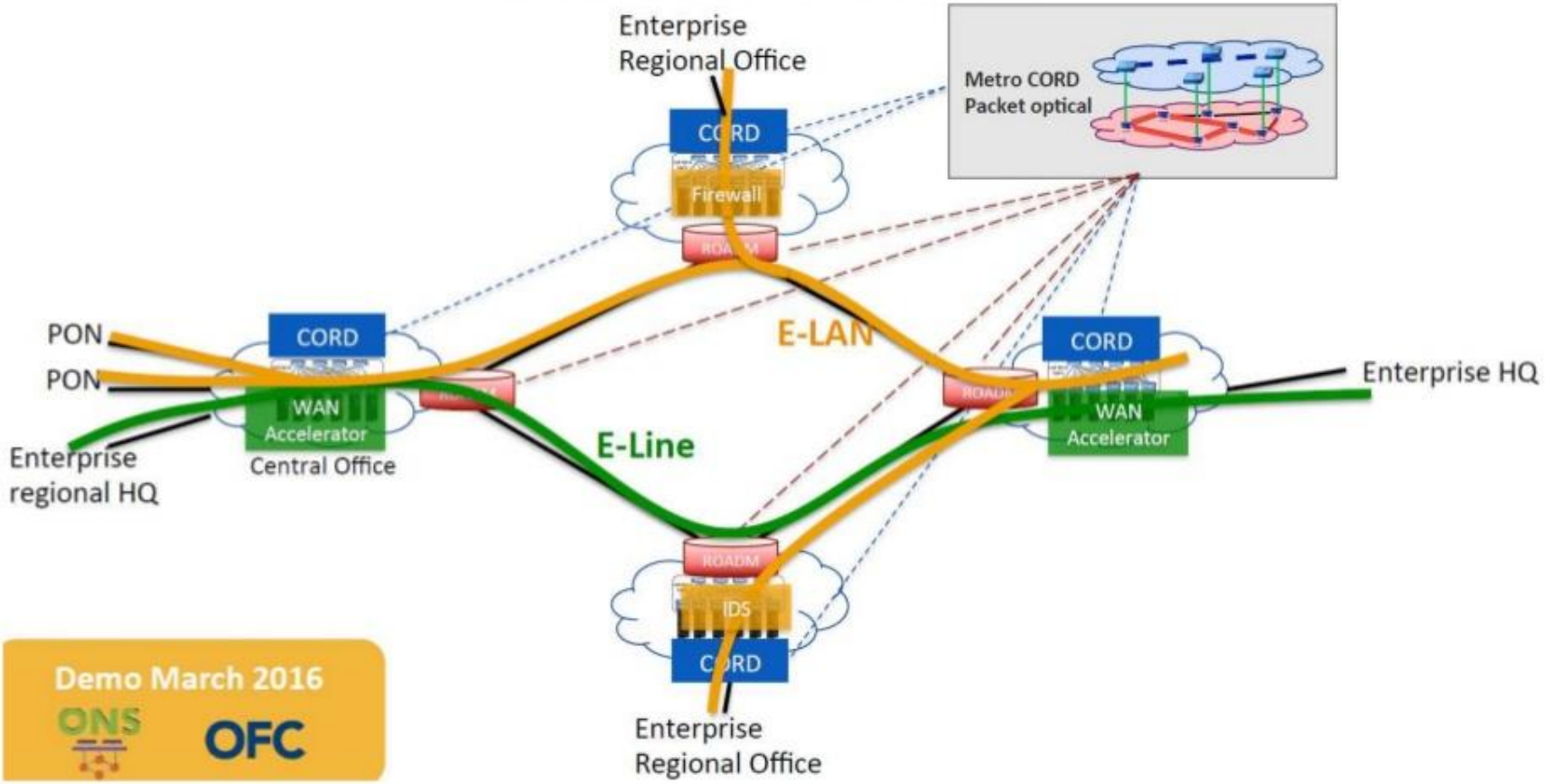
Enterprise perspective : An Enterprise Wants

