



The Standards People

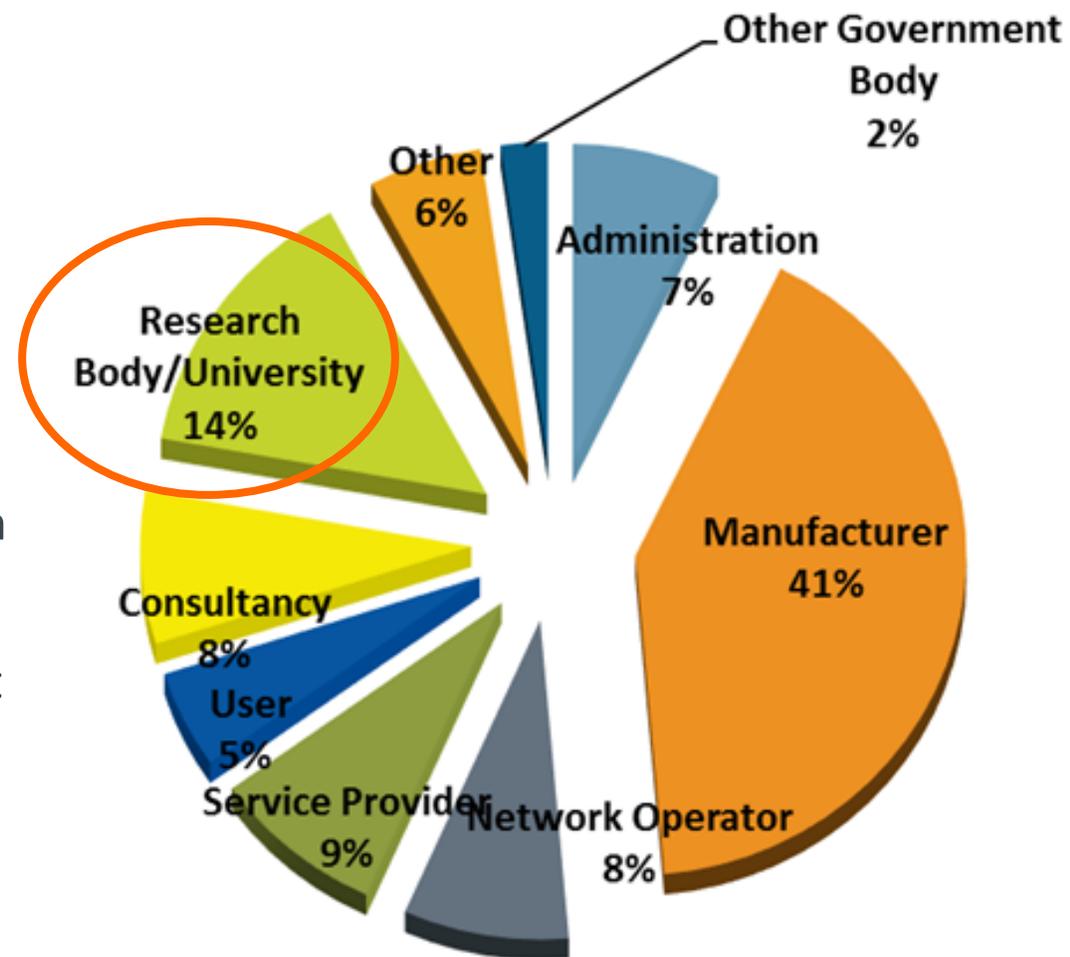
From Research to Standards, Research and Innovation in ETSI

