5G CHAMPION

28 GHz 5G Proof-of-Concepts at 2018 Winter Olympic games

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

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

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5G CHAMPION KR technical coordinator

Race to 5G Services

Requirements & Exploration | Standardization & Prototypes | 5G Services & Commercialization

2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | … | 2022

PoC

5G Testbeds

5G Trials

PyeongChang 2018

Olympic games 5G Services (Korea)

Soccer World cup In Russia

5G Olympic games 5G Services (Japan)

TOKYO 2020

Olympic games 5G Services (China)

BEIJING 2022

ITU WRC-15

ITU WRC-19

IMT Vision | ITU Requirements | IMT Proposals | IMT Specifications

5G Services & Commercialization

Rel-13	Rel-14	Rel-15	Rel-16	Rel-17
	• Scenarios & requirements • SI for low spectrum • Channel modeling for high spectrum	• WI low spectrum • SI for high spectrum	• WI low spectrum enhancement • WI for high spectrum	

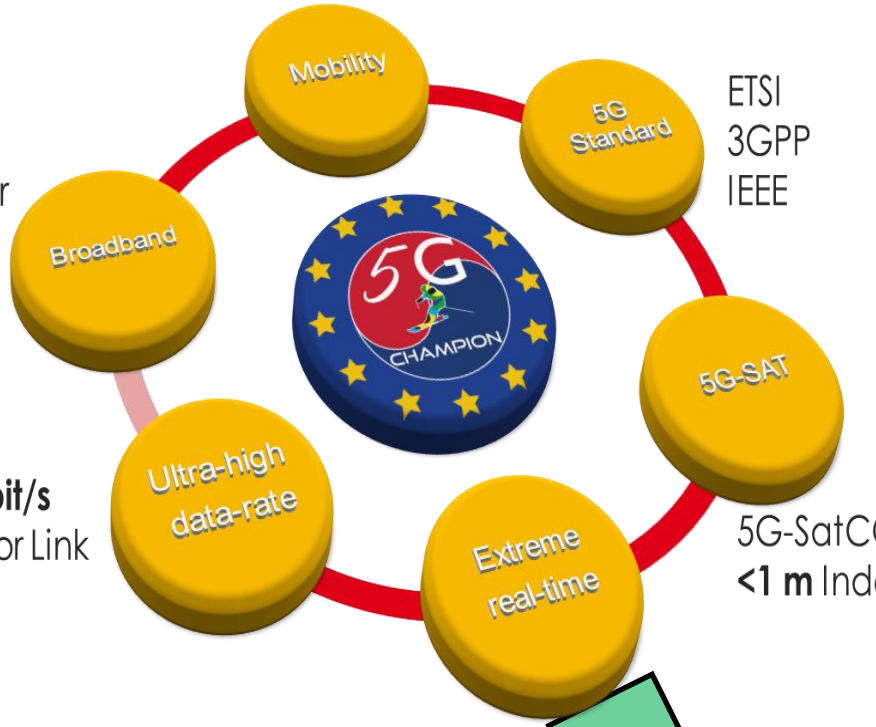
Collaborative Research

Metis	5G PPP Phase 1	5G PPP Phase 2	5G PPP Phase 3
	• Vision building • Key enabling technologies Exploration & validation	• System Optimization • Pre-Standardization	• Large scale trials • Early standardization

5G CHAMPION: 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



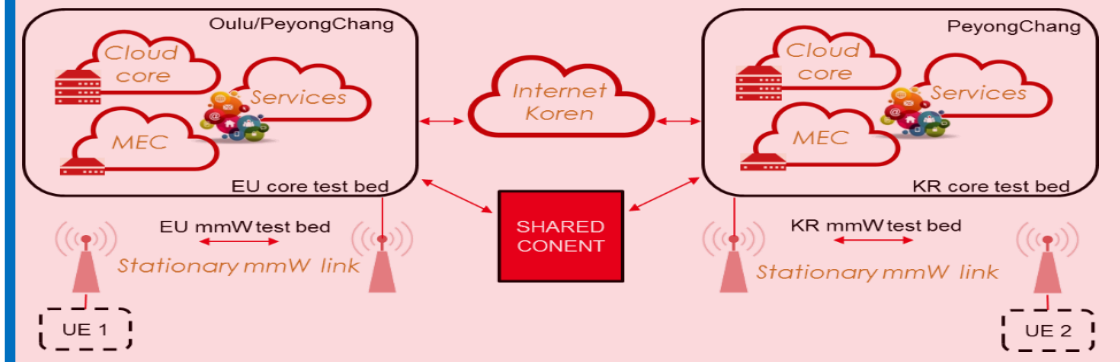
ETSI
3GPP
IEEE

20Gbit/s
Indoor Link

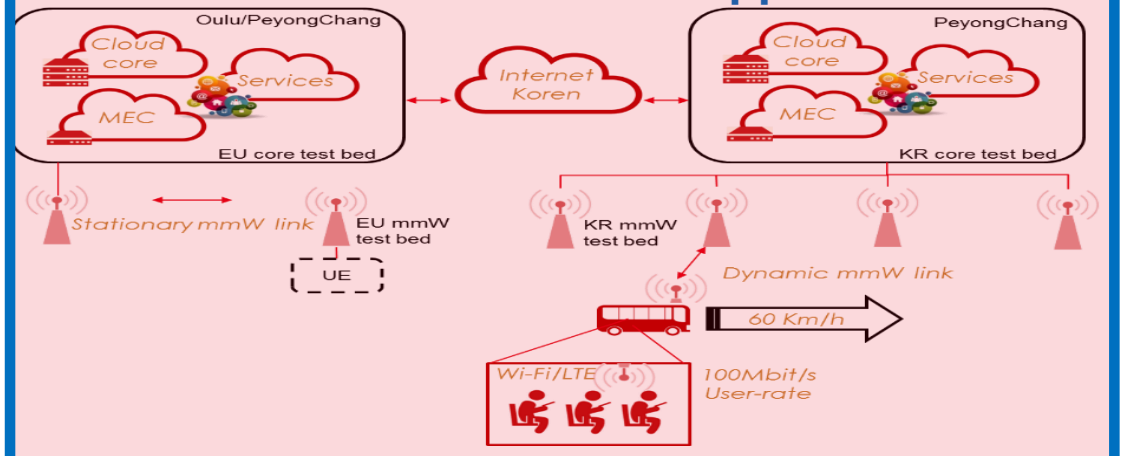
5G-SatCOM for NB-IoT
<1 m Indoor-outdoor positioning