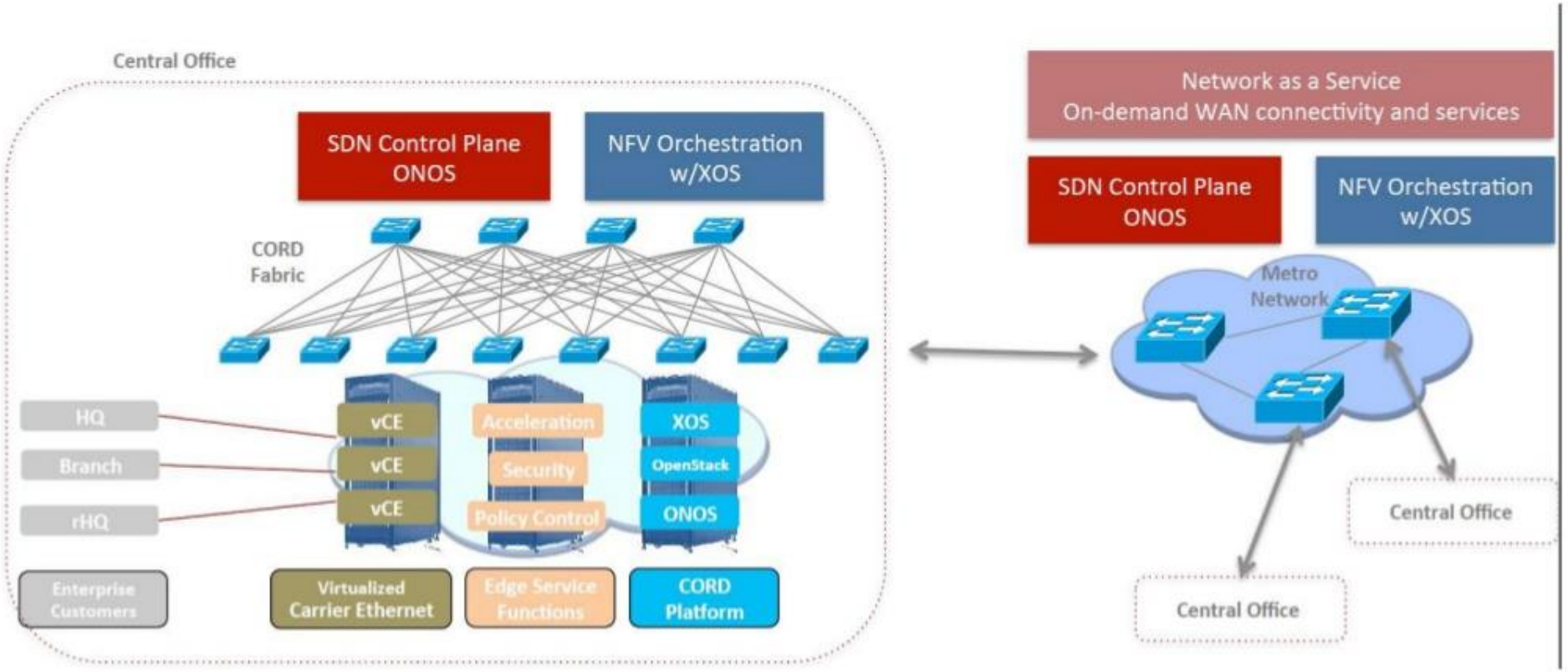
- **Customized "network on demand" service**
  - For different apps or user groups
  - With bandwidth on demand
  - Secure & isolated from other networks
- **Software defined to observe, control, and adapt**
  - With own portal and programmatic interface
- **Ability to handle with increasing complexity**
- **Lower cost**

