Multi-stakeholder Dialogue on 6G: Security and Governance Implications

UNIDIR, Geneva, 11.12.2024

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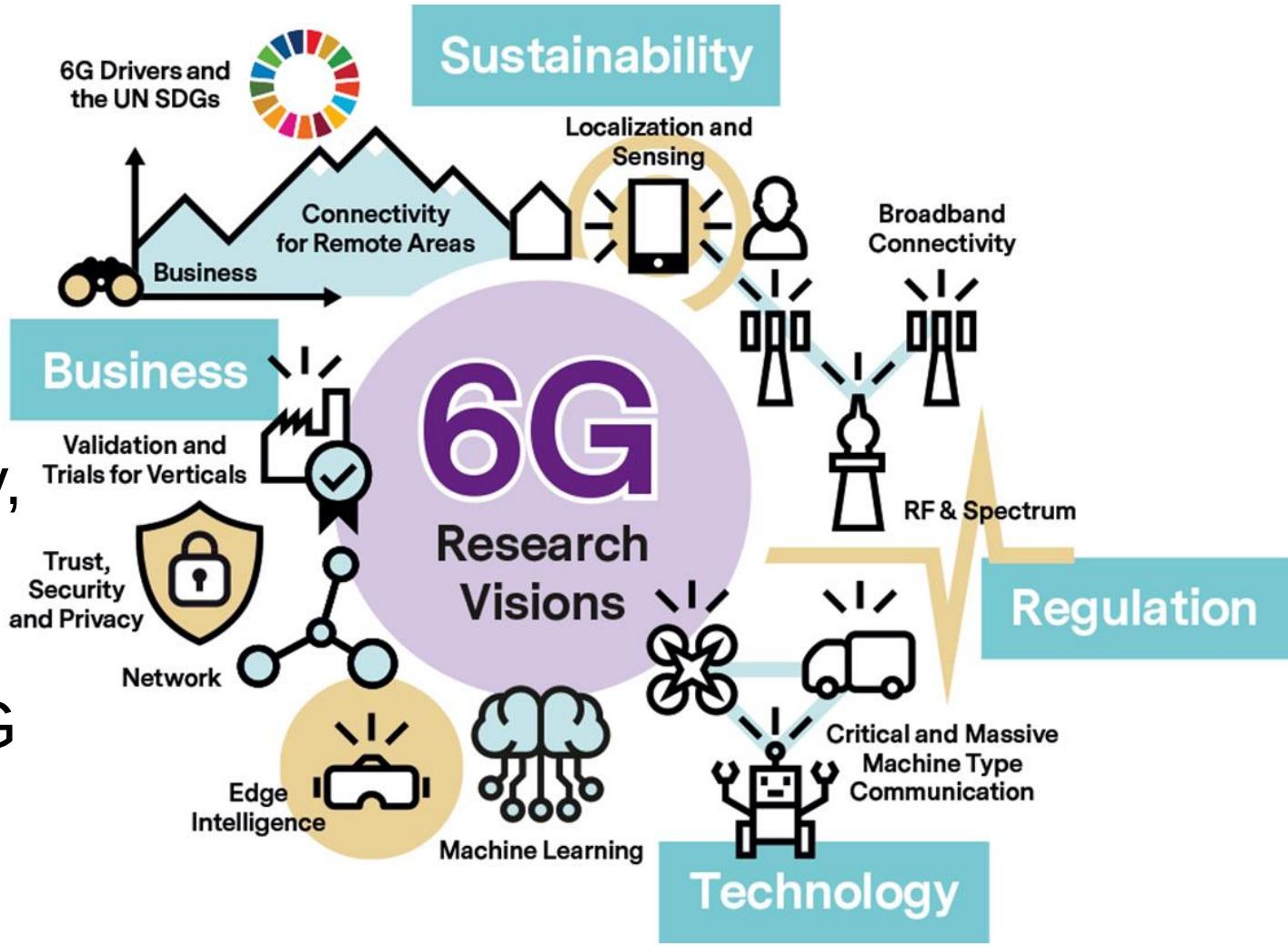
Finnish 6G Flagship's multi-disciplinary agenda (2018-2026)

- Finnish 6G Flagship's multi-disciplinary research roadmap includes technology, business, regulation and sustainability perspectives.
- Multi-stakeholder collaboration emphasises academia, industry, and public sector interplay.
- Sustainability has been identified as global driver for 6G R&D.