SDN/NFV based
on evolved packet core network

Short-latency interactive applications



Broadband interactive applications



Standardization & Prototypes

5G Services & Commercialization

2016 | 2017 | 2018 | 2019 | 2020 | ..

PyeongChang 2018

TOKYO 2020

BEIJING 2022

Olympic games
5G Services (Korea)

Soccer World cup
In Russia

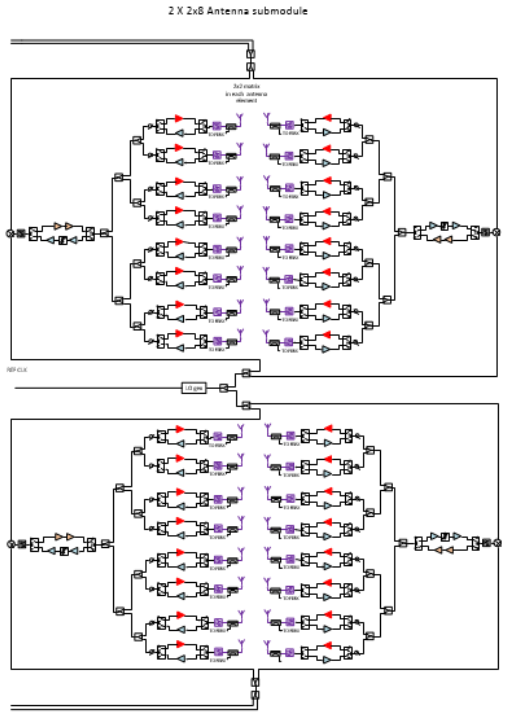
5G Olympic games
5G Services (Japan)

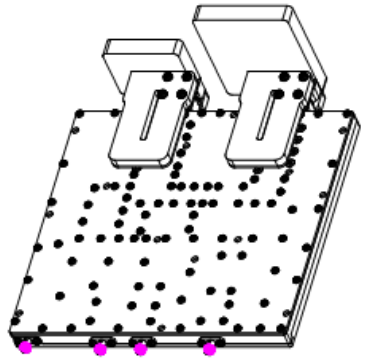
5G CHAMPION Consortium

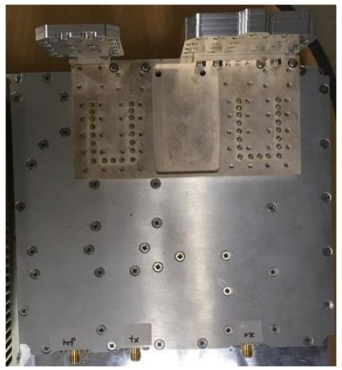
5G CHAMPION Developed Technologies: 28GHz High gain Antennas

RF Transciver at 28 GHz

- 24,25-26,5 GHz (Korea)
  1 GHz BW
- 26,65-29,19 GHz (Europe)
  - 400+ MHz BW
- RF-FE HW for **2 2x8** Antenna submodules
- Totally **4** boards required for PoC HW

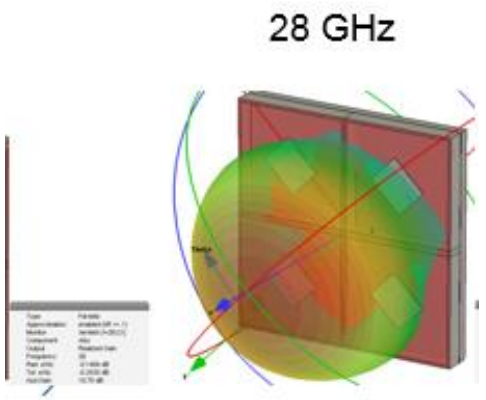


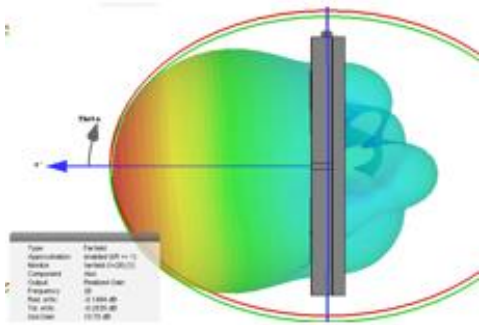


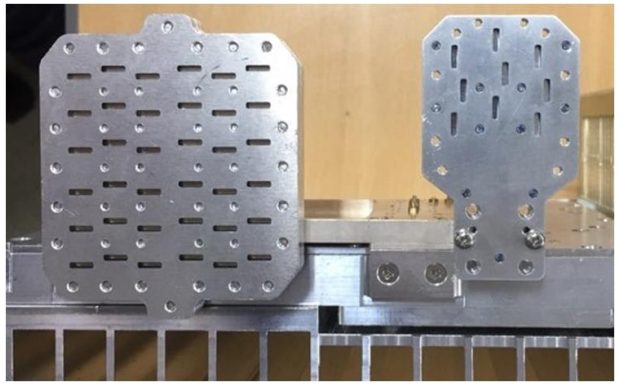


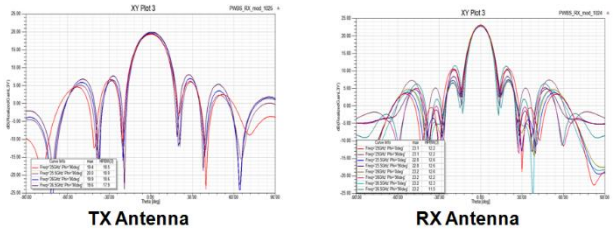
High gain antennas

- Fixed beam
- Electronic reconfigurable beams
- Sub-array gain 11dBi
- Beam width 52 degrees