Current State of the Art

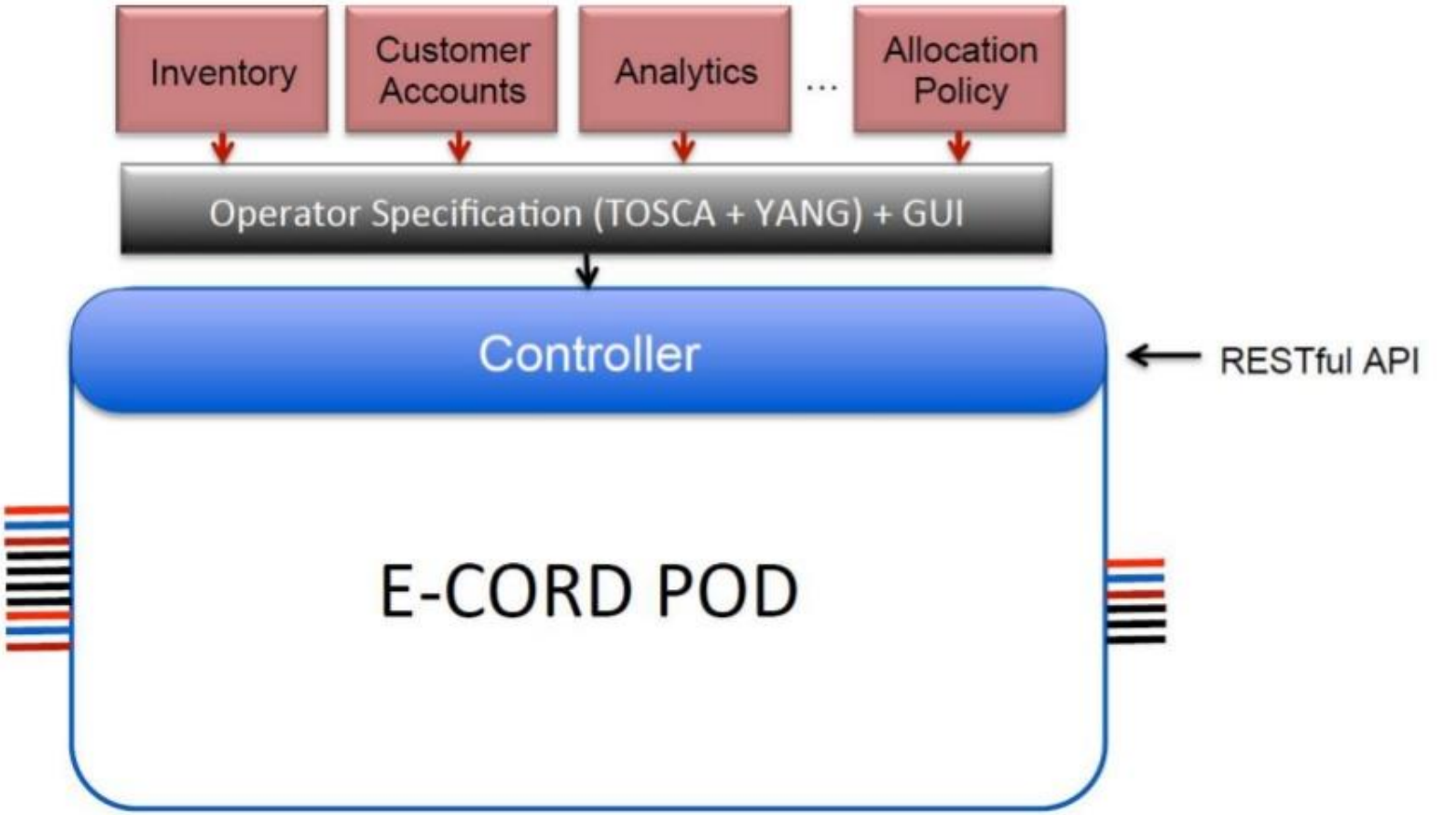


E-CORD in Metro

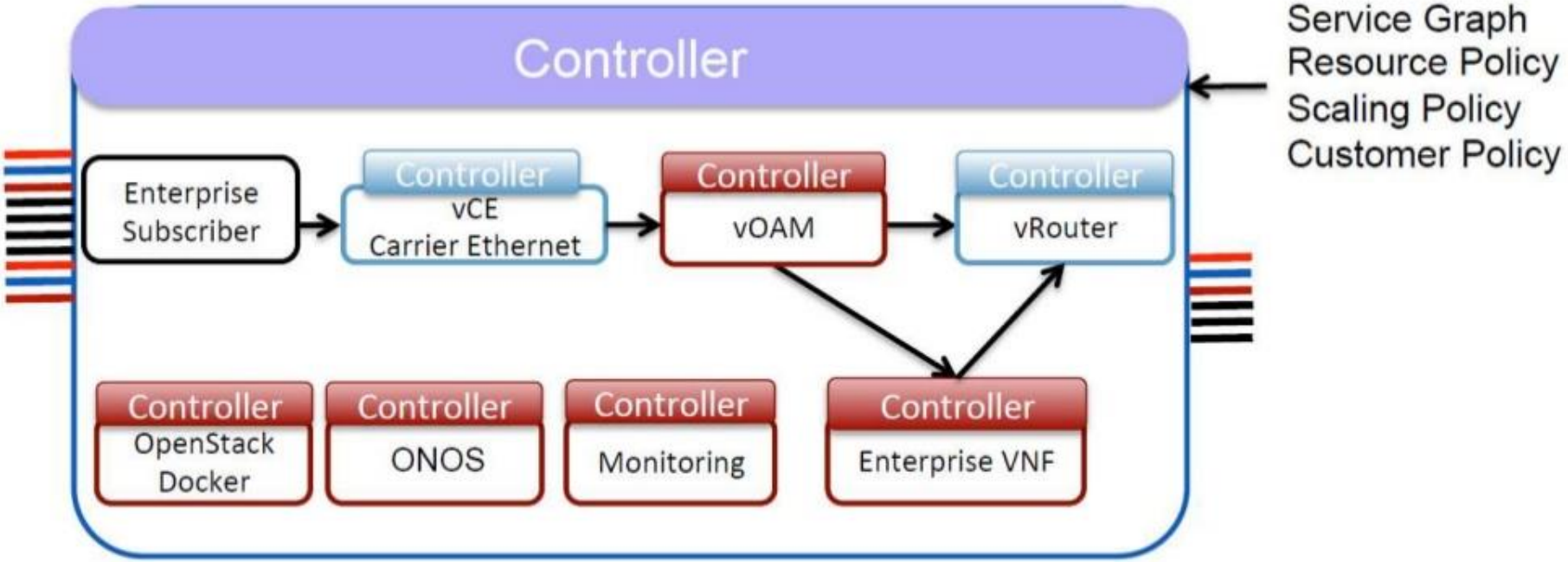



Central Office
SDN Control Plane
ONOS
NFV Orchestration
w/XOS
CORD
Fabric
HQ
Branch
rHQ
vCE
vCE
vCE
Acceleration
Security
Policy Control
XOS
OpenStack
ONOS
Enterprise
Customers
Virtualized
Carrier Ethernet
Edge Service
Functions
CORD
Platform
Network as a Service
On-demand WAN connectivity and services
SDN Control Plane
ONOS
NFV Orchestration
w/XOS
Metro
Network
Central Office
Central Office

