

ITU KALEIDOSCOPE

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**Sustainability and spectrum
management in the 6G era**

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Keynote session

Outline

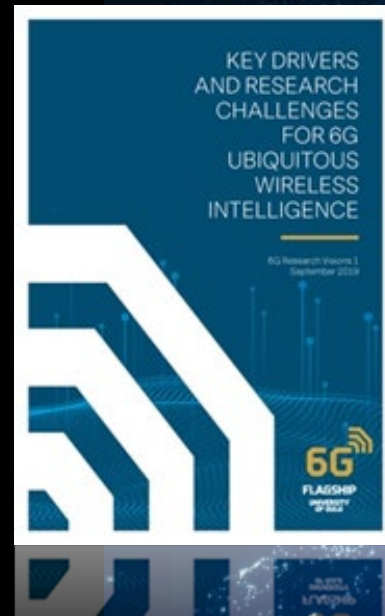
- Building a joint 6G vision
- Role of sustainability in 5G and 6G
- Role of spectrum management in 5G and 6G
- Recommendations for the 6G era
- Conclusions

Building a joint 6G vision

- World's first 6G Wireless Summit gathered major telecom players to vision 6G in Finland in March 2019.
- The Summit launched 6G White Paper development with 70 experts from around the world.
- Consensus that 6G is driven by United Nations' Sustainable Development Goals (UN SDGs).

Published in September 2019:

