ETSI Seminar 2023

The ETSI Approach to
Research, Innovation, and Technology
Trends

Presented by: David Boswarthick
                 ETSI Director NET (New Technologies)
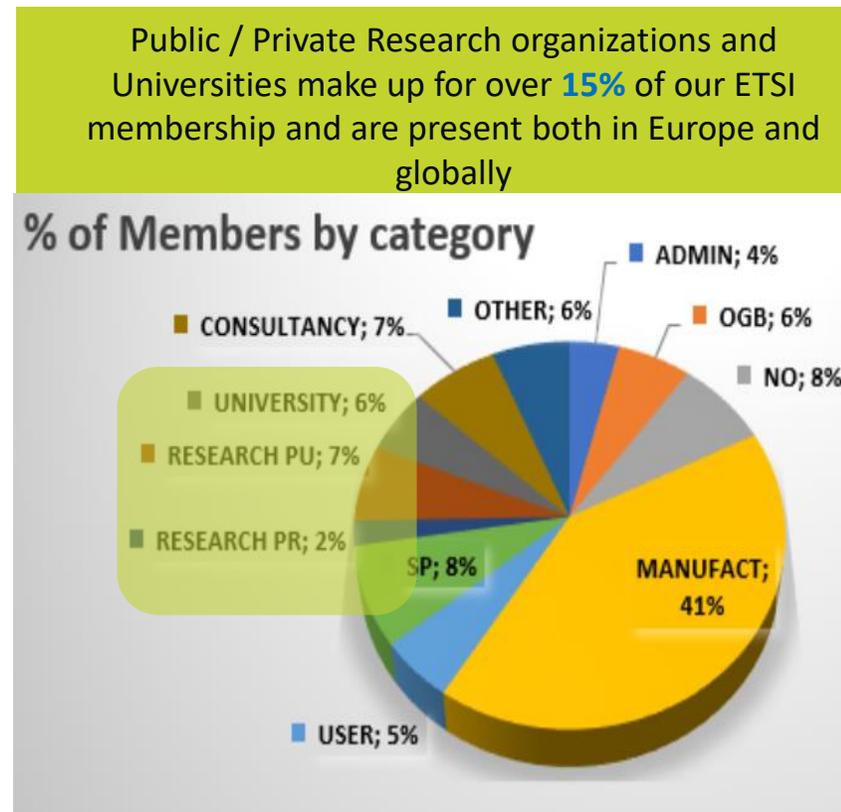
20/06/2023

ETSI - Bringing people together…

- Independent, non-profit standards organization

- Officially recognized by the European Union to support EU regulation

- **35+** year track record of technical excellence in the ICT sector

- Founding Partner of both **3GPP** and **oneM2M**

- Over **900** members from more than **60** countries

- Diverse community: private companies, research and academia, governments, public bodies, societal stakeholders

Public / Private Research organizations and Universities make up for over **15%** of our ETSI membership and are present both in Europe and globally

% of Members by category

- CONSULTANCY; 7%
- OTHER; 6%
- ADMIN; 4%
- OGB; 6%
- NO; 8%
- UNIVERSITY; 6%
- RESEARCH PU; 7%
- RESEARCH PR; 2%
- SP; 8%
- MANUFACT; 41%
- USER; 5%

Source: April 2023 edition of the ETSI Enjoy! magazine
https://www.etsi.org/newsroom/magazine

https://www.etsi.org/

ETSI Approach to Research and Innovation

- ETSI encourages a constant flow of research and innovation output into our standards work.

- **ETSI Board RISE group:** Strong links between Researchers, Innovators & Standardization expertise in ETSI

    - Working with EU platforms
    (such as Horizon Europe, SNS JU, 6G-IA, NetworldEurope)

    - Working with national / EU / global research platforms & projects (e.g. HEXA-X / Next G Alliance /one6G / IOWN)

    - Outreach to universities and research labs worldwide

- **ETSI Board TREND group:** Examines Future Technology Trends,

    - Produces the ETSI Technology Radar (ETR)

- **ETSI NET (New Technology) Team:** responsible for,

    - Building the tools and enablers for R&I into Standards,

    - Tracking Future Technology Evolutions & outreach,

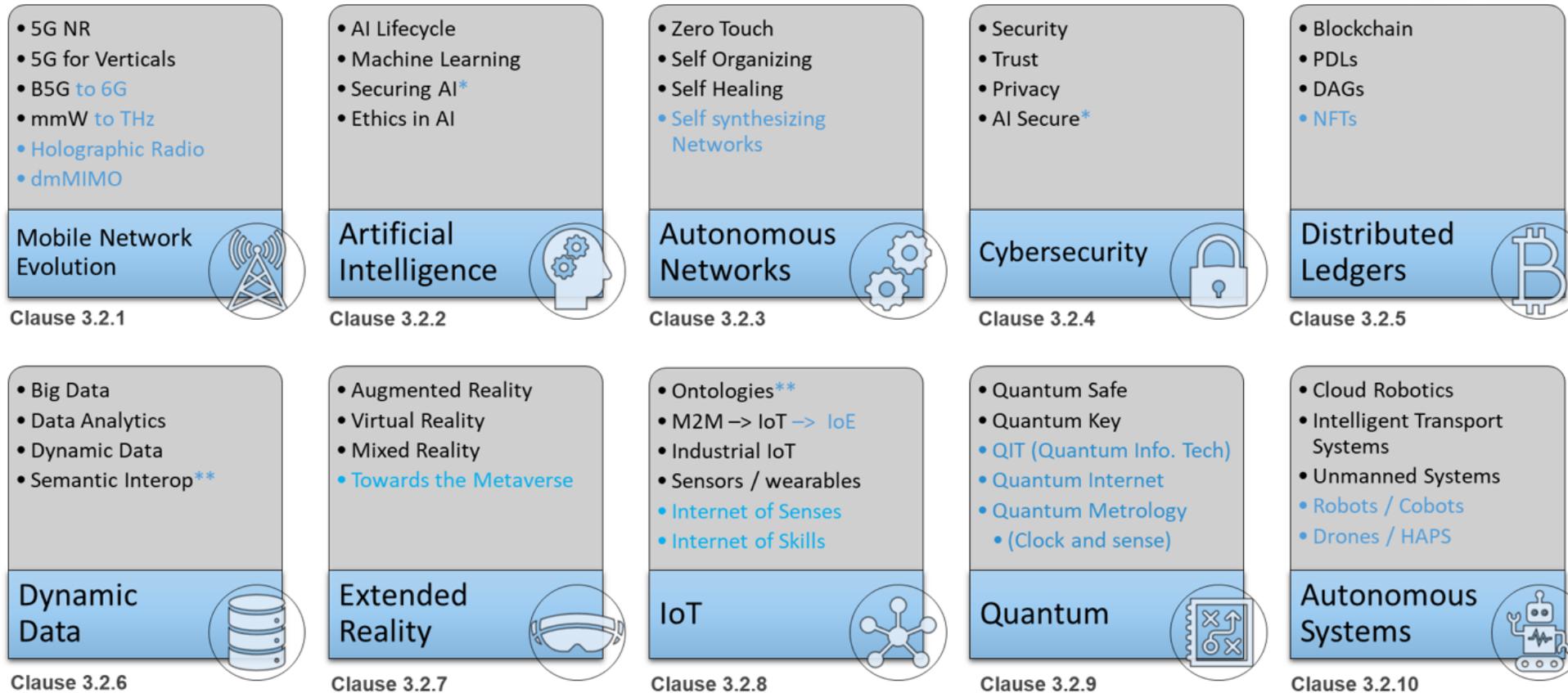   - Enable the creation of new technical groups, areas of work in ETSI

