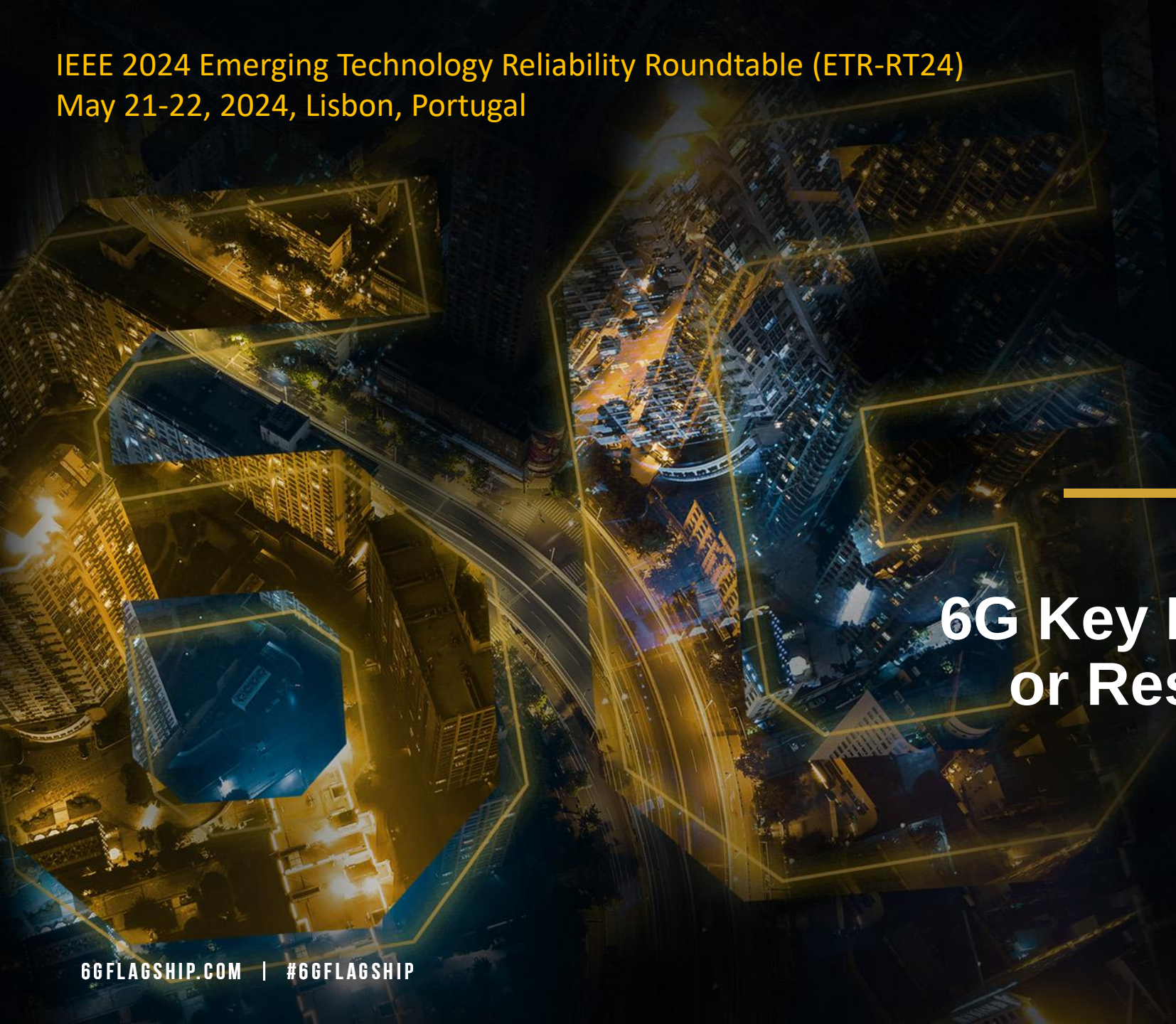
IEEE 2024 Emerging Technology Reliability Roundtable (ETR-RT24)
May 21-22, 2024, Lisbon, Portugal



6G FLAGSHIP
UNIVERSITY OF OULU

6G Key Enabler for Metaverse or Resilience of Society?