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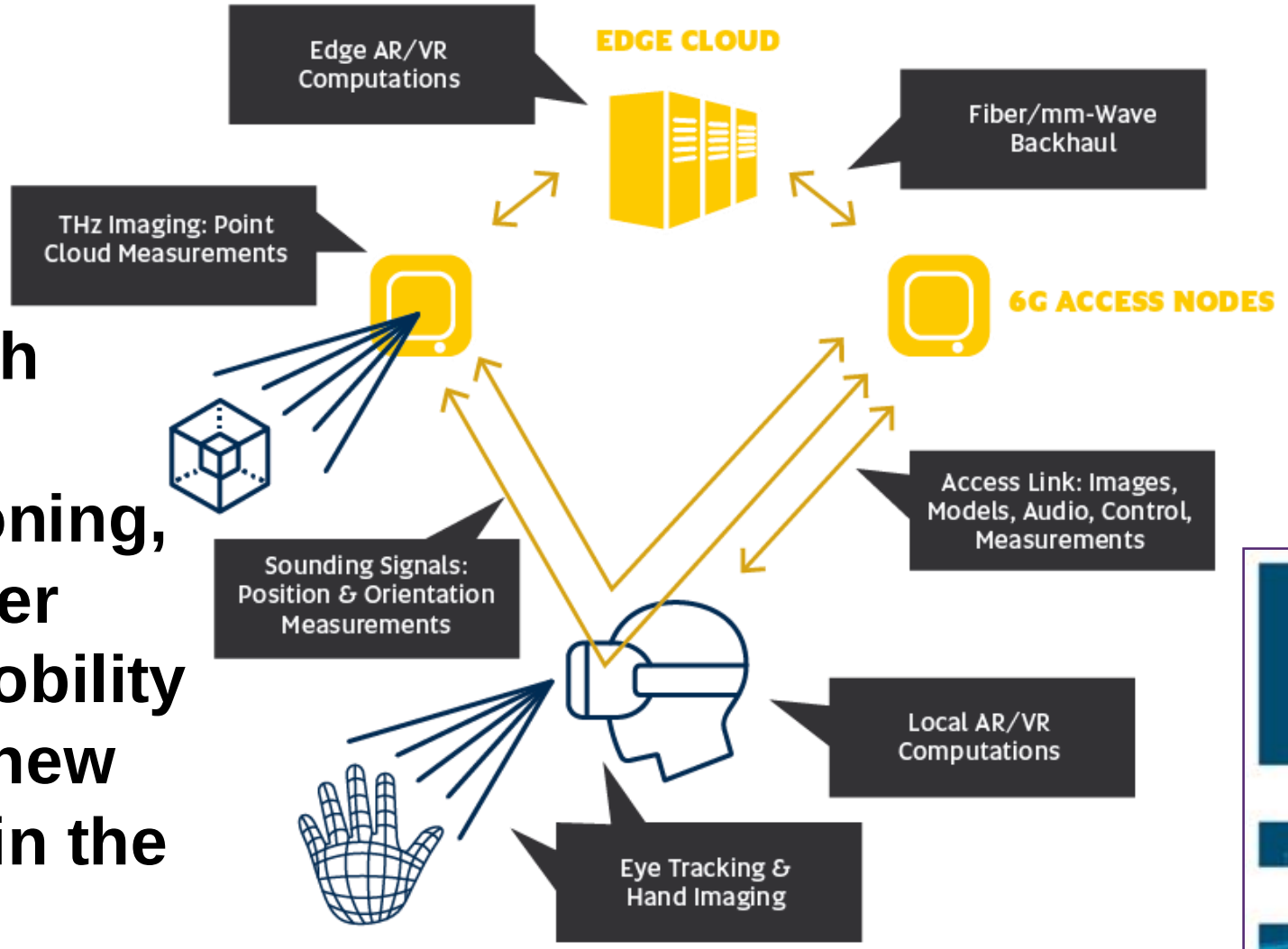
OVERVIEW OF 6G

World's first 6G White Paper by Finnish 6G Flagship in 2019

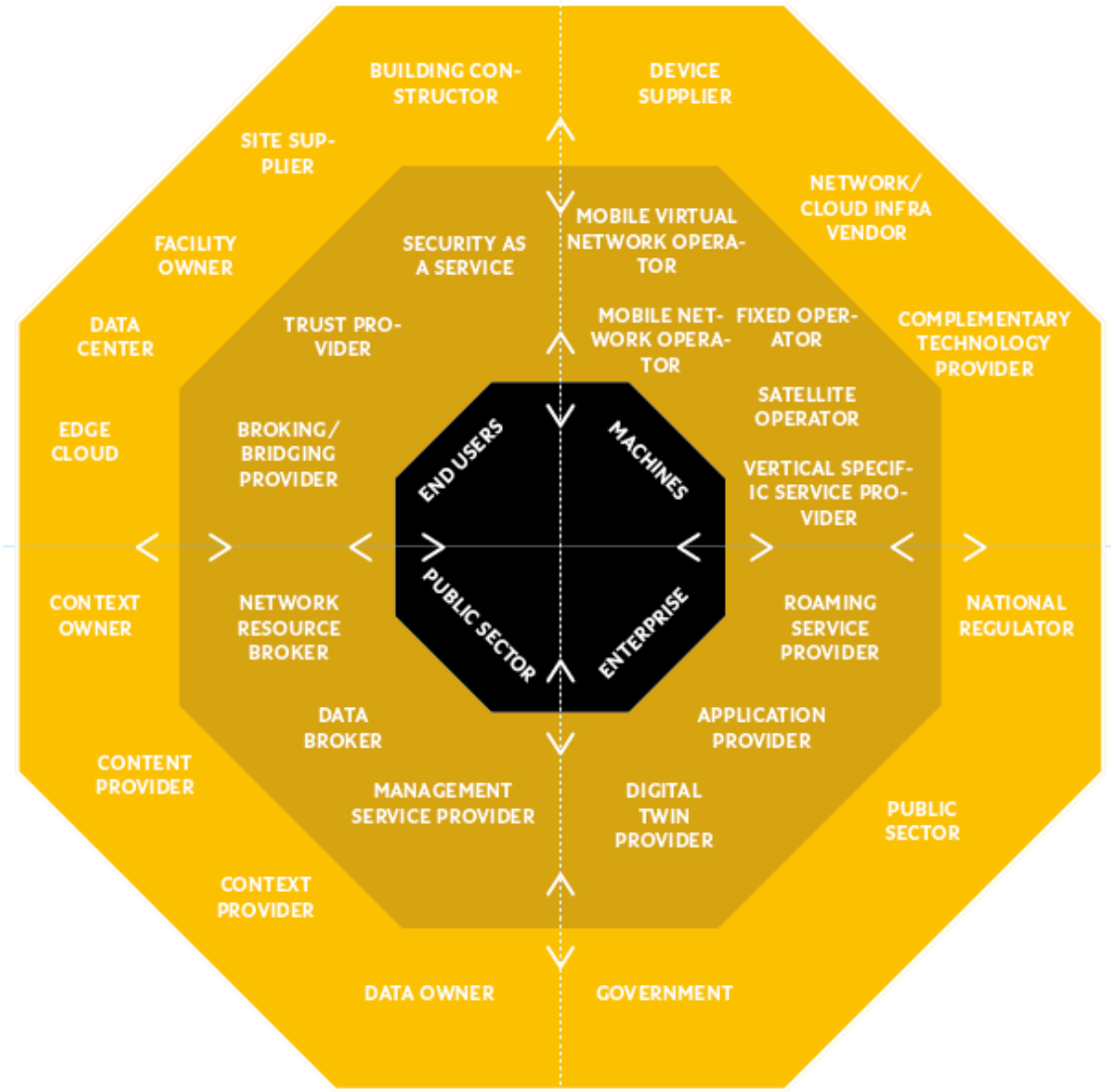
Integration of communication with sensing, imaging, positioning, locationing, computing and other capabilities with mobility opens a myriad of new applications in 6G in the 2030s.