Author: David Boswarthick, Director of New Tech. **For:** Information

Created: November 2021

ETSI community of researchers, academics and innovators

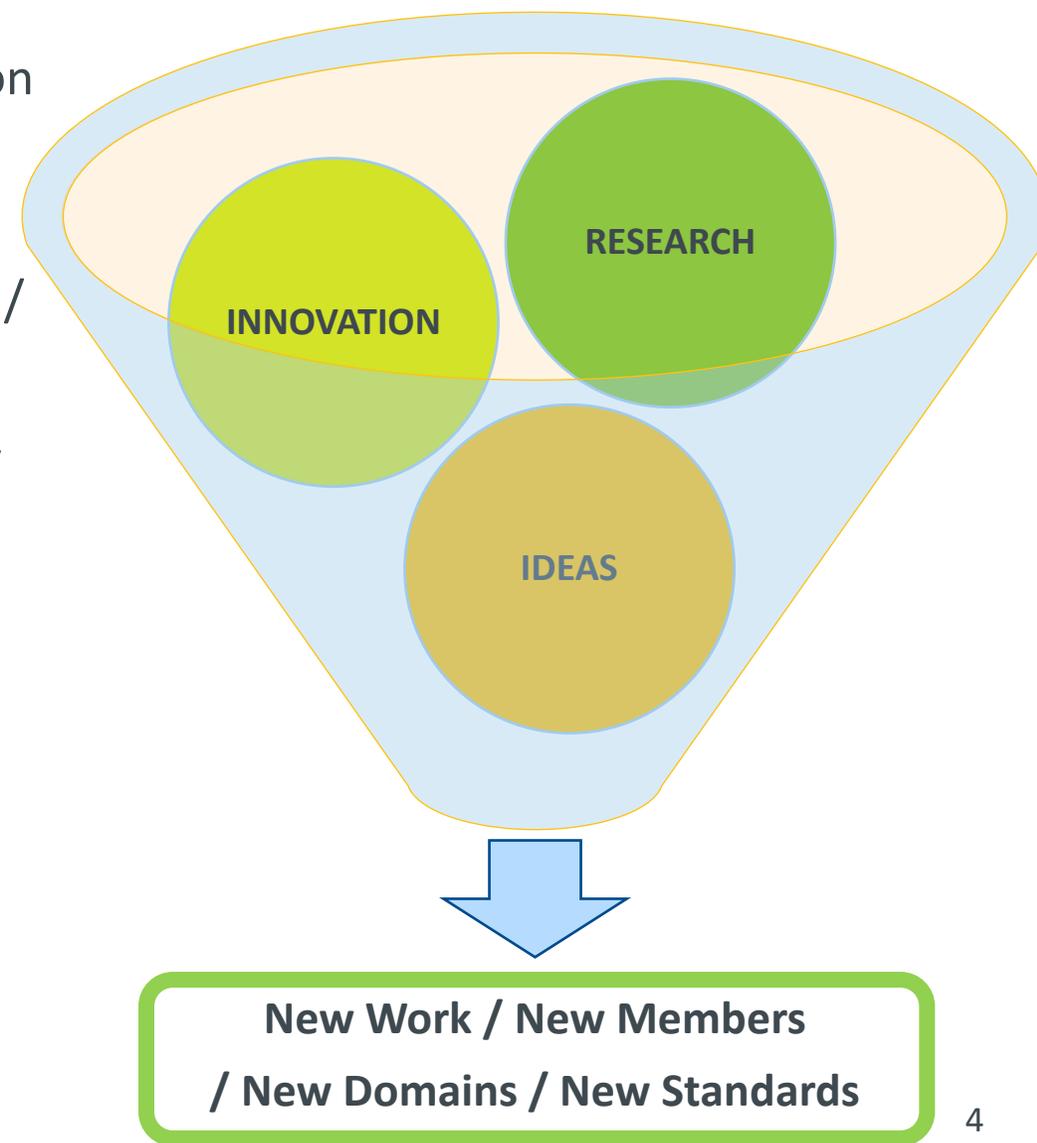
- ✔ ETSI currently has over 920 members organizations
- ✔ Public / Private Research organizations and Universities make up for over **14%** of our ETSI membership and are present both in Europe and globally
- ✔ Through a single membership, all university representatives and postgraduate researchers may have access to all of the technical work of ETSI
- ✔ All ETSI members have equal rights of direct participation in the standards-making activities and related services
- ✔ Being a research and innovation member of ETSI, will put you in good company.



Membership fee of €2 000* per calendar year, it's a great deal for universities and public research bodies

Research and Innovation, the lifeblood of ETSI's technical work

- ✔ ETSI encourages a constant flow of research and innovation output into the standards work of our Technical Groups
- ✔ ETSI has made the interactions with researchers and innovators a priority at all levels, (ETSI Board / Secretariat / and Technical Groups)
- ✔ **ETSI Board_TREND group:** is looking at Future Technology Trend Evolution, and produces the ETSI Technology Radar (*see next slide*)
- ✔ **ETSI Board_RISE group:** is developing mechanisms to facilitate better links between Research & Standards
- ✔ The new ETSI Department (NET) created in 2020 to serve the unique objectives of working with R&I and academia.



Presenting the ETSI Technology Radar (ETR)

The ETR has been developed by the ETSI Board TREND group in 2020, using the following methodology;

1. A thorough analysis of **15 publicly available technology reports**, <see ANNEX A> as well as **questionnaires** to the ETSI board, technical groups and ETSI members,
2. Consensus agreement on the top ten (10) most relevant (to ETSI) technology trends,
3. For the selected (10) technology trends, the identification of affinities and gaps with respect to current ETSI activities, the definition of a time frame of maturity for standardization, and recommendations for actions and more detailed analysis of the way forward to fill the identified gaps,

The ETR was published as an ETSI Whitepaper in April 2021 after approval by the ETSI Board.

The ETR has been promoted via press releases, Liaison and requests for feedback from partner organizations and European Research platforms.



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

The 10 Technology Trends in the ETR 2021 Edition

- B5G to 6G
- mmW to THz
- Autonomous
- Cell-less archi
- Full duplex

5G 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

Autonomous Networks



Clause 3.2.3

- Security
- Privacy
- Trust

Cybersecurity



Clause 3.2.4

- Blockchain
- PDLs
- DAGs

Distributed Ledgers



Clause 3.2.5

- Big Data
- Semantics
- Digital Twin

Dynamic Data



Clause 3.2.6

- Augmented Reality
- Virtual Reality
- Mixed Reality

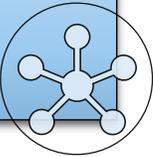
Extended Reality



Clause 3.2.7

- Ontologies
- Smart Cities
- Smart Factories

IoT



Clause 3.2.8

- QIT
- Quantum Compute
- Quantum Comms
- QKD / QSDC / QSS
- Sense / Metrology

Quantum



Clause 3.2.9

- Cloud Robotics
- Intelligent Transport Systems
- Unmanned Systems

Autonomous Systems



Clause 3.2.10

'Evolving' collection of Technologies of potential interest for Research projects and (pre)-Standardization activities