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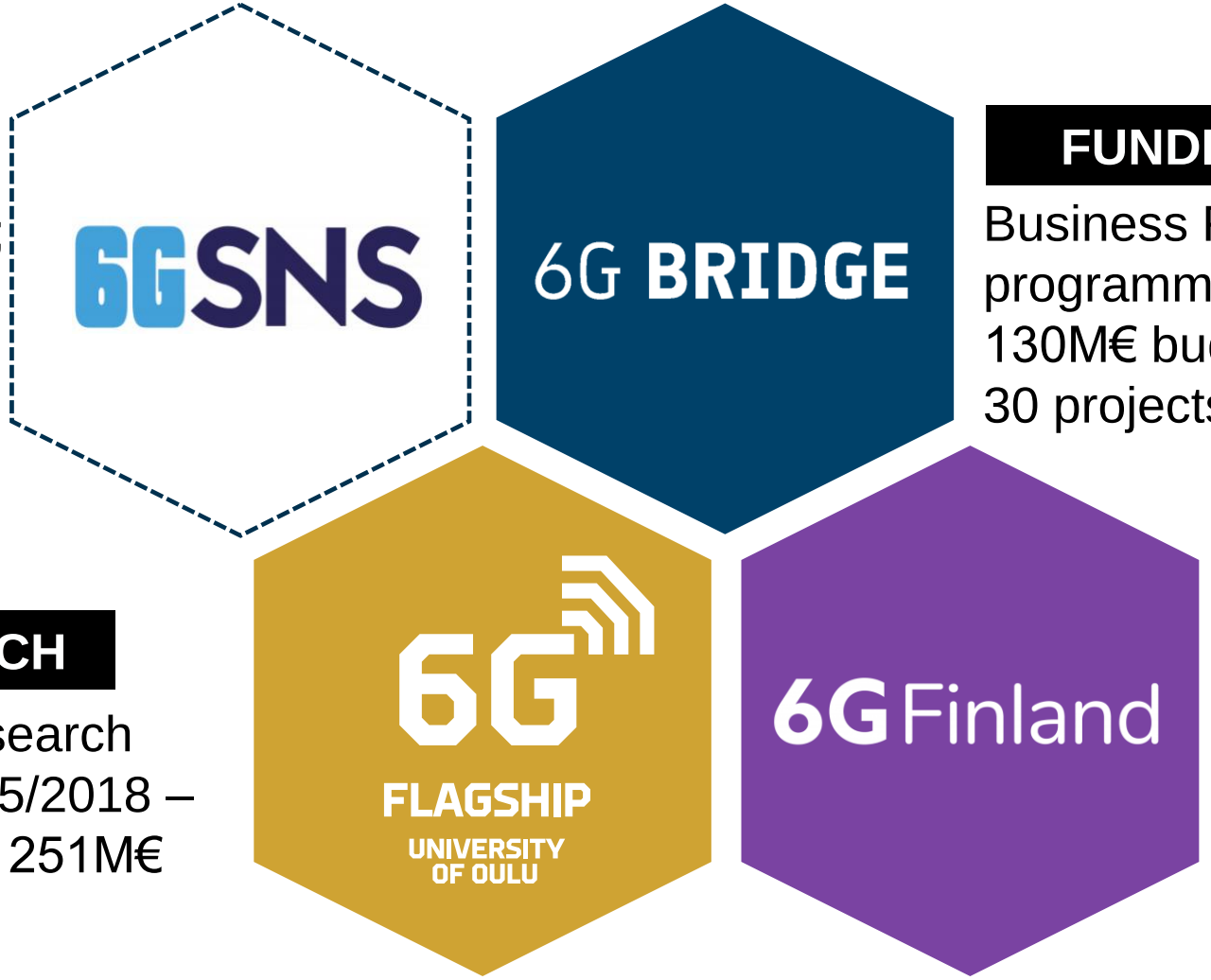
Facts sheet on 6G Flagship

- National research flagship for 2018 – 2026 with a total volume of 250M€.
- 2nd phase started May 2022 – plan to continue until the end of 2028.
- Operated by University of Oulu.
- Currently involves 500 researchers from 50 nationalities.
- Steered the first 6G visions work via 13 6G White Papers (downloaded over 1M times).
- Published 2700 per-reviewed papers and 100 doctoral theses.
- 400 research projects completed or on-going with a large number of partners.

6G Public Research in Finland – Main Components

EU LIAISON

EU level views on key 6G technologies; 62 projects with 380M€ funding; key project Hexa-X & Hexa-X-II



FUNDING

Business Finland funding programme 1/23 – 12/26 with 130M€ budget; currently about 30 projects funded.