[Key Drivers and Research Challenges for 6G Ubiquitous Wireless Intelligence - 6G Flagship]

World's first 6G White Paper by Finnish 6G Flagship

- **Different resource combinations provided by different stakeholder combinations will serve location specific needs of various end user groups with varying requirements.**
- **Stakeholder roles are evolving already in 5G and will further change in 6G, including local 5G/6G networks.**



RESOURCES/ASSETS

MATCHING/SHARING

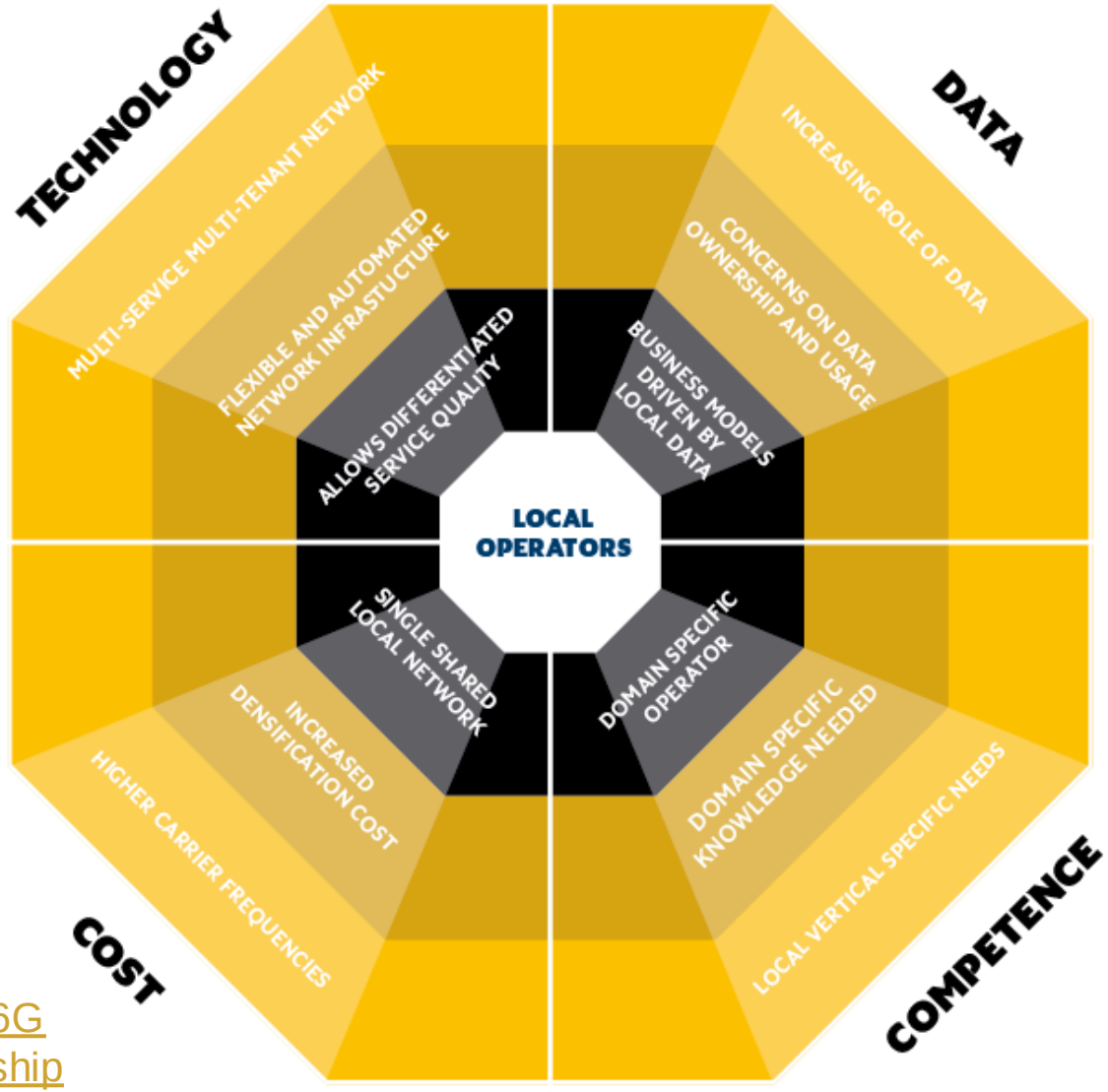
DEMANDS/NEEDS

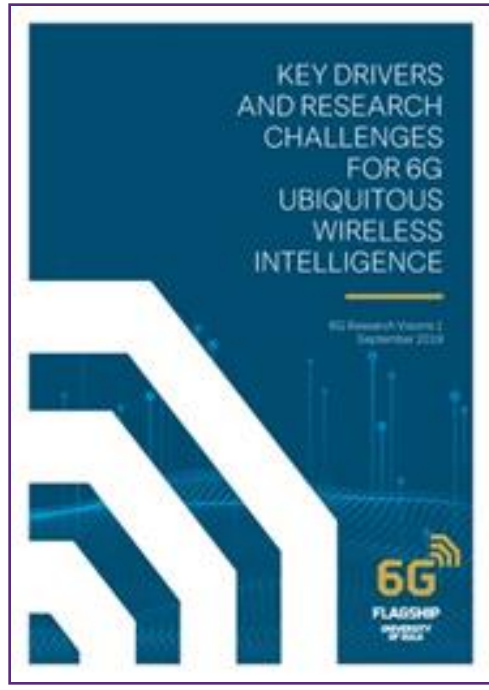
Key Drivers and Research Challenges for 6G Ubiquitous Wireless Intelligence - 6G Flagship

World’s first 6G White Paper by Finnish 6G Flagship

Location and context specific needs and increasing role of indoor networks will drive the “local operator” paradigm.

Local networks became a reality in 5G era through local spectrum licensing. The same is expected to continue in 6G.

