The first 5G system PoC in conjunction with the PyeongChang winter Olympics

5G CHAMPION

5G Communication with a Heterogeneous, Agile Mobile network in the Pyeongchang wInter Olympic competitioN

Hyun Kyu Chung | September 29, 2017
hkchung@etri.re.kr

Contents

Project Name(acronym): 5GCHAMPION

- **Project Name (Full):** 5G Communication with a Heterogeneous, Agile Mobile network in the Pyeongchang Winter Olympic competioN

Partners

- **Coordinator:** Hyun Kyu Chung (KR, ETRI), Emilio Calvanese Strinati (EU, CEA-LETI)
- **KR Partners:** ETRI, SMRT, SKT, HFR, Cleverlogic, SNU, DKU, HYU, KT, ELUON, iNSOFT, mobigen, GIST
- **EU Partners:** CEA-LETI, Nokia, Intel, TASF, Uoulu univ., HHI, TPZF, iMinds

Project Duration

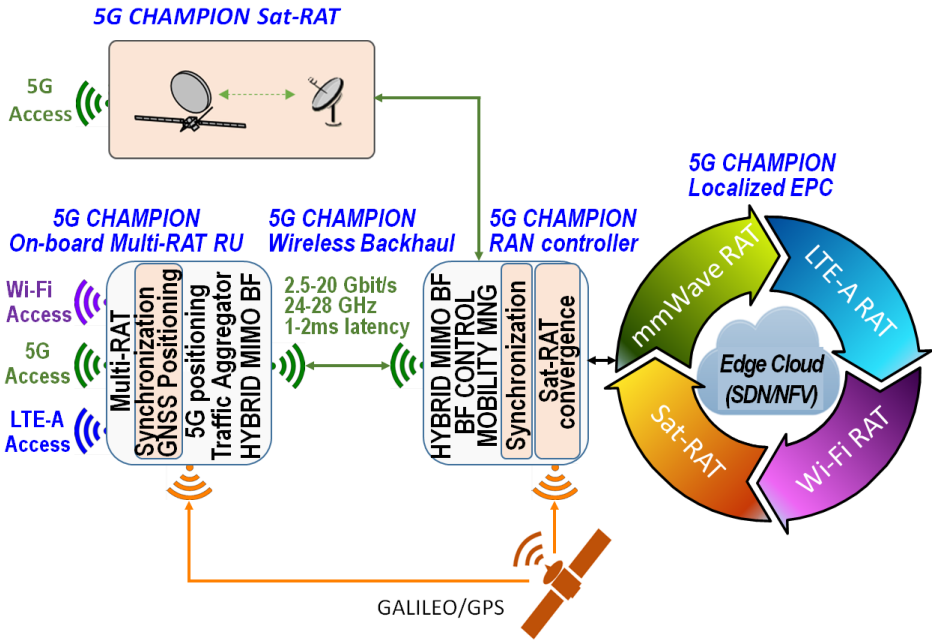
- 2 Years (2016.6. ~ 2018.5.)

5GCHAMPION Concept

5GCHAMPION *concept is a system including key building blocks*

- *for **mmWave access and backhaul network**,*
- *for sub 6 GHz direct **5G satellite narrowband access, positioning***
- *and for **a flexible and evolved packet core** network managed by SDN interface,*

*to **support various 5G use cases and all new and legacy access networks***



<5GCHAMPION high-level system architecture>

5CHAMPION overview

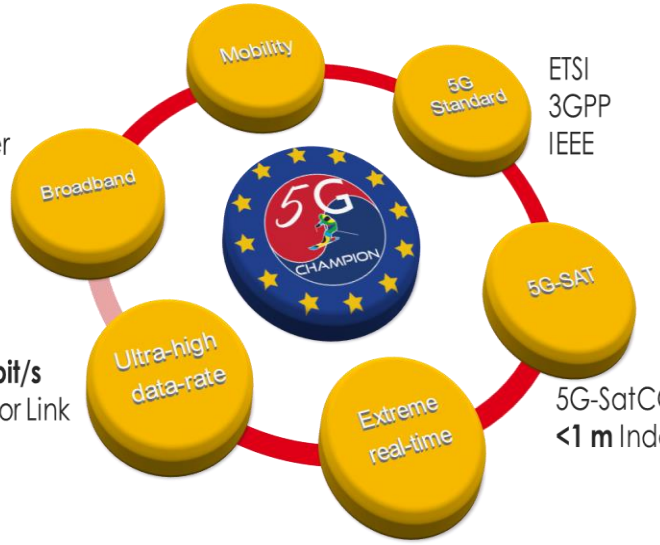
Work Packages

- **WP1** — Project Management (ETRI/CRA)
- **WP2** — System Architecture, Scenarios, Use cases and Requirements (ETRI/NOKIA)
- **WP3** — mmWave Backhauling & Fronthauling (HFR/UOULU)
- **WP4** — Core Network (ETRI/iMinds)
- **WP5** — Satellite Access & Positioning (-/TASF)
- **WP6** — Integration of 5GCHAMPION PoC and Olympics 2018 Demonstration (ETRI/NOKIA)
- **WP7** — Dissemination and Standardization (DKU/INTEL)

