



# 5G-Enhance

## *5G Enhanced Mobile Broadband Access Networks in Crowded Environments*

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Tokyo University of Agriculture and Technology Japan,  
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## EU partners

## Japan partners

### Universities

 **UNIVERSITY OF OULU** Finland

  
Tokyo University of Agriculture and Technology

Tokyo university of agriculture and technology

  
TOKYO

The university of electro-communications

### Research institutes

 **VTT** Finland

  
National Institute of Information and Communications Technology


National Institute of Information and Communications Technology

  
**Fraunhofer** FOKUS Germany

### private corporations

 **Acelleran** Belgium

 **愛媛CATV** Ehime CATV

 一般社団法人 **日本ケーブルテレビ連盟**

Japan Cable and Telecommunications Association

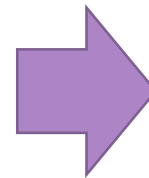
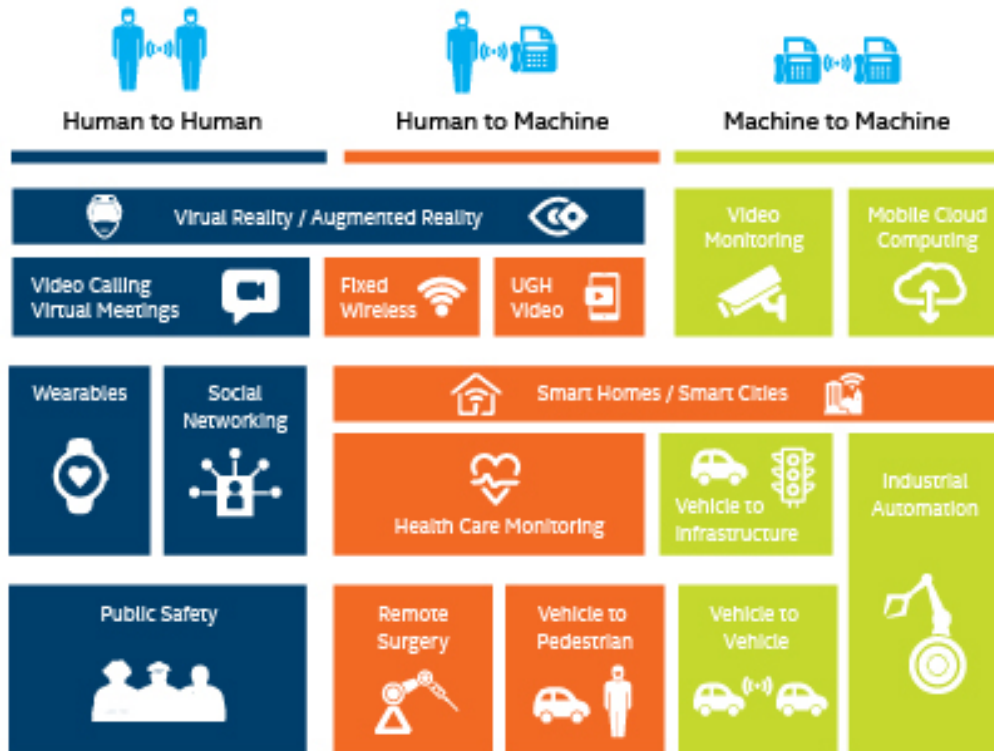
**BWA Japan**



# 5G wireless networks

Our target

Extreme Mobile Broadband



5G network requires flexibility and scalability for the various use-cases.

**5G-Enhance** focuses on eMBB in dense area scenario.

Proof availability of the 5G network based services by the two trials.

