SWS-240018

The European view on 6G use cases

6G SNS-ICE

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Introduction

European input

- **3GPP SA1** invited **SNS** to participate in the workshop and present the envisioned 6G Use Cases based on the projects' work
- As SNS values collaboration with all EU stakeholders, it has invited EU National Initiatives to contribute to a coherent European view, formulated through SNS-ICE
- The following projects have contributed:

SNS projects

6G-NTN

6G-Shine

NANCY

FIDAL

SEASON

TrialsNet

HEXA-X-II

National initiatives

6G Platform Germany (D)

RESTART (I)

FUTURE 6G NETWORK SERVICES (NL)

FRENCH ACCELERATION STRATEGY FOR FUTURE NETWORKS AND TECHNOLOGIES (F)

More detailed material available in the appendix

General 6G considerations

High-level SNS objectives for 6G

- **Disruptive high value applications support**, with performance requirements beyond those of current 5G capabilities (scalability and new KPIs), especially for highly immersive and “digital twinning” applications.
- **Green transition contribution** with significantly lower energy needs for highrate/performance connectivity and capabilities to decrease energy needs of use cases.
- **SDGs support** and in particular connectivity and service availability (coverage), affordability (cost) and accessibility for a large number of use cases of high public value.
- **Innovative business models** based on managed end-to-end service provision over heterogenous business and technological domains.

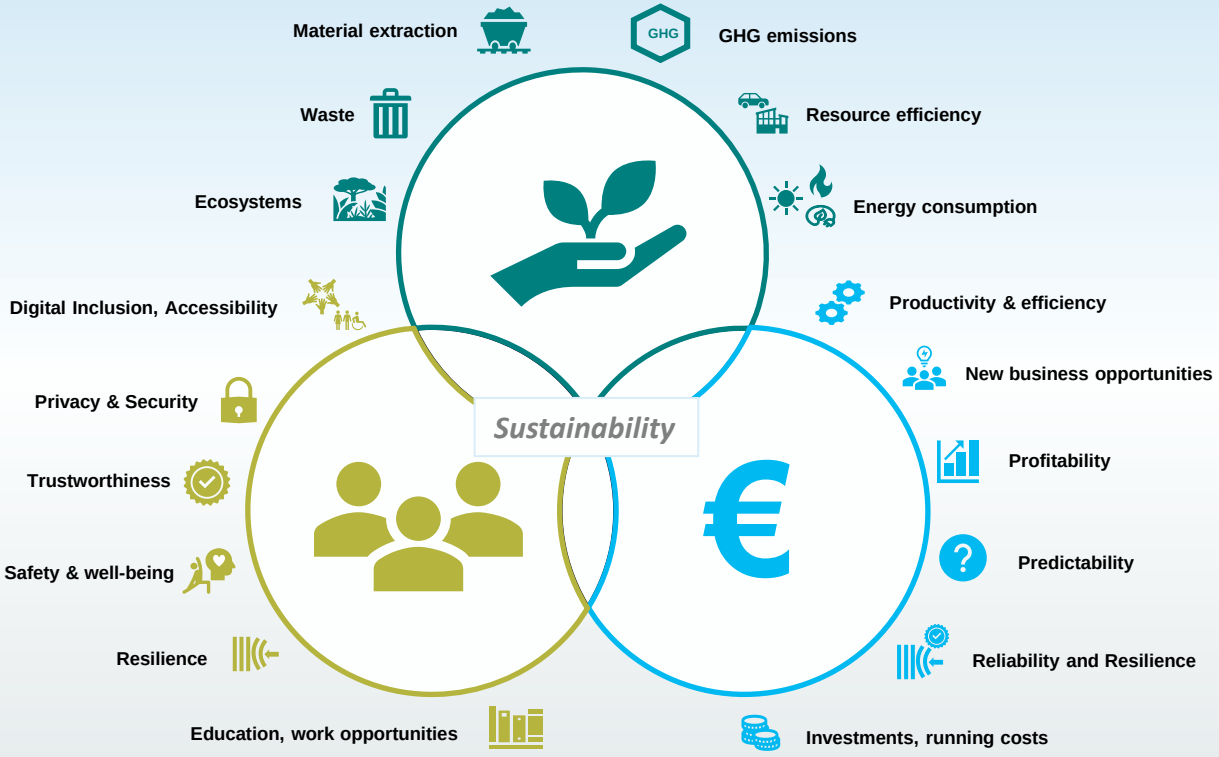
- **Global Single standards for 6G**, enabling interoperability, economies of scale and of scope.

