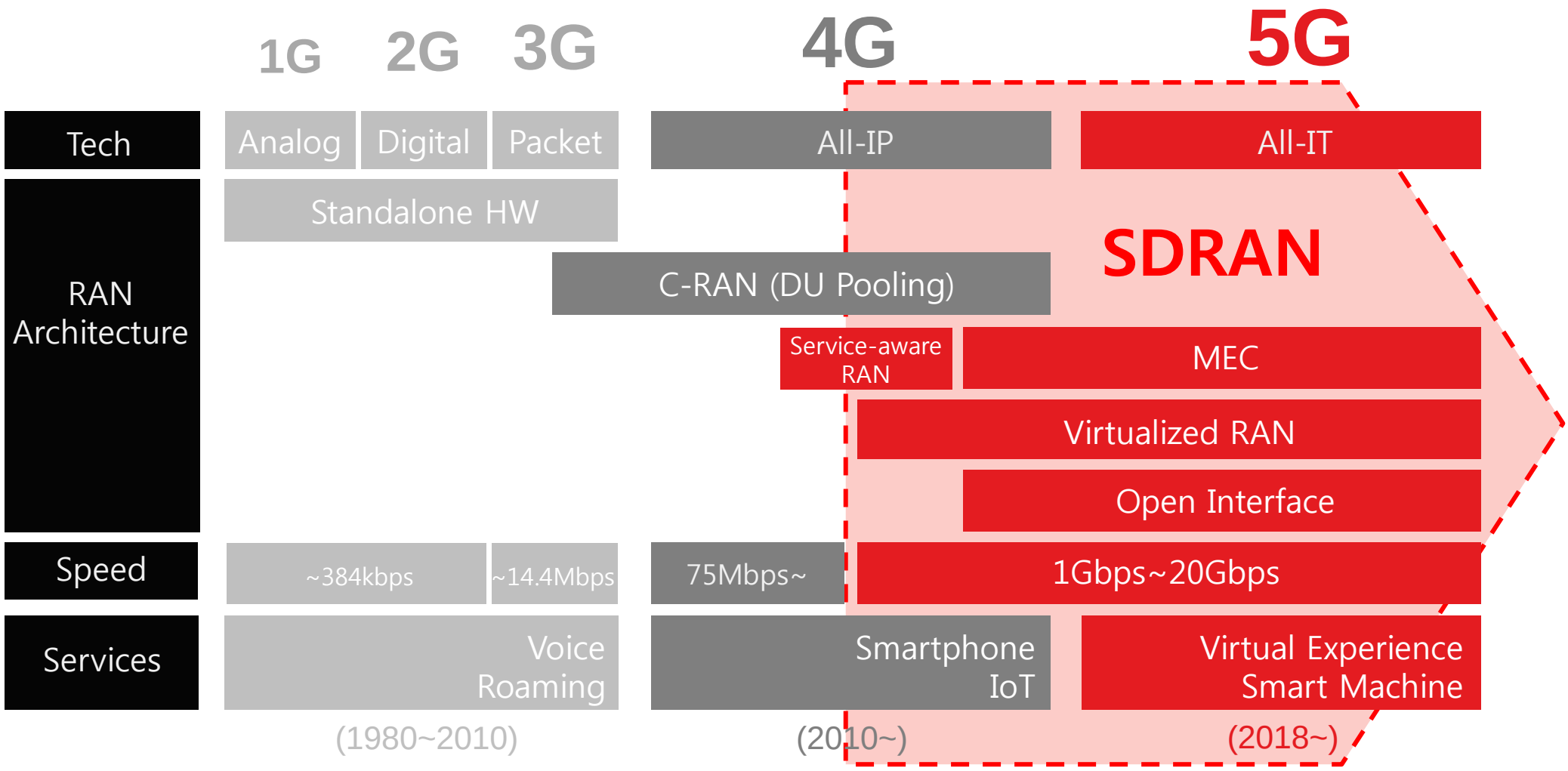

SK telecom
OCP Telco Requirements
- Sharing Experiences and Lessons Learned
June 9, 2016
Young Kim
Network Technology R&D Center

Contents

History of Mobile Network Evolution

ATSCALE

RAN Evolution Direction



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Operator Challenges

Current HW-centric mobile infrastructure leads to inefficiency when
- Re-allocating radio resources dynamically to cope with the change of traffic
- Introducing and providing customized/innovative services
- Upgrading Telco functionalities

Inefficient utilization of radio resources

Inability to customize for various customers

High upgrade costs

Mobile infrastructure needs re-architecting

Sharing Experiences: vRAN POC

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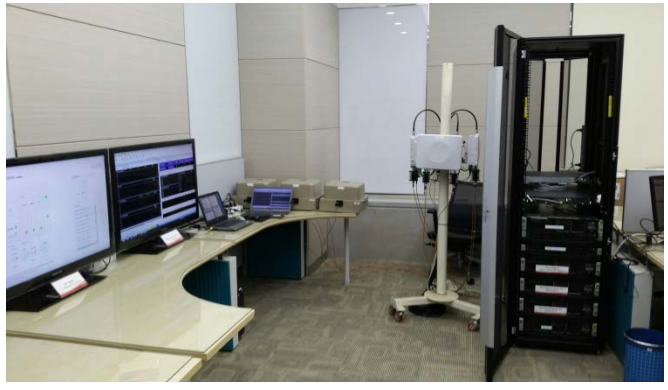
Virtualized RAN is under development including commercial UE IoT to overcome performance and stability issues (2014~2016)

【 Experiences 】

- **Live Migration/Auto Scaling**
  - Auto recovery in case of SW/HW faults
  - Live Migration (Service interruption < 1 sec)
  - Flexible resource management

- **Performance test of LTE-A features**
  - 2x2 MIMO, 2 CA, 300Mbps
  - Function(L1/L2) Split/Ethernet Fronthaul
  - Multi-Cell/UE Lab & Field test (Verification for 4 Cells, 10 Users)



【 Lessons Learned 】

- **Re-design of vRAN VNF**
  - VNF needs to be unbundled into more blocks, e.g. control/user plane, for independent scaling
  - Open interface for multi-vendor operation

- **Needs to verify the reliability in commercial environments (more users & cells)**
  - Capacity > 36 Cells & 600 Users per DU

- **Needs to enhance virtualization features**
  - Minimize the Auto Recovery time for commercial operation (< 2 min)
  - Live Migration: No service interruption

- **Needs to coordinate with E2E orchestrator**
  - Interworking btw RAN VNF manager and E2E orchestrator for E2E management
  - For unified operation of multi-vendor vRAN solutions, standard interface should be agreed

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Sharing Experiences: vEPC/vIMS

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Rapidly and flexibly responding to increased LTE data and voice traffic, virtualized EPC and IMS have been successfully commercialized

【Experiences 】

- **Commercial vEPC for IoT** (Aug. 2015~)
  - Both vMME and vSAEGW for IoT service are deployed and running on x86 servers
  - Call-processing VMs are auto-scalable
  - vEPC for B2C is being developed