[1]<https://blogs.intel.com/technology/2017/12/5g-americas-white-paper-explores-5g-services-use-cases-and-market-implications/>



# Key components of 5G-Enhance

Use cases of 5G networks with **eMBB** in **dense area**

Two large scale trials

Demo 1: 3D remote class for real-time surgery in Finland  
Demo 2: Ad-hoc outdoor sport event in Japan

Key concepts

Micro operator

Smart Spectrum

Key technologies

Dynamic TDD

Muti-connectivity

Spectrum measurement/learning

Spectrum resource database/management

Network sharing/management

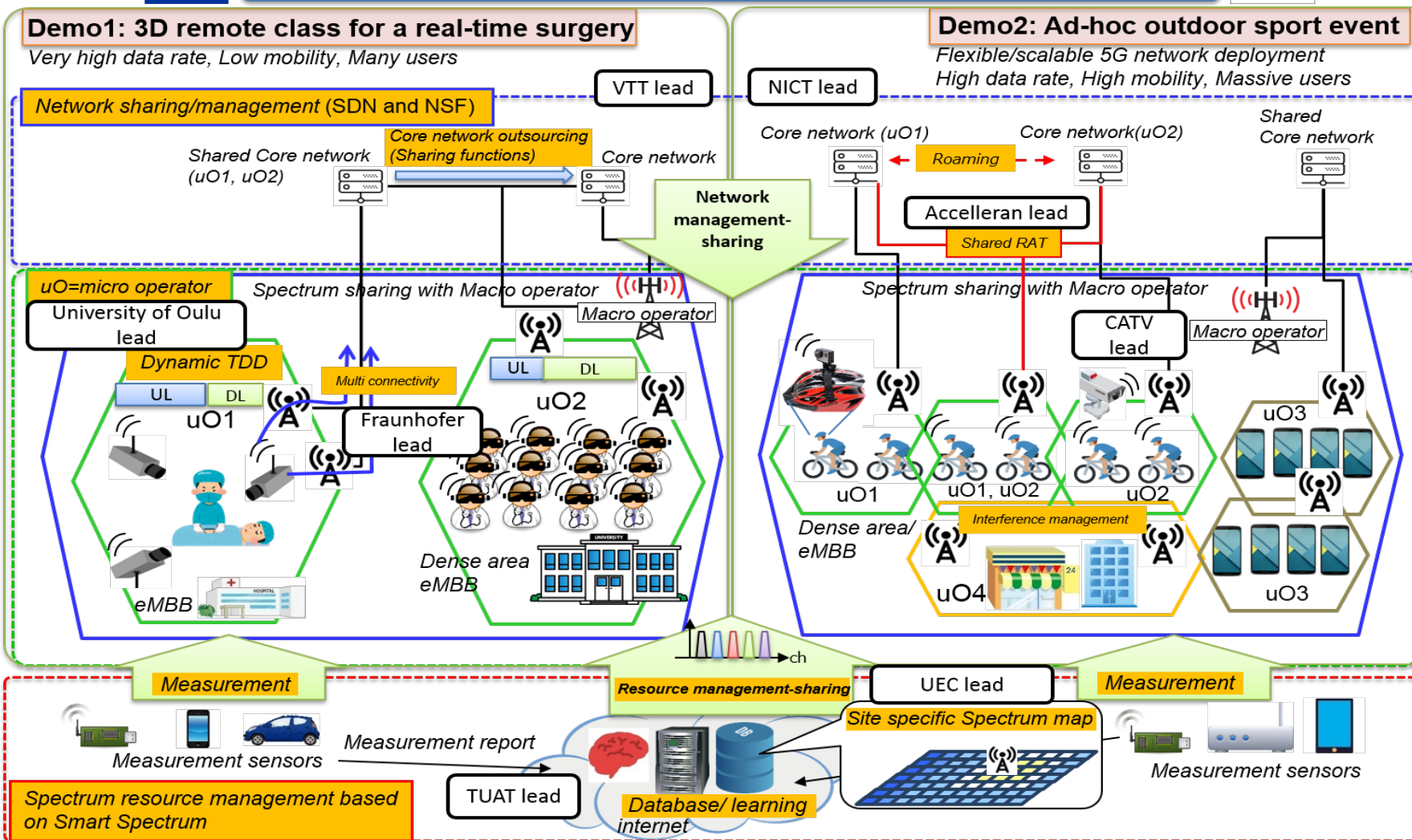


## 5G network large scale demonstration: Enabling healthy lifestyle with eMBB in crowded environments



Common Platforms for the demonstrations in EU and JP

interoperability





# Demo2 in Cycling-Shimanami, Ehime, Japan 2020



<http://cycling-shimanami.jp/english/>



- 7.215 people participated
- Participate from 22 countries and regions
- 626 international participants