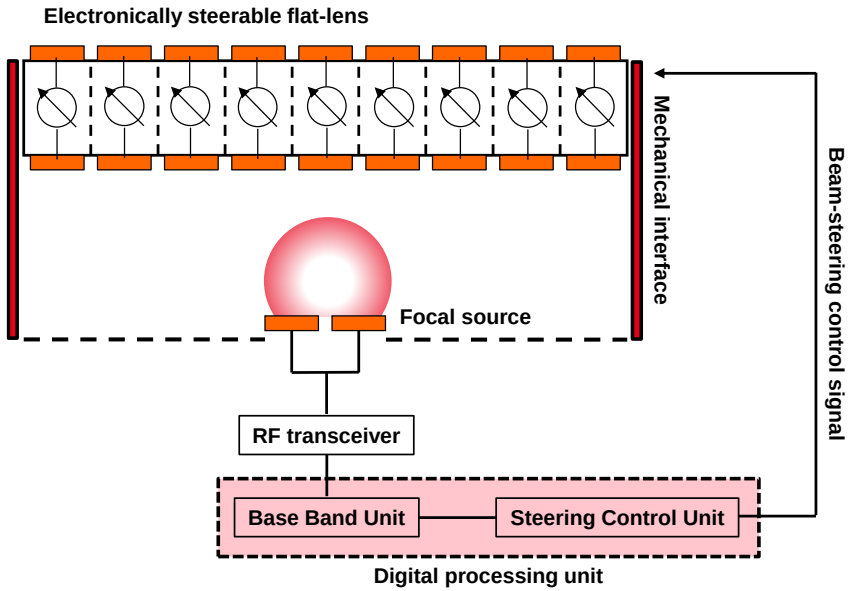


	TX	RX
Freq [GHz]	25 ~26.5	
Gain [dBi]	> 19	> 22
Beamwidth [deg]	17.9~18.9	11.5~12.6

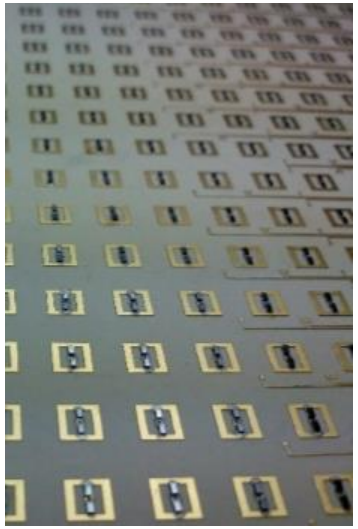
5G CHAMPION Developed Technologies: 28GHz High gain Antennas

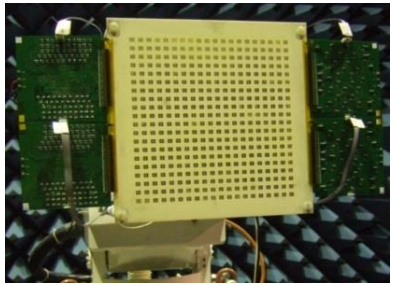
High gain antennas with electronically beam steering capabilities at 28 GHz

- Analogue beamforming solution based on flat-lens or transmitarray antennas,
- Flat-lens illulinated by a focal source antenna integrated on the RF transceiver,
- Phase-shift function on the flet-lens by using p-i-n diodes,
- Previosus proof-of-concept at CEA at 10 and 28 GHz.

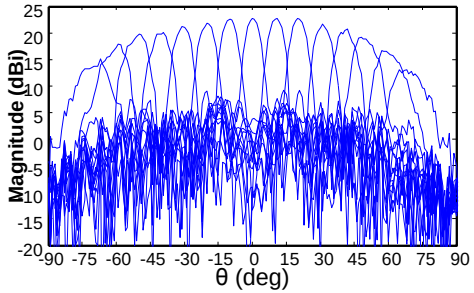


Transmitarray at X-band





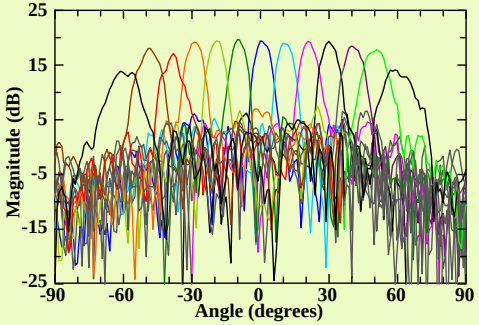
A. Clemente, L. Dussopt, R. Sauleau, P. Potier, P. Pouliguen, "Wideband 400-element Electronically Reconfigurable Transmitarray in X Band ," IEEE Transactions on Antennas and Propagation, vol. 61, no. 10, October 2013, pp. 5017-2027.



- 20×20 array (300×300 mm²),
- Max. gain: 23.2 dBi,
- Efficiency: 52.9%,
- Bandwidth (-3 dB): 15.6%,
- Beamsteering: ±70° in all azimutal planes.

