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SRIA – A TECHNICAL BLUEPRINT FOR EC RESEARCH

Disclaimer

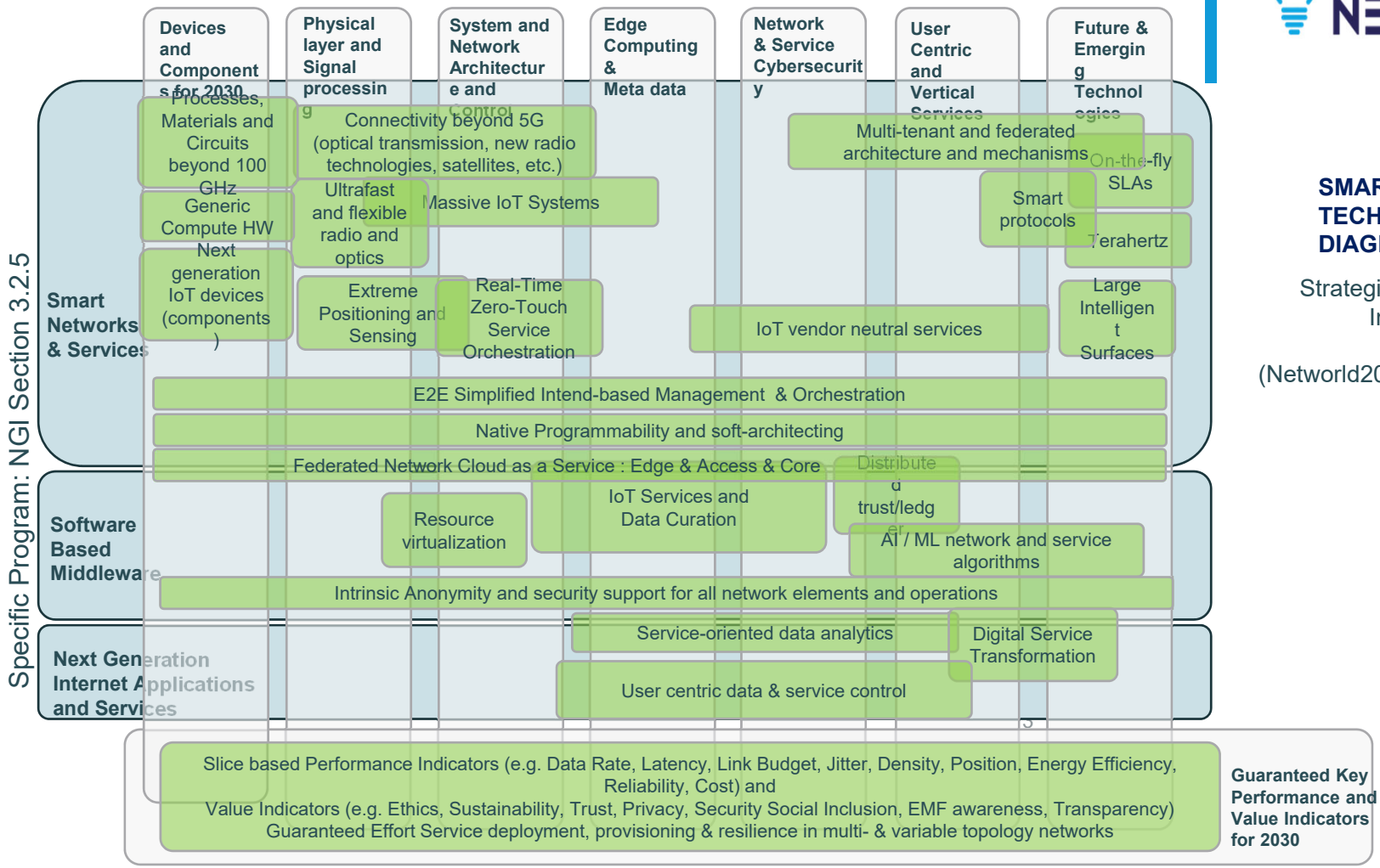
The SRIA contains 240 pages with ideas of more than 150 experts.

Therefore this presentation includes only some examples/thematic topics of the different areas covered by the SRIA.