- **Commercial vIMS** (Sep. 2015~)
  - vCSCF, vSBC, and vTAS are deployed
  - The NFV adoption is still in progress

  * Winner of 'vIMS Solution & Use Case of the Year' at 'IMS industry Awards 2016' held in Amsterdam (5.18)

- **Commercial NFV Orchestrator** (Aug. 2015~)
  - Using SKT's de-facto MANO spec., NFVO manages heterogeneous VNFs, VNFMs, and VIMs from different vendors

  * ETSI NFV PoC#23: E2E orchestration of virtualized LTE core-network functions and SDN-based dynamic service chaining of VNFs using VNF-FG

【 Lessons Learned 】

- **Re-design of Telco workload as a "cloud-friendly" workload is essential**
  - VNF shall be decomposed into LB, user/ control plane, DB and so one, so that each component is independently scalable
  - The performance should be linearly increased as more VMs are added
  - 'Stateless-design' is crucial for all-active HA and VNF portability(migration)

- **Efficient MANO implementation is needed**
  - Avoid vendor & domain-specific MANO
  - Accommodate telco-specific life-cycle mgmt. requirements(*e.g.,* backup, rollback, logging)
  - For fully automated orchestration, standard data models should be agreed

- **Open H/W and S/W will play a crucial role in maximizing TCO gains**

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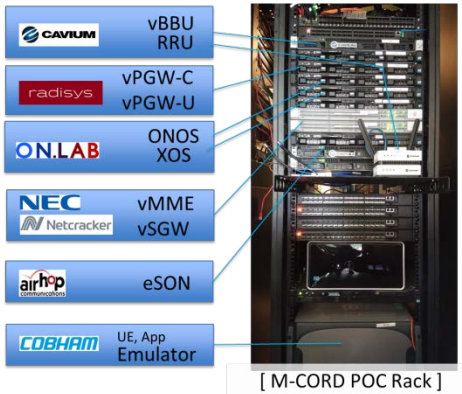
Sharing Experiences: M-CORD

SKT is leading PoCs for low latency services by integrating disaggregated RAN/EPC and open-source N/W controller (showcased at ONS `16)

【Experiences 】

- **SDN/NFV applied to E2E Mobile networks**
  - Applying SDN architecture to networking and application
  - Use of virtualized telco VNFs, including BBU, running on COTS H/W
- **RAN/EPC Disaggregation**
  - Cloud RAN with functional split, resulting in flexibility of architecture design and fronthaul
  - UP/CP separation in PGW with open interface (OpenFlow) controlling packet forwarding, resulting in separate scalability
- **Mobile Edge Services**
  - E2E network provision "as-a-Service"
  - Mobile edge service platform for customized services and better QoE



[M-CORD POC Rack]

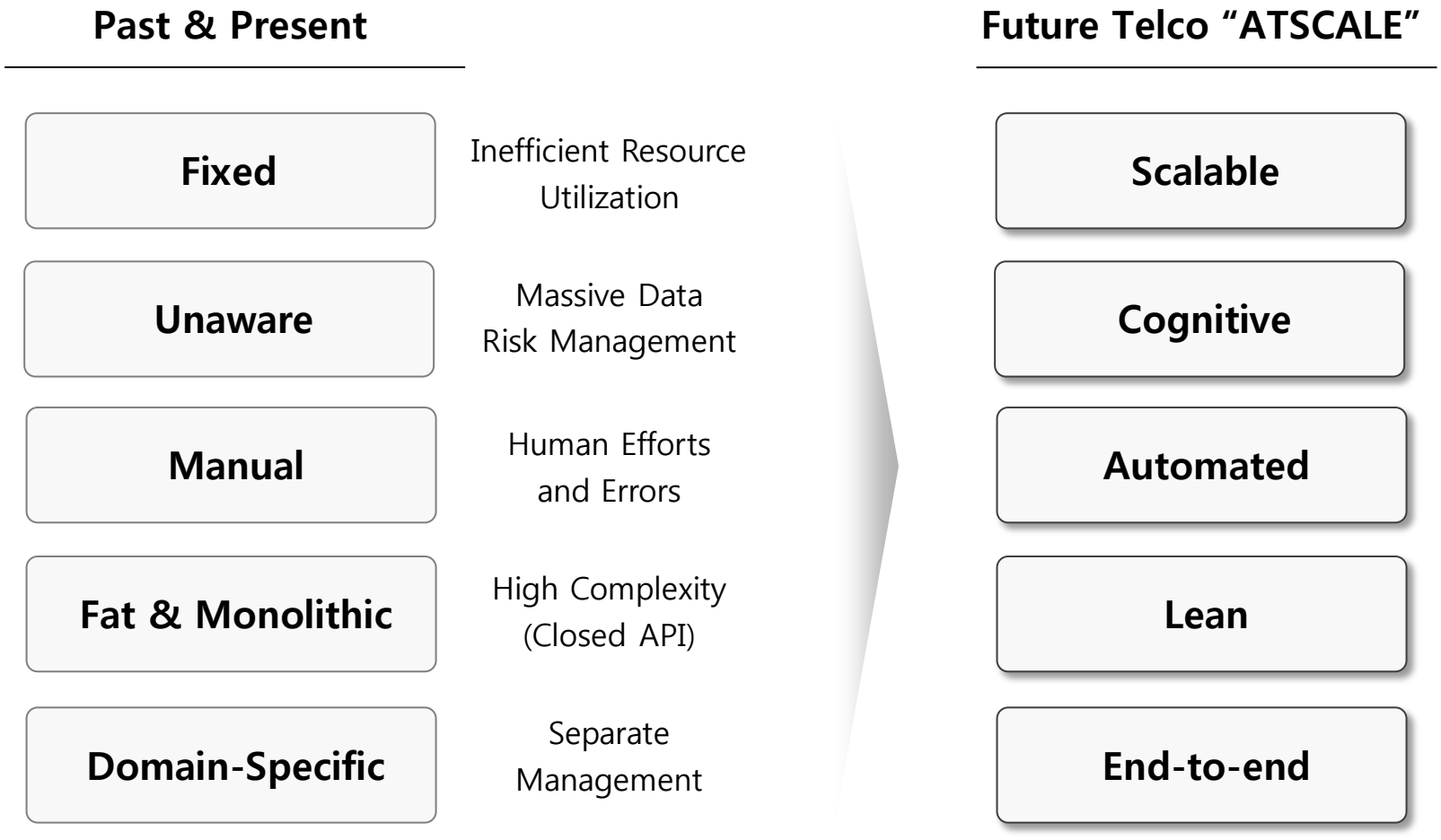
【 Lessons Learned 】

- **Need for NFV integration reference**
  - More than 6 weeks were spent purely on resolving interworking issues
    → Common NFV platform/certification may resolve interworking issues due to highly diverse NFV development environments (e.g., H/W, virtualization environment, NFV acceleration technologies, etc.)
- **Need for simplified Telco specific requirements**
  - Although it is technically feasible to separate CP/UP in PGW based on SDN today, Telco specific UP requirements such as PCC & QoS cannot be satisfied without major modifications.
    → Re-design and optimization of Telco UP S/W functions for IT/Cloud-friendliness is necessary for SDN-enabled Telco N/W commercialization.

