

4<sup>th</sup> OSA Workshop Paris

# Development of Access Platform based on Virtualization

Nov. 7, 2017.

**ETRI**



Electronics and Telecommunications  
Research Institute  
Research Institute  
Electronics and Telecommunications



# ETRI



## ■ Mission

- ETRI makes contribution to the nation's economic and social development through research, development and distribution of industrial core technologies in the field of Information, Communications, Electronics, Broadcasting and Convergence technologies.

# ETRI

## ■ Major achievements in Communication Research Area

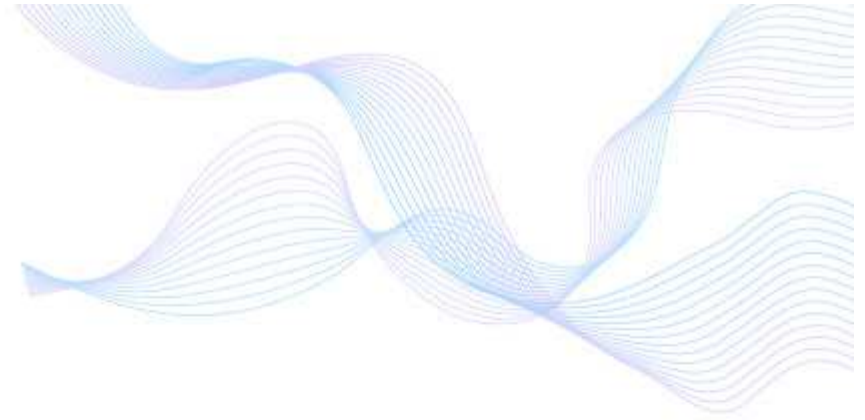
1976	Established ETRI
1995	Commercialize CDMA for the first time in the world
1999	Synchronized IMT 2000 STP system
2004	WiBro prototype
2007	World's first 3.6Gbps 4 <sup>th</sup> generation mobile communication technology(NoLA)
2010	4G LTE-Advanced Technology
~ 2017	under development of 5G Key technology

# OUR WORK

<b>Project</b>	<b>Development of 5G mobile access platform technology based on virtualization converged with computing</b>
<b>Period</b>	<b>2016.4.1. ~ 2020.12.31. (57Months)</b>
<b>Object</b>	<b>Develop the virtualization base station system that can operate in real time by building a virtualization platform that can accommodate communication functions and virtualizing multi-RAT access function of 5G mobile communication</b>

- This work has been supported by Institute for Information & communications Technology Promotion(IITP) grant **funded by the Korean government(MSIT)**. [No. 2016-0-00183]