**全7コース**

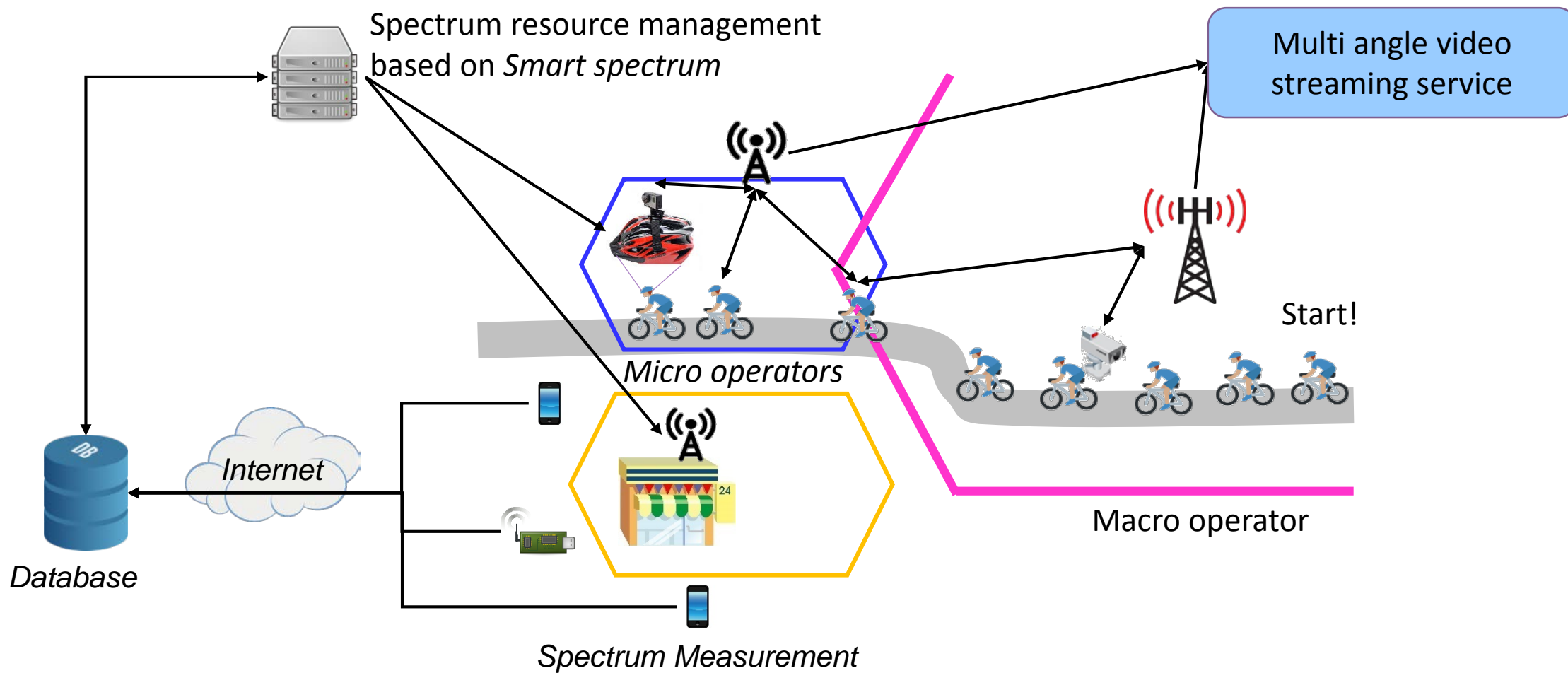
- 高瀬本線 宇治IC-因島南IC
- Aコース [尾道(由島)-宇治(外道)] (約70km, 1,000名)  
美島瀬野公園-因島南IC-大三島IC-しまなみアースランド
- Bコース [宇治-大三島(往復)] (約110km, 1,500名)  
宇治IC-大三島IC-大三島南道-しまなみアースランド
- Cコース [宇治-尾道(往復)] (約140km, 500名)  
宇治IC-因島南IC-みたとオアシス尾道-しまなみアースランド
- Dコース [宇治-尾道(片道)] (約70km, 1,500名)  
宇治IC-因島南IC-新浜橋上屋
- Eコース [宇治-生口島(往復)] (約110km, 1,000名)  
宇治IC-生口島南IC-生口島南道-しまなみアースランド
- Fコース [宇治-上島(片道)] (約70km, 500名)  
宇治IC-生口島南IC-可朝津
- Gコース [宇治-大島(往復)] (約30km, 1,000名)  
美島瀬野GA-大島南IC-しまなみアースランド