Re-architecting the RAN

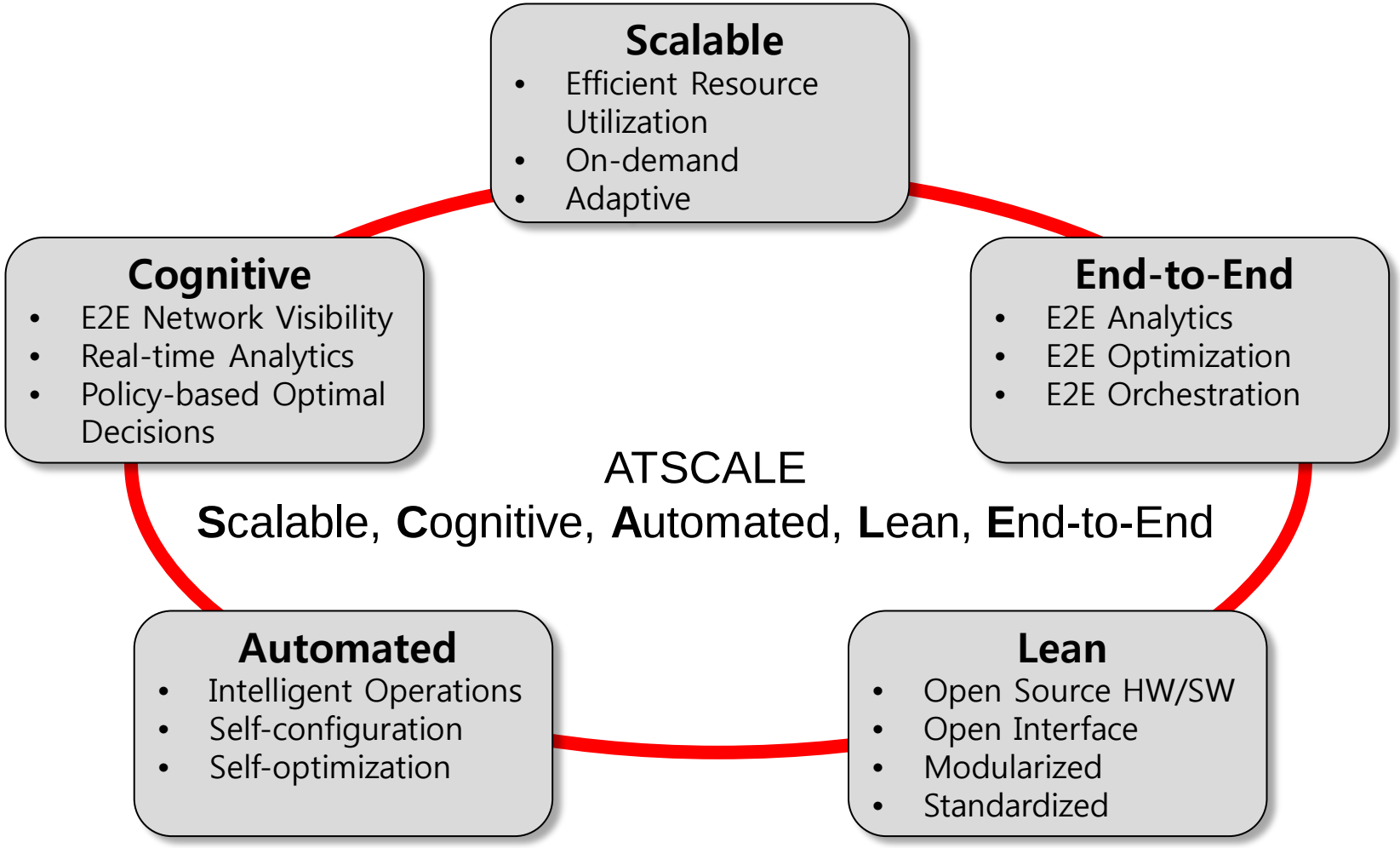
Direction of SKT's Future RAN Architecture

- Network that fulfills diverse requirements/services **at-scale**
- ATSCALE: **S**calable, **C**ognitive, and **A**utomated, **L**ean, **E**nd-to-end



Re-architecting the RAN

SKT's future RAN will be
"Scalable", "Cognitive", "Automated", "Lean", and "End-to-End"



Re-architecting the RAN : How?

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4 Basic Principles

"Unbundling"

- Software/Hardware Decoupling
- Unbundled Function Blocks
- Control-/User-plane Separation

"Open"

- Open Source Software (OpenStack, ONOS)
- Open Hardware (OCP, TIP)
- Open Interface (Fronthaul, API)

"Softwarization"

- NFV (Network Functions Virtualization)
- SDN (Software Defined Networking)
- Orchestration & Network Slicing (XaaS)

"Cloudification"

- Cloud-based "All IT" Infra
- SDN-enabled Fabric
- Re-architecting as a Data Center

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SDRAN (Software-defined RAN)

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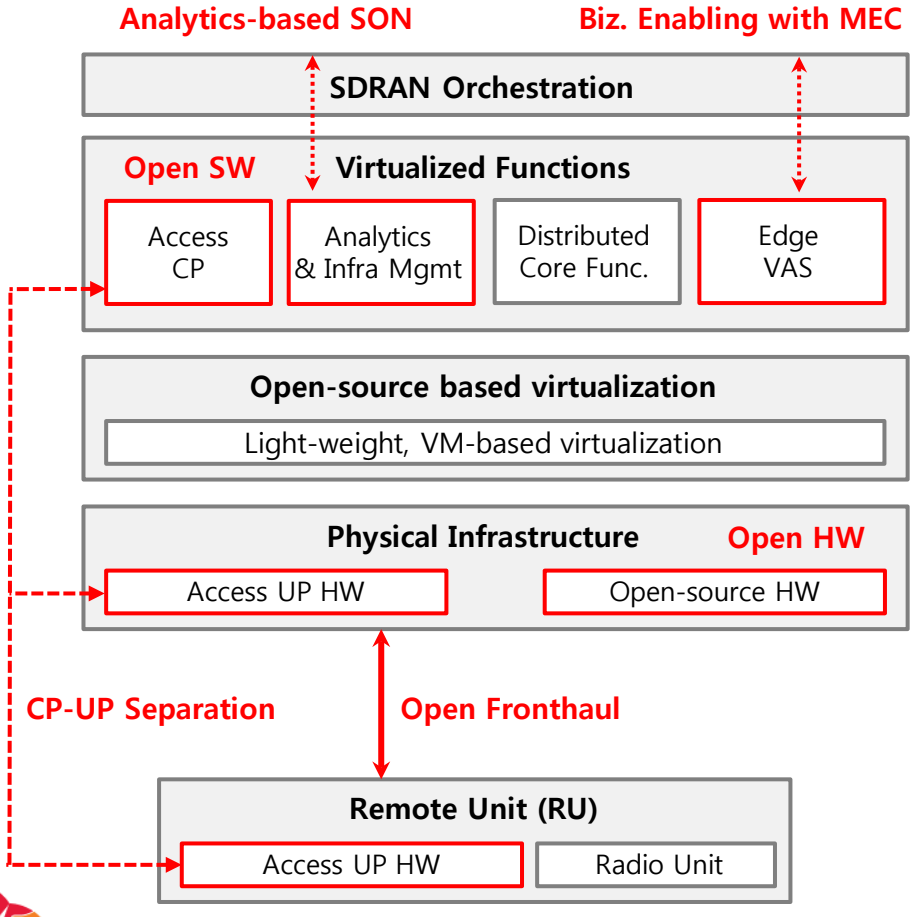
Software-based "All-IT" network infrastructure with open RAN innovations