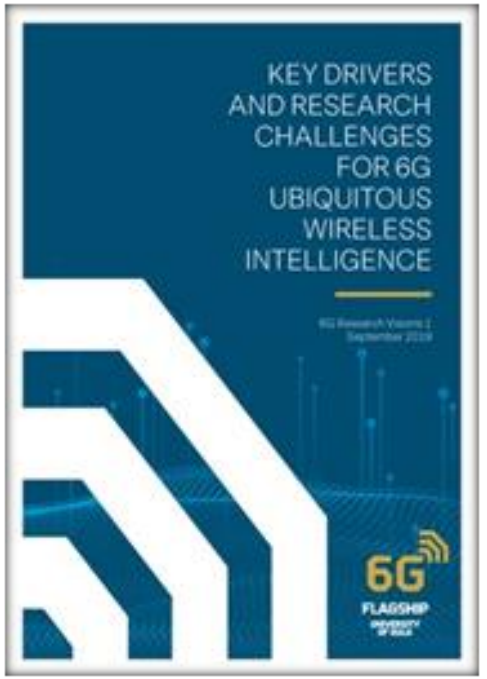


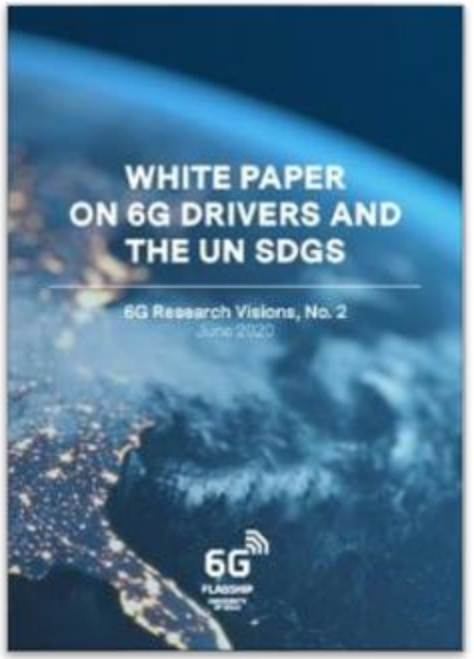


[Key Drivers and Research Challenges for 6G Ubiquitous Wireless Intelligence - 6G Flagship]

Sustainability is a globally agreed key driver for 6G R&D

- World's first 6G Summit organized by Finnish 6G Flagship gathered major telecom players for joint 6G vision building in 2019, leading to the world's first 6G White Paper[1].
- Consensus that 6G R&D is driven by sustainability and United Nations' Sustainable Development Goals (UN SDGs).
- Our follow-up work[2] connected 6G with the UN SDGs.

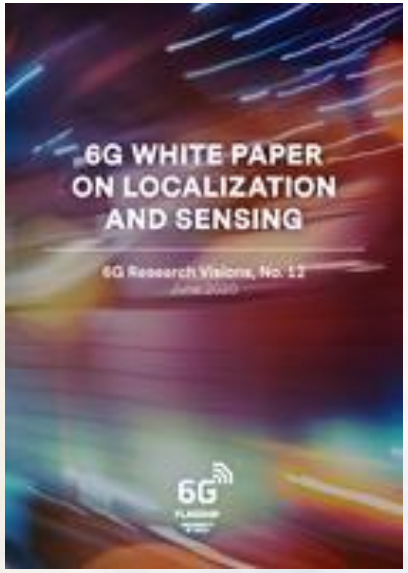




[1] **M. Latva-aho & K. Leppänen (eds.) (2019). Key drivers and research challenges for 6G ubiquitous wireless intelligence. (6G Research Visions, No. 1). University of Oulu, Finland. http://urn.fi/urn:isbn:9789526223544**