ETSI White Paper No. 45

ETSI Technology Radar

First edition – April 2021

ISBN No. 979-10-92620-39-1

2
ETSI TECHNO. RADAR

1
Links to RESEARCH

3
Enable New Work in ETSI

ETSI Technology Radar - Overview

- ETSI Technology Radar (ETR) tracks the major technology trends that are just on/over the horizon (approx. 0 –> 7 years). *Identifies potential for new standards work in ETSI*.

- ETR was first published in April 2021 and originally contained 10 broad Tech-Trends

Initial ETR TRENDs [2021]

• 5G NR • 5G for Verticals • B5G to 6G • mmW to THz • Holographic Radio • dmMIMO **Mobile Network Evolution** Clause 3.2.1	• AI Lifecycle • Machine Learning • Securing AI* • Ethics in AI **Artificial Intelligence** Clause 3.2.2

- Zero Touch
- Self Organizing
- Self Healing
- Self synthesizing Networks

Autonomous Networks
Clause 3.2.3

- Security
- Trust
- Privacy
- AI Secure*

Cybersecurity
Clause 3.2.4

- Blockchain
- PDLs
- DAGs
- NFTs

Distributed Ledgers
Clause 3.2.5

- Big Data
- Data Analytics
- Dynamic Data
- Semantic Interop**

Dynamic Data
Clause 3.2.6

- Augmented Reality
- Virtual Reality
- Mixed Reality
- Towards the Metaverse

Extended Reality
Clause 3.2.7

- Ontologies**
- M2M –> IoT –> IoE
- Industrial IoT
- Sensors / wearables
- Internet of Senses
- Internet of Skills

IoT
Clause 3.2.8

- Quantum Safe
- Quantum Key
- QIT (Quantum Info. Tech)
- Quantum Internet
- Quantum Metrology
  - (Clock and sense)

Quantum
Clause 3.2.9

- Cloud Robotics
- Intelligent Transport Systems
- Unmanned Systems
- Robots / Cobots
- Drones / HAPS

Autonomous Systems
Clause 3.2.10

ETSI Technology: Radar https://www.etsi.org/images/files/ETSIWhitePapers/etsi_wp45_ETSI_technology_radar.pdf

- 5G Evolution
- Artificial Intelligence
- Autonomous Networks
- Cybersecurity
- Distributed Ledgers
- Dynamic Data
- Extended Reality
- IoT
- Quantum
- Autonomous Systems

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ETSI Technology Radar - Update

- ETSI Technology Radar (ETR) is in the process of being updated by BOARD_TREND

- Revision of the ETR planned for publication DECEMBER 2023, with 11 additional Technology Trends

New ETR TRENDs [2023]

|					

• Terabit PONs
• Optical networks
• Photonics space comms
• Photodiodes for THz
• Links to OWC
• Photonic Sensing
 	
Photonics
	• Sub-THz
	• Full THz
	• PNS with THz
	  • Position
	  • Navigate
	  • Sense
	New ISG
	
	(sub)THz and THz Comms
		• RIS beamforming
		• Meta-materials/surfaces
		• RIS Wireless Power Transfer
		• Location and sensing
		New ISG
		
		Reflective Intelligent Surfaces (RIS)
			• VLC = Visible Light Comms
			• LiFi = Light Fidelity
			• OCC = Optical Camera Comms
			• FSOC = Free Space Orbital Comms
			• LIDAR = Light Detect and Ranging
			
			Optical Wireless Communications (OWC)
				• Satellite (LEO/MEO/GEO)
				• High Throughput Sats (HTS)
				• Cubesats
				• HAPS
				• UAV
				
				Non-Terrestrial Networks (NTN)
					• Cognitive radio / efficient radio spectrum sharing
					• Autonomous operation
					• Mesh radio networking
					• Energy harvesting
					• URLLC and mMTC for industry automation
					
					Self organizing Wireless area Networks

• EDGE powered by artificial intelligence (AI) techniques • EDGE Native • Disaggregation and virtualization at the distributed EDGE **Intelligent Distributed EDGE**	• Waveform/sequence/coding/modulation/beamforming • MIMO, massive MIMO, and intelligent reflecting surface (RIS) for ISAC • Passive sensing using communication waveforms • Millimeter wave and THz ISAC **Integrated Sensing & Communicating Networks (ISAC)**	• High Performance Computing (HPC) • Neuromorphic Compute • Convergence of compute & comms architectures = • *Unified network compute fabric* **High Performance Compute (HPC)**	• Energy Harvest/Transf. • Low Power Operations • AmBC (amb. Backscatter) • Recycle materials • Resource optimization • Efficient bandwidth **Sustainable**	• Human machine interf. • Mind to mind comms • Embedded / ingested devices • Wearables (VR/AR/XR) • SIM - > Smart Agents **Next Generation User Interfaces**	

The ETSI ISG (Industry Specification Group) A pre-normative incubator for Research

❖ ETSI ISGs are the perfect tool for developing 'early' standardization work resulting from research projects / other sources of innovation.