SDRAN Architecture



Key Values

1 Open Architecture

- Network function virtualization
- Open interface (fronthaul, service API)
- CP-UP separation
- Open HW and SW

2 Operational Intelligence

- SW-based risk management
- Auto Recovery
- Reconfiguration without service interruption
- Automated operation and optimization with real-time analytics

3 Biz. Enabling Platform

- 3rd party services
- Rapid Creation of Innovative Services
- Edge service slicing

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SDRAN - Enabling Features (1/5)

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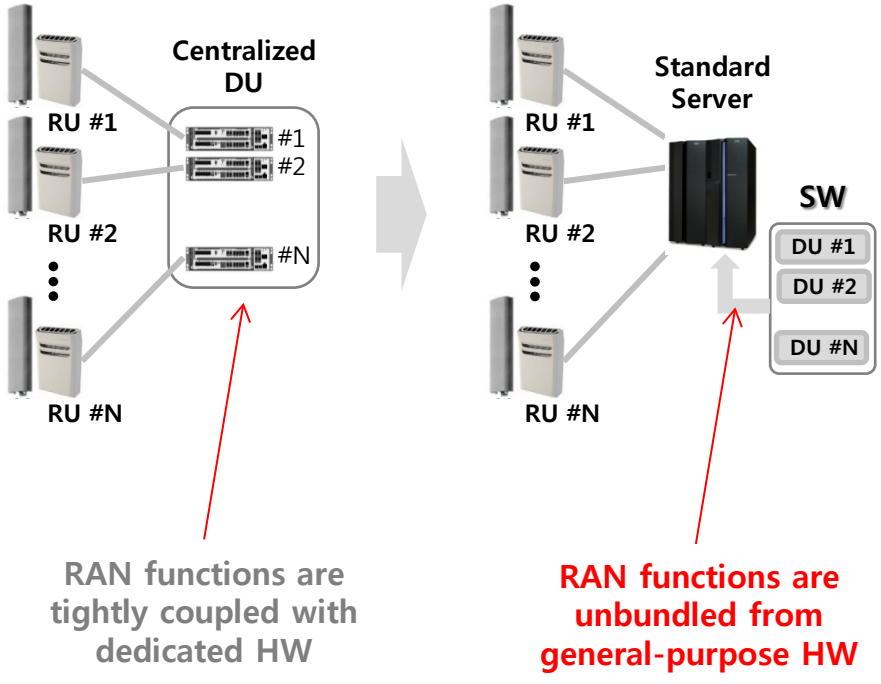
Network Function Virtualization

- Apply IT virtualization technologies to Telco infrastructure



Requirements

- RAN functions are virtualized on any COTS (standard servers) on the market
- Meet carrier-grade performance requirements, such as real-time processing and availability

Benefits

- Open source solution, e.g., OpenStack, is already widely used in the industry
- Brings pooling gains, i.e., enables efficient use of hardware resources
- Cost-efficiency by using general purpose computing platforms

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SDRAN - Enabling Features (2/5)

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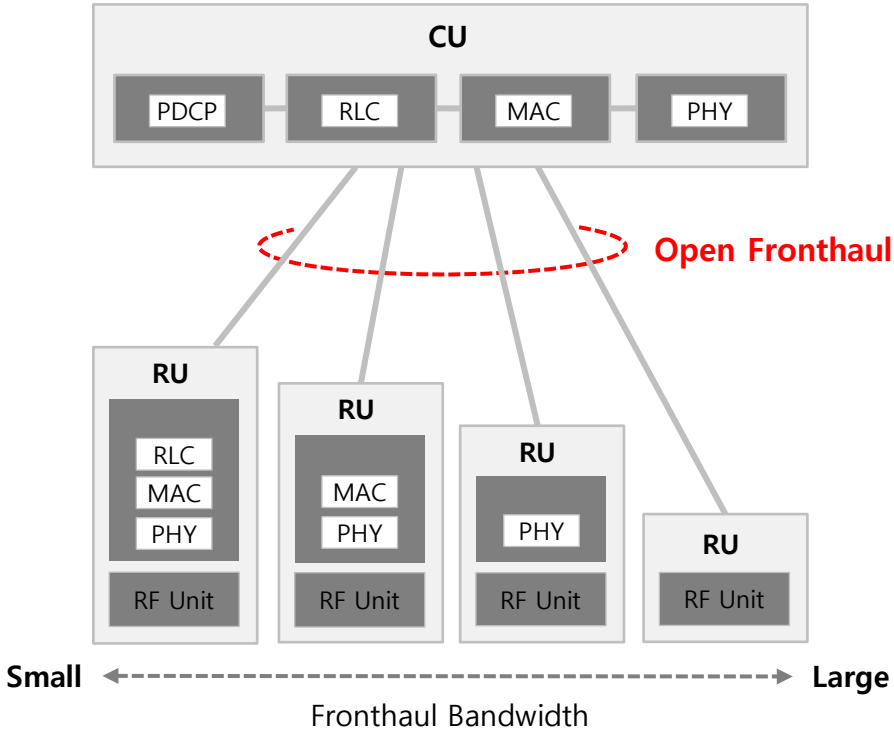
Open Fronthaul with Function Split

- Unbundling central unit (CU) and remote unit (RU)



Requirements

- Support flexible function split between CU and RU
- Define open interface for fronthaul, especially O&M related specifications
- Show multi-vendor interoperability with compliance testing

Benefits

- Select best combination of CU and RU in terms of costs, fronthaul bandwidth, and coordination
- Cost-efficiency by leveraging wide ecosystem

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SDRAN - Enabling Features (3/5)

