



5G trials in PyeongChang and at CEA-Leti

Presenter: Dr. Antonio CLEMENTE

Wireless Communication Department, CEA-Leti, France



Third annual ITU IMT-2020 Workshop & Demo Day, Genève
July 18 2018

Outline

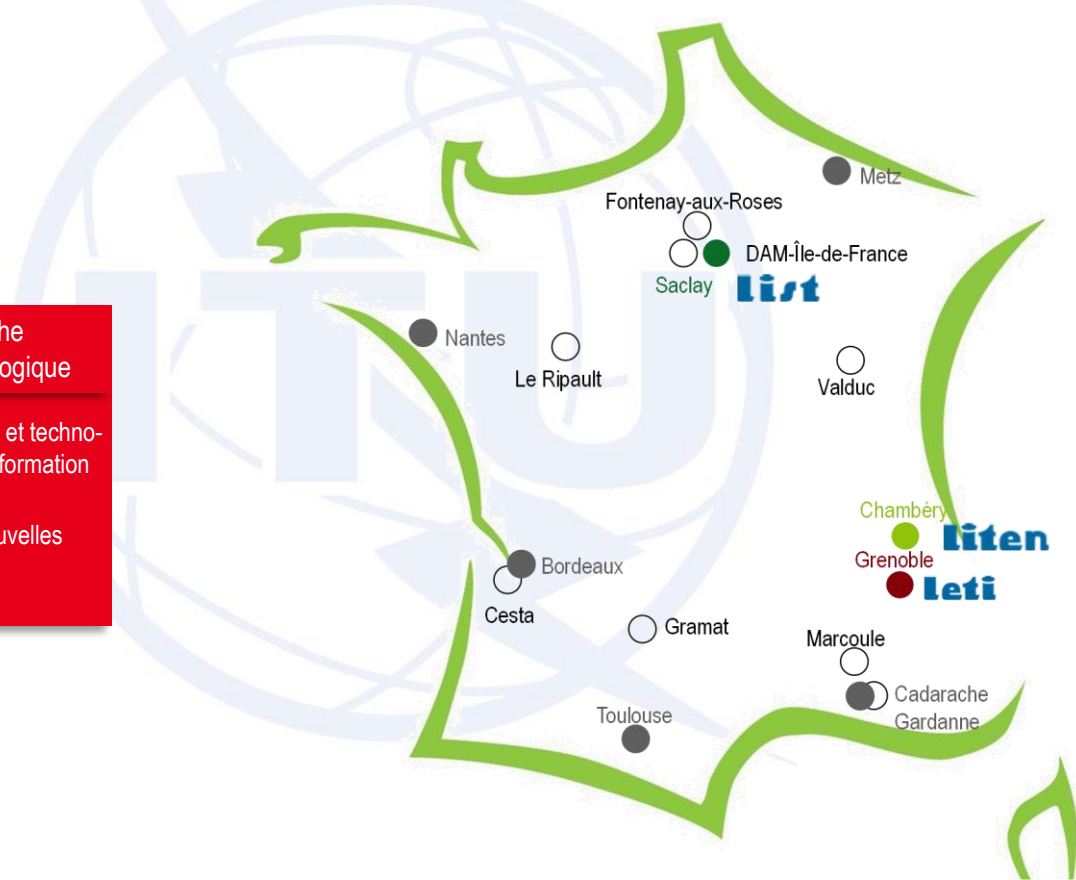
- Introduction
- 5GCHAMPION PoCs
- 5G Trials at CEA-Leti
- Conclusions and future works

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- **Introduction**
- 5GCHAMPION PoCs
- 5G Trials at CEA-Leti
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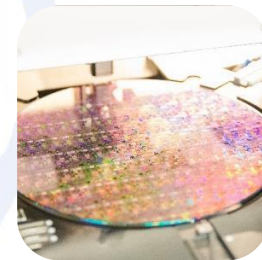
LETI – Laboratory of electronics & information technology

CEA TECH	Recherche Technologique
leti	Électronique et technologies de l'information
liten	Énergies nouvelles
list	Logiciel



LETI – Laboratory of electronics & information technology

- Research institute in CEA TECH
 - Atomic Energy and Alternative Energy Commission
 - Founded in 1967
- Micro electronics & nano technologies
- Key figures
 - 1,800 collaborators
 - 2,800 patents
 - Budget: 318M€
 - 8,500 m² clean rooms

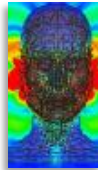


Wireless Communication Department



Antennas optimization

*Miniature
Smart
Integration*



Channel propagation modeling

*Characterization
Modeling
Emulation*



Contactless

*Arduous application
VHBR (Very High Bit Rate)
Power harvesting*



Cellular IoT

*Physical layers
Protocols*



Wireless sensors networks (WSN)

*Central network
Mesh network
Specific Scenario*



Localization

*Radio link
Localization algorithms
Multi-modality*



COMMUNICATION

**RADIO LINK DESIGN,
OPTIMIZATION & CHARACTERIZATION**

**ANTENNAS MINIATURIZATION
& INTEGRATION**

**RFID SOLUTION DESIGN FOR
HARD ENVIRONMENT**

LOCALIZATION & NAVIGATION



5G below 6GHz

*Disruptive air interface
Advanced protocols
Network architecture*



5G above 6GHz (mmW)

*New physical layers
Evolved protocols*



LiFi

*Physical layer
Protocol stack
Platforms*



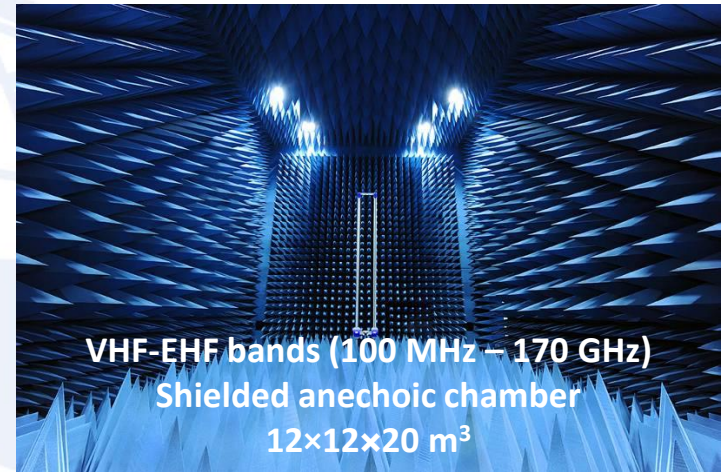
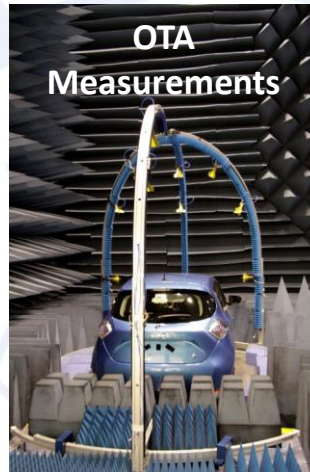
Flexible & Cognitive radio

*Air interface
MAC layer
Demonstrator*

Wireless Communication Department

- Antenna measurements and EM Propagation Facilities:

- Three anechoic chamber in the frequency range 100 MHz – 170 GHz,
- On-probe measurements up to 170 GHz,
- Channel emulator up to 6 GHz,
- Channel sounder for Doppler up to 300 Km/h (100 MHz – 40 GHz),
- Over-The-Air Test Facilities.



