

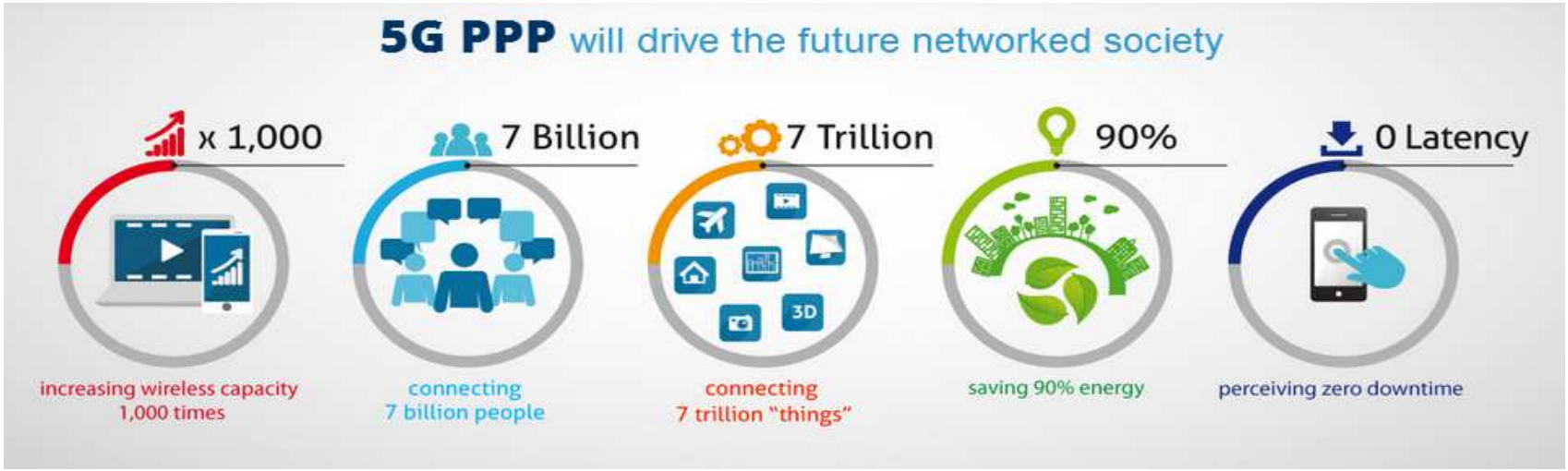
European Commission



5G PPP DRIVES THE FUTURE

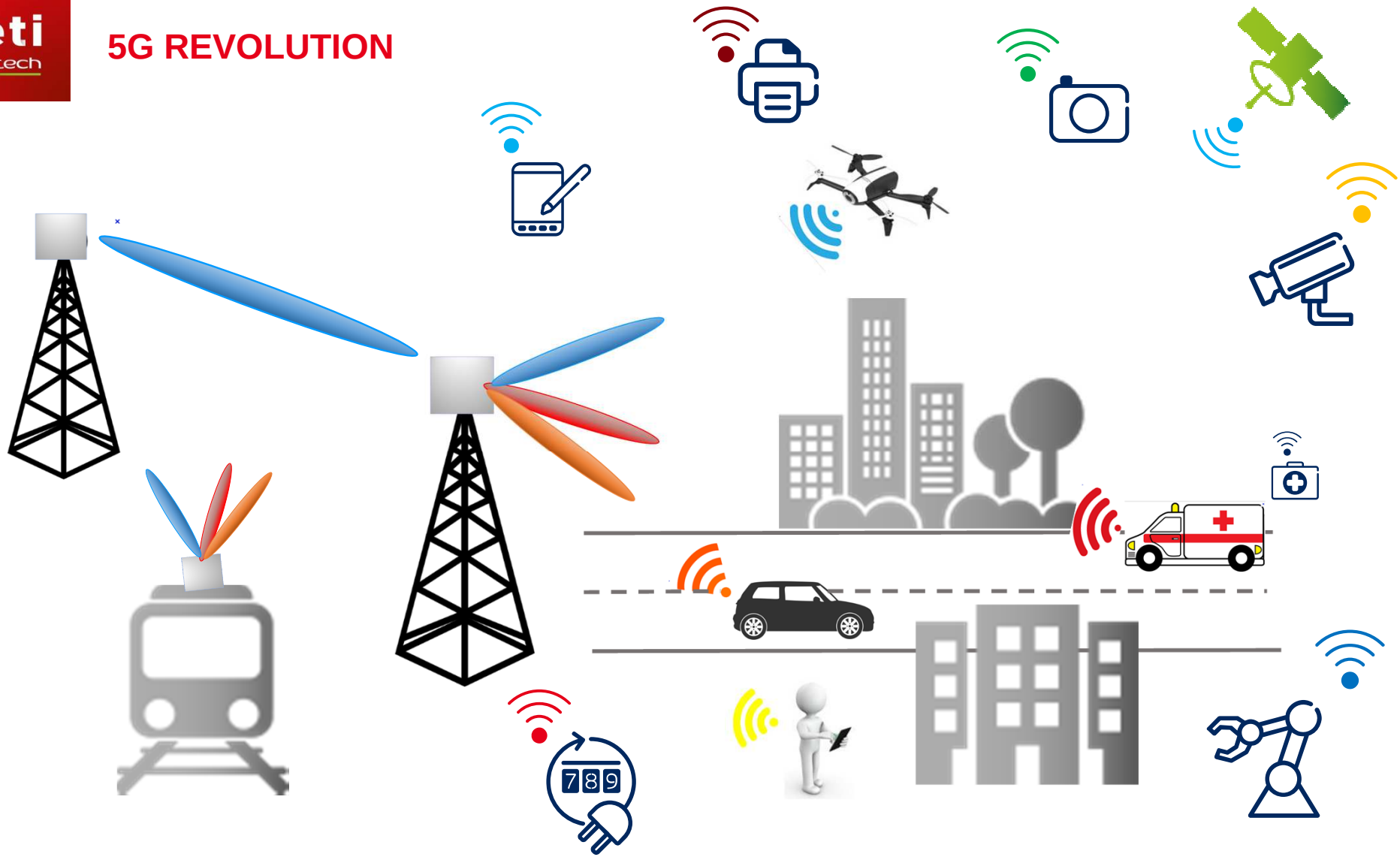
Leti Innovation Days | June 28-29, 2017

5G PUBLIC-PRIVATE-PARTNERSHIP

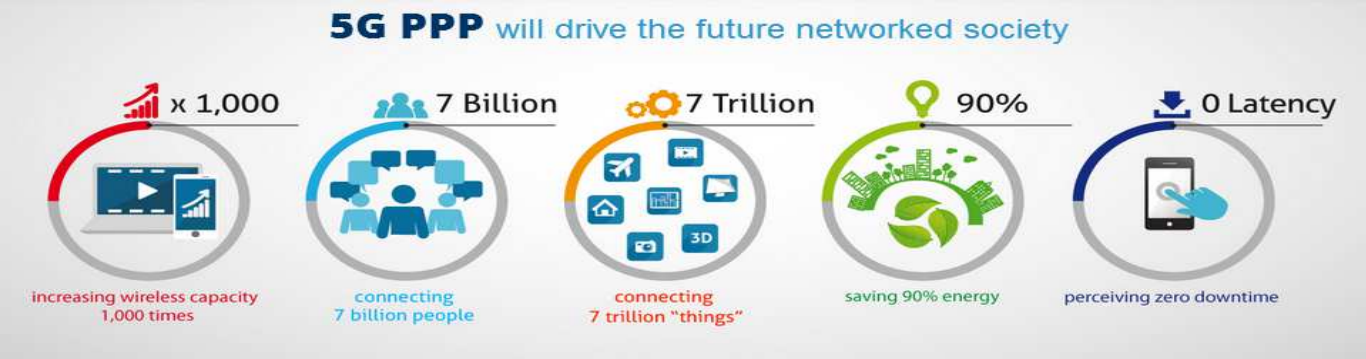


European Commission

5G REVOLUTION



5G CHALLENGES AND LETI APPROACHES



Approach

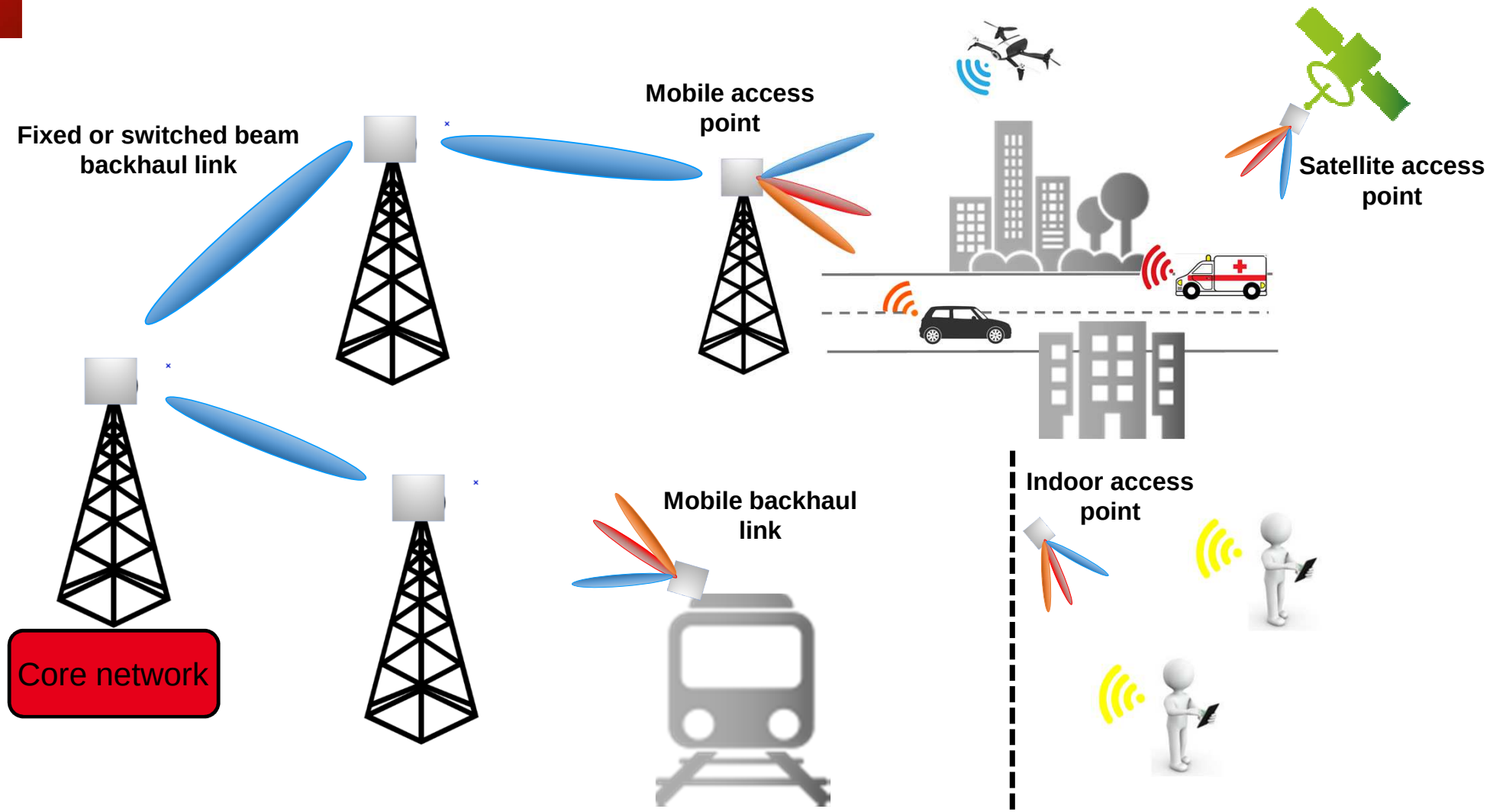
Explore higher frequencies	Provide Quality-of-Service	Ease IoT deployment	Go further ?

Challenges

Power consumption / performance	Latency, Reliability, Coexistence	Scalability, localization	Optical Wireless Communication

1- mmWave	2- QoS	3- IoT	4- LiFi

1- MILLIMETER WAVE APPLICATIONS



1- MILLIMETER WAVE TRANSMISSIONS

- **Transmission @ frequency > 10 GHz requires new developments**
  - New radio (Single-Carrier BF-OFDM) for energy-efficiency
  - RF impairment modeling and mitigation with new channel model
  - High-throughput (> 3Gbps) Forward Error Correction (LDPC)
  - Full-duplex for higher bandwidth
  - Small cell control with machine-learning (Q-Learning) for optimized power consumption
  - New antennas systems: hybrid beamforming for best performance / power consumption tradeoff
  - New RF architectures
  - New technologies (e.g. GaN) & low-loss RF wafers

- **First deployment in Korea (Winter Olympic Games)**
  - 5G-Champion leaded by CEA for Europe