The topic editors will do the deep dive in the topics today and tomorrow

The full document is availabe at:

https://www.networld2020.eu/sria-and-whitepapers/



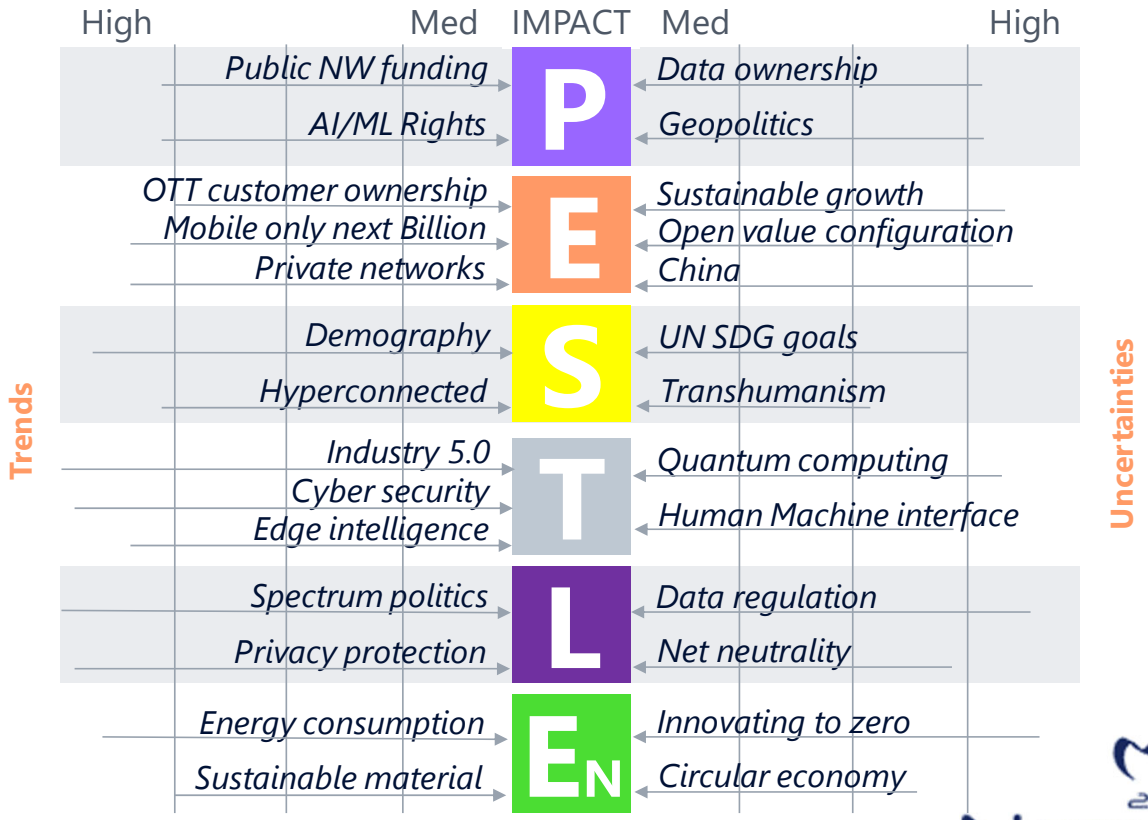
SMART NETWORKS TECHNOLOGY SCOPE DIAGRAM –V4

Strategic Research and Innovation Agenda
(Networld2020 ETP and 5G-IA)

Starting point: Brush up to existing technology chapters (2018) and introduction of two new chapters: Devices and Components & Policy Frameworks and Key Performance and Value Indicators towards 2030