[2] **M. Matinmikko-Blue, et al. (eds.). (2020). White Paper on 6G Drivers and the UN SDGs. (6G Research Visions, No. 2). University of Oulu. http://urn.fi/urn:isbn:9789526226699**

https://www.6gflagship.com/white-papers/

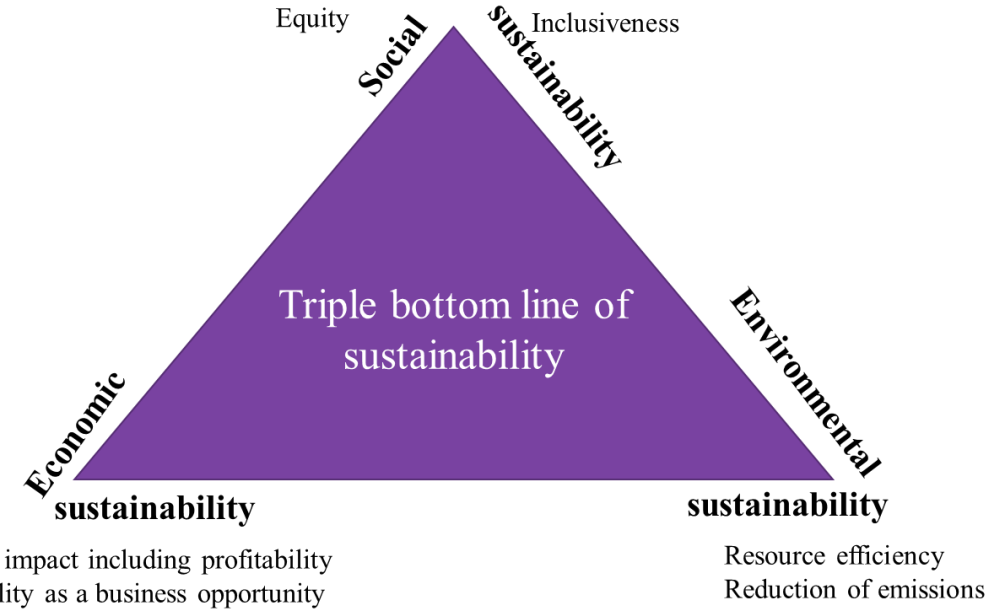


ROLE OF SUSTAINABILITY IN 6G

Connection between 6G to UN SDGs

Sustainable development[1] is the "**development that meets the needs of the present without compromising the ability of future generations to meet their own needs**".

Sustainability[2] is the "**principle of ensuring that our actions today do not limit the range of <u>economic, social, and environmental</u> options open to future generations**".



SUSTAINABILITY WILL CHANGE THE GAME IN MOBILE COMMUNICATIONS. Total consumed mobile data will no longer determine, which countries are the leaders.

[1]World Commission on Environment and Development's Brundtland report ´Our Common Future`. 1987.
[2]J. Elkington. Cannibals with forks: The triple bottom line of 21st-century business. Capstone Publishing Ltd. 1997.

Connecting UN SDGs to ICTs

SDG:	Target:	Indicator:
4 QUALITY EDUCATION	**4.4** By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship	**4.4: Proportion of youth/adults with ICT skills, by type of skills**
5 GENDER EQUALITY	**5.b** Enhance the use of enabling technology, in particular information and communications technology, to promote the empowerment of women	**5b: Proportion of individuals who own a mobile telephone, by sex**
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	**9.c** Significantly increase access to information and communications technology and strive to provide universal and affordable access to the Internet in least developed countries by 2020	**9.c: Percentage of the population covered by a mobile network, broken down by technology**
17 PARTNERSHIPS FOR THE GOALS	**17.6** Enhance North South, South South and triangular regional and international cooperation on and access to science, technology and innovation and enhance knowledge sharing on mutually agreed terms, including through improved coordination among existing mechanisms, in particular at the United Nations level, and through a global technology facilitation mechanism	**17.6: Fixed Internet broadband subscriptions, broken down by speed**
17 PARTNERSHIPS FOR THE GOALS	**17.8** Fully operationalize the technology bank and science, technology and innovation capacity building mechanism for least developed countries by 2017 and enhance the use of enabling technology, in particular information and communications technology	**17.8: Proportion of individuals using the Internet**

There are only 5 ICT indicators (previously 7) in the UN SDG framework of 169 targets and 231 indicators. In reality, the linkage to ICT is stronger.

THE 17 GOALS | Sustainable Development (un.org)

ICT sector’s dual role

- ICT solutions and services have **enabling role** to help different sectors of society towards environmentally and socially sustainable operations in an economically feasible manner (so called ”handprint” or second order effects).
- ICT solutions and services’ **own environmental and social sustainability burden** is significant and must be addressed (so called footprint or first order effects).

- The role of 6G for **emitting and consuming less** is equally important, as is support for **absorbing and enabling more** in other sectors.
- Urgent need for **new indicators, measurement methods, requirements and design principles** for future sustainable 6G solutions and services and their use to solve major sustainability challenges.

Example: Indicators for ICT's environmental sustainability

- Energy related indicators
  - Energy consumption
  - Energy efficiency
  - Use of renewable energy
- Climate related indicators
  - Carbon emissions (direct from energy, GHG scope 1)
  - Carbon emissions (indirect from energy, GHG scope 2)
  - Carbon emissions (other indicrect, GHG scope 3)

- Environment related indicators
  - E-waste production
  - Distribution/utilisation of recycled/refurished/reused products
  - Recycled/refurbished/reused components used in products
  - Recyclability
  - Reparability
  - Expected lifetime
  - Raw materials depletion
  - Water usage consumption
  - Waste heat recovery
  - Land use
  - Eco toxicity
  - Human toxicity
  - Eutrophication

European Commission, Joint Research Centre, Baldini, G., Cerutti, I. and Chountala, C., Identifying common indicators for measuring the environmental footprint of electronic communications networks (ECNs) for the provision of electronic communications services (ECSs), Publications Office of the European Union, Luxembourg, 2024, https://data.europa.eu/doi/10.2760/093662, JRC136475.

