가상 네트워크
(SDN/NFV for Telecom)

2018. 12.

(2019년 5월까지 사용 권장)

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I. 개요

II. SDN 트렌드

III. Use Case

IV. Case Study

0. 소개 – My history for 200x

❖ Enterasys Networks

드래곤 IDS/IPS

2000 Network Computing WELL-CONNECTED AWARD

2002 Network Computing WELL-CONNECTED AWARDS

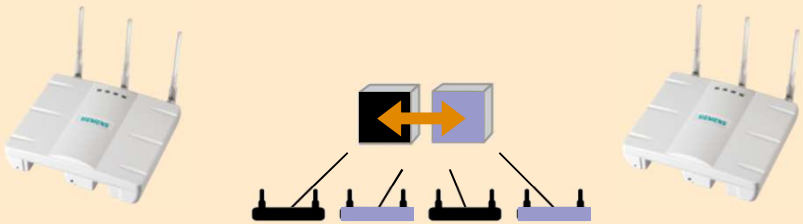
INFORMATION SECURITY excellence Awards 2002 WINNER

Network Computing EDITOR'S CHOICE

통합 WLAN+Wireless IDS/IPS

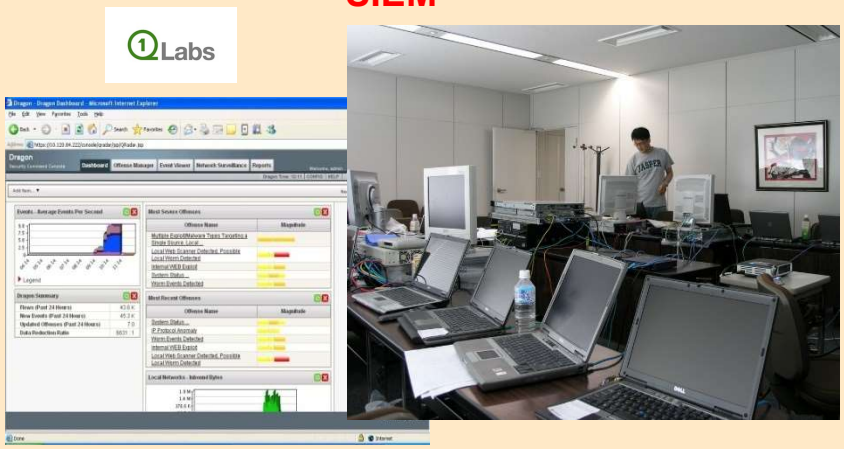
AirTight NETWORKS

SIEMENS Siemens Enterprise Communications

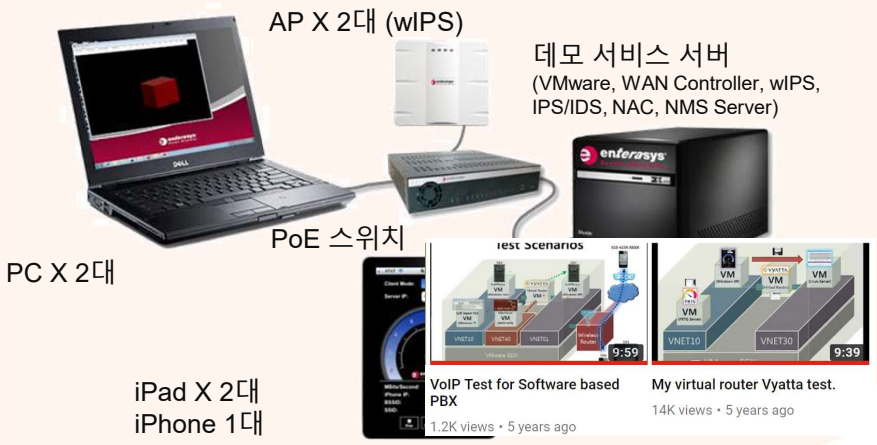


My History for 2000

SIEM

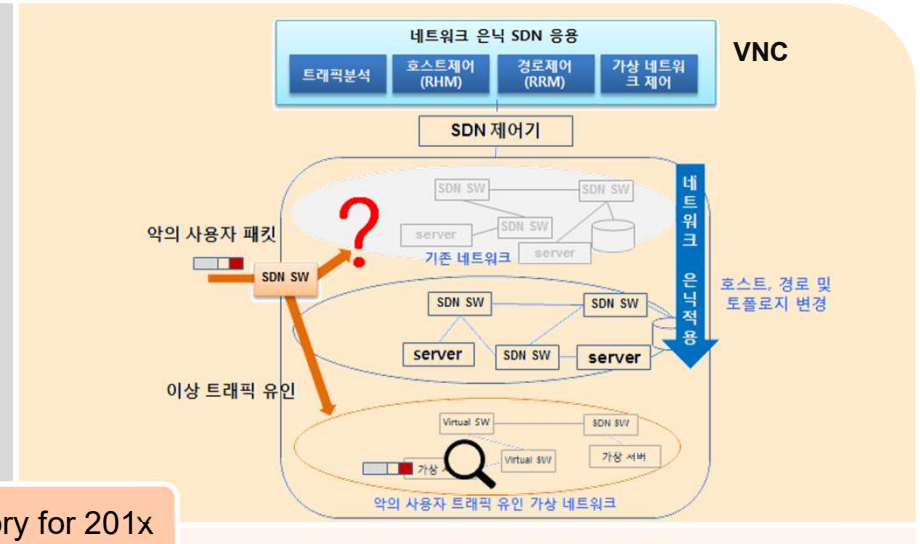


플로우 기반 유/무선 네트워크 구축 및 관리

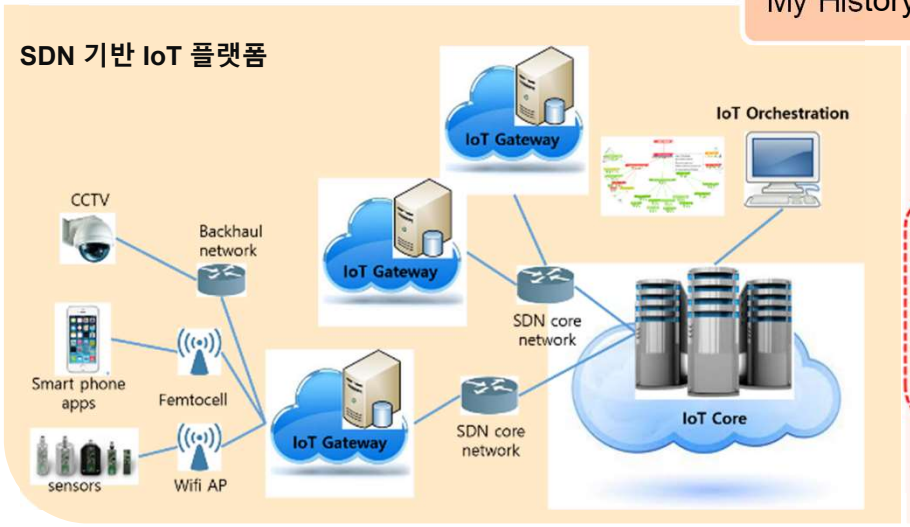


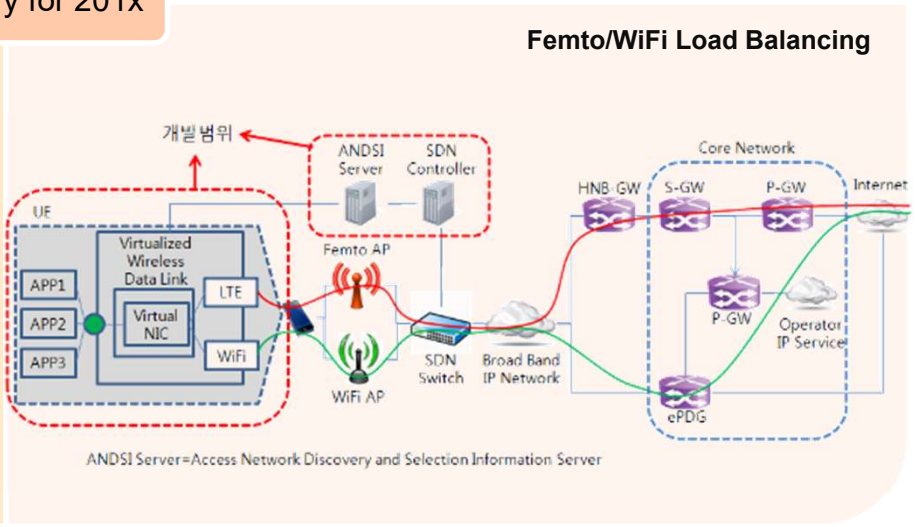
0. 소개 – My history for 201x

❖ Enterasys Networks, NAIM Networks, SDN/NFV 포럼, ONF, JS Lab



My History for 201x





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I. 개요

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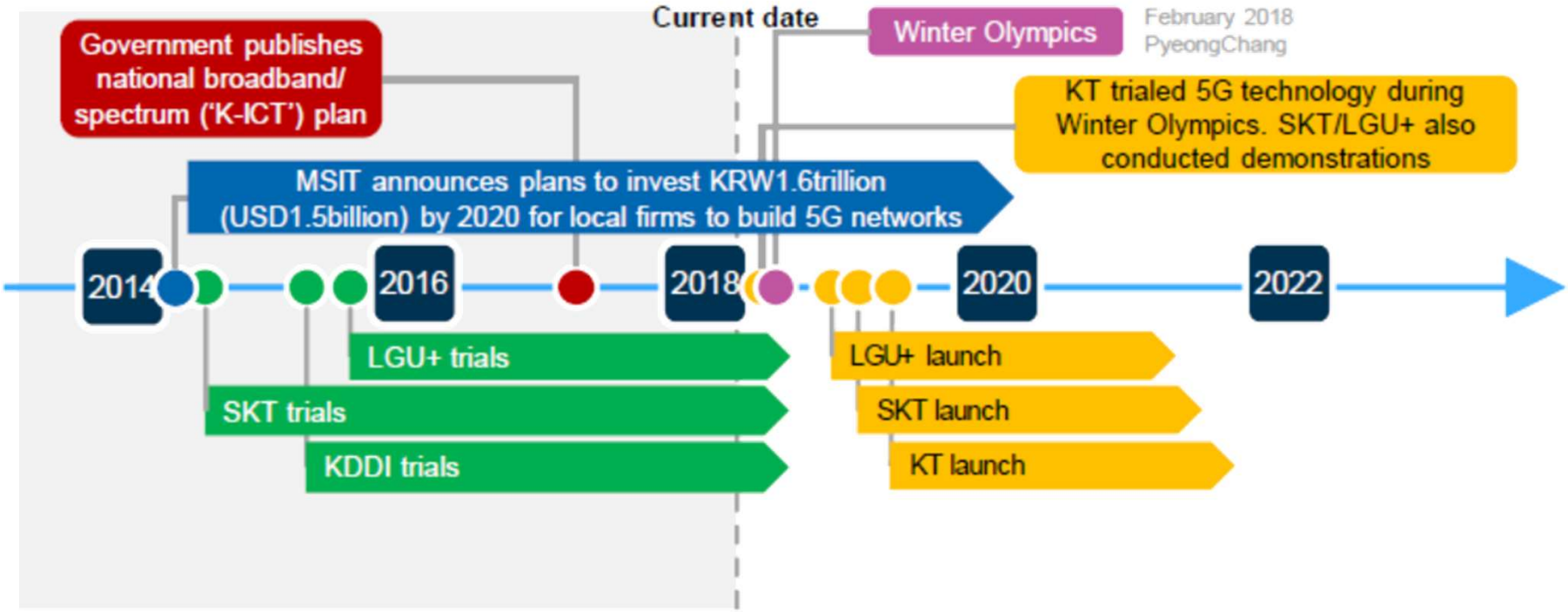
❖ 5G Roadmap



South Korea – 5G launch timeline [Source: Analysys Mason, 2018]

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I. 개요

❖ Avatar 2009년 개봉, 1994년 시나리오 .. SDN/NFV는?

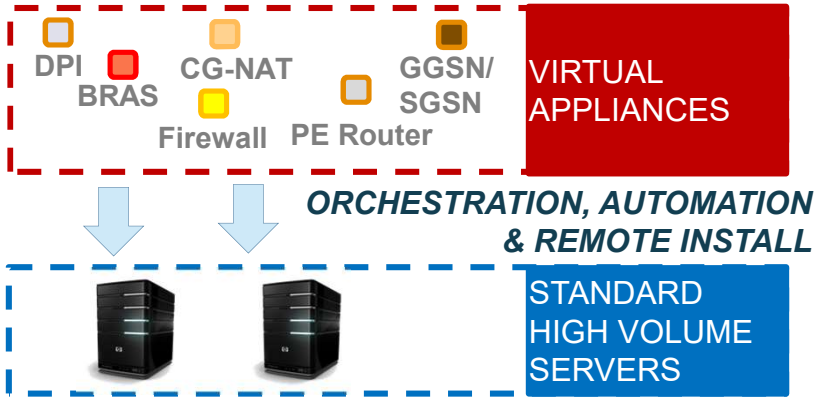
I. 개요

❖ NFV 개념: 하드웨어 의존성을 최소화 하는 네트워크 가상화로 독립적이며 유연하고 단순한 네트워크를 만드는 도구 제공

Traditional Network Model: APPLIANCE APPROACH

- Network Functions are **based on specific HW&SW**
- **One physical node per role**

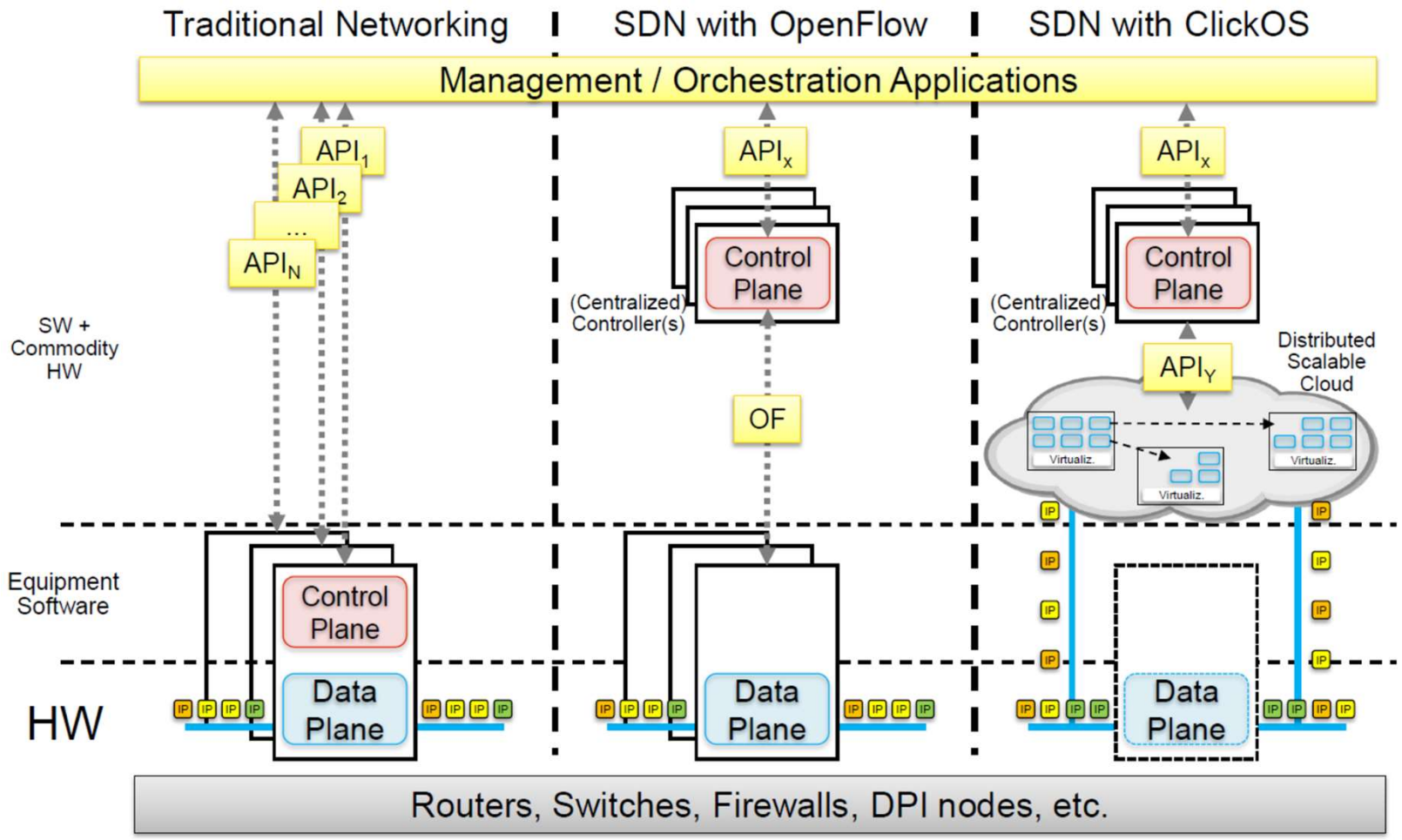
Virtualised Network Model: VIRTUAL APPLIANCE APPROACH



- Network Functions are **SW-based over well-known HW**
- **Multiple roles** over **same HW**

I. 개요

- ❖ NFV 와 SDN은 독립적이며 상호 보완
- ❖ SDN 역할: 과금 가능한 D2D, NFV 성능 개선, DevOps, …



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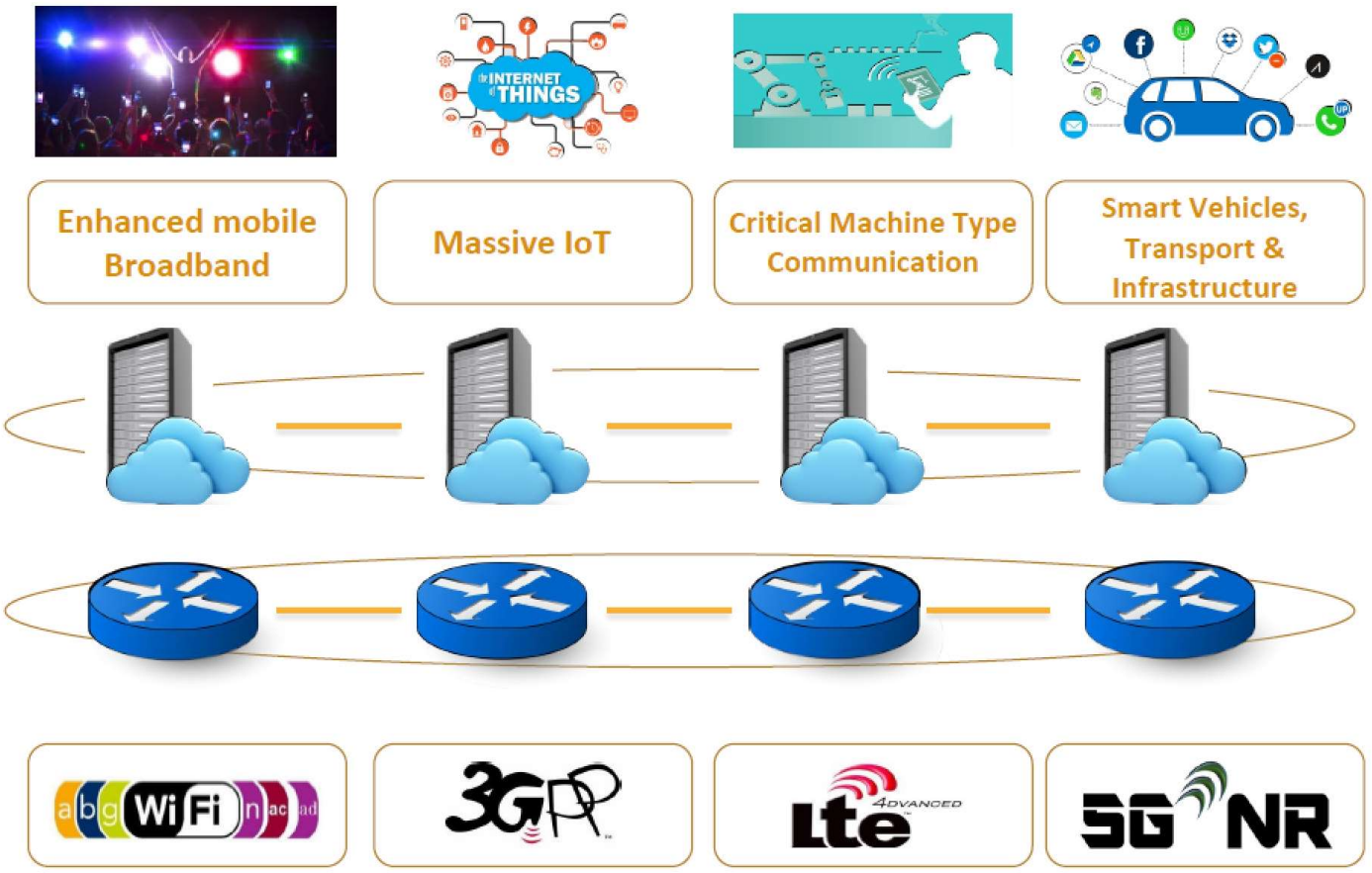
I. 개요