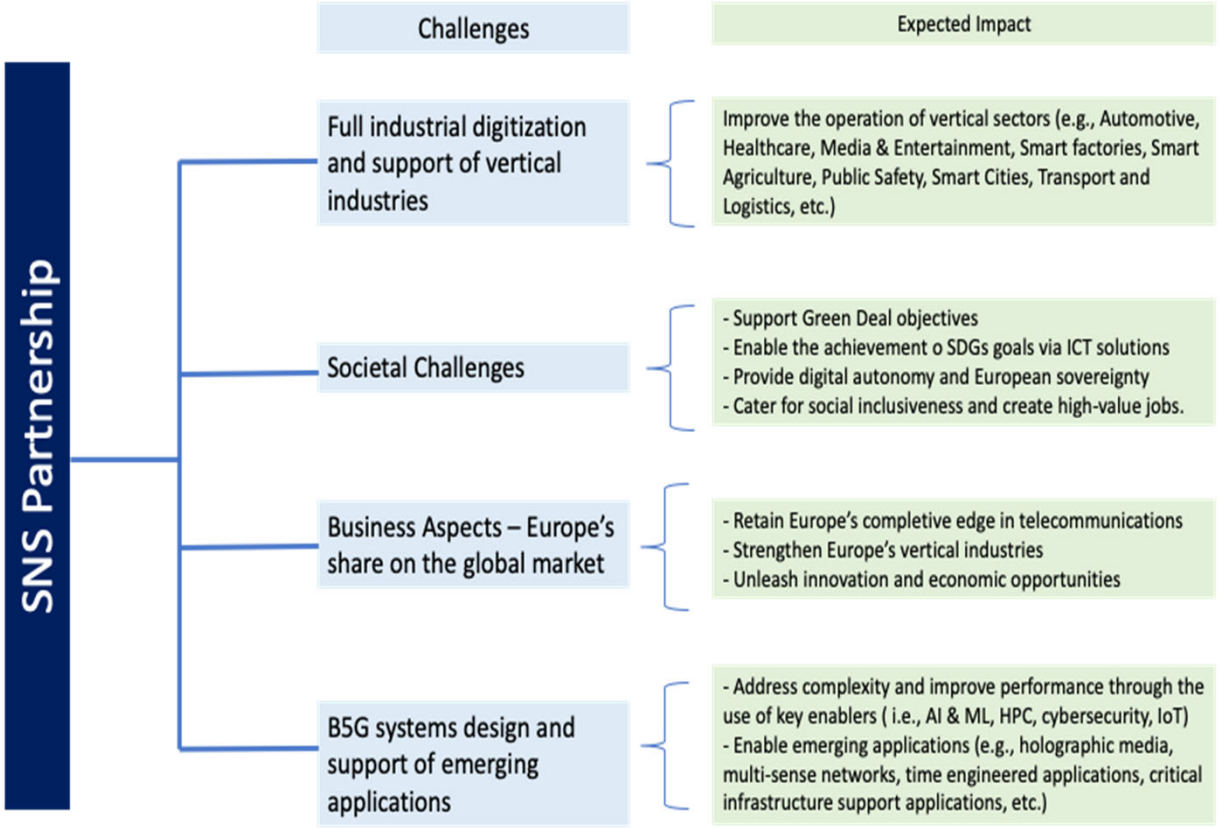
Chapter 1: Intro

- Global Megatrends – Societal Challenges
  - Trends related to the natural environment
  - Trends related to the political system
  - Trends related to the education system
  - Trends related to the economic system
  - Trends related to the media-based and culture-based public system

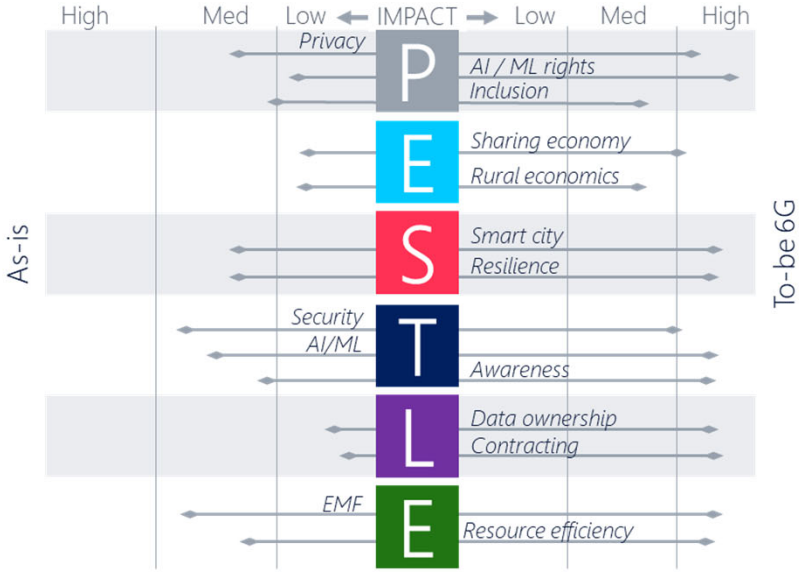


Chapter 1: Intro

- Strong Contribution to the European Economy
  - About 27.2 % (1.74 million employees) of ICT employment
  - 37 % (€ 234 billion) of ICT market size
  - 47 % (€ 15 billion) of R&D expenditure in Europe.
- Smart Networks Vision



Chapter 2: Policy Frameworks and Key Performance and Value Indicators towards 2030