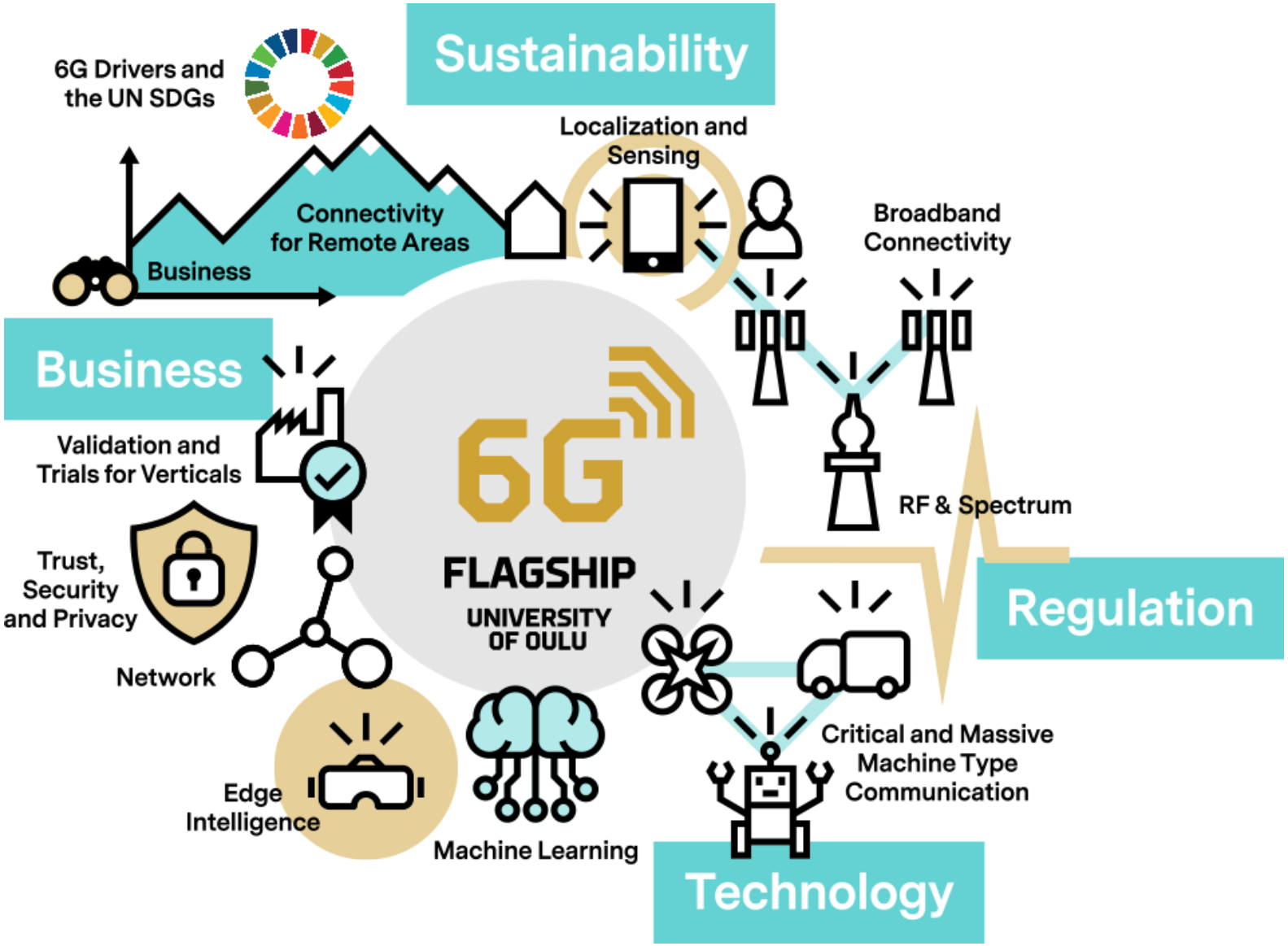
RESEARCH

National research flagship for 5/2018 – 6/2026 with 251M€ budget

POLICY

National 6G coalition formed on 5/22 to lead 6G policy level, and other strategic discussions in Finland

Unique Research Agenda



Vertical application areas:

- Health
- Industry
- Vehicular
- Energy
- Security & Defence

Flagship Targets

6G Flagship Vision for 2030

Data-driven sustainable future society enabled by near-instant, unlimited wireless connectivity

Strategic Research Areas (SRAs)

1. Wireless connectivity solutions
2. Device and circuit technologies
3. Distributed intelligent wireless computing
4. Sustainable human-centric services and applications

Flagship Goals

1. 6G technology enablers
2. 6GTN development
3. 6G vertical applications
4. 6G opinion leadership

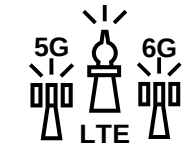
Impact Actions

A 6G-enabled Sustainable Society

B Strategic Vertical Areas (SVAs)
- Health
- Industry
- Vehicular
- Energy
- Security & defence

C Global 6G Collaboration

D Research infra-structures – 6G Test Network (6GTN)



Beyond 6G Flagship

6GTN as the core of 6G Radio Park

Training 6G experts for industry

Influence on 6G standard

Expertise building beyond 6G

2027 2028 2029 2030

Test Network - Key Tool for Co-Creation

5GTN

PyeongChang 2018

ACADEMY OF FINLAND

ESFRI European Strategy Forum on Research Infrastructures

SLICES-RI: 15 countries (**https://slices-ri.eu/**)

First open test network (https://services.5gtn.fi/).