Environmental sustainability impact of the use of ICTs

- ICTs have environmental impacts at each stage of their lifecycles (**first order effects**).
- ICTs can enable efficiencies in lifestyle and in all sectors of the economy through the provision of solutions that can improve energy efficiency, inventory management and business efficiency by reducing travel and transportation (**positive second order effects**).
- ICT can be used to maintain or even increase fossil-based economy, resulting in higher GHG emissions. (**negative second order effects**)
- Effects enabled by the use of ICTs can be modified due to rebound, i.e., the tendency that increased efficiency is offset by increases in emissions due to e.g., consumption. (**higher order effects** that can be positive or negative.)
- ICTs have structural effects at the societal level by reshaping how people lead their lives. (**higher order effects** that can be positive or negative.)

Recommendation ITU-T L.1480 (12/2022). Enabling the Net Zero transition: Assessing how the use of information and communication technology solutions impact greenhouse gas emissions of other sectors.

ON REGULATORY FRAMEWORKS

Current regulatory landscape for 6G development

- Global framework for IMT-2030 (6G) was developed at ITU-R. Requirements definition phase is on-going.
- Spectrum discussions are on-going. It is difficult to find new spectrum for 6G systems that is not in use for other radio systems.
- A lot of R&D effort takes place on 6G globally and in Europe, including European Commission funded (Smart Networks and Services Joint Undertaking) and national level funded research and development projects. Research is conducted quite independent of regulations.
- Incorporating environmental, social and economic sustainability principles has started in Europe but is still far away from being a reality.

Deployment of infrastructure and networks: Foundation for digital economy

Access and connectivity: People can use mobile technology

Enabling services and relevant content: Life-enhancing services for people

Extract from future technology trends of IMT-2030

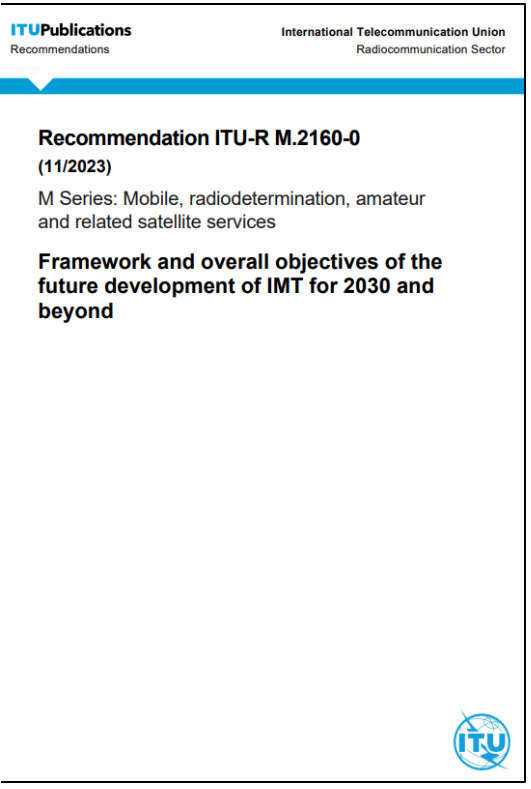
New services and application trends for IMT towards 2030 and beyond can be summarized as follows:

- **Networks will support enabling services** that help to steer communities and countries towards reaching the United Nations' Sustainable Development Goals (UN SDGs)
- **Monitoring and steering of circular economy** will be possible, helping to create a better understanding of sustainable data economy
- **Sharing and circular economy-based co-creation** will enable the promotion of sustainable interaction with existing resources and processes
- Development of products and technologies that **innovate to zero** will be promoted; for example, zero-waste and zero-emission technologies

ITU-R Report M.2516. (11/2022). Future technology trends of terrestrial International Mobile Telecommunications systems towards 2030 and beyond.

Usage scenarios for IMT-2030

- Four overarching design principles
  - **Sustainability**
  - **Security and resilience**
  - **Connecting the unconneted**
  - **Ubiquitous intelligence**
- Six usage scenarios expanding three 5G usage scenarios and three new
  - Immersive communication, massive communication and hyper reliable and low-latency communication
  - Integrated sensing and communication, AI and communication and ubiquitous connectivity