<http://6gflagship.com/6gwhitepaper/>

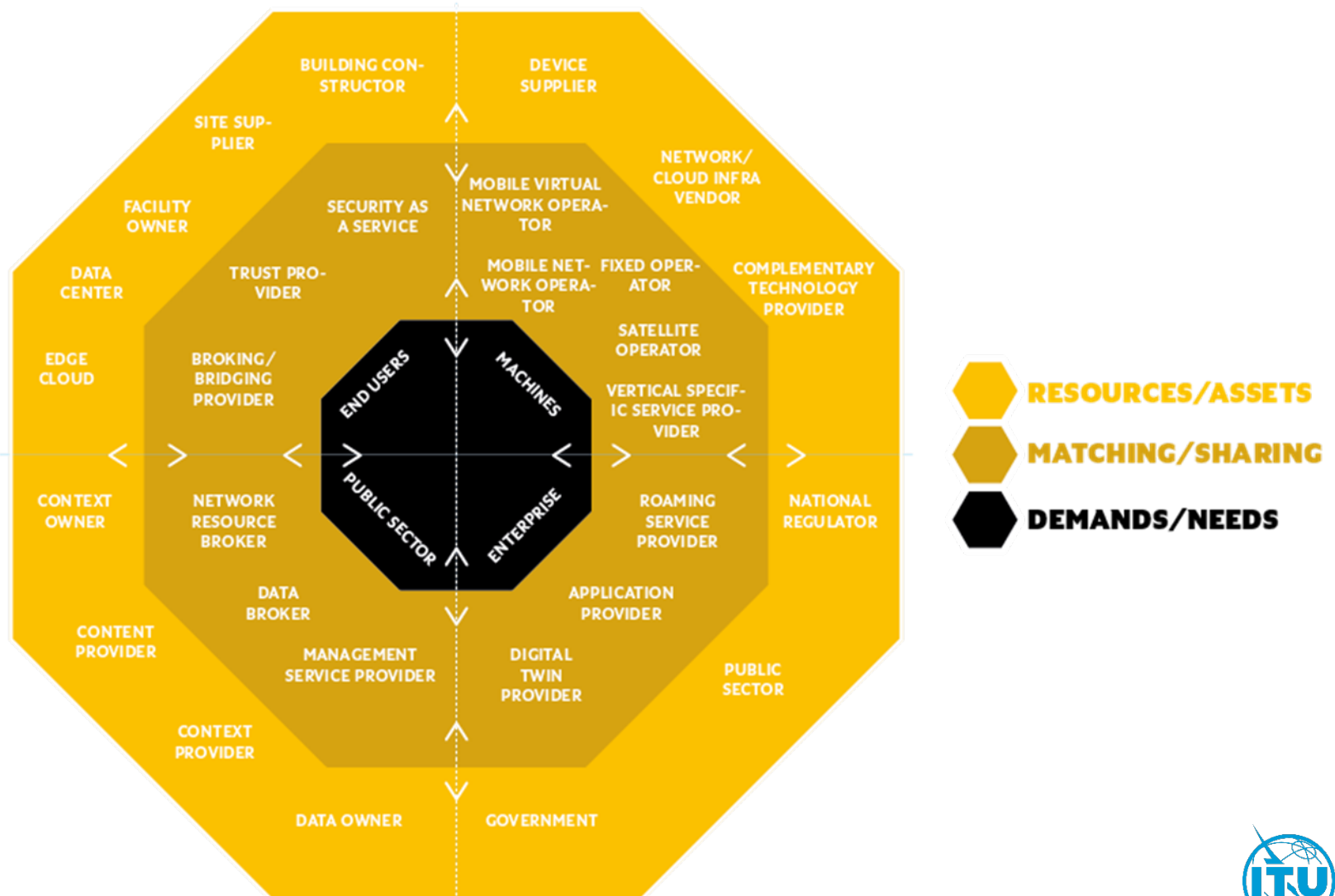


M. Latva-aho & K. Leppänen (eds.) (2019). Key drivers and research challenges for 6G ubiquitous wireless intelligence. [White paper]. (6G Research Visions, No. 1). University of Oulu, Finland.
<http://urn.fi/urn:isbn:9789526223544>

6G brings a new business ecosystem

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

Different resource combinations will emerge to serve versatile needs. The same needs can be met with different resource combinations.



<http://6gflagship.com/6gwhitepaper/>

Towards a large number of local networks

Different stakeholders can deploy their own local 5G/6G networks¹, independent of mobile network operators (MNOs), through local spectrum access rights².

This opens many business, regulation and technology related aspects to consider in research. Currently, divergence between countries is high, leading to market fragmentation even inside Europe.



<http://6gflagship.com/6gwhitepaper/>

¹M. Matinmikko, et al. (2017) **Micro operators to boost local service delivery in 5G.**

Wireless Personal Communications, 95(1), 69-82.

²M. Matinmikko, et al. (2018) **On regulations for 5G: Micro licensing for locally operated networks.**

Telecommunications Policy, 42(8), 622-635.

Second edition of 6G Flagship white papers for joint 6G vision building in 2020-2021



White Paper on 6G Drivers and the UN SDGs

HIGHLIGHTS:

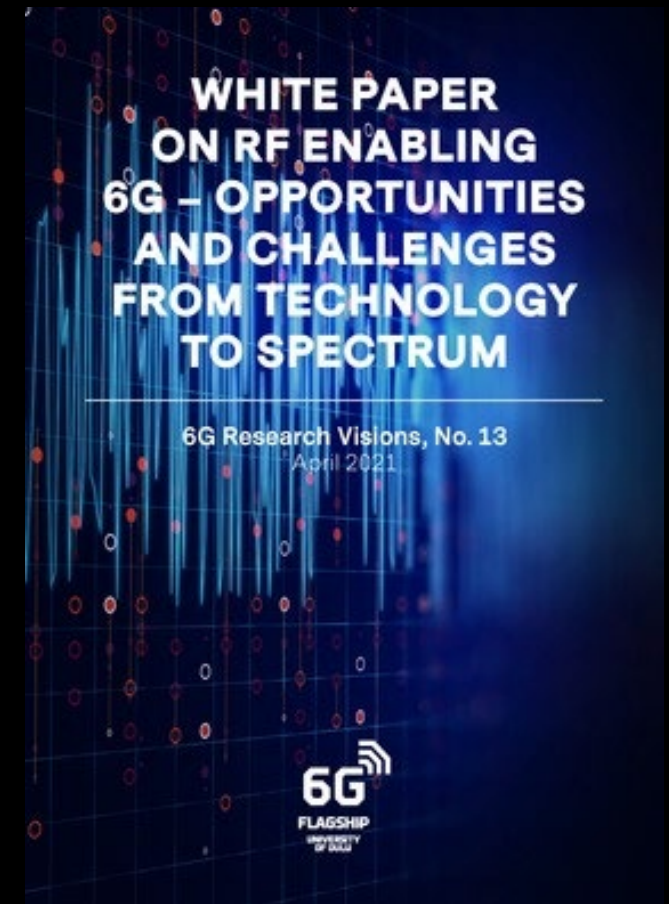
- We identify megatrends influencing the sustainable development of 6G.
- We develop a novel linkage between 6G and the UN SDGs that are both targeted for 2030.
- We envisage three-fold role of 6G as:
 - 1) a provider of services to help support activities towards reaching the UN SDGs,
 - 2) a measuring tool for reporting of indicators;
 - 3) a reinforcer of developing 6G in line with the UN SDG.