5CHAMPION overview
1st 5G SYSTEM PoC at PyeongChang Winter Olympics

2 ms latency on the air
2.5 Gbit/s on mmW mobile backhaul

100 Mbit/s
mobile user

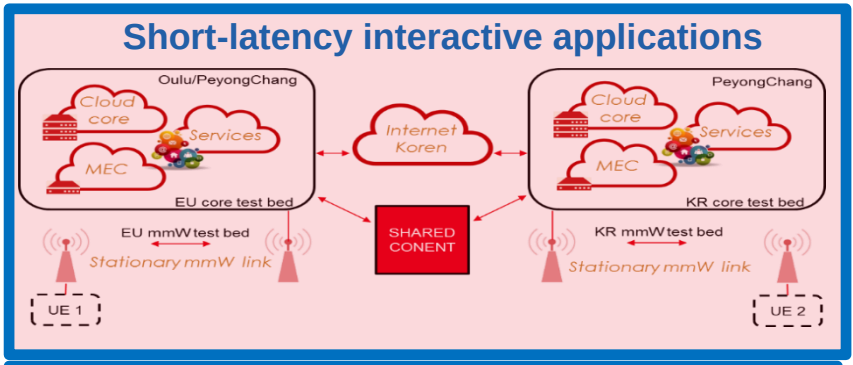


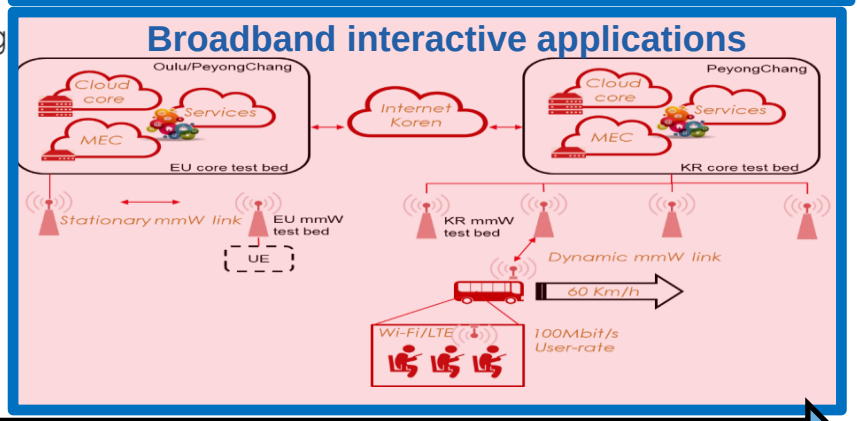
ETSI
3GPP
IEEE

20Gbit/s
Indoor Link

5G-SatCOM for NB-IoT
<1 m Indoor-outdoor positioning

SDN/NFV based
on evolved packet core network





Standardization & Prototypes

5G Services & Commercialization

2016

2017

2018

2019

2020

…

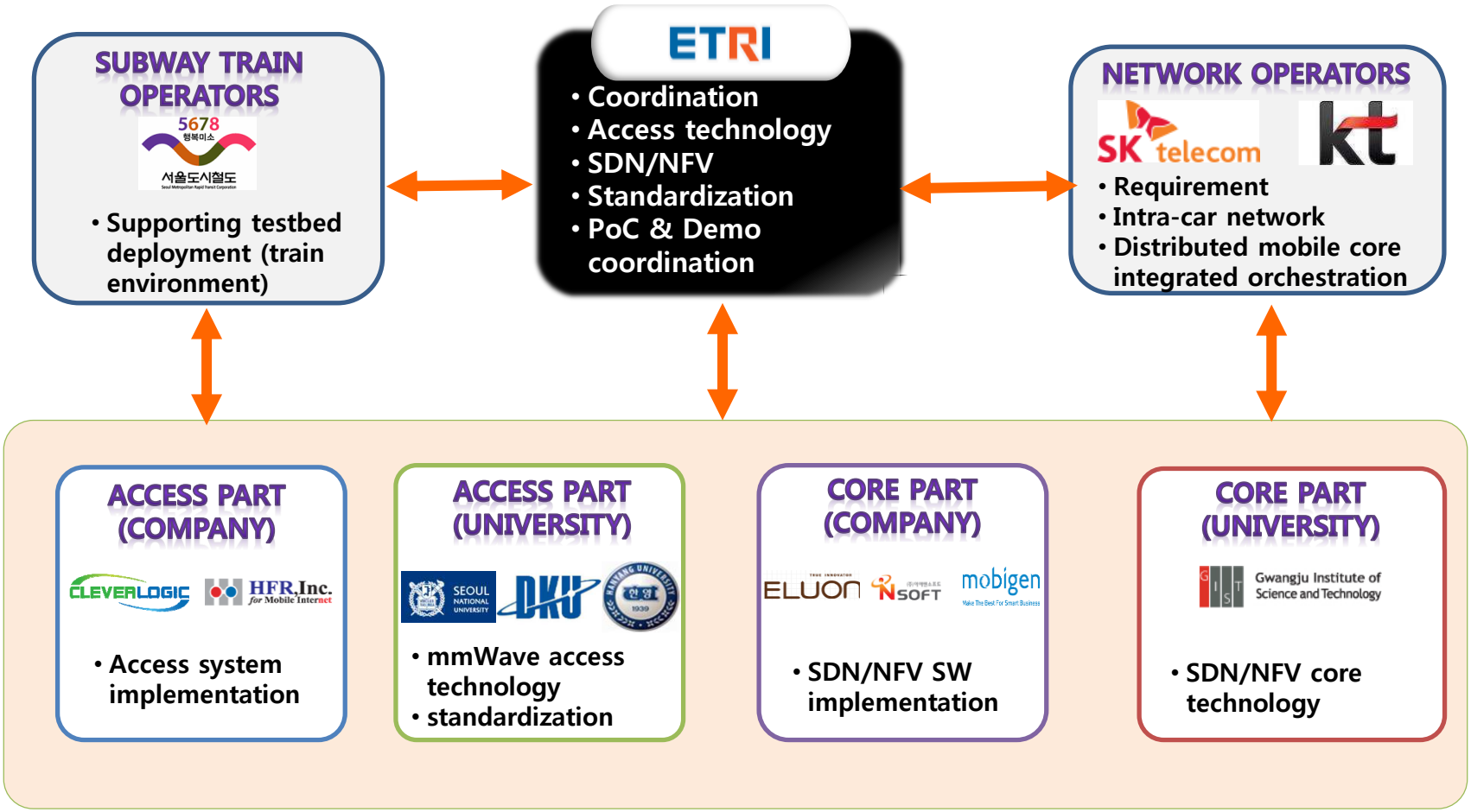
Olympic games
5G Services (Korea)

Soccer World cup
In Russia

5G Olympic games
5G Services (Japan)

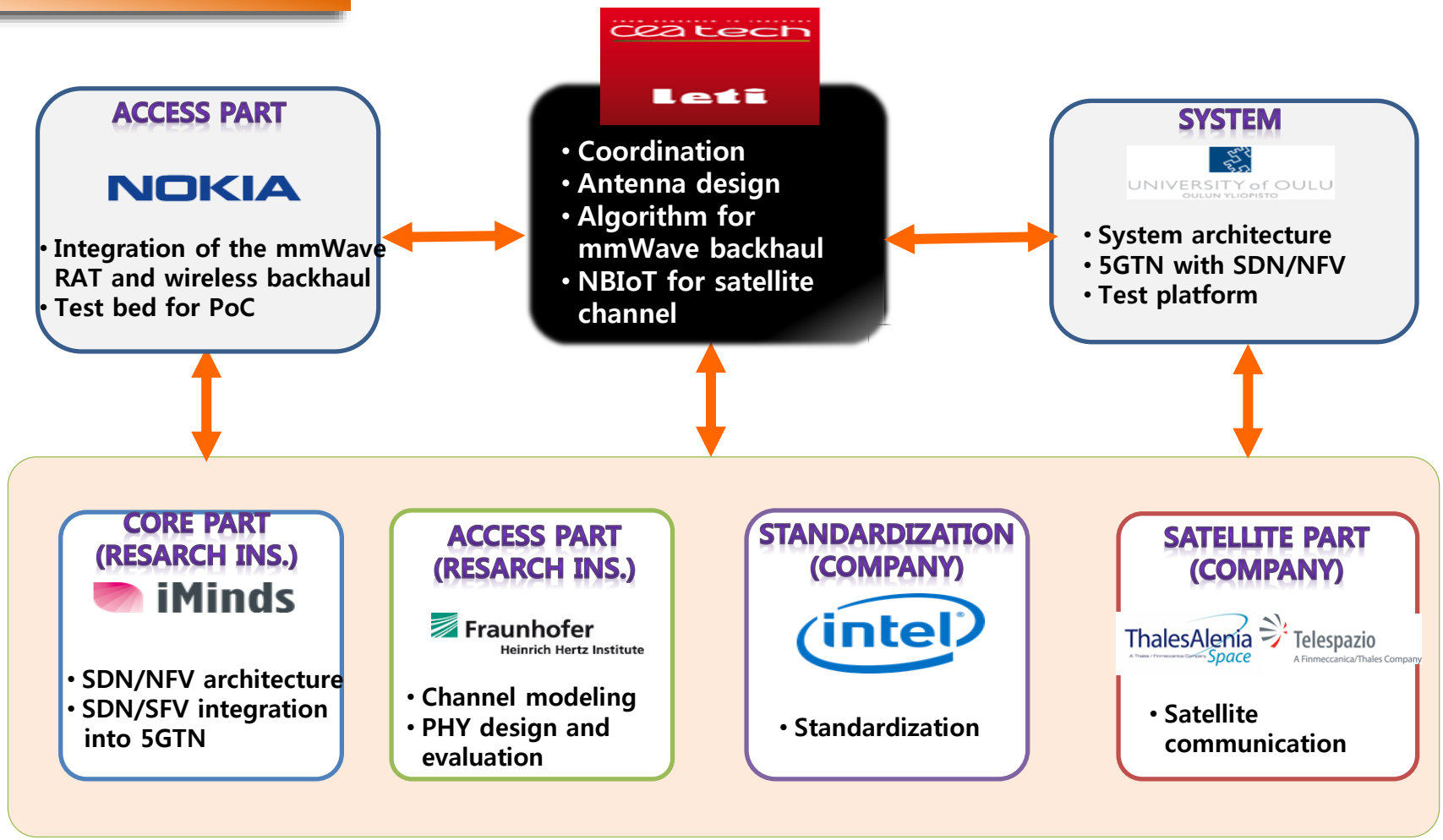
5CHAMPION overview

KR partners (13)