5G mmW trials in Olympics with ETRI and Nokia

Operator grade live 5G micro-operator network

Selection to AoF FIRI roadmap

Selection to ESFRI FIRI roadmap

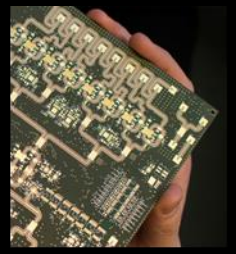
First 6G PoC devices

First 6G "network"

6G Standardization begins

2015 2018 2019 2020 2021 2023 2025 2026

5GTN | 4G-LTE | 5G PoC | 5G NR | 5G+ | 5G+ ... 6G | 6GTN



800 MHz @26/28 GHz
10 Gbps
Hybrid beamformer

5G PoC/5GNR

5G Macros at 3.5GHz
For IoT - NB IoT/LTE-M

Cloud RAN based 5G
@3.5GHz
5GNR @24 GHz

From Human Centricity to Holistic Digitalization of Society

ABC (Always Best Connected)

Vision for future made in 2003

Next 50 billion connected things

2013 vision

6G metaverse and digital twins

2023

Critical Drivers Towards 6G

#1
Society

Digital inclusion via global coverage

- Connectivity is key to satisfy UN SDGs and needs of digital societies; current terrestrial technologies with evolutionary features need to be complemented by specific remote areas solutions including satellite.

#2
Business

New ecosystems and disruptive business models

- Digital societies and emergence of new verticals create new ecosystems and disrupts current business models requiring field specific regulation changes; ownership of customers and networks changes.

#3
Standards

Global collaboration and standards

- 6G coalitions forming in a new geopolitical landscape; a new standard is introduced after every 10-years – business reshaped in 20-year cycles; spectrum regulation principles changing 20+ year cycles.

#4
Technology

- **Security**
- **Network**
- **Radio**
- **AI**

Data privacy and security

- Expansion of verticals with new stake holders and emergence of large number of new players providing different network elements, critical applications and operation inherent parts of networks sets new privacy & security requirements.

Service driven network architecture

- Networks are ubiquitous and specialized services with various connectivity mechanisms are becoming more and more popular. Service driven architectures are becoming dominant after the network ownership driven era.

Super resilient connectivity

- Extreme speeds, reliability, low latency and localization/sensing accuracy can be achieved only locally in rather short-range networks utilizing the higher frequency bands even above 100GHz.

Smart AI enabled networks and applications

- Networks and applications become intelligent, self-learning and context dependent; edge intelligence is the key technical enabler and challenges/complements centralized cloud solutions.

Are these adequate given the current global turmoil?

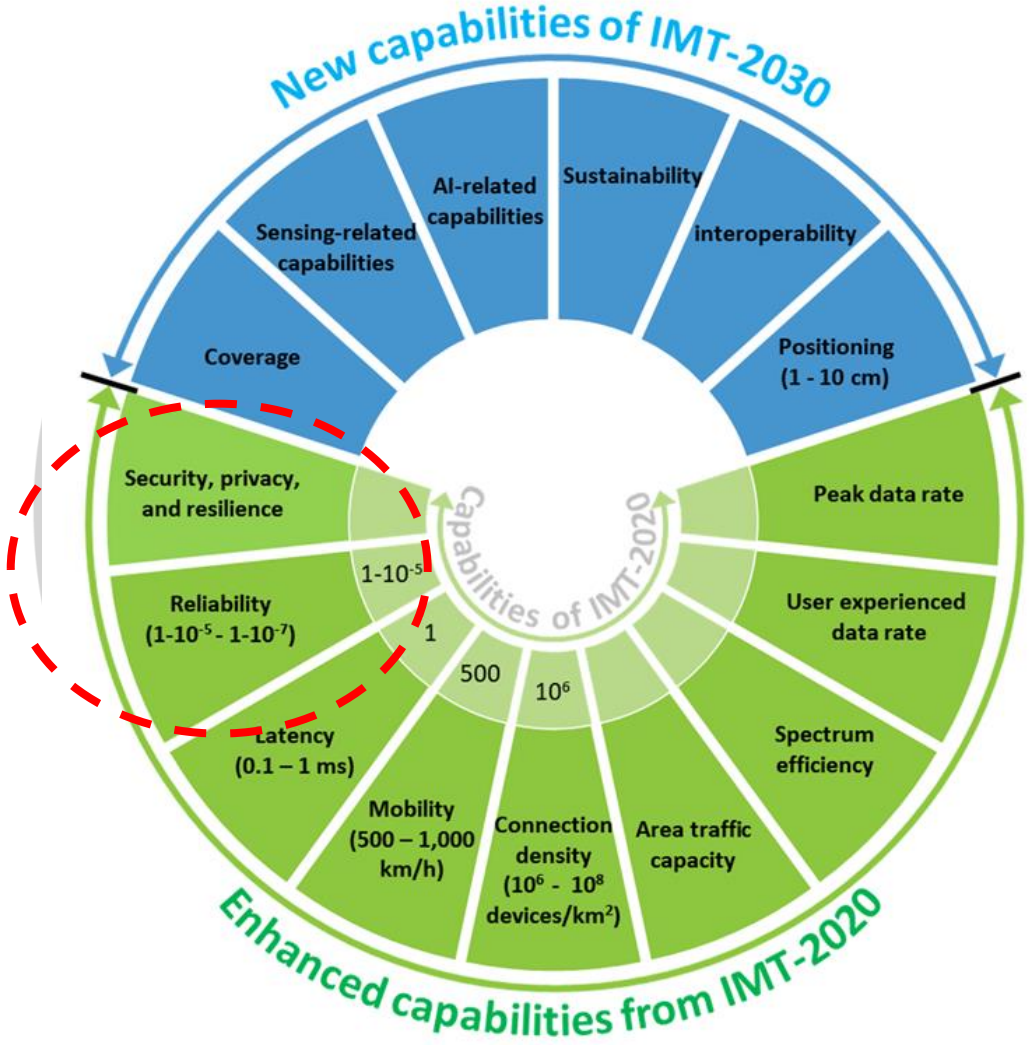
How About Resilience?