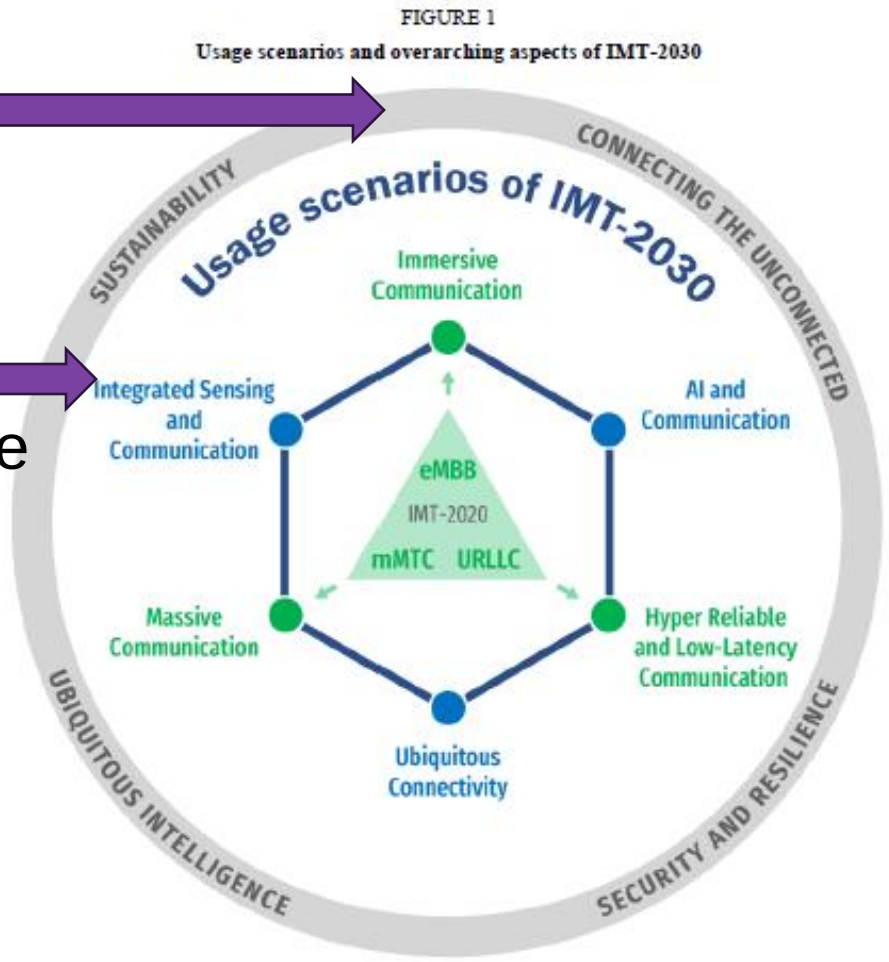

ITUPublications
Recommendations

International Telecommunication Union
Radiocommunication Sector

Recommendation ITU-R M.2160-0
(11/2023)

M Series: Mobile, radiodetermination, amateur and related satellite services

Framework and overall objectives of the future development of IMT for 2030 and beyond



[Recommendation ITU-R M.2160-0 (11/2023) - Framework and overall objectives of the future development of IMT for 2030 and beyond]

Capabilities – performance indicators

ENHANCED:

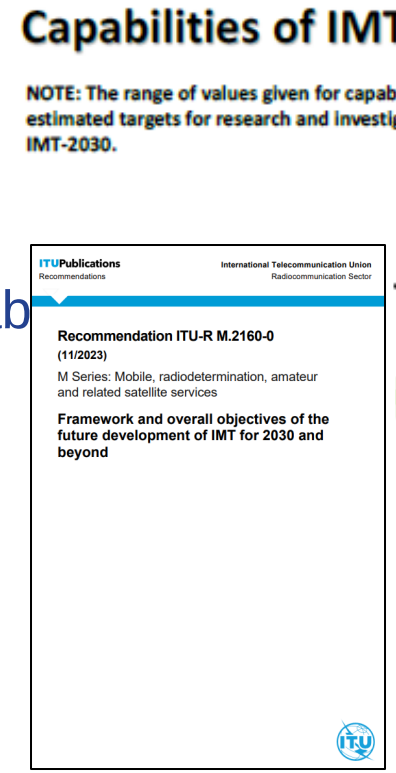
- Peak data rate
- User experienced data rate
- Spectrum efficiency
- Area traffic capacity
- Connection Density
- Mobility
- Latency
- Reliability
- Security and resilience

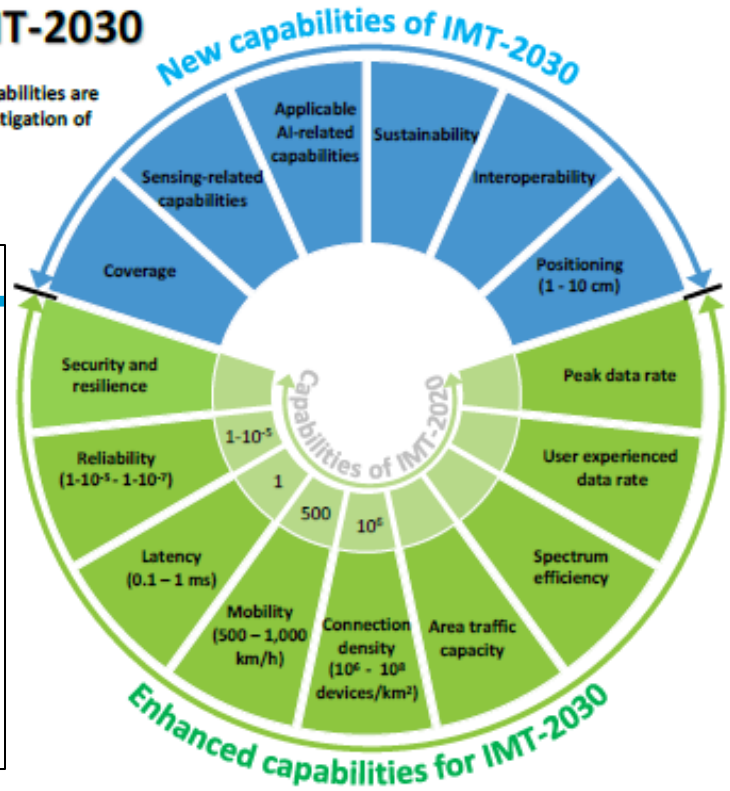
NEW:

- Coverage
- Positioning
- Sensing-related capab
- AI-related capab.
- Sustainability
- Interoperability

FIGURE 2

Capabilities of IMT-2030





➢ **Requirements for IMT-2030 radio interface are being defined in 2024-2025 in ITU-R WP5D. It is difficult to introduce non-technical requirements into the work (e.g. sustainability, security)**

Recommendation ITU-R M.2160-0 (11/2023) - Framework and overall objectives of the future development of IMT for 2030 and beyond