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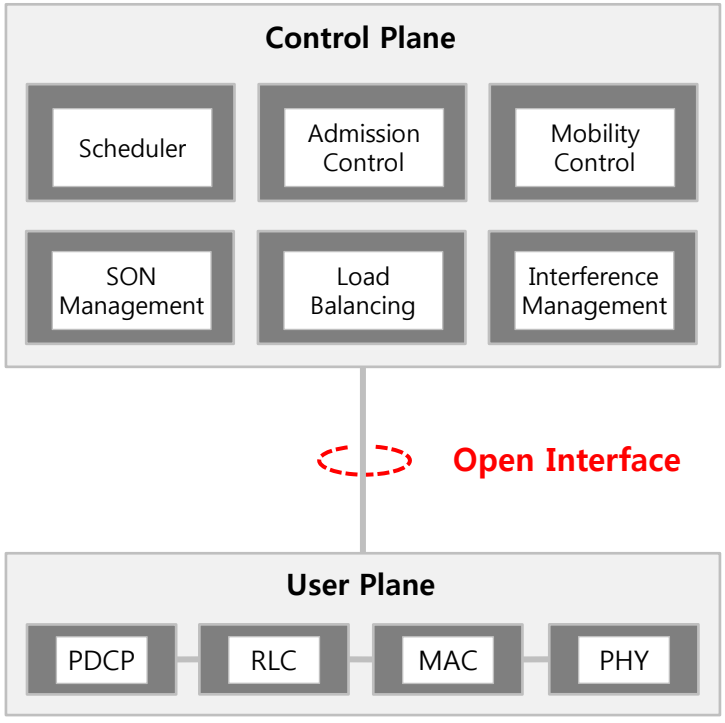
CP-UP Separation

- Unbundling control plane (CP) and user plane (UP)



Requirements

- Define CP functions which can be differentiated by each operator (scheduler, admission control, handoff control, SON management, load balancing, interference management, link aggregation, multi-RAT management, etc.)
- Define open interface between CP and UP
- CP run as virtualized function
- UP run on standardized and dedicated hardware

Benefits

- Separate HW expansion of CP and UP
- Enables RAN slicing
- Operators can introduce differentiated CP
- Cost-efficiency by using GPP and/or commoditized UP hardware

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SDRAN - Enabling Features (4/5)

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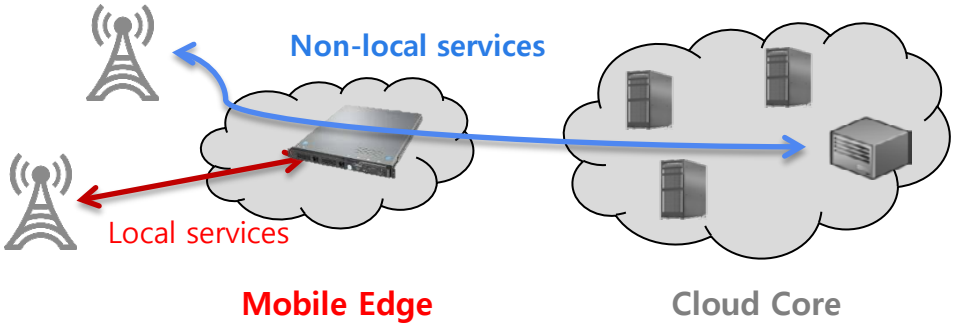
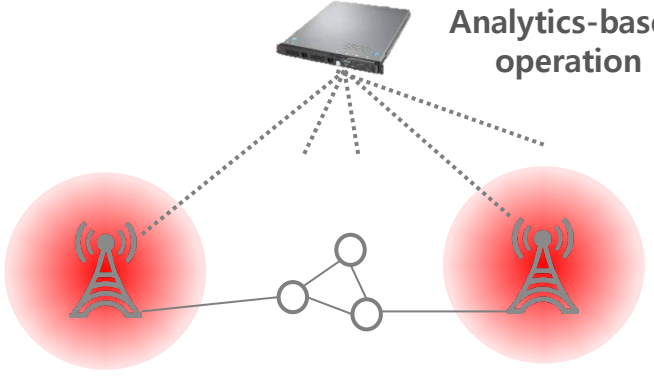
Open API for MEC & Analytics

- Provides additional information for non-telco applications





Requirements

- Define open API for
  - 3rd party applications
  - Analytics functions
- Need to provide necessary information, for example, radio condition, user information, resource allocation, etc.

Benefits

- Brings operational intelligence (risk management, automated operations, and optimization) to operators using real-time analytics
- Brings new business opportunities with mobile edge computing platform

SDRAN - Enabling Features (5/5)

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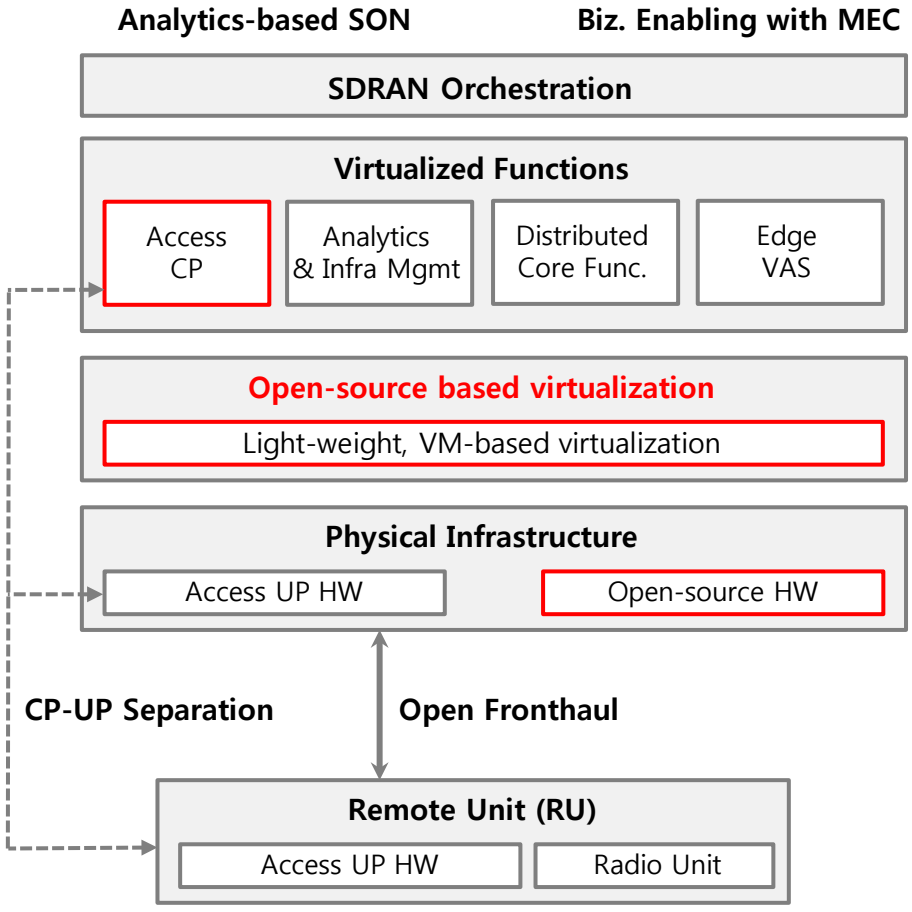
Open HW/SW

- Standardize HW components and modularize SW components



Requirements

- Define common specifications for HW components such as server, switch, storage, rack, etc.
- Define open interface between SW components (L1, L2, L3)

Benefits

- OCP has proven that openness and collaboration can successfully drive innovations on HW technologies for data centers
- Provides power efficiency, flexibility, and scalability
- Cost-efficiency with standardized HW components

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SDRAN – Extension to E2E Architecture