❖ 5G 코어의 SDN/NFV

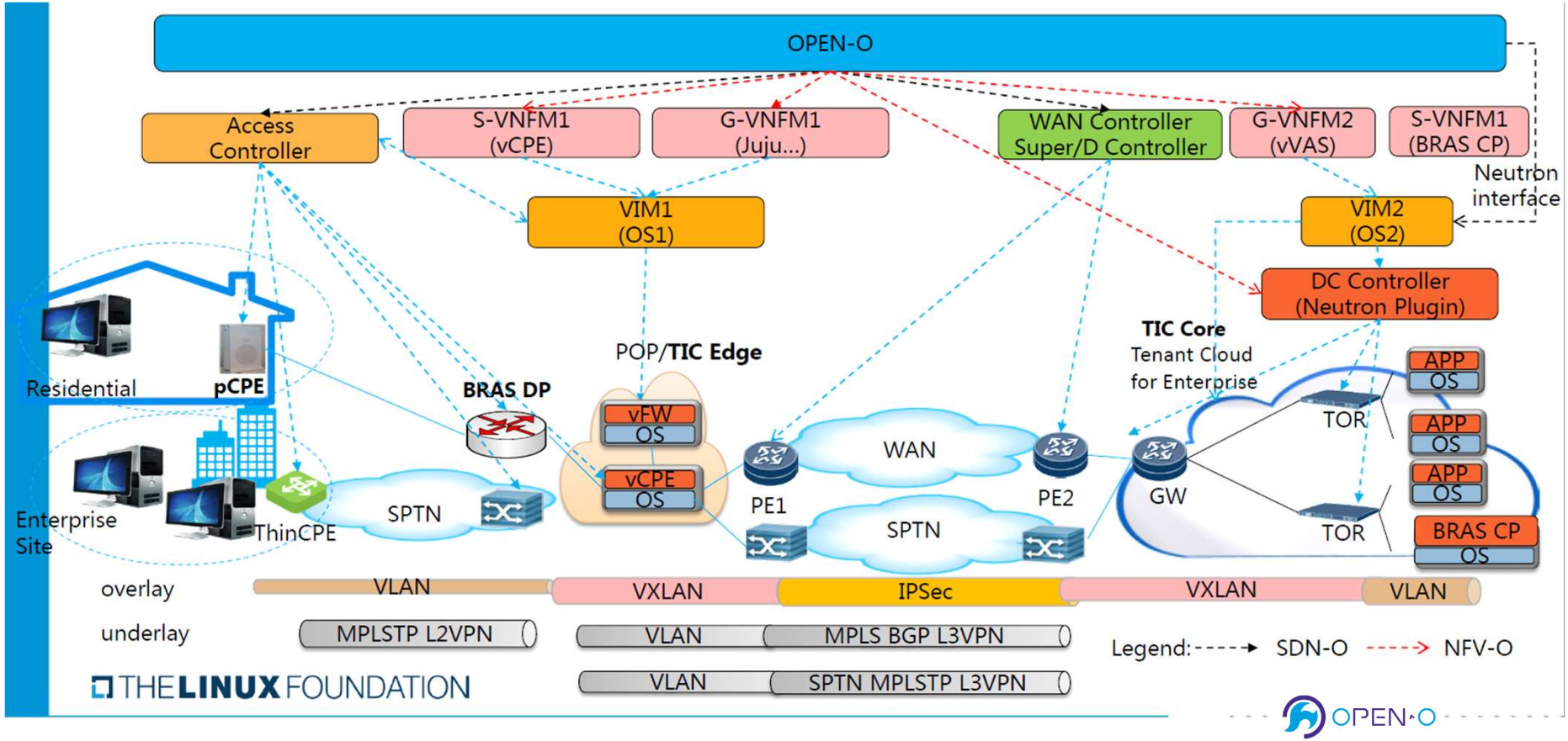
❖ 필요 기능 구현을 위한 기술 설계



- 서비스
- 슬라이싱
- **NFV**
  (CDN, EPC, DNS,..)
- **SDN**
  (WDM, IP,..)
- **Multi-RAT**

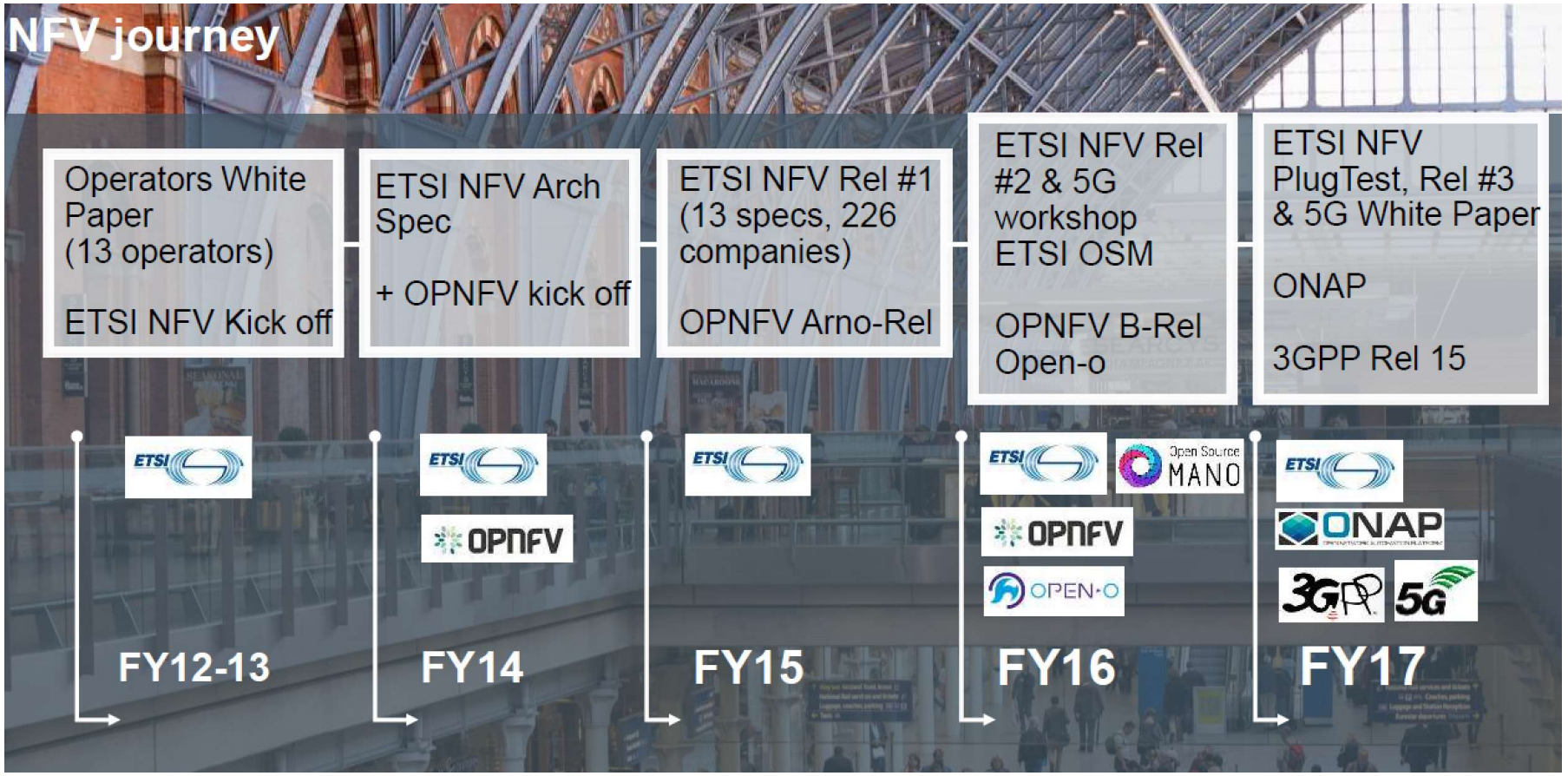
I. 개요

❖ 종단간 SDN/NFV 서비스를 위한 오케스트레이터 필요 (OPEN-O)



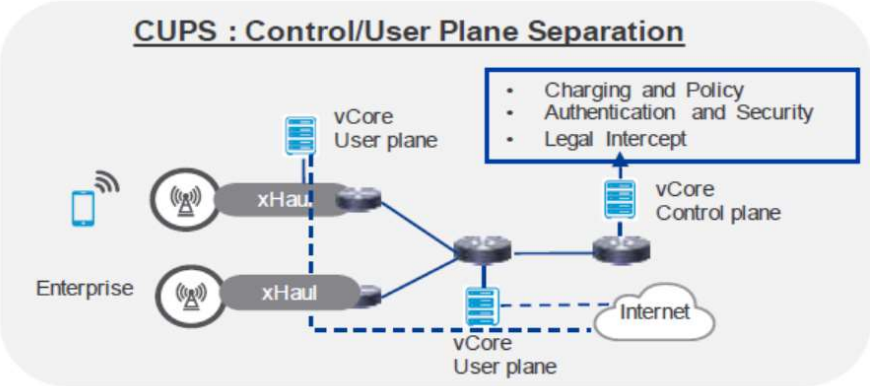
I. 개요

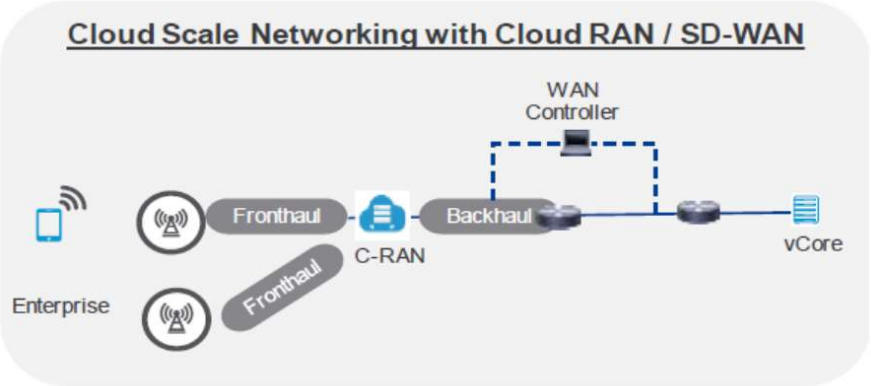
- ❖ SDN/NFV 발전
- ❖ Container 기반 Cloud 기술 도입 가속화

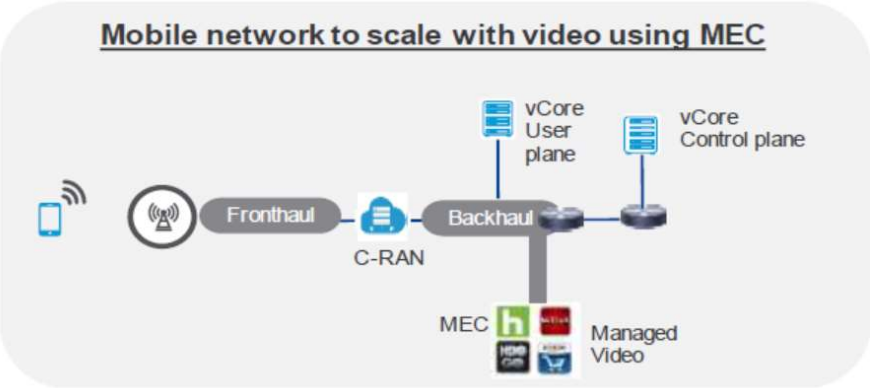


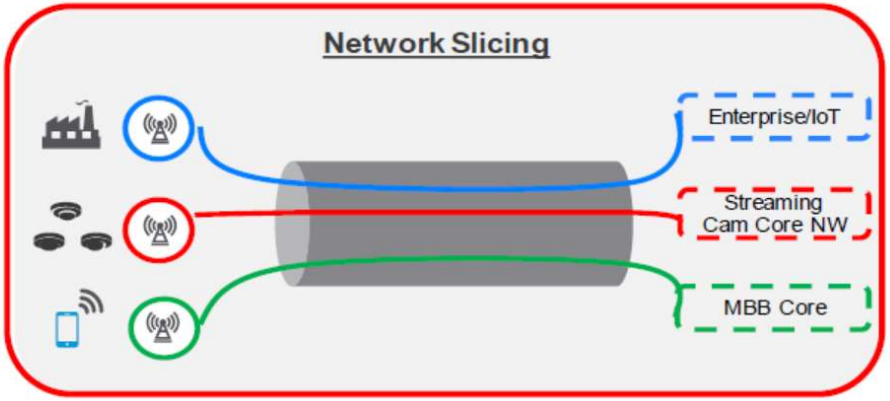
I. 개요

❖ **5G Enabling Technologies: CUPS, Cloud Scale, MEC, Network Slicing**





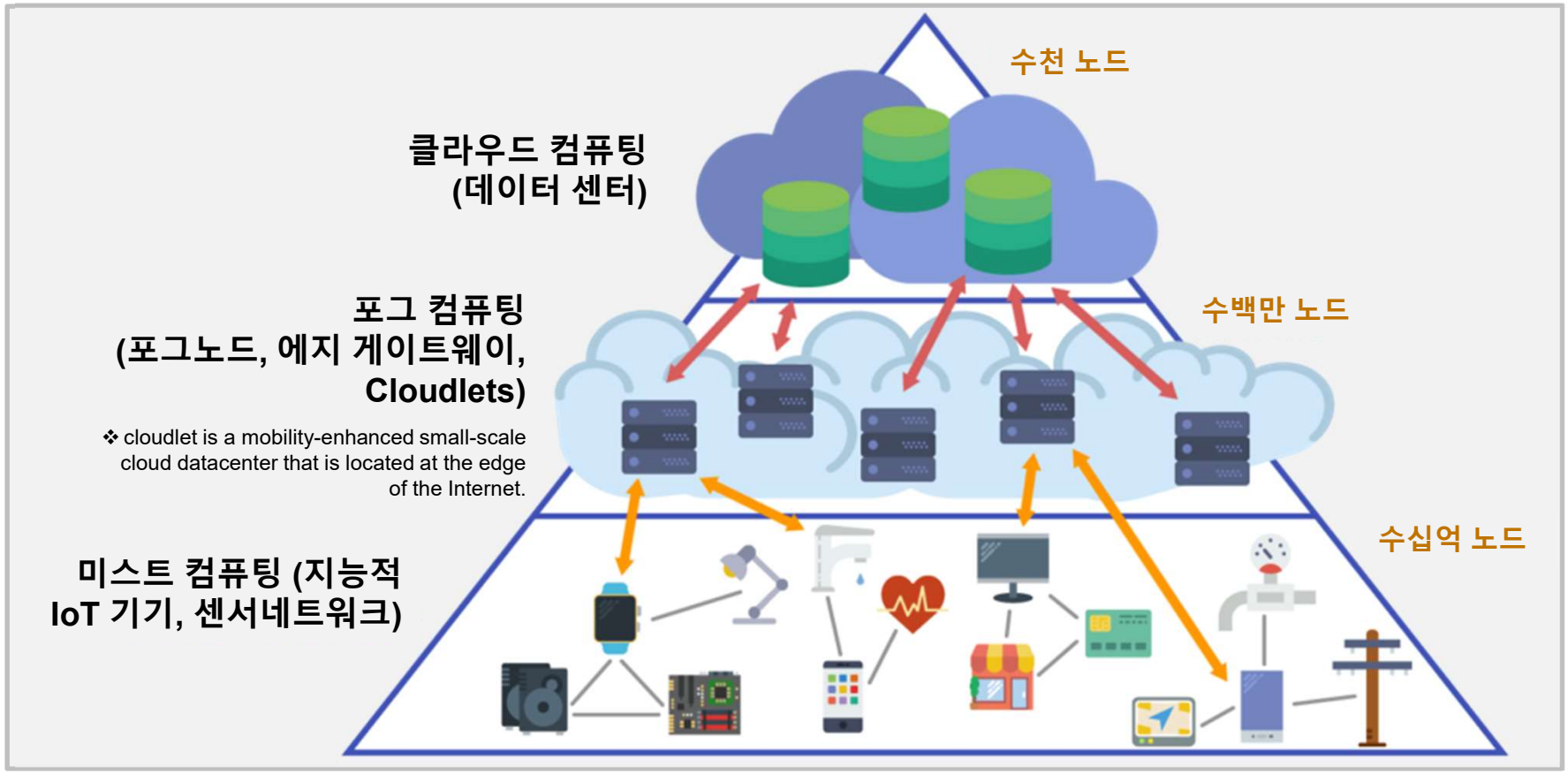




I. 개요

❖ 클라우드 서비스 기술 응용 영역의 확장

1. 클라우드 컴퓨팅 (Cloud Computing)
2. 포그 컴퓨팅 (Fog Computing)
3. 미스트 컴퓨팅 (Mist Computing)



https://www.pubnub.com/blog/moving-the-cloud-to-the-edge-computing/

I. 개요

❖ 관리 표준과 오픈소스

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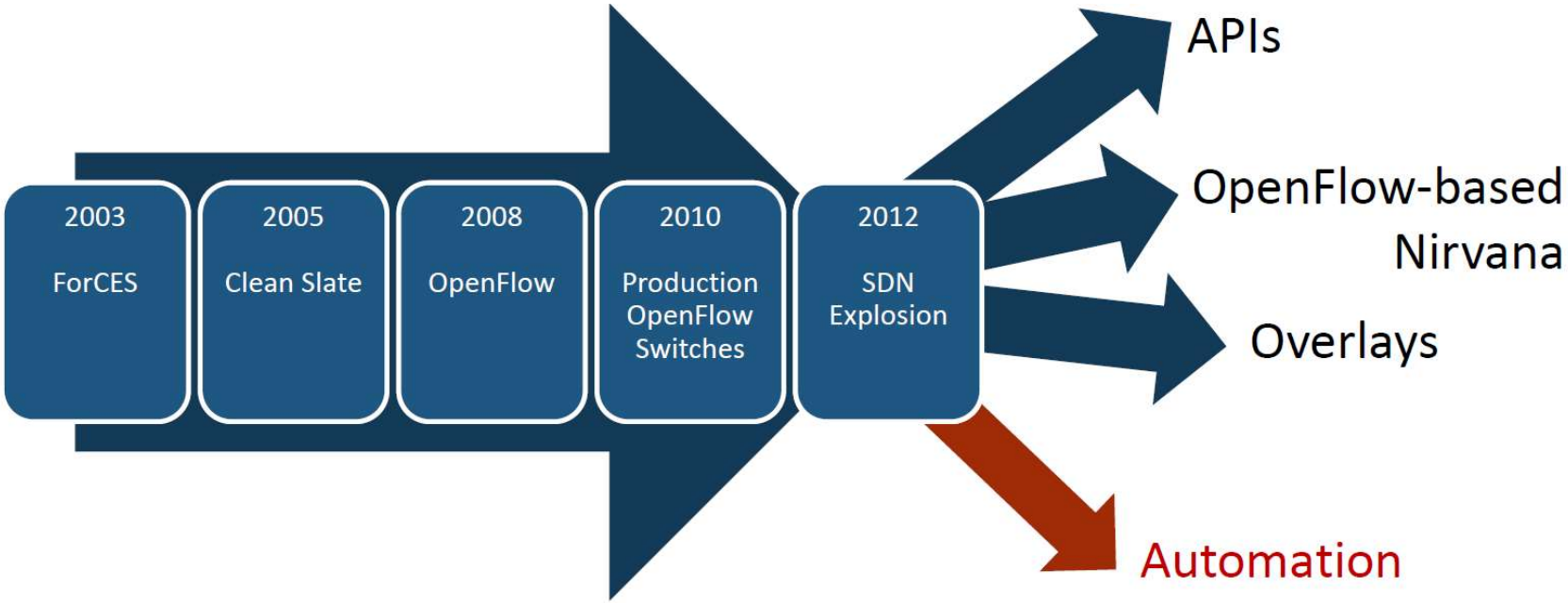
II. SDN 트렌드

II. SDN 트렌드

❖ A Brief History of SDN

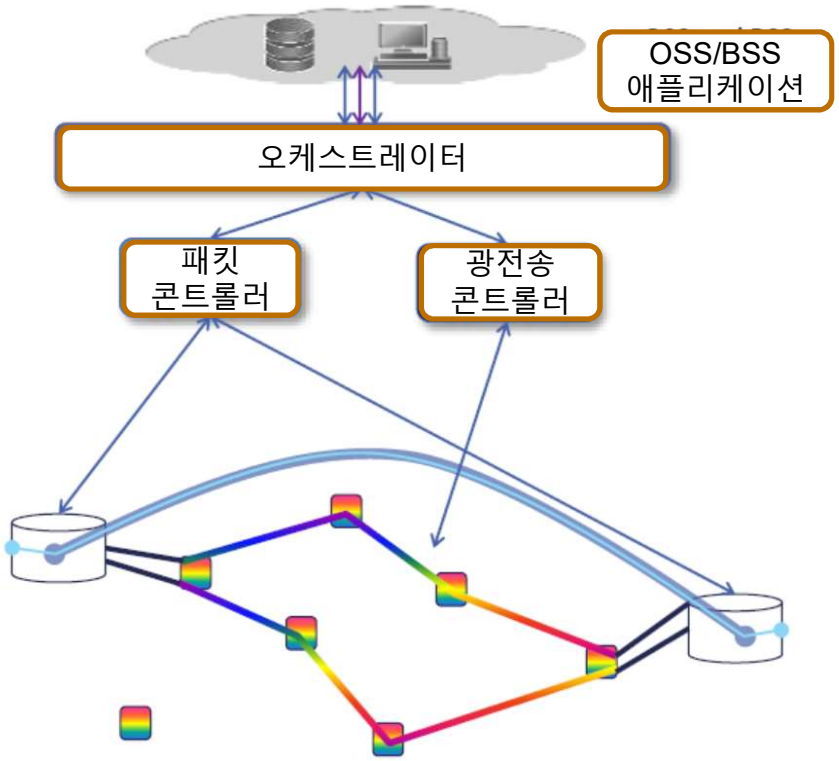
- API
- Overlays
- OpenFlow-based Nirvana
- Automation