PyeongChang 2018™

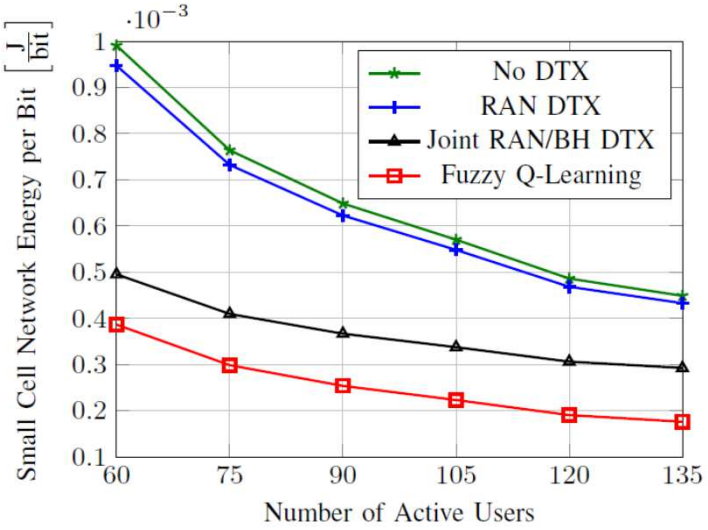
mmMAGIC

Flex5Gware

TOKYO 2020

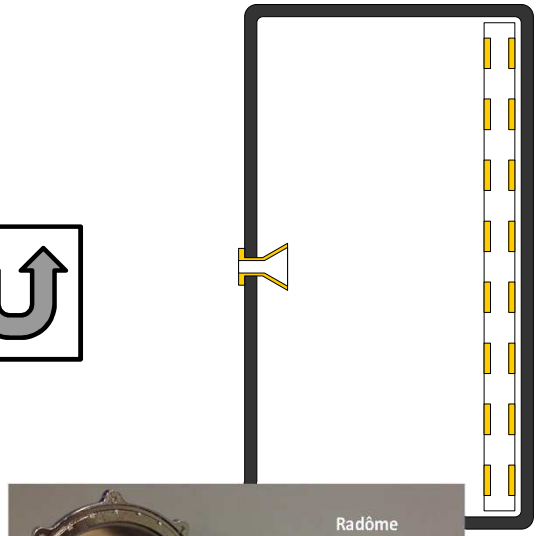
5G MiEdge

MiWaveS



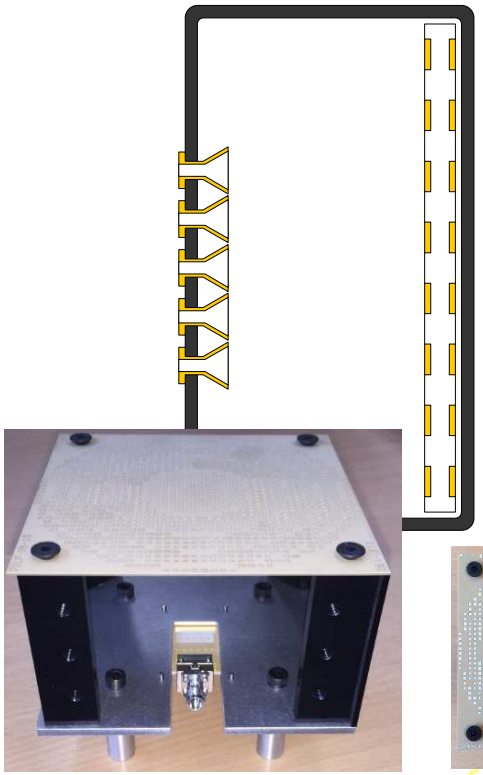
1- BEAMFORMING WITH TRANSMITARRAYS

1 - Fixed beam

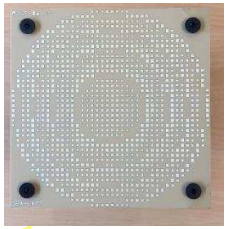




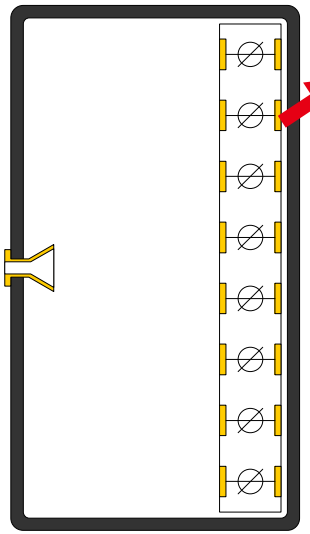
2 - Switched beam (active focal array)

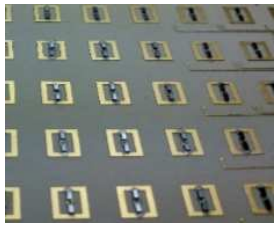


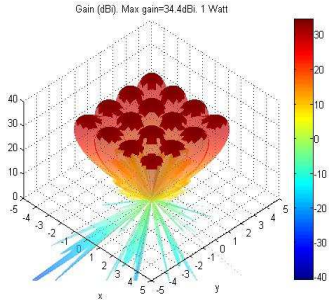
Coll. With VTT



3 - Beamsteering/Beamforming (electronically-reconfigurable TA)









2- MULTISERVICE TRANSMISSIONS

- **Mixing communication types with different QoS requires new solutions:**
  - Asynchronous transmissions
  - Flexible numerology
  - « Clean » out-of-band transmissions