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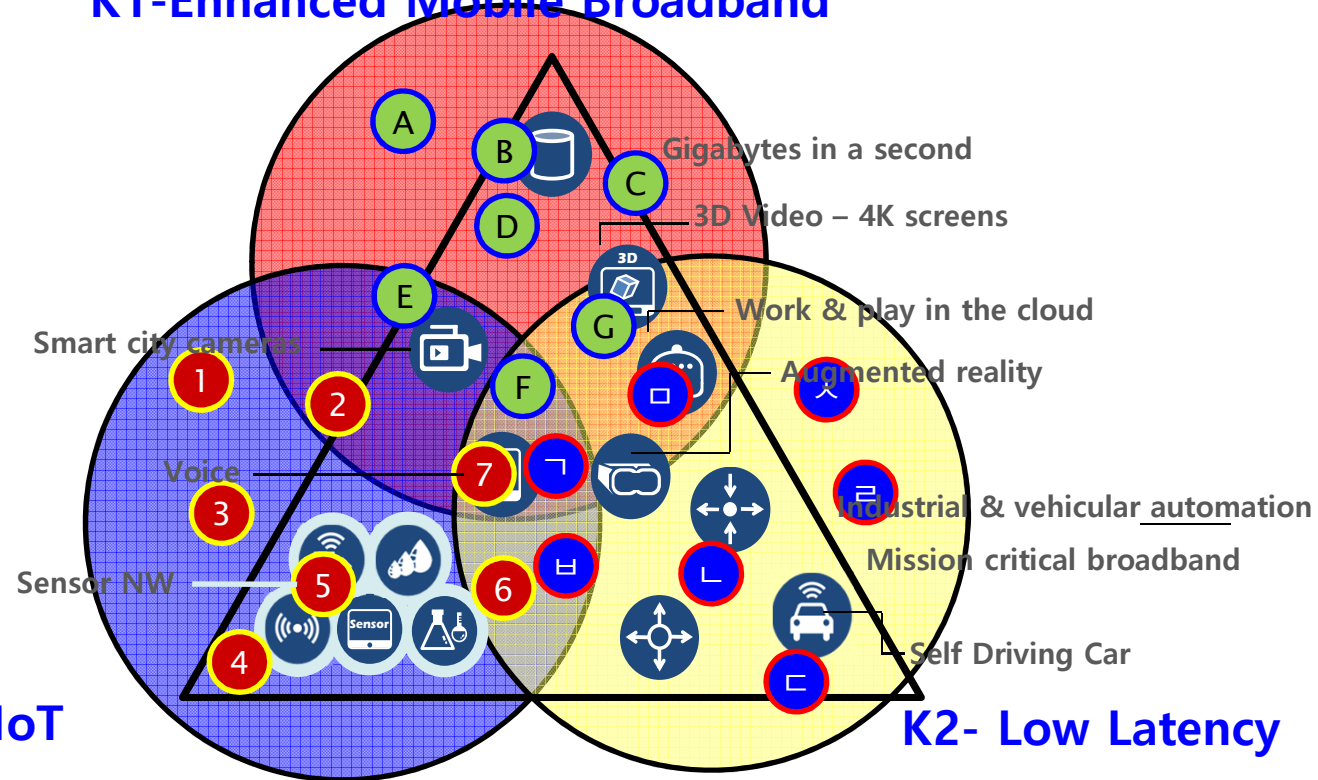
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# I. INTRODUCTION: 5G SYSTEMS

## K1-Enhanced Mobile Broadband



Different requirements on various service

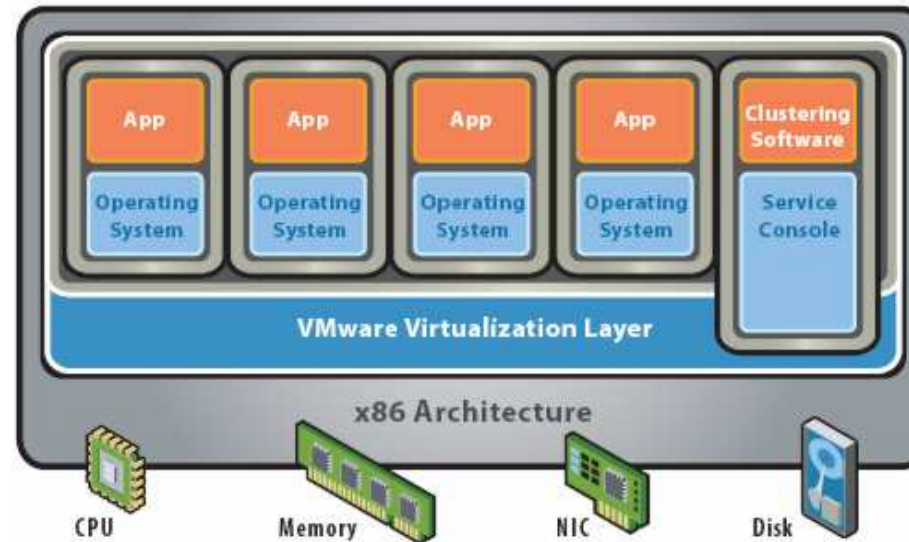
→ Differentiated networks for optimal service delivery.

→ Virtualized systems are required to provide integrated services

# I. INTRODUCTION: VIRTUALIZATION FOR 5G SYSTEMS

- ❖ Paradigm change of communication equipment (Open HW / SW) from based on HW to based on SW
- ❖ Flexible systems required by 5G → Solve with system virtualization
  - ◆ Efficient use of limited frequency resources
    - Efficient and resilient deployment of radio resources
    - Accepts network diversity to accommodate various IoT devices (Multi-RAT acceptance)
  - ◆ Actively coping with changes in standards
    - A new standard is born every 1.5 years
    - Adapt to rapidly changing user service requirements (easy to provide new services)
  - ◆ Benefit
    - Flexibility in system installation and maintenance / management
    - Reduce OPEX through remote control and management of the system
    - Reduce CAPEX by performing various functions with one device
    - Efficient use of wireless resources to increase profits
    - Various applications such as temporary base station
    - (educational, measurement, military, emergency network construction, special purpose satellite, etc.)
    - Easy portability / coherence between systems → Network Slicing, RAN Slicing Utilization / matching