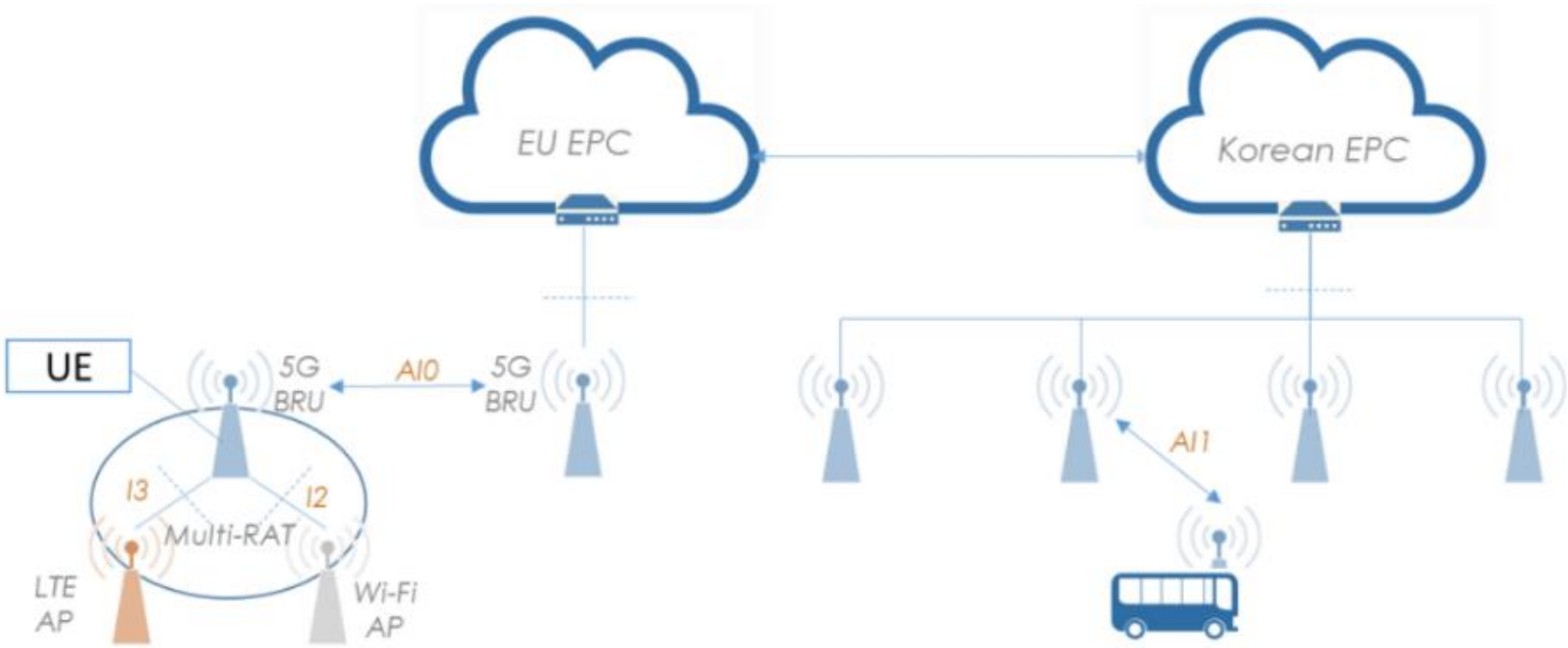


5CHAMPION overview

EU partners (8)



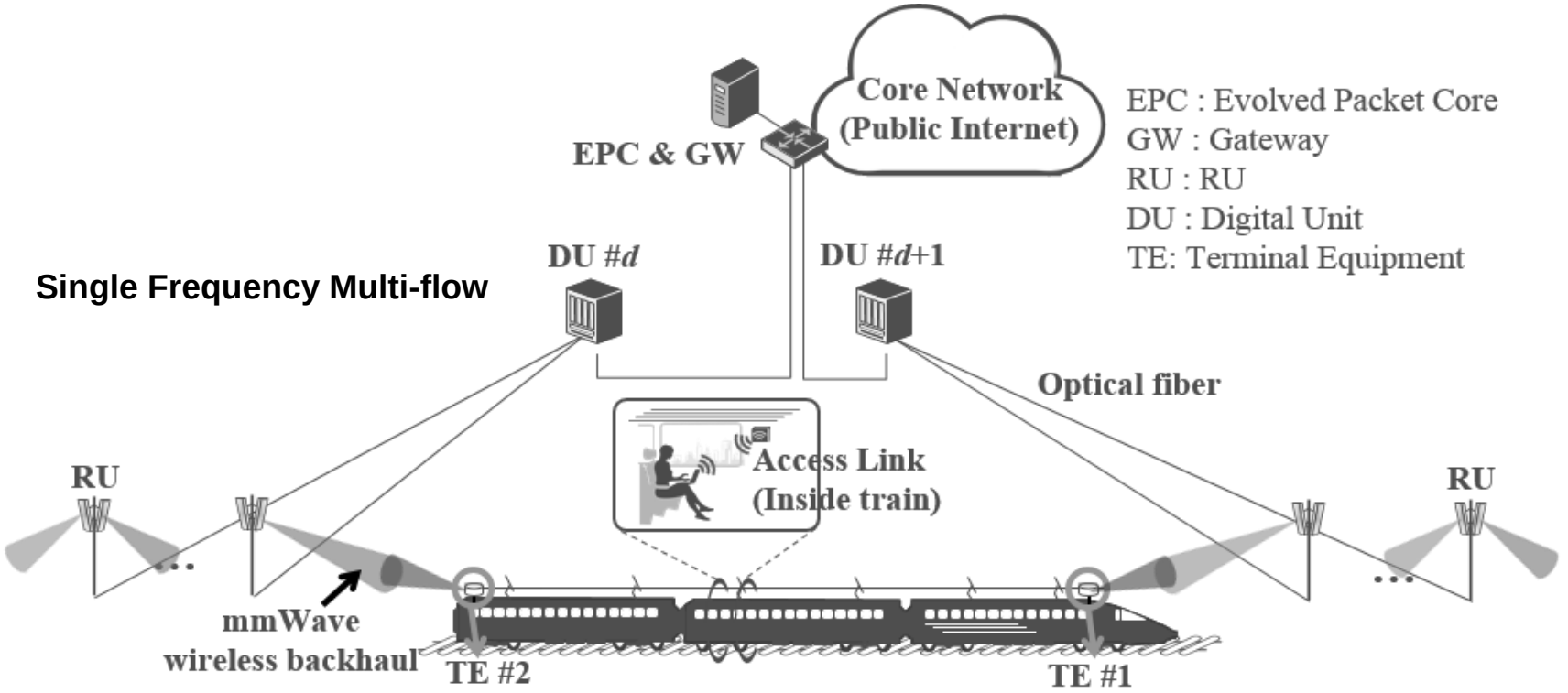
Common radio-access architecture



<Common radio-access architecture>

KR radio-access architecture

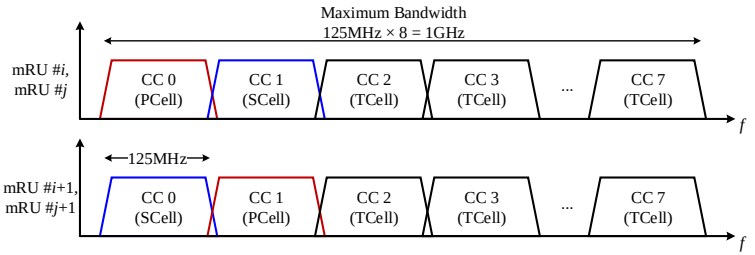
- Focus on High Speed Mobile (Train, BUS)



<KR Radio Access Concept >

KR radio-access architecture

- **MHN-E system**
  - Numerology targeting up to 500 Km/hr
  - Frame structure enabling
    - Carrier aggregation
    - Efficient synch signal structure for fast handover in High mobility
  - SFMF (Single Frequency Multi-Flow)
  - Antenna configurations and require
    - EIRP ≤ 36dBm @ 25~26GHz (Requirement for FACS in Korea)
      FACS: Flexible Access Common Spectrum
    - mRU : 2T2R, mTE : 1T2R
    - G_{TX} ≈ 16 dBi
    - G_{RX} ≈ 21 dBi