● スタート・フィニッシュ会場  
● エイドステーション  
● 給水・トイレ等

AS-77大三島南所  
AS-78大三島南所  
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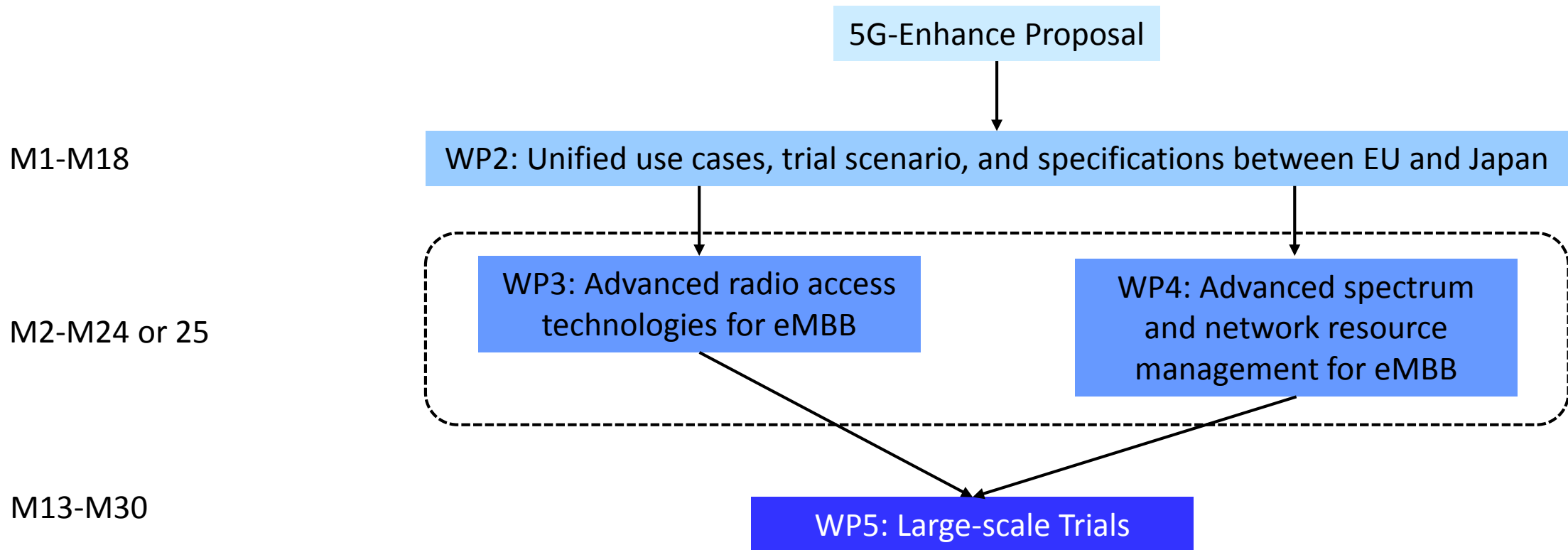
# Demo2 in Cycling-Shimanami, Ehime, Japan 2020







