

6G

FLAGSHIP
UNIVERSITY
OF OULU

6G Future: A Research Challenge

2nd Visions for Future Communications Summit

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ACADEMY OF FINLAND



FLAGSHIP PROGRAMME



6G

FLAGSHIP

UNIVERSITY
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WORLD'S FIRST 6G WHITE PAPER

The 6G research vision is based on three cornerstones:

1

6G technologies will bring to life the data-driven and hyper-connected future society.

2

Major drivers for 6G include sustainability goals and societal challenges on top of productivity targets and technology enablers.

3

Numerous business and societal players together create the new 6G infrastructure, products and services.

<http://urn.fi/urn:isbn:9789526223544>



6G Flagship aims to integrate intelligence with mobile communication technologies.



Drivers for 6G Research

SUSTAINABILITY GOALS

Quality Education • Clean Water and Sanitation
Gender Equality • No Poverty • Good Health and
Well-being • Climate Action • Sustainable Cities and
Communities • Peace, Justice, and Strong Institutions
Zero Hunger • Industry,
Innovation and Infrastructure • Reduced Inequalities
Responsible Consumption and Production • Decent
Work and Economic Growth

PRODUCTIVITY IN VERTICAL INDUSTRIES

Health • Manufacturing • Finance Technologies
Society 5.0 • Transport • Global Affordable
Coverage • Education • Agriculture • Energy
FinTech

SOCIETAL CHALLENGES

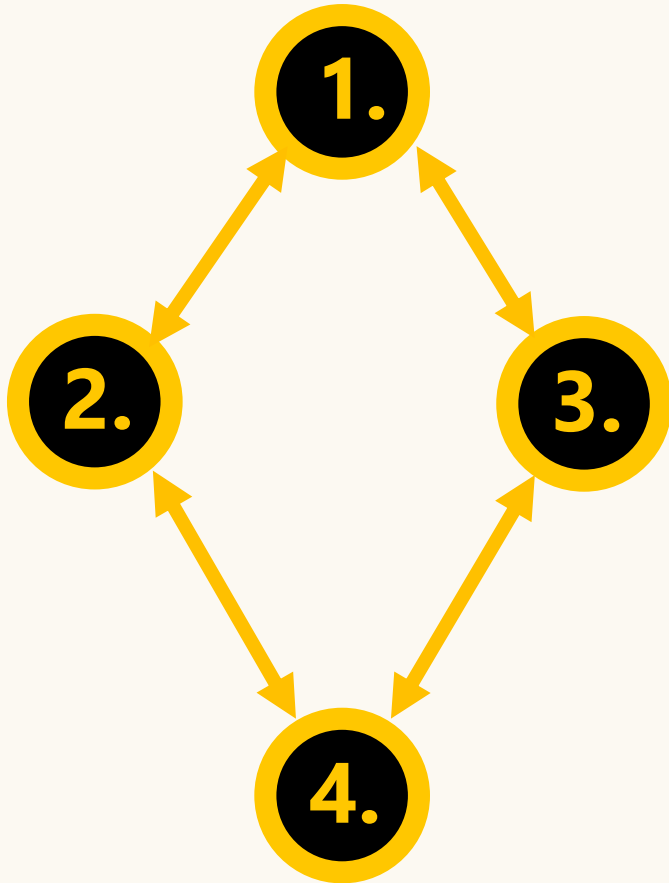
Education Innovations • Societal Services
Health and Wellbeing Services • Urbanisation vs.
Remote • Infrastructure • Work Life Change
Data Security and Privacy • Automation
Personalisation

TECHNOLOGY ENABLERS

Non-device Centric Communications
Accurate Positioning • Data Sharing
Novel Sensing • Small Data AI • Distributed Trust
Cyber-physical Security • Terahertz Technologies
4D-Imaging • Haptic Remote Telepresence
Photonic Signal Processing • Proactive Decision
Making • Pervasive User Identification
Zero-energy Communications • AI Inspired Air
Interfaces



6G Research Program



1.



