



6G networks: Wireless only or impossible without more wires?

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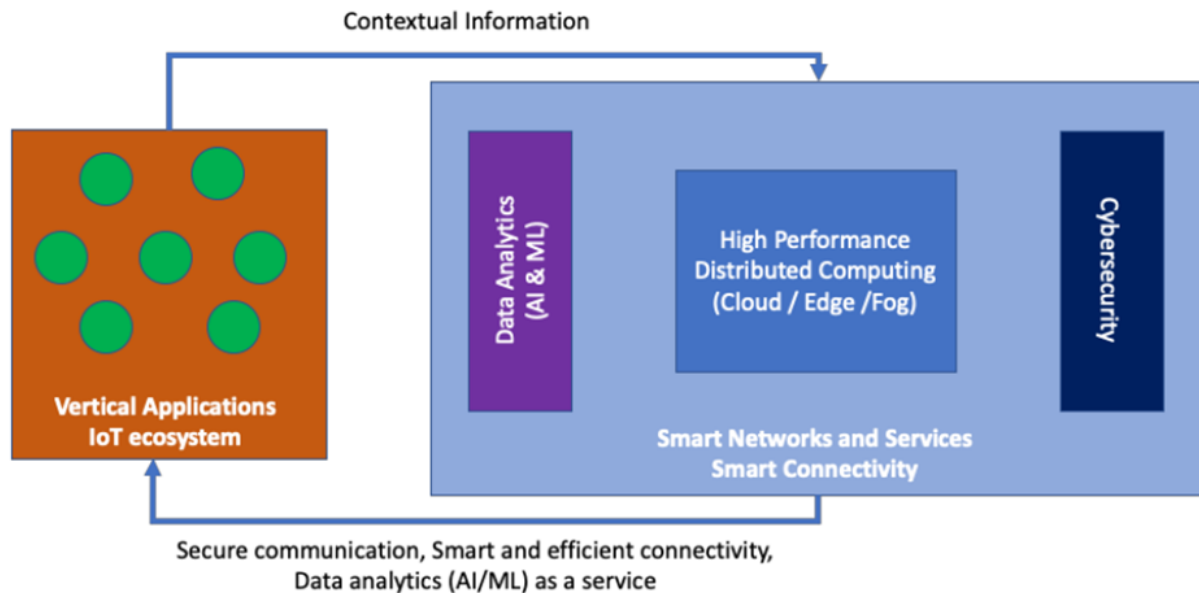
While 5G is ramping, 6G research is starting



<https://hexa-x.eu/>

Emerging 6G theme: Connecting the digital, physical & human world

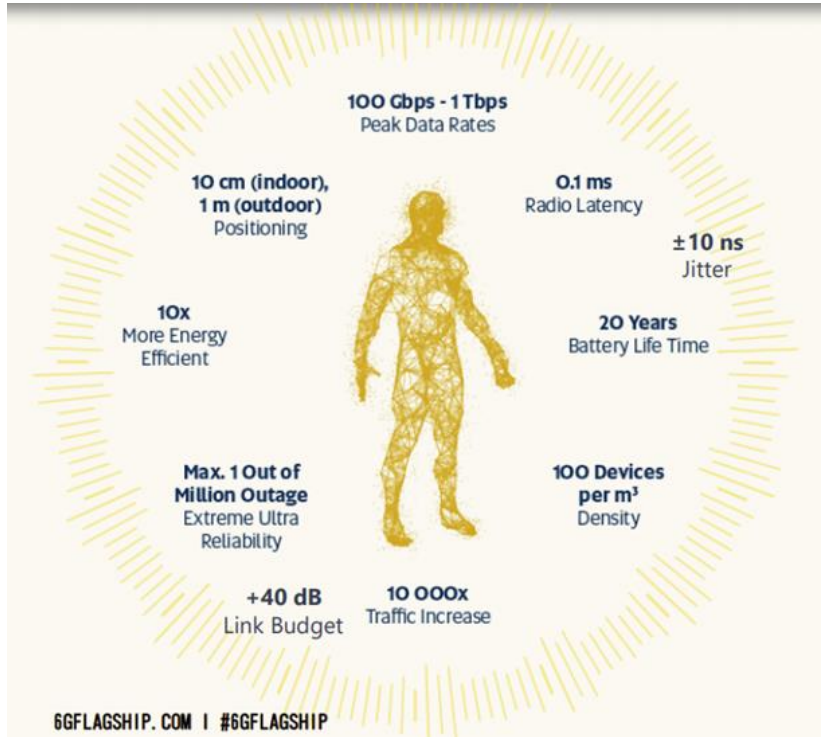
„6G networks“ or „smart networks & services“ or ... ?



https://ec.europa.eu/info/sites/default/files/research_and_innovation/funding/documents/ec_rtd_he-partnership_smart-networks-services.pdf

Whatever the name, collaboration and a break-down of technology silos is required

6G mobile KPIs



Targets are not achievable without (packet) optical network innovation:

- Higher capacity & deeper fiber
- Lower & predictable latency
- Increased programmability
- Security by design
- Reduced carbon footprint

... all while achieving sub-linear cost scaling with capacity

6G mobile pushes boundaries also in other technology domains

Optical network KPIs

	Target KPI	Current 2020	Short-term ~2025	Mid-term ~2028	Long-term ~2030
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 (baseline)	100%	40%	30%	20%
	Service provisioning	Hour	Min	Second	Sub-second
	Network operations	Operator-controlled, reactive	Intent-based, proactive	Self-diagnosing	Self-optimizing



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¹ 25% CAGR, in line with conservative traffic predictions

² Extrapolation of Ethernet roadmap

³ Using 400G DP-16QAM as baseline

⁴ 50% CAGR, in line with internet content provider traffic predictions. Assumes exploitation of frequency and space domain.