B5G -> 6G Building Block Technologies

- Reconfigurable Intelligent Surfaces: RIS
- High frequency bands such as upper mmWave, sub-THz and THz
- Optical Wireless Comms (OWC):
 - VLC = Visible Light Comms
 - LiFi = Light Fidelity
 - OCC = Optical Camera Comms
 - FSOC = Free Space Orbital Comms
- Pervasive AI / ML, predictive AI
- Non-Terrestrial Networks (NTN)
 - CubeSats, satellites (LEO / MEO / GEOs) (low/medium/geosynchronous Earth Orbit)
 - HAPS (High Altitude Platform Station), UAV (Unmanned Aerial Vehicles)
 - Underwater Comms (OK it is terrestrial)
- Quantum communication networks (beyond QKD)
- HPC (High Performance Computing)
- EDGE Intelligence (EDGE powered by artificial intelligence (AI) techniques (e.g. machine learning, deep neural networks))
- Blockchain / DLTs
- VR / AR / XR
- Cell-free 'ultra' massive MIMO
- Waveform, Multiple Access and Full-Duplex (NOMA / RSMA.. others)
- New 'smart' network protocols (TCP/IP)
- ... and potentially many more

USE CASES / APPLICATIONS or SERVICES

- Device Centric -> Service Centric -> User Centric
- Internet of "skills"
- IoT to Internet of "Everything"
- Tactile Internet (sense and smell and touch) haptic
- Remote learning
- Fully Autonomous mobility (unmanned)
- Smart Cities / smart agriculture (smart environment / infrastructure)
- Holographic telepresence (Teleportation)
- Remote healthcare / remote surgery / eHealth for all
- Industrial automation / connected robots and systems
- Network enabled (indoor / outdoor) positioning, navigation and sensing
- Digital Twins
- Precision 'sense' & 'actuation'
- Brain to computer interactions (BCI)
- Mind to Mind communications
- Earth to Space and Space to (deep) space communications
- ... and potentially many more

"Yottabytes are predicted by 2030"

NEW Technology Trends possibly for the ETR 2022 Edition

- Terabit PONs

AGREED

Photonics

Clause 3.2.11

- Sub-THz
- Full THz
- PNS
 - Position
 - Navigate
 - Sense

THz

- RIS beamforming
- Meta-materials/surfaces
- RIS Wireless Power Transfer
- Location and sensing

RIS **ISG RIS CREATED**

- VLC = Visible Light Comms
- LiFi = Light Fidelity
- OCC = Optical Camera Comms
- FSOC = Free Space Orbital Comms
- LIDAR = Light Detect and Ranging

OWC

- Satellite (LEO/MEO/GEO)
- High Throughput Sats (HTS)
- Cubesats
- HAPS
- UAV

NTNs

- EDGE powered by artificial intelligence (AI) techniques

Intelligent EDGE

- Quantum Comms
- Beyond only QKD
- Quantum Entanglement

Quantum Networks

- High Performance Compute
- Converged compute – comms archi.

HPC

- SD Radio
- SD Networking

Software Defined

- Energy Harvest/Transf.
- Low Power Operations
- AmBC (amb. Backscatter)
- Recycle materials
- Resource optimization
- Efficient bandwidth

Sustainable

NEW Technology Trends USE CASES for the ETR 2022 Edition

- Massive Digital Twinning
- Virtual worlds

Digital Twins



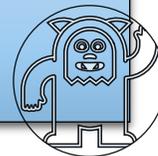
- Internet of Skills
- Internet of Everything
- Internet of Senses (Tactile)

IoE / IoS



- Teleportation
- Immersive Telepresence

Holographic Comms



- Education

Remote Learning



- Telemedicine

eHealth



- Immersive Cities
- IoT Micro-Networks for Smart Cities

Smart Cities



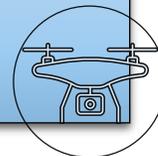
- Sensing
- Positioning
- Measuring
- Navigating

Earth Monitor



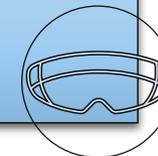
- Unmanned mobility
- Robot swarms

Mobility



- AR/VR + AI + Internet
- Holograms
- Avatars
- Collaborative working
- Social Networking

Metaverse



- Human machine int.
- Mind to compute int.
- Mind to mind comms
- Embedded / ingested devices