# I. INTRODUCTION: 5G VIRTUALIZATION

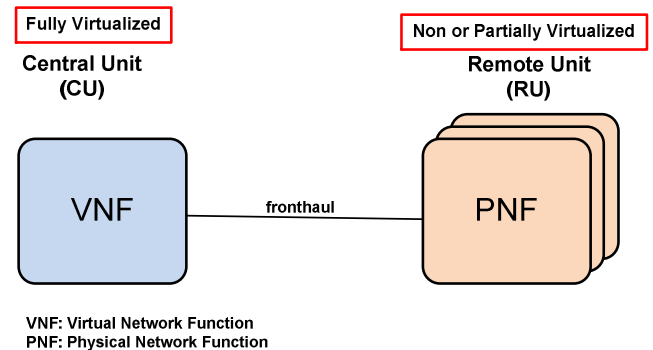
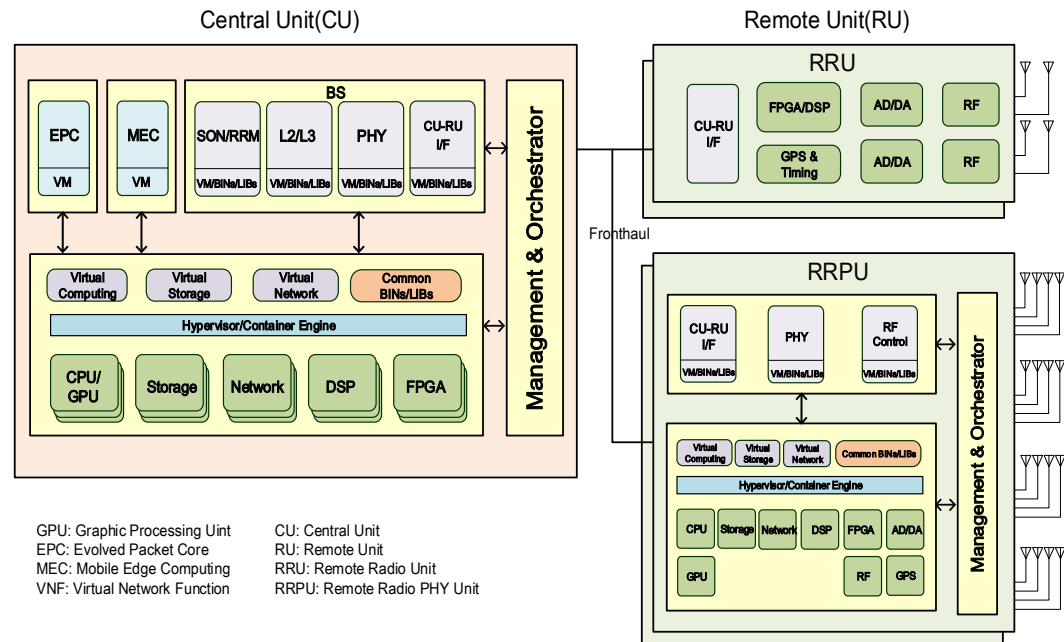


- Virtualized CPU, Storage, Network by **HYPERVISOR**
- New Innovative Development Paradigm
- **SW**, independent of **HW**
  - Increase **Portability** of SW
  - Increase System **Flexibility**
- Apply to
  - Wired Network: Cloud Server, Edge Server, Router
  - Mobile Network: EPC, HSS, MEC Server
- **Now eNB(BS) Virtualization**