Wireless Connectivity

Ultra-reliable low-latency communications vs. 1 Tbps

Enabling **Unmanned Processes**

2.



Devices & Circuits

THz communications materials & circuits

Enabling **Unlimited Connectivity**

3.



Distributed Computing

Mobile edge intelligence

Enabling **Time Critical & Trusted Apps**

4.



Services & Applications

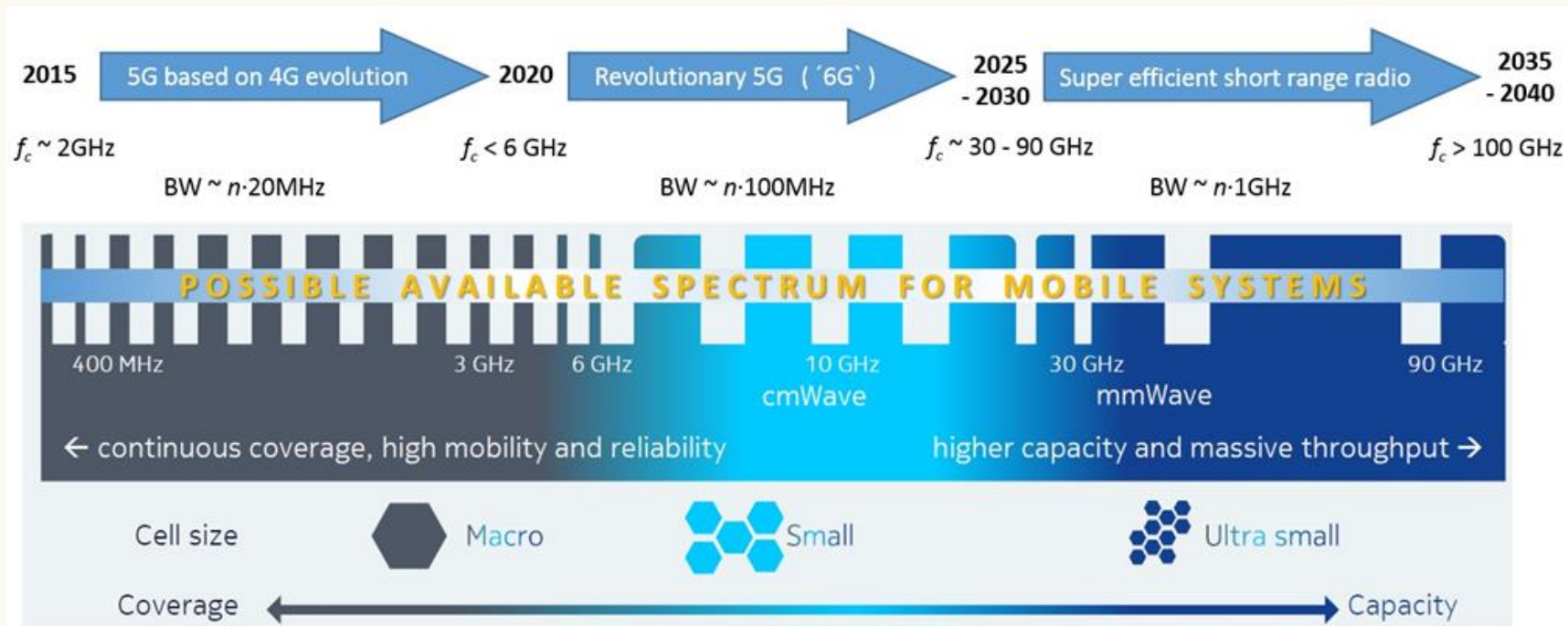
Multidisciplinary research accross verticals

Enabling **Disruptive Value Networks**



Short range connectivity starts to dominate

- 1) Higher frequencies needed => the physics of radio signals propagation mean shorter link ranges
=> More basestations needed => **the role of short range connectivity** is drastically increasing.
- 2) Higher frequencies do not propagate through walls => **base stations must be installed indoors**
=> who does that and pays the bill?? => new value chains / business models needed.
- 3) Spectrum regulation has to enable **local frequency licencing** for the benefit of different verticals
=> Radio Spectrum Policy Group (RSPG) in European Commission is pushing this.