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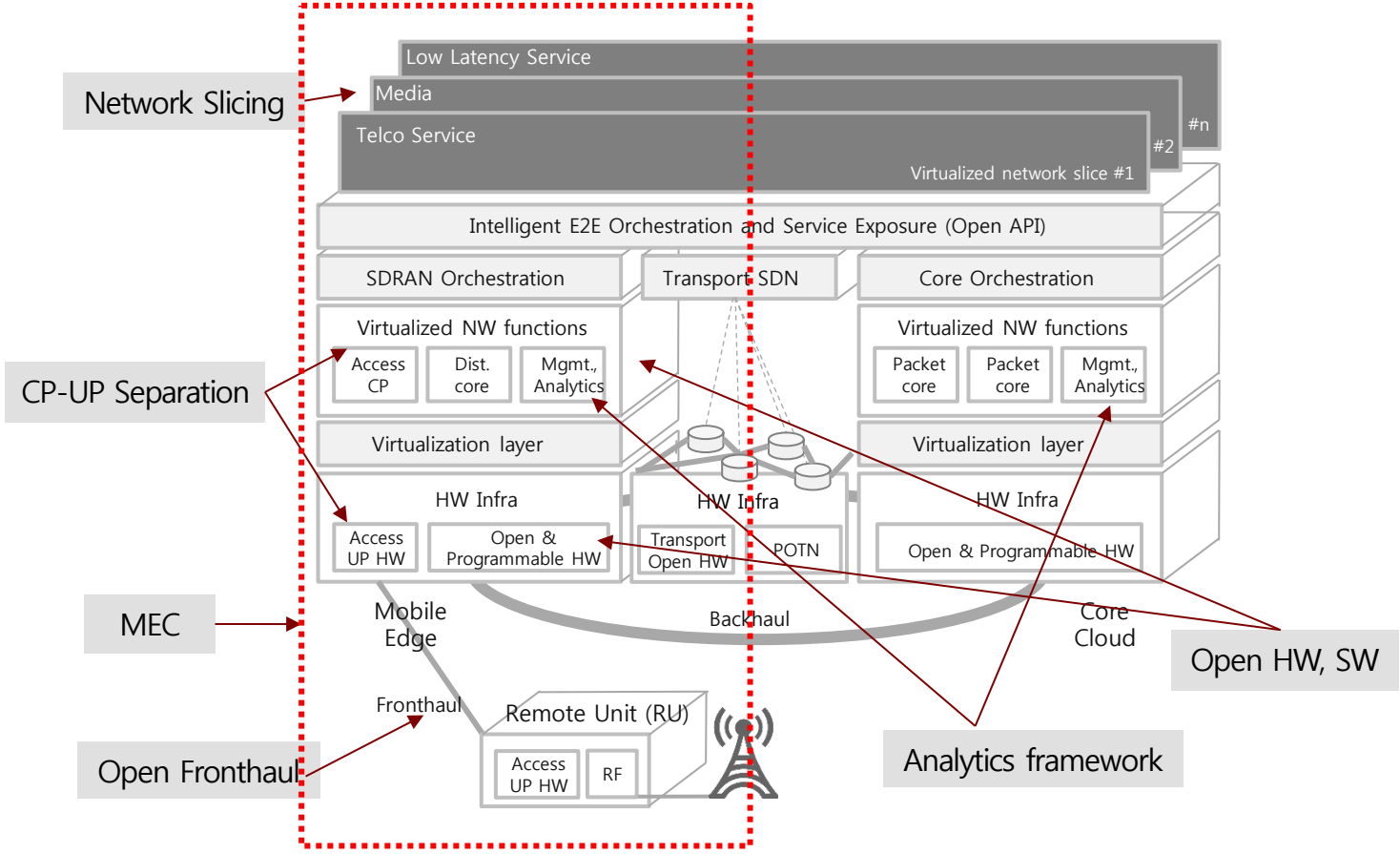
SDRAN will complete the end-to-end "ATSCALE" network infrastructure



- Each area (access, transport, and core) is now being virtualized using technologies like NFV and SDN
- E2E orchestrator connects access, transport, and core networks, and provides managements of services in the aspect of the end-to-end connection

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SDRAN Opportunities

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Operator Opportunities provided by SDRAN

Operational Intelligence	New Business	Customer Experience	Cost-efficiency
			
Real-time Big Data Analytics Automated Operations Zero-touch Network	Edge Service Platform Innovative Services	Real-time Optimization Service Agility	Unbundled RAN Components Multi-vendor Interoperability

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SDRAN Opportunities

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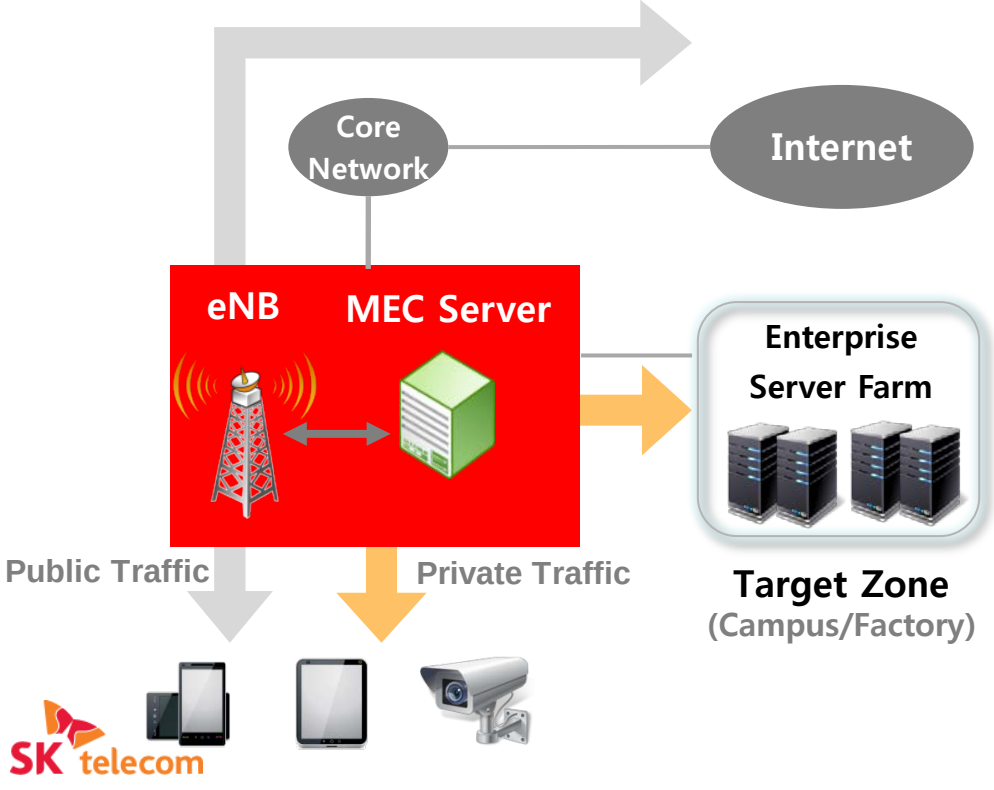
New Business