- Policy Objectives
  - UN SDGs
  - The Green Deal
  - Full industrial digitization and support of vertical industries
- Societal, Economical and Business Drivers for 6G

Chapter 2: Policy Frameworks and Key Performance and Value Indicators towards 2030

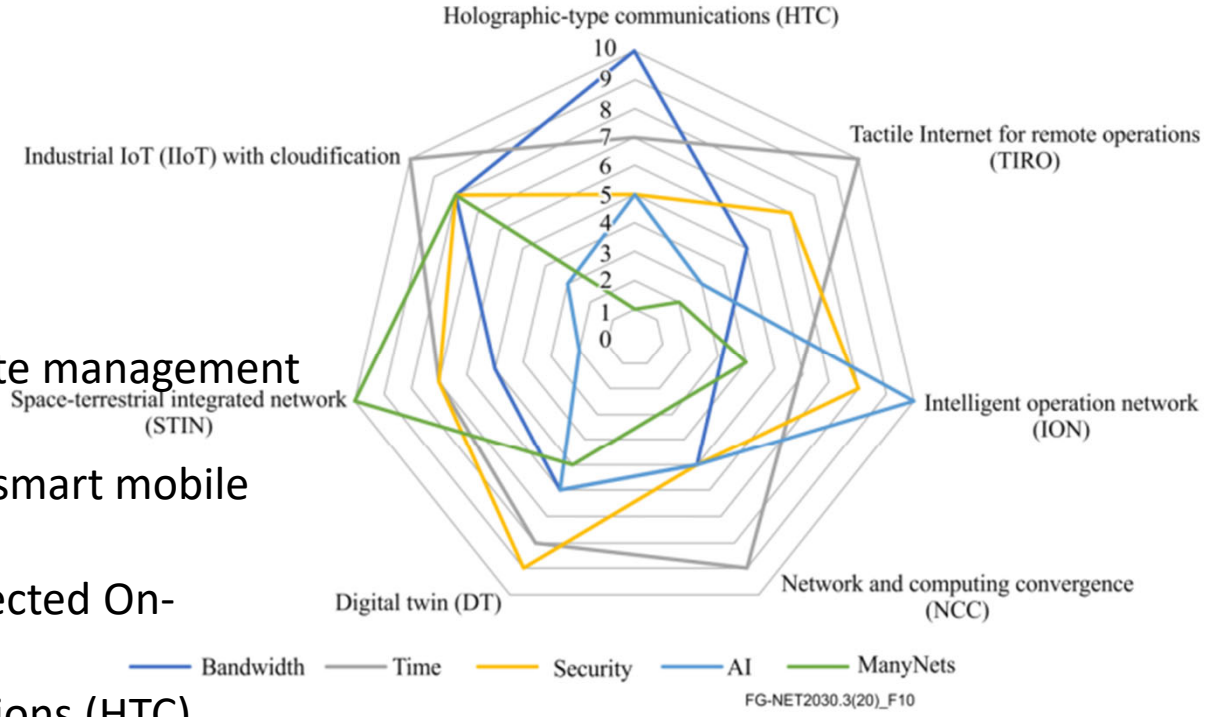
- Key Performance Indicators

Example: Selected KPIs Forecast for Terrestrial Radio Communications during the short, medium, and long -term evolution of 5G NR.

Target KPI	5G NR (Rel.16) 2020	Short-term Evo. ~2025	Medium-term Evo ~2028	Long-term Evo. ~2030
Spectrum	<52.6 GHz	<150 GHz	<300 GHz	<500 GHz
Bandwidth	<0.5 GHz	<2.5 GHz	<5 GHz	<10 GHz
Peak Data Rate	DL: >20 Gbps UL: >10 Gbps	DL: >100 Gbps UL: >50 Gbps	DL: >200 Gbps UL: >100 Gbps	DL: >400 Gbps UL: >200 Gbps
User Data Rate	DL: >100 Mbps UL: >50 Mbps	DL: >500 Mbps UL: >250 Mbps	DL: >1 Gbps UL: >0.5 Gbps	DL:>2 Gbps UL: >1 Gbps
Density	>1 device/sqm	>1.5 device/sqm	>2 device/sqm	>5 device/sqm
Reliability [BLER]	URLLC: >1-10^{-5}	>1-10^{-6}	>1-10^{-7}	>1-10^{-8}
U-Plane Latency	URLLC: <1 ms	<0.5 ms	<0.2 ms	<0.1 ms
C-Plane Latency	<20 ms	<10 ms	<4 ms	<2 ms
Energy Efficiency (Network/Terminal)	Qualitative	>30 % gain vs IMT-2020	>70 % gain vs IMT-2020	>100% gain vs IMT-2020
Mobility	<500 Km/h	<500 Km/h	<500 Km/h	<1000 Km/h
Positioning accuracy	NA (<1 m)	<30 cm	<10 cm	<1 cm