II. SDN 트렌드

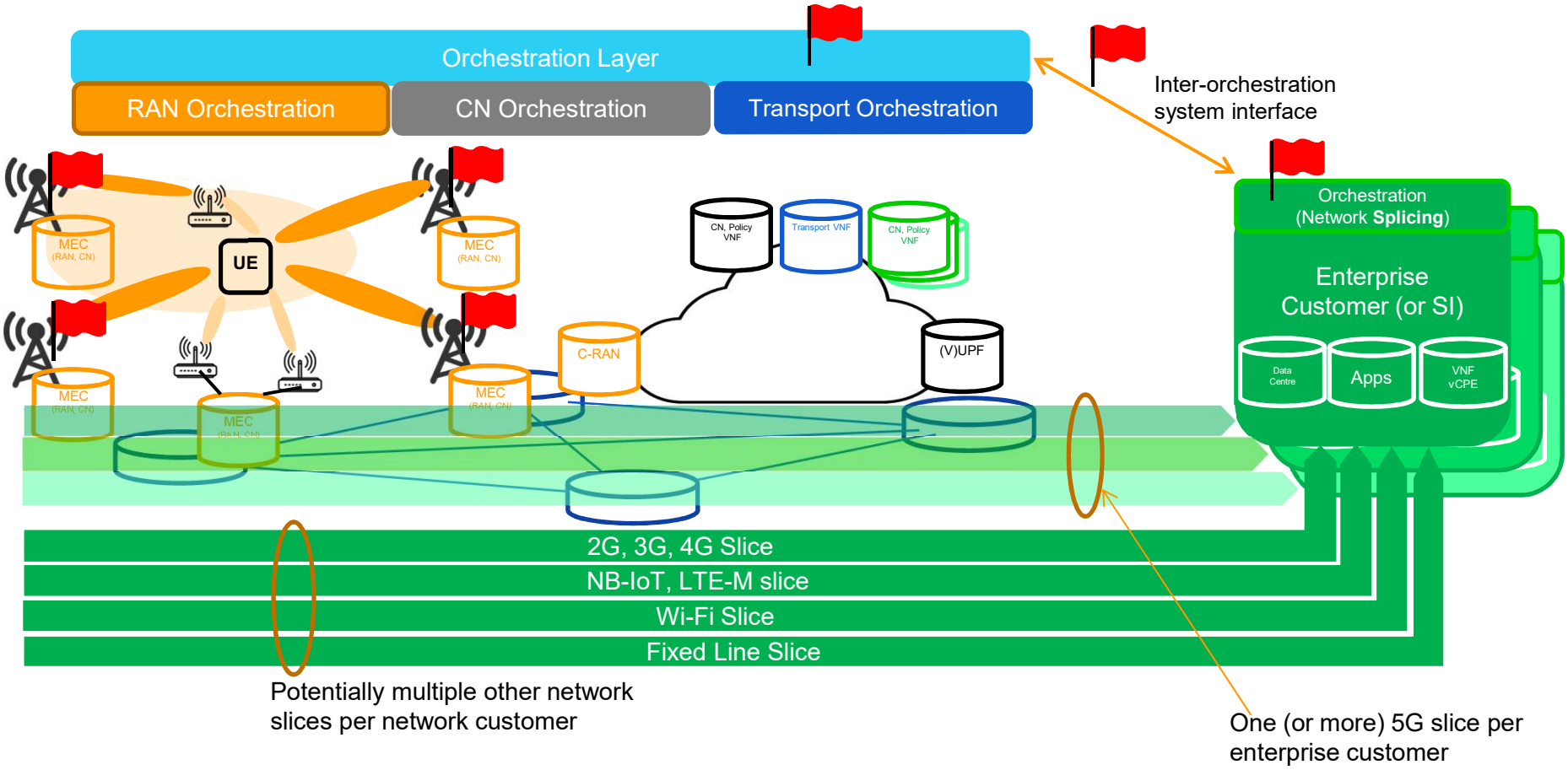
❖ Telecom 환경의 SDN 구성 : 전송(Transport) 영역 예

- Packet-Optical 멀티레이어 구성
- 레이어별 컨트롤러 사용
- 중앙 집중 오케스트레이터



II. SDN 트렌드

- ❖ **Technical Gap**
- ❖ **Pain points for commercial slicing** (by Samsung)
- ❖ **코어의 All IP 기반 제어 → SDN/NFV 기반 제어**



II. SDN 트렌드

❖ Baerfoot Networks의 P4

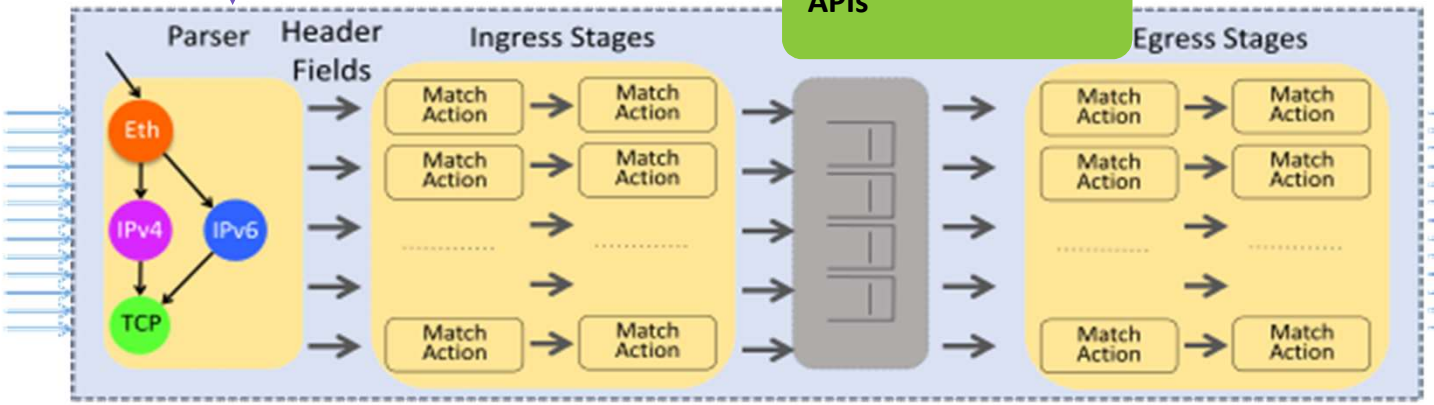
P4 Program

컴파일러 (Compiler)

Auto-Generated

APIs

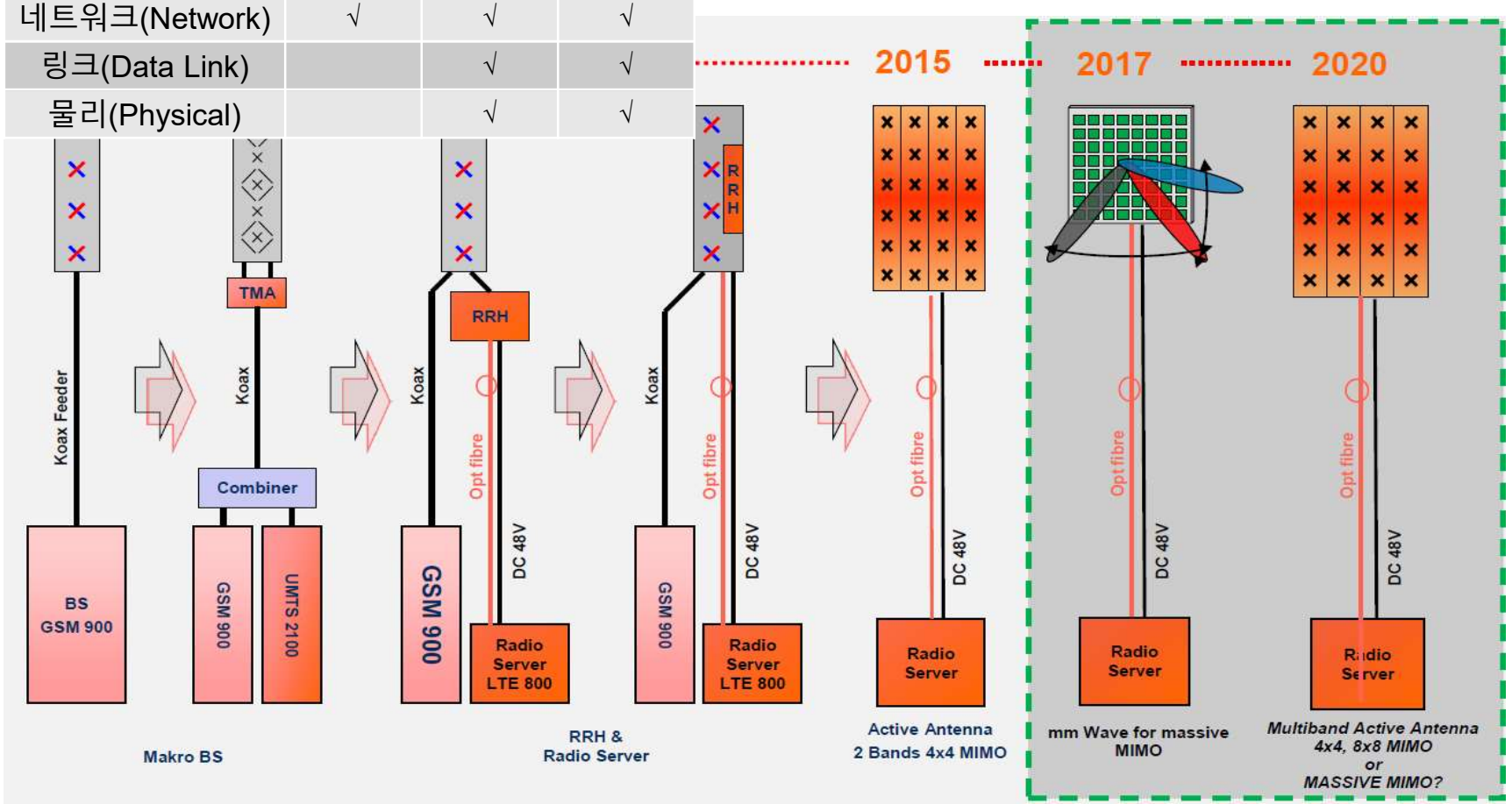
Target Binary



II. SDN 트렌드

❖ 무선 통신의 소프트웨어 정의화

Paradigm / Layer	SDN	SDR	가상화
전송(Transport)	√		√
네트워크(Network)	√	√	√
링크(Data Link)		√	√
물리(Physical)		√	√



SDR Forum: http://www.sdrforum.org → http://www.wirelessinnovation.org/

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III. Use Case

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- **ETSI의 PoC: Use Case 사용하여** 2018년 12월 현재 43개 진행
- **NFV Wiki:** https://nfvwiki.etsi.org/index.php?title=Main_Page

•PoC#1: CloudNFV Open NFV Framework
•PoC#2: Service Chaining for NW Functin Selection in Carrier Networks
•PoC#3: Virtual Function State Migration and Interoperability
•PoC#4: Multi-vendor Distributed NFV
•PoC#5: E2E vEPC Orchestration in a multi-vendor open NFVI environment
•PoC#6: Virtualised Mobile Network with Integrated DPI
•PoC#7: C-RAN virtualisation with dedicated hardware accelerator
•PoC#8: Automated Network Orchestration
•PoC#9: VNF Router Performance with DDoS Functionality
•PoC#10: NFV Ecosystem
•PoC#11: Multi-Vendor on-boarding of vIMS on a cloud management framework
•PoC#12: Demonstration of multi-location, scalable, stateful Virtual Network Function
•PoC#13: SteerFlow: Multi-Layered Traffic Steering for Gi-LAN
•PoC#14: ForCES Applicability for NFV and integrated SDN
•PoC#15: Subscriber Aware SGi/Gi-LAN Virtualization
•PoC#16: NFVIaaS with Secure, SDN-controlled WAN Gateway
•PoC#17: Operational Efficiency in NFV Capacity Planning, Provisioning and Billing
•PoC#18: VNF Router Performance with Hierarchical Quality of Service Functionality
•PoC#19: Service Acceleration of NW Functions in Carrier Networks
•PoC#20: Virality based content caching in NFV framework
•PoC#21: Network Intensive and Compute Intensive Hardware Acceleration
•PoC#22: Demonstration of High Reliability and Availability aspects in a Multivendor NFV Environment
•PoC#23: Demonstration E2E orchestration of virtualized LTE core-network functions and SDN-based dynamic service chaining of VNFs using VNF FG
•PoC#24: Constraint based Placement and Scheduling for NFV/Cloud Systems
•PoC#25: Demonstration of Virtual EPC (vEPC) Applications and Enhanced Resource Management
•PoC#26: Virtual EPC with SDN Function in Mobile Backhaul Networks
•PoC#27: VoLTE Service based on vEPC and vIMS Architecture
•PoC#28: SDN Controlled VNF Forwarding Graph
•PoC#29: Service orchestration for virtual CDN service over distributed cloud management platform
•PoC#30: LTE Virtualized Radio Access Network (vRAN)
•PoC#31: STB Virtualization in Carrier Networks
•PoC#32: Distributed Multi-domain Policy Management and Charging Control in a virtualised environment
•PoC#33: Scalable Service Chaining Technology for Flexible Use of Network Functions
•PoC#34: SDN Enabled Virtual EPC Gateway
•PoC#35: Availability Management with Stateful Fault Tolerance
•PoC#36: Active Video Monitoring in an L3VPN
•PoC#37: Demonstration high availability vEPC and SDN controlled Service Chain
•PoC#38: Full ISO 7-layer stack fulfilment, activation and orchestration of VNFs in carrier networks
•PoC#39: Virtualised service assurance management in vGi-LAN
•PoC#40: VNFaaS with end-to-end full service orchestration
•PoC#41: Network Function Acceleration with resource orchestration
•PoC#42: Mapping ETSI-NFV onto Multi-Vendor, Multi-Domain Transport SDN
•PoC#43: Toward an efficient dataplane processing

https://www.etsi.org/technologies-clusters/technologies/nfv/nfv-poc

III. Use Case

❖ 제조사, 통신사 참여 PoC

PoC	NFV Use Case **	Carriers	Vendors
CloudNFV Open NFV Framework	Use Case #5 Virtualization of the Mobile Core and IMS	Sprint Telefonica	6Wind, Dell, Enterprise Web, Huawei, Mellanox, Overture, Qosmos
Service Chaining for NW Function Selection in Carrier Networks	Use Case #2 Virtual Network Function as a Service (VNFaaS) , Use Case #4 Virtual Network Forwarding Graphs	NTT	Cisco, HP, Juniper
Virtual Function State Migration and Interoperability	Use Case #1, NFV Infrastructure as a Service (NFVIaaS)	AT&T BT	Broadcom, Tieto
Multi-vendor Distributed NFV	Use Case #2 VNFaaS, Use Case #4 Virtual Network Forwarding Graphs	CenturyLink	Certes, Cyan, Fortinet, RAD
E2E vEPC Orchestration in a multi-vendor open NFVI environment	Use Case #1 NFVIaaS, Use Case #5 Virtualization of the Mobile Core and IMS	Sprint Telefonica	Connectem, Cyan, Dell, Intel
Virtualised Mobile Network with Integrated DPI	Use Case #2 VNFaaS, Use Case #5 Virtualization of the Mobile Core and IMS, Use Case #6 Virtualisation of Mobile base station	Telefonica	HP, Intel, Qosmos, Tieto, Wind River
C-RAN virtualisation with dedicated hardware accelerator	Use Case #6 Virtualisation of Mobile base station	China Mobile	Alcatel-Lucent, Intel, Wind River
Automated Network Orchestration	Use Case #1 NFVIaaS	Deutsche Telekom	Ericsson, x-ion
VNF Router Performance with DDoS Functionality	Use Case #2 VNFaaS	AT&T, Telefonica	Brocade, Intel

III. Use Case

❖ SDN 사용 NFV PoC

ETSI NFV POC with SDN	SDN NE	SDN Controller	Comment
POC#1 - Open NFV Framework Project			
POC#2 - Service Chaining for NW function selection in Carrier Networks	OpenFlow	RYU	
POC#8 - Automated Network Orchestration	OpenFlow	OpenDaylight	
POC#13 - Multi-Layered Traffic Steering for Gi-Lan	OpenFlow	Vendor SDN controller	
POC#14 - Forces applicability for NFV and integrated SDN	Forces		
POC#15 - Subscriber Aware Sgi/Gi-lan virtualisation	OpenFlow	OpenDaylight	
POC#16 - NFVIaaS with Secure SDN-controlled WAN Gateway	OF 1.3	RYU	
POC#21 - Network intensive and compute intensive hardware acceleration	OpenFlow	Floodlight (POF)	
POC#23 - E2E orchestration of Virtualised LTE Core-Network functions	OpenFlow	Proprietary controller	
POC#26 - Virtual EPC with SDN functions in Mobile Backhaul Networks	OpenFlow	Ryu	
POC#27 - VoLTE Service based on vEPC and vIMS architecture	OpenFlow, OF-epc		
POC#28 - SDN Controlled VNF Forwarding graph	OpenFlow	Vendor SDN controller	
POC#34 - SDN-enabled Virtual EPC Gateway	OpenFlow	OpenDaylight	With extensions for GTP
POC#38 - Full ISO-7 layer stack fulfilment, activation and orchestration of VNFs in carrier networks	OpenFlow	Vendor SDN controller	

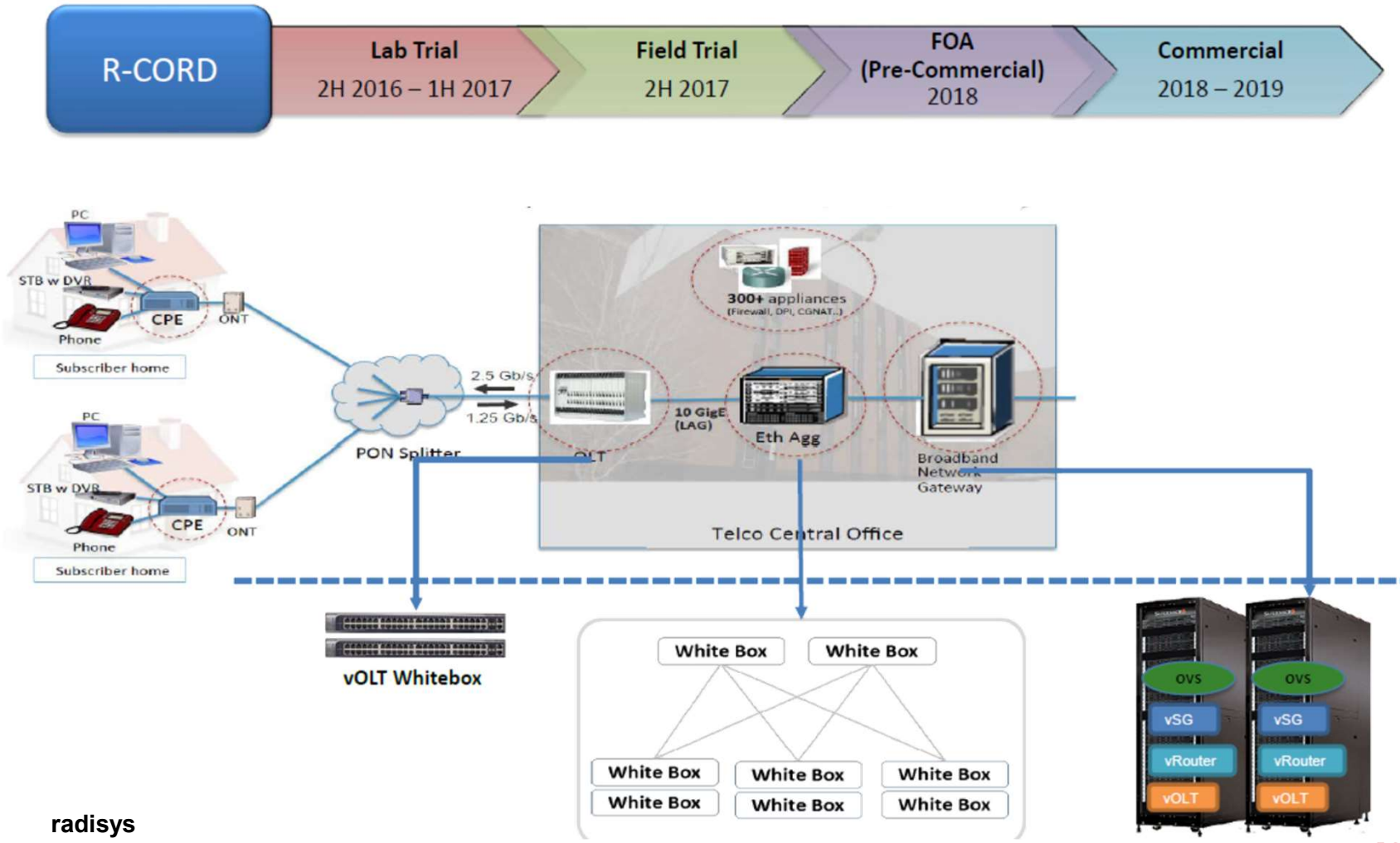
III. Use Case

- ❖ **Ericsson 참여 PoC / Use Cases**
- ❖ **NFV Wiki에서 PoC/Use Case Report 공개 중**
- ❖ **NFV Wiki:** https://nfvwiki.etsi.org/index.php?title=Main_Page

PoC	Main Contact	e-mail	PoC team	Use Cases
#8: Automated Network Orchestration	Christoph Meyer	christoph.meyer@ericsson.com	Deutsche Telekom Ericsson X-ion	UC#1: Network Functions Virtualisation Infrastructure as a Service
#19: Service Acceleration of NW Functions in Carrier Networks	Bob Monkman	Bob.Monkman@arm	AT&T Ericsson Avago Technologies ARM Tieto Procera	UC#2: Virtual Network Function as a Service (VNFaaS) UC#4:VNF Forwarding Graphs