New Devices



(Example RIS) The Innovation - Standards - Market Flow

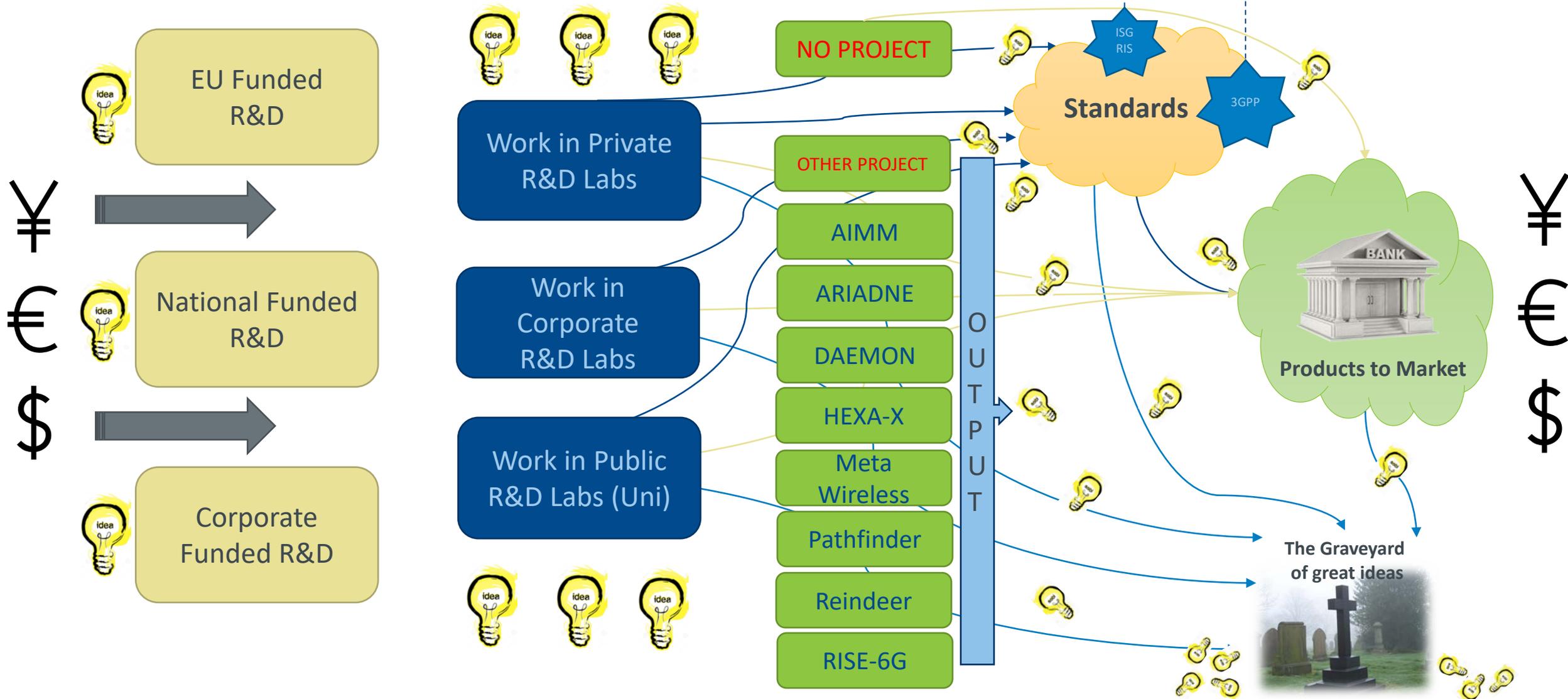
2018

Perfect Timing

2021

202?

2030



Example of research to pre-standards, new ISG RIS (Sept. 2021)

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.

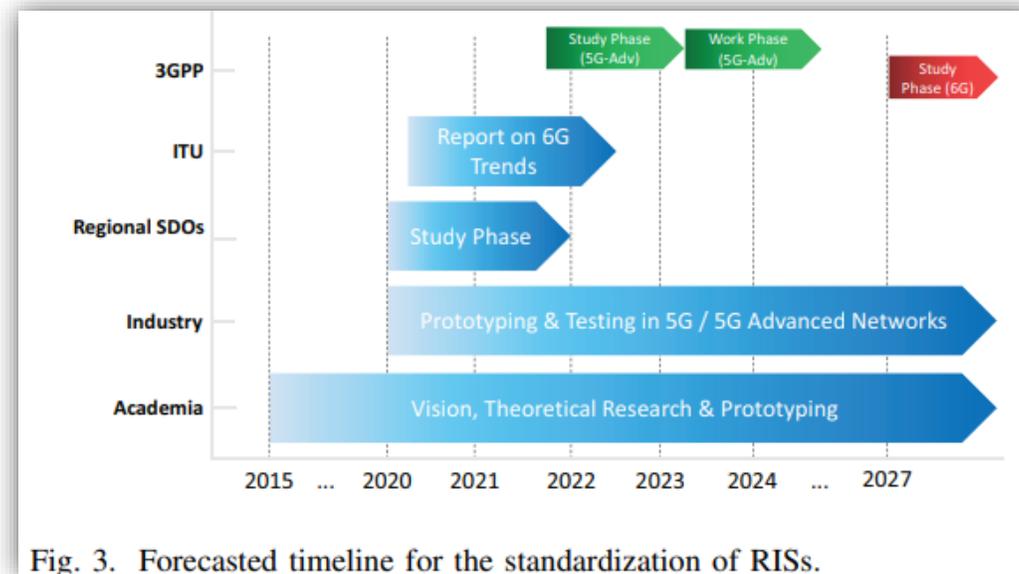
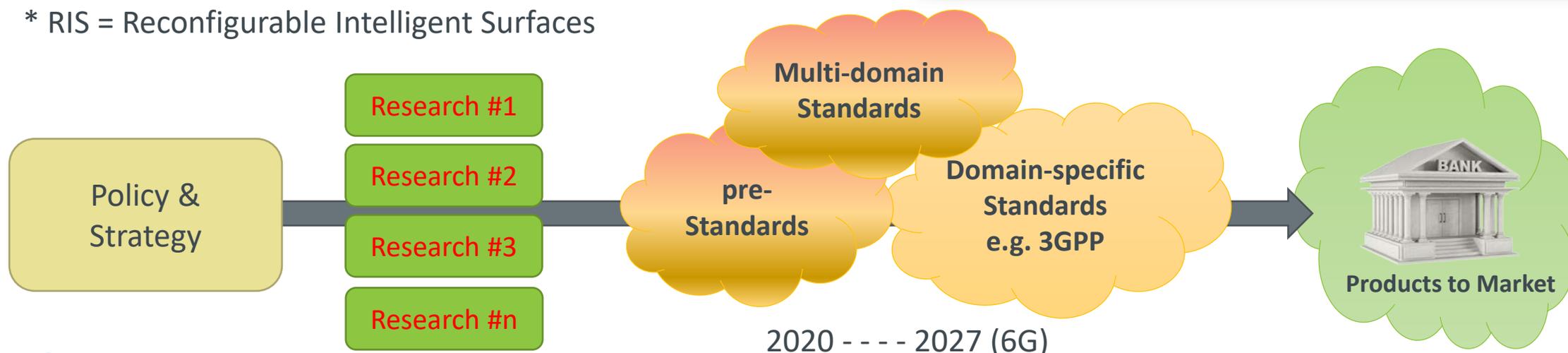


Fig. 3. Forecasted timeline for the standardization of RISs.