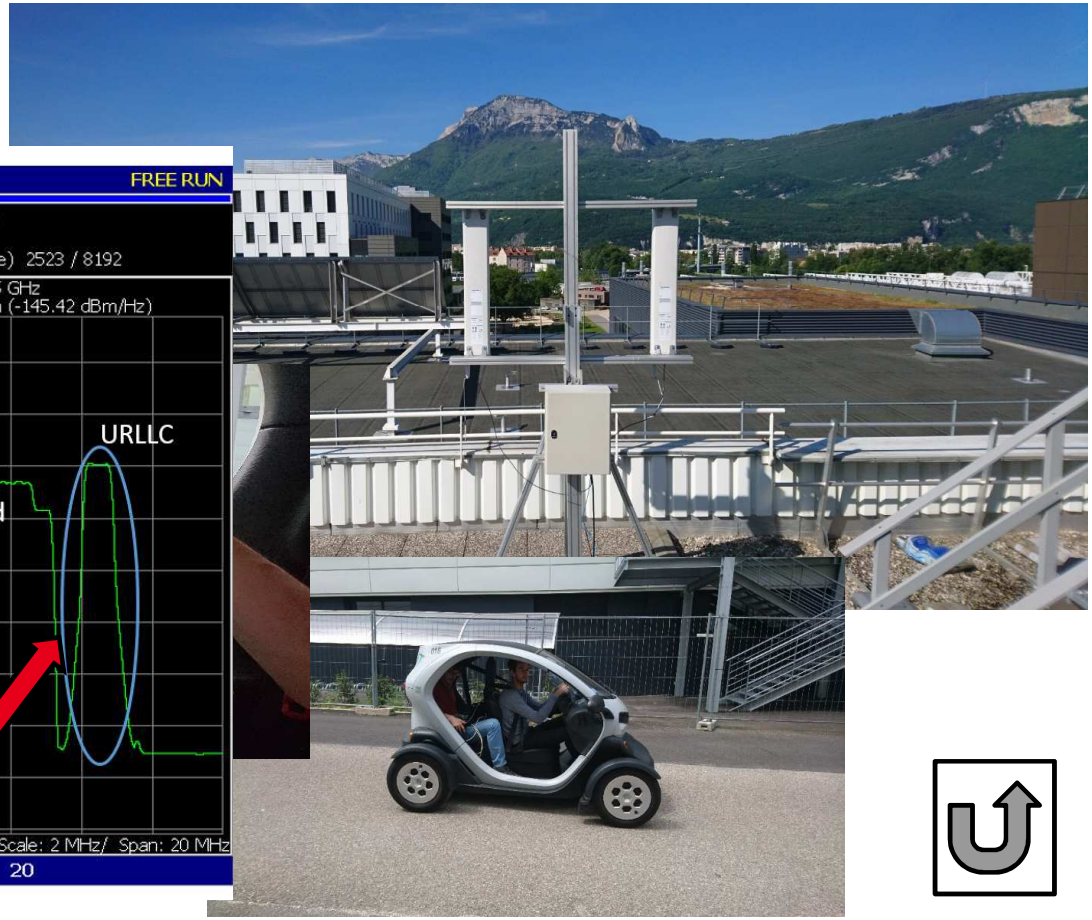
Waveforms	CP-OFDM (WOLA)	UFMC	FBMC	BF-OFDM
Higher spectral efficiency with efficient MIMO integration	♦	♦		♦
Low in-band and OOB emissions	♦	♦	♦	♦
Enable asynchronous multiple access			♦	♦
Low Tx implementation complexity	♦			
Low Rx implementation complexity				♦
Support of multi-service (single carrier…)				♦

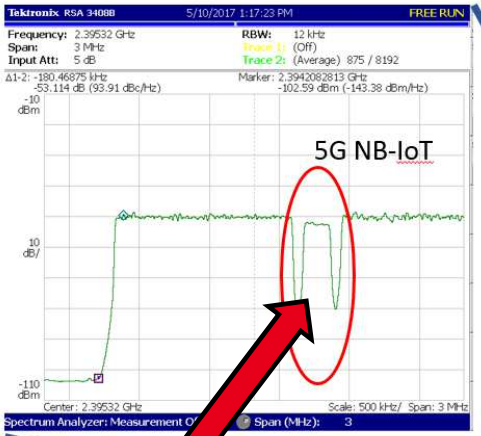


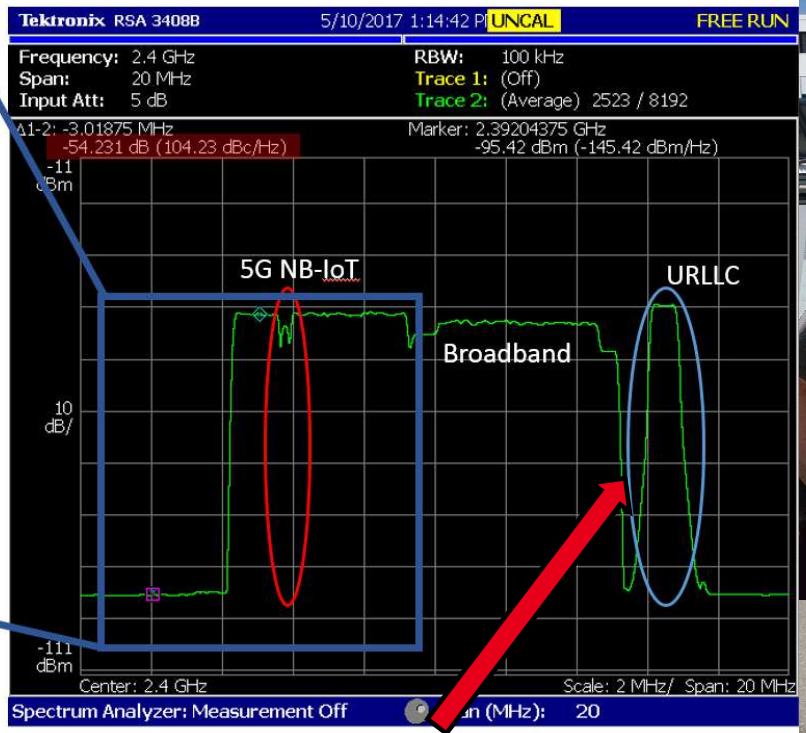
Extracted from: "5G waveform & Multiple Access Techniques", Qualcomm, 4th November 2015

