Overview of 6G activities

SaT5G demo event Feb 6, 2020
Zodiac Aerospace, Wessling, Germany
Adj. Prof. Dr.Sc., Harri Saarnisaari, University of Oulu
What (the hell) is 6G?
6G “dreams” are discussed now worldwide. Possibility to participate.

“Technology used in 2030s”

“It should not be just a higher data rate”
Where 6G vision is created?

- **Annual 6G Summit**
  - 1\textsuperscript{st} edition: March 2019
  - Great worldwide success: > 200 participants from industry, academia
  - 2\textsuperscript{nd} edition: March 2020

- **6G white papers as outcome**
  - 2019: 1\textsuperscript{st} one, a brief overview
  - 2020: 12 separate papers, more deep views
  - Great interest, some groups have >35 members

- **IEEE Future Network, …**

- **White paper working groups**
  - Still possible to register

- **White paper workshop during the summit**
  - 19\textsuperscript{th} March

- **Drafts out end of April**

- **Officials out end of June**

- **See 6gsummit.com for further details and contacts**
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.
#1 Verticals Driving Development

#2 Network Architectures Change

#3 New Value Chains Appear

#4 Connecting the Last Billions

#5 Autonomous Wireless Systems

#6 Major Technology Leap Required
Many think that it should be improved 5G and solving issues that 5G did not (1000x better)

- Even higher data throughput and related (new) technology
- E.g. holographic communication requiring Tbits/s

A lot of discussions from this perspective
Some 6G Key Performance Indicators (KPIs)

Generic 6G targets presented by academia and industry in different fora.

- 100 Gbps - 1 Tbps: Peak Data Rates
- 0.1 ms: Radio Latency
- ±10 ns: Jitter
- 20 Years: Battery Life Time
- Max. 1 Out of Million Outage: Extreme Ultra Reliability
- 10,000x: Traffic Increase
- 100 Devices per m²: Density
- 10 cm (indoor), 1 m (outdoor): Positioning
- 10x: More Energy Efficient
- +40 dB: Link Budget
We should not forget connecting the last billions, environment, other societal challenges.

There is room for both views.
Some more 6G “KPIs”

- Remote areas
- Low revenue areas
- Areas with minimal/no exist infrastructure
- Affordable and sufficient (QoS) connectivity
- Low power consumption
- Easiness to use
- Local requirements
- Green materials, manufacturing and products
- Affordable and sufficient (QoS) connectivity
6G research drivers

Putting these views together
6G goals have different directions and requirements. Seems that there is need for several new “6G signals”, technology and other innovative solutions.
**6G PESTLE Analysis**

We are moving towards a data sharing / data market economy where issues with data ownership and contractual policies require special attention.

PESTLE - political, economic, social, technological, legal and environmental analysis.

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<th>PESTLE - Inclusion, Sustainability &amp; Transparency</th>
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As-is

To-be 6G
White paper topics

• 6G Drivers and United Nations’s sustainable development goals
• Validation and Trials for Verticals
• Machine Learning in Wireless Communications
• Networking
• Broadband Connectivity for 6G
• RF & Spectrum

• Connectivity for Remote Areas
• Business of 6G
• Edge Intelligence
• Security and Privacy
• Critical and Massive MTC towards 6G
• Localization and Sensing
Some lifts
Transition to higher frequencies and increasing role of indoor networks will boost network sharing in cities and indoor spaces, and drive the “local operator” paradigm.

Also running of “village networks” e.g., in Africa and Asia may benefit from it.
Stakeholder roles in 6G will change compared to the current mobile business ecosystem and new roles will emerge.
Many of the KPIs used for 5G are valid also for 6G. However, the KPIs must be critically reviewed and new KPIs must be seriously considered.
Extended spectrum towards THz enables merging communications and new applications, such as 3D imaging and sensing.

New opportunities for semiconductors, optics and new materials in THz applications.

New paradigms for transceiver architecture and computing will be needed to achieve 1 Tbps.
Artificial intelligence will play a major role both in link and system level solutions of 6G wireless networks.

New grant-free access methods are critical for truly massive machine-type communication.

Signal shaping is a way to achieve record-high spectral efficiency.

Analog modulation schemes in 6G?

The strongest security protection may be achieved at the physical layer.
6G Networking

6G needs a network with embedded trust

6G adopts the idea of ID/locator split and mainly relies on private addresses for devices

6G will create data markets – privacy protection will be a key enabler

6G needs an upgraded networking paradigm – from best effort to dependability

Artificial intelligence and block chain may play a major role in 6G networks
6G is not only about moving bits: it will become a framework of services, including communication service.

In 6G, all user specific computation and intelligence may move to edge cloud.

Integration of sensing, imaging and highly accurate positioning capabilities with mobility opens a myriad of new applications in 6G.

Trust and privacy are key prerequisites for successful 6G service platform.
Recapping some interesting technology areas

- Extreme URLLC
- RAN agnostic/automatically orchestrated transceivers
- Remote Telepresence and Holographic projection
- 4D-Imaging and image projection and XR
- Non-device centric Communications (HBI)
- Tactile Haptic Internet
- Below cm positioning
- Cyber-physical Security
- Consent and Privacy
- Preserving Data Sharing
- Terahertz technologies
- Net neutrality – exploring new billing models
- Support for Ambient/Novel sensing
- Full spectrum photonic signal processing
- Small data AI (distributed learning)
- AI inspired Air Interfaces
- Distributed Trust Zero-energy communications
- Proactive decision making/informations offering
- Pervasive user identification and authentication
6G Flagship World’s First 6G Research Program

6G Enabled Wireless Smart Society & Ecosystem

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

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

Devices & Circuits
THz communications materials & circuits
Enabling Unlimited Connectivity

Distributed Computing
Mobile edge intelligence
Enabling Time Critical & Trusted Apps

Services & Applications
Multidisciplinary research across verticals
Enabling Disruptive Value Networks

6G Flagship was elected as Finland’s high-tech Flagship, by Finnish Government through Academy of Finland
6G Flagship Goals

• To support companies in finalisation of the 5G standard by carrying out technology and system pilots.

• To develop/co-create the fundamental technology components to enable 6G systems.

• To speed up dependable, robust and secure digitalisation of society via 5G and 6G.
6G WIRELESS SUMMIT
17-20 MARCH 2020
LEVI, FINLAND
www.6Gsummit.com