# Work Packages and schedule



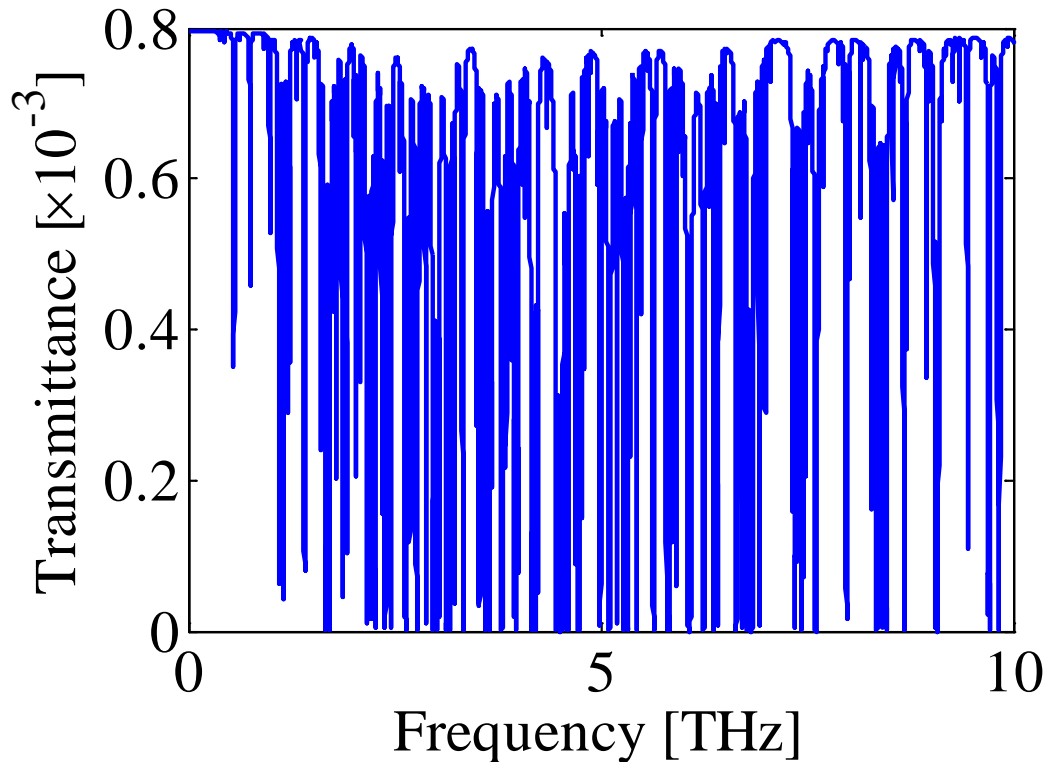


# What will 6G/future wireless communication be?!

- We may need more spectrum resources for future wireless systems:
  - Frequency domain: Terahertz
  - Spectrum sharing: Spectrum databases/map, Radio environment map
  - Once we find possible spectrum resources for future wireless service, we can develop new wireless communications/systems.
- We have to tackle social issues, such as falling birthrate, environmental issues, and aging problem.