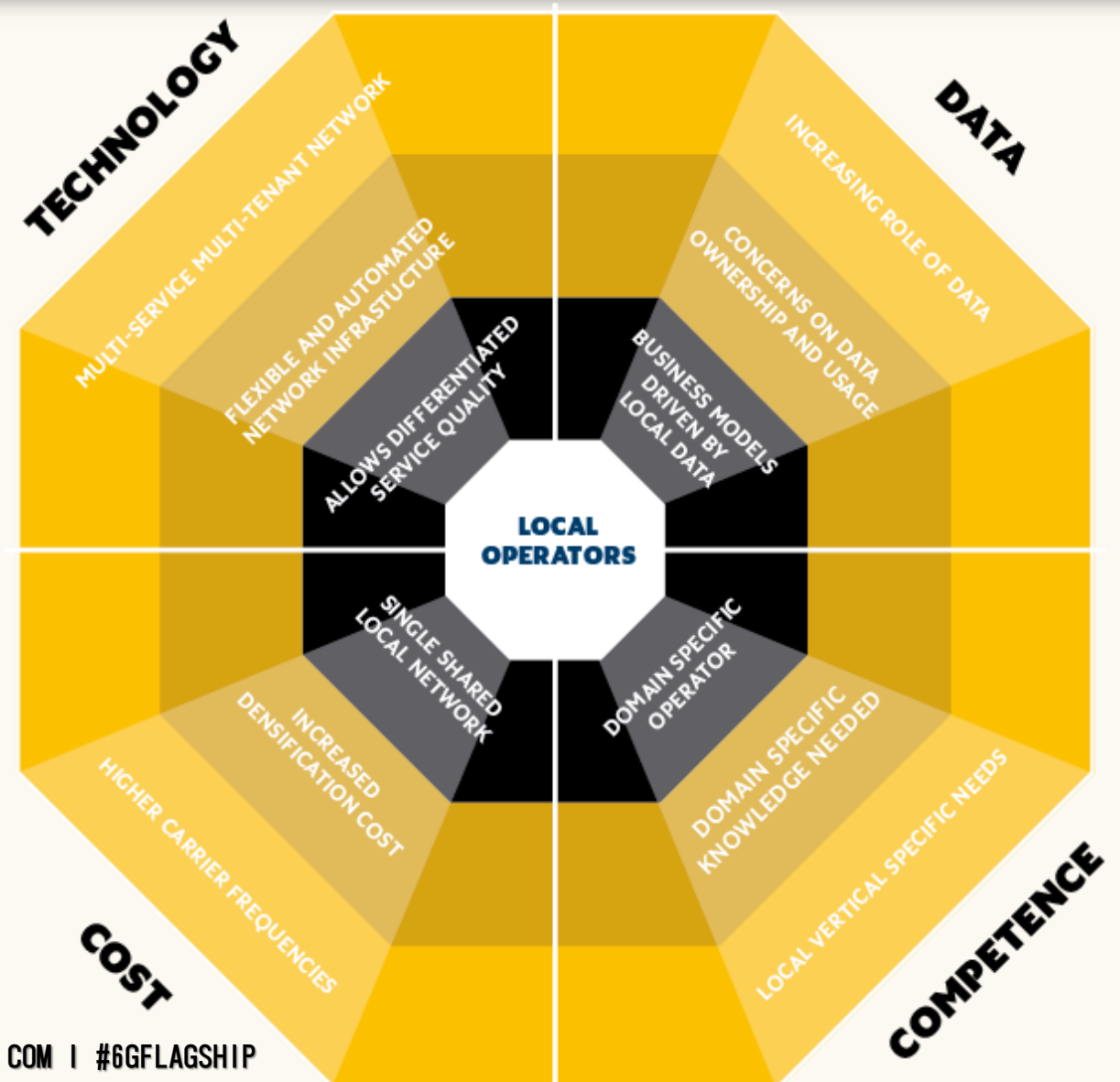




Towards Local Operator Paradigm

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.