Transmitarray at Ka-band

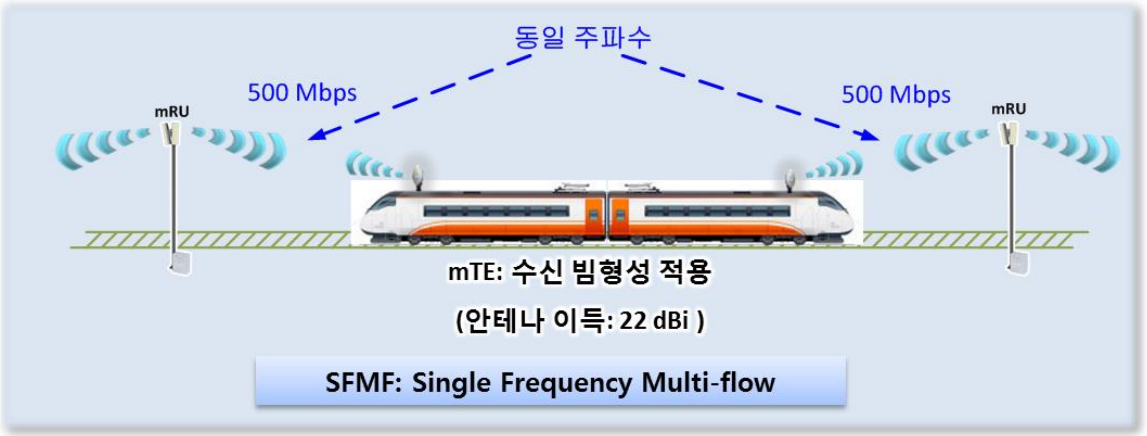
L. Di Palma, A. Clemente, L. Dussopt, R. Sauleau, P. Potier, and P. Pouliguen, "Circularly-polarized reconfigurable transmitarray in Ka-band with beam scanning and polarization switching capabilities," IEEE Transaction on Antennas and Propag., under review.

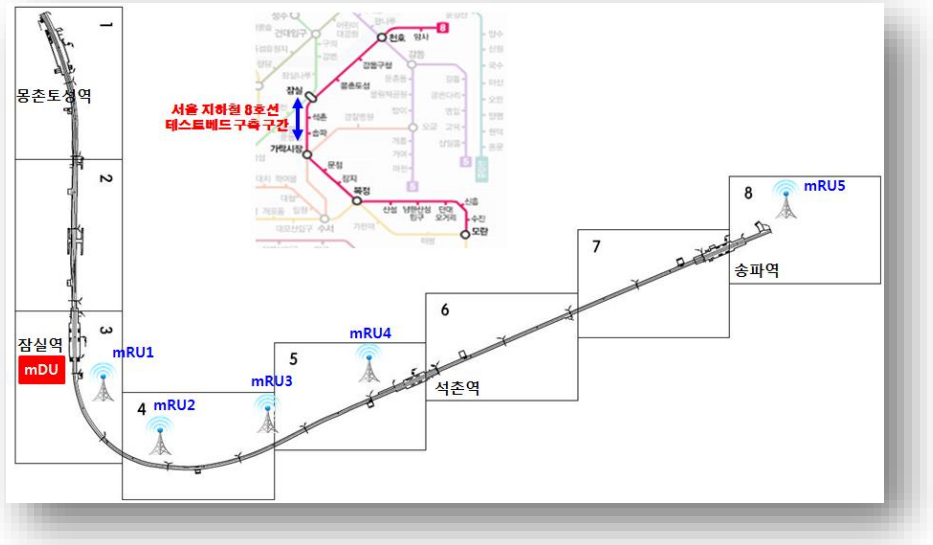


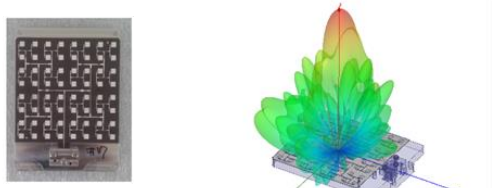
- 20×20 array (102×102 mm²),
- Max. gain: 20.8 dBi,
- Efficiency: 58%,
- Bandwidth (-3 dB): 14.6%,
- Beamsteering: ±60° in all azimutal planes.