❖ This tool has been used for many successful standards efforts on technologies such as mWT, NFV, Edge, Artificial Intelligence, AR/VR/XR, Quantum Safe, Quantum Key and many more.

❖ Any group of at least four ETSI members can a request to the ETSI Director-General the creation of new ISGs in ETSI as long the relevant criteria are met.

❖ Streamlined ISG process enables **deliverables (GSs and GRs)** to be published in matter of months, an ideal mechanism for **early stage (pre)standardization**.

❖ ETSI ISGs are open to both ETSI members and non-members.

❖ New ISGs can be initiated by ETSI both members and non-members, potentially opening up new domains / areas of work for ETSI.

❖ **Researchers and academics can take up official positions** (Chair / Vice-Chair), become rapporteurs for ETSI deliverables and actively drive the current and future standards work of ETSI.

ARF Augmented Reality Framework	**CDM** european Common information sharing environment service and Data Model
CIM cross-cutting Context Information Management	**ENI** Experiential Networked Intelligence
ETI Encrypted Traffic Integration	**F5G** 5th Generation Fixed Network
MEC Multi-access Edge Computing	**mWT** millimetre Wave Transmission
NFV Network Functions Virtualisation	**NIN** Non-IP Networking
OEU Operational energy Efficiency for Users	**PDL** Permissioned Distributed Ledger
QKD Quantum Key Distribution	**RIS** Reconfigurable Intelligent Surfaces NEW
SAI Securing Artificial Intelligence	**THz** Terahertz Modelling NEW
ZSM Zero-touch network and Service Management	**17 ISGs currently**
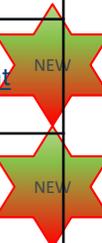
The ETSI SDG (Software Development Group)
A toolbox for Research and Standardization

- ❖ ETSI SDGs are the perfect tool for developing '**early**' implementation work resulting from research projects / other sources of innovation.

- ❖ This tool has been designed for collaborative software development at ETSI based on the successful experience with Open Source MANO and TeraFlowSDN.

- ❖ SDGs allow for early experimentation, prototyping, validation and testing of concepts defined by ETSI Technical Groups, and provide them with **early and regular feedback**. It's an ideal mechanism for **optimizing the quality of standards and reducing their time to market**

- ❖ Any group of at least four ETSI members, can request to the ETSI Director-General the creation of new SDG in ETSI, as long the relevant are criteria are met. Various licence types are allowed, including Open Source

- ❖ ETSI SDGs are open to **ETSI members, non-members and individuals**.

- ❖ **Researchers and academics can take up official positions** (Chair / Vice-Chair), apply for technical leadership positions (TSC, MDL), lead the alignment and feedback to ETSI Technical Groups, and take an active role in driving the current and future work of ETSI.
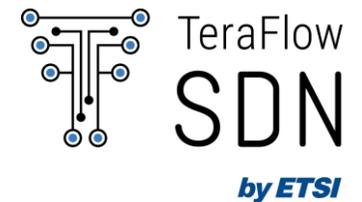
Example:
# ISG Building Blocks used for 5G Technologies

All ICT systems are a collection of distinct technologies linked together to provide the requisite solutions and services.

5G is a good example as it assembles several technologies including *(but not limited to)*:

- **(Radio)**   mWT / Massive MIMO / Beam forming …
- **(Network)**   Slicing / Edge / Cloudification / Zero Touch …
- **(Transport/Optical)**   PONs / ARNs / …
- … to name but a few

Several of the technologies listed above have been examined in ETSI ISGs before being offered to 3GPP via direct member contribution, including topics relating *(but not limited)* to:

- ISG NFV / OSM
- ISG mWT
- ISG MEC
- ISGs ZSM / ENI / SAI / IPE / NIN
- ISGs SAI / PDL / ARF / F5G
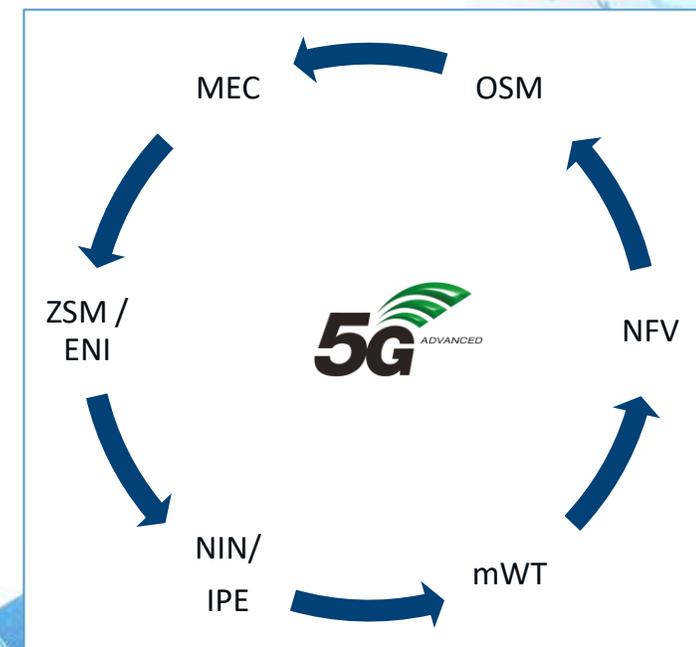
Potential 6G pre-standards Groups,
# What next 'may' be enabled in ETSI ISGs/TBs ?

ETSI is always considering potential new areas of work.

The topics identified in the ETSI Technology Radar (ETR) are a good starting point but not only.

ETSI is 100% member-driven and is interested in suggestions and contributions from our Member organizations (present & future) about potential new areas of work for 2023 and beyond.