Prioritize resilient society rather than tech advances

- How about defining sufficient & scalable services instead of ”metaverse” ?
- How to solve remote areas connectivity challenge?
- How to prepare networks against natural disasters, intentional disturbances, power outages etc.?
- How to cope with misinformation, hallucinating AI applications and information security?
- Howabout supply chains resilience including electronic components and materials?

⇒ ***Can and will any of these be made to 6G technical requirements by ITU-R and what would be the KPIs for those?***

How To Address Resilience in IMT-2030 Requirements?



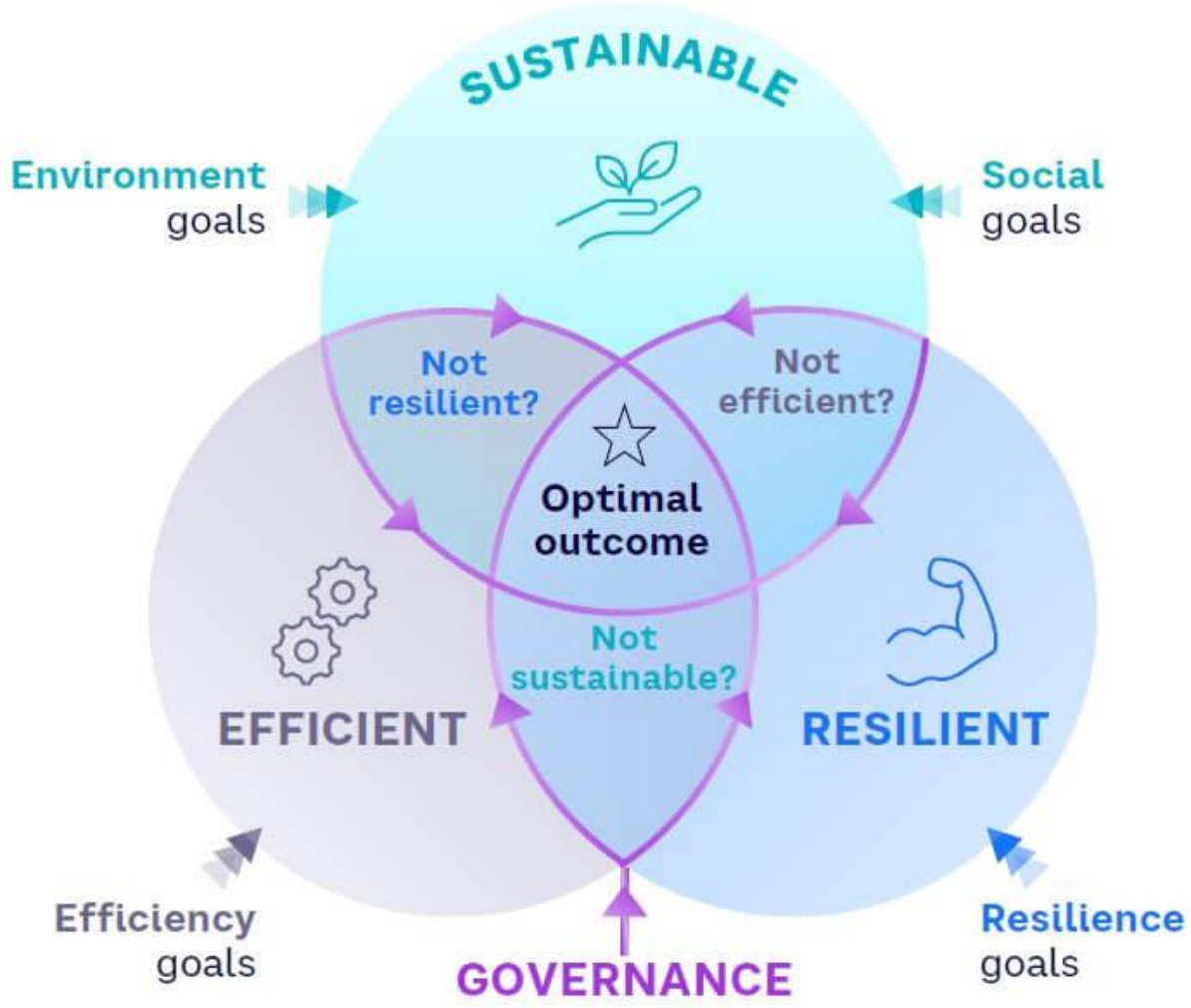
Quality of resilience features

- ITU-T Recommendation G.827 (Digital networks – Quality and availability targets)
- Service level definitions
- Fault localization and related parameters
- Network recovery parameters (Mean Time to Failure, Mean Up Time,Mean Down Time, etc. etc.)

Operational features

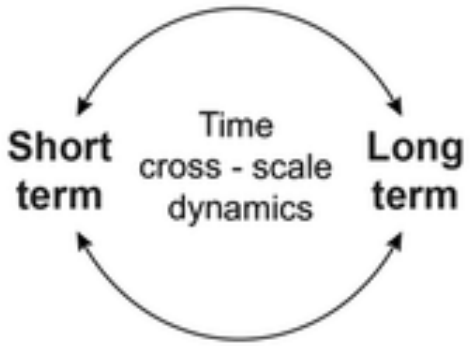
- Overhead and signaling requirements
- Flexibility
- Scalability
- Cost of recovery
- Dedicated link protection, dynamic rerouting

Sustainability, Efficiency and Resilience



Source: Arthur D. Little (Toward sustainable, efficient & resilient mobility systems)

Sustainability vs. Resilience

	RESILIENCE	COMMON FEATURES	SUSTAINABILITY
Graph terms interpretation	change, behavior, complexity evolution , system approach dynamics, system	- adoption → of different practices, policies, standards - disaster resilience - ecological modernization → - Hierarchical relationship between sustainability & resilience - Mostly community level - Case studies - Glocal approach - social ecological systems → Complex System Approach	long-term sustainability, policies decision-making, institutions climate change, transformation
Methodological differences	Resilience Theory Approach	Multi-domain operation: - ecology - economy - society	Sustainability Science Approach
Time processes	**ADAPTATION** - Adaptive cycles and multiple equilibria - Result of change is emergent and open-ended - Emergent properties guide trajectory		**TRANSFORMATION** - Radical reorganization of the SES - Creation of new order, open ended - Reorder system dynamics - Shift from one trajectory to another