Sustainability considerations

- It is imperative that 6G standardization takes sustainability expectations into consideration
  - Critically, **Sustainable 6G** – minimization of the footprint (negative impact) of ICT operations
  - Additionally, **6G for sustainability** – inducing positive impact and avoiding risks in other sectors (handprint) from use cases

- Key Value Indicators (**KVIs**) are becoming established as a toolset for assessing impact

- <u>SA1 should consider using KVIs in relation to use cases and requirements</u>



Analysis per use case available in the appendix

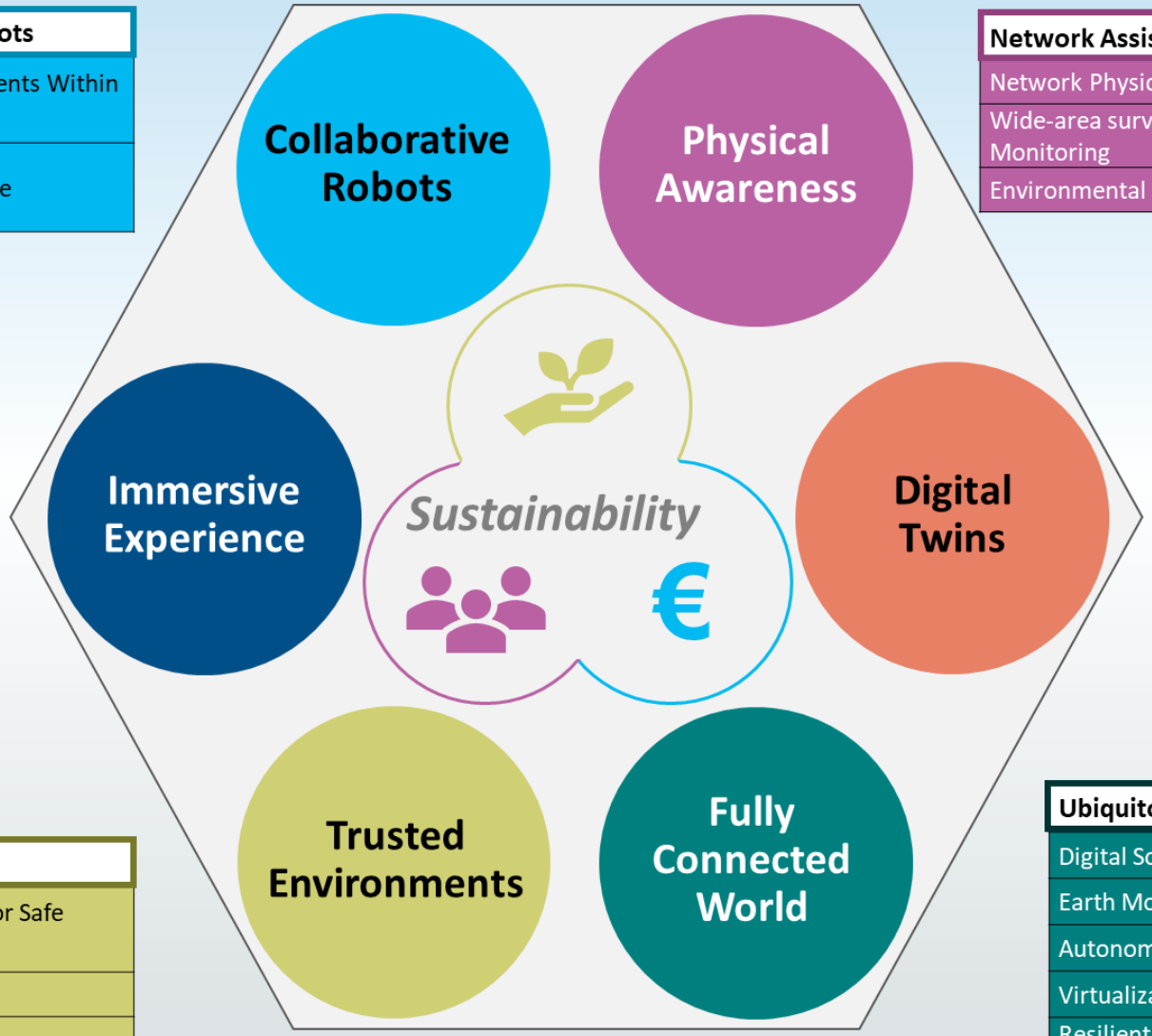
Use cases

Scenarios, problem descriptions, and requirements

Use case families

Cooperating Mobile Robots
- Autonomous Embodied Agents Within Flexible Manufacturing
- Mesh Embodied Intelligence

Network Assisted 3D Mobility
- Network Physical Data Exposure
- Wide-area surveillance/Smart Crowd Monitoring
- Environmental radio sensing



Seamless Immersive Reality
- Immersive Enterprise & Industry
- Immersive Education
- Immersive Gaming
- Live and Interactive Immersive Content Creation

Realtime Digital Twins
- Cloud Continuum
- Smart Maintenance
- Digital Twins (Building Model)
- Public Protection & Disaster Relief Digital Twin

Human-Centric Networks
- Industrial Sensors Network for Safe Production & Manufacturing
- Wireless In-Vehicle Network
- Virtual Control Room

Ubiquitous and Resilient Network
- Digital Sobriety and Enhanced Awareness
- Earth Monitor, Sustainable Food Production
- Autonomous Supply Chain
- Virtualization of Device Functionalities
- Resilient Communication for Safety critical Applications

More details available in the appendix

IMMERSIVE EXPERIENCE

Immersive Experience use cases are based on an evolving XR technology.