5G CHAMPION Developed Technologies: mHN-Mobile Hotspot Network

mmWave enabled Single Frequency Multi-flow (SFMF) based frequency effiency gain

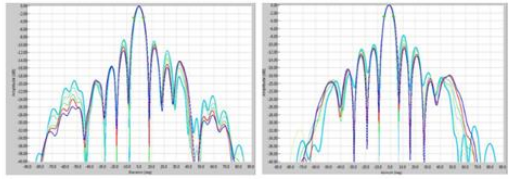


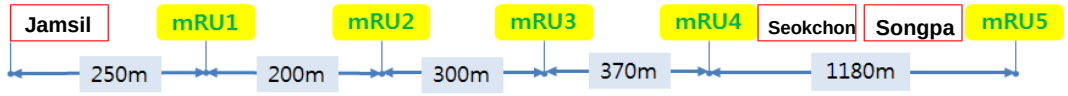




8x8(64) Patch Array antenna

3 dB Beam width : 8°

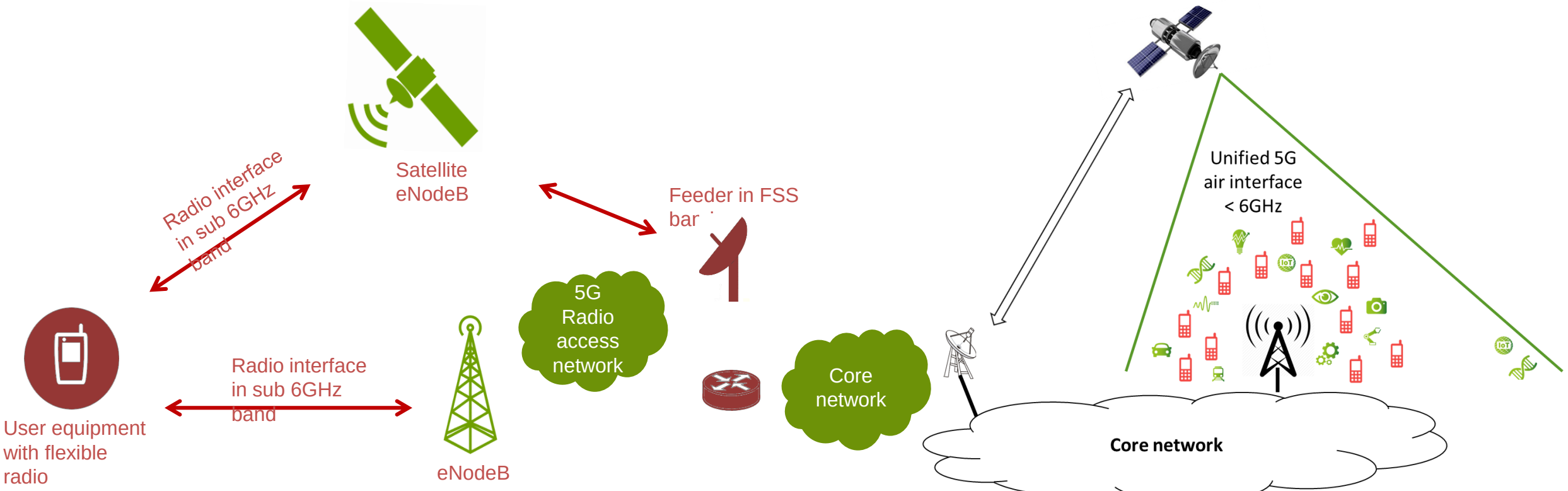




Prototype tested in Seoul Metro line 8

Performance Objective in simulation environment:
Provide a mmWave high capacity backhaul link with 2.5 Gbps in the high mobility environment (500km/h).
Provide a user-experience data rate of 100 Mbps in the high-mobility environment (500km/h)

5G CHAMPION Developed Technologies: Satellite/"Terrestrial" cellular network interworking

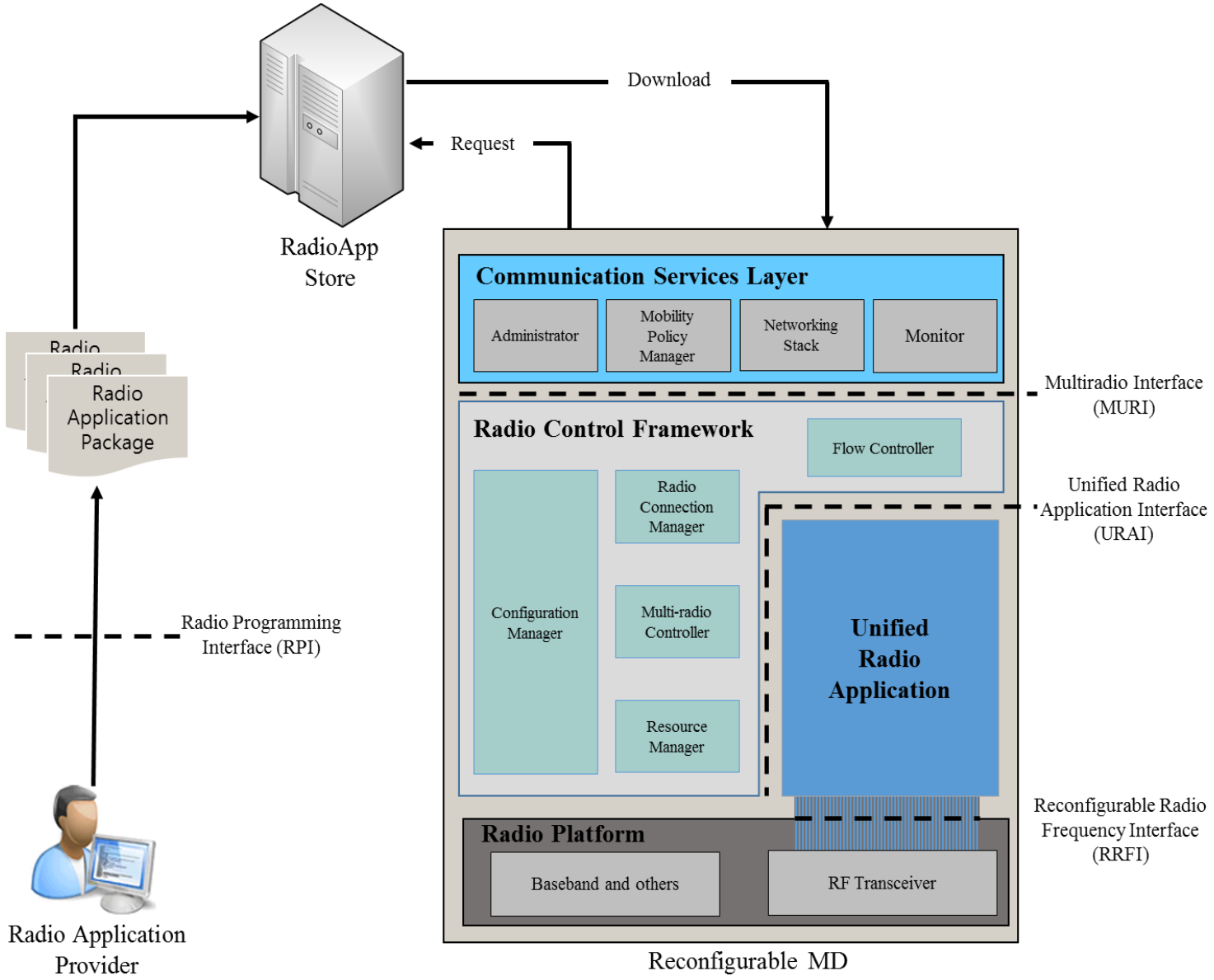


Support low bandwidth direct service to 5G devices with satellite channel bandwidth, MAC/PHY protocols settings without any hardware modification of the UE