III. Use Case

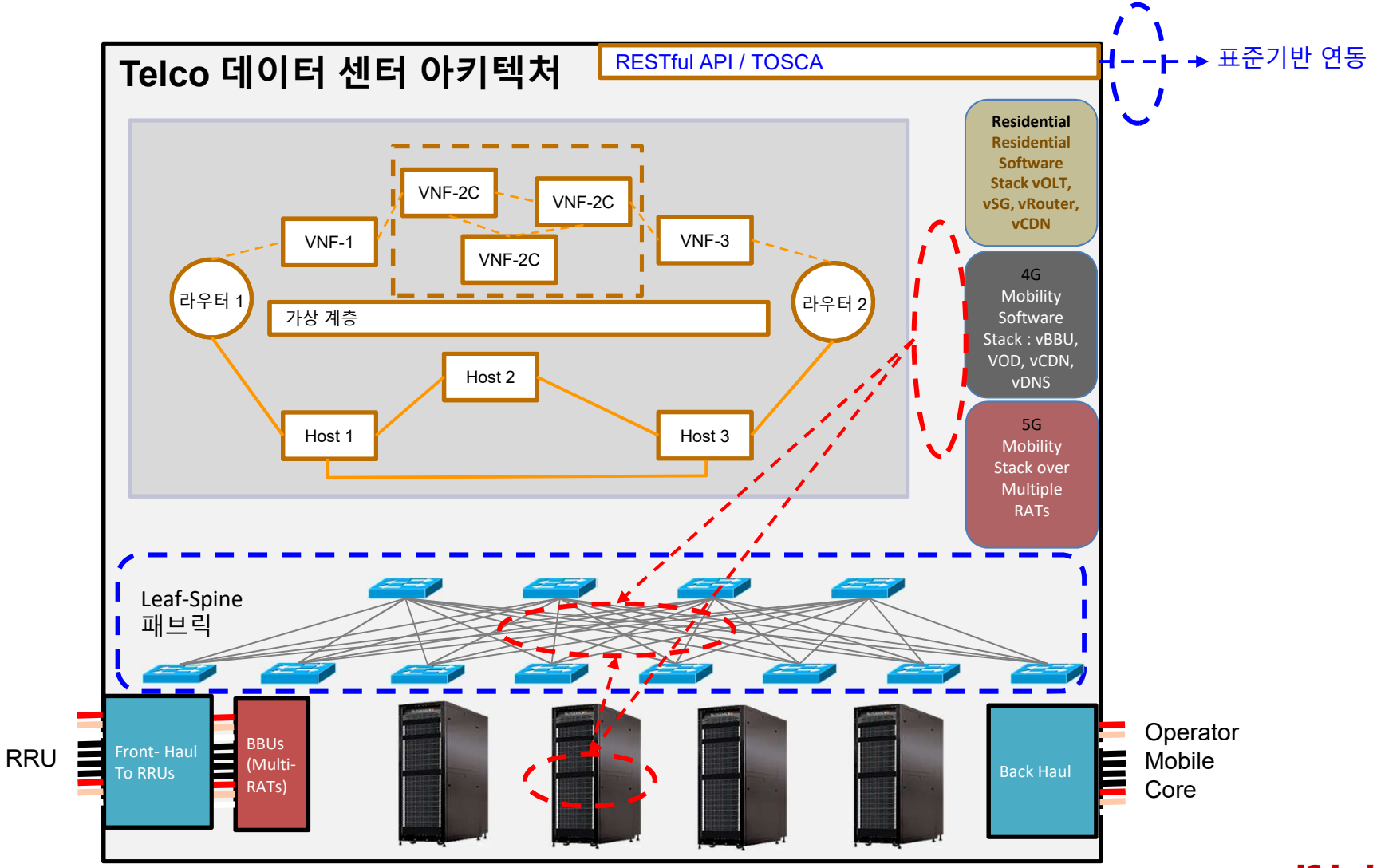
❖ 통신 시설의 변화 (데이터센터化)



radisys

III. Use Case

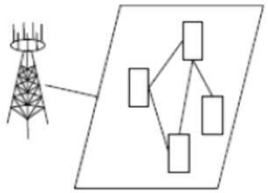
❖ **데이터센터化 하는 통신국사:** SDN 제어기, OpenStack, XOS and more



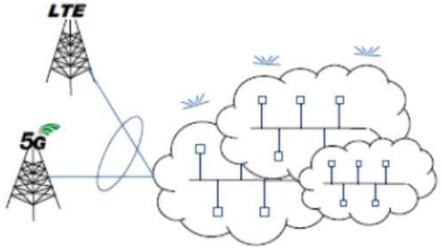
BBU (Baseband Unit) RRU (Remote Radio Unit) vSG (Virtual Subscriber Gateway) RAT (Radio Access Technology)

III. Use Case

❖ 5G 코어(Core) 네트워크 아키텍처 변화



5G



- Functional entities
- Single Core
- Dedicated protocols

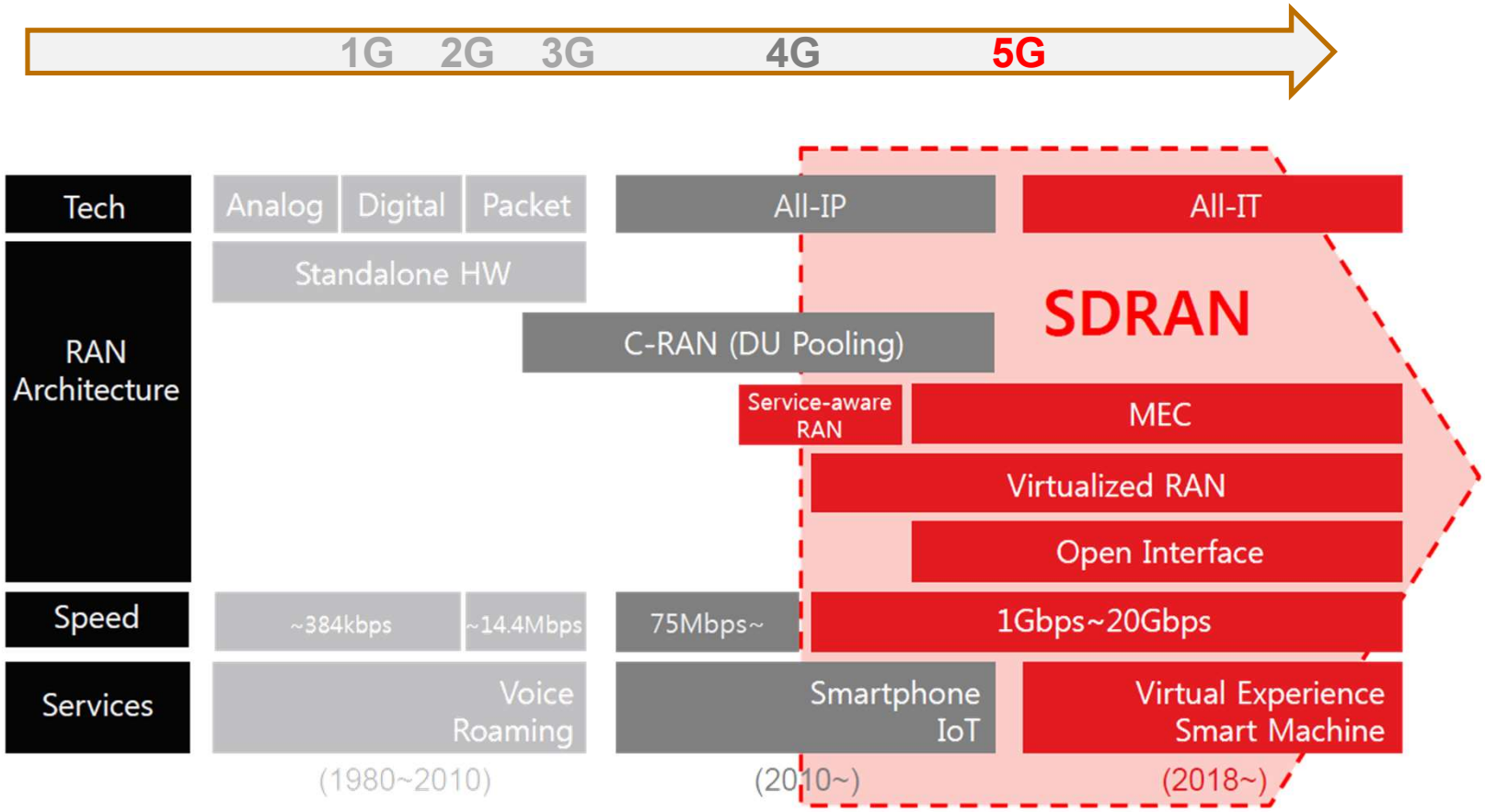
- Service Based (SBA/SBI/NAPS)
- Virtualization & Slicing
- Softwarization/ Cloudification
- Application Programming Interfaces
- Harmonized protocols (HTTP ...)
- Exposure to 3rdParties
- Backward & Forward Compatibility

Source: Georg Mayer
https://cloudifynetwork.com

SBA: Service Based Architecture SBI: Service Base Interface NAPS: Northbound APIs

III. Use Case

❖ 소프트웨어 정의 무선 통신 환경



SK telecom

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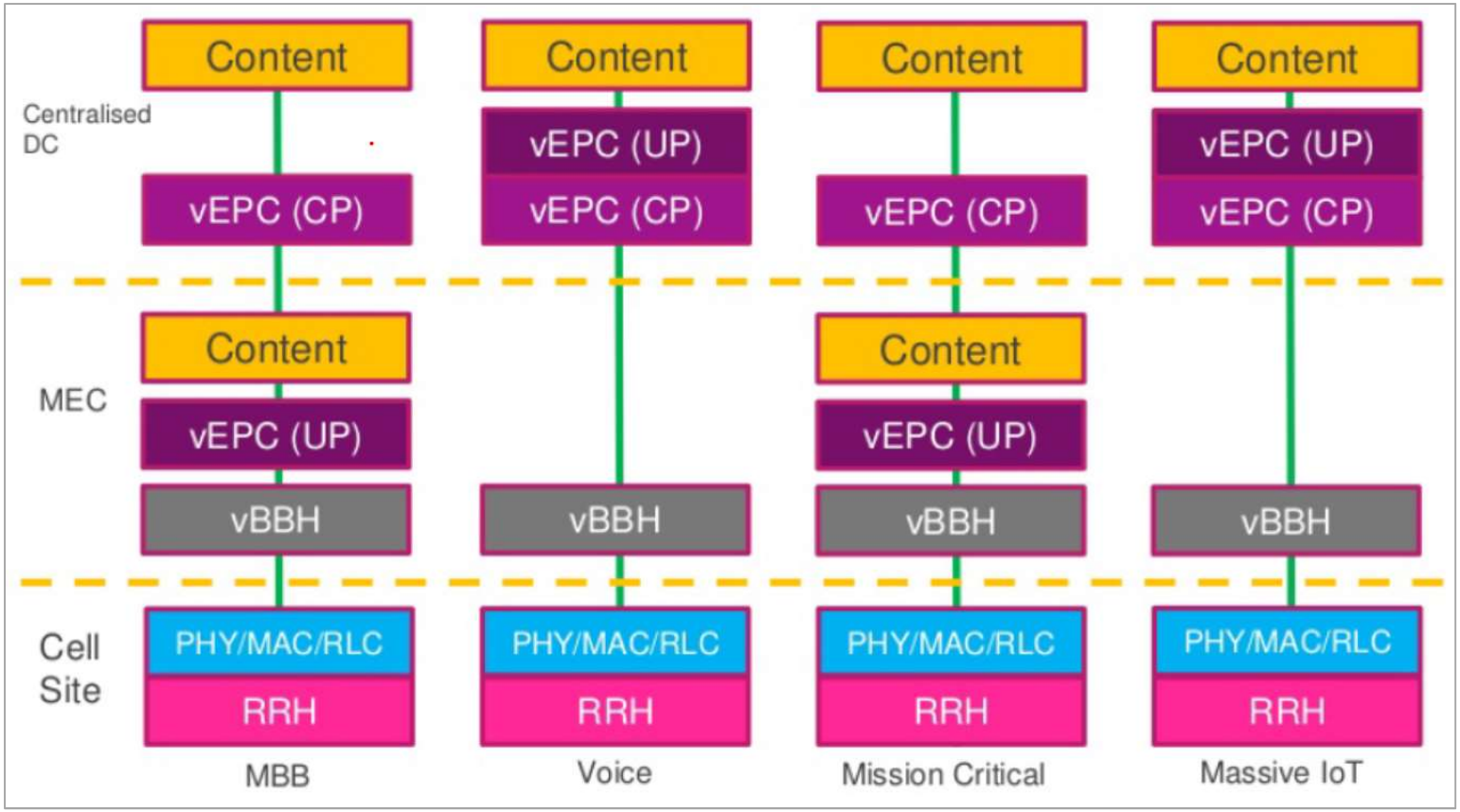
III. Use Case

❖ Network Slicing (네트워크 슬라이싱)



Jeff Schmidt 12/2017

Enhanced Mobile. Broadband(eMBB) Virtual Evolved Packet Core (vEPC) Remote Radio Head (RRH) Baseband Hotels (BBH)

III. Use Case

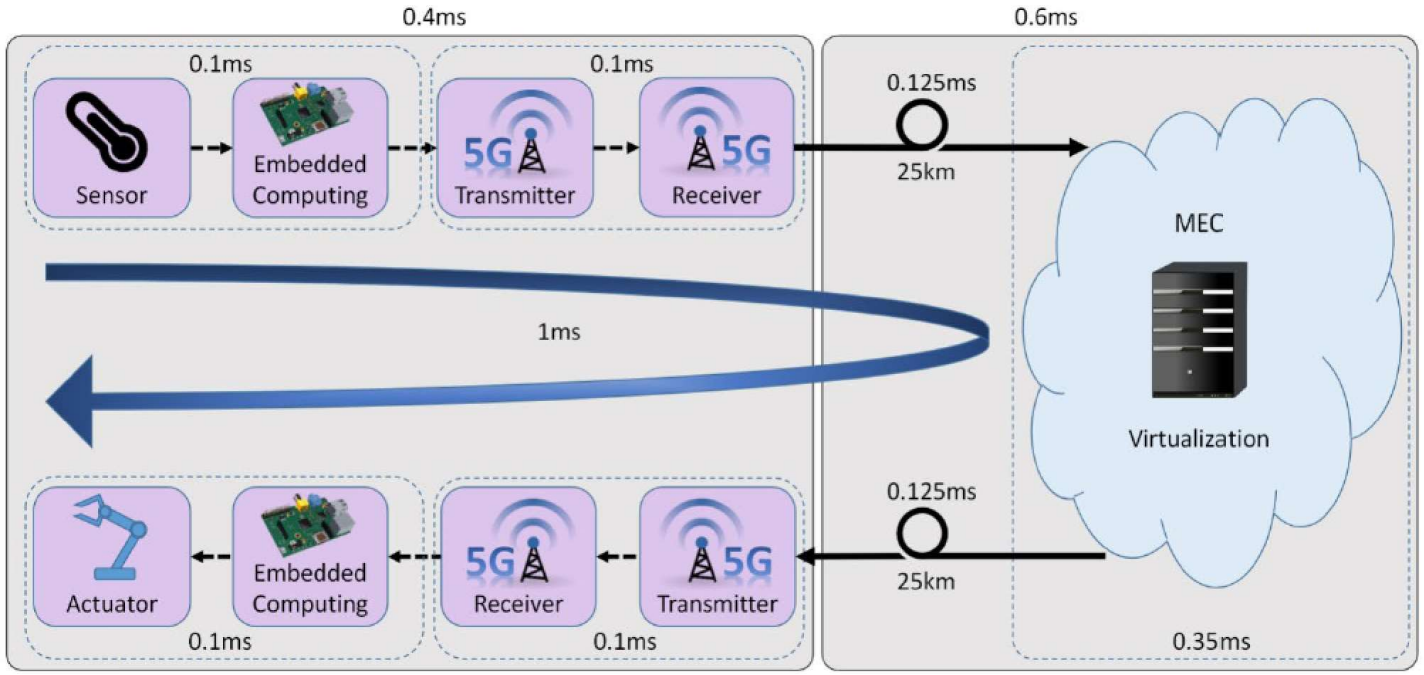
❖ 권장 사용자 경험치(UE Requirement: Data rate, Latency, Mobility)

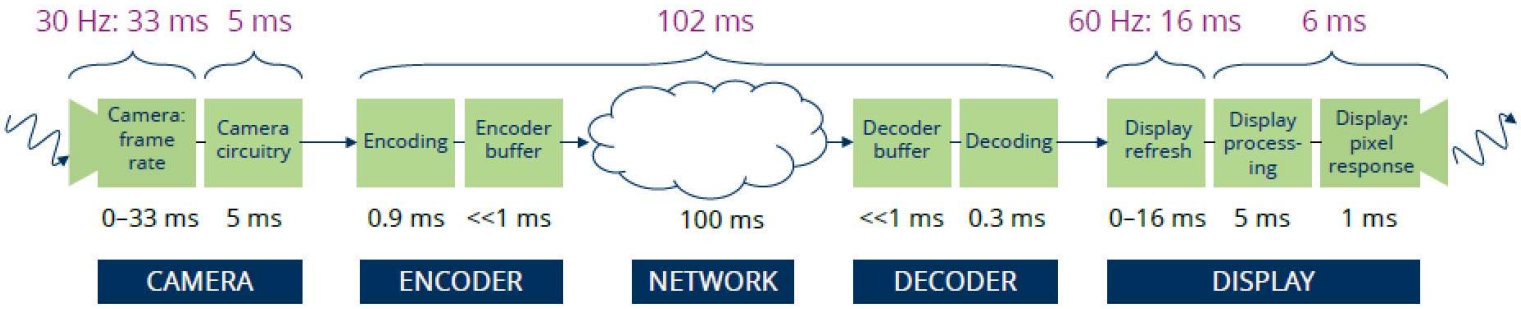
Use case category	Connection Density	Traffic Density
Broadband access in dense areas	200-2500 /kr	
Indoor ultra-high broadband access	75,000 / km^2 (75/1000 m^2	
Broadband access in a crowd	150,000 / km (30.000 / sta	
50+ Mbps everywhere	400 / km^2 in s 100 / km^2 in r	
Ultra-low cost broadband access for low ARPU areas	16 / km^2	
Mobile broadband in vehicles (cars, trains)	2000 / km^2 (500 active u trains, or 1 active us cars)	
Airplanes connectivity	80 per plane 60 airplanes	
Massive low-cost/long-range/low-power MTC	Up to 200,00	
Broadband MTC	See the requ and 50+Mbp	
Ultra-low latency	Not critical	
Resilience and traffic surge	10,000 / km^2	
Ultra-high reliability & Ultra-low latency* (*) the reliability requirement for this category is described in Section 4.4.5	Not critical	
Ultra-high availability & reliability* (*) the reliability requirement for this category is described in Section 4.4.5	Not critical	
Broadcast like services	Not relevant	Not relevant

Use case category	User Experienced Data Rate	E2E Latency	Mobility
Broadband access in dense areas	DL: 300 Mbps UL: 50 Mbps	10 ms	On demand, 0-100 km/h
Indoor ultra-high broadband access	DL: 1 Gbps, UL: 500 Mbps	10 ms	Pedestrian
Broadband access in a crowd	DL: 25 Mbps UL: 50 Mbps	10 ms	Pedestrian
50+ Mbps everywhere	DL: 50 Mbps UL: 25 Mbps	10 ms	0-120 km/h
Ultra-low cost broadband access for low ARPU areas	DL: 10 Mbps UL: 10 Mbps	50 ms	on demand: 0-50 km/h
Mobile broadband in vehicles (cars, trains)	DL: 50 Mbps UL: 25 Mbps	10 ms	On demand, up to 500 km/h
Airplanes connectivity	DL: 15 Mbps per user UL: 7.5 Mbps per user	10 ms	Up to 1000 km/h
Massive low-cost/long-range/low-power MTC	Low (typically 1-100 kbps)	Seconds to hours	on demand: 0-500 km/h
Broadband MTC	See the requirements for the Broadband access in dense areas and 50+Mbps everywhere categories		
Ultra-low latency	DL: 50 Mbps UL: 25 Mbps	<1 ms	Pedestrian
Resilience and traffic surge	DL: 0.1-1 Mbps UL: 0.1-1 Mbps	Regular communication: not critical	0-120 km/h
Ultra-high reliability & Ultra-low latency	DL: From 50 kbps to 10 Mbps; UL: From a few bps to 10 Mbps	1 ms	on demand: 0-500 km/h
Ultra-high availability & reliability	DL: 10 Mbps UL: 10 Mbps	10 ms	On demand, 0-500 km/h
Broadcast like services	DL: Up to 200 Mbps UL: Modest (e.g. 500 kbps)	<100 ms	on demand: 0-500 km/h

III. Use Case

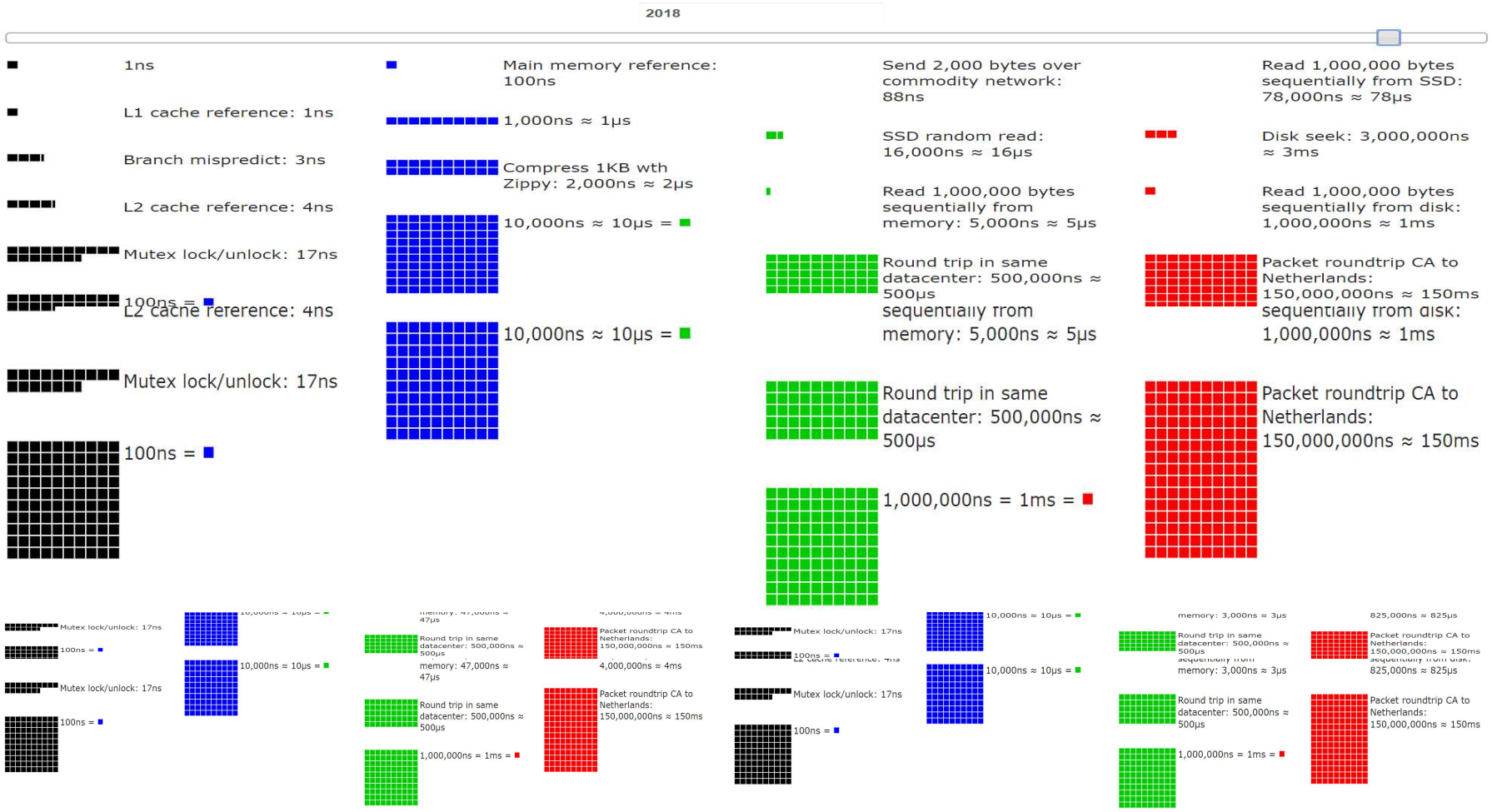
❖ Latency 고려 Use Case 별 인프라





III. Use Case

❖ **Latency 고려 Core 설계** (Data Plane과 Control Plane의 위치 고려)