Recent Research Activities on Resilient Networks

cost
EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

RECODIS
Resilient communication services protecting end-user applications from disaster-based failures

Home | Working Groups | MC/WG Meetings | Dissemination Meetings | Other Dissemination Activities | Calls for STSMs | Completed STSMs | The final book of RECODIS | Publications | ITC Conference Grants | Training School | Joint Project Proposals

Resilient Communication Services Protecting End-user Applications from Disaster-based Failures

Welcome to the webpage of COST CA15127 Action "Resilient Communication Services Protecting End-user Applications from Disaster-based Failures" (RECODIS). RECODIS is one of COST (European Cooperation in Science and Technology) Actions supported by the COST Association.

Scientific Scope

The scientific scope of COST-RECODIS is the resilience of communication networks under disaster-induced failures. Such events can seriously disrupt a communication network, making its services unavailable. They follow from natural disasters, weather-induced disruptions, technology-related failures, or malicious attacks, and they are observably increasing in number, intensity and scale. When network services that are part of a critical infrastructure become unavailable, commercial and/or societal problems are the inevitable result. This COST Action, driven by researchers from academia and industry in strong cooperation with governmental bodies, aims to fill the gap by developing appropriate solutions to provide resilient communications in the presence of disaster-based disruptions of all types for existing and future communication network architectures.

Action Chair: Jacek Rak, Gdansk University of Technology, Poland

Action Vice Chair: David Hutchison, Lancaster University, United Kingdom

RECODIS Action activities were performed between March 1, 2016, and February 29, 2020, by nearly 200 Members, including MC Members, MC Substitute Members and Regular Members from 31 COST countries.