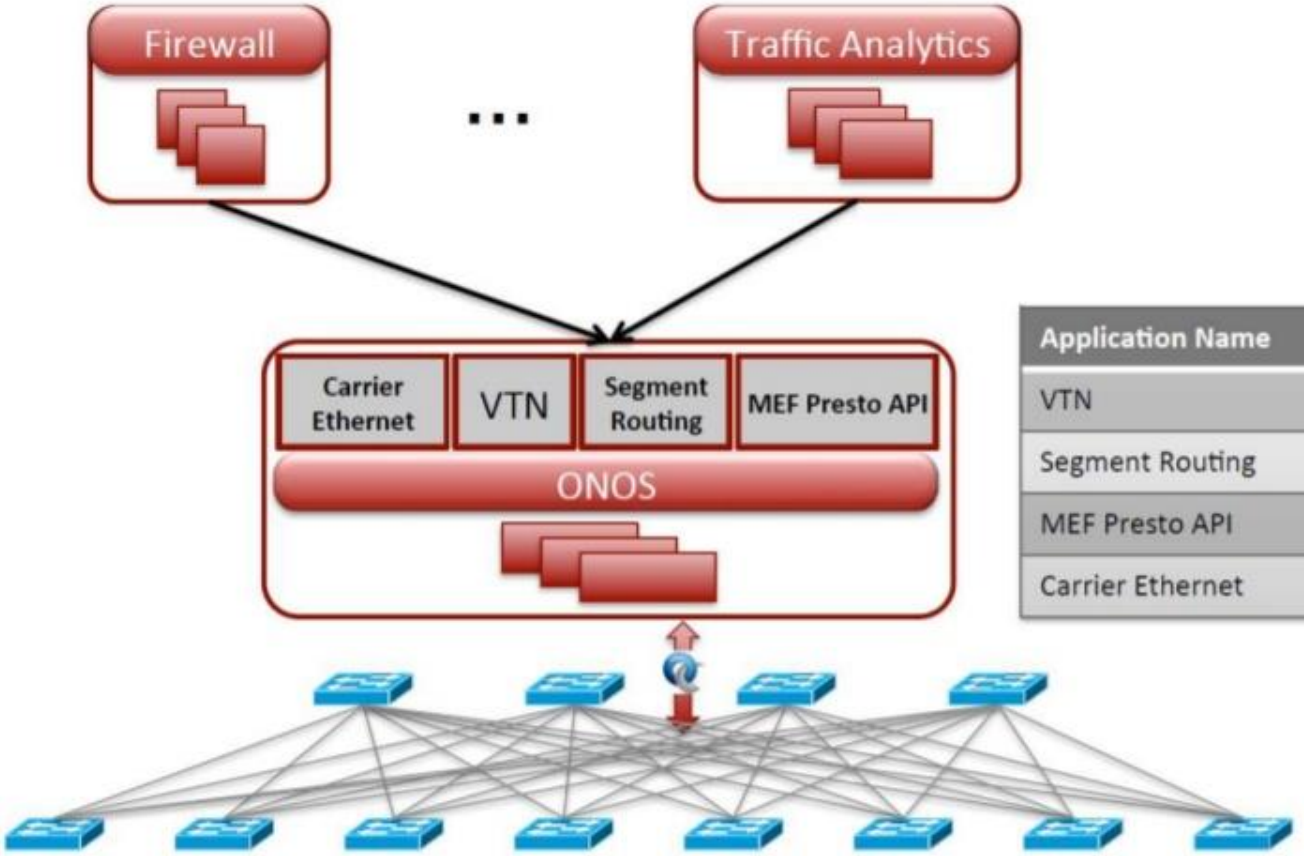
E-CORD : External view



E-CORD : Internal view



Role of ONOS

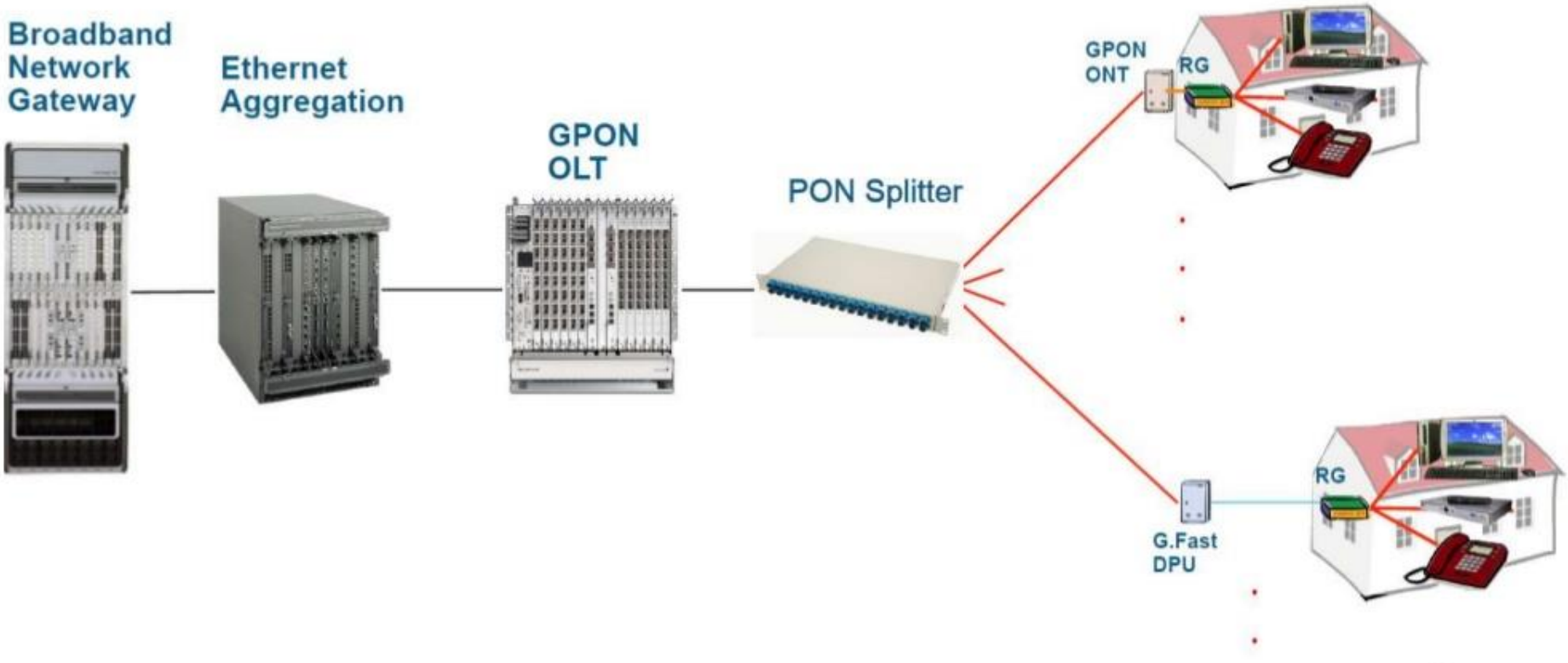


Application Name	Description
VTN	Service connectivity
Segment Routing	Fabric Management
MEF Presto API	Ethernet services API
Carrier Ethernet	Encapsulation and metering