- "Proximity to end users" brought by mobile edge computing platform brings new opportunities to operators to *create new business models*
- Example: **Private Network**
  - Local routing and traffic control for enabling the smart work service with high security



Customer Experience

- Low latency enabled by mobile edge service platform will *enhance the customer experience* in certain applications like **AR** and **VR**
- Low latency will *create new services* like **self-driving car** and **robotic surgery** which have been impossible in existing networks

SDRAN Challenges

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IT World vs. Telco World

Simplicity & Flexibility

Programmability
Easy-to-reconfigure
Open

99.999% Reliability & Availability

Stability
Deterministic performance
Standard

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SDRAN Challenges

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Challenges SDRAN needs to deal with

Mission Critical	Real-time Processing	System Integration	Reliability
			
RAN Slicing CP-UP Separation	Distributed System with Function Split HW Accelerator	Open Interface Compliance Testing	Operational Intelligence

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Global Collaboration

SK telecom is committed to open source and standards-based solutions
We are carrying out various R&D projects to verify the SDRAN concept & performance in collaboration with global telco/IT companies

Gold Member
OCP Telco Project

SDRAN

Founding Member
Board Chair

ON.LAB

Member and Collaborator
CORD and ONOS Partner

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Global Collaboration

OPEN Compute Project

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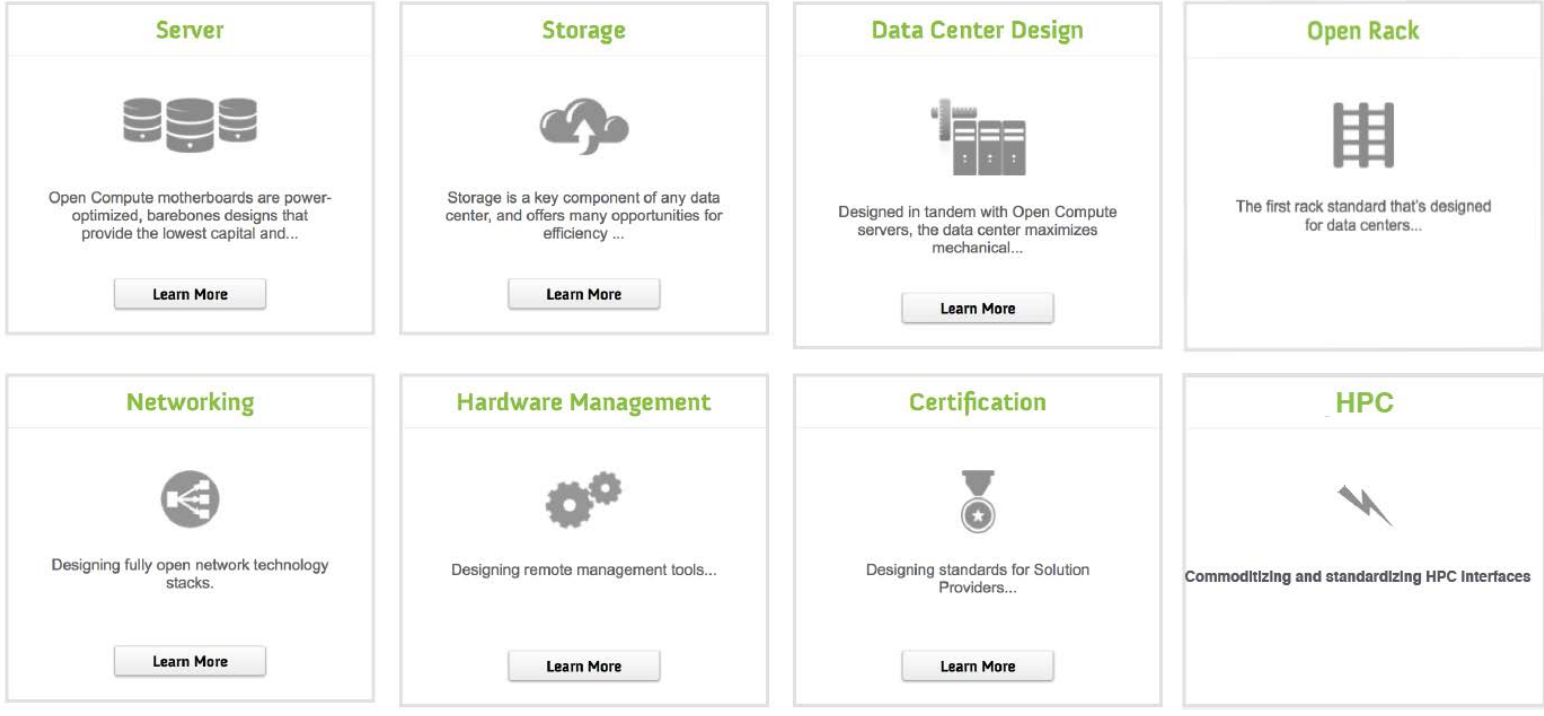
- **Open Compute Project (OCP)**
  - *Redesigning hardware* to efficiently support the growing demands on IT infrastructure
  - Break and open the black box of proprietary infrastructure, making it more *efficient*, *flexible*, and *scalable*
- **8 Projects + Telco Project (created on Jan. 2016)**
  - *OCP Telco Project*: Focus on data center technologies for *telecom companies*