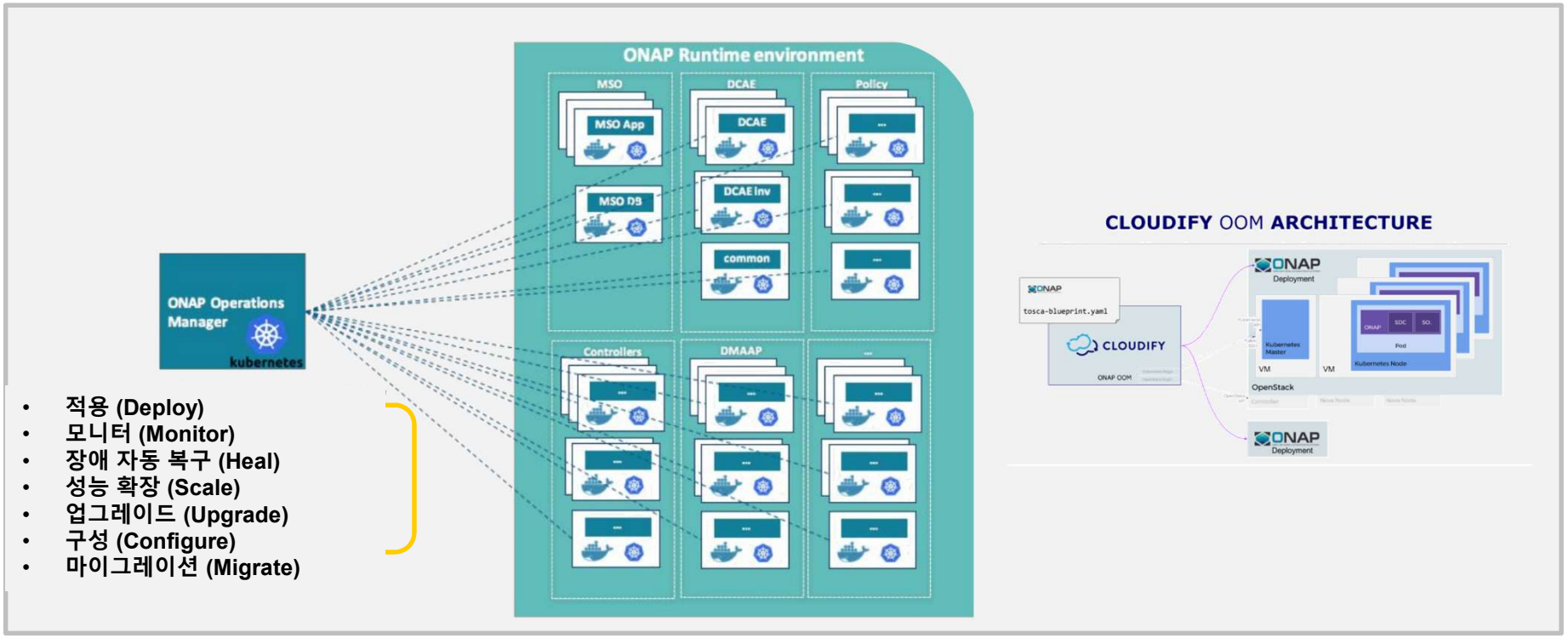


https://people.eecs.berkeley.edu/~rcs/research/interactive_latency.html

III. Use Case

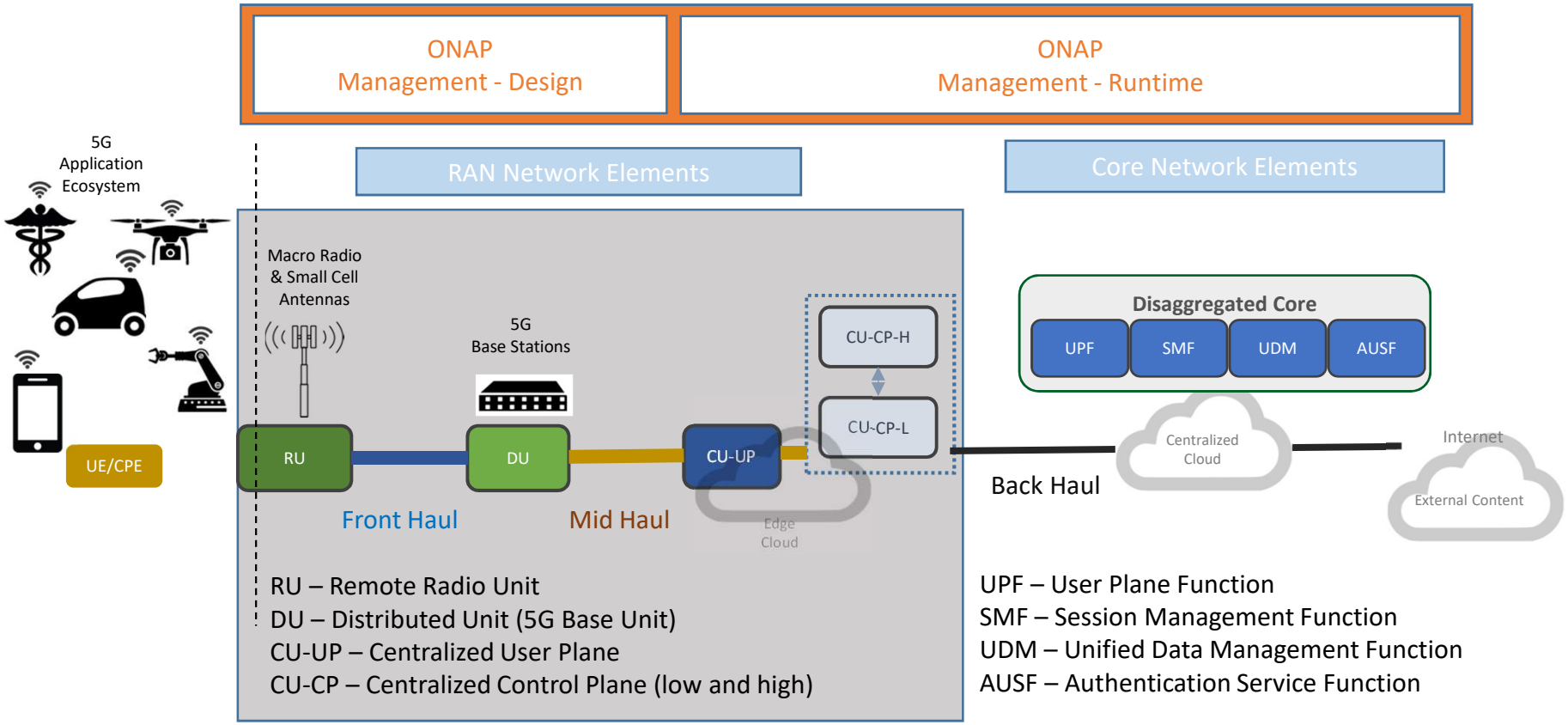
❖ ONAP Operation Manager (OOM)

- 리눅스재단 프로젝트: AT&T 제안 ECOMP
- 도커(Docker)와 쿠버네티스(Kubernetes) 사용 마이크로서비스 구성
- 멀티스택 / 멀티클라우드



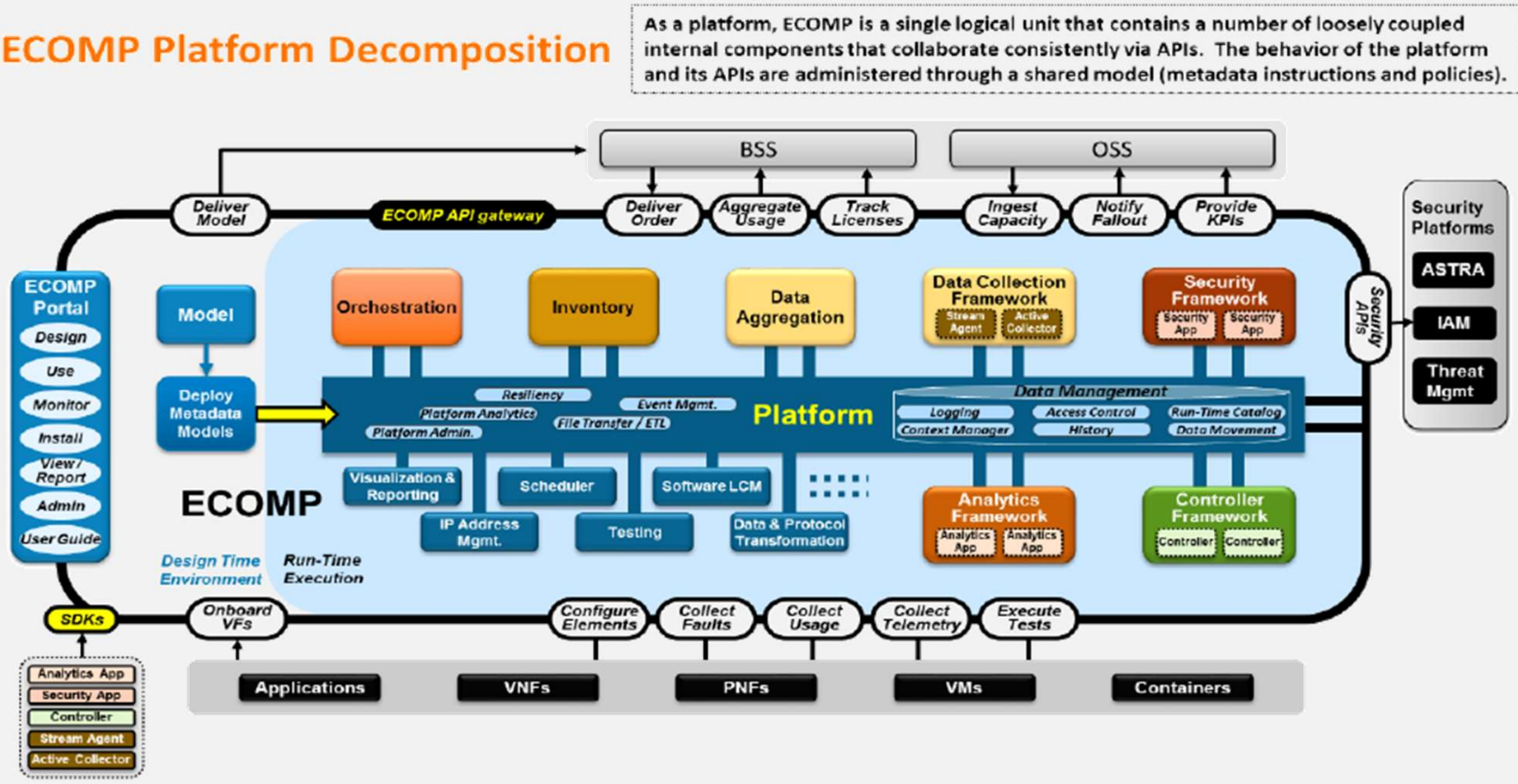
III. Use Case

❖ 5G Radio Access by ONAP – Network Architecture



III. Use Case

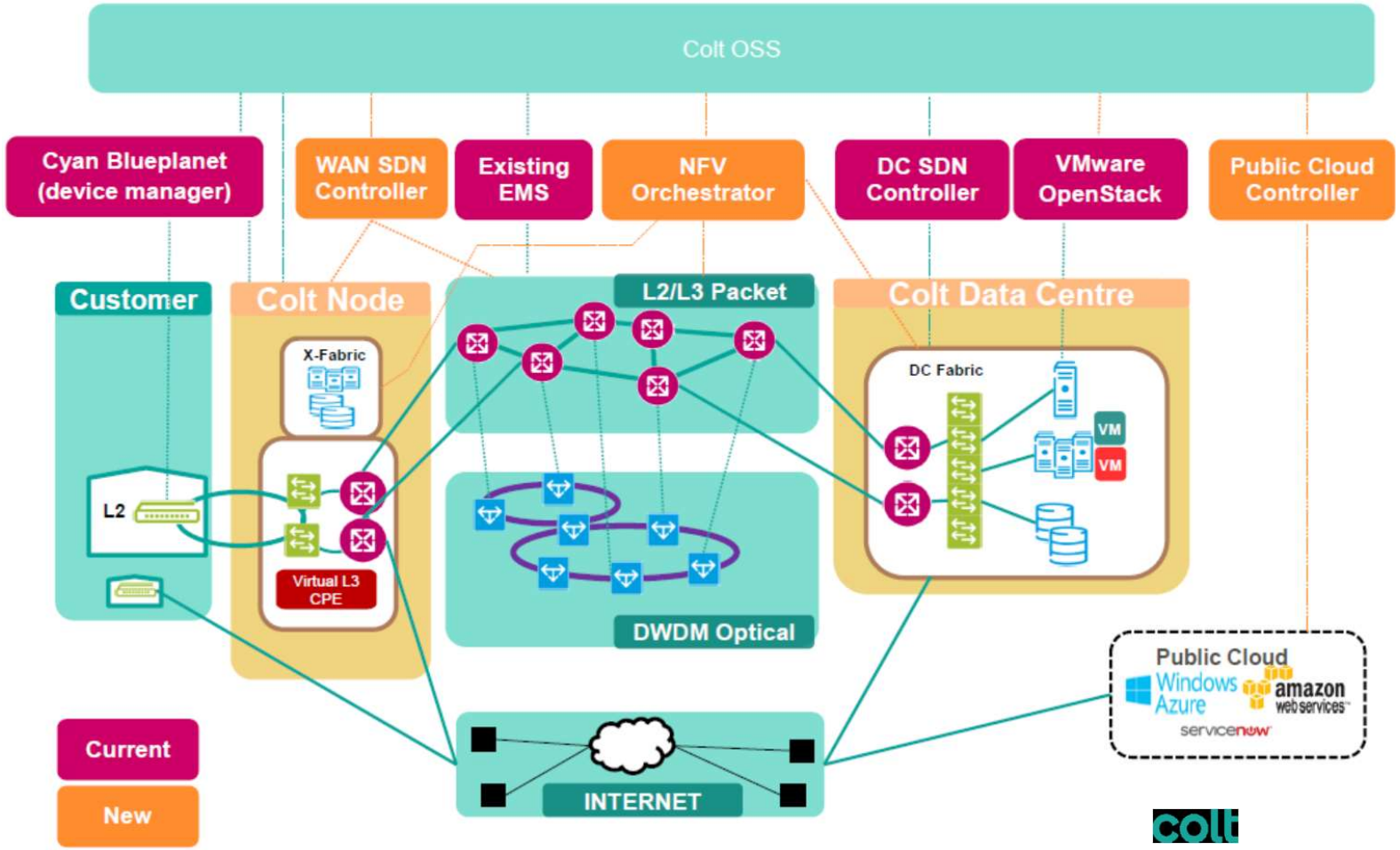
❖ ONAP Operation Manager (OOM)을 위한 ECOMP 프레임워크