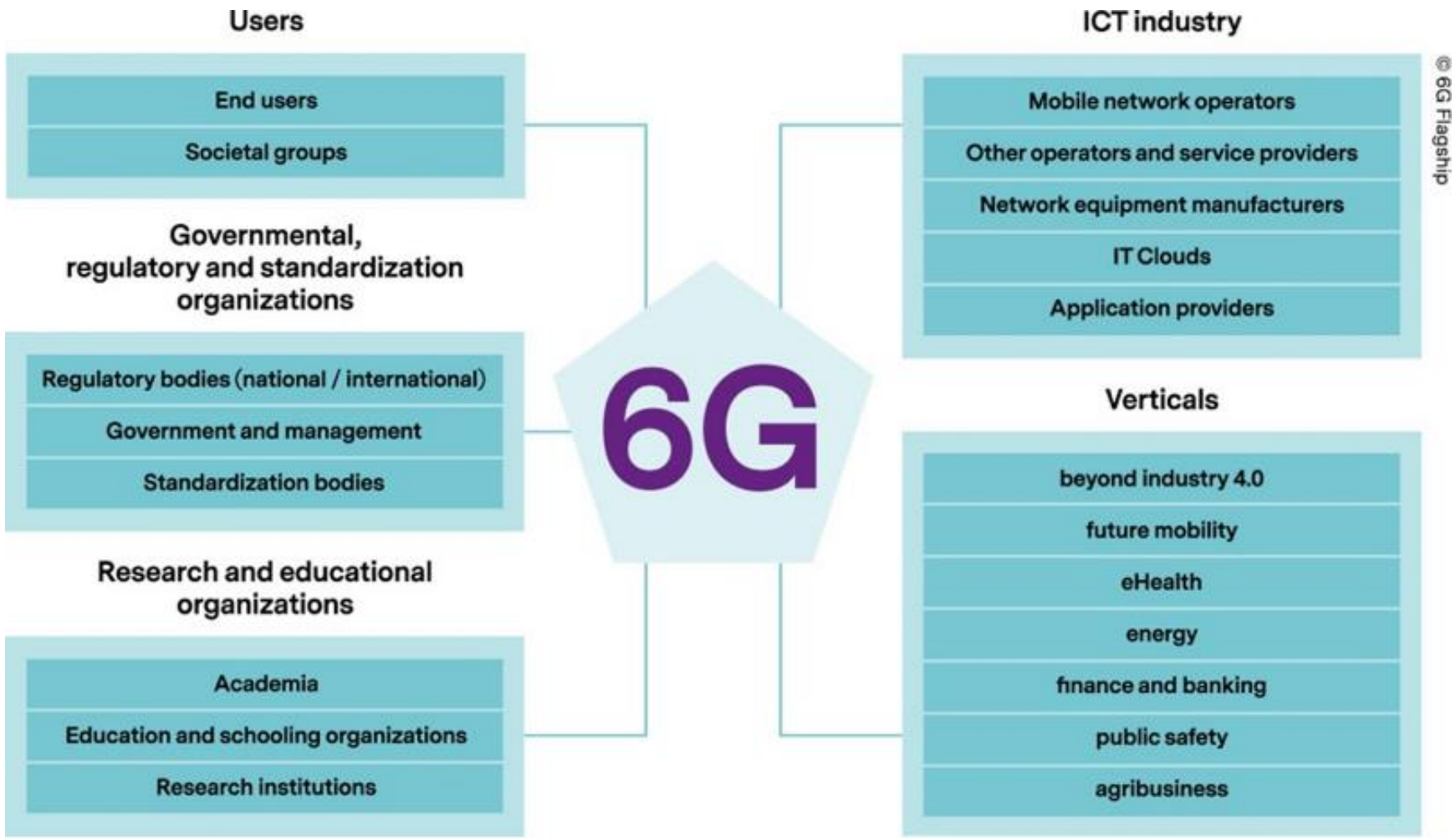
Sustainability in Joint Statement of EU-US TTC in 2023

- EU - US Trade and Technology Council's (TTC) Joint Statement EU-US TTC in Sweden (europa.eu) includes 6G Outlook annex, where sustainability is included as follows:

6G technologies must also be an **enabler for sustainability, considering environmental, social, and economic perspectives**. A **reduced carbon footprint** and **energy efficiency** will be important design goals for 6G networks. More broadly, 6G should allow for **reduced energy consumption across all sectors** of the economy and society. Ideally, 6G technologies will **generate less pollution** and **reduce other environmental** impacts to better contribute to **long-term social sustainability** while **maintaining economic feasibility**.

ROLE OF COLLABORATIONS

Collaborations between academia, industry, and governments



[2] M. Matinmikko-Blue, et al. (eds.). (2020). White Paper on 6G Drivers and the UN SDGs. (6G Research Visions, No. 2). University of Oulu. http://urn.fi/urn:isbn:9789526226699

https://www.6gflagship.com/white-paper-on-6g-drivers-and-the-un-sdgs/

Collaborations between academia, industry, and governments

- Close collaboration between academia, industry and governments benefits everybody.
- Research domain emphasizes freedom and often considers regulations and industry needs as a burden and limiting factor.
- Values driven technology development is now an important topic in Europe.
  - Multi-disciplinary approach
  - Multi-stakeholder collaboration
- Real stakeholder needs are still not properly addressed. Research domain lacks mechanisms for the collaboration (incentives).

Conclusions

- **6G is used as an umbrella term for future digitalization developments in the 2030s.**
- **Radio spectrum continues to be the key asset and target for regulation and is under heavy debate with conflicting stakeholder views.**
- **Sustainability is a key driver 6G R&D and needs to be taken seriously including minimizing negative and maximizing positive impacts on environment, people and economy.**
- **Close collaboration between academia, industry and governments benefits everybody. This calls for multi-disciplinary multi-stakeholder mindset and actions.**

Thank you!

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On-going research activities

6G Flagship – More than wireless

Finnish 6G Flagship at University of Oulu

GreenI ICT Visiiri – Vihreän siirtymän kansallinen ICT-ekosysteemi | TIEKE

VISIIRI – Vihreän siirtymän kansallinen ICT-ekosysteemi projekti

Hexa-X-II - European level 6G Flagship project

European level 6G Flagship project