Orange's perspective on 6G

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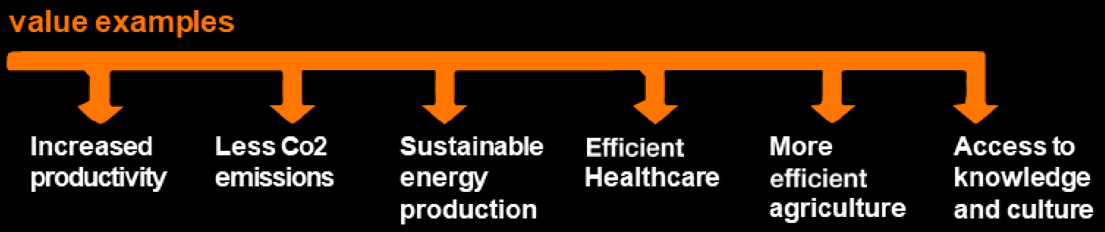
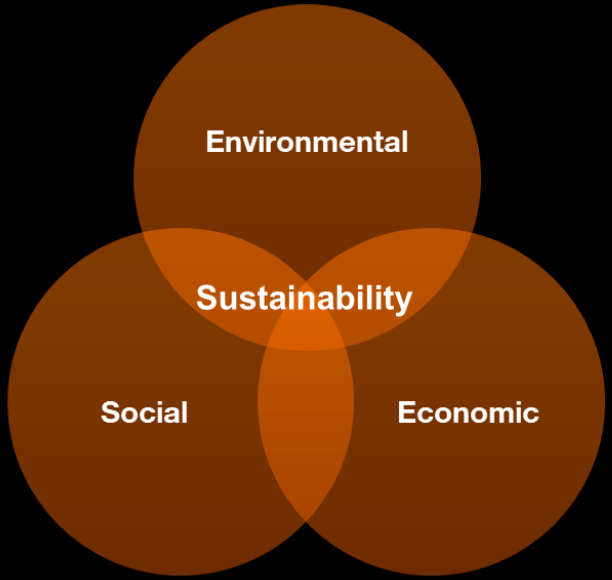
6G?

- 6G research has been ongoing for more than 5 years, however the technology will be decided by standardization, mainly 3GPP.
- The 6G design should be based on an assessment of
  - market needs
  - feasibility under sustainability constraints
- Orange calls on the industry to reassess the generation-based terminology which fosters misconceptions and may be less relevant in the future for users.

Value and sustainability should be the core drivers for defining future mobile network technology design





This is a necessary condition for the long-term economic sustainability of the telecommunications industry.

Future use cases should be driven by value and sustainability

Value areas

- Sustainable capacity extension
- Digital inclusion
- Exposure of network assets
- Value- and sustainability-enabling use cases

Generic use cases

Extension/massification of 5G use cases and capabilities

- Support traffic growth and coverage at minimum cost, under energy and environmental constraints
- Exposure of network data, functions and resources to third parties
- Immersive experiences
- Digital Twins
- Robots & autonomous systems

New uses cases, not yet identified

Application areas

- Human link
- CO2 emissions reduction
- Entertainment
- Healthcare
- Education
- Industry
- Agriculture
- Energy production & management
- …

Need to evaluate the value the use cases will enable to future users, and their relevance from a business, social and environmental perspective.

Strong value on empowering other sectors to meet their own environmental, social, and economic targets.

A societal dialogue is needed to help define what future technology evolutions should deliver, through an ecosystem-wide effort.

Performance requirements

KPI	Possible extreme value	5G reference [12]	Complement, e.g., target scenario
User experienced data rate (at cell edge)	300 Mbit/s 100 Mbit/s	300 Mbit/s 50 Mbit/s	dense urban other outdoor environments Note: 250 Mbit/s required for immersive experiences. The majority of identified future usages would require less than a hundred of Mb/s.
Area capacity	3 Tb/s/km² 450 Gb/s/km²	750 Gb/s/km² 100 Gb/s/km²	dense urban outdoor & wide area Note: 30% activity factor assumed
Connection density	35 000 / km² 15 000 / km² 1.10^{6}/ km²	25 000 / km² 10 000 / km² 1.10^{6} / km²	mobile broadband – dense urban mobile broadband – urban macro massive IoT
Positioning accuracy	< 10cm < 1m	1m 3m	indoor deployment outdoor & wide area
Energy efficiency	x10 vs. 5G	no quantitive requirement	at least as much as capacity increase, so that the network energy consumption remains stable or decreases
Minimum end-to-end latency	N/A 0.5 ms (URLLC)	N/A 0.5 ms	in generic deployments, for services that require it for specific services & uses cases associated to specific deployments
Reliability	N/A 99.999 %	N/A idem	for most of services, typically (mobile broadband for specific services & uses cases associated to specific deployments
Mobility	500 km/h	idem	for specific services (very high speed trains, planes)

The envelope of extreme performance enabled by 5G specifications seem sufficient to accommodate the use cases currently identified for 2030-2040.