R-CORD

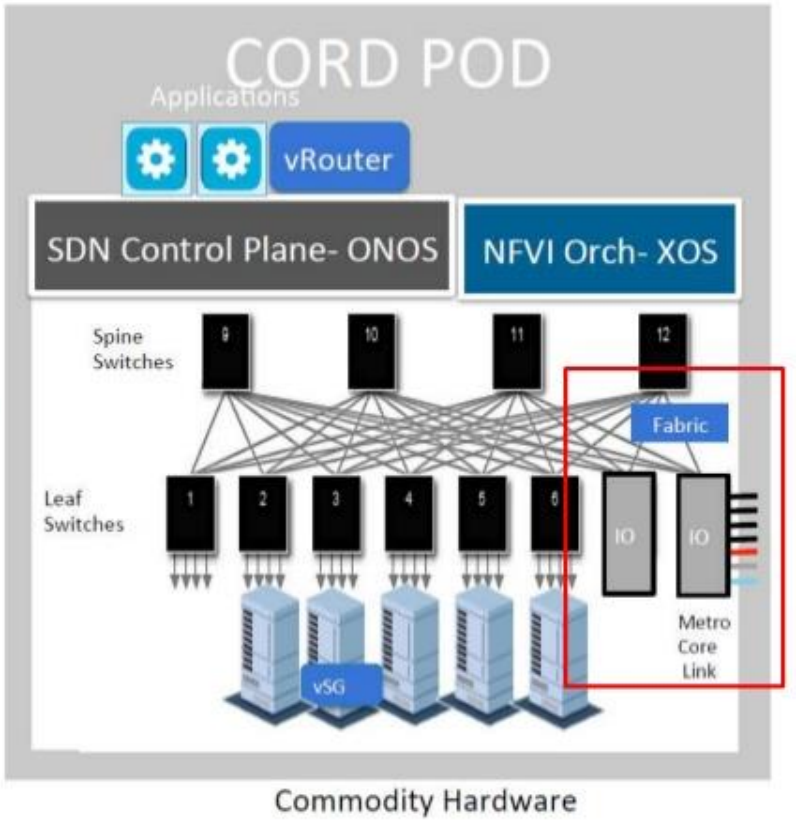
Add applications and equipment that supports: Mobility, Metro Ethernet, Transport

Legacy broadband access architecture using GPON



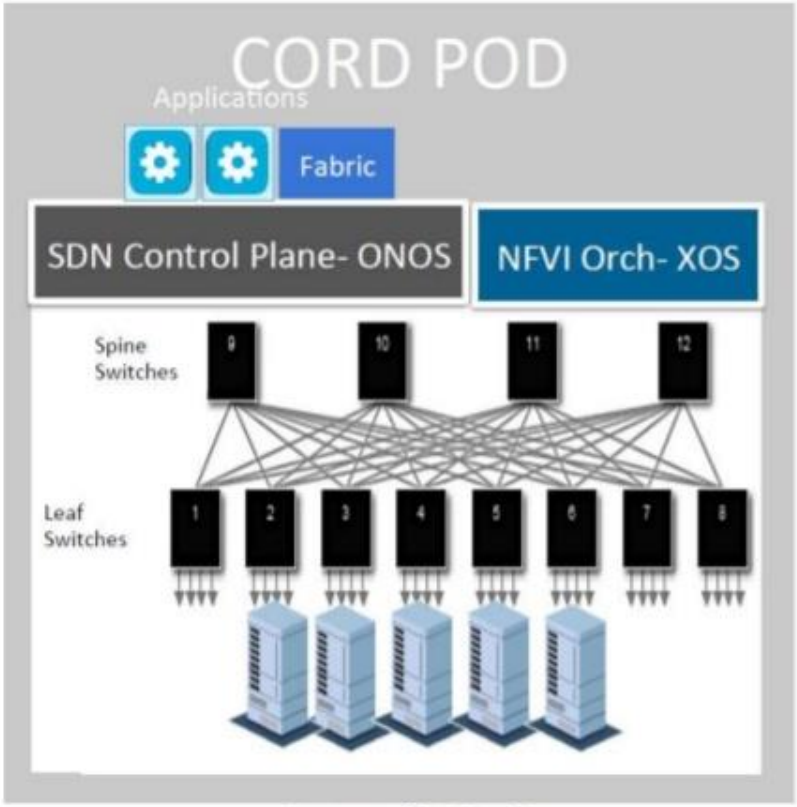
Virtualizing Broadband Network Gateway(BNG)

- Fabric switches
- Subscriber management VNFs
- SDN control and agent SW
- Routing VNF
- Servers



Commodity Hardware

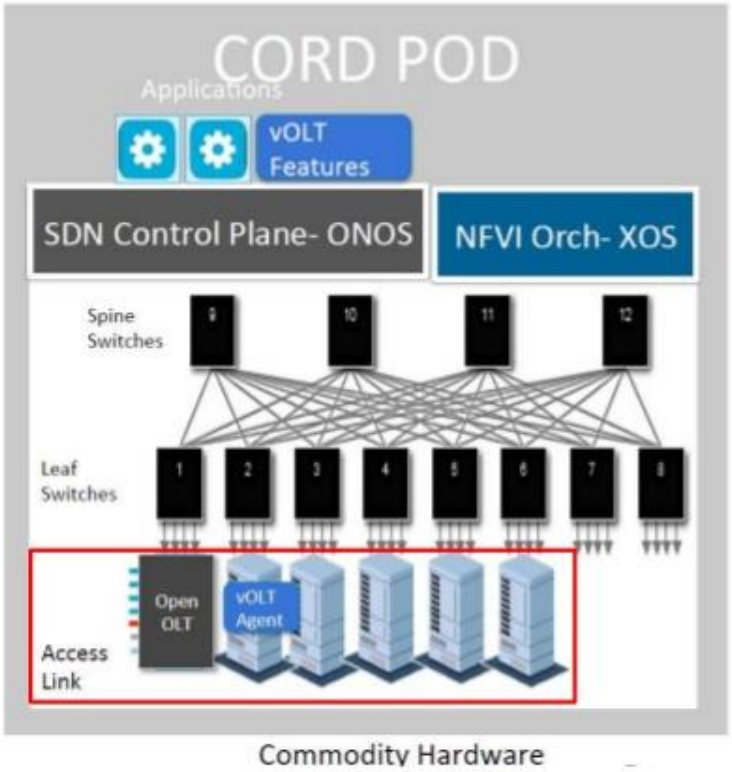
Virtualizing Ethernet Aggregation Switch