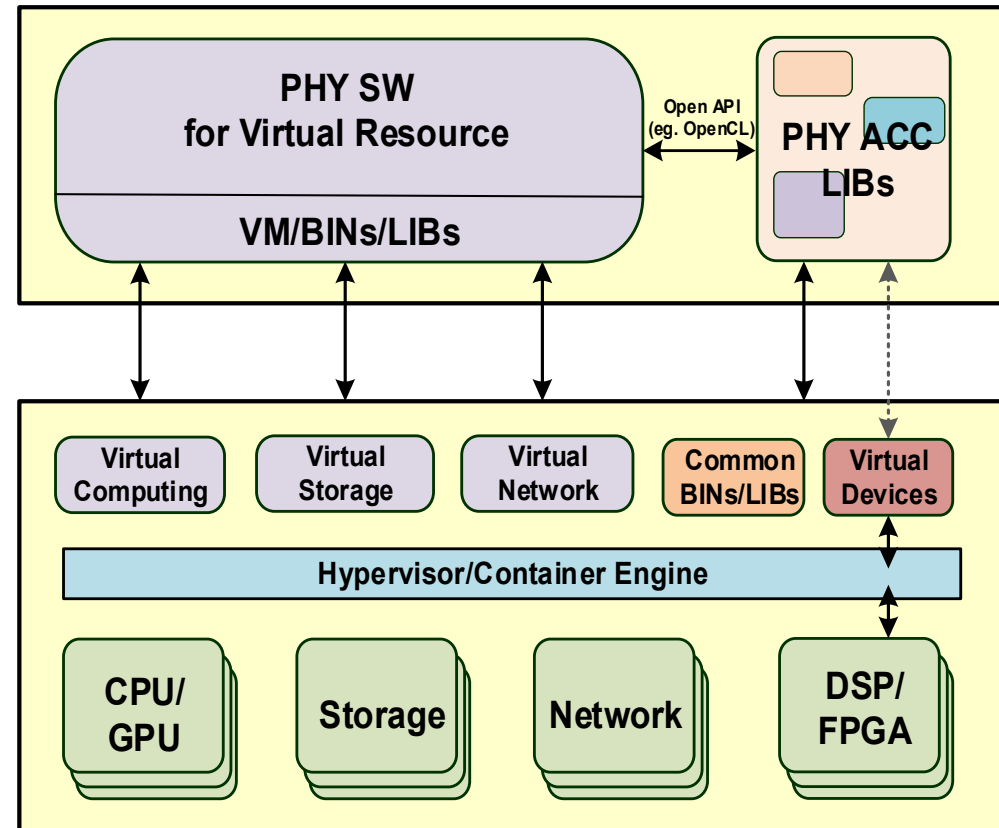
# II. SYSTEM DESIGN: SYSTEM SPLIT STRUCTURE

- System Split**
  - CU:** Collection of Digital Processing, **Centralized**, all protocols **beyond the PHY layer except RF** (Radio Frequency).
  - RU:** Collection of Radio Processing, **Distributed**, most of it is constituted by **passive HW, PHY Layer** for performance
- Virtualization**
  - VNF:** Fully Virtualized
  - PNF:** Non or Partially Virtualized
- Fronthaul**
  - To meet Bandwidth & Latency**
  - Medium:** 1G/10G Ethernet, optical, and USB 3.0
  - Standard:** RoF, CPRI, and nFAPI