2- FIELD TRIALS









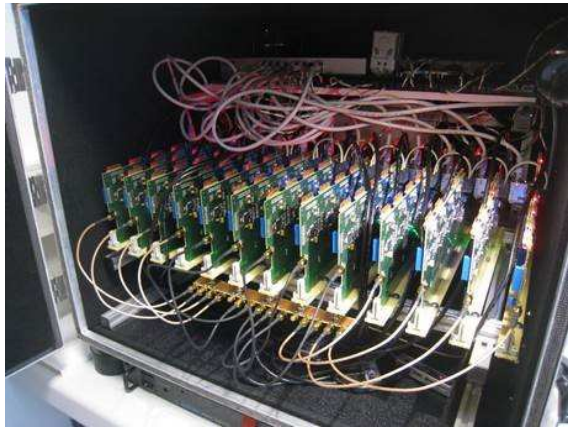
IoT communications
Narrow-band (180 kHz)
SC-BF-OFDM for low-power
10ms burst

Critical communications
Polar codes for reliability
< 0,5ms latency

3- INTERNET-OF-THINGS

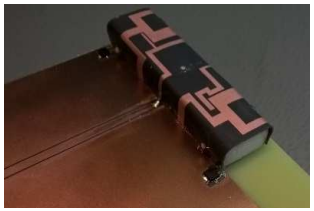
- **Sensors Deployment and scalability are challenging issues**
  - Ultra-robust communication protocol
  - Efficient antennas (reconfigurability, form factor, directivity)
  - Security (key management)
  - Ultra-Low-Power Circuits & energy scavenging

- **Localization of IoT helps services deployment**
  - Zigbee technology
  - Impulse-Radio Ultra-Wide-Band technology
  - Mixing with sensors (GPS, IMU, MAPS)
    - Hybrid localization techniques

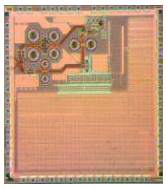


Massive IoT nodes deployment



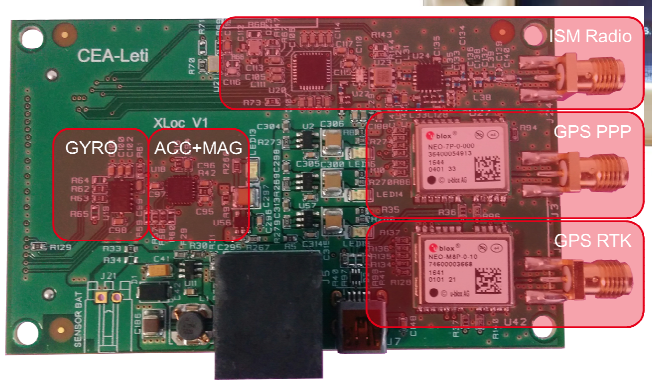


Dual-band reconfigurable antenna
700MHz-1GHz, 10 MHz BW



IEEE 802.15.4 ULP Radio
« Letibee » Chip

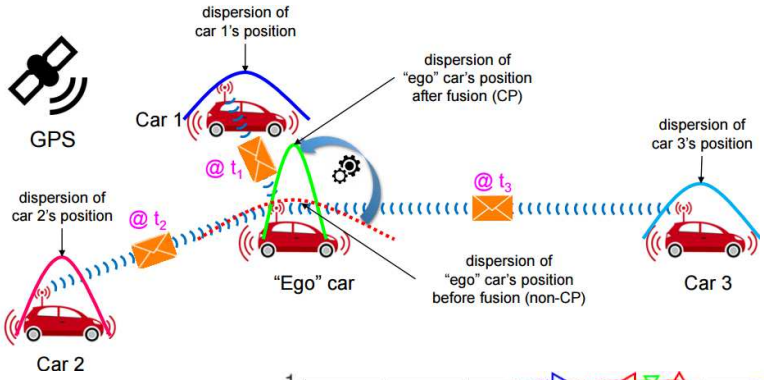
uwb embedded technology



« Hyloc » LETI's hybrid localization platform

3- COOPERATIVE FUSION-BASED VEHICULAR LOCALIZATION

- Challenges & Proposal
  - Combine vehicle-to-vehicle (V2V) radio-based ranging (UWB, IEEE 802.11p...) with V2V cooperative messages & on-board sensors (GPS, inertial unit, wheel speed…)