6G White Paper on RF Enabling 6G

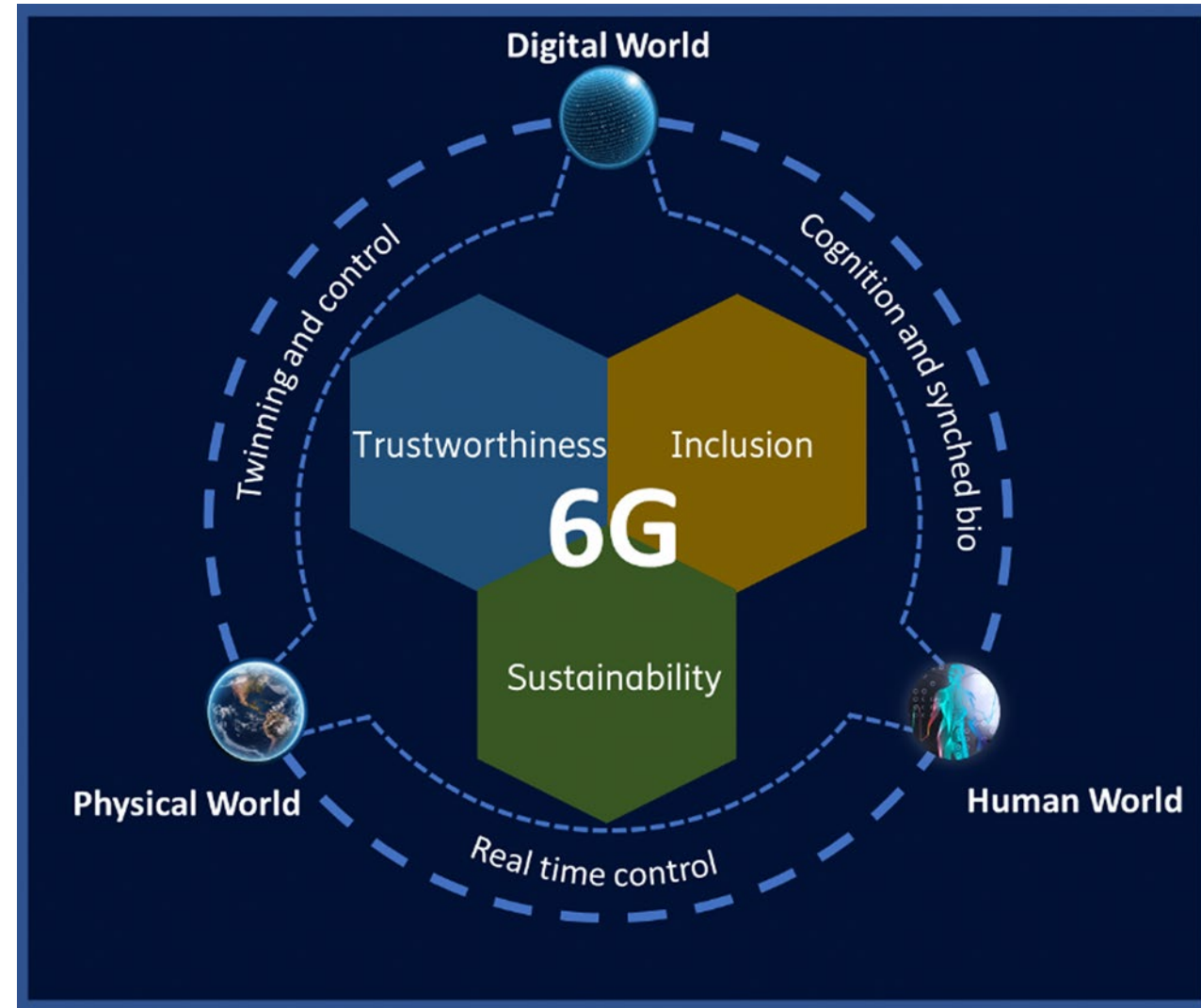
HIGHLIGHTS:

- White paper identifies opportunities and challenges related to 6G transceivers and emerging communications concepts, semiconductor technologies, antennas and packaging, radio channel modeling, spectrum sharing and prototyping and testing.



European Hexa-X vision for 6G connecting physical, digital and human worlds

- Key values:
 - Sustainability
 - Inclusion
 - Trustworthiness
- Research challenges:
 - Connecting intelligence
 - Network of networks
 - Sustainability
 - Global service coverage
 - Extreme experience
 - Trustworthiness



On the role of sustainability and sustainable development for 5G and 6G

Sustainability refers to the “principle of ensuring that our actions today do not limit the range of economic, social, and environmental options open to future generations” [Elkington 1997].

Sustainable development refers to the “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” [Brundtland report 1987].

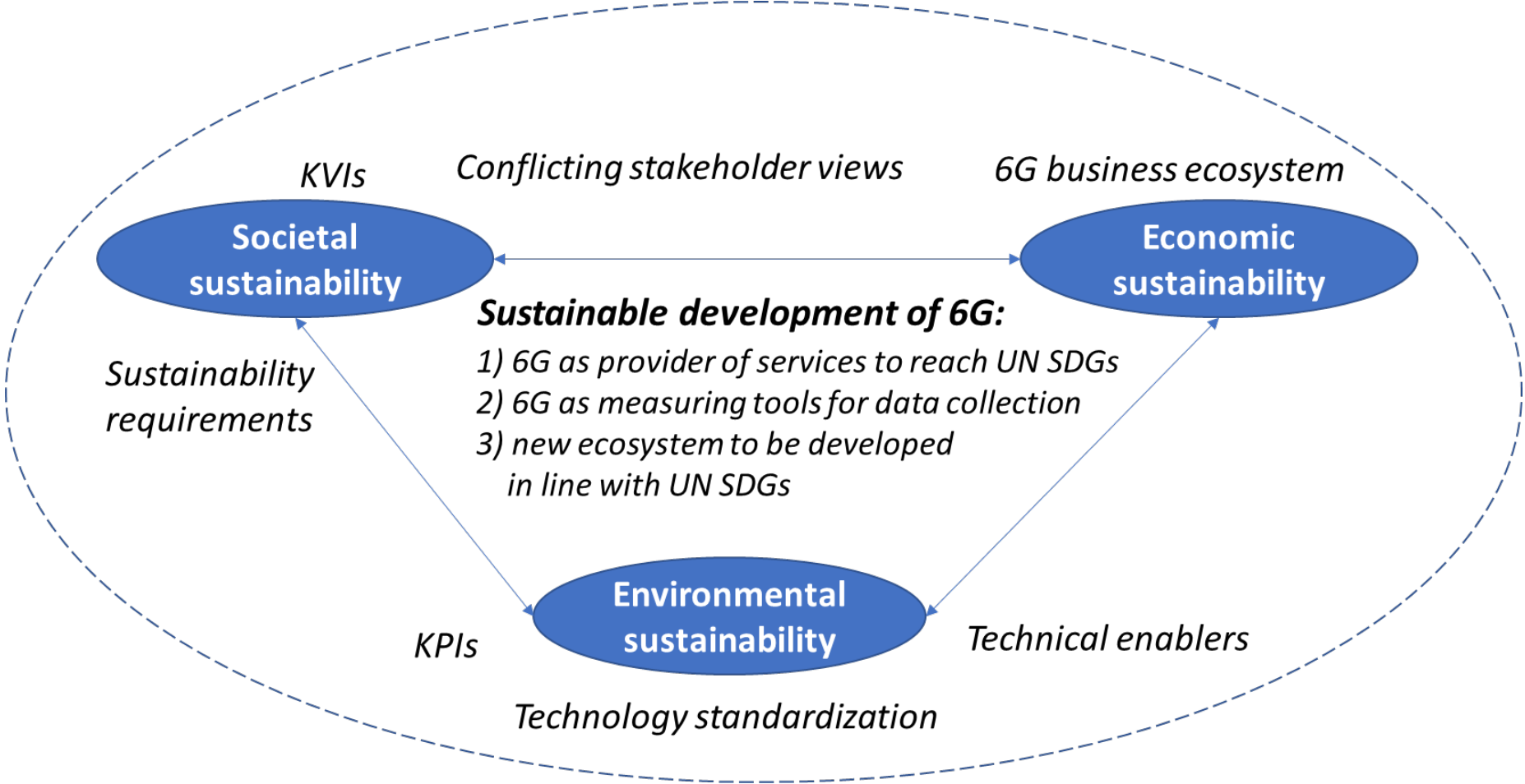
UN SDGs present a concrete framework for sustainable development with specific targets and indicators whereof only 7 are ICT specific.