Stakeholder roles in 6G will change compared to the current mobile business ecosystem and new roles will emerge.



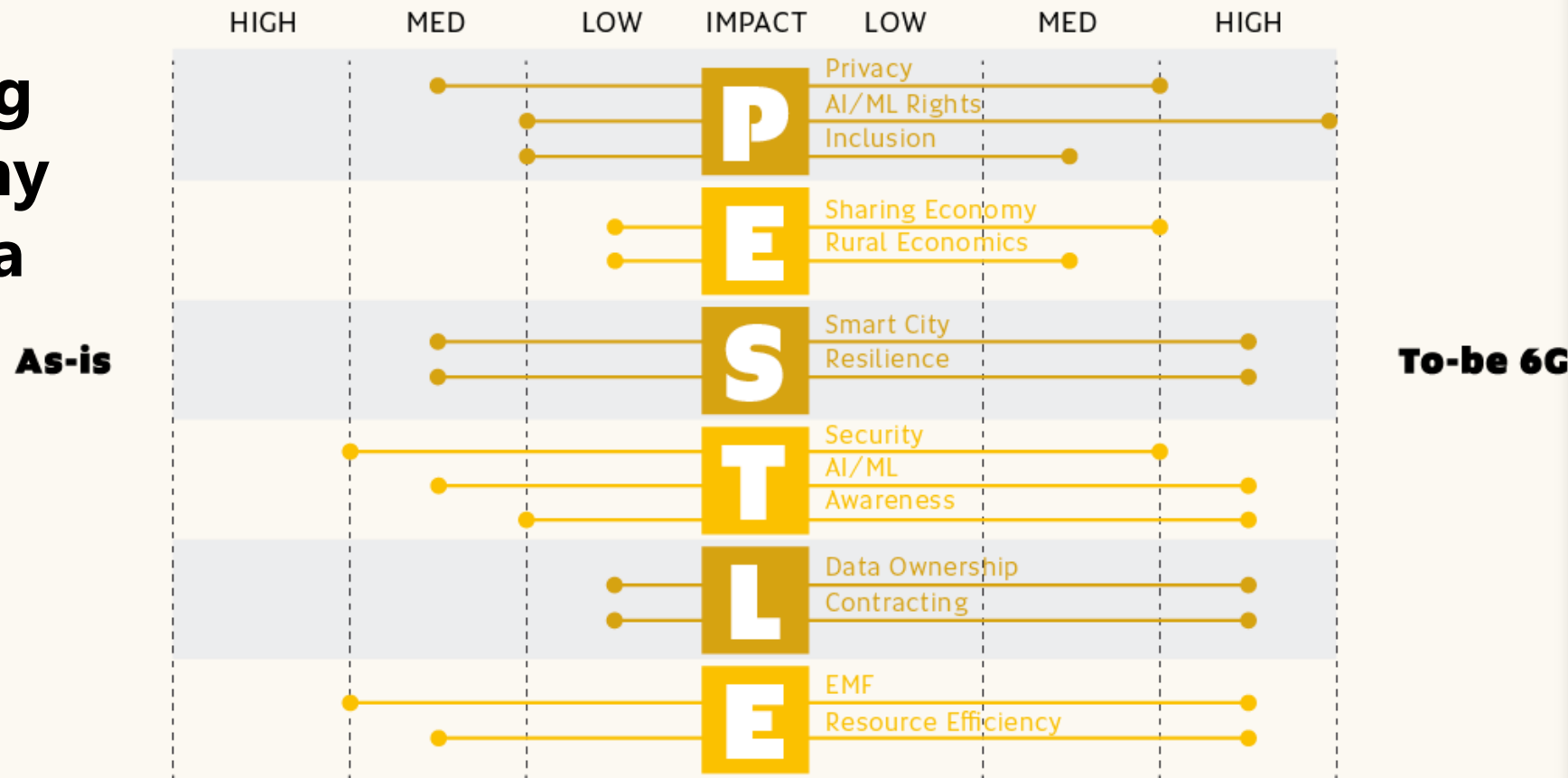