* RIS = Reconfigurable Intelligent Surfaces



ISG RIS Founding Members

| No | Organization | Country | Type | ETSI Member | ETSI Board Member | Contact Points |
|----|------------------------------------|------------|--------------------|-------------|-------------------|---|
| 1 | British Telecommunications plc | UK | Operator | Yes | Yes | Adrian Sharples (adrian.sharples@bt.com) |
| 2 | CEA-LETI | France | Research Institute | Yes | No | Emilio Calvanese Strinati (emilio.calvanese-strinati@cea.fr) |
| 3 | CNIT | Italy | Research Institute | Yes | No | Stefano Buzzi (s.buzzi@unicas.it) |
| 4 | CNRS | France | Research Institute | Yes | No | Marco Di Renzo (marco.di-renzo@universite-paris-saclay.fr) |
| 5 | IMEC | Belgium | Research Institute | Yes | No | Olivier Caytan (olivier.caytan@ugent.be) |
| 6 | InterDigital Europe Ltd | UK | Vendor | Yes | No | Alain Mourad (alain.mourad@interdigital.com) Arman Shojaeifard (arman.shojaeifard@interdigital.com) |
| 7 | NPL (National Physical Laboratory) | UK | Research Institute | Yes | No | Tian Loh (tian.loh@npl.co.uk) Sundeep Bhandari (sundeep.bhandari@npl.co.uk) |
| 8 | NEC Europe Ltd | Germany/UK | Vendor | Yes | Yes | Xavier Costa (xavier.costa@neclab.eu) Vincenzo Sciancalepore (vincenzo.sciancalepore@neclab.eu) |
| 9 | UK DCMS | UK | Government | Yes | Yes | Simon Hicks (simon.hicks@dcms.gov.uk) Francois Ortolan (francois.ortolan@dcms.gov.uk) |
| 10 | University of Oulu | Finland | Academia | Yes | No | Markku Juntti (markku.juntti@oulu.fi) |
| 11 | ICS (University of Surrey) | UK | Academia | Yes | No | Rahim Tafazolli (r.tafazolli@surrey.ac.uk) Mohsen Khalily (m.khalily@surrey.ac.uk) |
| 12 | ZTE Corporation | China | Vendor | Yes | Yes | Richie Leo (richie.leo@zte.com.cn) |

7 out of 12 = Research & academia = interesting model

ETSI Resources for Researchers and Academics

- Advice on ETSI Standards Activities
- Dedicated research Webpages
- Dedicated ETSI mentor for academics/researchers
- Research guides / leaflets / videos
- Support to researchers for EU Project proposals
- Advice on EU research landscape
- Help with setting up new standards groups
- ... and more



ETSI Research webpages:

www.etsi.org/research



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



ETSI Research Helpdesk:

research@etsi.org



Director New Technologies:

David.Boswarthick@etsi.org

<<EXTRA SLIDES>>

Early Thoughts on 5G and Beyond (or 6G)

As we work on 5G - everyone is eager to announce 6G news

China To Launch 6G Network By 2030



Hexa-X – The joint European initiative to shape 6G

Early Commercial 6G Deployments Could Start as Early as 2028, Standards Expected in 2026

Data security, user privacy, and energy sustainability are the key features that make 6G a completely new communication system, not just a better 5G

London, United Kingdom - 04 May 2021

ATIS launches 'Next G Alliance' targeting 6G prospects in North America
New industry initiative focuses on establishing leadership in 6G

European Commission and European ICT community present a new 900million Euro joint undertaking to develop 6G in Europe
22nd June, 2021

6G R&I
What is 6G? The NGMN Alliance offers some foundational ideas

S. Korea to invest over US\$195 mil in 6G tech by 2025
Seoul aims to commercialise network, which is expected to reach theoretical speeds up to 50 times faster than 5G, as early as 2028

Japanese government earmarks \$482 million for 6G R&D
Finnish, Japanese research groups forge 6G alliance

ETSI Approach to Research & Standards for B5G / 6G

Operators are currently deploying **5G** networks across the globe. It is important to use caution when using the term **6G** to avoid diluting the impact of present day **5G** rollouts. **5G** is with us for at least another 10 years ++.