AT&T의 ECOMP (Enhanced Control, Orchestration, Management & Policy) 백서

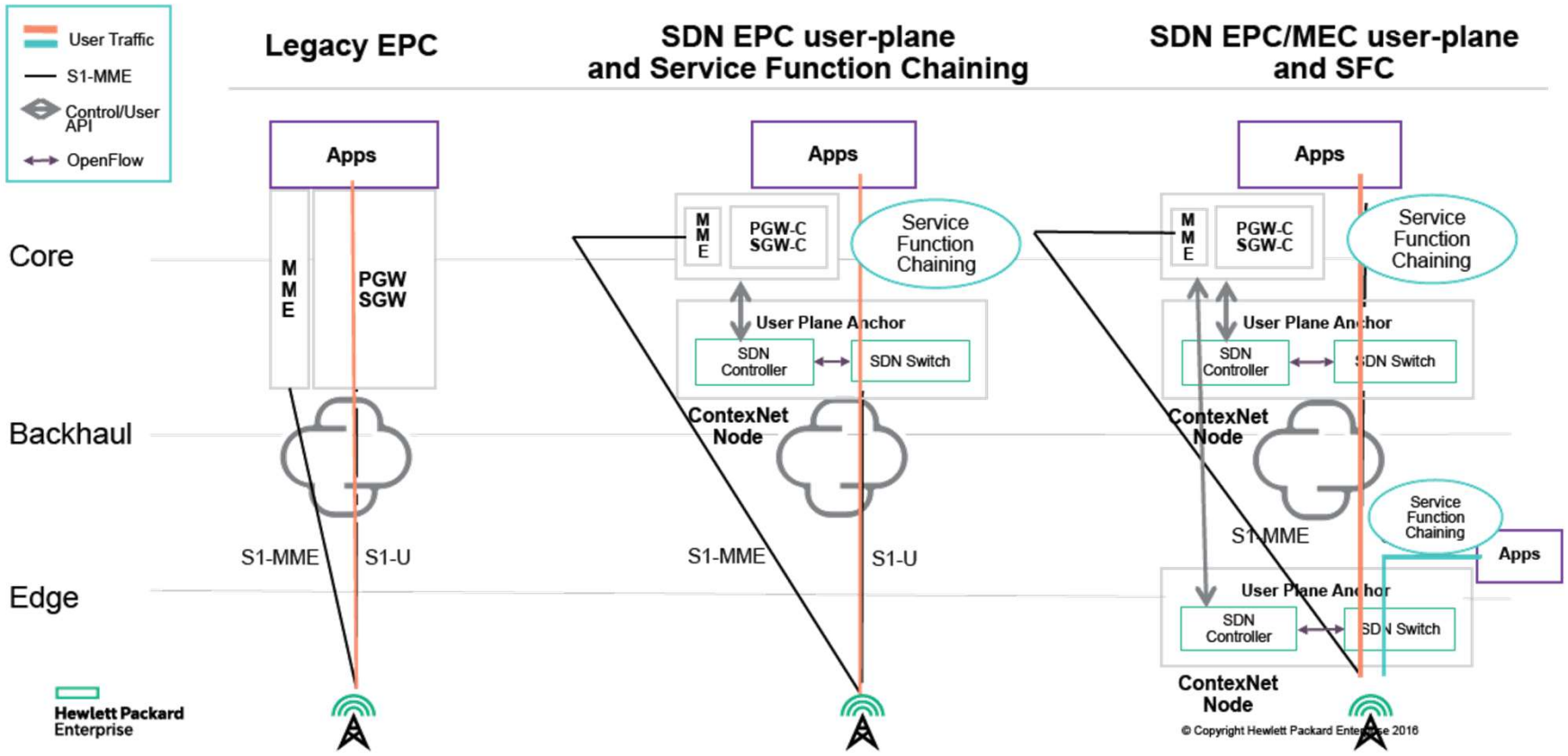
III. Use Case

❖ Colt의 종단간 오케스트레이션과 자동화



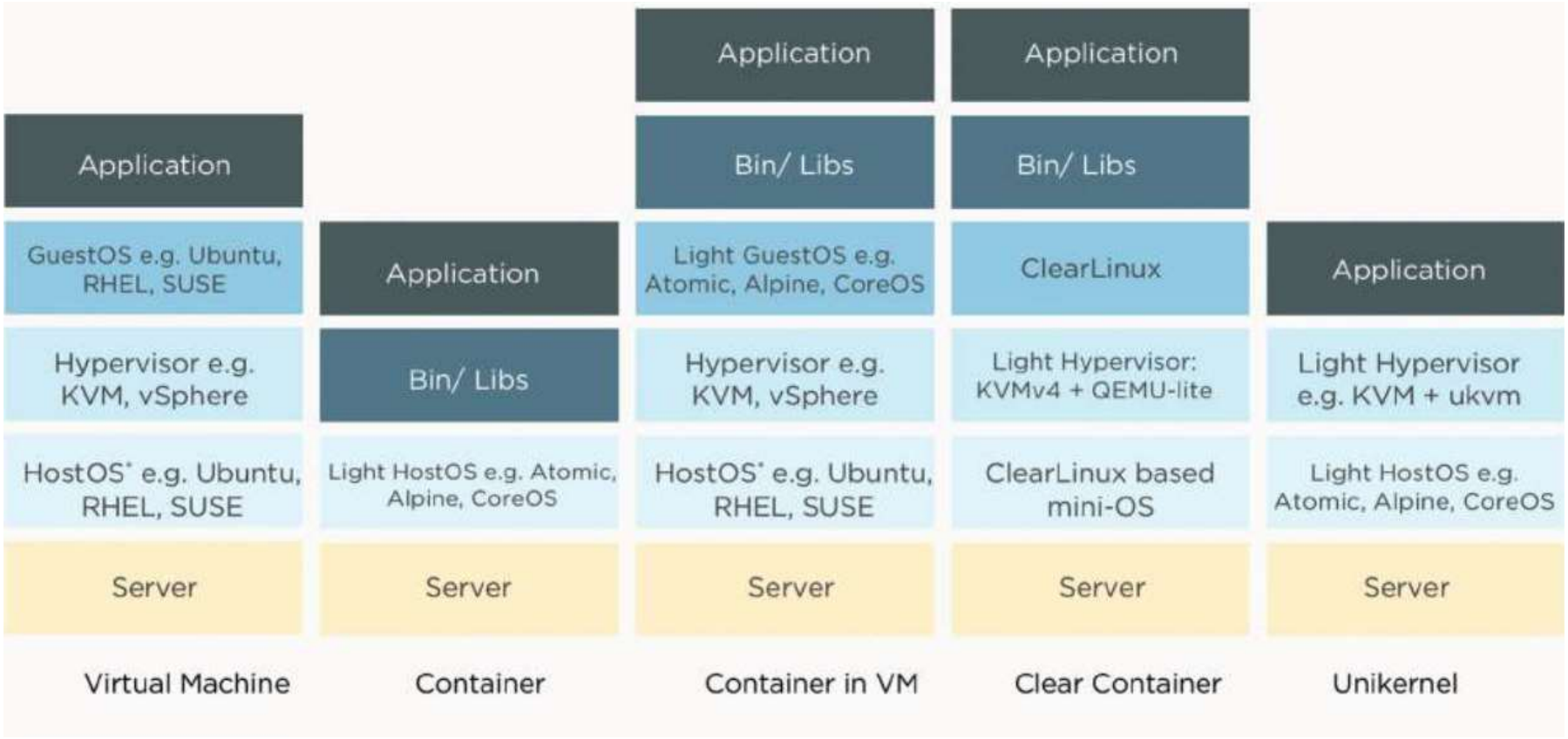
III. Use Case

❖ Telecom 환경의 SDN 구성 : HPE의 무선(Radio) 영역 제시



III. Use Case

❖ NFVI의 가상 계층 선택 종류

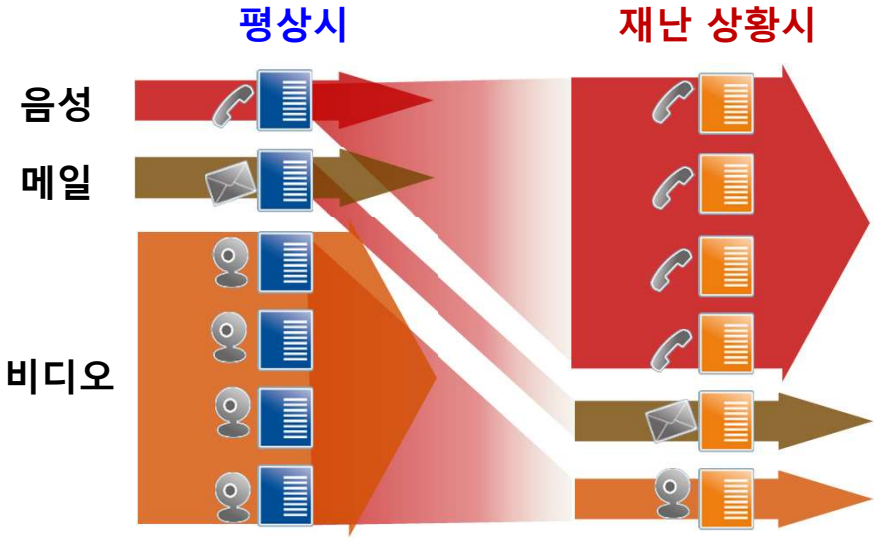


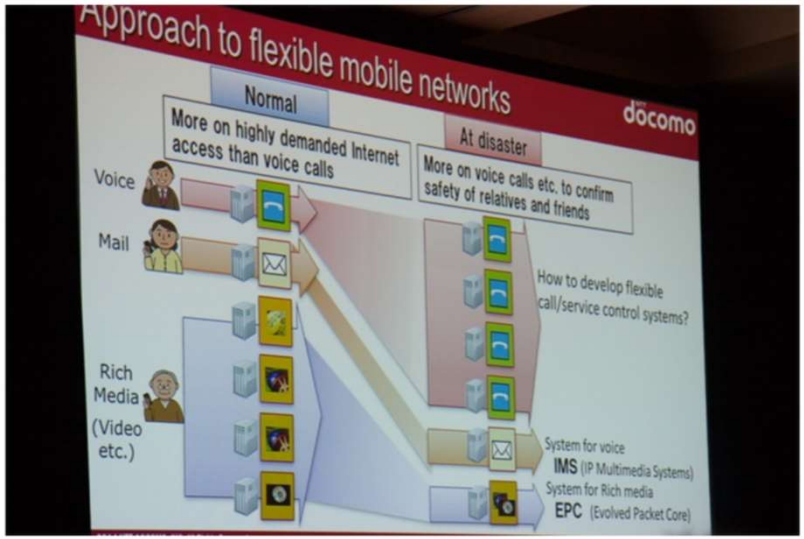
james@jslab.kr

IV. Case Study

IV. Case Study

- ❖ 일본의 국가재난 안전통신망 (NTT docomo)
- ❖ NFV 표준 발표 이전에 네트워크 가상화 기능 적용

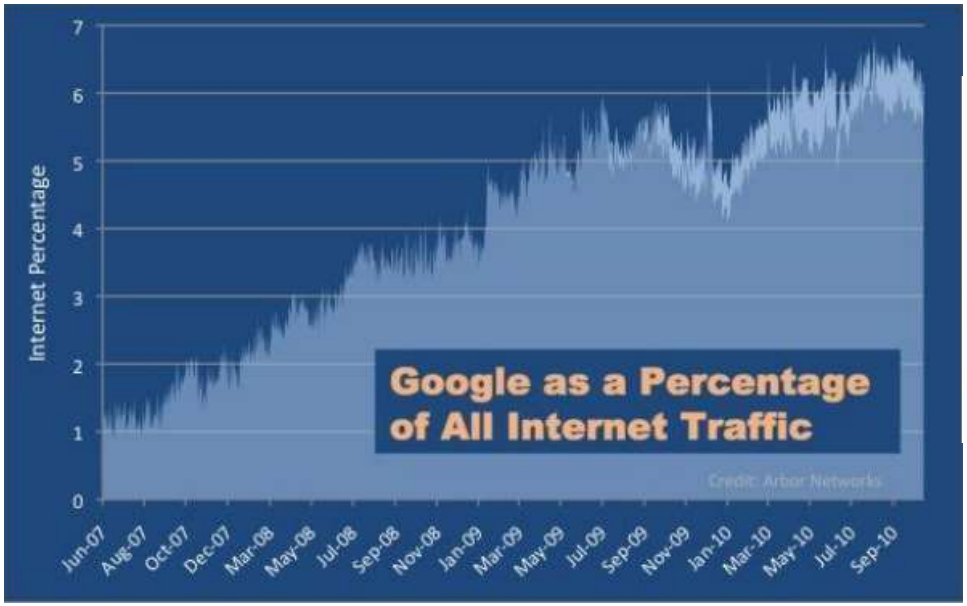


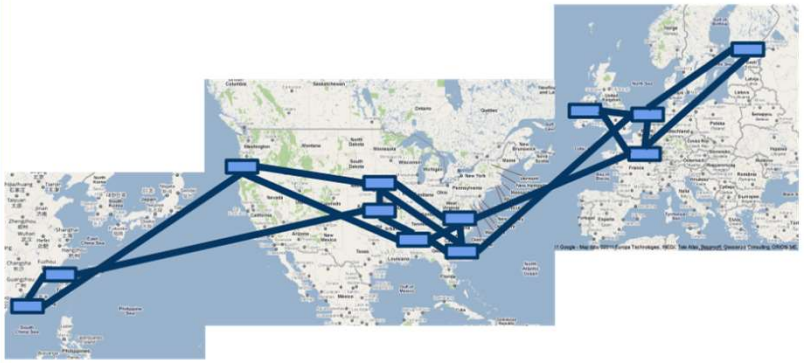


IV. Case Study

❖ 구글

- 대용량 백본 망 운영
- 요구사항 및 트래픽 특성에 따라 논리적인 망 운영
- 대용량 트래픽 처리
- 다양한 요구사항/트래픽

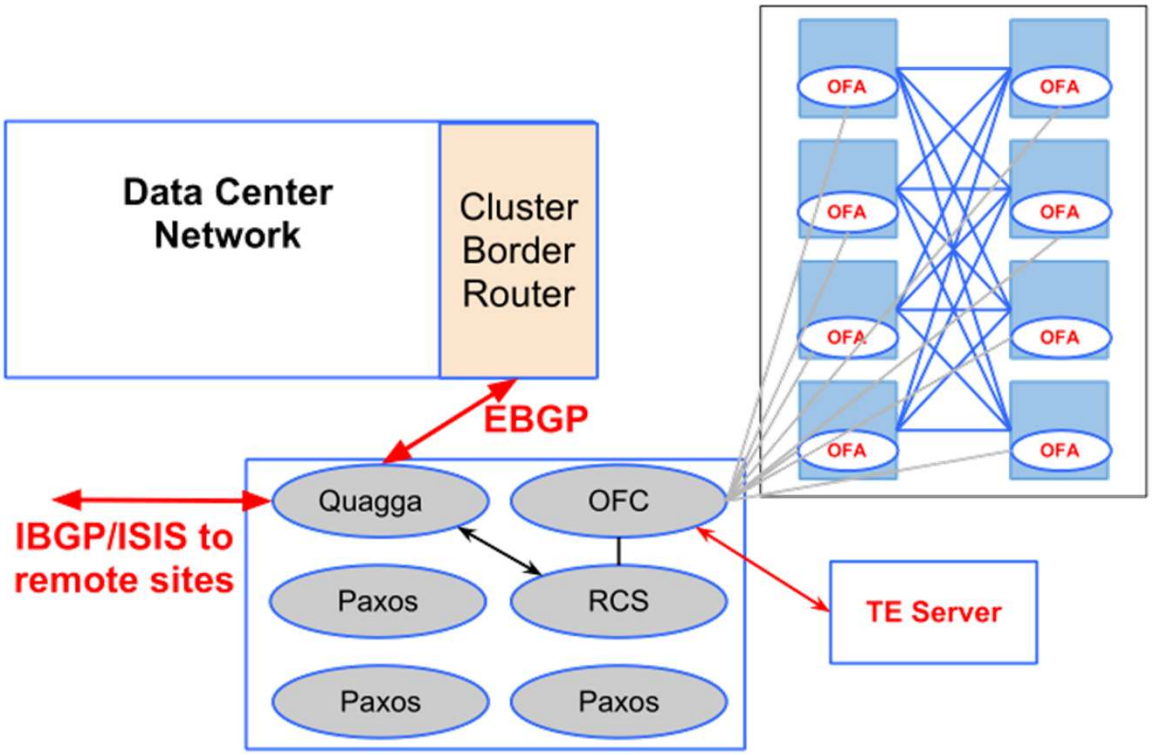


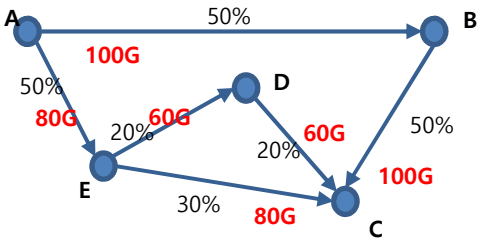


IV. Case Study

❖ 구글

- 하드웨어 자체 제작
- 오픈소스 소프트웨어 사용
- 단계별 도입

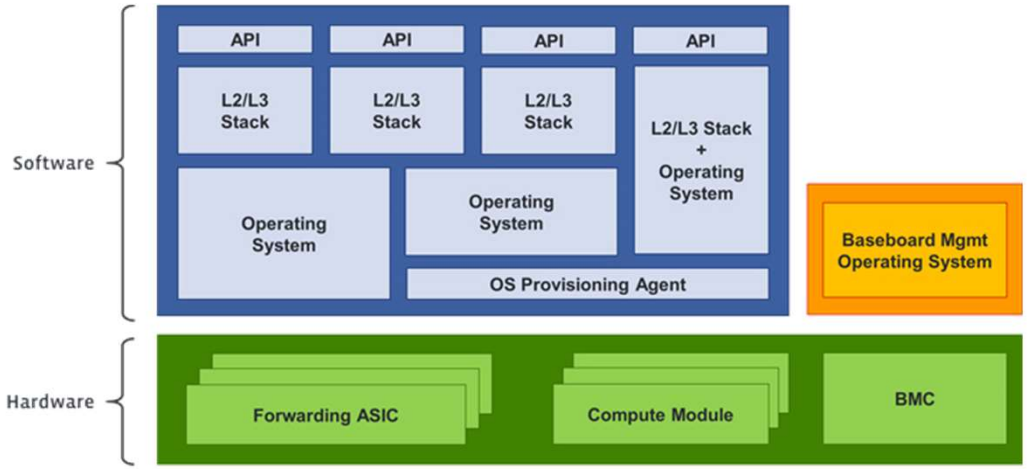




IV. Case Study

❖ Facebook

- 6-pack 스위치 구현에 대한 내용 공개(2015년 2월)
- 데이터센터 인프라에 대한 범용화 적극 추진
- 데이터센터용 ToR 스위치 자체 개발



Facebook 2017

https://code.fb.com/data-center-engineering/the-growing-ecosystem-around-open-networking-hardware/

IV. Case Study

❖ 페이팔(PayPal): 2015년 오픈스택 기반 SDDC 이전 완료 발표

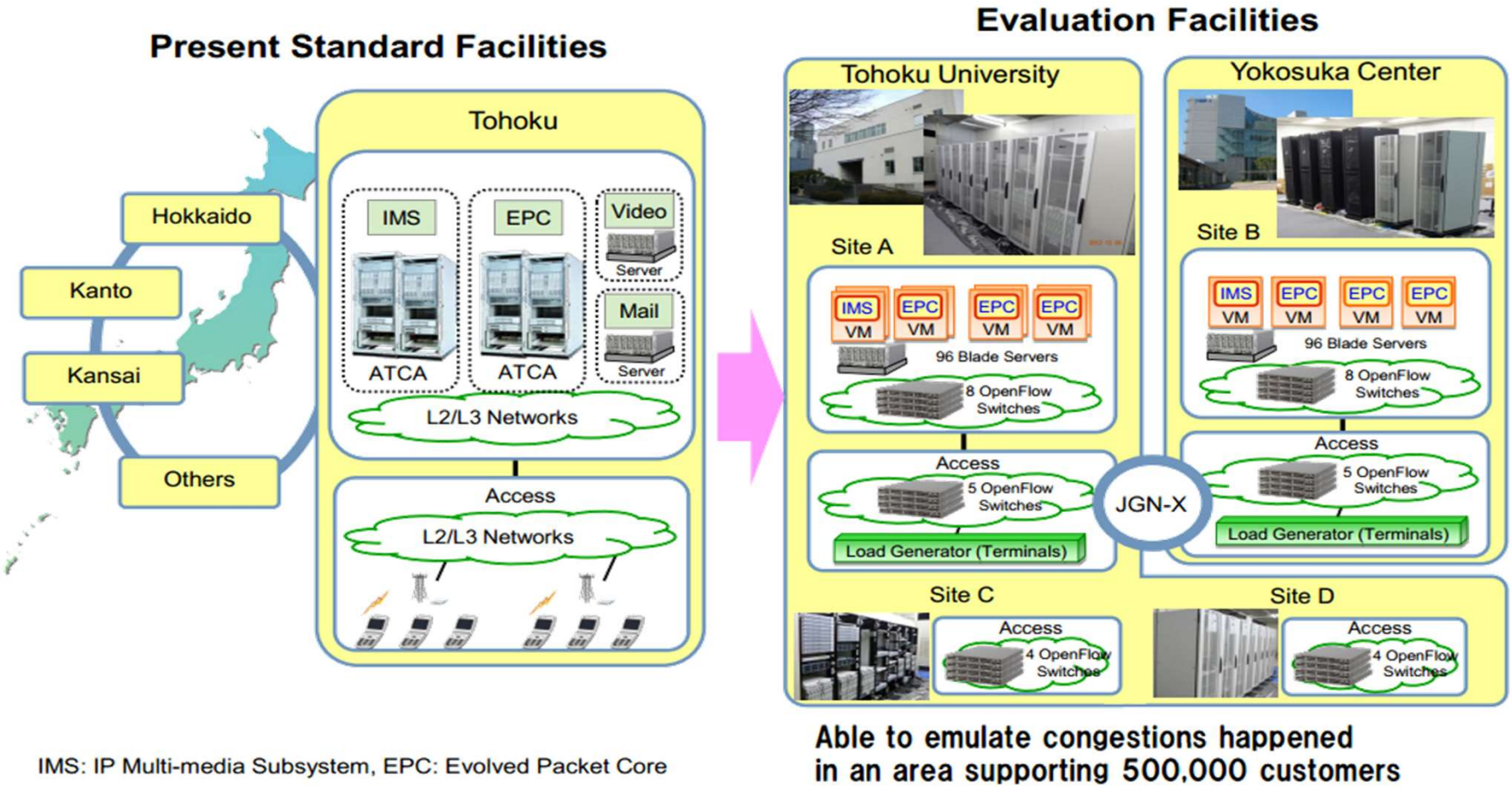
PayPal Declares It's 100% OpenStack Cloud

After a three-year migration, PayPal says it has implemented its own OpenStack cloud for close to 100% of its operations, making it one of the largest financial services OpenStack clouds in production.