Today, there is *no consensus of what the 6G technologies will include*, but they will be a mix of,

- *Evolutionary* technology developments, building on 5G evolutions

- and *Revolutionary* technology leaps, requiring a 'new' Generation
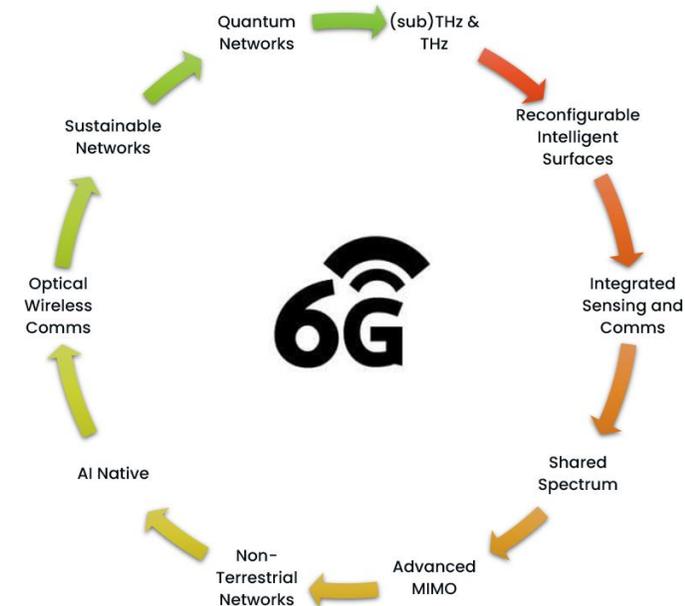
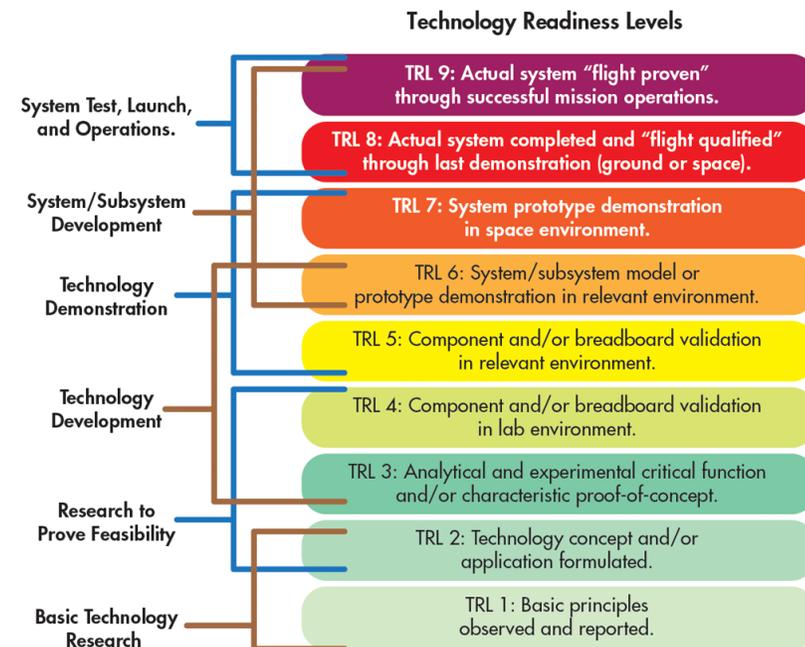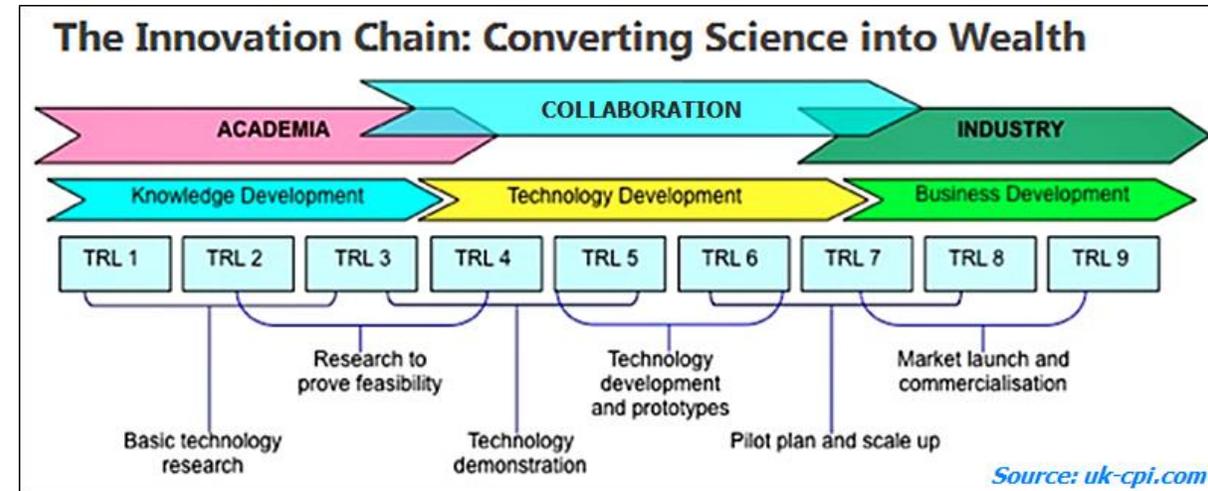6G, the Window of Opportunity (for pre-standards work)