With focus on the radio access, ITU-R WP5D has just recently (February 2020) initiated the development of a “Technology Trends Report”, which will lead to an updated vision document to agree technical KPIs on global level. In the coming years, associations in the commercial domain such as NGMN, GSMA, 5GAA, 5GACIA as well as regional associations, e.g. 5G IA and international counterparts will contribute to this discussion to achieve a global consensus

Chapter 3: Human Centric and Vertical Services



Service/Use Case Examples

- Robotic Automation
- Massive monitoring and remote management
- Digital Twin
- Extreme pervasiveness of the smart mobile devices in Cities
- Autonomous and Hyper-connected On-demand Urban Transportation
- Holographic type communications (HTC)
- Tactile Internet for remote operations (TIRO)
- Intelligent operation network (ION)
- Network and computing convergence (NCC)
- Space-terrestrial integrated network (STIN)
- Industrial IoT (IIoT) with cloudification

System trends

Chapter 4: System Architecture

Trend is towards as a holistic system that combines the problem of data communication with that of distributed computing, transforming the existing infrastructure from the best effort Internet to a *sustainable, greener Intercompute system*.

- Spans all types resources, regardless of:
  - their nature (compute, networking),
  - realization (virtual/physical)
  - and position (remote/local), dynamically adding and removing resources as they come and go (churn).

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Chapter 4: System Architecture

Problem space:

- **intercomputing** through an autonomic, distributed, adaptive approach to resource control, including resource pooling, service request scheduling and conflict resolution.
- Natively integrate AI/ML mechanisms to implement adaptive decision making.
- Explore functional extensions of the basic transport mechanisms to overcome known limitations of the current TCP/IP model.
    - Providing guaranteed packet delivery, increased dynamics in network topologies as well as compute resources and the resulting required flexibility in routing, while also considering security and precision delivery as explicit goals.

Chapter 5: Edge Computing and Meta-data

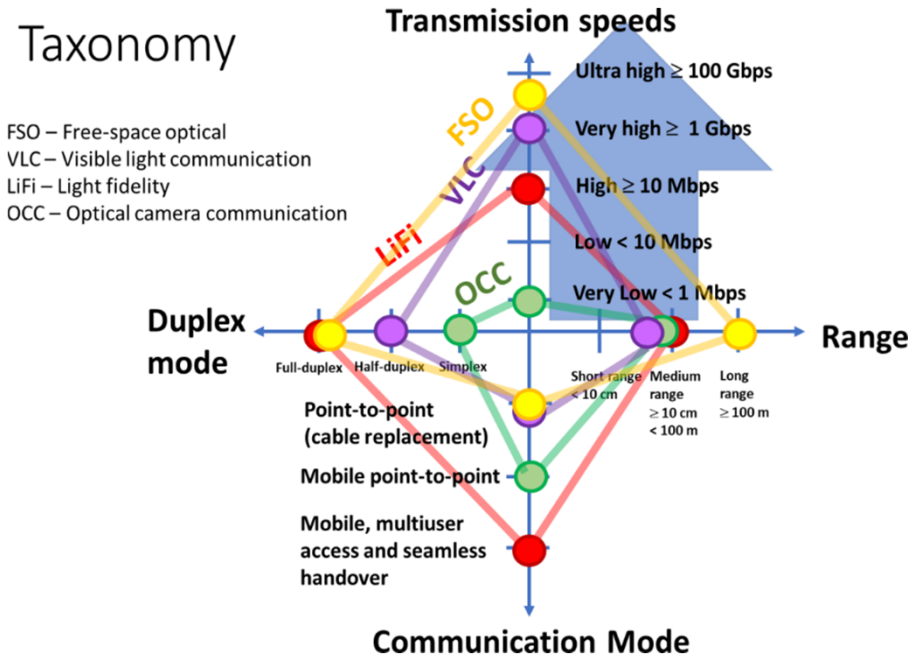
Areas discussed

- ETSI MEC evolution
- Activities on MEC in other Standardization Bodies
- NFV, SDN, orchestration
- Computing platform technologies
- Containers and container orchestration
- Distributed services
- Edge, Mobile Edge Computing and Processing
- Edge AI