6G PESTLE Analysis

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

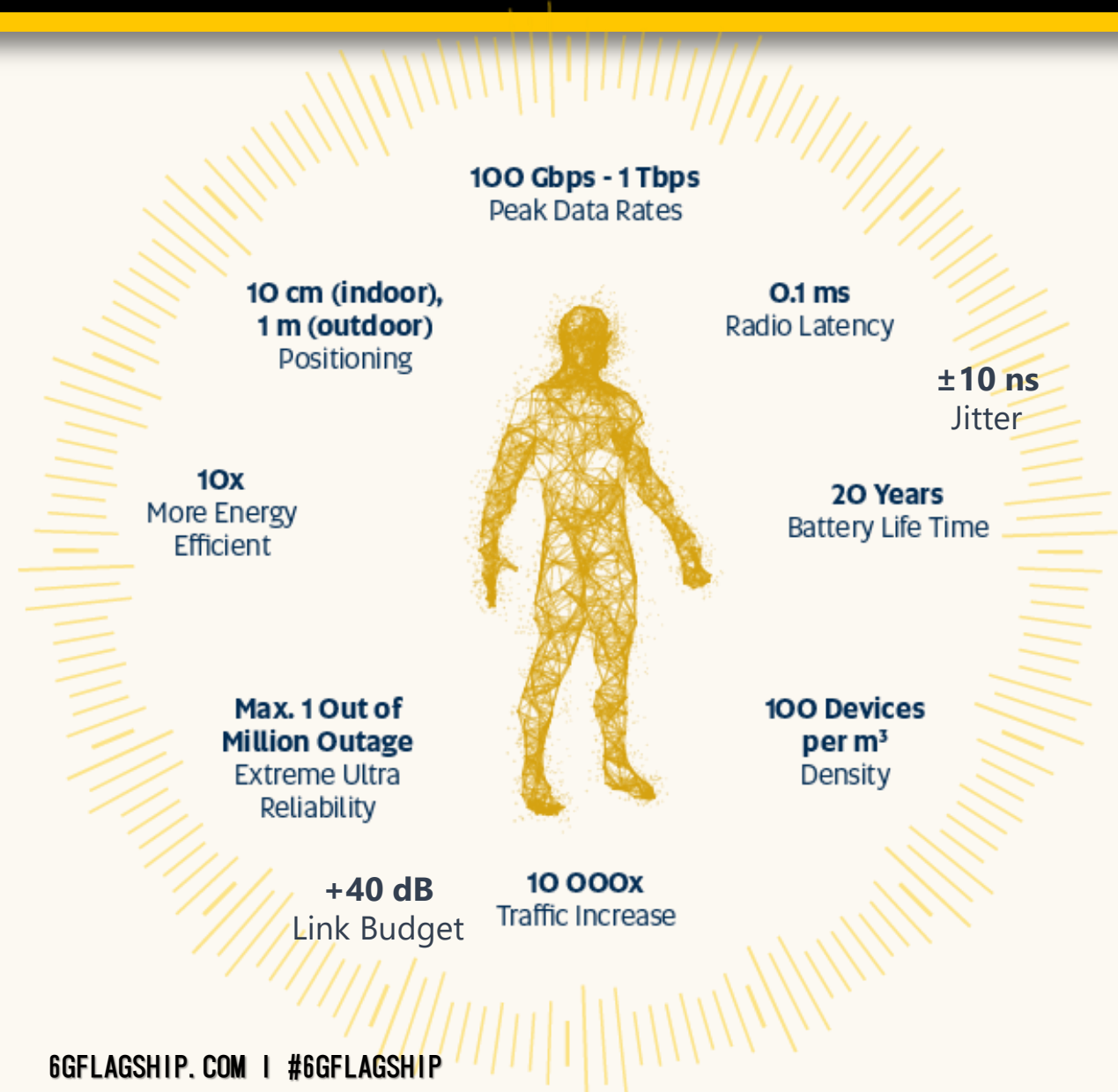
PESTLE – Inclusion, Sustainability & Transparency