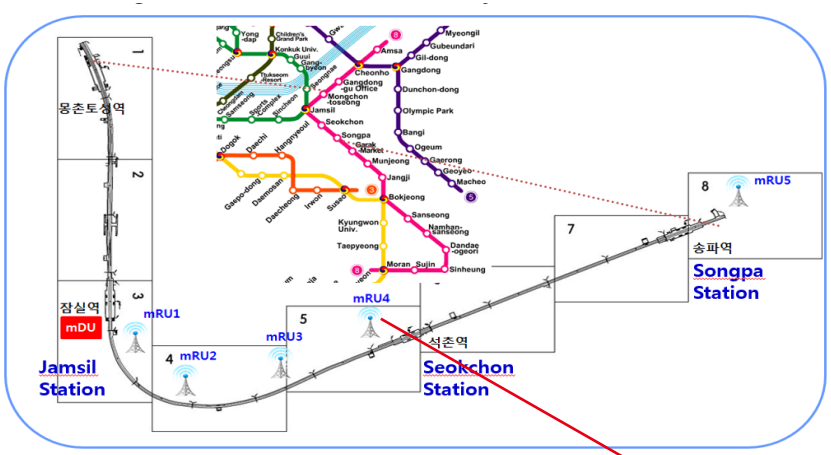
<Carrier aggregation (8×125MHz) >

MHN-E: Mobile Hotspot Network Enhancement

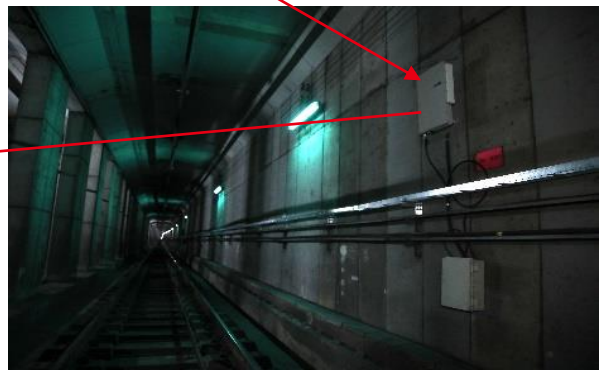
Implementation and testing in first year (2016.6~2017.5)

- **Demonstration on the running subway train (in Seoul)**
  - 1.25 Gbps @ 90 km/hr (500 MHz BW)
  - Seamless handover (5 mRUs, 2.5 km)

Video Clip



<Preparation of the test in the running train>



<mRU deployed in subway tunnel>

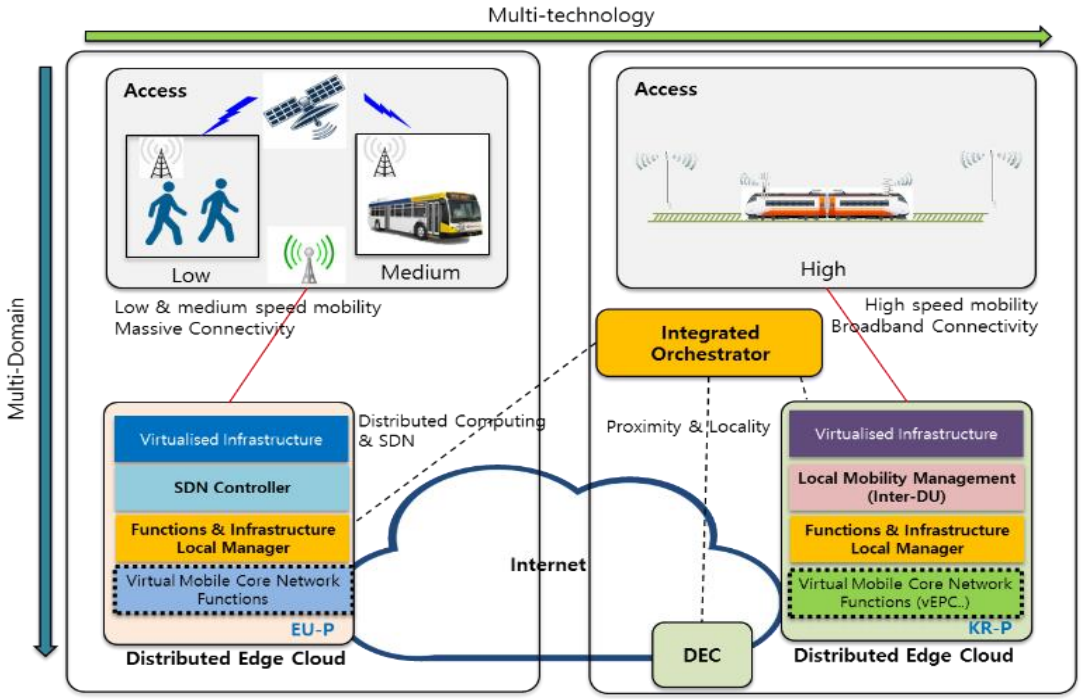
<mTE deployed in Engine room of train>

5G CHAMPION Developed Technologies: 5G Core

NFV/SDN enabled Infrastructure

- For evolved 5G networks characterized by agility and flexibility
- NFV/SDN Integrated Management/Orchestration
- Real-time monitoring & Fast Isolation/Recovery
- Supports High-Performance Data Plane Acceleration

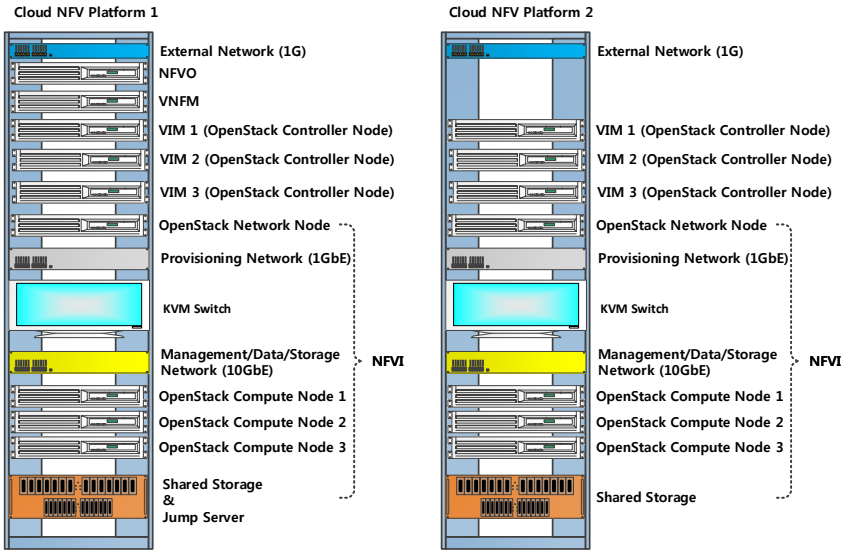
Distributed packet core functionality to a number of local sites near to the end users for reducing latency and backhaul traffic



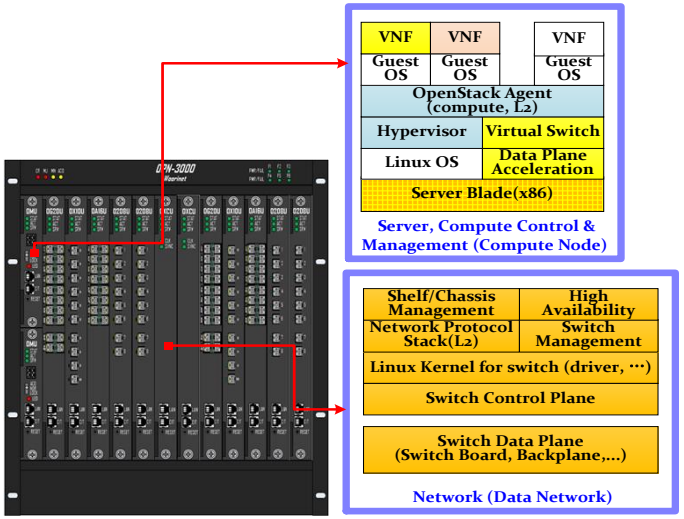
Agile management of the core network functionality and services through an SDN/NFV evolved packet core

5G CHAMPION Developed Technologies: 5G Core

- **Hardware Infrastructure**
  - Provides environment for software based Mobile Core Functions
  - General purpose appliances including resources for computation, storage and networking
  - Employing virtualisation technology for allowing to get more value out of finite resource