3/31/2015 , Charles Babcock, an editor-at-large for InformationWeek

IV. Case Study

❖ 일본의 국가재난 안전통신망

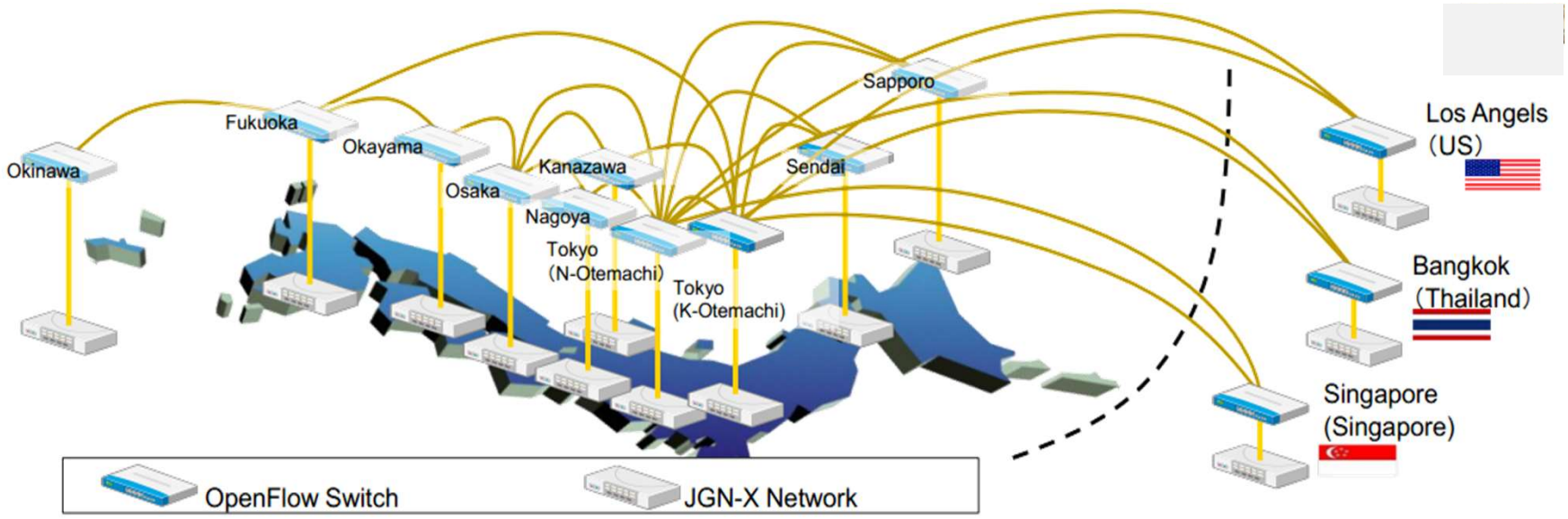


IMS: IP Multi-media Subsystem, EPC: Evolved Packet Core

Able to emulate congestions happened in an area supporting 500,000 customers

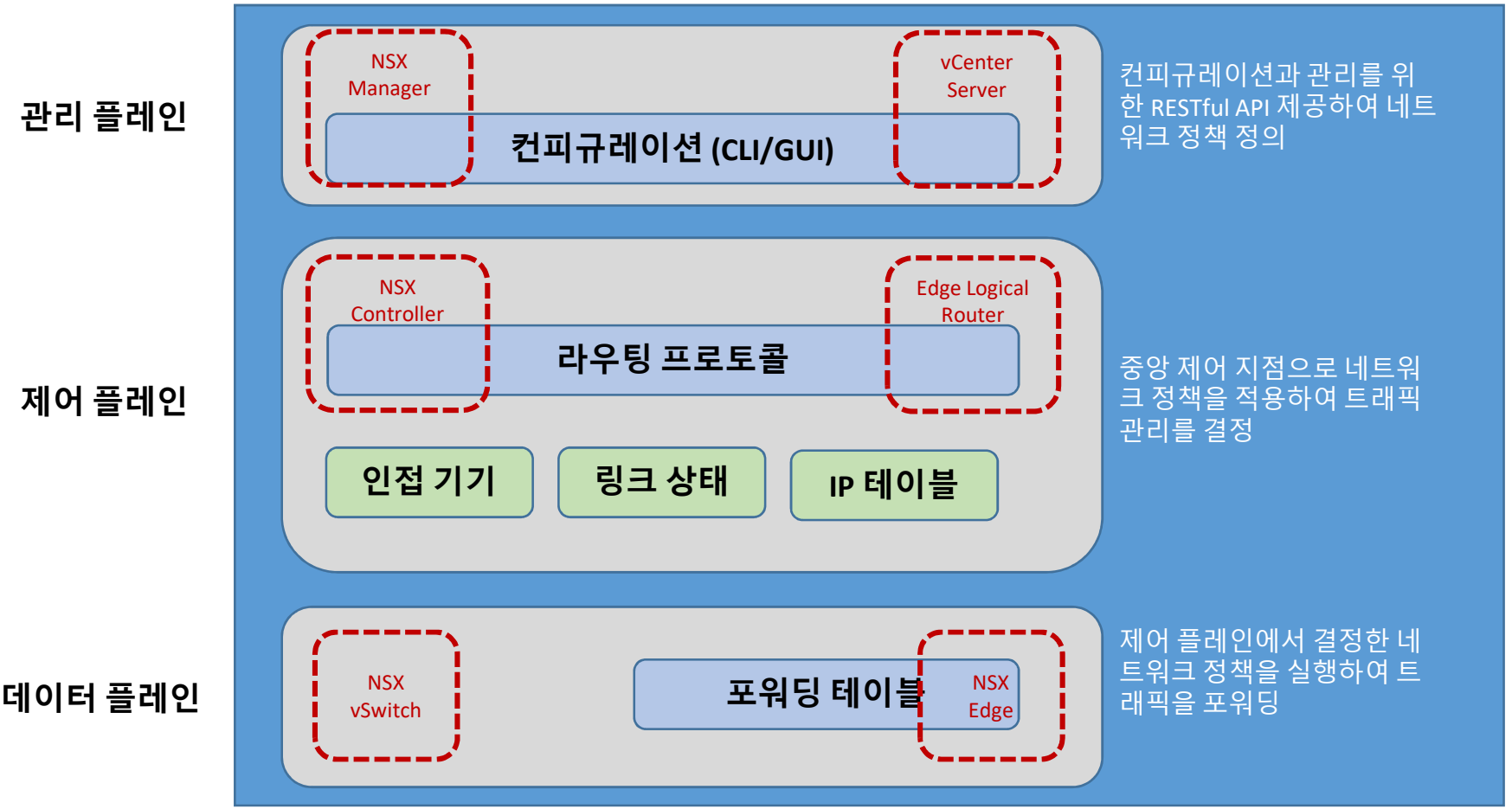
IV. Case Study

- 2013년 삿포로 Snow Festival 생중계
- O3 프로젝트: 2020년 도쿄올림픽을 위한 8K HD 비디오 서비스 제공



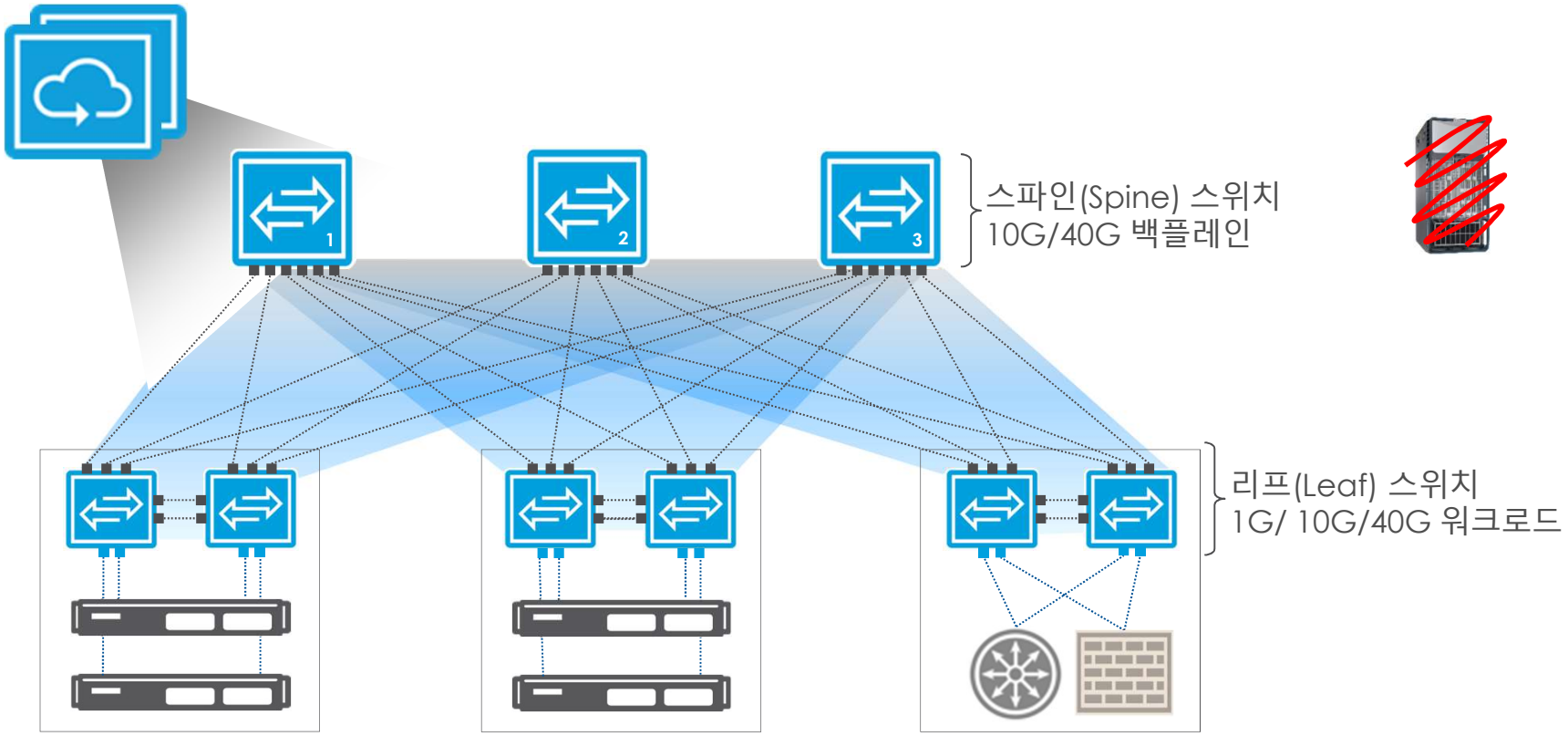
IV. Case Study

❖ VMware의 NSX 제품 솔루션



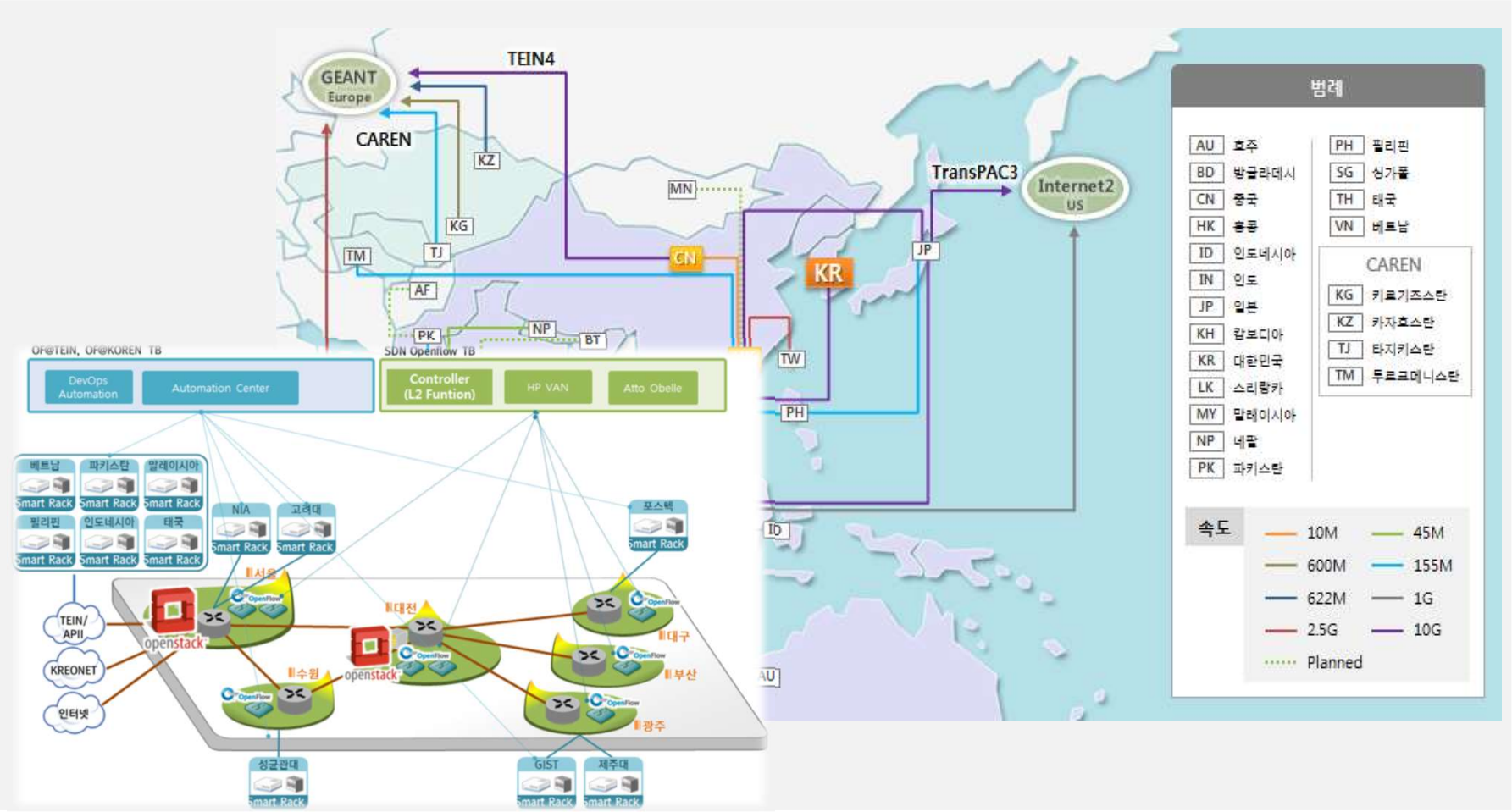
IV. Case Study

❖ **BigSwitch: SDN 기술 상용화 구성 'BCF'(Big Cloud Fabric)**



IV. Case Study

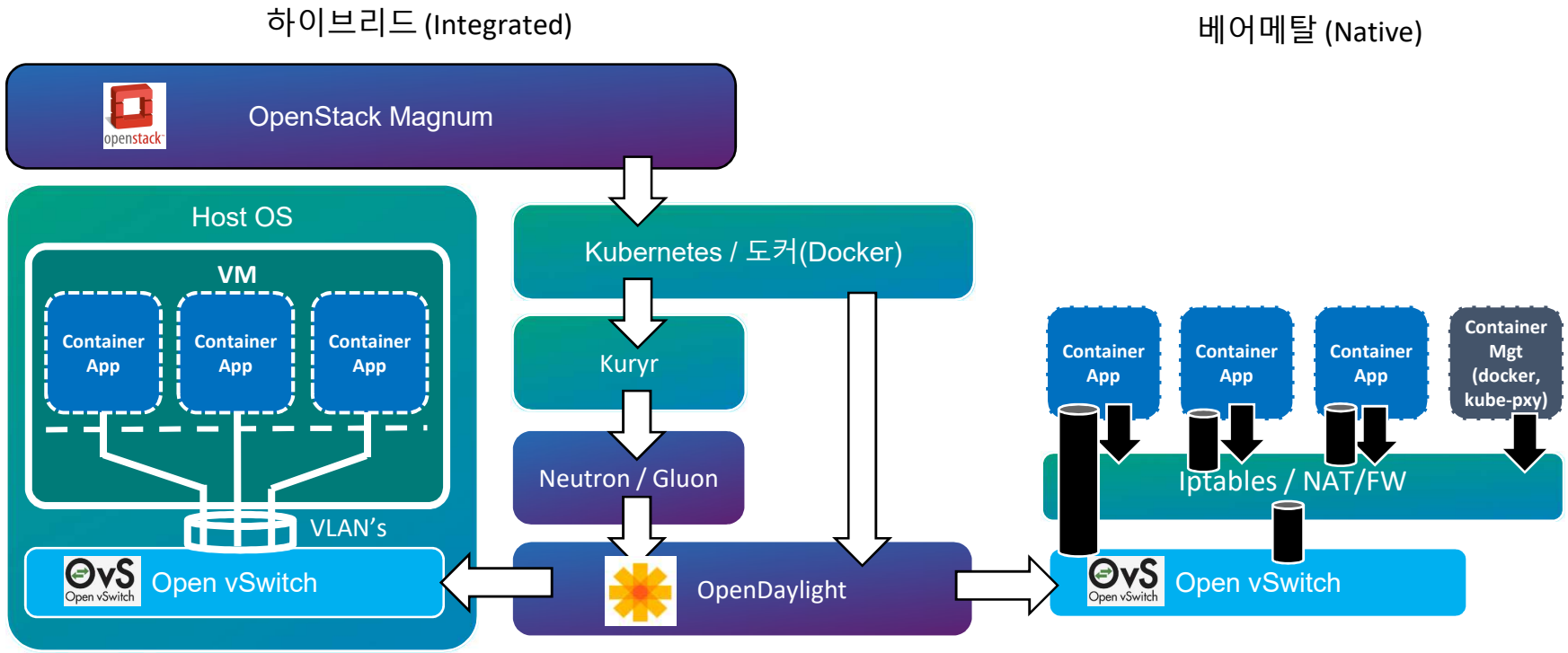
- ❖ OF@KOREN (미래네트워크연구시험망),
- ❖ OF@TEIN (국제연구망)



IV. Case Study

❖ ODL의 컨테이너 네트워킹을 위한 2가지 적용 방법

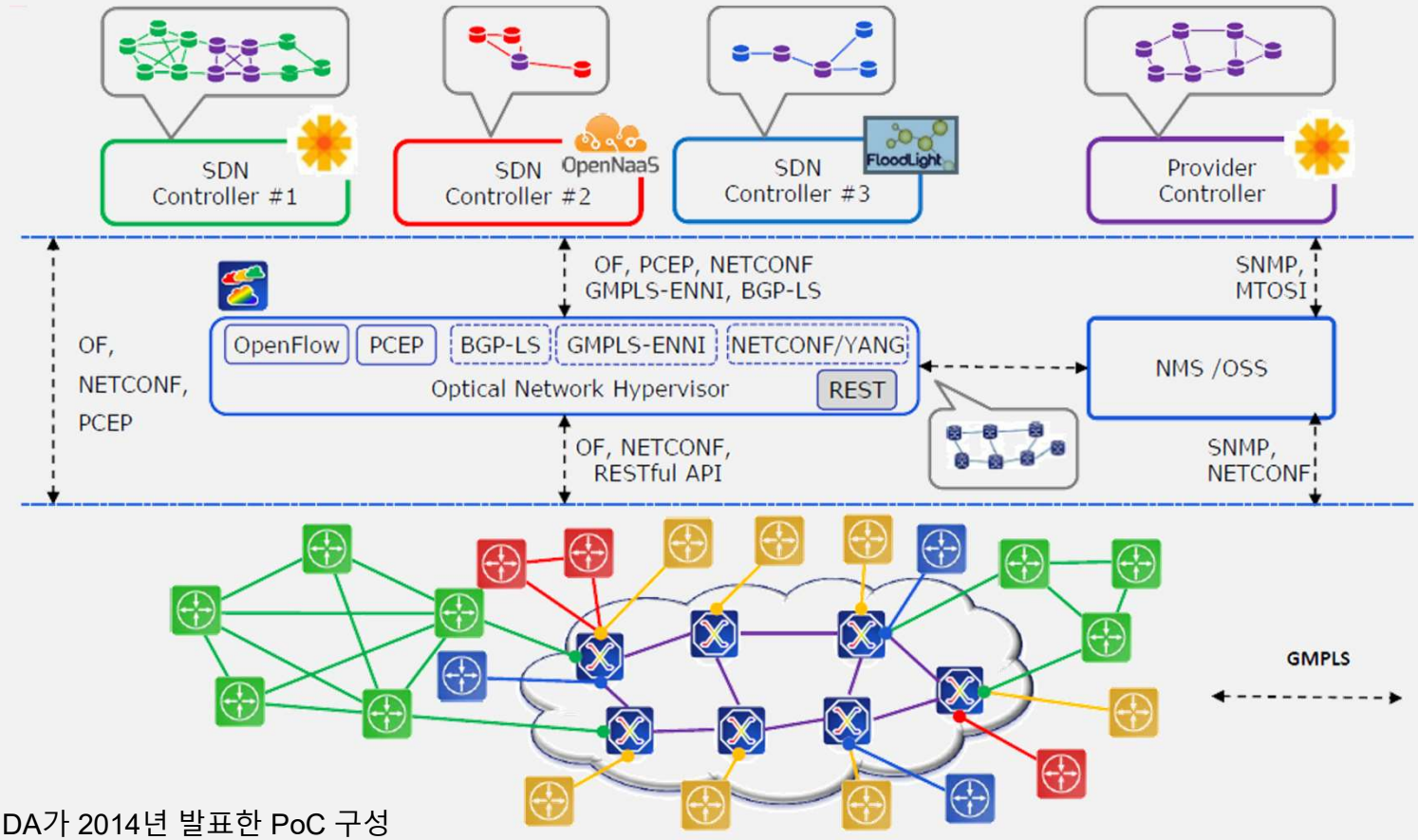
- 하이브리드
- 베어메탈



IV. Case Study

❖ 광전송망의 하이퍼바이저 아키텍처 (SDN 계층 구조)

- **WAN 은 OpenFlow 나 Restful API를 사용하는 가상 토폴로지로 표현**



AIDA가 2014년 발표한 PoC 구성

IV. Case Study

❖ 링크 추상화 모델

- NE당 OF 가상 스위치 1대에 매핑
- 추상화한 링크는 SDN 컨트롤러에서 자동으로 탐지
- 광신호는 2개의 양방향 플로우 또는 4개의 단방향 플로우 매핑

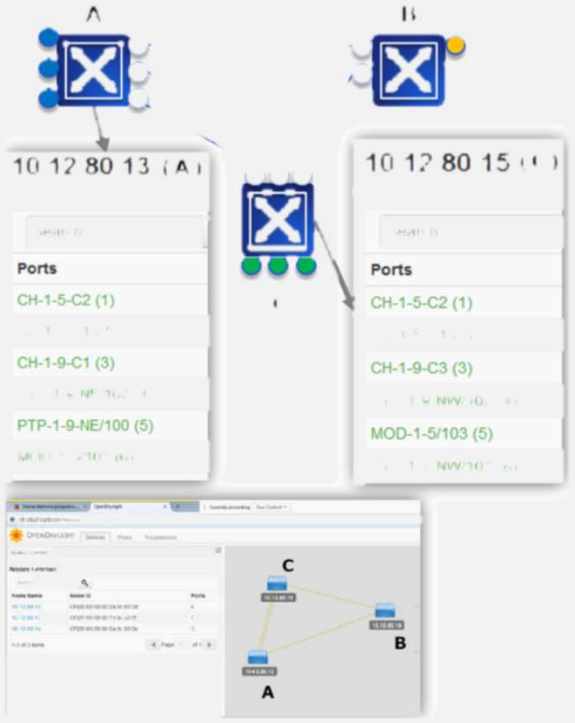
Modelling of static constraints

Geography	✓	Yes
Optical performance (Reach)	✓	Yes
Feasible Port Connectivity	✗	No
Optical parameters (Tunablility)	●	Some (OF 1.4)

Modelling of dynamic optical constraints

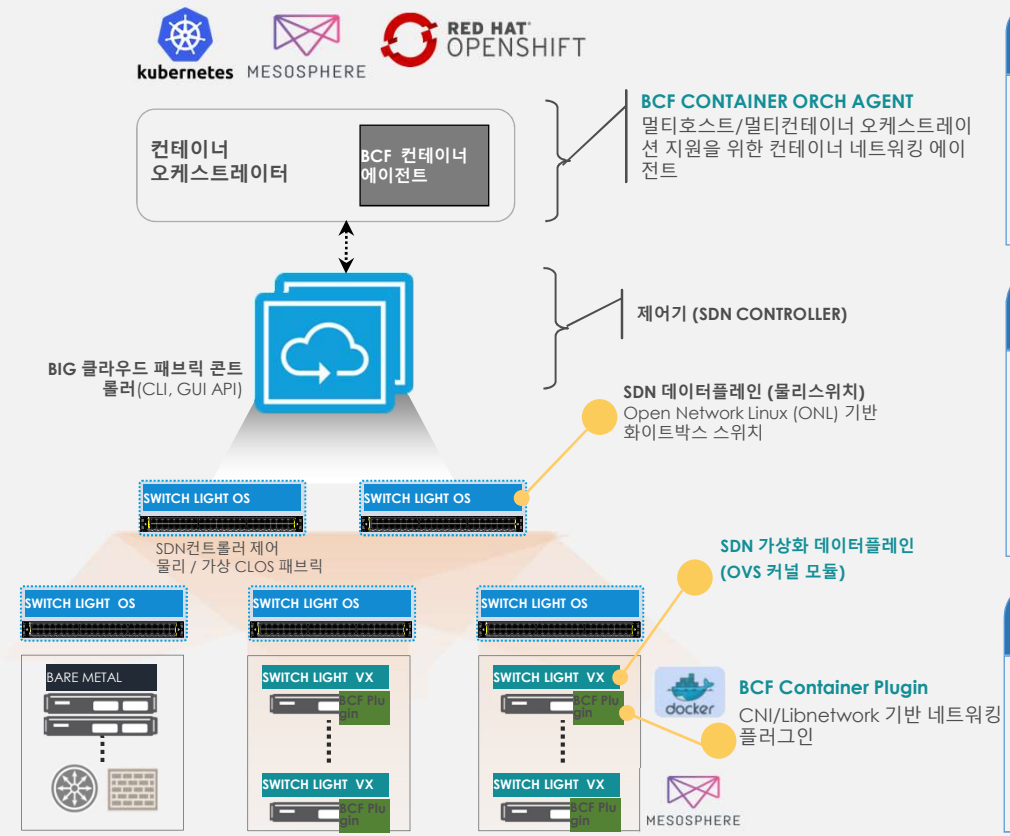
WL-Blocking	✓	Yes
Internal contention	●	Partly