Source: B. Barani, former DG Connect
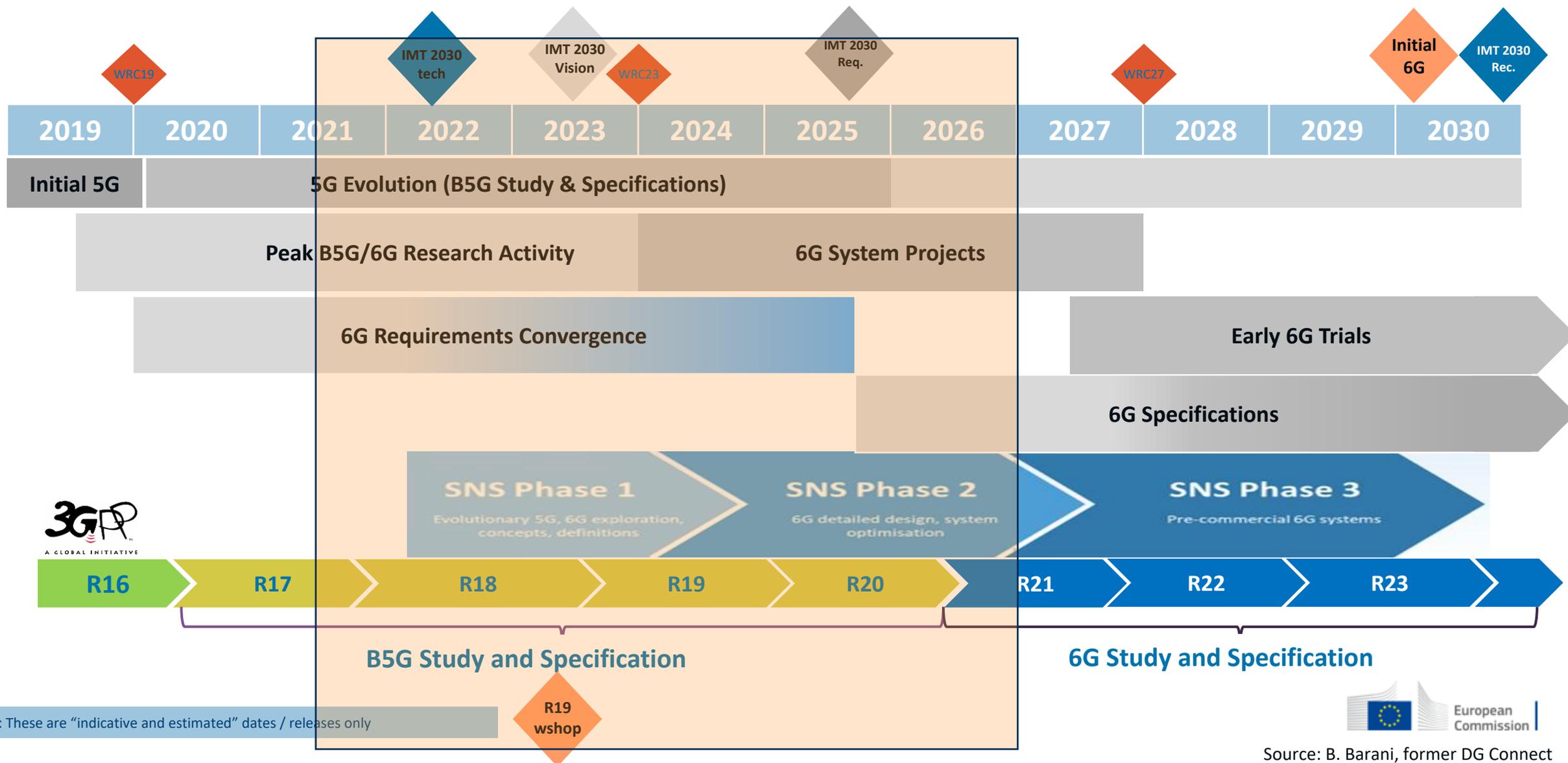
NOTE: These are "indicative and estimated" dates / releases only
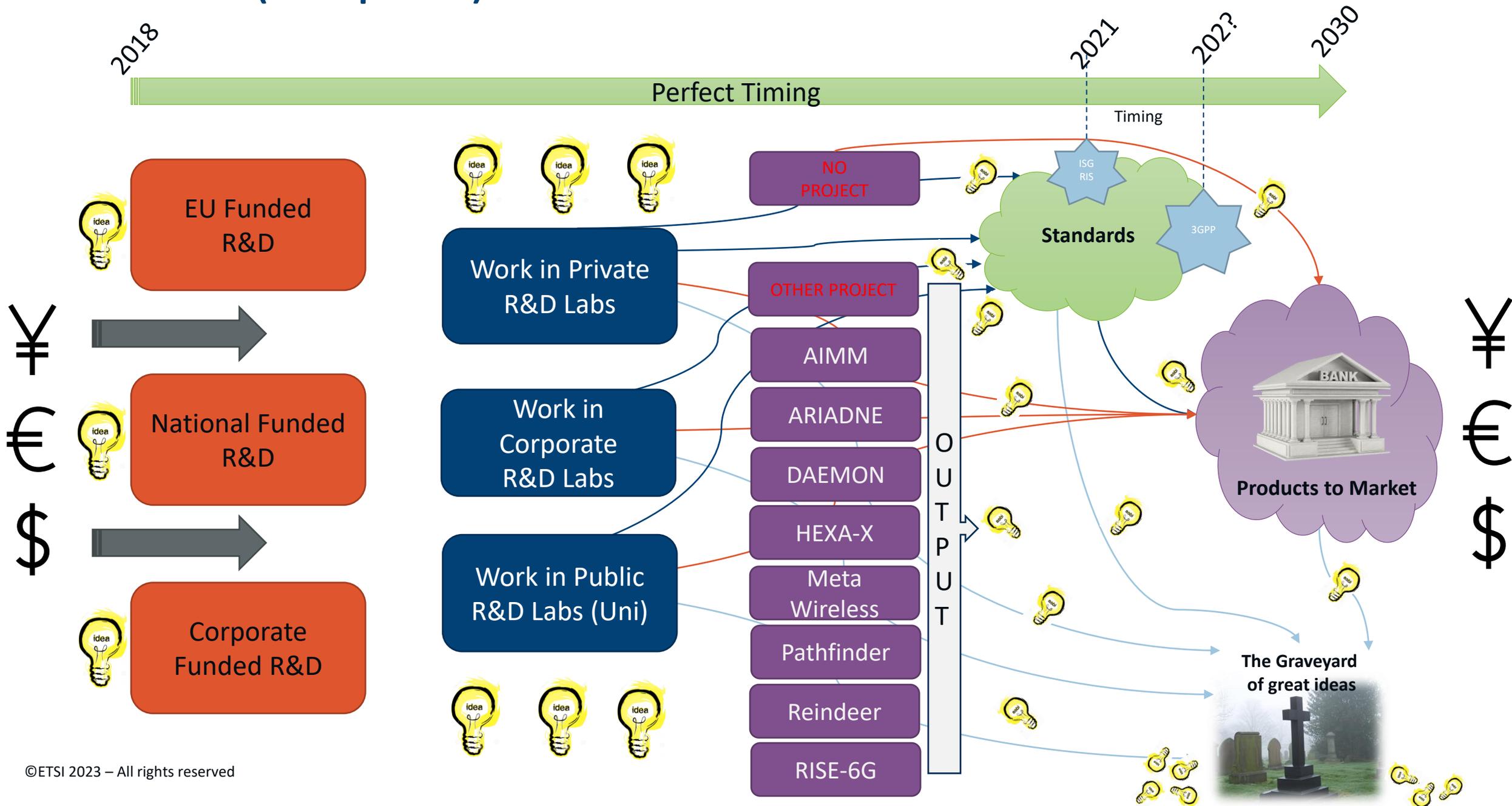
Is there a "Right time" for moving research into standards?