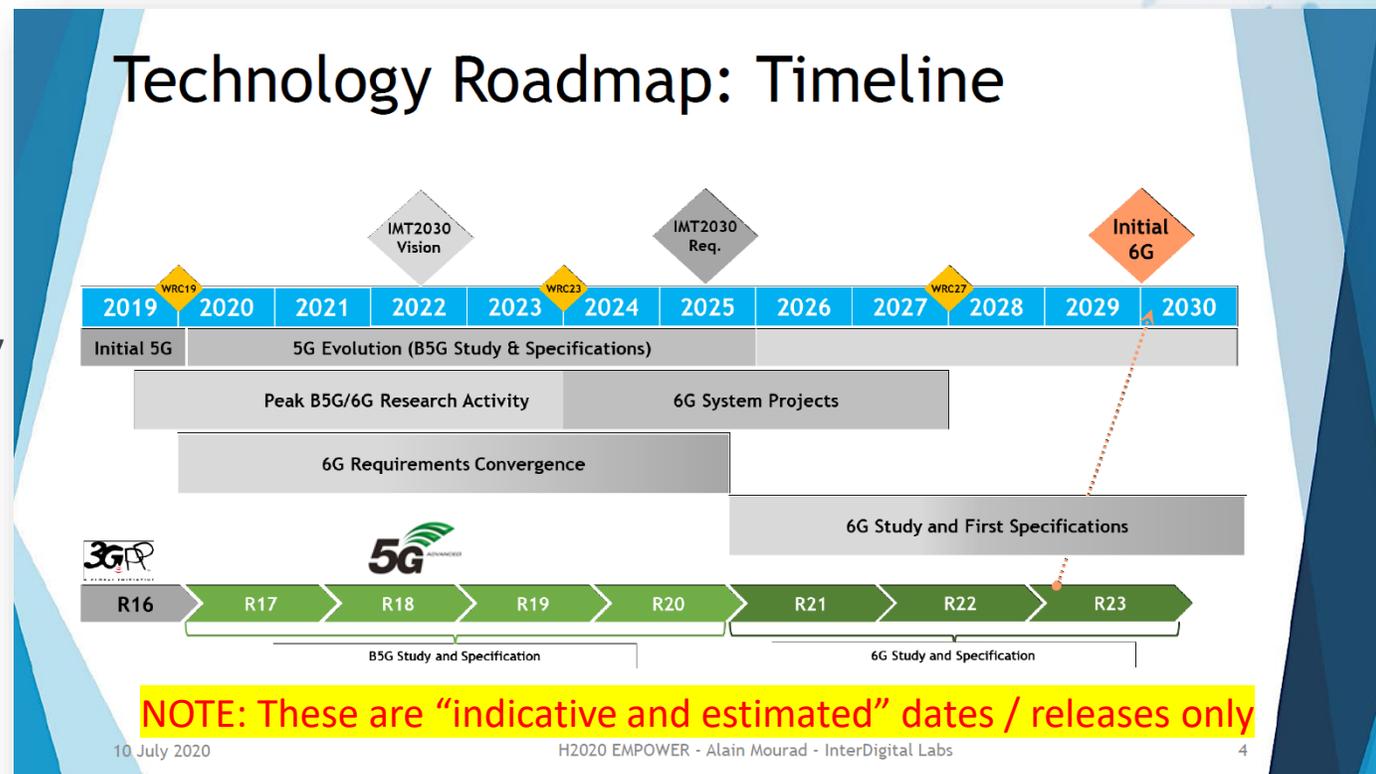
In ETSI we speak only of “RESEARCH and pre-standards work” for candidate B5G / 6G technologies.

6G is currently at the **Vision & Research** phase.

Initial study items for **6G** are not expected to be seen in 3GPP (SA1) until > 2025/2026.

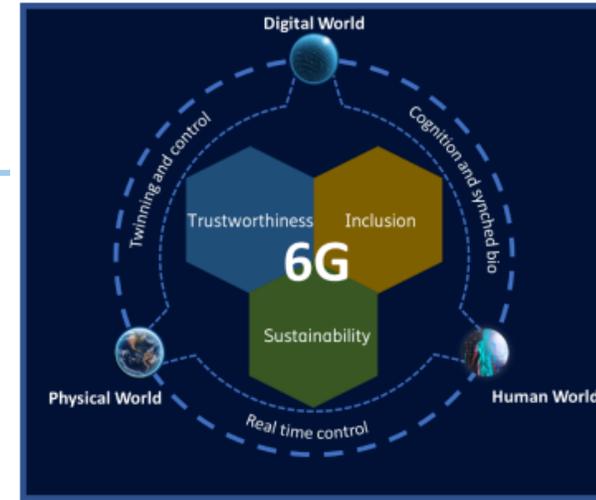
Current assumption is the first **6G** services *may* be deployed as of 2030... but of course expectations can and often do change due to global / market pressure.

5G evolution and **6G** developments will run as *parallel tracks* for several years.



6G Potential Use Cases

- 6G will enable the “Fully Automated Society”
- Holographic type communications -> tactile communications
- Smart working based on seamless holographic interactions
- Smart co-design and maintenance using real-time digital twins
- Multi-Sensory XR Applications for work and entertainment
- Connected Robotics, Co-bots and other Autonomous Systems
- Accurate indoor / outdoor “positioning” to include “sensing”
- Move from IoT > Internet of Senses > Internet of Experiences
- To meet these use cases 6G must:
 - provide undersea, terrestrial, air and space coverage.
 - enable full integration of advanced Artificial Intelligence (AI) characteristics.
 - Consider privacy and security as core components.