Chapter 6: Radio Technology and Signal Processing

Technologies/Methods discussed

1. Spectrum re-farming and reutilisation, as well as co-existence;
2. Millimetre wave systems;
3. Optical wireless communications (OWC), especially VLC;
4. Terahertz communications including new materials (graphene);
5. Massive and ultra-massive MIMO including intelligent reflecting surface;
6. Waveform, non-orthogonal multiple access and full-duplex;
7. Enhanced modulation and coding;
8. Integrated positioning and sensing including radar;
9. Random access for massive connections;
10. Wireless edge caching for further increased spectrum and energy efficiency.



Examples of Optical Wireless Communications

Chapter 7: Optical networks

Technologies/Methods discussed

1. Flexible Capacity Scaling: Coherent technologies and new wavelength bands
2. New Switching Paradigms: FlexE, FlexOTN and Flexgrid, plus, SDN control
3. Deterministic Networking
4. Optical Wireless Integration: high capacity and control for RoF with signal QoS monitoring
5. Optical Network Automation: common information model
6. Optical Integration 2.0: Silicon Photonics & amplific.

Examples of Optical Wireless Communications KPIs

	Target KPI	Current 2020	Short-term Evo ~2025	Mid-term Evo ~2028	Long-term Evo ~2030
Metro/Core	Spectrum[1]	5THz	15THz	30THz	50THz
	Port speed[2]	400Gb/s	1.6Tb/s	3.2Tb/s	6.4Tb/s
	Bandwidth[3]	<75GHz	<300GHz	<600GHz	<1200GHz
	Line capacity[4]	25Tb/s	200Tb/s	600Tb/s	1.5Pb/s
	Node capacity[5]	150Tb/s	1.2Pb/s	3.6Pb/s	9Pb/s
Access	PON speeds	10Gb/s	50Gb/s	100Gb/s	>200Gb/s
	User data rate[6] (consumer)	100Mb/s	~1Gb/s	>2.5Gb/s	>5Gb/s
	User data rate[6] (business)	1Gb/s	~10Gb/s	>25Gb/s	>50Gb/s
	Latency[7]	<1ms	<100µs	<10µs	<1µs
	Power consumption[8]	100% (baseline)	40%	30%	20%
	Service provisioning	Hour	Min	Second	Sub-second
	Network operations	Operator-controlled, reactive	Intent-based, proactive	Self-diagnosing	Self-optimizing

Chapter 8: Network and Service Security

- Security transformation
  - Networks' evolution towards more dynamism and flexibility impacts security
  - Static security solutions do no longer apply
    - Change towards a "Software Defined Security"
  - Security challenges should be considered from the start
    - E.g., slice integrity and isolation across multi-owned infrastructure segments
  - Programmability on the radio side also leads to new range of potential attacks

Chapter 8: Network and Service Security – Some KPIs

Towards access to real time Cyber Threat Intelligence information (attacks/threats and vulnerabilities), risk Analysis tools and Services enabling 100% of awareness and level-based appropriate protection counter-measure deployment

Short-term Evo. ~2025	Medium-term Evo ~2028	Long-term Evo. ~2030
Benchmark strategy including data set and models	Monitoring and attack detection EU-wide strategy	Data protection strategy with response time and robustness outperforming attackers capabilities

Trust in ICT infrastructure through systematic Exposure of cybersecurity levels 100% compliant with European-legal basis (certification, Security Service Level attributes, GDPR/EU strategy for Data,...)

Short-term Evo. ~2025	Medium-term Evo ~2028	Long-term Evo. ~2030
Local, private implementation for limited set of verticals	End-to-End hybrid implementation for most of verticals	High grade support with technology, system and solution independence

Compliance with highly critical applications and essential services requirements leading to sovereign solutions able to provide 100% availability of services for verticals

Short-term Evo. ~2025	Medium-term Evo ~2028	Long-term Evo. ~2030
Federated, consolidated, common basis across CERTs (CSIRT network, NIS directive application)	CTI platforms(including openCTI) and tools for State-of-The-Art sanitization	100% of qualified threats knowledge and appropriate counter measures made accessible

Improve attack detection & response mean time of Cybersecurity incidents including zero % unprotected data leakage