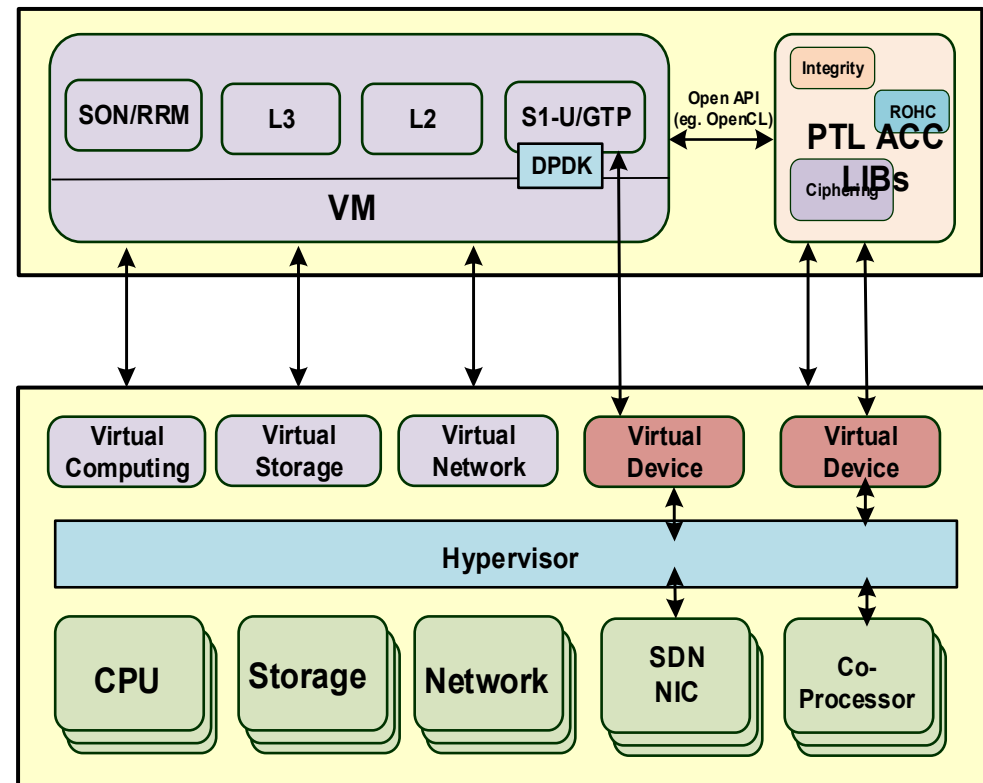
## II. SYSTEM DESIGN : MODEM

- **Hardware Resources**
  - **CPU, Storage, and Network**
  - **Co-processor** (eg, Intel Xeon PHI KNL) for SW-based acceleration
  - **DSP/FPGA** for HW-based acceleration
- **SW PHY**
  - uses the **virtualization resources** to perform the LTE MODEM
  - uses **Linux** (Redhat or Ubuntu) as a virtual machine (**VM**)
  - **independent of platform HW**
- **PHY ACC LIBs**
  - some functions of a modem **with high complexity** in the form of a library
  - **SW-based modem acceleration:** vectorization/parallelization using a plurality of virtual computing resources
  - **HW-based modem acceleration:** using DSP/FPGA:
  - allowing access to the SW PHY via **standardized/open APIs such as Open API** for increasing portability