Outline

- Introduction
- **5GCHAMPION PoCs**
- 5G Trials at CEA-Leti
- Conclusions and future works



<http://www.5g-champion.eu/>

5GCHAMPION Project

- Consortium composed of **8 EU and 13 KR partners,**
- **5G PoC at 2018 Winter Olympic Games:**
 - 10 objectives including technical, standardization, dissemination ...,
 - 3 demonstrators (**PoC at OG, satellite, and short-range indoor link**).
- System including key building blocks for:
 - **mmWave** backhauling & fronthauling,
 - **Sub 6 GHz** direct 5G **satellite** narrowband access, positioning,
 - **Flexible and evolved packet core** network managed by SDN interface.

Education /research Institutes	
Network and Service Operators	
Manufacturers	
Technology providers	

Project Coordinator: Dr. Emilio Calvanese Strinati
EU Technical Manager: Dr. Antonio Clemente

KR Coordinator: Dr. Hyun Kyu Chung
KR Technical Manager: Dr. Taesang Choi





5GCHAMPION PoC in PyeongChang

<http://www.5g-champion.eu/>

- Korean PoC
- EU PoC

KR mmWave 5G System

KR mmWave 5G (MHN-E)

IoT Street (Yulgok Street) (using Demo BUS)



EU mmWave 5G system

S-vEPC

eNB

KR SDN/NFV system Using LTE-A Femto

5GCHAMPION Booth (Indoor) in Gangneung K-ICT center

EU Core (Finland)