Short-term Evo. ~2025	Medium-term Evo ~2028	Long-term Evo. ~2030
5G systems & services certification frameworks, Basic security level exposure with generic security attributes defined	Methodologies and tools for composition and time evolution of certified perimeters (systems & services)	Evolutive approach for data and disruptive technologies

Chapter 9: Satellite Communications Technologies

Technologies/Methods discussed

1. System architectures
2. Evolution of Networking Architectures
3. Hybrid infrastructures: Broadcast/Multicast/Unicast/Storage – EdgeCasting
4. Smart Satellite Networking
5. Optical based Satellite Communications
6. Software Defined Payloads
7. Radio Access Network beyond 5G and 6G
8. Antennas
9. Spectrum usage
10. Artificial Intelligence for SatCom
11. Security
12. Communication, Computation and Storage
13. Plug and Play Integrated Satellite and Terrestrial Networks

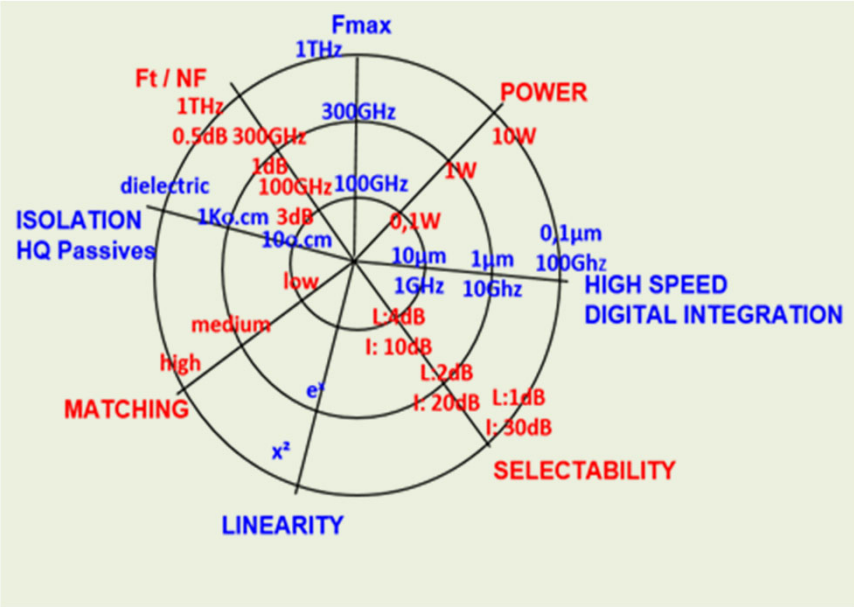
KPI	Short tTerm Evo.	Medium-Term Evo	Long-Term Evo
Minimization of unmet capacity[1]	<0.1.%	<0.05%	<0.01%
Maximization of satellite resource utilization[2]	>99%	>99.9%	>99.99%
Time to reallocate satellite resources[3]	<1 min	<5 sec	<1 sec
Solving and detecting time of satellite operation incidents	<10 min	<5min	< 1 min
Energy Reduction using adaptive intersegment links	>50%	>80%	>90%
Connectivity gain for converged satellite cloud scenarios[4]	>100%	>150%	>200%
Reduction of required manual intervention[5]	>50%	>80%	>90%
Widespread IoT coverage [6]	> 50%	>99%	> 99.9%
Reliability (perceived zero downtime)[7]	>50%	>99%	>99.9%
Experienced data rate (Broadband)	DL: >50 Mbit/s UL: >25 Mbit/s	DL: >500 Mbit/s UL: > 250 Mbit/s	DL: >1.0 Gbit/s UL: >0.5 Gbit/s
Area traffic capacity (Broadband)	DL: >75 Mbit/s/km2 UL: >37 Mbit/s/km2	DL: >750 Mbit/s/km2 UL: >370 Mbit/s/km2	DL: >1.5 Gbit/s/km2 UL: >0.75 Gbit/s/km2
Experienced data rate (NB-IoT)	DL: >2 Kbit/s UL: >10 Kbit/s	DL: >20 Kbit/s UL: >100 Kbit/s	DL: >40 Kbit/s UL: >200 Kbit/s
Area traffic capacity (NB-IoT)	DL: >8 Kbit/s UL: >40 Kbit/s	DL: >80 Kbit/s UL: >400 Kbit/s	DL: >160Kbit/s/km2 UL: >800Kbit/s/km2