Commodity Hardware

Virtualizing OLT(vOLT)

We need to create a new standard high volume (HV) PON MAC

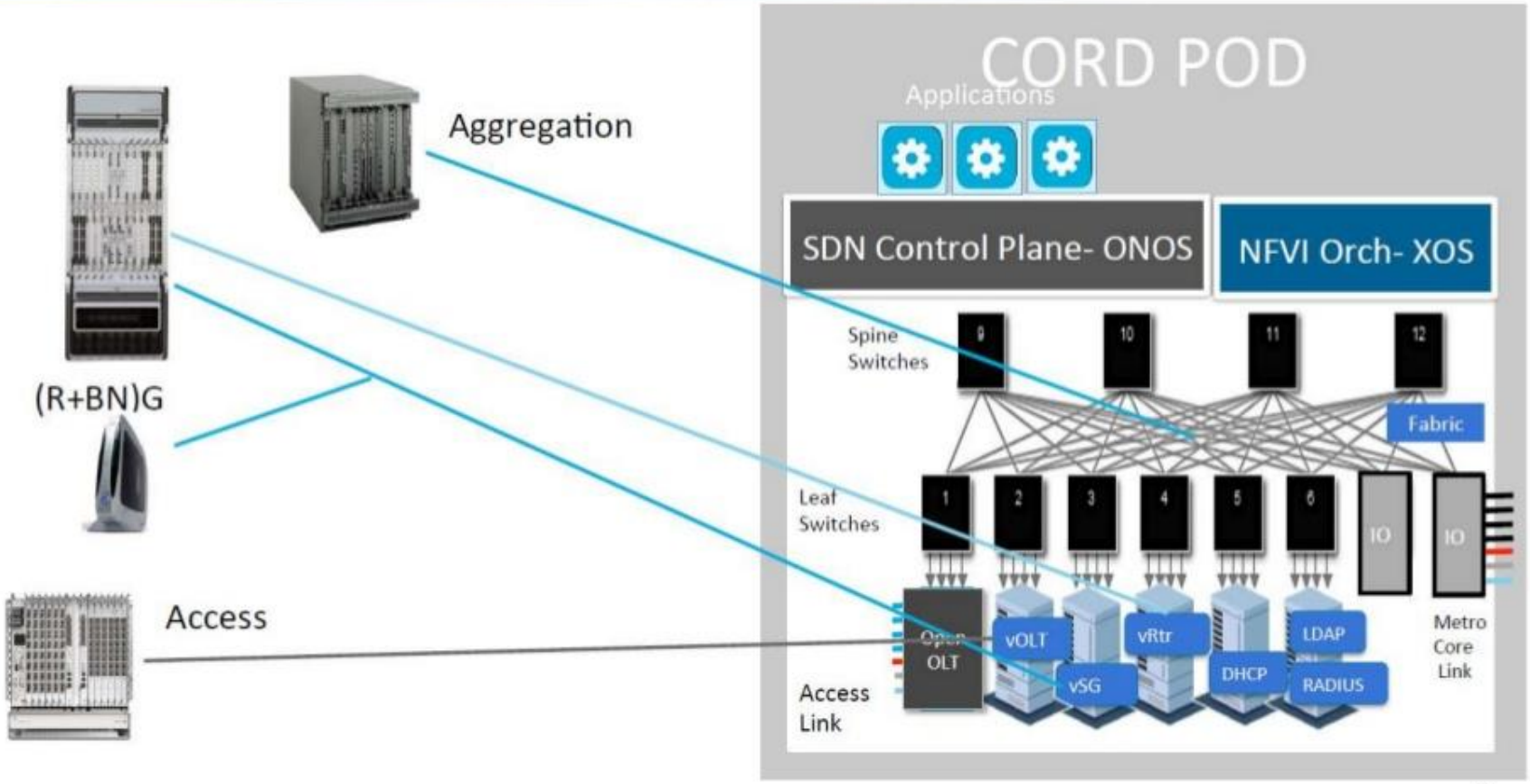


OLT(Optical Line Termination) (광선로종단장치) - 국사내에 설치되어 백본망과 가입자망을 서로 연결하는 광가입자망 구성 장치 . 가입자 광 신호를 국사측에서 종단하는 역할