5GCHAMPION PoC in PyeongChang



<http://www.5g-champion.eu/>



AR use case

- HD-video
- Real-time data



VR use case

- 360 video
- IoT
- Testbed interoperability

Moving Hotspot

- HD-video
- Testbed interoperability

3D Super Multiview

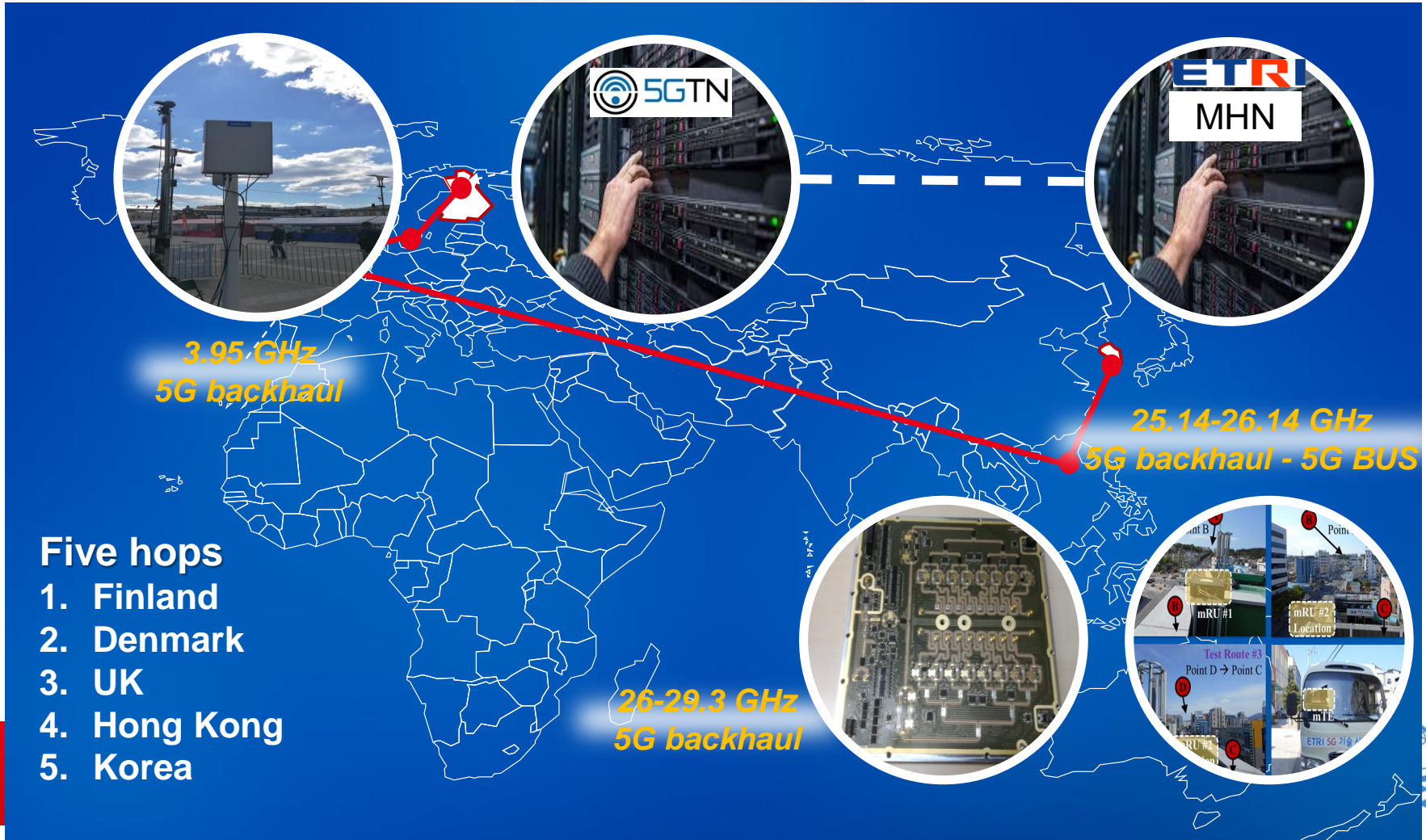
- Ultra-broadband



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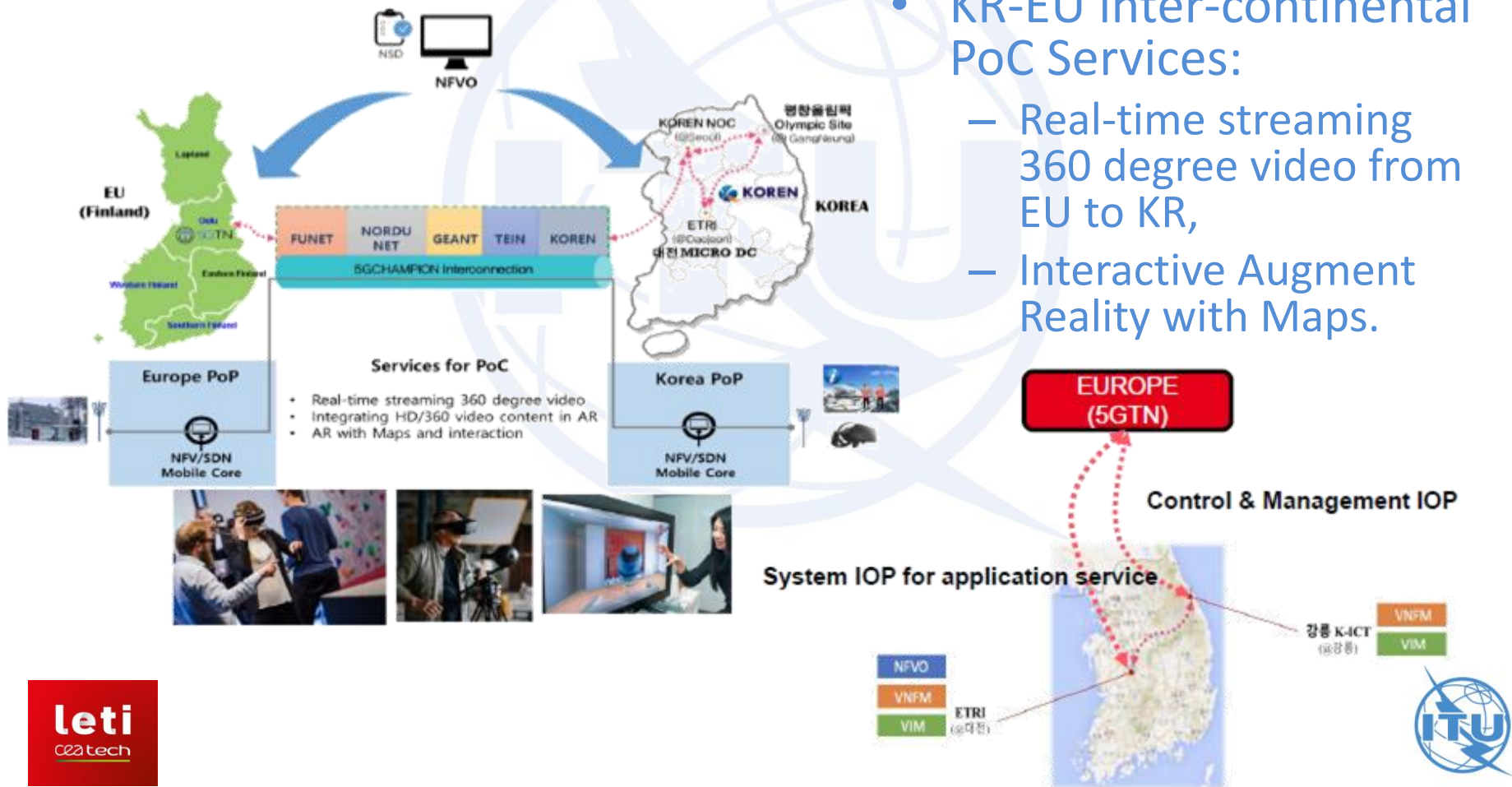


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5GCHAMPION PoC in PyeongChang

- KR-EU inter-continental PoC Services:

- Real-time streaming 360 degree video from EU to KR,
- Interactive Augment Reality with Maps.





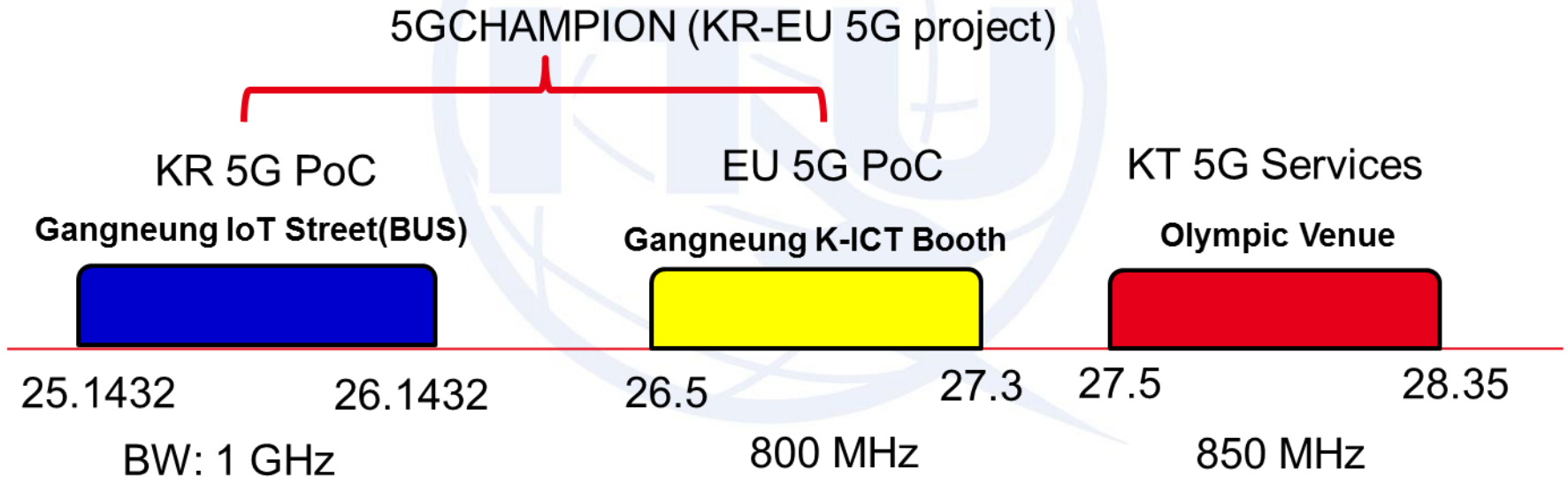
5GCHAMPION PoC in PyeongChang



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Frequency plan

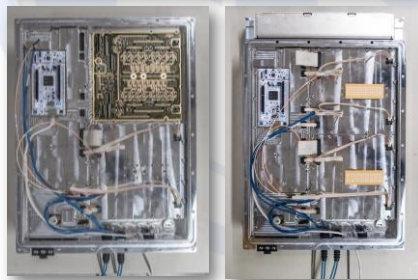
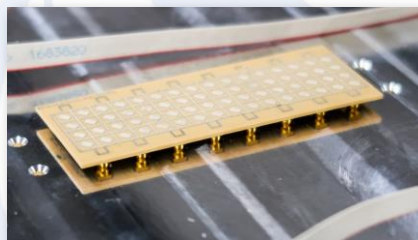




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5GCHAMPION PoC in PyeongChang

mmWave backhaul system for last-mile connectivity



Antenna

- 16 (2x2) elements
- 22 dBi array gain
- Wideband (5 GHz)