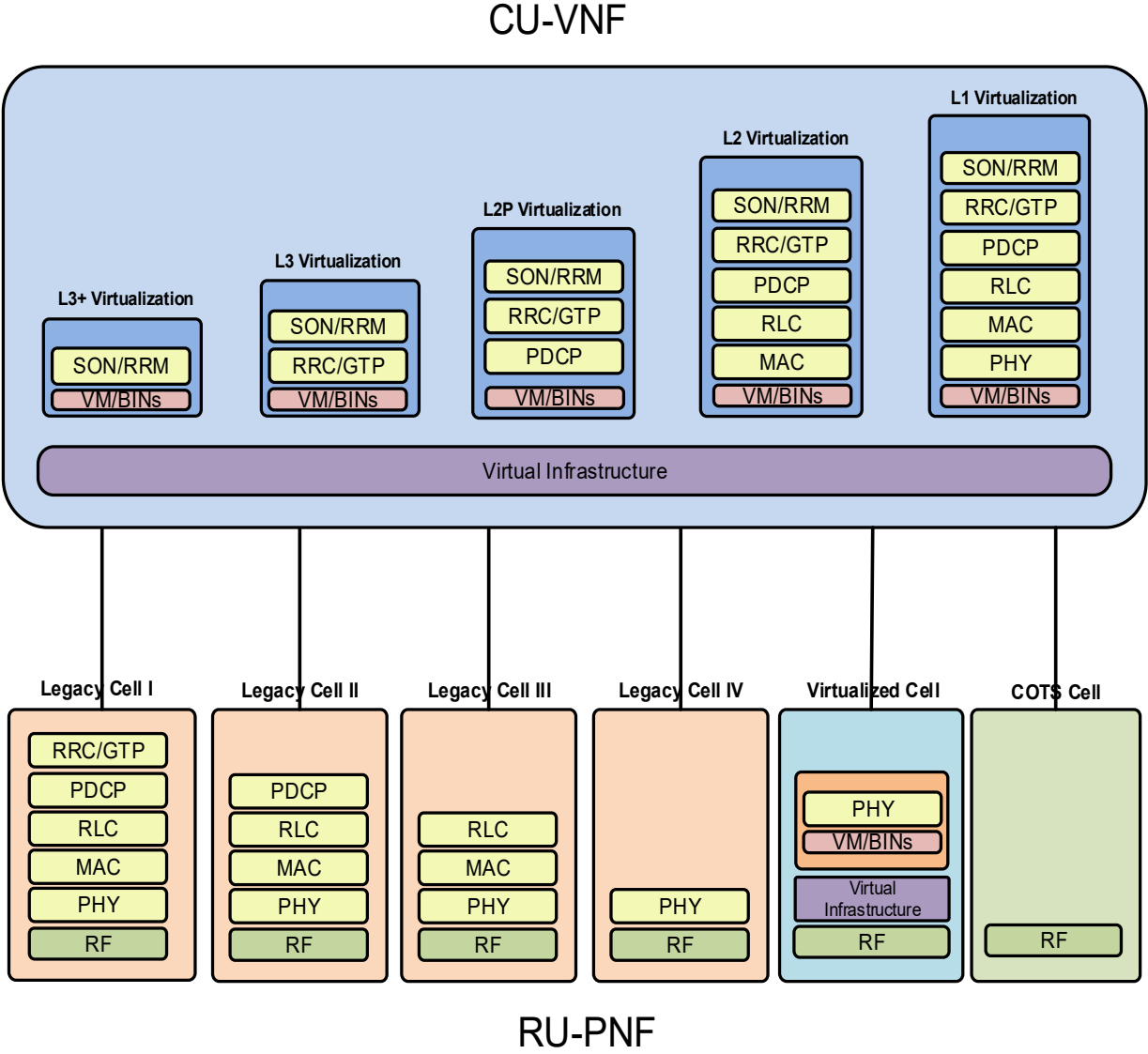


## II. SYSTEM DESIGN : WIRELESS PROTOCOL

- **Hardware Resources**
  - **CPU, Storage, and Network, Co-processor** as Wireless MODEM
  - **DPDK** by Intel is used for data plane acceleration.
- **Wireless Protocols**
  - **SON, RRM, L3, L2, S1-U and GTP** performs the LTE radio access protocol using virtualization resources
  - uses Linux (Redhat or Ubuntu) as a virtual machine (VM)
  - **independent of platform HW**
- **PTL ACC LIBs**
  - some functions (eg **Integrity, ROHC, Ciphering**, etc.) of a wireless access protocol with high performance complexity
  - **SW-based PLT acceleration:** vectorization/parallelization using a plurality of virtual computing resources
  - **NO HW-based PLT acceleration**
  - **Open API** as Wireless MODEM

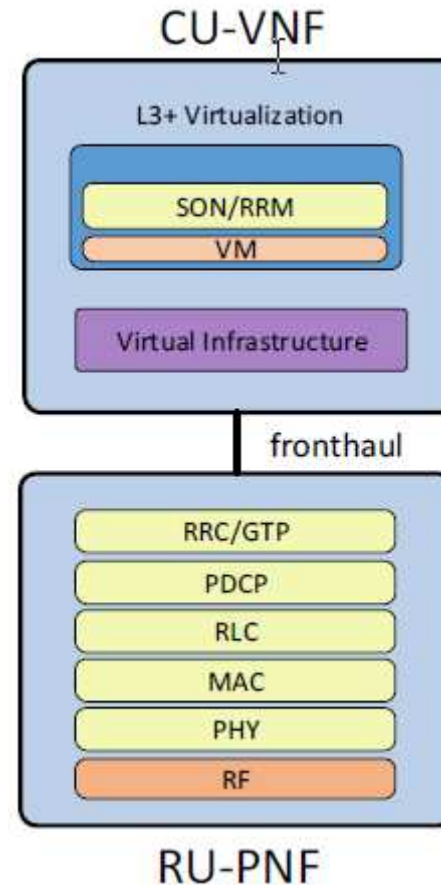


# II. SYSTEM DESIGN : SYSTEM SPLIT USE CASE



# III. IMPLEMENTATION: SERVICE VIRTUALIZATION

- **Service Virtualization**
  - Service virtualization refers to the **virtualization of the part**
  - has **virtualized SON and RRM**
  - also referred to as **L3 + layer virtualization** in the sense of virtualization for higher ones than layer 3
- **Functional Arrangement**
  - CU: L3+ elements such as **SON and RRM** are placed, **Virtualized**
  - RU: other protocols such as **RRC, GTP, L2, L3, modem, and RF** are placed, **non-Virtualized**



