μO5G seminar 18.12.2018

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6G Flagship Programme – 6Genesis
6G ???
Some notions on Wireless Technologies at Dawn of 5G

• Do you remember/have heard these discussions/controversies?
  • Why do we need 4G as we have 3G?
  • Why do we need 5G as we have 4G?
  • Why do we need 6G as ......
  • Why do we need a caterpillar as we have the spade?

• What happens in 5G?
  • It is the largest technology shift in ICT since 2G → 3G (e.g. 5G Core, Softwarization, Beamforming, Network Slicing, RAN virtualisation).
  • 5G is for verticals, happening rather slowly
  • US vs. East vs. Europe
THz allows to combine data transmission with sensing information and imaging.
THz solid state sources – the “THz gap”

Solving the THz Gap not only provides ubiquitous communications but also new forms of intertwined sensing and imaging with 6G radio.

J. V. Moloney et al. SPIE Newsroom (2011)
First use cases/requirements were discussed and some of these are summarised in this slide.

3+4 Open Challenges for 6G

- massive – Data rate beyond 10Gb/s (the end of OFDM)
- massive – Reliability using 50+ year old framework
- massive – Low latency at 1ms and below
- massive – WPN deployment with Resilience against jamming & more
- massive – Scalability solution mapping
- massive – Rural coverage
- massive – Security & Privacy architecture
Globecom 12/2018 – “First” conference to touch 6G

First timelines were offered and these are summarised.
Globecom 12/2018 – “First” conference to touch 6G

First technical requirements were discussed and some of these are summarised.
Transmit only devices? Sustainable Devices
Beyond OFDM waveforms
Vertical Specific Service Operators
New software architectures to support dynamic virtualisation
Zero jitter, low latency transport
Fully distributed AI or Fog AI
Global network slicing
First conference to discuss 6G
Vision for 2030

Our society is data-driven, enabled by near-instant, unlimited wireless connectivity.

6G will emerge around 2030 to satisfy the expectations not met with 5G, as well as, the new ones fusing AI inspired applications in every field of society with ubiquitous wireless connectivity.
"I think Oulu is the world’s best place, second to none, for radio access engineering”

Rajeev Suri, CEO, NOKIA

6 Oulu ICT facts

1. 2.6B users for wireless technologies developed in Oulu.
2. 3-4B€ exports per year from wireless industry in Oulu.
3. 200 new startups from ICT since 2014.
4. 150 researchers makes CWC one of the leading radio group.
5. Core technology contributions from 3G to 5G
6. 1000+ ICT companies is directly reached in 6Genesis.

UO is among top 3 universities globally*)

*) In 10 key flagship research areas (#1 in four areas) with FWCI 1.86.
National Flagship on wireless communications

6G Enabled Wireless
Smart Society & Ecosystem

- National Flagship for 2018-2026
- Volume 251M€
- Operated by University of Oulu
- Collaboration with Nokia, VTT, Aalto University, BusinessOulu, OUAS.

1. Wireless Connectivity
   Ultra-reliable low-latency communications and Tbps
   Enabling Unlimited Connectivity

2. Devices & Circuits
   THz communications materials & circuits
   Enabling Unlimited Connectivity

3. Distributed Computing
   Mobile edge intelligence
   Enabling Time Critical & Trusted Apps

4. Services & Applications
   Multidisciplinary research across verticals
   Enabling Disruptive Value Networks

6Genesis was elected as Finlands high-tech Flagship, by Finnish Government through Academy of Finland
Basic pillars enabling future smart society

Flagship focuses on 5G & 6G
- **Now:** Utilize benefits of 5G
- **Next:** Develop 6G enablers

### Wireless intelligent edge
- Technology convergence
- Enablers for speed, experience, performance & security

### Next gen requirements
- Real-time
- Sensing-based
- Distributed intelligence
- ..list goes on!

#### WIRELESS INTELLIGENT EDGE

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<tr>
<th>Theme</th>
<th>Design</th>
<th>Benefit</th>
<th>Scale</th>
<th>Flexibility</th>
<th>Reliability</th>
<th>Elements</th>
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<td>5G</td>
<td>ULTRA-FAST COMMUNICATION</td>
<td>LOW LATENCY REAL-TIME</td>
<td>RADIO</td>
<td>SOFTWARE, ARCHITECTURES &amp; SERVICES</td>
<td>PRIVACY, SECURITY &amp; INTEROPERABILITY</td>
<td>MATERIALS, ELECTRONICS &amp; SENSORS</td>
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<tr>
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<td>CONNECTED DEVICES &amp; OBJECTS</td>
<td>INTEROPERABILITY SENSING BASED OPS</td>
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Enabling next generation business cases

**Challenge**

Requires

- Real-time data
- Edge processing
- Process AI

**6G technologies disrupt businesses**

- Thz radios
  - Sensing system
  - Machine vision
  - Preference analytics

- Wireless AI
  - Machine vision
  - Preference analytics

- Cyber security
  - Machine vision
  - Preference analytics

- Augmented UX
  - Machine vision
  - Preference analytics

- Smart sensors
  - Sensor mesh
  - Swarm AI

- IoT systems
  - Multi-radio

- Local processing
  - Local processing
- Open test network for co-creation (https://services.5gtn.fi/).
- Main parts located in Oulu & Helsinki regions.
- Was used in EU-Korea demos at 2018 Winter Olympic Games.
- Operator grade live network with plugged in 5G prototype radios.
- Awarded Academy of Finland FIRI status Dec/2018
- Near future targets: become the first operational local micro-operator at University of Oulu Digital Campus.
- Long Term Target: World’s First 6G Test Network
6Genesis Flagship Summary

- Elected Academy Flagship
- 8 year, 251M€ program
- Hosted by Univ. of Oulu
- Science & business ecosystem

- Work in themes and waves
- Products: Take 5G to use
- Science: Enablers for 6G
- Mutual ROI is prioritized

Join us at www.6genesis.com