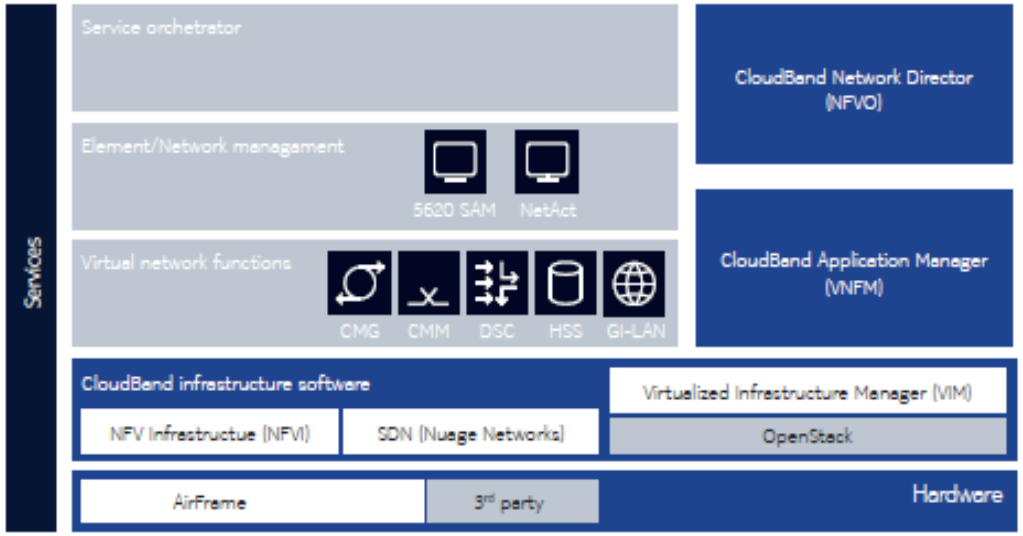
- **Vertical Handover**
- **Below 6 GHz (Low Power IoT)**
- **Evalutaion of 5G Waveform performance**

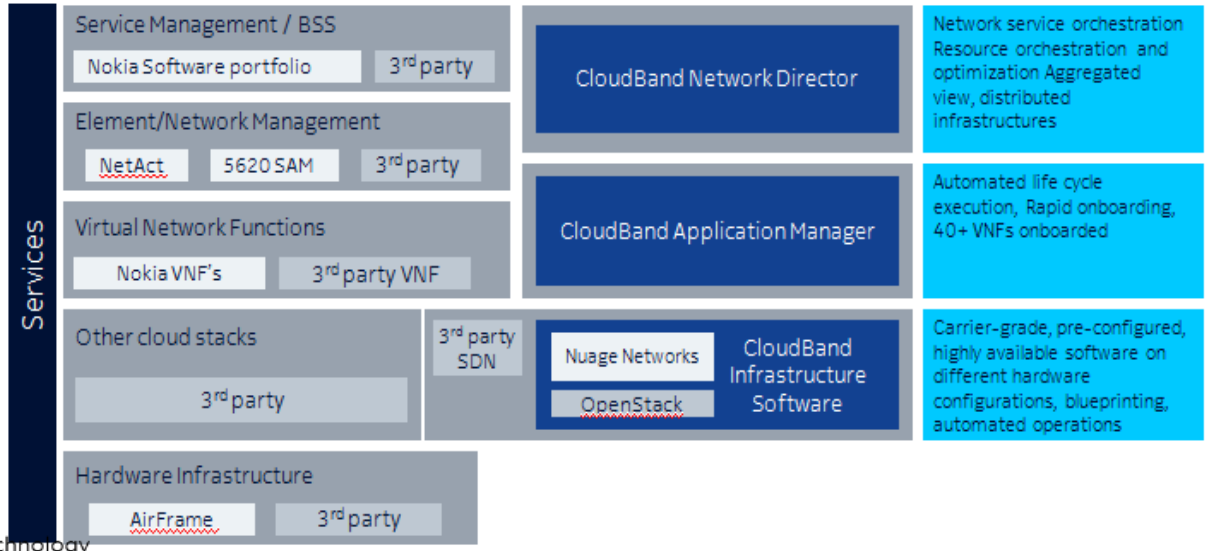
Satellite Connectivity for MTC (Machine Type Communications)