Virtualizing Customer Premises Equipment(CPE)

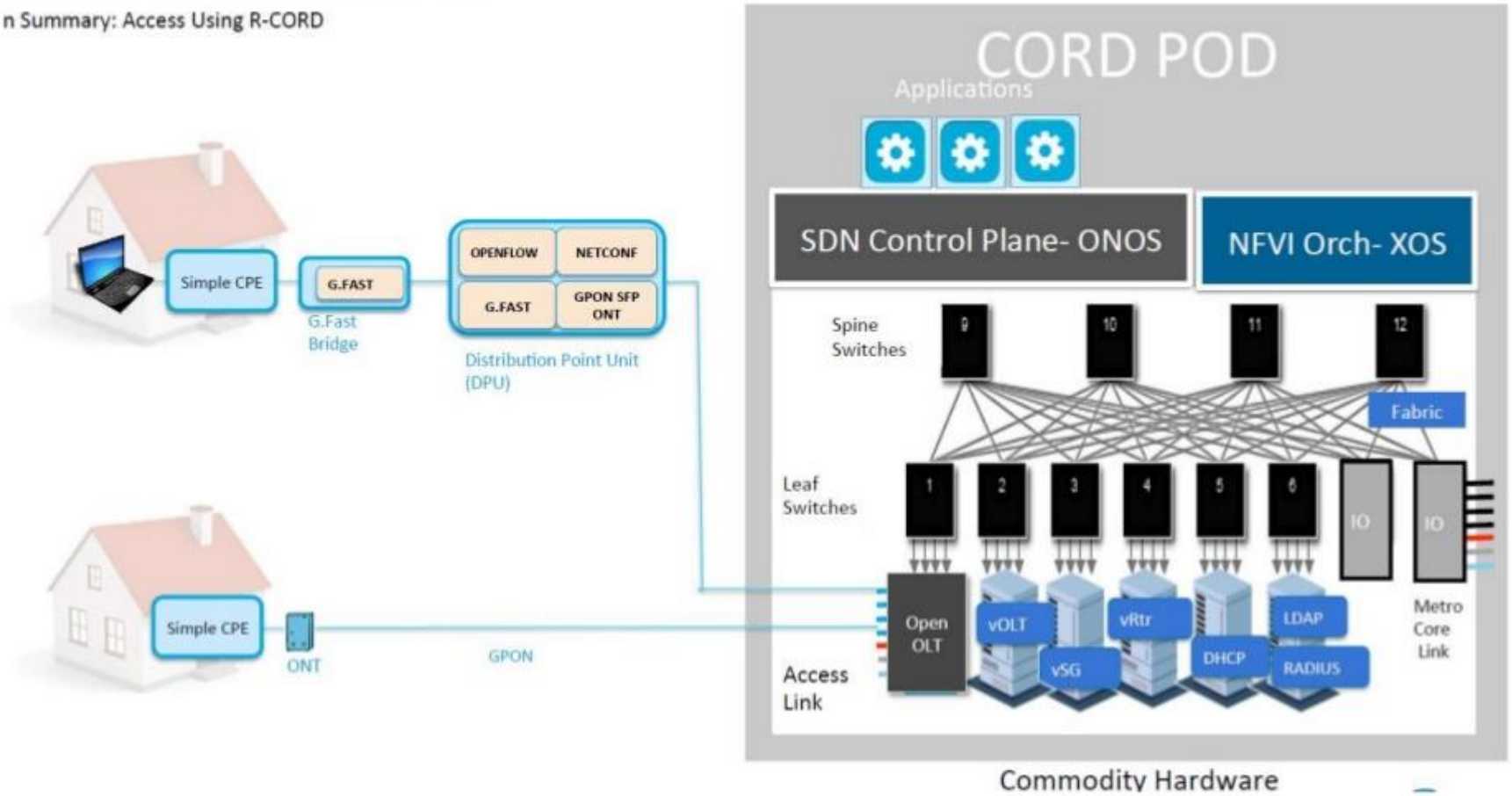
- 표준 SoC 및 OEM에 따라 만들어진 High Volume devic로서 CPE가 존재
- The physical interfaces must remain in CPE at the home to be useful
- Controlling and orchestrating CPE cooperating with the NFVI
- CPE may host VNFs

Mapping all the legacy elements into CORD



Access using R-CORD

n Summary: Access Using R-CORD



A-CORD

❖ **CORD 내의 물리 장치와 소프트웨어를 위한 범용 모니터링 프레임워크**