RF-FE

- Adaptive beamforming
- 800 MHz bandwidth
- Smart RF
- MIMO

TRX – Digital Front-end

- 8 RF-channels
- 400 MHz processing

Base band

- OFDM (100 MHz)
- 8x8 MIMO processing
- Up to 256 QAM
- 0.2 ms Subframe



UNIVERSITY of OULU
OULUN YLIOPISTO



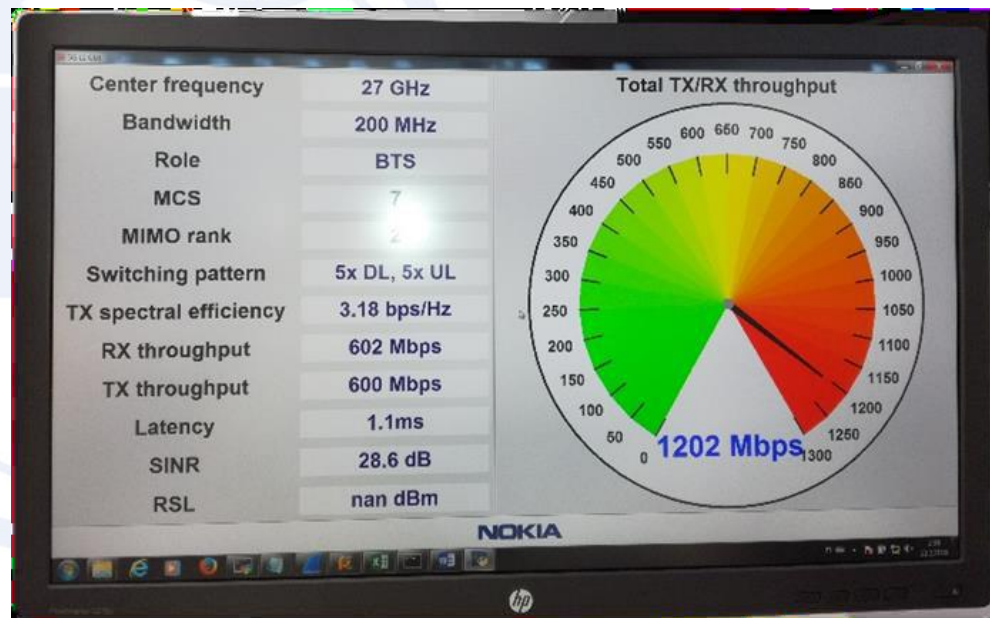


<http://www.5g-champion.eu/>

5GCHAMPION PoC in PyeongChang



mmWave backhaul system for last-mile connectivity



- Performances:
 - Up to 20 Gbps max data rate (short range communications),
 - 1.2 Gbps, 1.1 ms latency (intercontinental 360 video streaming).





<http://www.5g-champion.eu/>

5GCHAMPION PoC in PyeongChang

mmWave backhaul system for moving hot-spot

Gangneung Yulgok Steet

Gangneung ICT Squire demo configuration



3D multi-view display



mRU

mTE

- Max 5 Gbps (moving hotspot),
- Bandwidth extension (500 MHz → 1 GHz BW),
- 2×2 MIMO and radio frame format update.



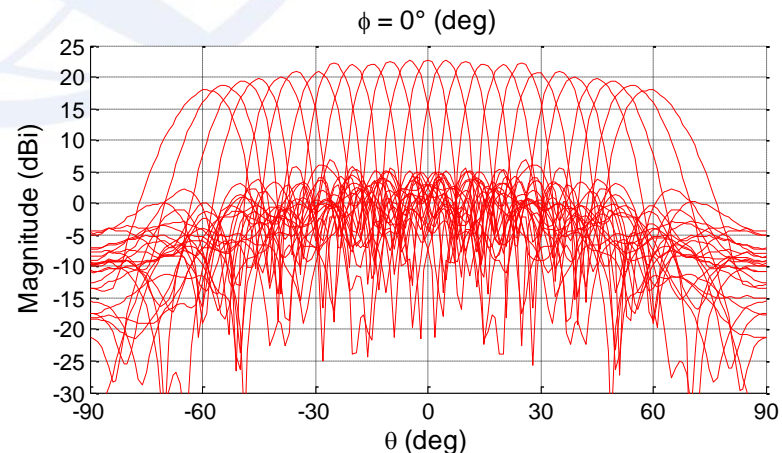
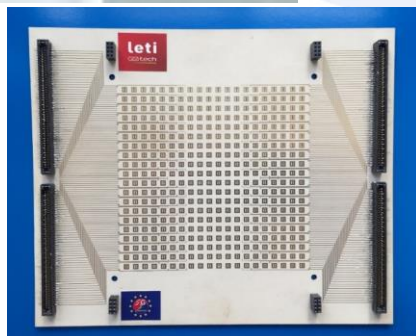
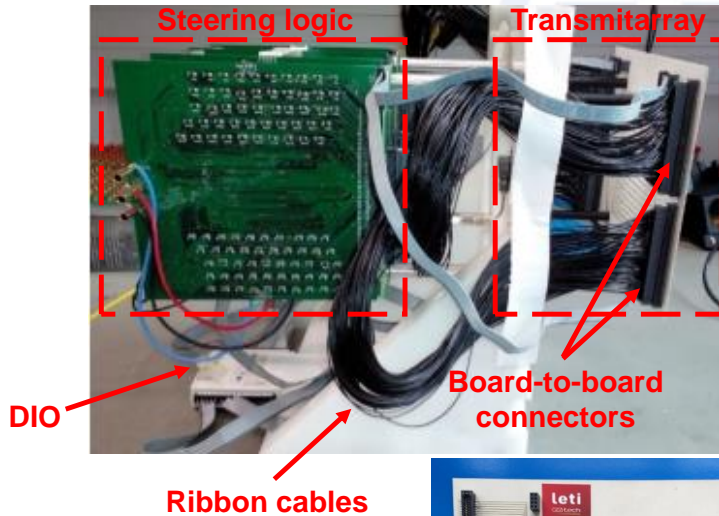


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5GCHAMPION PoC in PyeongChang

Advanced antenna technology for future mmWave backhauling

- Frequency band: 26.5 – 29.3 GHz (EU), 24.25 – 27.5 GHz (KR),
- Analogue beamforming: one beam at each temporal slot,
- Scanning capability: $\pm 60^\circ$ in 2D.