5G CHAMPION Developed Technologies: Reconfigurable Radio System

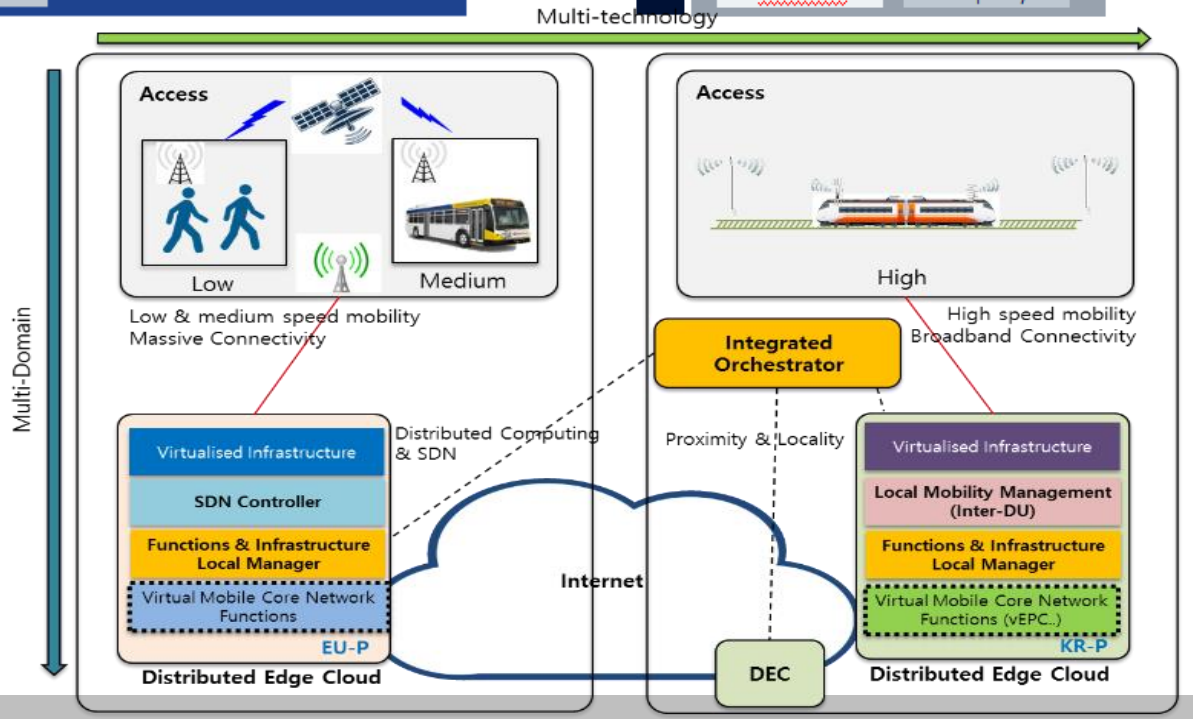


5G CHAMPION Developed Technologies: 5G Core Network



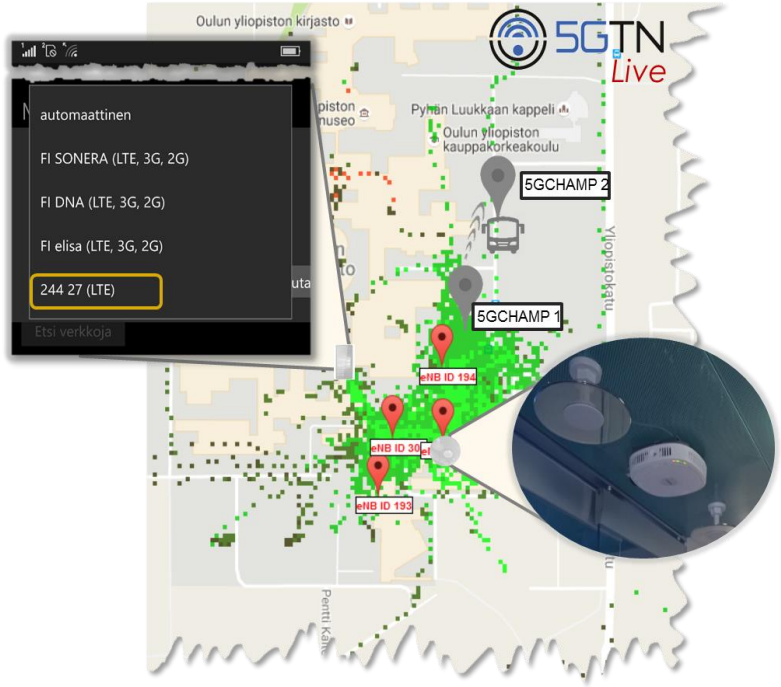


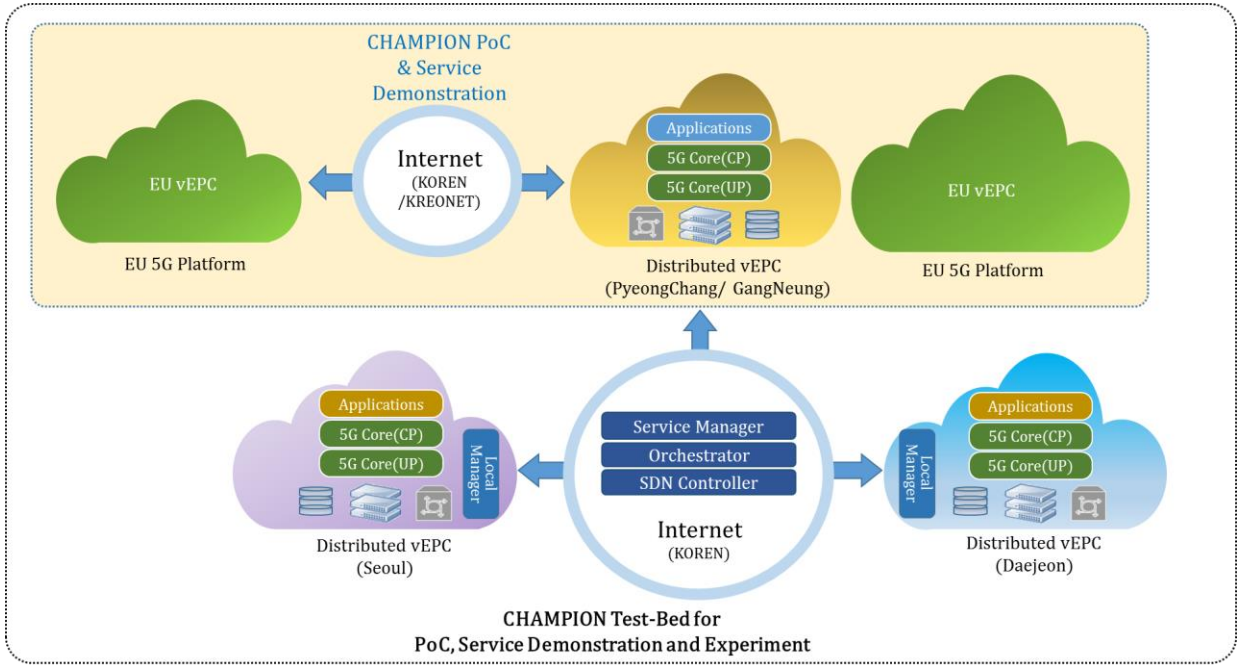
Distributed packet core functionality to a number of local sites near to the end users for reducing latency and backhaul traffic