- Different maturity levels for research (TRLs = Technology Readiness Levels)

- Early, exploratory research (TRL 1, 2, 3) is *typically* not ready for standards *(there are exceptions)*.

- As soon as research moves to TRL 4, 5 -> and up is considered 'mature' enough to be developed further via early-standards work (pre-standards).

- Before moving to market (TRL 7, 8, 9) standards are generally required to ensure interoperability of solutions, equipment and services.

- NOTE: This is a guideline and there are exceptions.

The Innovation Chain: Converting Science into Wealth

Source: uk-cpi.com

Technology Readiness Levels

TRL 9: Actual system "flight proven" through successful mission operations.

TRL 8: Actual system completed and "flight qualified" through last demonstration (ground or space).

TRL 7: System prototype demonstration in space environment.

TRL 6: System/subsystem model or prototype demonstration in relevant environment.

TRL 5: Component and/or breadboard validation in relevant environment.

TRL 4: Component and/or breadboard validation in lab environment.

TRL 3: Analytical and experimental critical function and/or characteristic proof-of-concept.

TRL 2: Technology concept and/or application formulated.

TRL 1: Basic principles observed and reported.

(Example RIS) The Innovation - Standards - Market Flow

2018 2021 202? 2030

Perfect Timing

Timing

EU Funded R&D

National Funded R&D

Corporate Funded R&D

Work in Private R&D Labs

Work in Corporate R&D Labs

Work in Public R&D Labs (Uni)

NO PROJECT

OTHER PROJECT

AIMM

ARIADNE

DAEMON

HEXA-X

Meta Wireless

Pathfinder

Reindeer

RISE-6G

OUTPUT

ISG RIS

3GPP

Standards

BANK

Products to Market

The Graveyard of great ideas

Recent pre-standards Group, Industry Specification Group - ISG RIS (Sept. 2021)

ETSI ISG RIS:

Mission: Provide an opportunity for ETSI members to collect their pre-standards research efforts on RIS technology across various EU/UK collaborative projects, extended with relevant global initiatives, towards paving the way for future standardization of the RIS technology.
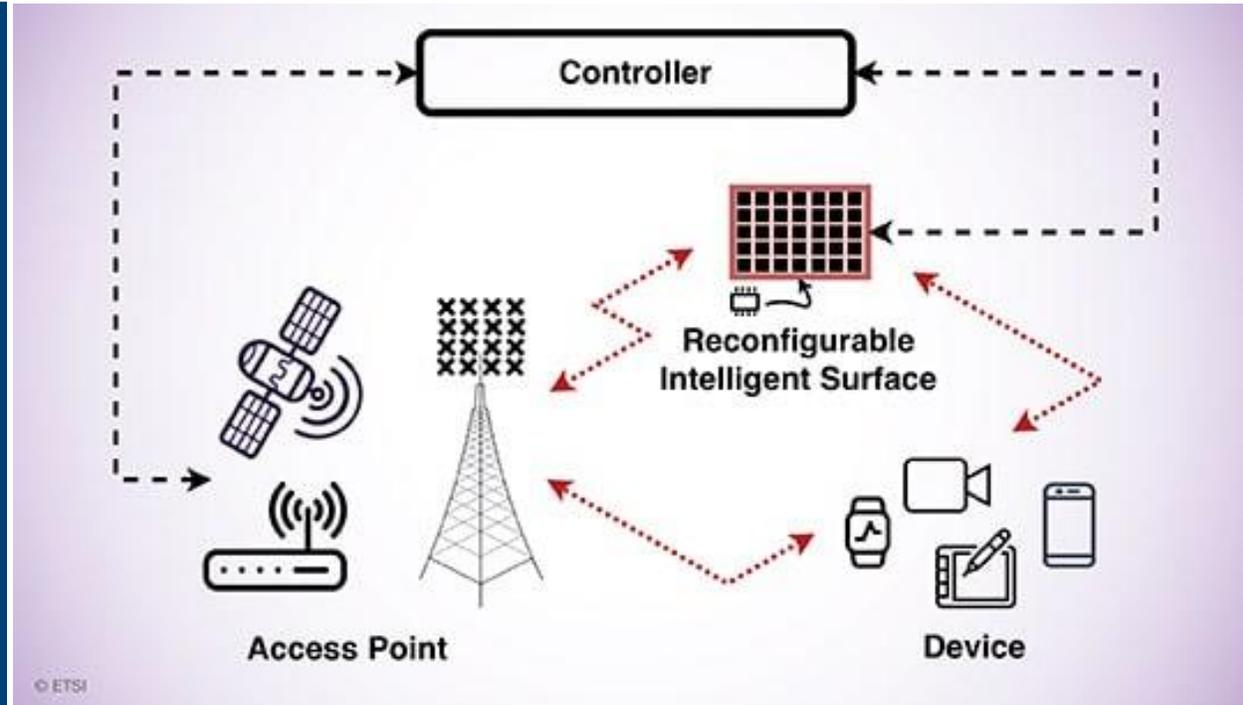
Currently 44 members and 3 participants

1 x deliverable published

3 x deliverables currently being drafted.

More information on https://www.etsi.org/committee/RIS

Recent pre-standards Group, Industry Specification Group - ISG THz (Sept. 2022)

ETSI ISG THz:

Mission: Establish technical foundations for THz communications (100 GHz -> 10 THz).

Place for ETSI members *(and non-members)* to progress their pre-standardization activities resulting from EU/National research efforts in the domain of THz technologies.

The ISG will expand the community to include various industry players and international initiatives as well as investigating what is needed for THz standardization.