6G Flagship’s white paper developed a first connection between 6G and the UN SDGs.






Sustainability and 6G



Linking 6G and UN SDGs via existing indicators



 UN Targets	 UN Indicators	 6G can
<p>4.2 By 2030, ensure that all girls and boys have access to quality early childhood development, care and pre-primary education so that they are ready for primary education</p>	<p>4.2.1 Proportion of children under 5 years of age who are developmentally on track in health, learning and psycho-social well-being, by sex</p> <p>4.2.2 Participation rate in organized learning (one year before the official primary entry age), by sex</p>	<p>Increase access to remote learning and developmental activities to children under 5 years.</p> <p>Enable improved socialization through virtual interactions.</p> <p>Improve remote access to pediatrics in locations with poor connectivity.</p> <p>Facilitate remote and virtual training of local pediatricians.</p> <p>Help improve and develop the knowledge and skills of local medical community.</p> <p>Deliver prosthetic technologies to support handicapped children.</p> <p>Permit family and experts to monitor the cognitive development of children with Brain-Computer Interfaces.</p> <p>Help coordinate virtual meetings for preschoolers.</p>

Role of spectrum management in 5G and 6G

- Spectrum decision-making defines, which radio services can be operated in different bands by various stakeholders, with the general aims to **maximizing the value of spectrum, its efficient utilization and benefits to the society**. This is interpreted differently.

<p>Administrative allocation:</p> <p>Regulator decides which stakeholder can access the spectrum. Goal is to create rules and conditions to minimize harmful interference and to protect incumbent spectrum users.</p> <p>It is used in 5G for assigning local spectrum access rights in some countries.</p>	<p>Market-based mechanism:</p> <p>Regulator defines spectrum property rights that are awarded using some market mechanisms, such as auctions.</p> <p>Auctions are used in 5G extensively with different rules and obligations. Secondary markets typically allow MNOs to transfer rights to others for establishing local networks.</p>	<p>Unlicensed commons approach:</p> <p>Regulator allows spectrum access to many wireless systems under pre-defined rules and conditions that are based on sharing of the spectrum.</p> <p>It can be used to establish local networks, technologies depend on the conditions.</p>
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M. Matinmikko-Blue, et al. (2021). Analysis of 5G spectrum awarding decisions: How do different countries consider emerging local 5G networks? European Conference of the International Telecommunications Society (ITS), June 2021.