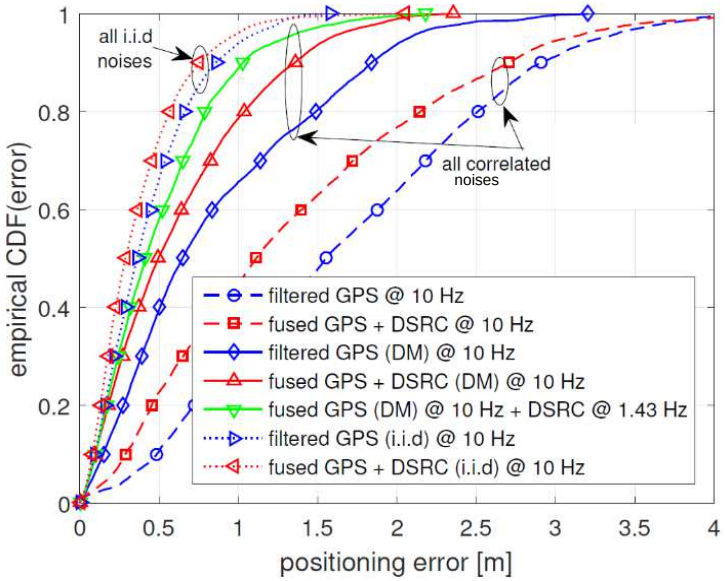
HIGHTS



GPS UWB IEEE 802.11p

- Results

  Accurate/reliable location info (~5-10cm) & local dynamic maps (incl. relative positions wrt. neighbors) for advanced safety services & Autonomous vehicles



3- DEPLOYMENT OF IOT IN SMART CITIES

Technology Improvement for LArge Scale Smart Cities Deployment



Security and privacy



- Security deployment for heterogeneous nodes
- Authentication / Key management
- Reliable communication
- Secure protocol /End-to-end security
- Lightweight cryptography for The IoT

Traceability



- RFID (HF/UHF)
- Energy harvesting (zero power tags)
- Privacy and trust
- Supply and delivery chain management

Localization



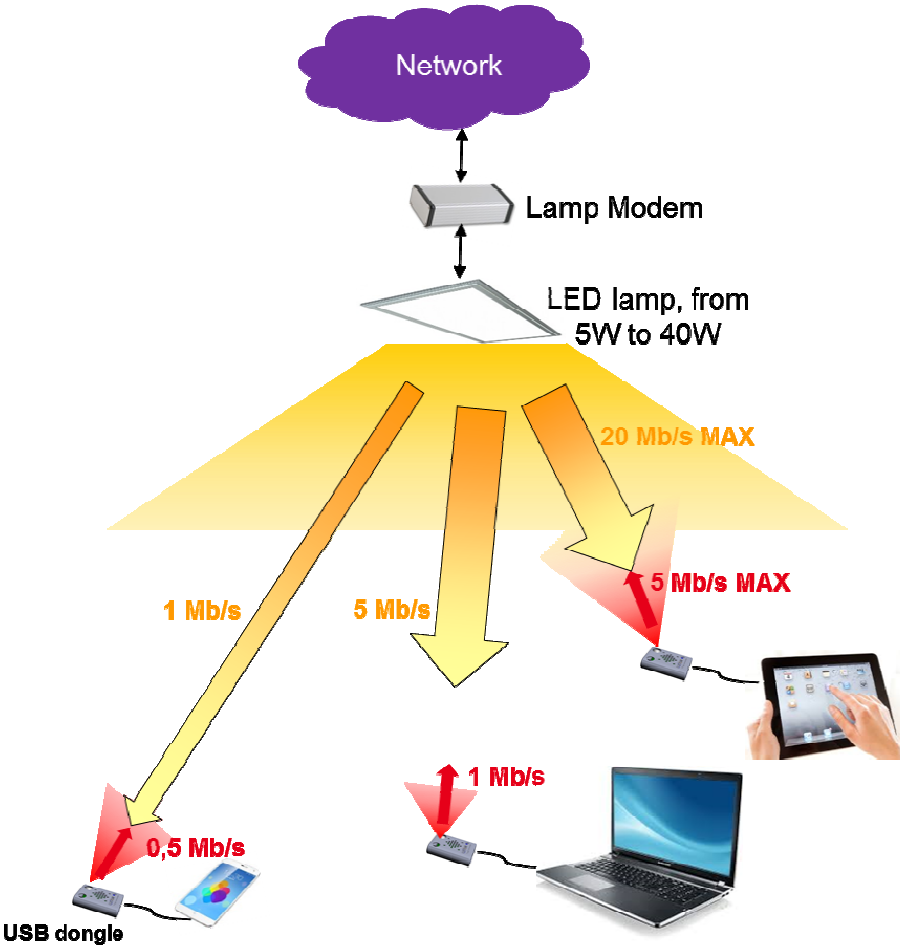
- Outdoor localization in mobility
- Indoor navigation and tracking
- Crowd collaborative localization