Future technology evolutions should aim at further improving the cost and energy efficiency in delivering the high 5G performance levels for a wider number of concurrent users.

Area capacity to be higher than for 5G, and to rely on the existing macro radio sites without additional densification.

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Key Design Principles – Initial views on Day-1 features

Support mid-bands deployment on existing macro radio sites with similar coverage as 5G 3.5 GHz

6 GHz licensed as prime band
7-15 GHz of high interest
Native spectrum sharing with 5G

Air interface reusing whenever possible 5G features to facilitate sharing and reuse of HW

Integrated non-terrestrial networking for global coverage

Environmentally sustainable: energy-saving features for zero Watt at zero load

Evolution from 5G Core Network, relying on Service Based Architecture

Seamless interaction with other access networks (Wi-Fi, NTN, Non-Public Networks)

APIs to expose network assets

Where new frequencies are not needed, software upgrade of network equipment is to be privileged

Cloud native

Data-centric & AI native

Trustworthy (secure, resilient, inclusive)

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Orange 6G standardisation approach and principles

Do not accelerate 6G timescale (compared to 5G)	• Standardisation studies start ~ September 2024 to last up to 21 months • Specification starts ~ 2026 to begin with 6G use cases and requirements • First specifications complete by end of 2029 or early 2030
Equal emphasis on sustainability and performance requirements	• Ensure societal and environmental requirements have the same emphasis/priority as traditional technical requirements for performance and capacity • Engage societal stakeholders in use case definition (co-design) and standardisation
Globally harmonized 6G standards	• 3GPP as the focus for 6G network standardisation • Minimise options in the standards (e.g. 5G architecture options) • Re-use of O-RAN architecture & open interfaces to be considered (e.g. Open Fronthaul, RIC, SMO,…)
Continue to evolve 5G	• By default, add new (software) features to 5G system and minimise the specification of new functionalities requiring new HW (unless significant gains can be justified) • e.g. re-use of 5G CN SBA and AI/ML principles to add new modules to 5G CN to support 6G functionality

Orange 6G standardisation approaches and principles

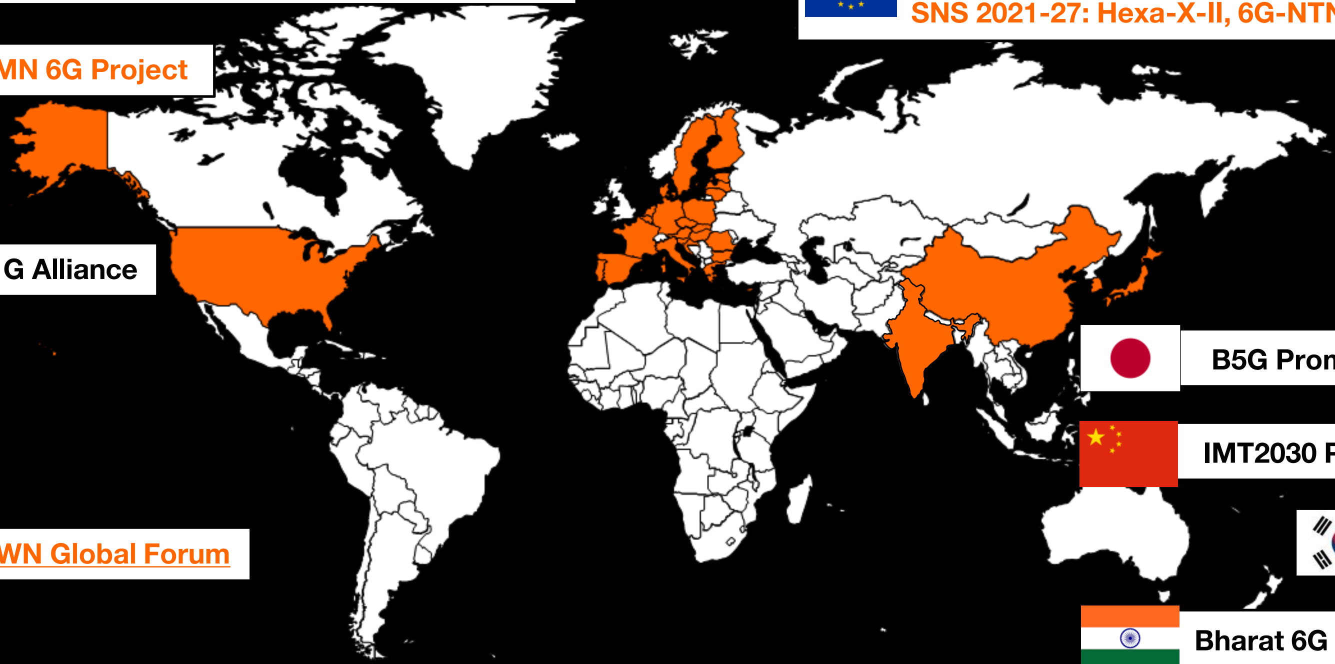
KPIs and KVIs	• Introduce Key Value and KVI (Key Value Indicator) concepts to assess the added values • Increased performance and capacity for traditional MBB services • New services should at least focus on XR / immersive communication & digital twins
Eco-design and circular economy	• Modularity of network functions with software upgrade for new features & functions. • Maximum support of hardware re-use and refurbishment
Do not re-invent the wheel for verticals	• Gap analysis to identify whether enhancements are relevant for legacy 4G/5G services for verticals (e.g. Cellular IoT, Industrial IoT, V2x, NTN, UAS)
Interoperability and backwards compatibility with 5G	• Spectrum sharing should be supported, with minimal overheads and re-use of existing base station HW. • Seamless inter-connection and mobility with 5G