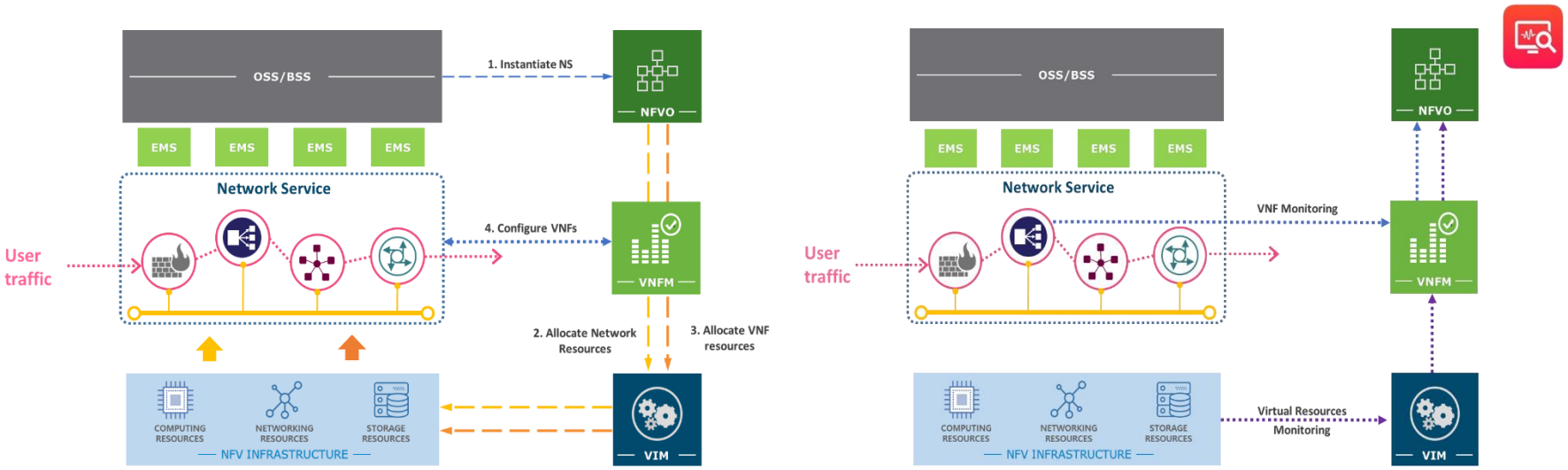
<Rack-type Hardware Infrastructure >



<Blade-type Hardware Infrastructure >

Mobile Core: Management and Orchestration (MANO)

- NFV Orchestrator (NFVO) is responsible for on-boarding of new network services (NS) and virtual network function (VNF) packages; NS lifecycle management; global resource management; validation and authorization of network functions virtualization infrastructure (NFVI) resource requests.
- VNF Manager (VNFM) oversees the lifecycle management of VNF instances; coordination and adaptation role for configuration and events reported from VNFs.
- Virtualized Infrastructure Manager (VIM) controls and manages the NFVI compute, storage, and network resources

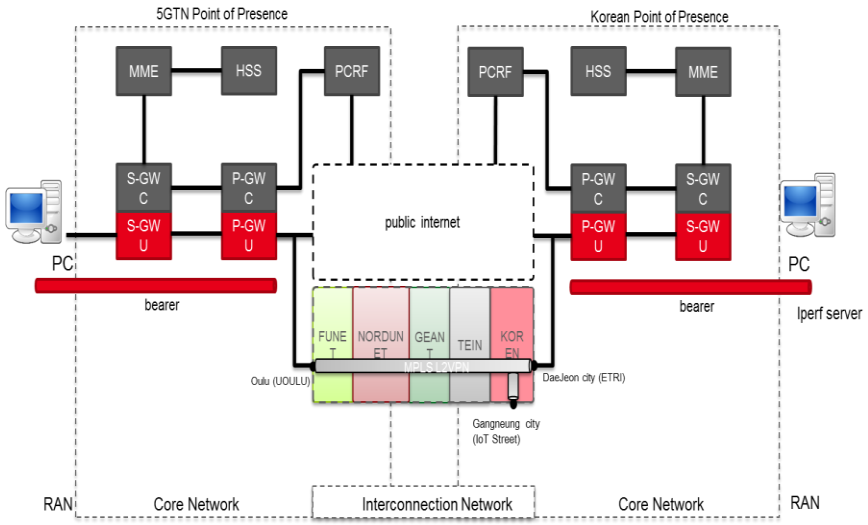


<MANO Operation for Korean 5G Networks>

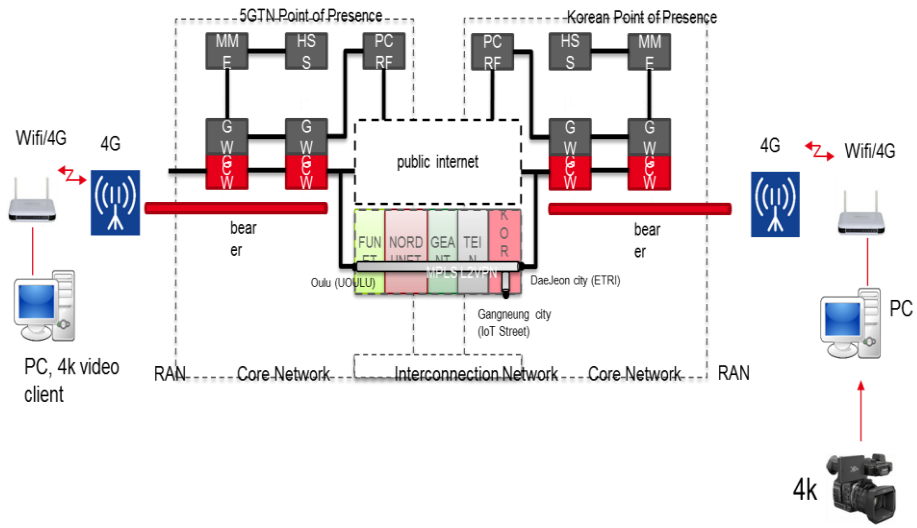
Korea-Europe Mobile Core Interconnection

Video Clip

- **Core-to-Core: bandwidth of network and latency**
  - Bandwidth: up to 10Gbps between Korea and Europe core
  - Latency: assumed to be tenths of ms except propagation delay
- **End-to-End: Service Conformance**
  - Radio attached to network
  - 4k video streamed from Korea to Finland