⁵ Based on degree 4 node with 50% local add/drop

⁶ 50% CAGR based on Nielsen's law

⁷ Excluding propagation delay

⁸ 15% reduction per Gb/s p.a., extrapolated from past transponder data

<https://bscw.5g-ppp.eu/pub/bscw.cgi/d367342/Networld2020%20SRIA%202020%20Final%20Version%202.2%20.pdf>

Extrapolations result in challenging 2030 targets

Main research themes

Optical networks	
Sustainable capacity scaling (7.1)	Expand network capacity beyond the Shannon's and Moore's limits, explore all possibilities in the space and frequency domain, economically and environmentally sustainable.
New switching paradigms (7.2)	Develop novel switching architectures and new routing protocols, and design new semantic description and information models allowing the control of new devices by SDN control.
Deterministic networking (7.3)	Achieve deterministic QoS targets while using function chaining over shared compute and network resources needs to be addressed. Includes hybrid use of electronic and optical switching as well as scalability of guaranteeing deterministic QoS for large number of flows/applications.
Optical wireless integration (7.4)	Progress on tighter integration between optical and wireless technologies and a converged network infrastructure using common transmission and switching functions.
Optical network automation (7.5)	Develop advances in network control, automation, and autonomy en-route to truly self-driving networks, able to cope with technological advances in optical networks, including increased programmability and remote configurability at the device level.
Security for mission critical services (7.6)	Address techniques to safeguard network infrastructure against data leakage and unexpected service outages.
Ultra-high energy efficiency (7.7)	Develop optical technologies in the IT and communications industries to limit the increasing ICT energy consumption.
Optical integration 2.0 (7.8)	Create new IT and networking devices in which optical, RF and digital electronic functions can be combined, e.g. in multi-chip modules (MCM) comprising highly integrated CMOS dies and high-speed optical engine chipllets on the same package substrate

<https://bscw.5g-ppp.eu/pub/bscw.cgi/d392313/Annex%20v2.3%20-%20Public.pdf>



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There is work ahead of us ...



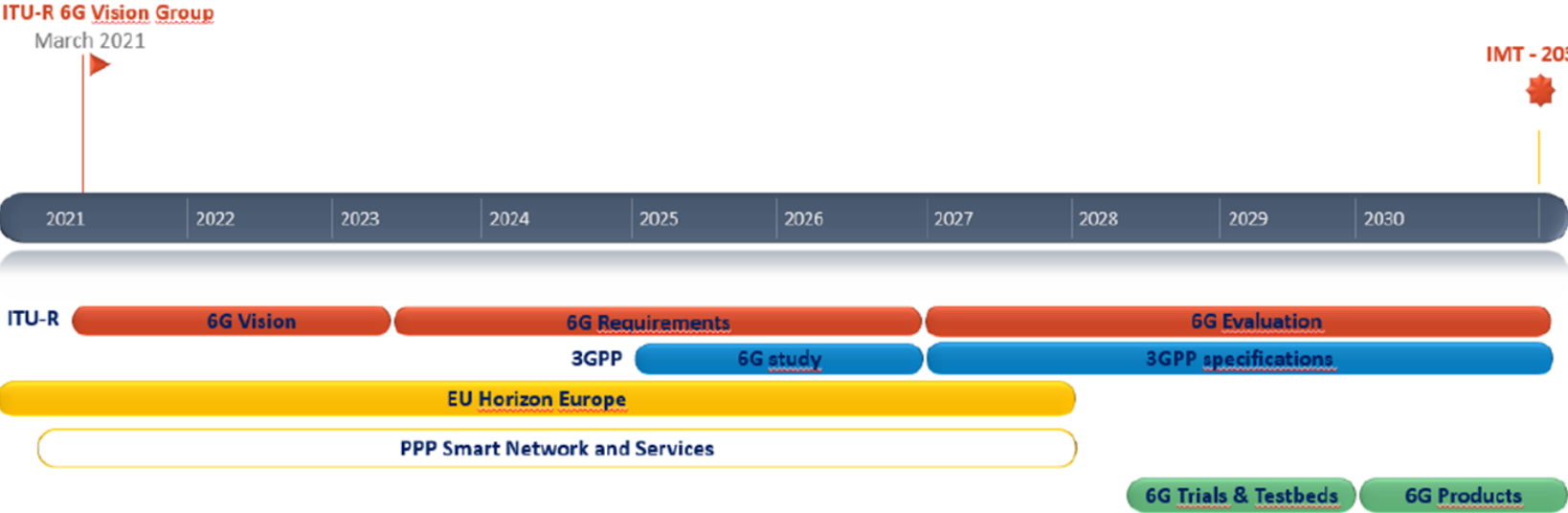
Thank you

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6G roadmap



[WhitePaper-6G-Europe.pdf \(5g-ppp.eu\)](https://www.adva.com/WhitePaper-6G-Europe.pdf)