# Future topic (1)

## *Terahertz (more than 1 Terahertz)*



### **Vast spectrum resources!!**

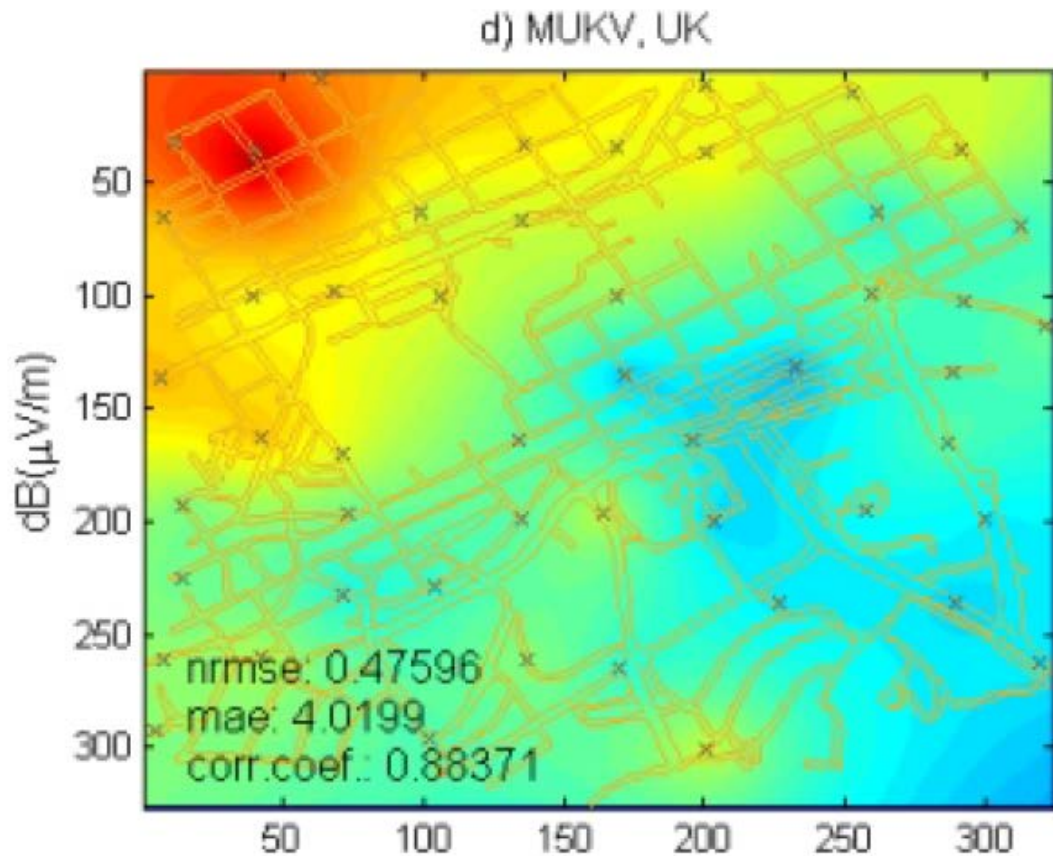
#### Keywords and challenges

- Device
- New modulation/coding
- New transceiver architecture
- Nano size sensor networks

J. Kokkonen, J. Lehtomaki, K. Umebayashi, and M. Juntti, "Frequency and Time Domain Channel Models for Nanonetworks in Terahertz Band", IEEE Transaction on antennas and propagation.

## Future topic (2)

### *Spectrum databases/map in whole frequency and area*



### **Understanding spectrum usage Finding more white space**

#### Keywords and challenges

- Measurements
- Database
- Learning

M. Höyhtyä *et al.*, "Spectrum Occupancy Measurements: A Survey and Use of Interference Maps," in *IEEE Communications Surveys & Tutorials*, vol. 18, no. 4, pp. 2386-2414, Fourthquarter 2016.



# Research challenges in EU-JP ICT call (Beyond 5G)

- 5G eMBB topics are related to many techniques (mmWAVE, massive MIMO, small cell depolyments, smart spectrum, etc) and metrics (Throughput, energy efficiency, latency, etc). **However, scalability is not so much emphasized.**
- As the number of mobile nodes increases and the current network architectures lack of radio resources and signalling, network scalability and intelligence should be an essential part of the future networks. For doing this, the following research challanges are expected.
- Device centric mobility solution
- Virtulalized signalling
- Power consumption optimization at mobile nodes
- Multiple radio resources allocation
- Higher directionality at mmWAVE and Terahertz
- Ultra-high speed backhauling
- Ultra dense HetNet
- Reconfigurable HW design