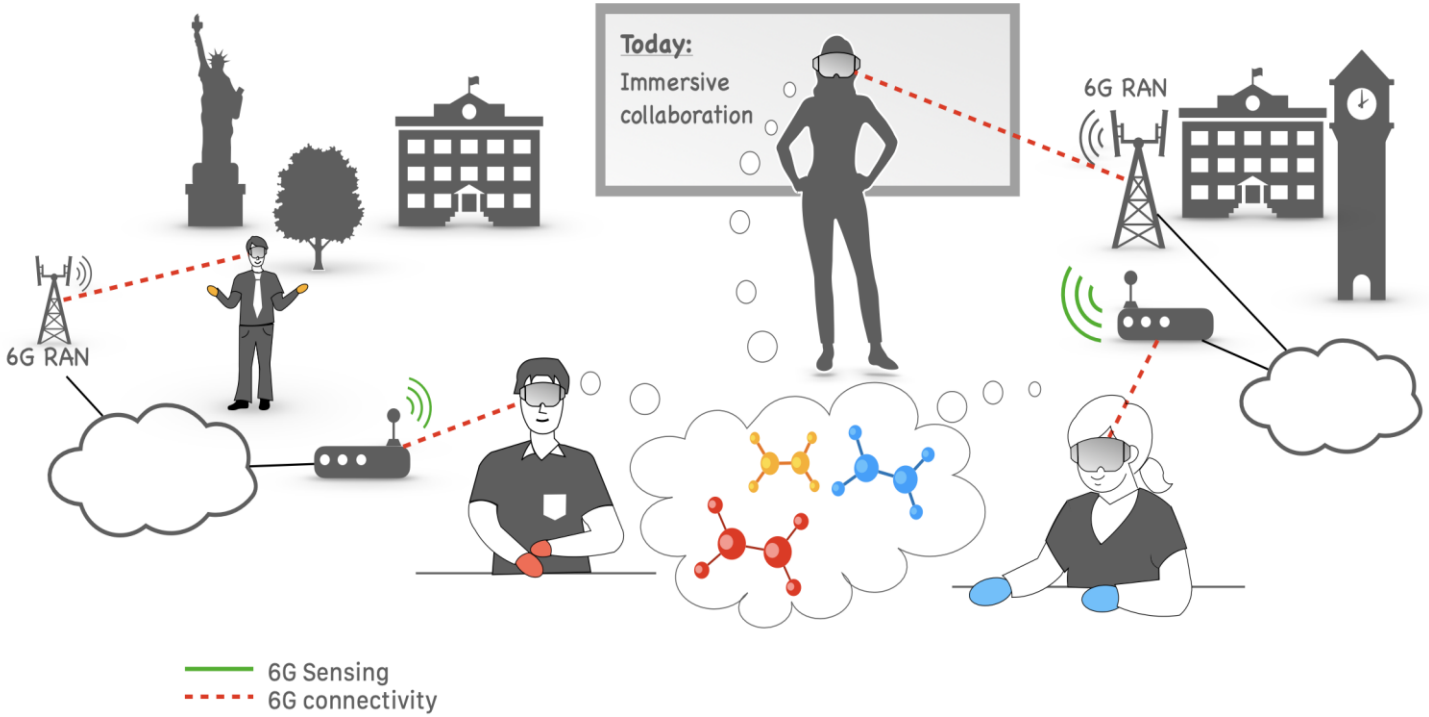
Immersive Experience is all about meeting the fundamental human need of "experiencing" a now digitally extended or virtual environment to understand and to act.

AI-generated image (Dall-E)

Use Cases

Seamless Immersive Reality | Immersive Enterprise & Industry | Immersive Education | Immersive Gaming | Live and Interactive Immersive Content Creation

Seamless Immersive Reality



Immersive collaboration
Mixed reality collaboration and immersive telepresence
e.g., remote lectures

Immersive experience "on the go"
Tailored experience and capabilities depending on user's situation and role
e.g., XR city tour

** digital representation of real object*

Seamless Immersive Reality

Immersive Experience

Functional Requirements

- AI/ML/Compute
- Sensing
- Positioning
- Privacy & Security
- Service Continuity
- Low Latency Synchronization

KPIs

User-experienced data rate [Mb/s]	Depending on scenario: **250**	DL, UL for UE taking role of gateway
Area traffic capacity [Mb/s/m^2]	**20**	Wide area: focus on immersive experience “on the go”
E2E Latency [ms]	**<10**	Split rendering scenario
Positioning [cm]	**<10**	Positioning accuracy (H and V)

COLLABORATIVE ROBOTS

The network's main users are machines.