Log in

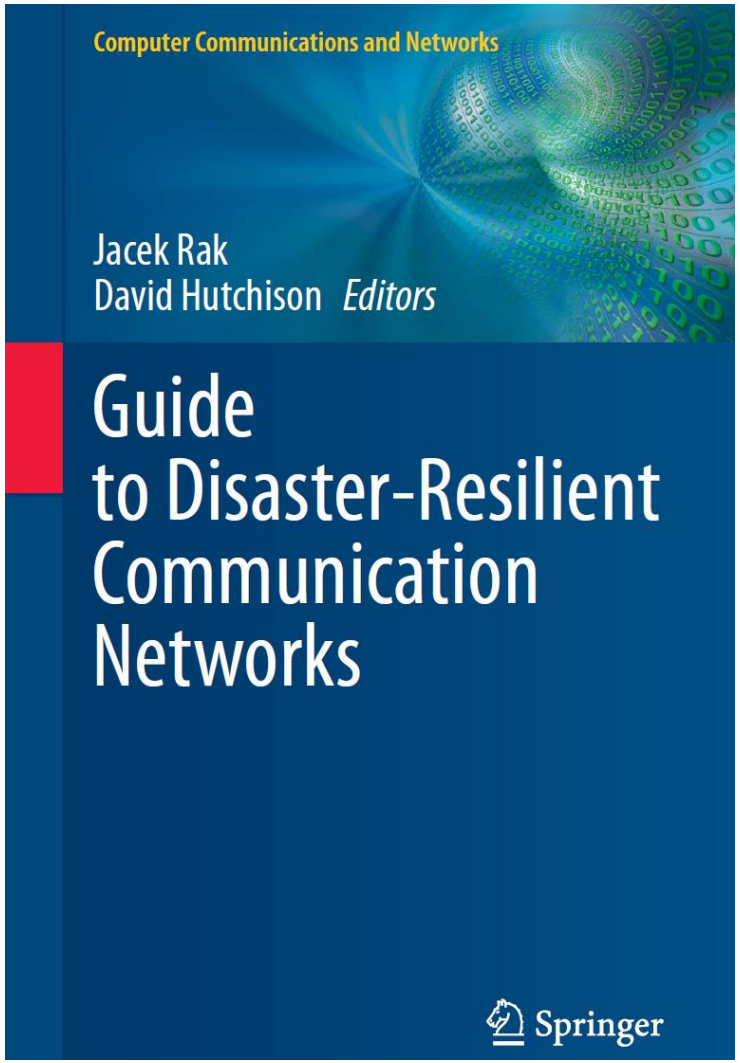
News

Final book of RECODIS

„**Guide to Disaster-Resilient Communication Networks**" (Springer), 834 pages is available!

Email contact

contact@cost-recodis.eu



Ended Feb 2020

Recent Research Activities on Resilient Networks

U.S. Department *of* Defense

DoD and NSF Kick-Off Resilient and Intelligent NextG Systems Program

June 27, 2022 |

The National Science Foundation (NSF) announced awards for the "Resilient and Intelligent NextG Systems" (RINGS) program on April 18. The RINGS program officially kicks off today. The Department of Defense is pleased to be a part of this unique, collaborative effort to expand public-private partnerships.

The RINGS program is NSF's single most significant effort to date to engage government, academic, and industry partners in a joint research program. This program seeks to accelerate research, drive innovation, and increase the competitiveness of the U.S. in NextG networking and computing technologies. The Innovate Beyond 5G (IB5G) program in the Office of the Under Secretary of Defense for Research and Engineering contributed $6 million towards the total of over $37 million awarded to 41 research projects.

References to Networks Resilience

Reifert, Robert-Jeron, et al. "Comeback kid: Resilience for mixed-critical wireless network resource management." *IEEE Transactions on Vehicular Technology* (2023).

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Dobson, Simon, et al. "Self-organization and resilience for networked systems: Design principles and open research issues." *Proceedings of the IEEE* 107.4 (2019): 819-834.

Sterbenz, James PG, et al. "Resilience and survivability in communication networks: Strategies, principles, and survey of disciplines." *Computer networks* 54.8 (2010): 1245-1265.

Cholda, A. Mykkeltveit, B. E. Helvik, O. J. Wittner and A. Jajszczyk, "A survey of resilience differentiation frameworks in communication networks," in *IEEE Communications Surveys & Tutorials*, vol. 9, no. 4, pp. 32-55, Fourth Quarter 2007.

Joint Statement for 6G Supporting Resilience

THE WHITE HOUSE

FEBRUARY 26, 2024

Joint Statement Endorsing Principles for 6G: Secure, Open, and Resilient by Design

BRIEFING ROOM ▸ STATEMENTS AND RELEASES

The Governments of the United States, Australia, Canada, the Czech Republic, Finland, France, Japan, the Republic of Korea, Sweden, and the United Kingdom concur on these shared principles for the research and development of 6G wireless communication systems;

Jointly Shared Principles of 6G

1. Trusted Technology that is Protective of **National Security**

2. **Secure, Resilient**, and Protective of **Privacy**

3. Global Industry-led and **Inclusive Standard** Setting & International Collaborations

4. Cooperation to Enable **Open** and Interoperable Innovation

5. **Affordability, Sustainability**, and **Global Connectivity**

6. **Spectrum** and **Manufacturing**

An Example of Resilient ICT Design: Dual-Use Technology Development in NATO DIANA Test Centers