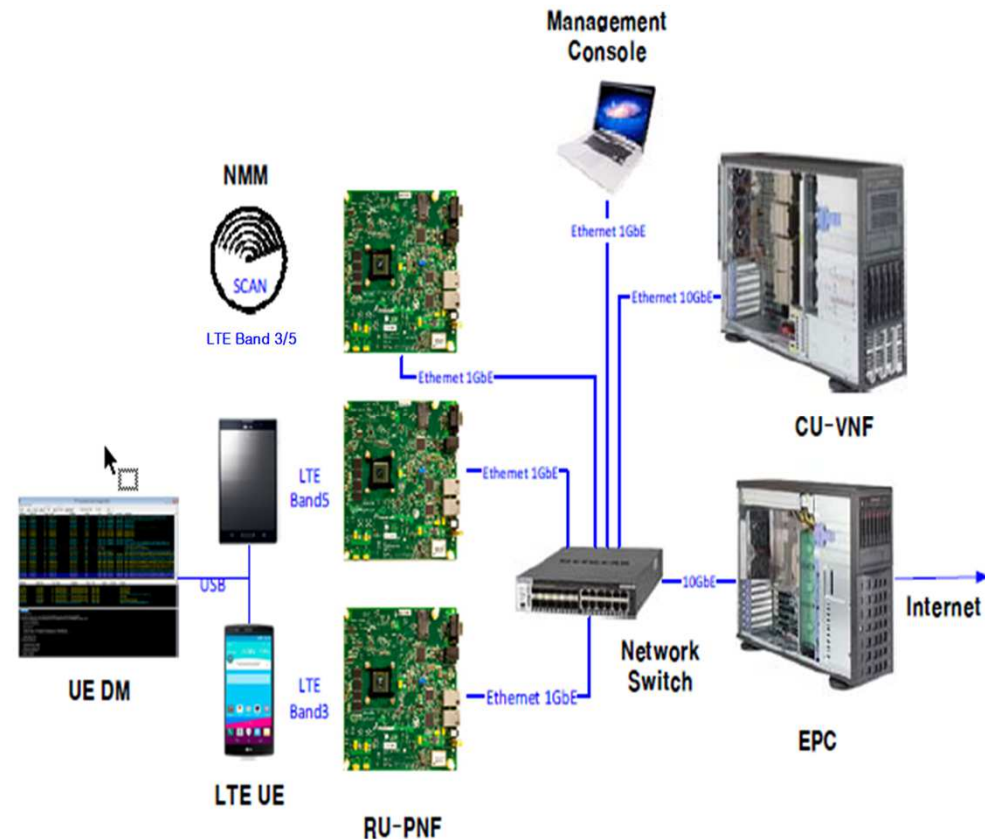
## IV. TESTING & ENVIRONMENT

- **Implementation**

- The **CU-VNF** with virtualization SON and RRM was virtualized on **the Intel Xeon-based HW** through the **VMware ESXi** hypervisor
- The **RU-PNF** with L1/L2/L3 and RF functions are implemented on a **Freescale 9131 based small cell base EVM board**.
- **UE**(User Equipment) uses a **commercially available LTE terminal**
- The **EPC** is connected behind the CU-VNF and configured to be able to interwork with the Internet.

- **Testing**

- **Two commercial terminals** operated **LTE Band3 and Band5**
- There is no problem making **LTE attach and playing YouTube** video stream
- **One RU-PNF** is responsible for the scan function of the neighboring cells for the **SON NMM**(Network Monitoring Mode) function.
- CU-VNF confirms that the **cell search and the SIB reading** procedure
- The **PCI Confusion/Collision** problem was resolved and that the **correct PCIs** were allocated to each cell





## V. CONCLUSION

- **Virtualization**
  - makes communication functions very **flexible**
  - **Key component** for 5G System
- **BS Virtualization:**
  - **Include many difficulties** in realizing virtualization because involve highly complex communication elements.
  - **Acceleration Technology** is needed.
  - **Step-by-Step Implementation** is needed that increases the weight of virtualization after confirming the feasibility of virtualization
- **Current & Future work**
  - **L2+ Virtualization**
  - **L1 Virtualization**