Hexa-X 6G vision



Multi-sense XR

Source: Samsung 6G whitepaper



Holographic Comms



Digital twin

6G Early Performance Targets

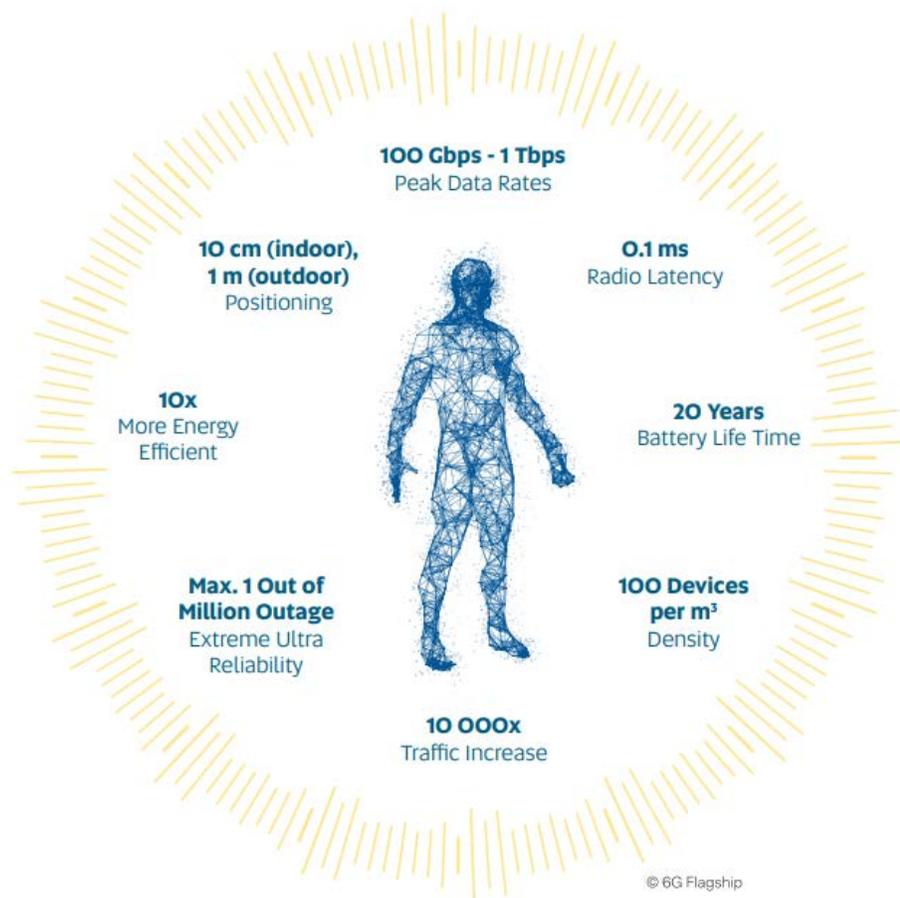
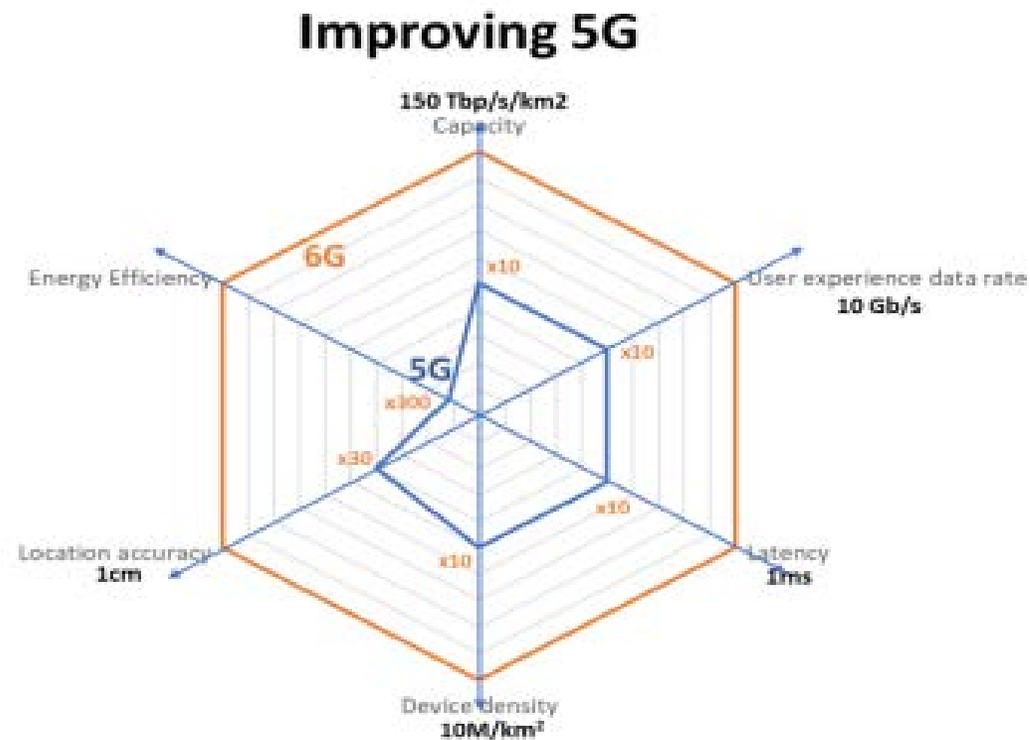


Figure 7. Generic 6G targets presented by academia and industry in different fora.

Source: EU 6G Flagship Project



Source: 5G-IA WP on 6G

6G Architectural Design Assumptions

6G Architectural Elements:

- Higher integration of Satellites and HAPS/UAVs
- Multiple public / private sub-nets, both fixed and wireless
- Software based / AI controlled
- Full integration of distributed (Native) AI
- Zero-Touch / fully Autonomous management and provisioning
- More Virtualization / Cloud, pushing processes to the EDGE
- Include Cell-less architectures
- New Radio technologies and advanced antenna design
- *Secure by design (from the start)*
- *Greater coverage (than 5G)*
- *Power/Resource efficient*
- ... and much more