Examples of Satellite Wireless Communications KPIs

Chapter 10: Opportunities for Devices and Components

Technologies/Methods discussed

1. Sub-10GHz RF
2. Millimeter-wave and TeraHertz
   - THz Communication
   - Solid-state technologies for THz applications
   - Passive THz Imaging
   - Active mm-wave and THz radar imaging
3. Ultra-low Power Wireless
4. Antenna and Packages
5. On-chip antennas, lens-integrated antennas, antenna MIMO arrays, Metamaterials and metasurfaces
6. High-speed Transceivers, Wireline and Optical
7. Baseband Modems
8. Processors for Cloud-AI, Edge-AI and on-device-AI
9. Memories
10. Hardware for Security
11. Opportunities for IoT Components and Devices



Some Technology limitations

Chapter 11: Emerging Technologies and Challenging Trends

The Physical Stratum: Communication and Computing Resources

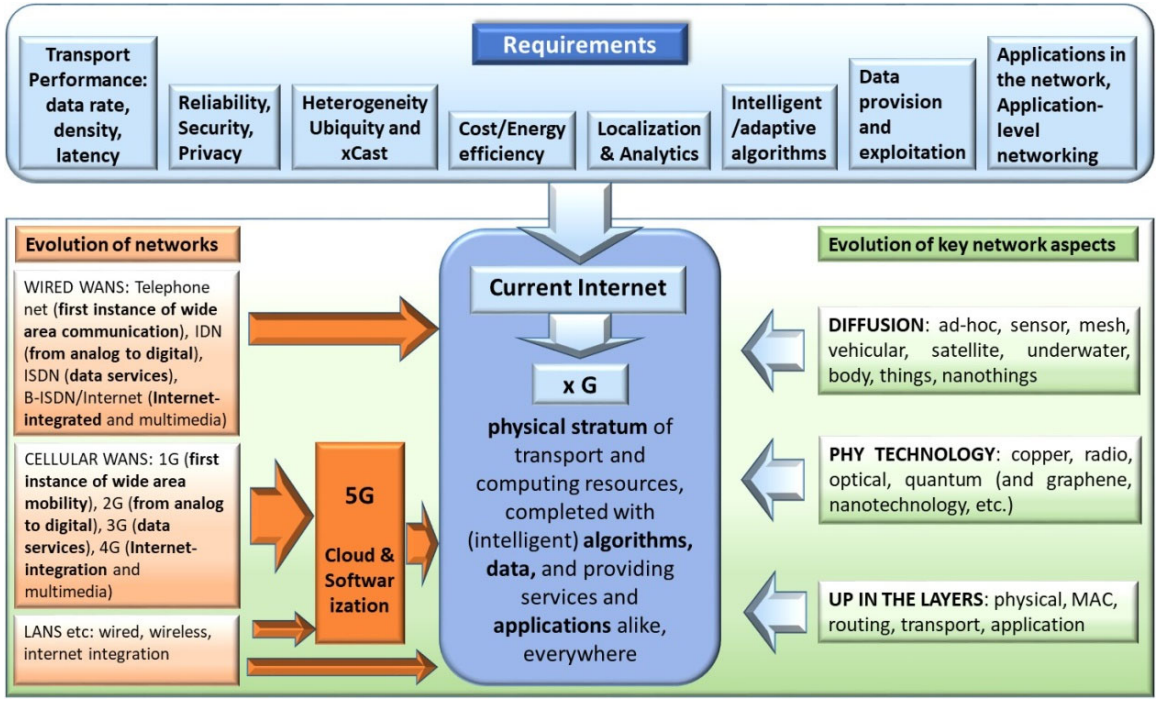
- Nano- and Bio-Nano Things
- Quantum Networking
- AI/ML for the Physical Layer
- DSL
- The Air Mobility Network

Protocols, Algorithms and Data

- Impact of AI/ML on the Network
- Impact of IoT on the Network
- Impact of Blockchain Technologies on the Network
- Evolution of Protocols
- Smart Living Environments

Applications

- Application Level Networking
- Applications (Components) in the Network
- Applications Making Specific Demands to the Network



Departing Words

- There is a large body of research to be realized in the next years!
- Key areas have been identified, and potential target objectives are being established across the community.
  - Choose wisely what you will target and why.
- Future mobile system evolutions will integrate increasingly more aspects, from the devices to the services, increasingly requiring complex trade-offs on system design.
- Take the time to look into the SRIA!
  - Available at https://www.networld2020.eu/sria-and-whitepapers/