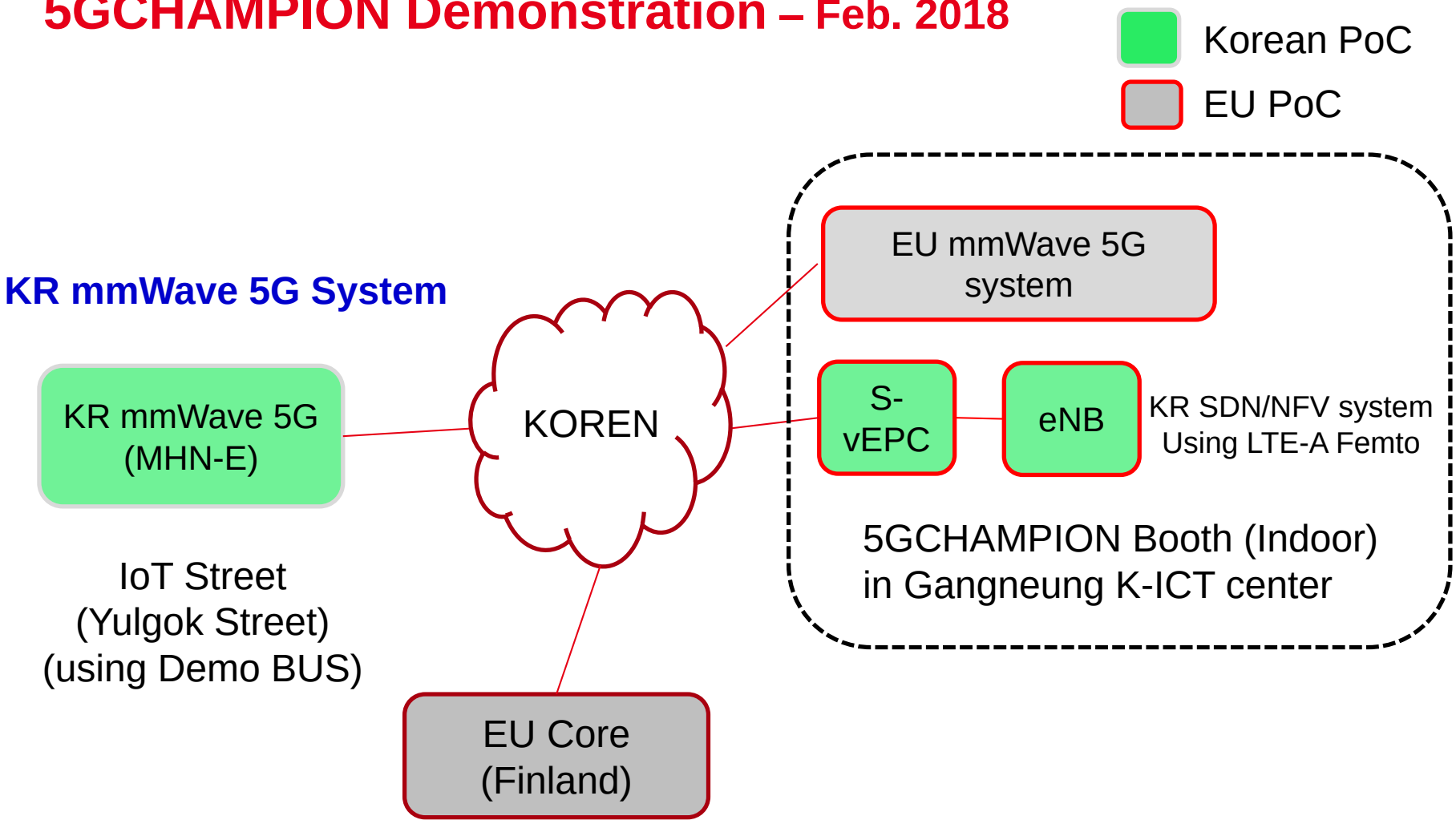
< Interconnection Demo: Core-to-Core >



<Interconnection Demo: End-to-End >

Olympics Demonstration PoC

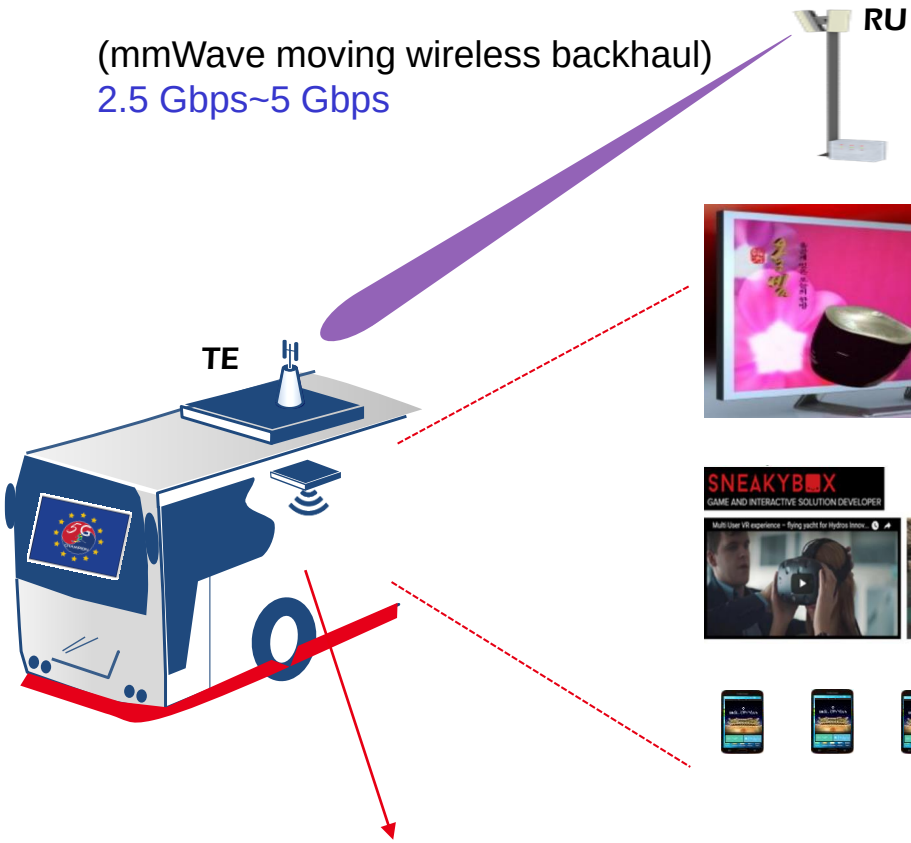
5GCHAMPION Demonstration – Feb. 2018



Olympics Demonstration PoC

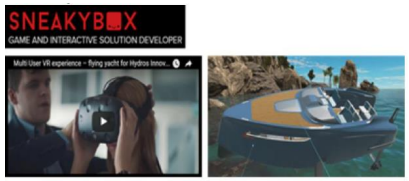
Services provided KR mmWave 5G system(MHN-E, outdoor)

(mmWave moving wireless backhaul)
2.5 Gbps~5 Gbps



Inside vehicle

Super Multi-view 3D display
(Actual video in K-ICT booth)