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

5G CHAMPION EU-KR Network & Trial Environnent



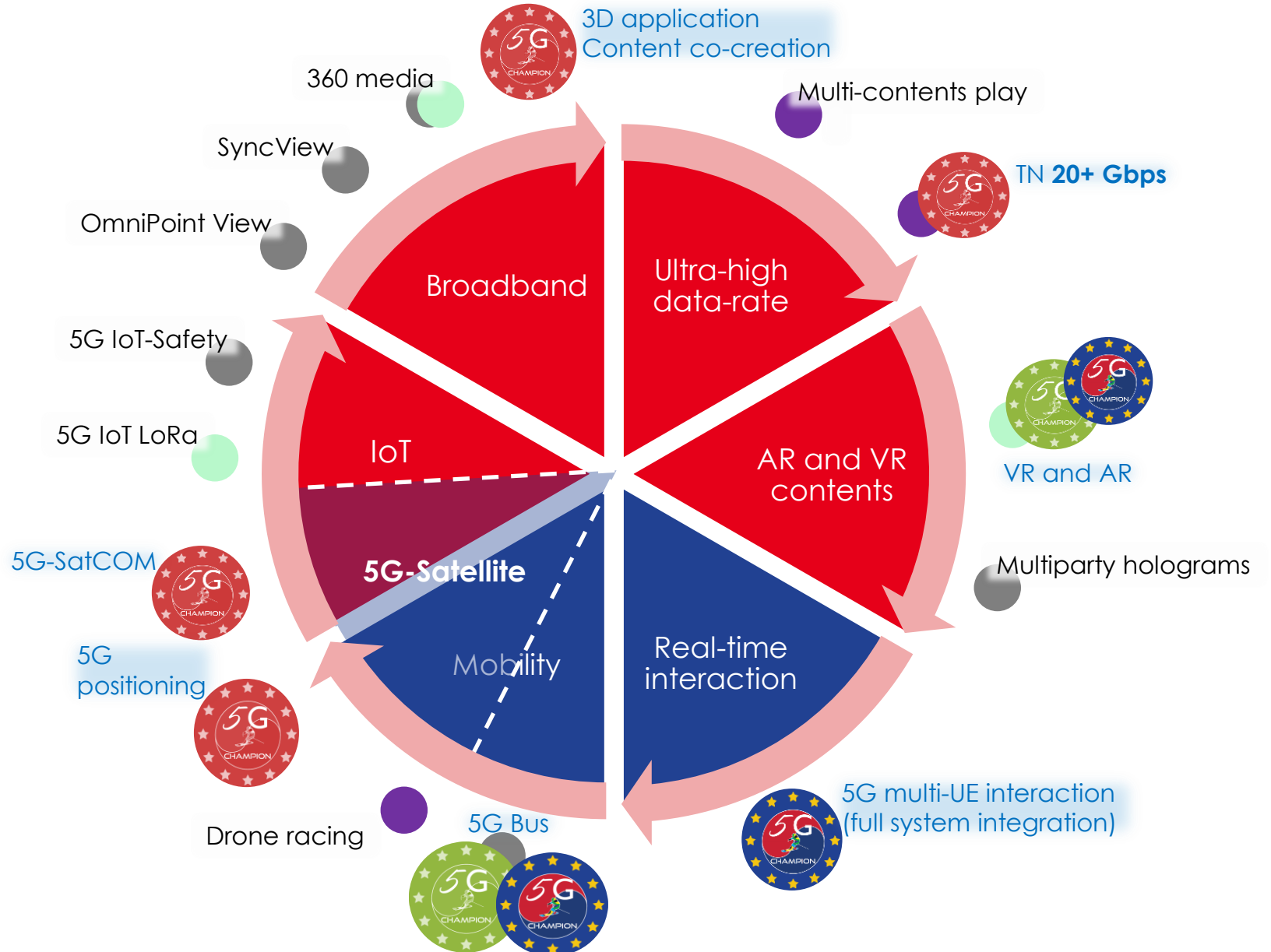


5G CHAMPION Unique features

- Open test network available for research, test technology & services and business models
- mmW mobile backhaul (real environment)
- SDN/NFV in EPC
  - Low/medium mobility management
- Connectivity to 5G CHAMPION services
- Interactive connetivity with 5G CHAMPION Network in Korea

- **Test Beds for**
  - PoC & Demonstration
  - Experiment
- **Interoperability**
  - Management (vEPC interoperability)
  - Cross domain Orchestration

5G CHAMPION Services at PyeongChang



Summary

First Collaborative PoC on 5G:

- **1st PoC with real-life public transportation** (mobility up to **60 Km/h**)
- **1st PoC including real-5G interactive services** (virtual interactive gaming, VR)
- **1st PoC integrating different technologies** (RF, Antennas, Software, HW, …)
- **1st PoC integrating satellites and terrestial networks**

5G CHAMPION showcases in a *realistic environment* (2018 Winter Olympic games):

System interoperability: *agile network design into a unique end-to-end system PoC*

- **Intra 5G System interoperability**
  - **Zero-latency applications**: Multi-UE interaction & control with realtime control on different wireless access (in Korea and EU)
- **Inter Satellite and 5G Systems interoperability (emulated)**
  - 5G air interface with **IoT**
  - Cooperative high precision outdoor positioning (**<1m**)

High broadband access to multiple UEs:

massive users with **100 Mb/s** in real outdoor environments

High mobility backhaul:

- real-field testing for mmW empowered city bus backhaul (**60 Km/h**)
- Emulation of **500 Km/h** high speed train backhaul

Thank you for your attention

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