The ISG will prepare systematic output on channel models, system parameters, and evaluation assumptions, for subsequent evaluation of THz communications systems by 3GPP.
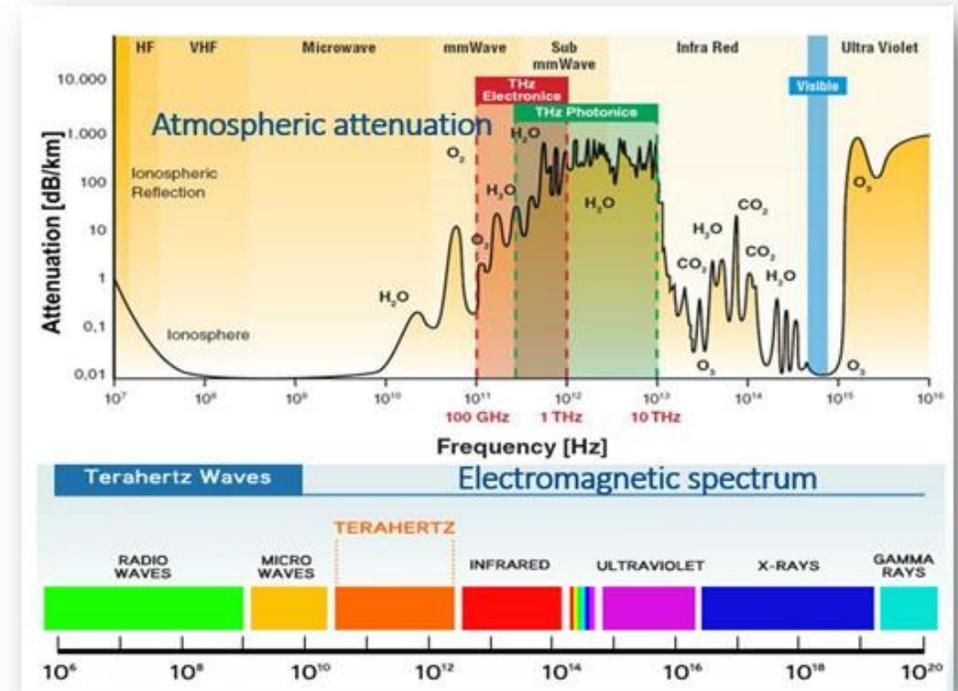
Approved at Board#139, 25 Founding Members *(record level of support for an ISG approval in ETSI)*

Currently 45 members and 2 participants

4 x deliverables currently being drafted.

More information on https://www.etsi.org/committee/THz

How does ETSI provide value to researchers?

- Opportunity to bring research results directly into standardization

- Be instrumental in the development of world class ICT standards that can be applied worldwide

- Benefit from ETSI's fair and effective IPR policy that is designed to protect your intellectual property

- Access to the leading-edge ICT knowledge from the 900+ other members

- Learn what the industry players are thinking and where they need research to be developed

- Opportunities to be visible, build a strong community and network with both industry and governmental standards setters and policy makers

- Opportunity to raise the profile and reputation of researchers as well as of the universities and research institutes, through participating in international standardization

- Gain insight into critical issues such as regulatory & spectrum matters, as well as deep knowledge of the latest European research agendas and policy priorities

- Researchers and academics can take up official positions (Chair / Vice-Chair), become rapporteurs for ETSI deliverables and actively drive the current and future standards work of ETSI.

- Reduced membership fee for universities and researchers allows access all technical aspects in ETSI and participate fully to all of ETSI's technical groups as well as the Partnership projects of oneM2M and 3GPP.

More information on www.etsi.org/research
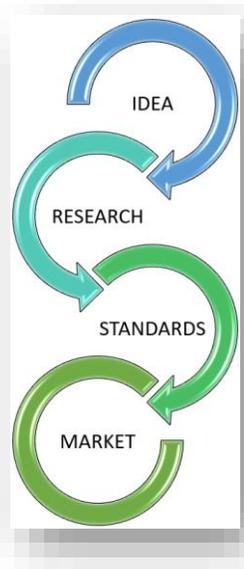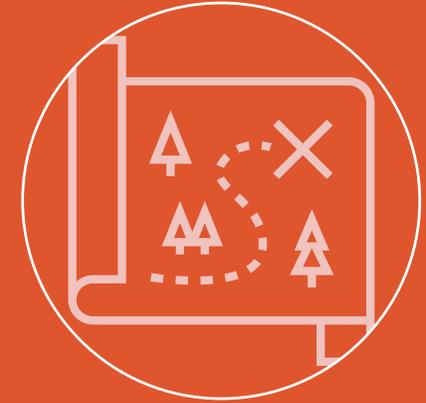
ETSI Support to Research Projects

General Advice on Standardization

Letter of Support to Projects

ETSI presence on Advisory Committee

Mapping of research to ETSI working groups

We are here to help.   Contact research@etsi.org

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ETSI Support to Research Projects

General Advice on Standardization

Researchers and Projects can seek advice from research@etsi.org on

1) General Standardization topics and 2) ETSI specific questions

Much information, guidance and extensive FAQ are available on the ETSI research website: https://www.etsi.org/research

ETSI provides guidance on where and how researchers and research projects may get involved in standardization

ETSI provides support to a number of EC / National funded projects

BUT any project may ask ETSI for advice, with no need for a pre-signed LoS

ETSI Support to Research Projects

Letter of Support to Projects

ETSI is able to provide a Letter of Support (LoS) to project consortia making project proposals <under certain conditions>. For both EC and National projects

If the project 1) is related to ETSI's scope 2) contains at least 2 ETSI members and 3) considers ETSI standards as input and/or output – then we can talk LoS

The ETSI LoS process is simple, and fast,

A LoS can be produced within 2 weeks if all conditions met & info is provided

A LoS from a recognized SDO *may* be considered positively in project proposal reviews as it demonstrates a plan for the project to engage in standardization

ETSI Support to Research Projects

ETSI presence on Advisory Committee

Members of ETSI staff and representatives of ETSI Technical Committees may be present on EXTERNAL Advisory Committees of projects where we have a LoS

'TYPICALLY' ETSI in NOT inside the project consortium and does not receive payment from the funding organization – our efforts are free of payment

Being inside the project external advisory committee allows ETSI to provide greater levels of standardization advice and support to the project

As our activities on the advisory committee are not funded 'TYPICALLY' we only participate to remote meetings with no travel for F2F interactions