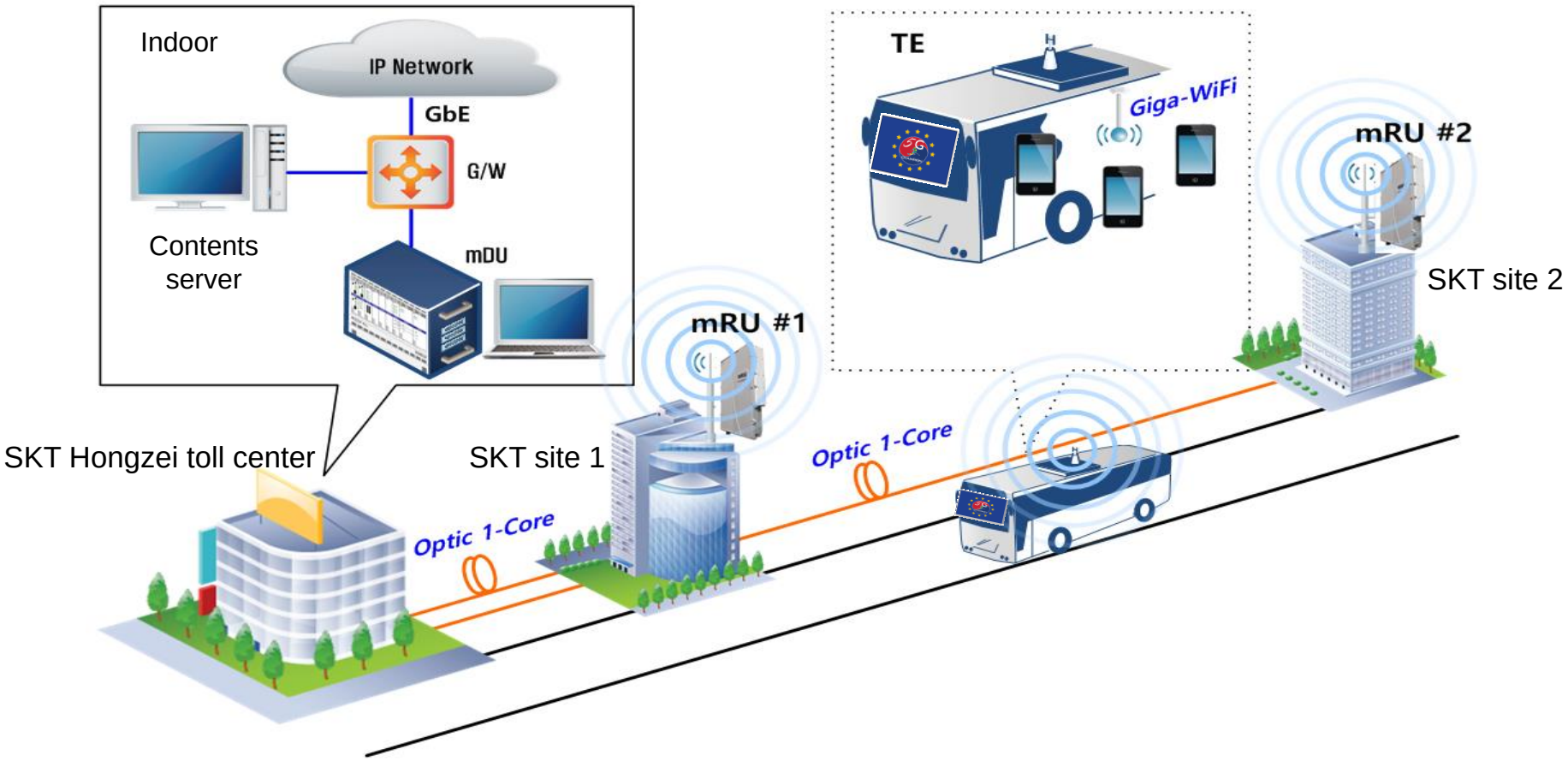
VR/AR

High speed internet
(Giga Wi-Fi AP will be deployed in BUS)

Real time transmission of the image inside the BUS
to K-ICT 5GCHAMPION Booth

Olympics Demonstration PoC

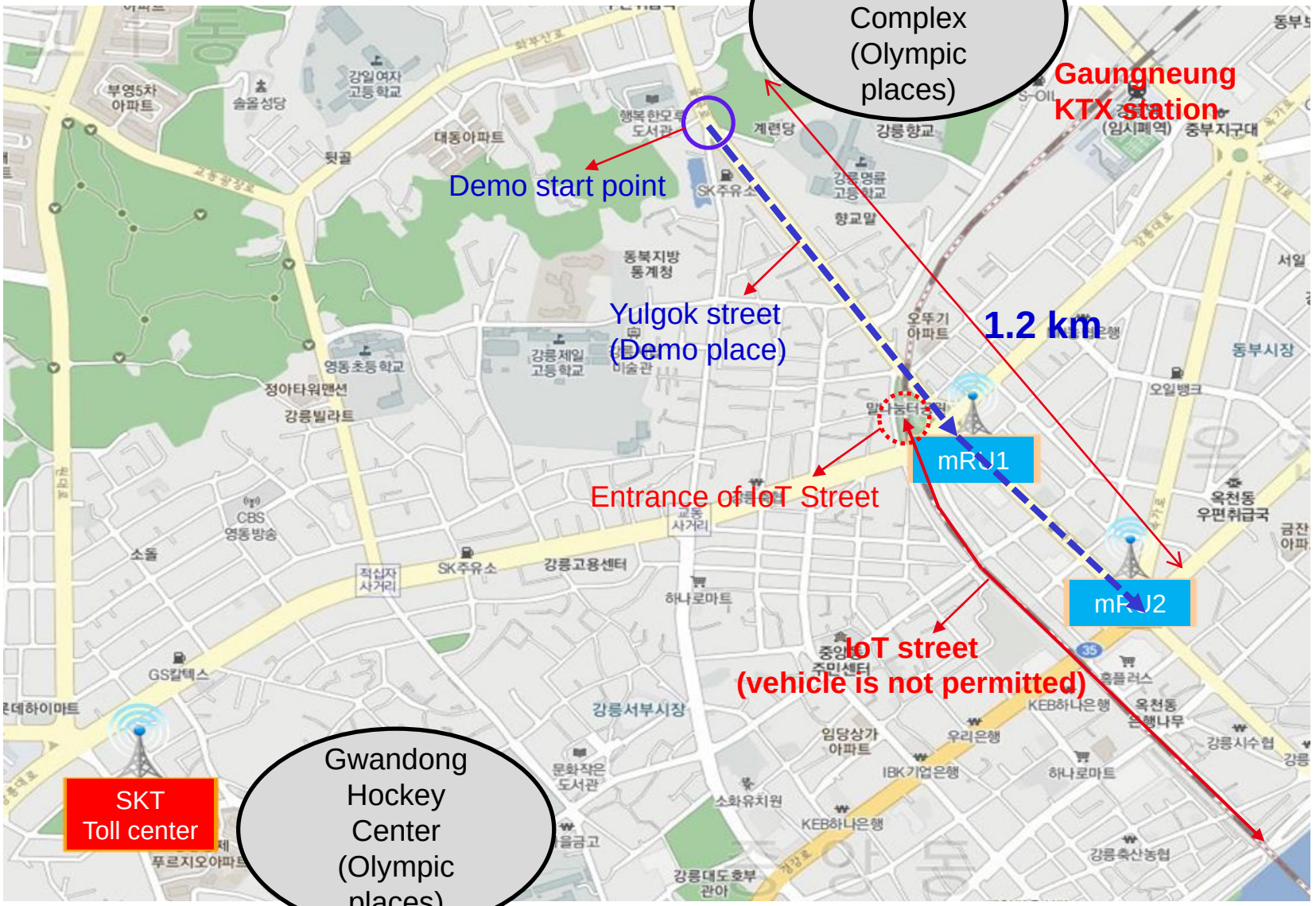
KR mmWave 5G system (MHN-E, outdoor) configuration



Source: HFR

Olympics Demonstration PoC

mRU candidate sites



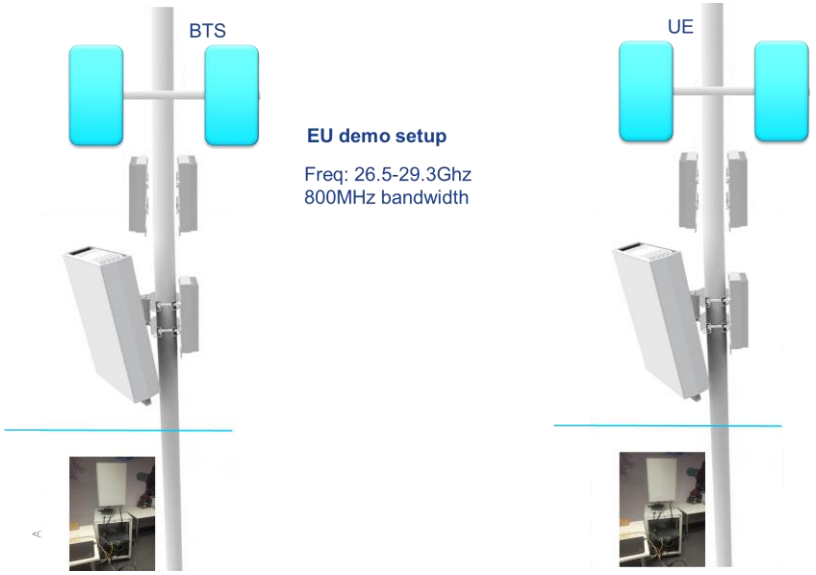
Olympics Demonstration PoC

EU and KR Equipments deployed in K-ICT 5GCHAMPION Booth

- mmWave 5G BS and UE 1 set (EU)
- SDN/NFV Core and LTE-A Femto (KR)

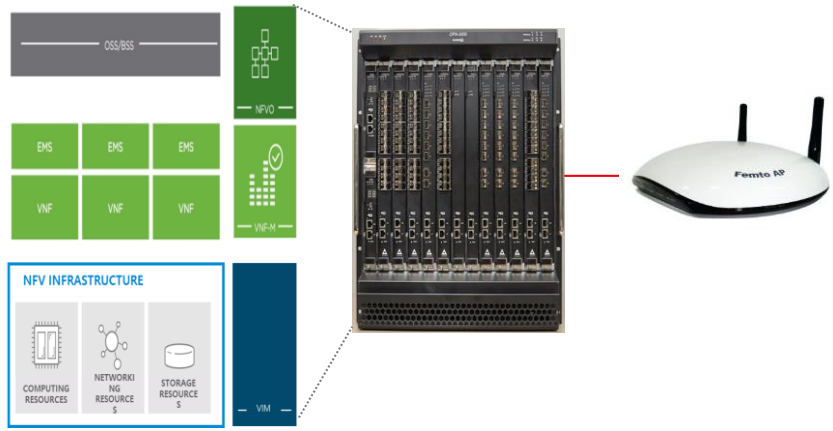
Currently, under discussion with related organizations in KR (MISP, Olympic Committee, NIA..)