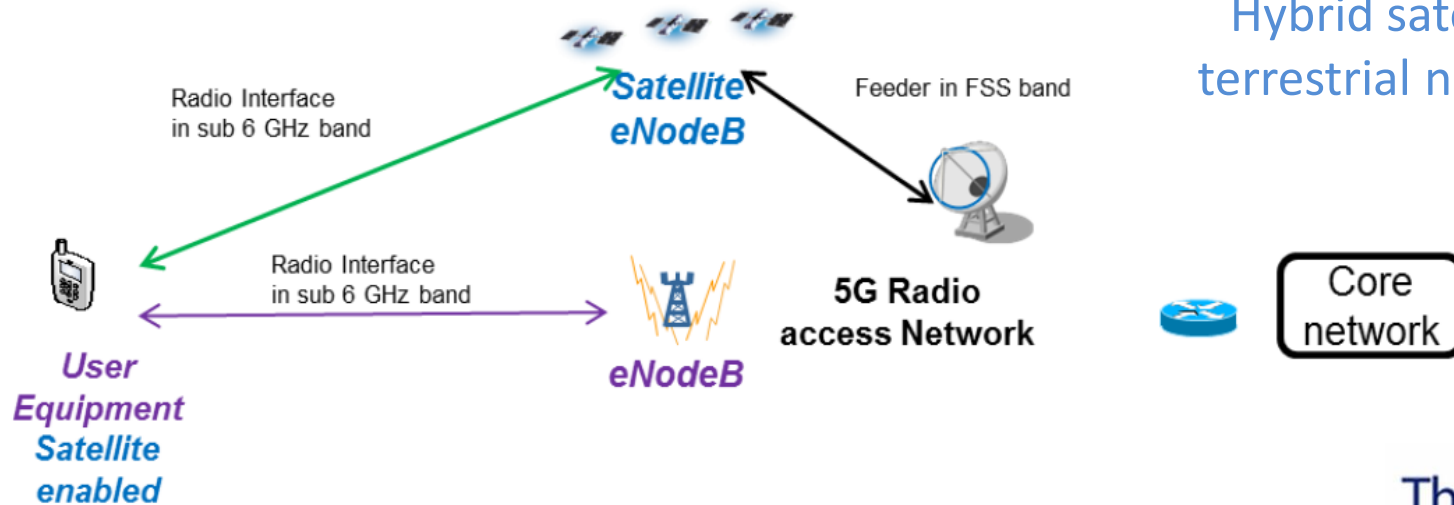


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5GCHAMPION PoC in PyeongChang

Narrowband satellite communications below 6 GHz

Hybrid satellite-terrestrial network



Frequency bands:

- Uplink (User to Satellite) 1980 – 2010 MHz,
- Downlink (Satellite to User) 2170 – 2200 MHz.



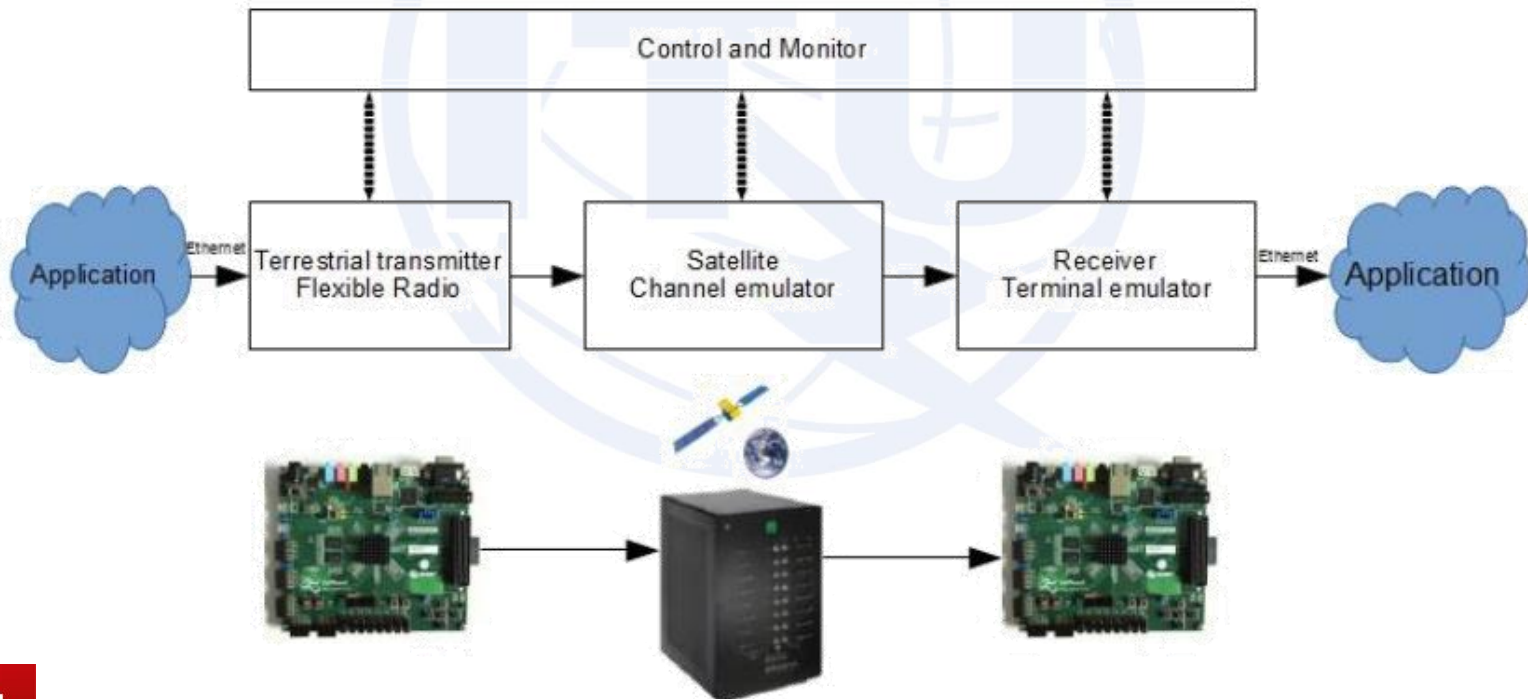


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5GCHAMPION PoC in PyeongChang

Narrowband satellite communications below 6 GHz

Lab Testbed





5GCHAMPION PoC in PyeongChang



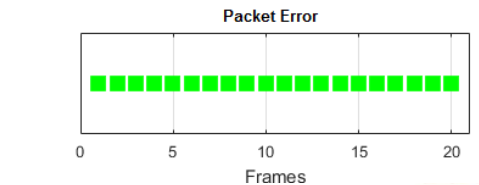
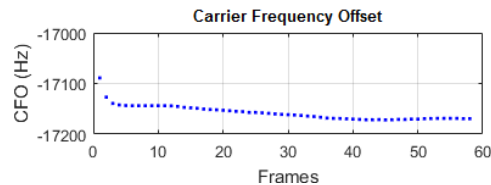
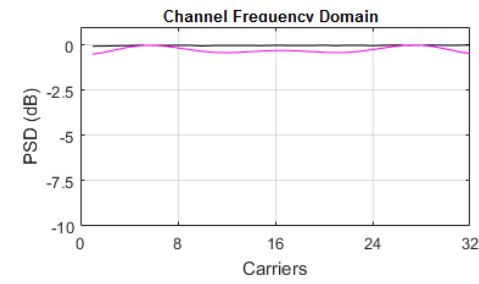
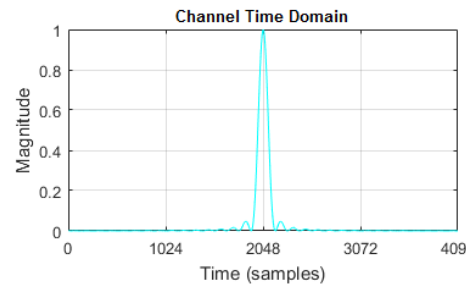
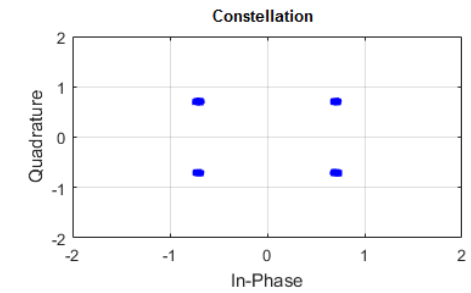
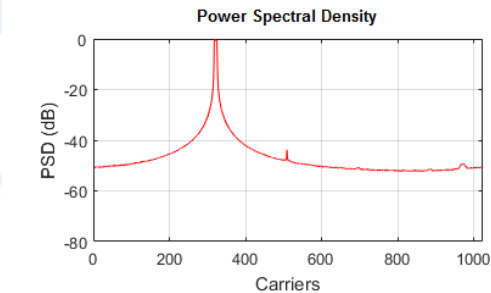
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Narrowband satellite communications below 6 GHz

- Test of different IoT-NB modulations (BF-OFDM, FSK, SC-FDMA),
- Realistic channel model in the emulator,
- Terminal and satellite impairments included in the analysis.