'TYPICALLY' indicates there may be exceptions to the rule

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ETSI Support to Projects

Project Name	Project Long Name	Fun...	Str...	Stream Type	Ty...	Cordis Link	Project General Objectives	Technologies Covered	Map to ETSI Groups
6G-SHINE	6G SHort range extreme communication IN entities	SNS	B	[6G] Radical technology advancement in preparation for 6G, IoT, devices and software	RIA	https://cordis.europa.eu/project/id/101095738	6G-SHINE project will pioneer the main technology components for in-X wireless subnetworks, short range low power radio cells to be installed in a wide set of vertical and consumer entities like robots, vehicle, production modules, classrooms, for the sake of supporting extreme communication requirements in terms of latency, reliability, or data rates. 6G-SHINE will leverage the opportunities offered by the peculiar deployment characteristics of such short range subnetworks, for a highly performant yet cost-efficient radio design that allow to bring wireless connectivity to a lever of pervasiveness which has never been experienced earlier. 6G-SHINE copes with topics ""New IoT components and devices"" and ""New physical layers and associated protocols"" of strand B-01-03 in the SNS work programme. Research will span physical layer, medium access control protocols, radio resource management of these in-X subnetworks, as well as connection with a broader 6G 'network of networks'. The performance of the designed solutions will be analyzed via simulations, and –for selected technologies– over demonstrator platforms. The project will result in a broad set of technology solutions that will be disseminated via scientific publications. Also, the designed solutions will be brought to future 6G standardization, and will be used in future telecommunication equipment and networks. The consortium consists of 12 partners that together bring essential expertise to each of the identified technologies with a mixture of academic institutions and industry players with a strong research department, representing the	Network of sub-networks, sidelink, RIS-aware PHY/MAC protocols, sub-THz PHY/MAC protocols	3GPP, ETSI RIS ISG, ETSI THz ISG (potentially new ETSI ISAC ISG)
6GTandem	A Dual-Frequency Distributed MIMO Approach For Future 6G Applications	SNS	B	[6G] Radical technology advancement in preparation for 6G, IoT, devices and software	RIA	https://cordis.europa.eu/project/id/101096302	6GTandem project will demonstrate ultra-high-capacity coverage, off-load of lower frequency bands and new services such as sub-cm resolution sensing and positioning in high traffic areas by adding sub-THz carriers to lower frequency bands in a seamless, tightly coordinated fashion. The two frequency bands will form a network collaborating and supporting each other in a "tandem" configuration enabling an introduction of high capacity, energy efficient, sub-THz enabled services, while mitigating known drawbacks of the sub-THz frequency bands such as susceptibility to line-of-sight blockage, coverage, and cost. Deployment will be addressed through the introduction of a thin and light dielectric waveguide to distribute a sub-THz RF signal through a daisy chain of integrated low-power antenna units, referred to as a "radio stripe". We will demonstrate the use of lower, sub-10 GHz frequency bands to support the sub-THz band with resilience and coverage and the implementation of a distributed MIMO system to extend the coverage of the sub-THz band as well as offering capacities in the order of Tbps system throughput. We will demonstrate the possibility to implement local fronthaul solutions for added sub-10GHz access points using the high bandwidth of sub-THz radio stripes. Key elements for 6GTandem: – A system defining an 'aligned tandem' dual-frequency distributed MIMO architecture – Medium-aware waveforms, transmission schemes and communication strategies for energy-efficient operation and development of cross-layer solutions to offer required service levels as	dMIMO, Antennas, Radio, sub-THz	ISG THz
ADROIT6G	Distributed Artificial Intelligence-Driven Open And Programmable Architecture For 6G Networks	SNS	B	[6G] Radical technology advancement in preparation for 6G, IoT, devices and software	RIA	https://cordis.europa.eu/project/id/101095363	As the world moves from the 5G towards the 6G era, the mobile communications fabric needs to be architected differently to accommodate the emerging stringent requirements of innovative extreme future-looking applications that cannot be served by existing 5G mobile networks. Heading towards the next decade, when 6G is expected to be widely deployed, 5G application types will be redefined by morphing the classical service classes of URLLC, eMBB, and mMTC and introducing new services. ADROIT6G is an SNS JU project supporting the EC's 6G policy by implementing the first phase of the 6G SNS roadmap towards the evolution of a 6G architecture. ADROIT6G proposes disruptive innovations in the architecture of emerging 6G mobile networks that will make fundamental changes to the way networks are designed, implemented, operated, and maintained. Such innovations include: (i) AI/ML-powered optimizations across the entire network, for high performance and automation; (ii) Transforming to a fully cloud-native network software, which can be implemented across a variety of edge-cloud platforms, including Non-Terrestrial Networks, with security built integrally into the network user plane; (iii) Software driven, zero-touch operations and ultimately automation of	AI/ML, cloud native	ETSI SAI ISG, ETSI ENI ISG, ETSI MEC ISG

The ETSI CAT•ALYST tool

It would be great to talk with the standards experts...

It would be great to talk more about research topics

Researcher/Innovator(s)

Standards Expert(s)

The ETSI "Come-and-Talk" (CAT•ALYST) tool is designed to encourage open exchange on research & technology topics.

CAT•ALYST sessions are made available upon demand and help the research community discuss with standards experts on specific topics of common interest.

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ETSI Resources for Researchers and Academics

Helpdesk for Researchers

www.etsi.org/research

https://www.linkedin.com/
showcase/etsi-standardization-
research-innovation-education

Helpdesk:
research@etsi.org

Director New Technologies:
David.Boswarthick@etsi.org

Dedicated research Webpages

Dedicated contact email

Guides / Leaflets / Videos

Support to EU Projects

Advice on EU Research

Setting up new Standards Groups

Advice on Standards Activities

… and more

For Further Information:

Contact:

research@etsi.org

David.Boswarthick@etsi.org

About the Speaker

Experience:

- 30+ years experience in Telecoms

- 24 years in ETSI (3GPP support and others)

- Experience in British Rail Telecoms, Monaco Telecom, GTS and others before entering the world of standardization

Role in ETSI:

- Director New Technology Department (NET)
  - **Links to Research and Academia**
  - **Future Technology Tracking**
  - **Building new groups in ETSI**

Contact:

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Research@etsi.org