AIDA가 2014년 발표



IV. Case Study

- ❖ BigSwitch/오픈스택(OpenStack)의 뉴트론(Neutron)연동 (예)
- ❖ 분산라우팅, Heat, LBaaS, 방화벽, VM-to-VM 경로/정책 가시화
- ❖ 프라이빗 클라우드를 위한 하드웨어 플랫폼



패브릭 자동화

- 호스트 자동 감지 & LAG / MLAG 연결
- 네트워크 자동 생성 (vSwitch, Leaf, Spine)
- IPAM / 컨테이너 네트워크 자동 컨피그

네트워킹 가시화

- 컨테이너 수준 가시화 – 컨테이너 이름, vSwitch, vNIC...
- 컨테이너간 연결 패브릭 트레이스
- 이벤트/로그 이력 패브릭 분석

운영의 단순화

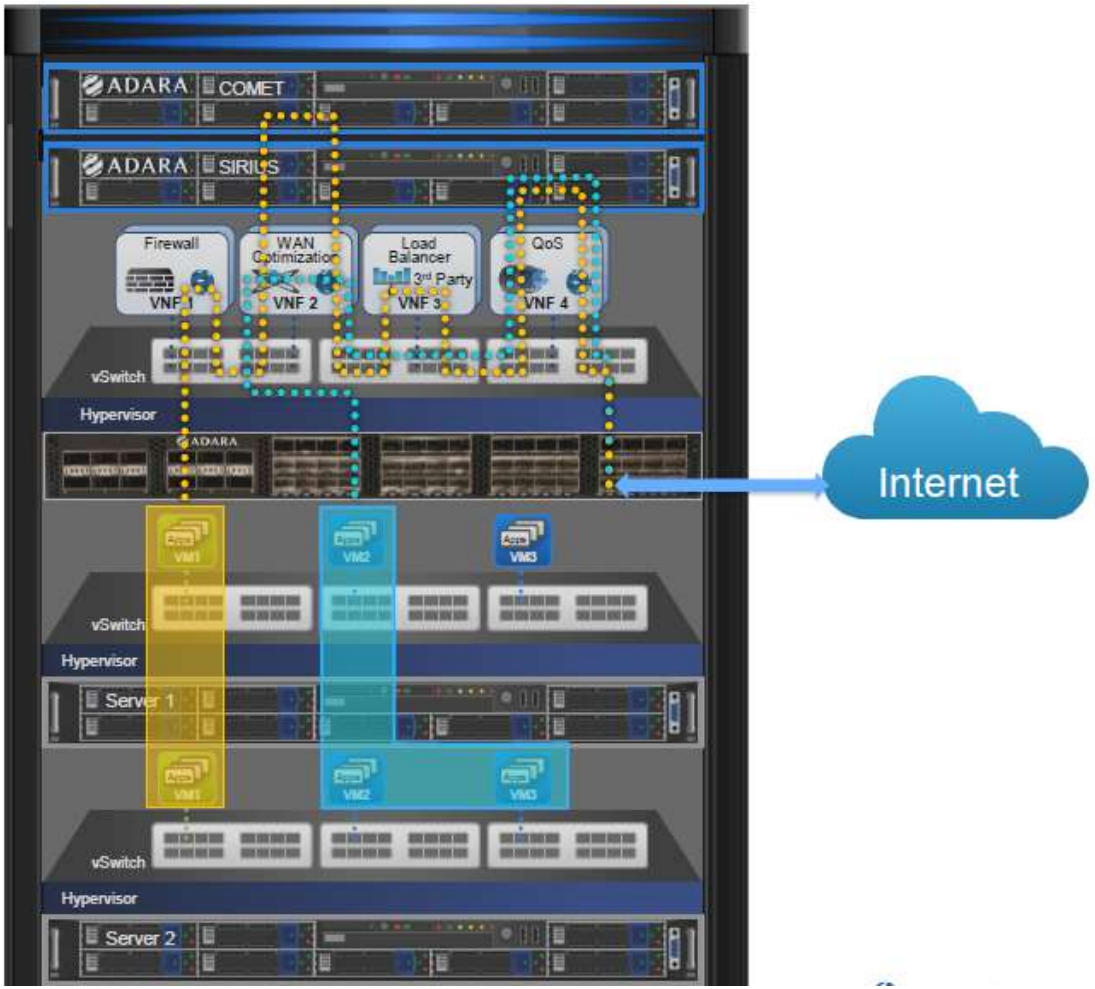
- Single pane of Glass – 물리/가상 스위치
- 컨테이너 클러스터 통합 적용 워크플로우

IV. Case Study

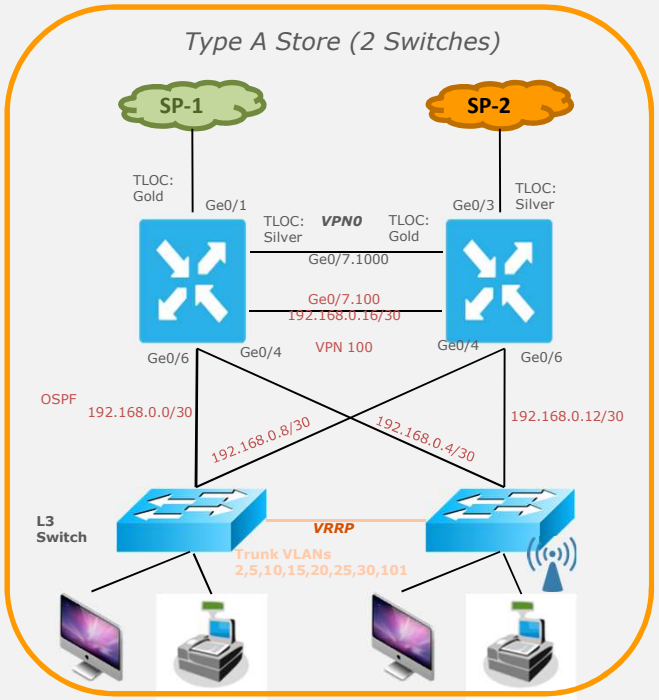
❖ Adara Networks - VMs in a Rack

NFV + SDN

- OpenFlow as the Service Chaining Protocol
- Enterprise Network Functions such as Firewall, WAN Optimization, Load Balancer and QoS
- Traffic Classification using OpenFlow
- Service Chain is a list of input and output ports (Virtual & Physical) connecting VNFs



IV. Case Study



ZTP – Zero Touch Provisioning
(장비를 연결하여 전원을 On)

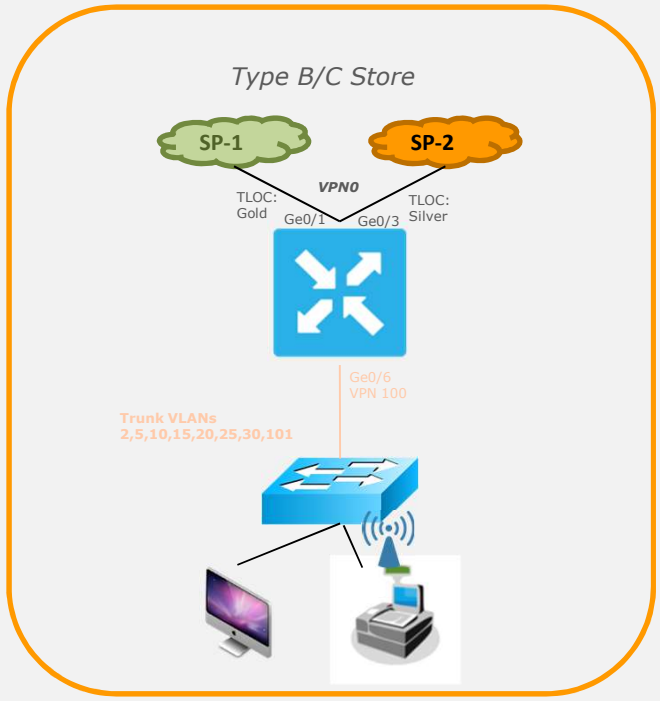
SD-WAN 전송은
Full-mesh, scalable encryption
(MPLS, Internet, LTE 기반)

vEdge

서비스별 토폴로지 생성
Global VPN 영역 분리

처리용량 기반의 라우팅
(app-aware)

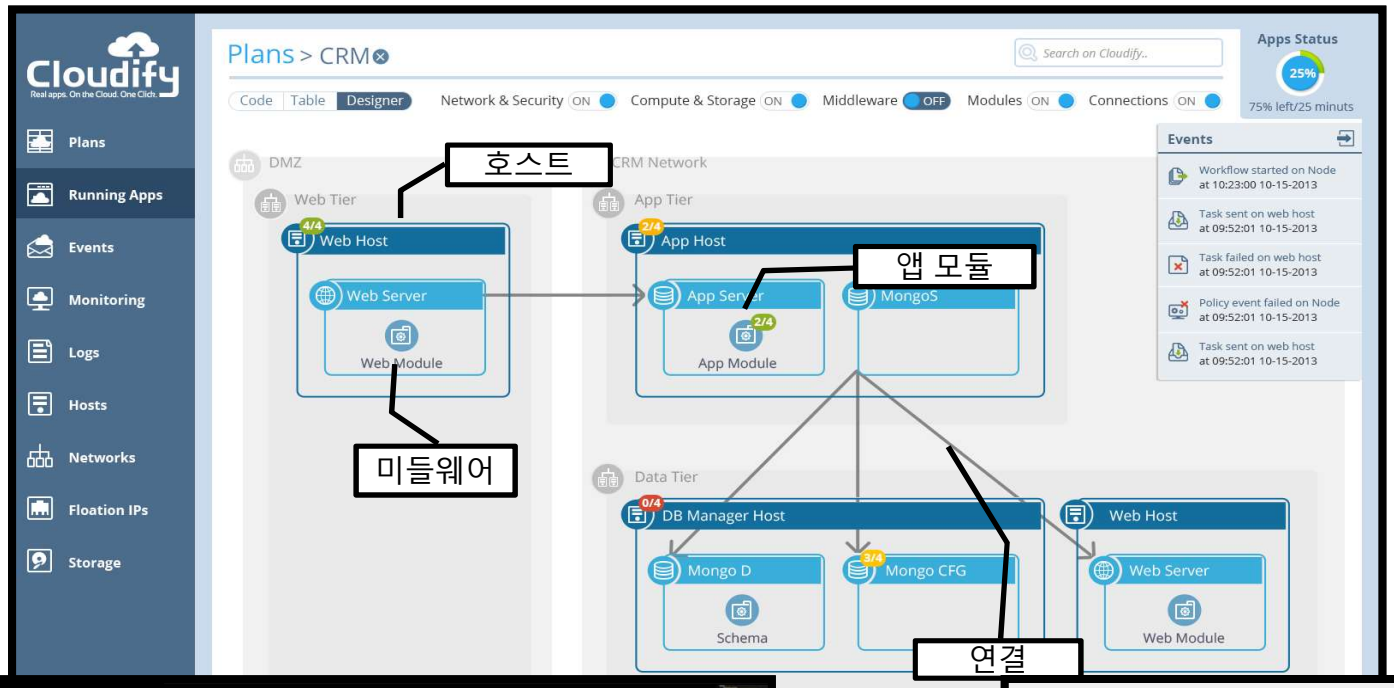
애플리케이션 인식 (DPI)



Store Main - 100 (VLANs 1,5,10,15,20,25)	Loss Prevention – 135 (VLAN 35)	Kiosk - 130 (VLAN 30)	Guest WiFi– 201 (VLAN 101)	Voice – 121 (VLAN 21)	PCI - 115 (VLAN 300)
• *Store-to-DC* • *Routing Policies pre-configured DC prefixes* • *Hub-n-Spoke policy in effect* • *QoS policies for critical traffic* • *Performance Routing*	• *Store-to-Store* • *BFD Tunnels established for regional stores* • *Video traffic can be routed directly from one store to another without having to hit DC*	• *Local NAT Exit for internet traffic* • *Kiosk mgmt traffic still accessed via Stores VPN*	• *Local NAT exit for Internet traffic* • *OpenDNS for Guest WiFi CF, etc* • *DHCP Server local for Guest-WiFI VLAN*	*Store-to-VoIP provider* *Groups of stores can be enabled for direct connectivity (any to any)*	• *Store-to-DC* • *Similar policies as store traffic – but Tx can be an independent VPN* • *Additional security for end-to-end segmentation* • *Map to PCI VRF in DC core*

IV. Case Study

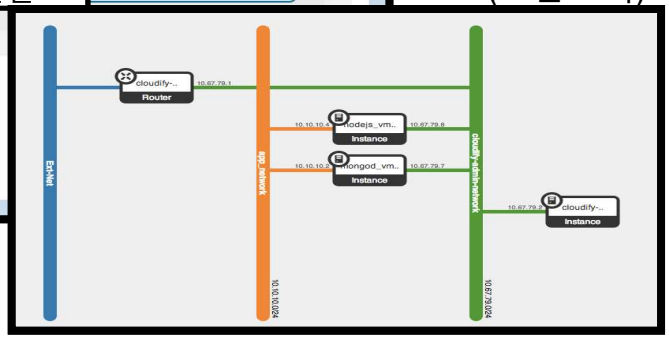
❖ **멀티 클라우드 오케스트레이션 :** 표준 TOSCA 기반 GUI 서비스 (TOSCA 표준 적용 오픈소스 Cloudify 예)



생성 소스 (TOSCA)

```
types:
    openstack_host:
        derived_from: cloudify.types.host
        properties:
            -   install_agent: false
            -   region
                    instance:
                        - name
                        - image
                        - flavor
                        - key_name
        interfaces:
            cloudify.interfaces.lifecycle:
                -   create: cloudify.plugins.openstack_host_provisioner.tasks.provisio
                -   start: cloudify.plugins.openstack_host_provisioner.tasks.start
```

적용 후 맵 (오픈스택)

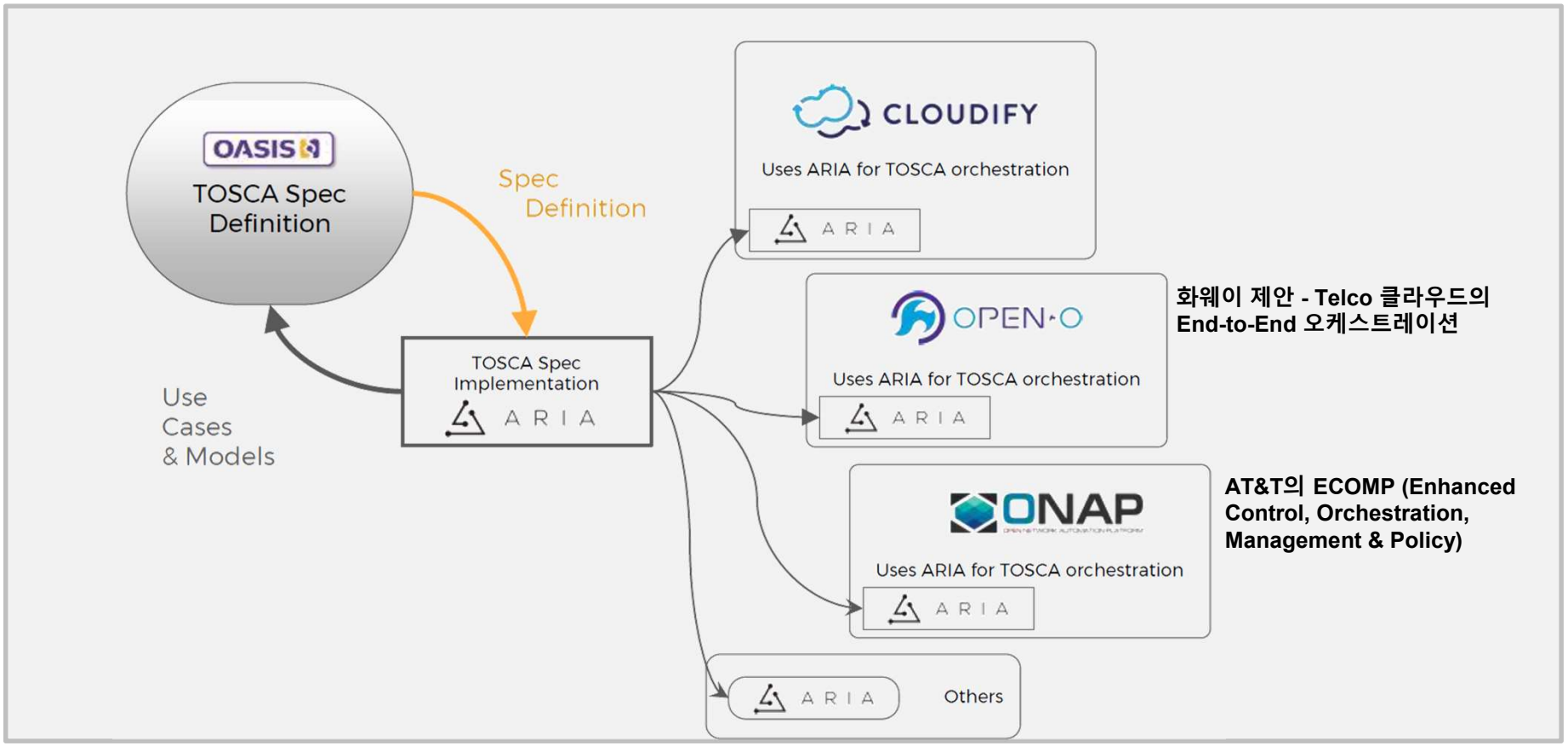


TOSCA: OASIS open standards consortium (Topology and Orchestration Specification for Cloud Applications)

IV. Case Study

❖ 표준 TOSCA 스펙 적용 오픈소스 'ARIA'

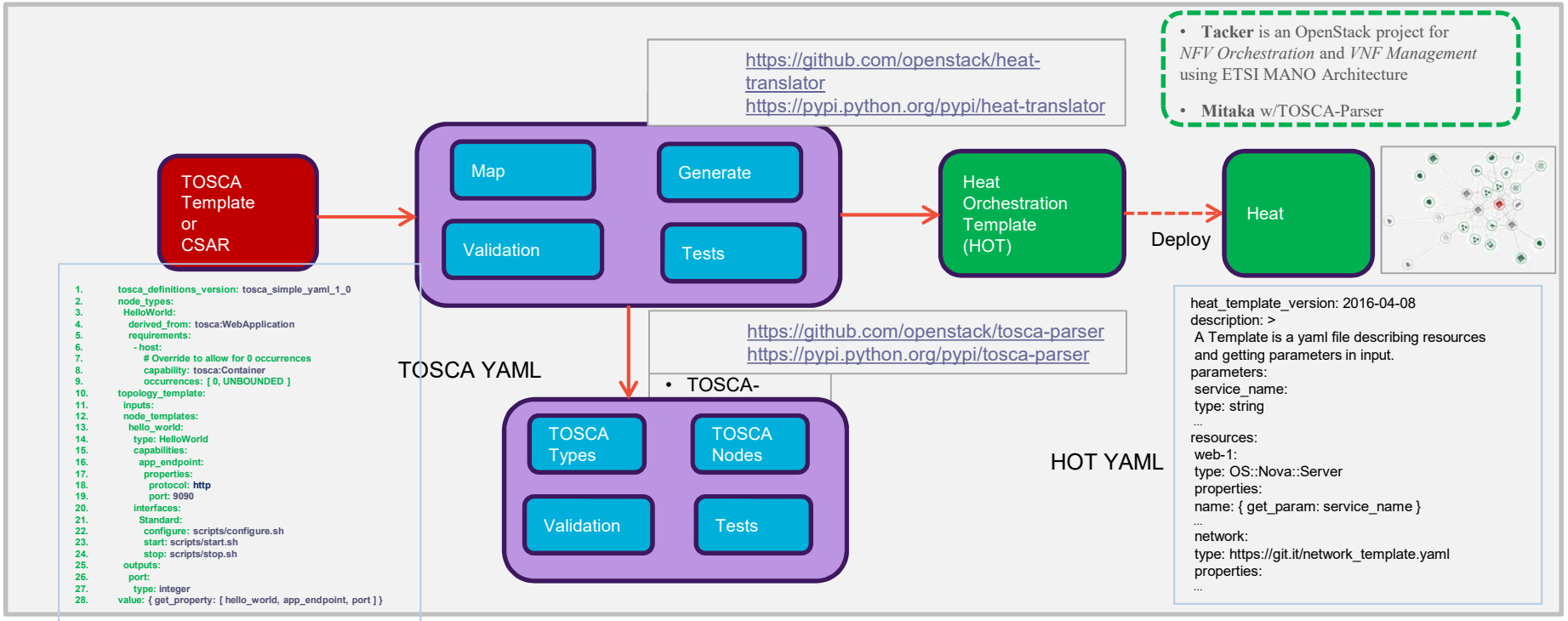
1. 오케스트레이션이 TOSCA 프로파일 지원을 위한 Python 라이브러리
2. TOSCA 애플리케이션 생성을 위한 SDK
3. CLI Tools: 오케스트레이션을 위한 TOSCA 템플릿



IV. Case Study

❖ TOSCA 처리 과정 (오픈스택 예)

- TOSCA Simple Profile for Network Functions Virtualization (NFV) Version 1.0 Committee Specification Draft 03 (17 March 2016)
- 토스카 파서(TOSCA-Parser): Parser for TOSCA Simple Profile in YAML
- 히트번역기(Heat-Translator): An OpenStack project to map and translate non-Heat (e.g. TOSCA) templates to Heat Orchestration Template (HOT)



CSAR (Cloud Service Archive) TOSCA (Topology and Orchestration Specification for Cloud Applications)

IV. Case Study

❖ SDN/NFV 포럼(www.sdnnfv.org)

① **SDN/NFV 포럼 2014년 10월 1일 출범**

② **목표 :** SDN/NFV 등장으로 산업 격변기에 있는 국내 인터넷인프라 산업을 활성

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