Single Carrier BF-OFDM

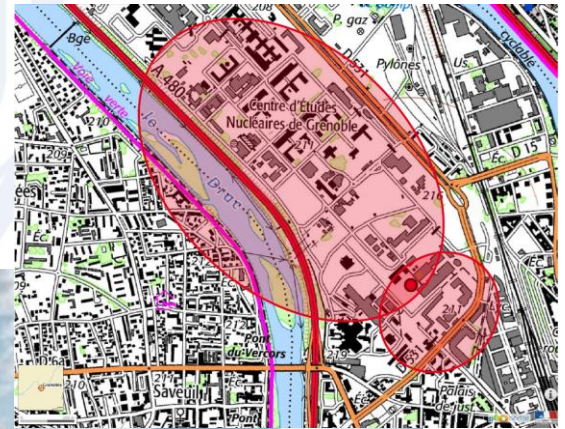


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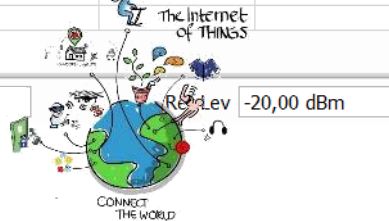
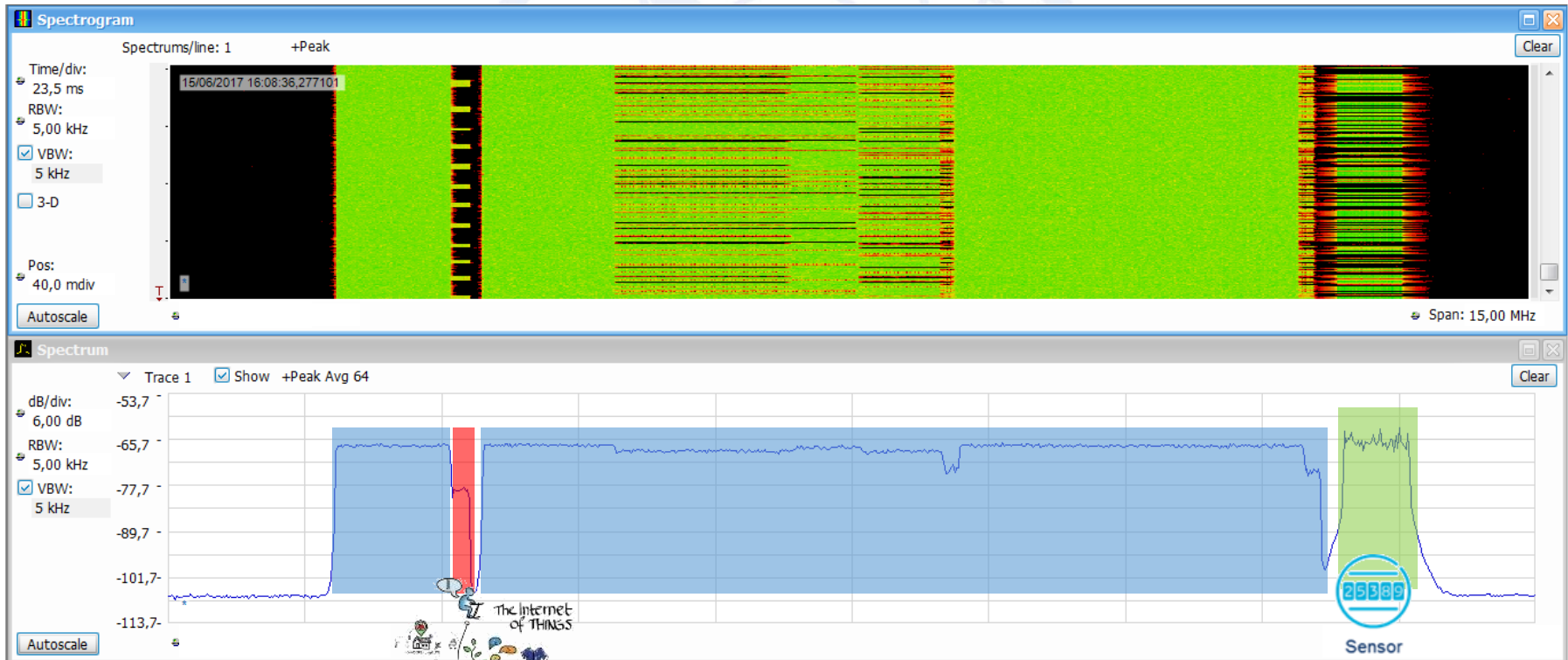
5G Trials at CEA-Leti

- Field trials at 3,5GHz TDD band started in 04/2017.
- Authorization received by French regulator ARCEP for 5G experimentation on Minatec campus at CEA-Leti, Grenoble,
 - 40MHz BW,
 - Indoor/outdoor.
- Ongoing experimentation,
 - 5G multiservice transmission (eMBB + MMTC + URLLC),
 - 5G eDSA,
 - 5G full duplex.



5G Trials at CEA-Leti

- Multiservice scenario (IoT, Broadband, URLLC) ...