4 – GOING BEYOND 5G: OPTICAL WIRELESS TRANSMISSION



Intra-vehicle


Pour transmettre des données en LiFi, une LED posée au plafonnier et un capteur intégré à la tablette suffisent. © PSA Peugeot Citroën

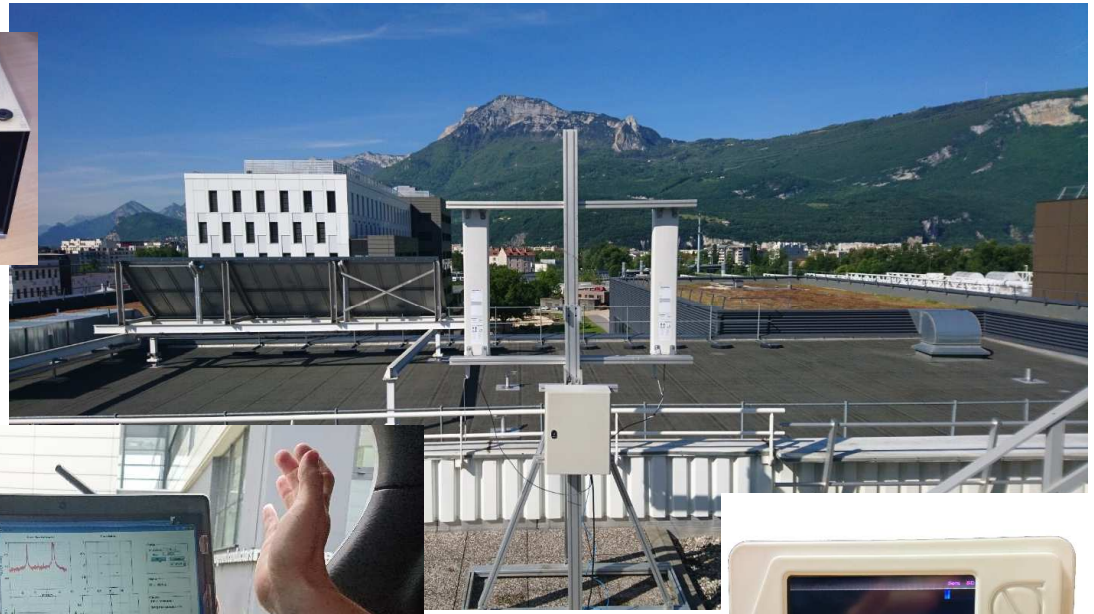


JOIN LETI FOR 5G (+) ADVENTURE!

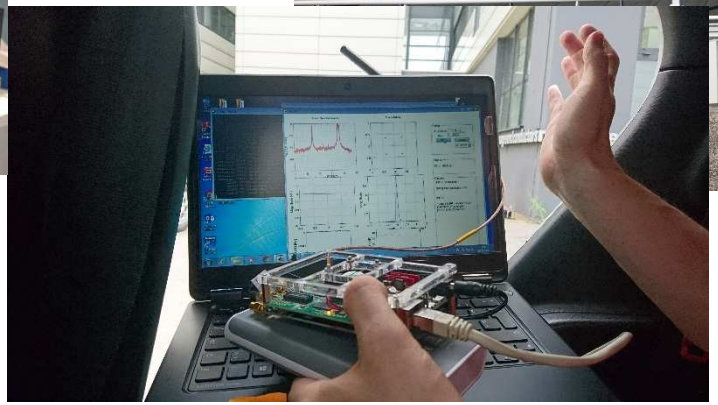






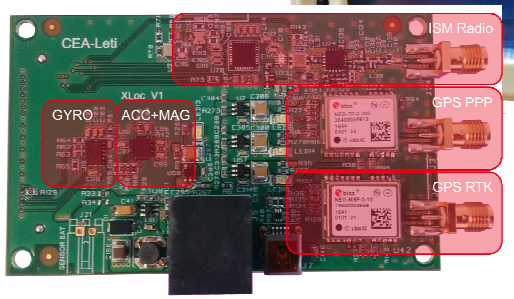


NANOELEC.



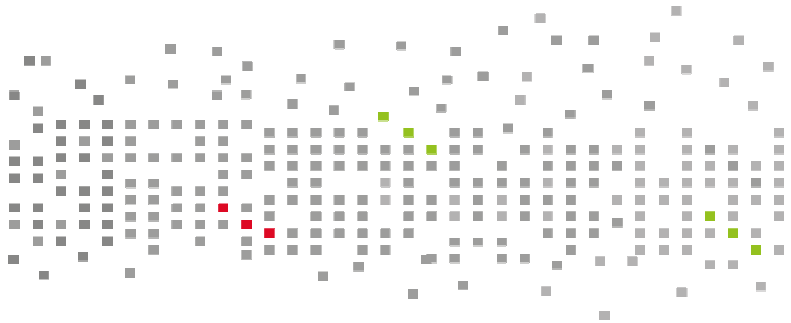












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