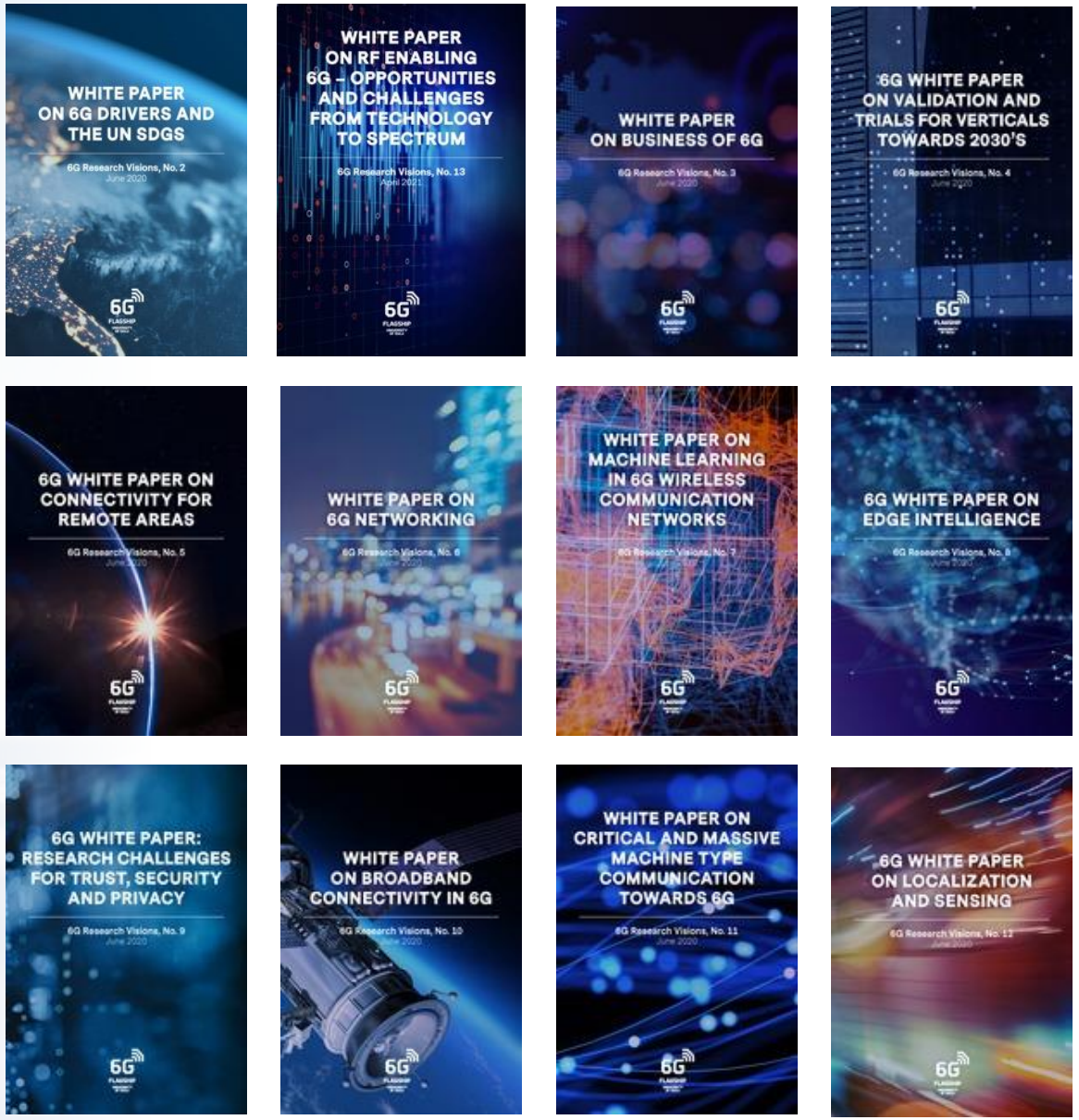
- NATO DIANA Test Centers (www.diana.nato.int/test-centres.html)

- Finland joined NATO on April 4th 2023 as a consequence of changed geopolitical climate.
- Finland became member of the Defence Innovation Accelerator for the North Atlantic (*DIANA*) March 14th 2024.
- DIANA 6G Test Center was established to University of Oulu and is operated by 6G Flagship.
- We'll focus on dual-use 6G technologies for national security and resilience.

- **DIANA** is instructed to accelerate civil-military emerging and disruptive technological solutions -particularly dual-use ones - to critical transatlantic defense and security challenges, leveraging existing elements from NATO nations and NATO bodies and guided by relevant NATO Strategies and Frameworks.

6G Visions and Research Directions

- *6gflagship.com/white-papers*



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