KOREN



mmWave 5G BS and TE 1 set (EU)

Source: Nokia (WP6)



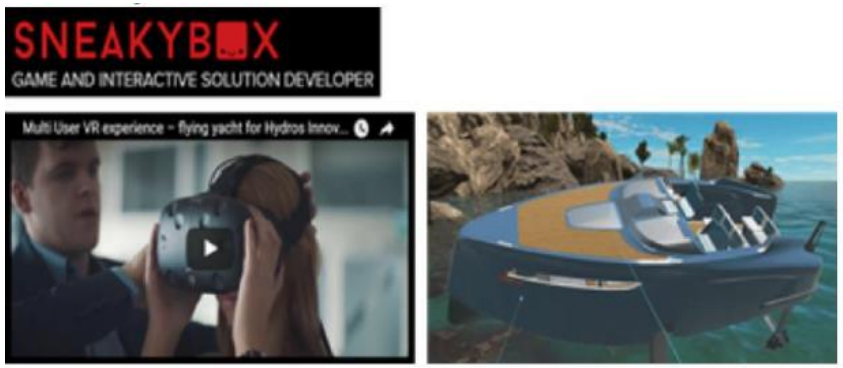
SDN/NFV Core and LTE-A Femto (KR)

Olympics Demonstration PoC

Services to be provided in K-ICT 5GCHAMPION Booth

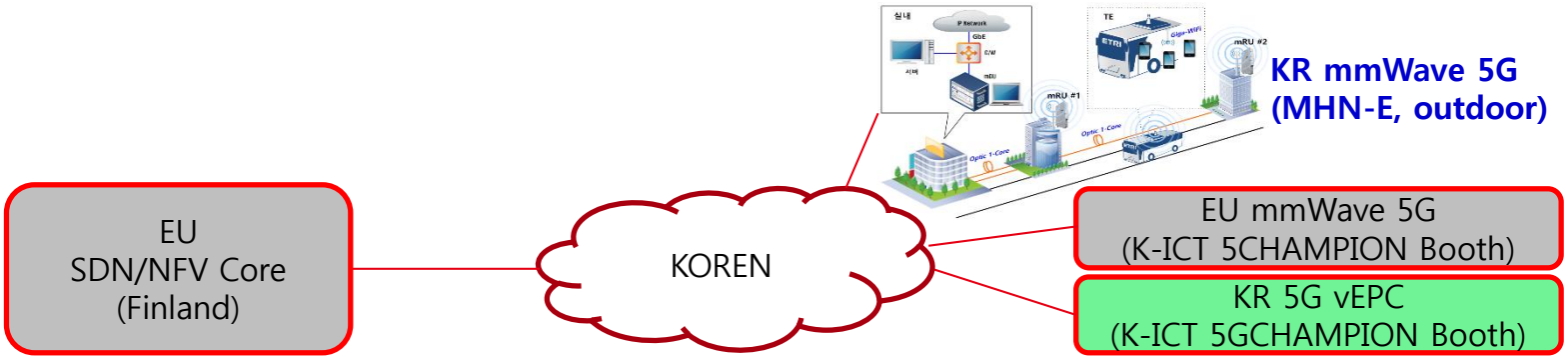
1) Services

- **VR/AR**
- **Super Multiview 3D**
- **High Speed Internet**

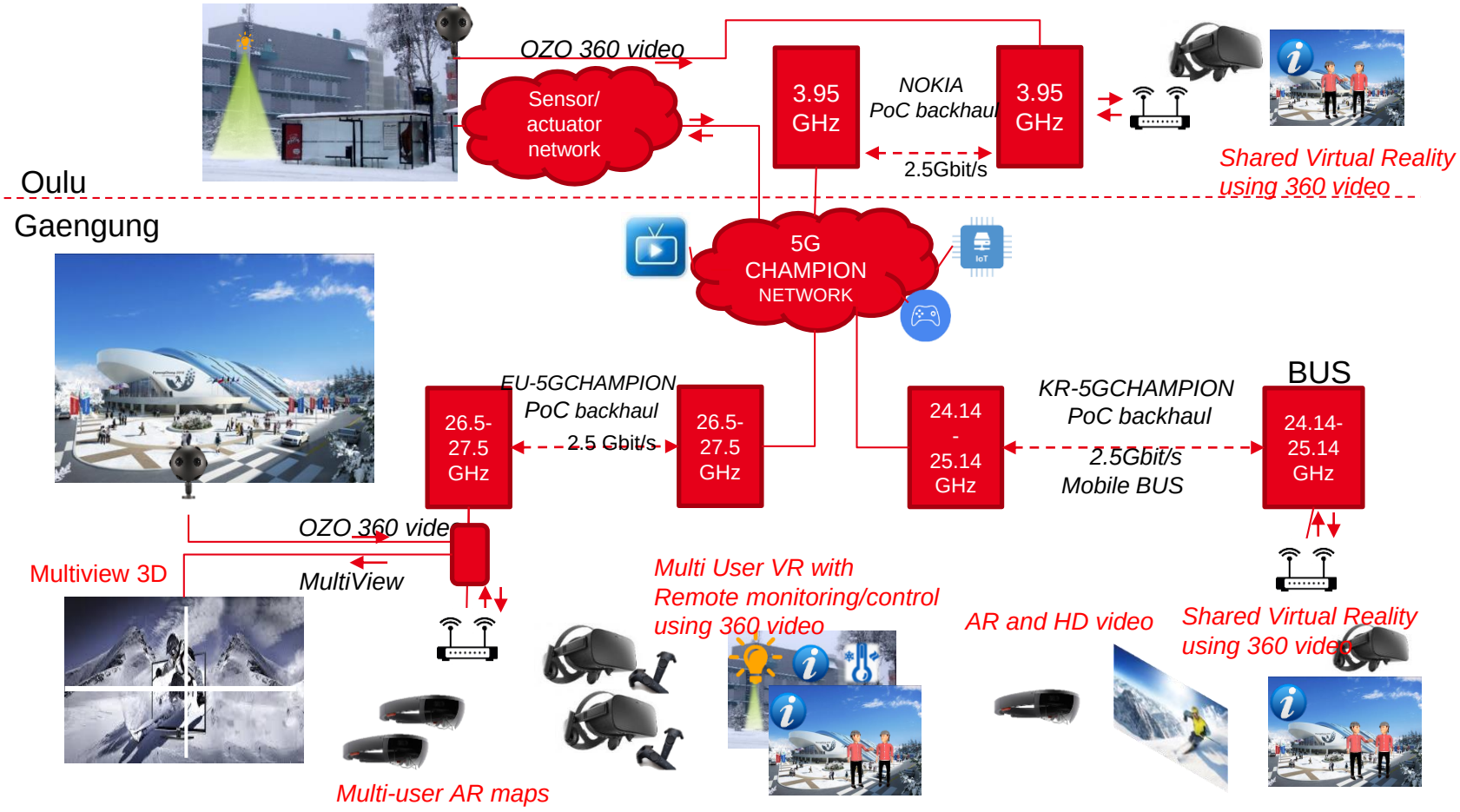


2) Service Scenarios

- **Scenario A: (Finland) EU 5G <-> (K-ICT 5GCHAMPION booth) KR 5G vEPC**
  - ✓ VR/AR and high quality CDN via inter-continental interoperability
- **Scenario B: (K-ICT booth) EU 5G <-> (IOT street, outdoor) KR 5G**
  - ✓ VR/AR and high quality CDN via moving outdoor system interoperability



Olympics Demonstration PoC



Summary

First Collaborative PoC on 5G:

- **with real-life public transportation** (mobility up to **60 Km/h**)
- **including real-5G interactive services**
  (virtual interactive gaming, VR)
- **integrating different technologies**
  (RF, Antennas, Software, HW, …)
- **integrating satellites and terrestrial networks**

Thank you for your attention