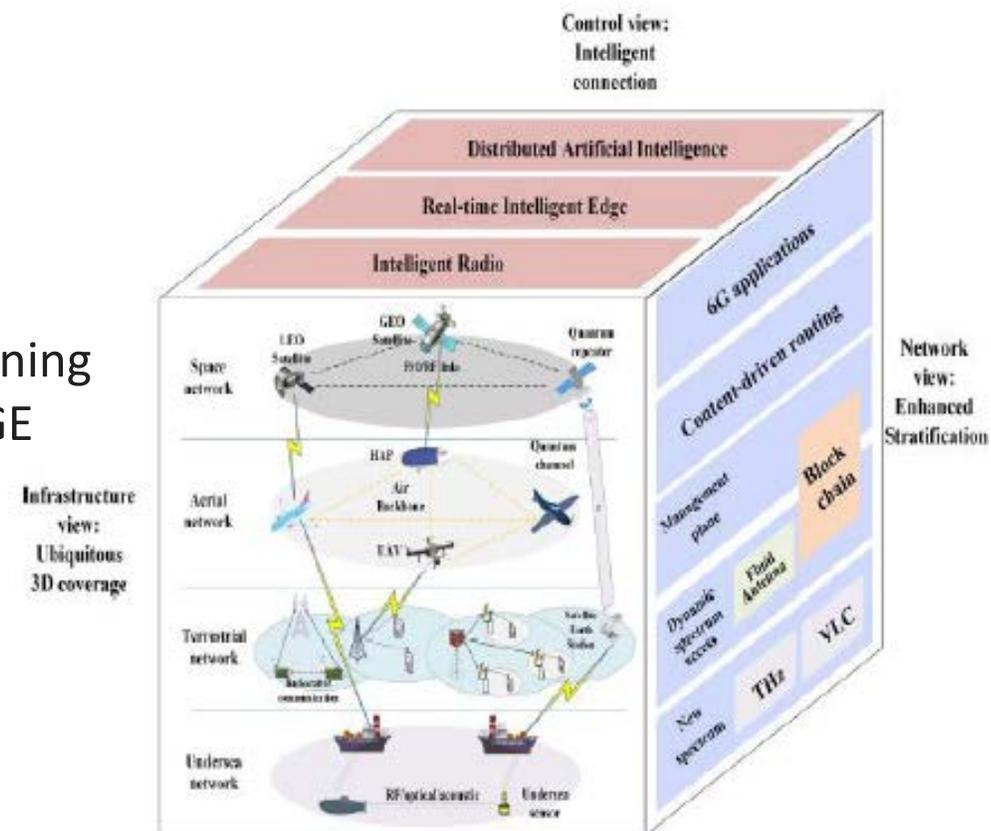


Fig. 1. Different Dimensions of 6G Architecture [17].

Source "A survey on green 6G network: Architecture and technologies." IEEE Access 7 (2019): 175758-175768.

Conclusion - *Cooperation, Communication, Coordination*

5G is the 'now Generation' and for the coming years 3GPP will focus on the evolution of 5G (Advanced and beyond)

6G will be deployed 'around' 2030, alongside an evolved 5G. Now is the right time to be doing the research into 6G Technologies and sharing the 6G vision

6G will be more than simply a better / faster 5G with lots of AI, but we still do not know precisely what it may contain. This is why we must research 6G now

ETSI has an important roll to play in linking the research into pre-standards / early standards to be provided to 3GPP (and others) when the time is right

Questions



ANNEX A: Reports considered in ETR

| |
|---|
| European Commission » Eurostat » CROS » Analysis of the future research needs for Official Statistics » Annex 5 - Megatrends in ICT https://ec.europa.eu/eurostat/cros/content/annex-5-megatrends-ict_en |
| THE INFLUENCE OF ICT MEGATRENDS ON GLOBAL MEGATRENDS, by Zvezdan Vukanović https://hrcak.srce.hr/file/299263 |
| Project INTEND: INtendify future Transport rEsearch NeedS https://intend-project.eu/wp-content/uploads/2018/05/intend-d3.1-report-on-main-megatrends.pdf |
| BMI Research published the second edition of its Towards 2050 https://www.capacitymedia.com/articles/3815182/towards-2050-the-industrys-megatrends |
| Deloitte: ICT megatrends in Brazil https://www2.deloitte.com/content/dam/Deloitte/br/Documents/technology-media-telecommunications/ICT-insights-report-eng.pdf |
| OECD TRANSFORMATIVE TECHNOLOGIES FUTURE JOBS https://www.oecd.org/innovation/transformative-technologies-and-jobs-of-the-future.pdf |
| Gartner Top 10 Strategic Technology Trends for 2019 https://www.gartner.com/smarterwithgartner/gartner-top-10-strategic-technology-trends-for-2019/ |
| Ericsson vision on convergence 5G AI and IoT https://t3chfest.uc3m.es/2018/static/resources/events_slides/2018-03-01_T3chfest_-_The_Convergence_of_5G_AI_and_IoT_v4.pdf?q=1519913894 |
| IERC report The Next-Generation Internet of Things https://www.riverpublishers.com/pdf/ebook/chapter/RP_9788770220071C3.pdf |
| Networld 2020 Strategic Research and Innovation Agenda 2021-27 https://www.networld2020.eu/wp-content/uploads/2018/11/networld2020-5gia-sria-version-2.0.pdf |
| Networld 2020 White Paper for Research Beyond 5G (relates to above) https://www.networld2020.eu/wp-content/uploads/2016/03/B5G-Vision-for-Researchv-1.1b_final-and-approved.pdf |
| Deloitte predictions for 2019 https://www2.deloitte.com/content/dam/Deloitte/ua/Documents/technology-media-telecommunications/DI_TMT-predictions_2019.pdf |
| F&S Technology Innovations Driving Future Growth for the Semiconductor Industry http://compass.formfactor.com/2018/wp-content/uploads/sites/8/COMPASS2018-Cotton-Keynote-Technology-Innovations.pdf |
| Munich RE Tech Trend Radar https://www.munichre.com/topics-online/en/digitalisation/future-technologies-tech-trend-radar-2018.html and the final report https://www.munichre.com/content/dam/assets/munichre/content-pieces/documents/pdf/MunichRe-IT-Technology-Radar-2018_free_version.pdf |
| EU ICT Rolling Plan (2020 version) Rolling Plan 2020 Joinup (europa.eu) |