Initial 6G Key Performance Indicators (KPIs)

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

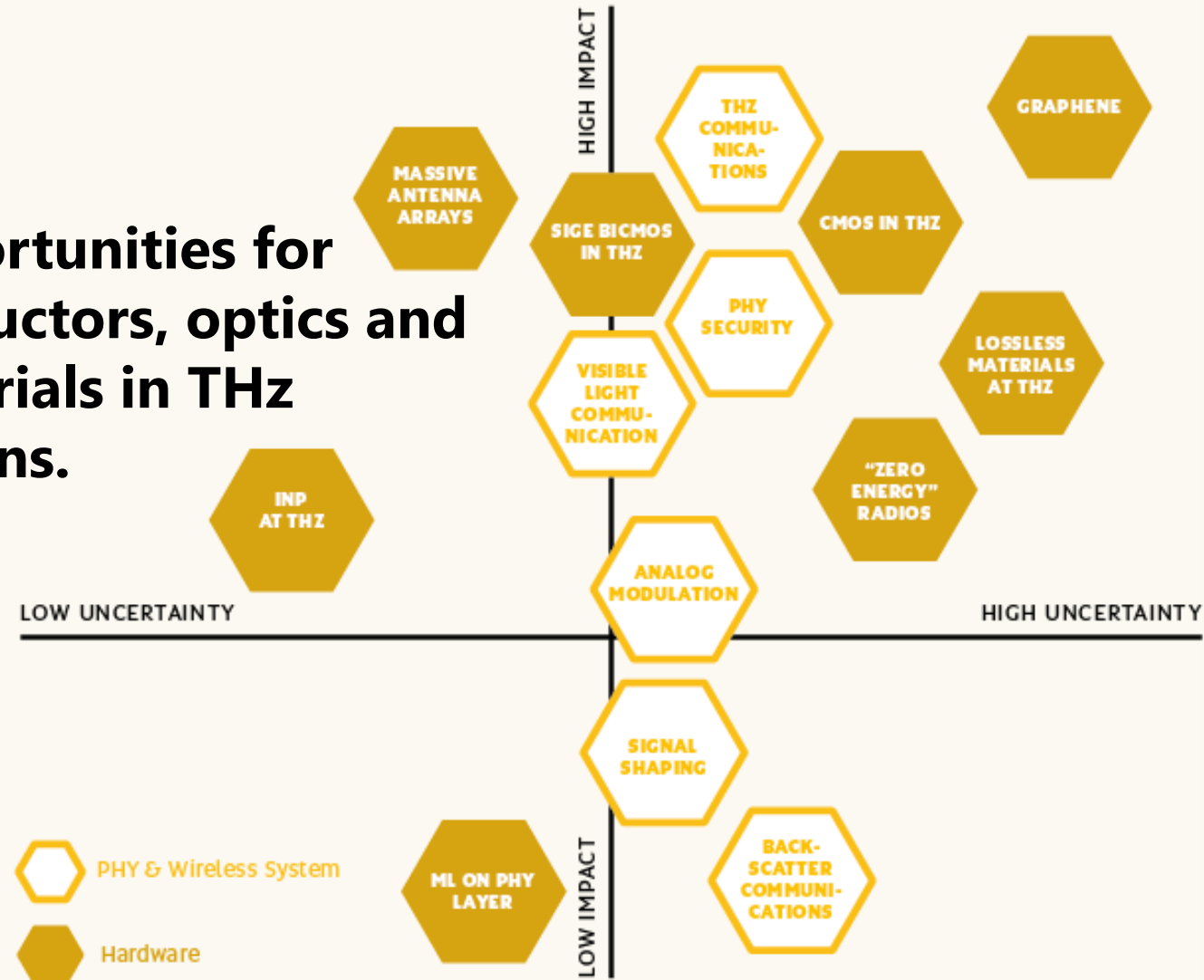


Radio HW Progress and Challenges

Extended spectrum towards THz enables merging communications and new applications, such as 3D imaging and sensing.