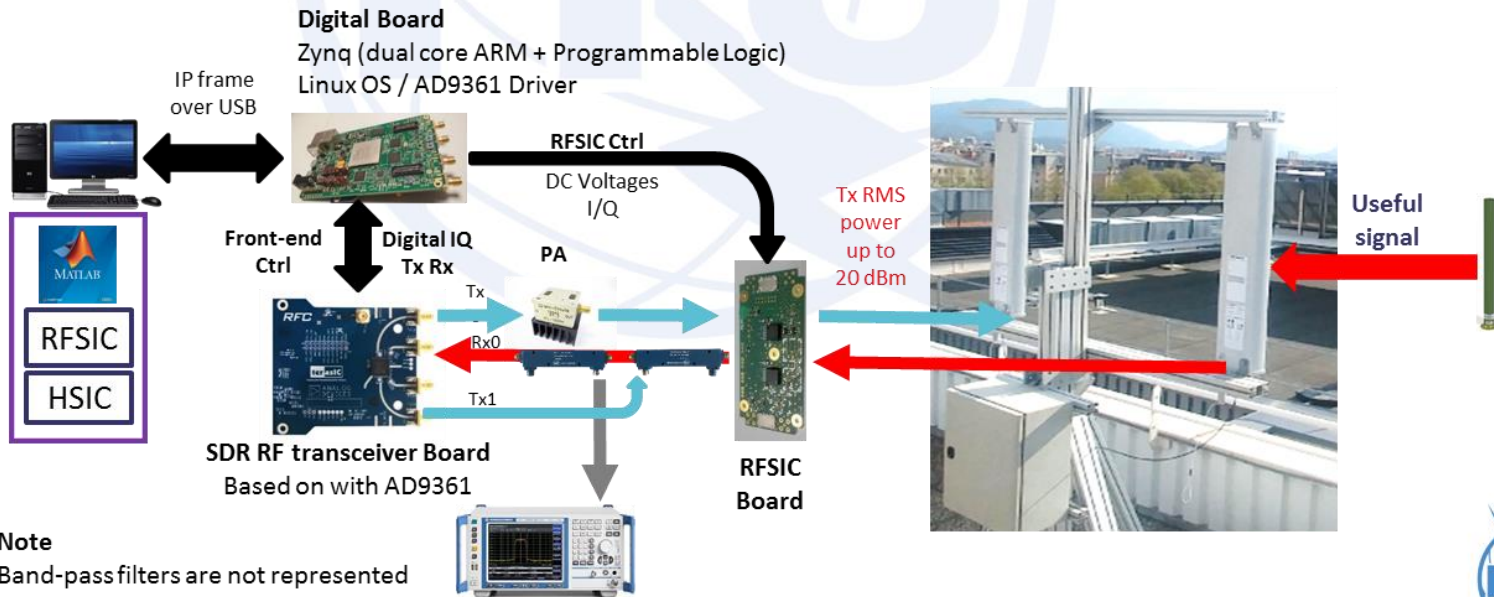
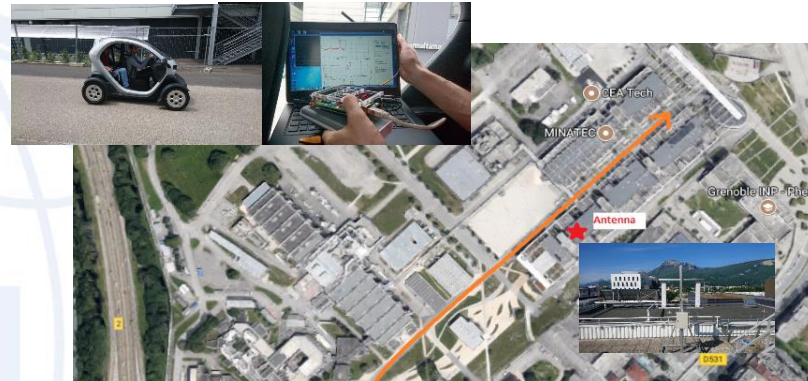
Res BW 5,00 kHz



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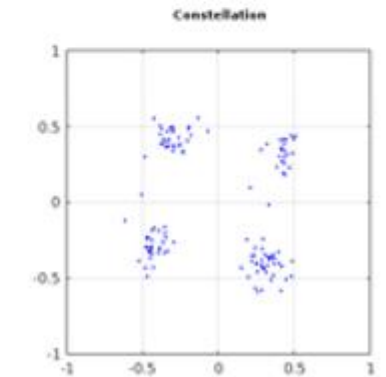
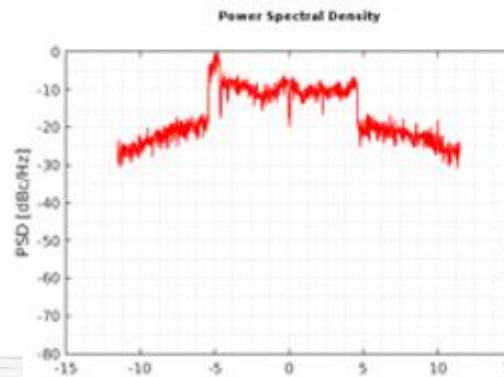
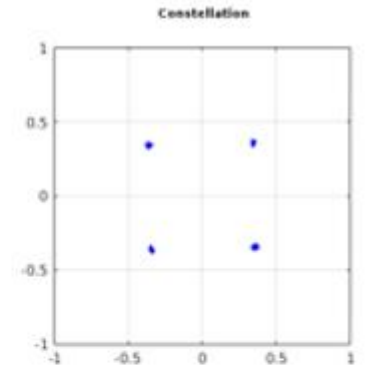
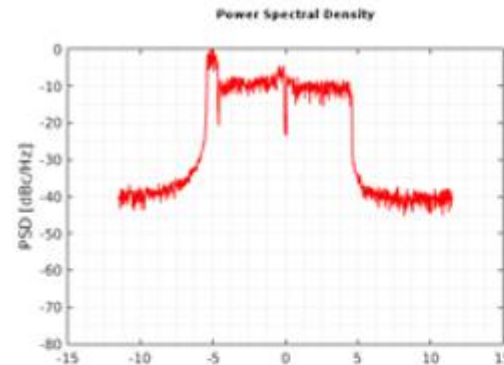
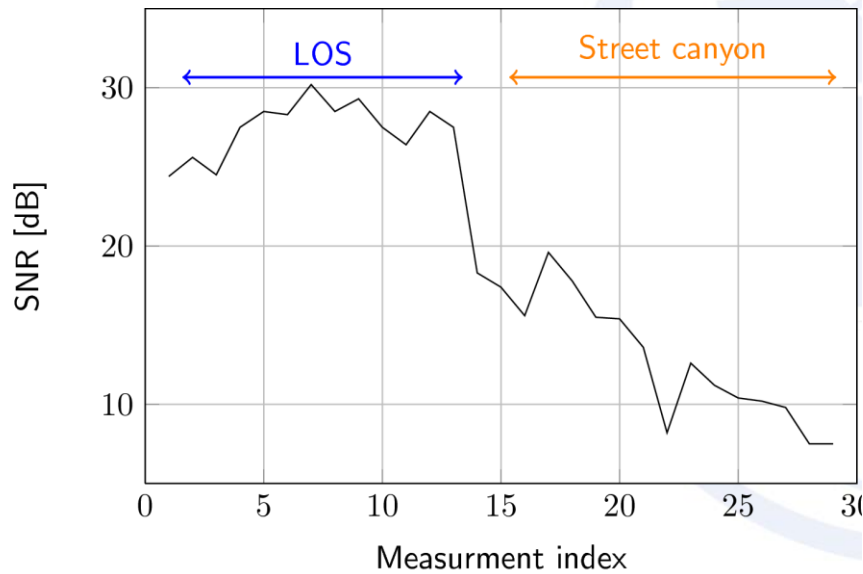
- Mobility and full duplex scenarios