M. Matinmikko-Blue, et al. (2019). Analysis of Spectrum Valuation Elements for Local 5G Networks: Case Study of 3.5-GHz Band. IEEE Transactions on Cognitive Communications and Networking, vol. 5, no. 3, pp. 741-753, Sept. 2019.

Role of spectrum management in 5G and 6G

- **Competition** over the scarce spectrum resource continues to be fierce. Spectrum sharing has not become the norm.
- **Complexity of spectrum bands and access models** increases leading to fragmentation. Same devices operate in a variety of bands under different spectrum access models.
- Traditional **split into radiocommunication services** is not consistent with the use of wireless technologies (e.g., 5G, 6G) for digitalization of the entire society. 6G combines the communication service with other services which further blurs the split.
- **Time-scales** of international spectrum management do not match with rapid technology development and changing user needs when systems are used for multiple purposes.
- **Market structures** change – local 5G networks that were strongly opposed 4 years but take place today. Stakeholder management is the bottleneck.
- Need for international collaboration on developing and benchmarking **best practices**.

Recommendations for the 6G era: Sustainability

- Role of wireless technologies for **emitting less** is equally important, as is support for **absorbing more** in other sectors.
- 6G combines communication with other services, like imaging, sensing, and locationing, providing a **measurement tool**.
- New mechanisms are needed to reduce the carbon footprint through **sharing and optimizing the use of all potential resources**.
- **Optimization** of the collection, processing, storage and transfer of data between different network locations is critical.
- Significant improvement of **energy efficiency** and **reduction of total energy consumption** for 6G is needed including new measures, measurement methodologies and techniques from end to end.
- **Sharing of data and methods** on the impact of the wireless communications sector **between sectors and stakeholders** is needed to develop sustainable solutions.

Recommendations for the 6G era: Spectrum management

- It is important **to reconsider the role of spectrum sharing** in accommodating stakeholders' changing and conflicting needs to reach long-term compromises.
- Spectrum access models based on sharing can be particularly effective for **serving local and temporal spectrum needs by various stakeholders** who currently do not have dedicated spectrum access rights.
- An example of this is **local spectrum licensing** where the current rules are typically based on larger exclusion distances reducing the efficiency of spectrum use.
- As a consequence, **spectrum governance rules** must evolve when moving towards 6G.

Recommendations for the 6G era: Sustainability and spectrum management

- **Spectrum authorizations** are a powerful tool to incentivize and force spectrum users to act towards sustainability.
- **Gaining access to spectrum is lengthy** and complex, while spectrum access needs for new innovative solutions combating sustainability challenges arise at rapid speed.
- There are no proper mechanisms currently in spectrum regulation to **allow fast access to spectrum for new innovative wireless solutions solving major sustainability challenges**. Their adoption is restricted by the license-exempt bands, subject to strict operational conditions.
- **Sharing based spectrum access models** can be particularly effective to solve sustainability challenges, e.g., to connect underserved areas by suitable stakeholders.
- Also, better analysis of the **impacts of operating frequency** and other elements on **energy consumption** is needed.
- While spectrum authorisations are a national matter, the approaches from one country, can through **sharing of best practices** help ICT sector to develop, trial and deploy innovative wireless solutions to solve sustainability challenges globally.

Conclusions

- A major refinement of traditional policies, especially a **widespread adoption of spectrum sharing is needed**, to allow all different sectors of society to measurably transform their operations towards sustainability through ICTs.
- Sustainability is about ensuring that our actions today do not limit the range of **economic, social, and environmental** options open to future generations. It is important to consider how long-term exclusive licenses without obligations to share fit in the new sustainability framework.
- **Sustainability must become a visible design criteria for 6G systems.** This requires that resource efficiency is taken seriously in technical performance requirements including indicators and methodologies that can quantify sustainability impact, in addition to new indicators addressing societal aspects.

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Thank you!