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Global Collaboration ON.LAB

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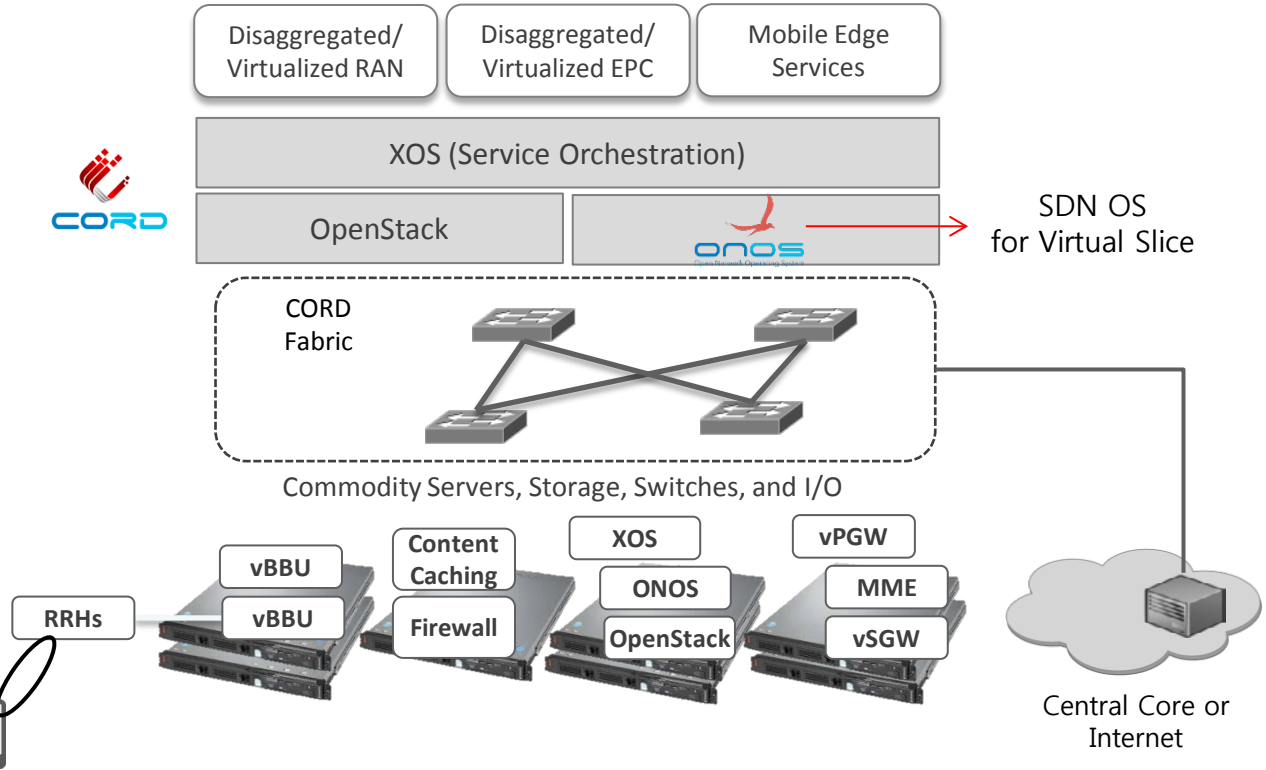
- **Mobile CORD (M-CORD)**
  - CORD (Central Office Re-architected as a DataCenter) extended to mobile network
- **M-CORD Vision**
  - Enable virtualized/disaggregated RAN and Core
  - Deploy network functions as services
  - Leverage best practices of SDN, NFV and Cloud

M-CORD



PoC Activities

- Real-time Analytics (SON)
- PGW C-/D-plane separation
- Low-latency Video
- Network Slicing
- Connectionless Service

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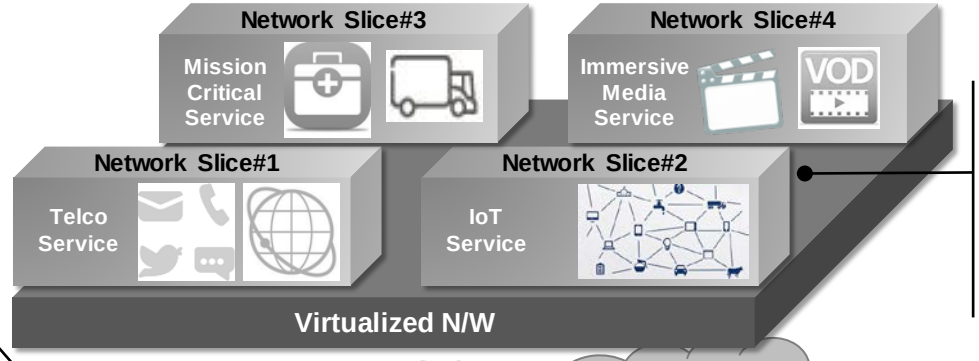
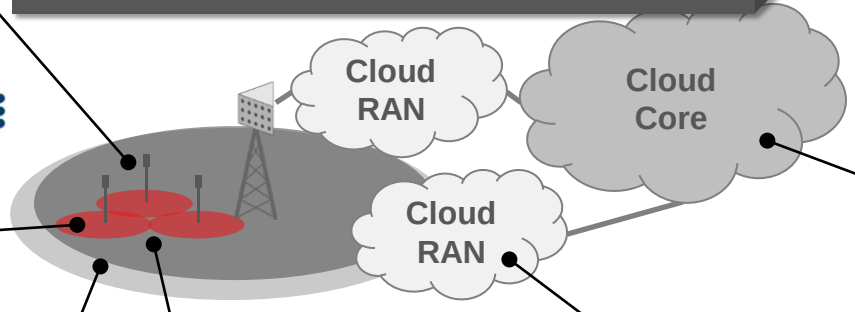
Global Collaboration 5G Testbed in SK Telecom Innovation Center

Testbeds with global leading telecommunications equipment manufacturers to develop and test 5G technologies to secure global leadership in 5G





mmWave RAN

- 3D Beamforming with Large-scale antennas
- Ultra wideband @ mmWave

Network Slicing

- Novel Network Architecture for Supporting Diverse Services
- Creation and Isolation of Virtualized Networks on as-a-service basis

Low Latency RAN

- Lower Latency than 4G
- Dynamic TDD
- Less Interference

Cloud Core

- Improved Performance and Scalability by UP/CP Separation
- Low Latency, Low Cost

New Air Interface

- New Waveform/Frame-structure
- New Multiple Access Scheme

Anchor Booster & Massive MIMO

- LTE-WiGig Tight Interworking
- Cloud BBU Base Band Unit

Cloud RAN

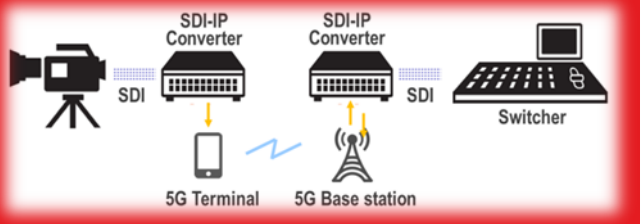
- World-first Maximum 19.1Gbps Transmission
- Key Enabler for Supporting Multi-RAT, Edge Computing

Global Collaboration Virtual Experience Room in SK Telecom Innovation Center

With the aim to secure leadership in the upcoming era of 5G, space to provide 5G customer experience and develop 5G service technologies

- **5G Based Live Production**

  Together with Sony, '4K UHD live broadcasting system' in 5G era without relay equipment



- **5G Robot**

  Teleoperation of 5G humanoid robot by transmitting control signal from motion suit to humanoid

- **T-AR for Tango**

  One-stop service for users to easily develop and execute an AR service by accurately learning 3D space


- **Remote AR**

  Remote Augmented Reality built with space recognition and gesture/motion sensing tech..


- **Beyond Surface**

  Table-top device providing multiple users with futuristic experience and independent tasks


- **Immersive Experience Room**

  Virtual environment through action camera and ultra-low latency streaming equipment


Summary

- SDRAN is RAN softwarization based on open architecture and open interfaces
- SDRAN transformation will be the key technology to
  - Simplify the network and enable cost-efficiency
  - Bring operational intelligence for network managements
  - Create new revenue streams with edge service platform
- Final goal is to develop a software-based “All-IT” telecom network infrastructure from the end-to-end perspective
- SKT is collaborating with best partners to implement the modular functions and integrate those blocks efficiently


thank you
danke
謝謝
gracias
merci
obrigado
dziękuję
bedankt
teşekkür ederim
go raibh maith agat
mochchakkeram
спасибо
ngiyabonga
tapadh leat
dank je
sukriya
kop khun krap
terima kasih
arigatō
dakujem
grazie
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hvala
mauruuru
рахмат
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