85 dB cancellation reach over the air at 3.5 GHz



5G Trials at CEA-Leti

- URLLC performances



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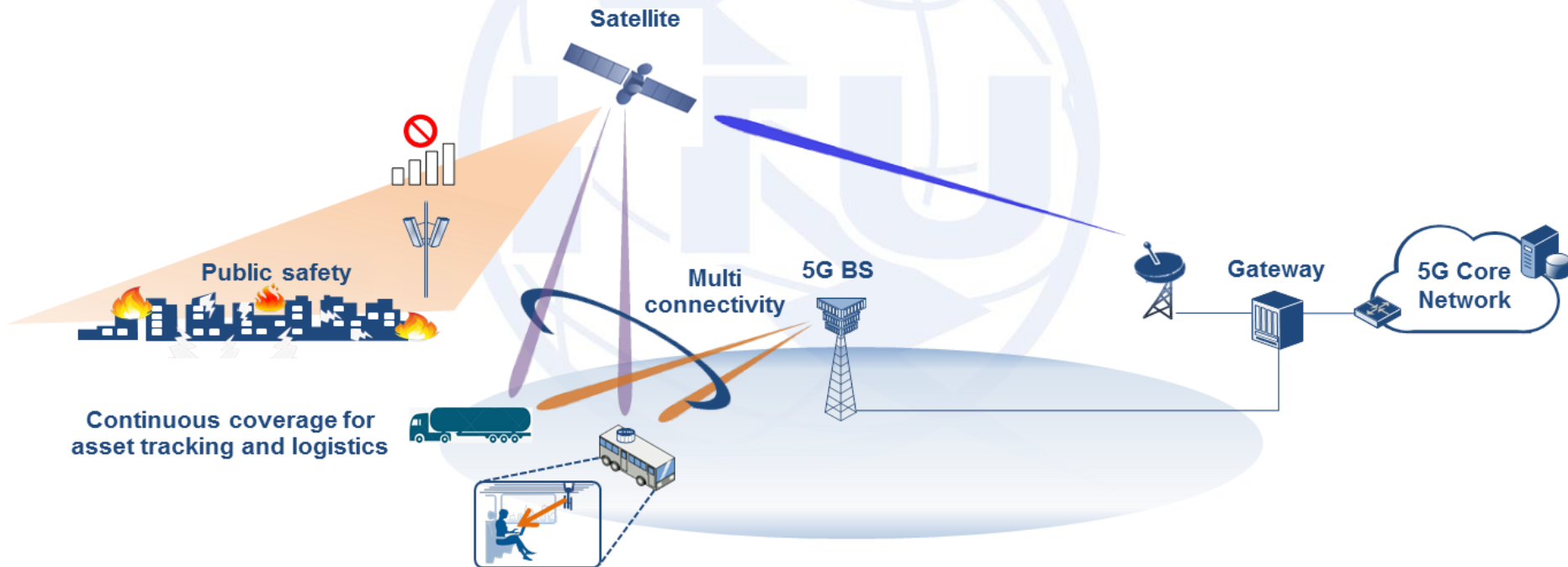
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 - 3 demonstrators (**PoC at OG, satellite, and short-range indoor link**).
- System including key building blocks for:
 - mmWave backhauling & fronthauling,
 - Sub 6 GHz direct 5G satellite narrowband access, positioning,
 - Flexible and evolved packet core network managed by SDN interface.
- 5G Trials at CEA-Leti:
 - Multi-Service 5G,
 - eDSA,
 - Full Duplex ...
- Extension of this work towards high data rate wireless backhauling and satellite communication is on-going (EU-KR Project 5GAllStar) ...

Conclusions and future works

- Extension of this work towards high data rate wireless backhauling and satellite communication is on-going (EU-KR Project 5GAllStar) ...



eMBB + mMTC + URLLC

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5GCHAMPION PoC in PyeongChang



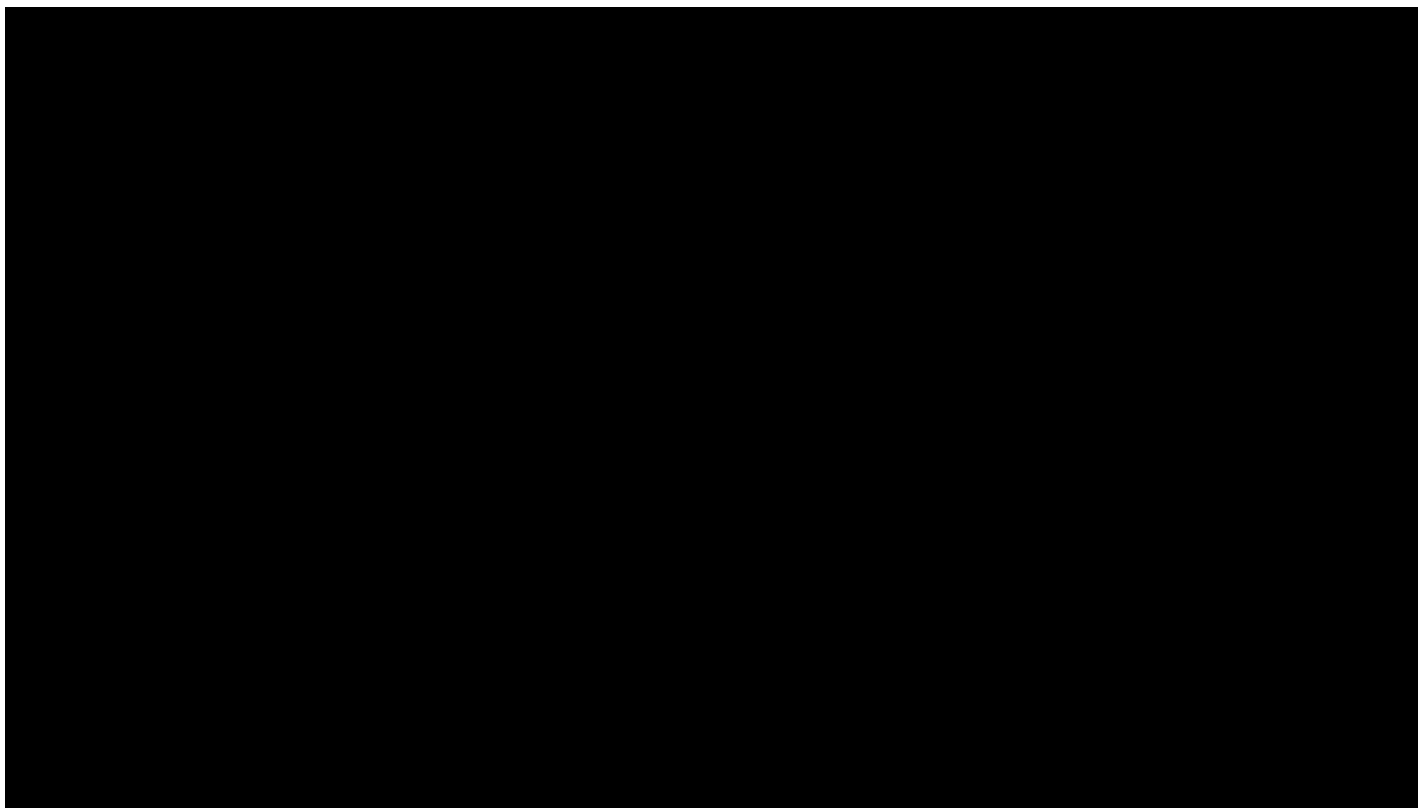
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5GCHAMPION 20 Gbps PoC

<http://www.5g-champion.eu/>





5GCHAMPION IoT-NB Satellite PoC



<http://www.5g-champion.eu/>