New paradigms for transceiver architecture and computing will be needed to achieve 1 Tbps.

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

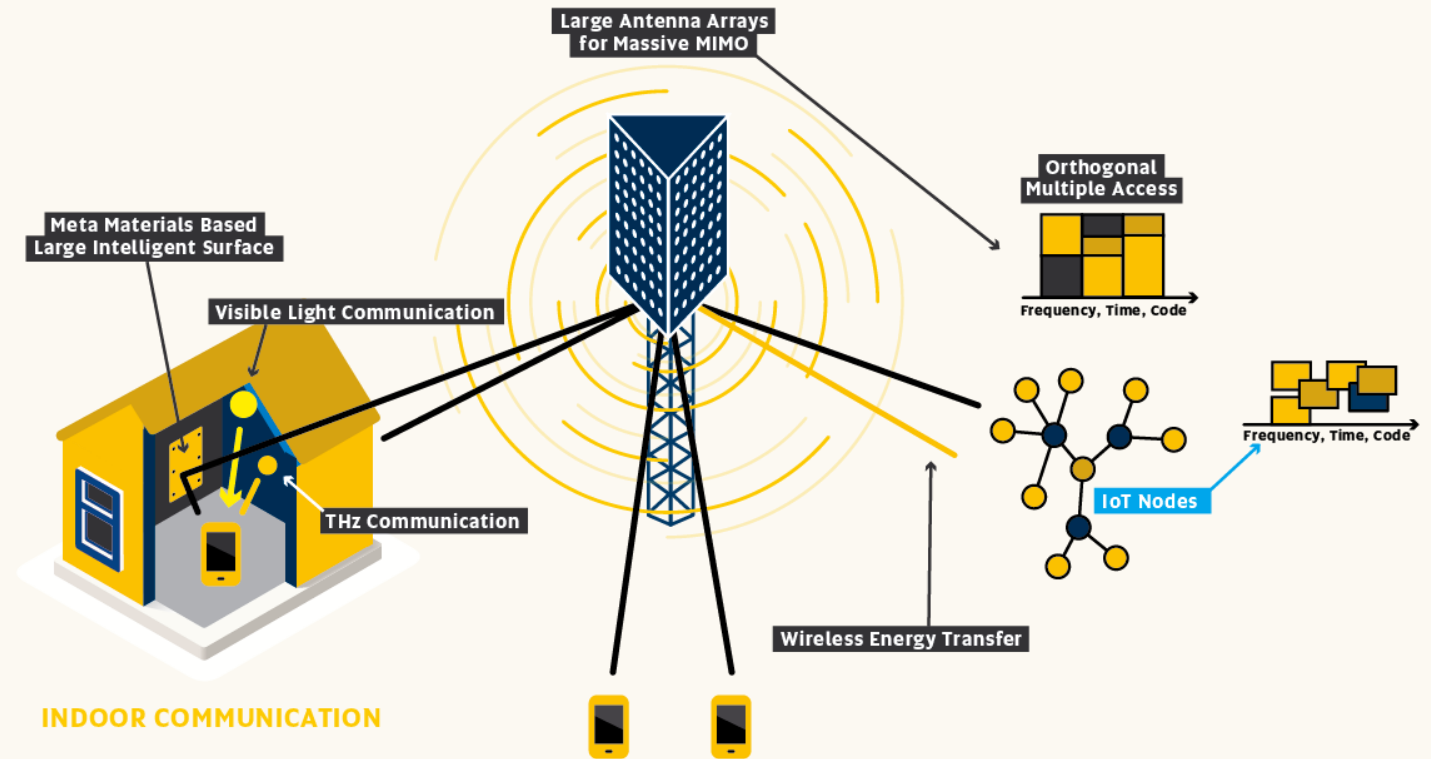


Physical Layer and Wireless System

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

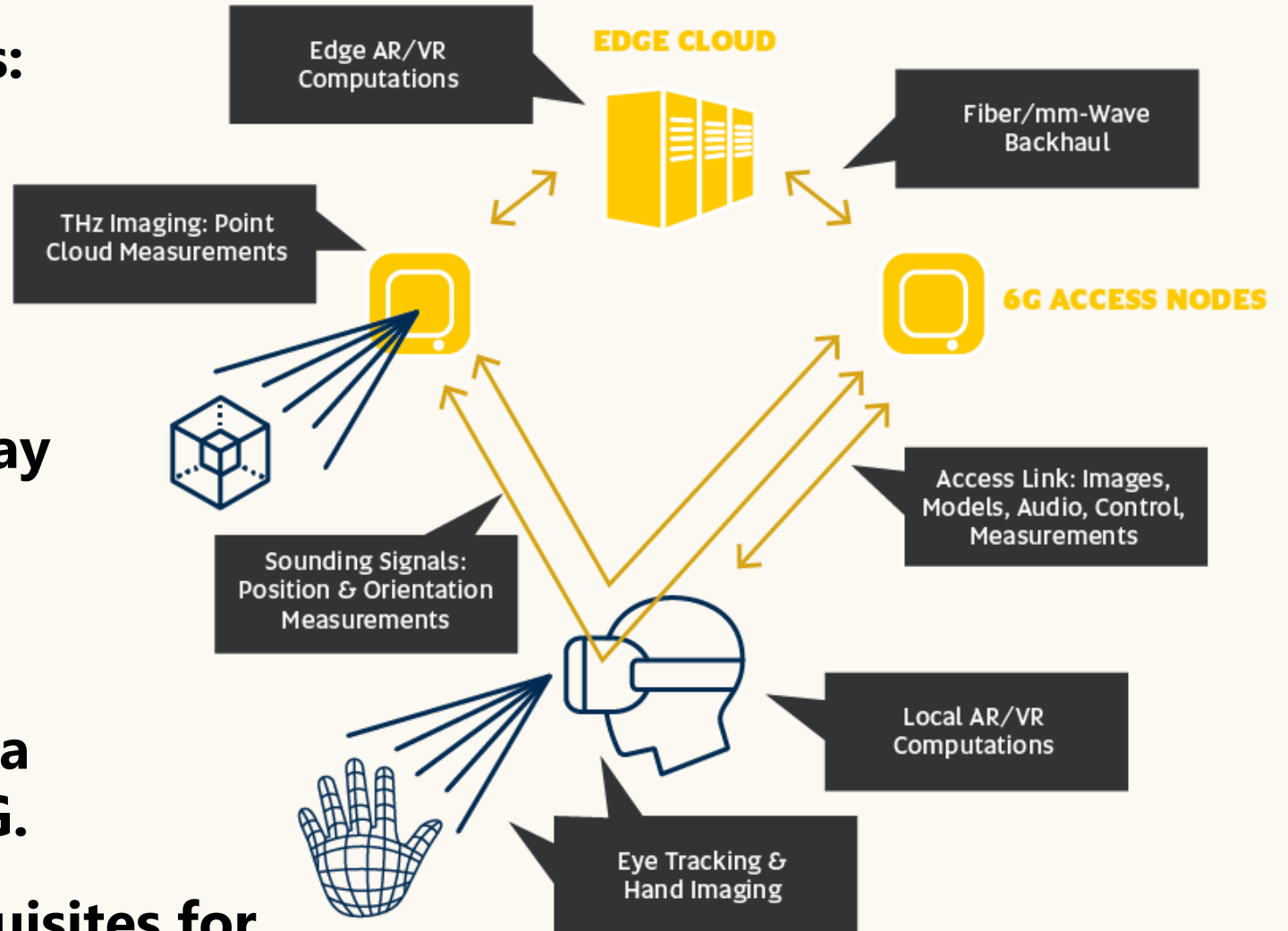
6G Merges Communications with New Applications

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





6G WIRELESS SUMMIT
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LEVI, FINLAND

www.6Gsummit.com



THANK YOU!
QUESTIONS?

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