6G initiatives and Orange implication

ITU-R M.[IMT.FUTURE TECHNOLOGY TRENDS]
ITU-R NEW VISION for IMT systems after 5G
ITU-R M.2160 IMT-2030 Framework

NGMN 6G Project

6G Flagship program
6G Wireless Summit, March 2019 and 2020
ICT-52 Hexa-X, RISE-6G, MARSAL, DEDICAT-6G
SNS 2021-27: Hexa-X-II, 6G-NTN, EINSTeIN6G



Next G Alliance

B5G Promotion Consortium

IMT2030 Promotion Group

6G Forum

Bharat 6G Alliance

IOWN Global Forum

Key take-aways

- **Value and sustainability** should be the core drivers for defining future mobile network technology design, as a **necessary condition** for the long-term economic sustainability of the telecommunications industry.

- **A new collaboration and societal dialogue** is needed to help define what future technology evolutions should deliver, through an **ecosystem-wide** effort.

- **The generation-based terminology needs to be reassessed,** as it fosters misconceptions and may be less relevant in the future for users.

- **Beyond usual performance enhancements, key research areas include**
    - Sustainable networks & terminals evolutions (incl. GHG)
    - Design to impact: how to design value-oriented networks under sustainability constraints, from technical and business perspectives
    - Networks for AI and AI for networks… subject to sustainability
    - Joint networks and applications design, leveraging exposure of network assets
    - Semantic communications (longer term)

Thank you!

Orange white paper
[Mobile Network Technology Evolutions Beyond 2030]

Focus on Environnemental Sustainability

Environmental sustainability includes

- Energy efficiency and absolute energy consumption
- Greenhouse gases emissions, including for equipment and terminals manufacturing
- Raw materials usage
- Impacts on water and biodiversity

Not studied so far in 3GPP

Key design principles towards environmental sustainability

Monitor energy use and evaluate embedded environmental impact

Consume zero Watt at zero load, and consume little at low loads: energy-saving features

Rely on software upgrades and hardware modularity to extend equipment usage duration

Extend and strengthen resource sharing

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Networks design to impact

The problem: Maximise a network utility function under constraints

The network utility function can be of different natures: customer satisfaction, inclusion, trust, etc.

The constraints include cost, energy consumption, Green House Gases emissions

The network to consider includes:

- fixed, mobile and non-terrestrial infrastructures
- from multi-country to local scales

Main sources of GHG emissions [1]:

- electricity consumption
- field interventions
- purchase of network equipment

How to set trade-offs between these items?

- extending coverage
- expanding capacity
- improving performance (e.g. reliability)
- adding new features (e.g. sensing)
- adding redundancy for enhanced resilience
- adding computing (e.g. for edge computing)
- everywhere vs. in some places only

[1] R. Bou Rouphael et al., *The Impact of Networks in the Greenhouse Gas Emissions of a Major European CSP*, ICECET 2023