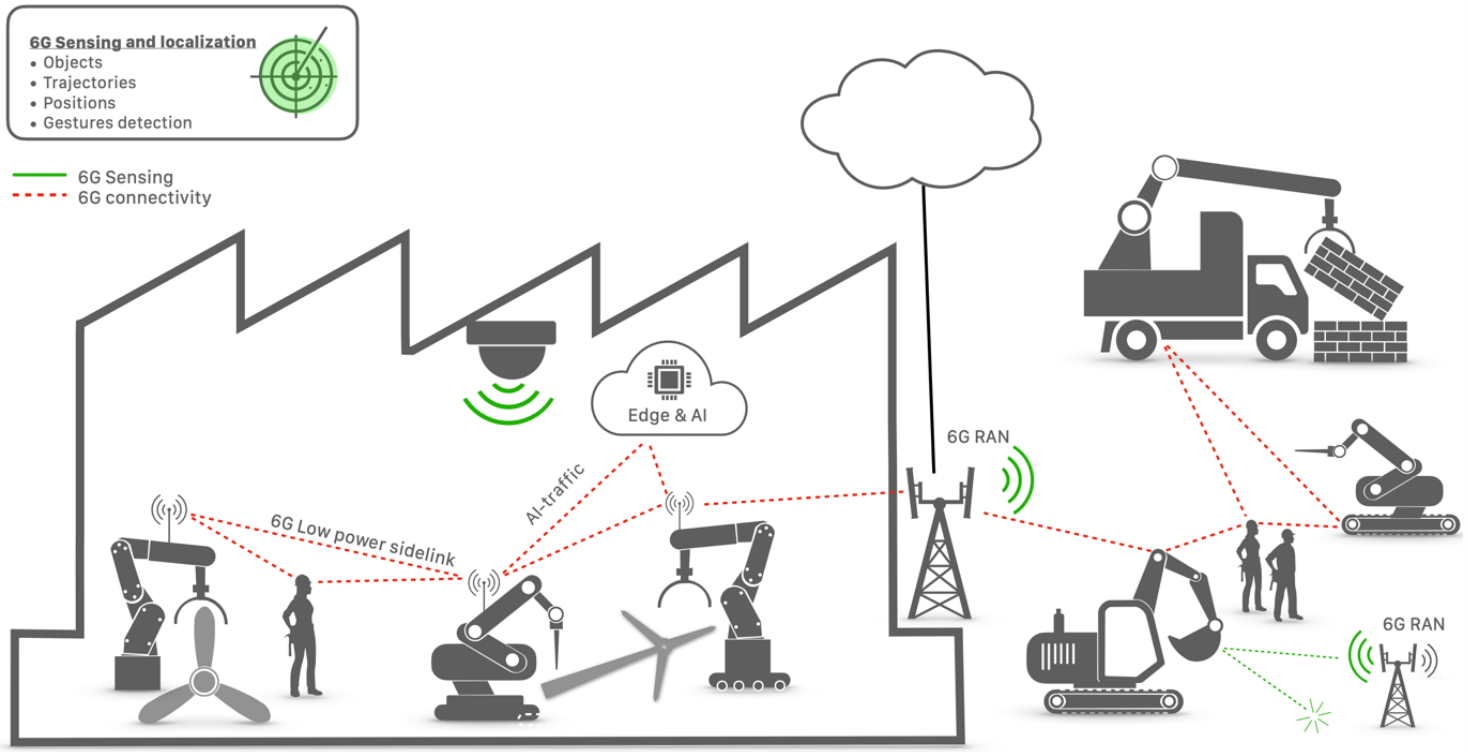
Emphasis lies on task-specific local connectivity. Depending on the task or needs, the network topology may undergo frequent changes. The level of machine autonomy determines the communication requirements.

Use Cases

Cooperating Mobile Robots | Autonomous Embodied Agents with Flexible Manufacturing | Mesh Embodied Intelligence

Cooperating Mobile Robots

Collaborative Robots



Cooperating mobile robots
Robots communicate locally to perform tasks beyond their individual capabilities.
E.g., flexible manufacturing, autonomous construction site

Autonomous embodied agents
AI/ML and integrated sensing enable tools/machines to make decisions.

Cooperating Mobile Robots

Collaborative Robots

Functional Requirements

- Local Connectivity & Mobility
- Dynamic topologies
- E2E Latency
- Positioning
- Sensing
- AI/ML

KPIs

Data rates [Mb/s]	< 10	Data rate between robots and campus network, depends on level of autonomy of robots Can be significantly higher locally in a subnetwork (raw sensor data, ML-related traffic)
Area density [Mb/s/m²]	< 0.1-1	World's largest industrial manufacturing campuses accommodate thousands of robots. 1 m^2 per robot, 10% of the overall area occupied
Mobility [km/h]	< 20	Slow vehicular
E2E Latency [ms]	< 0.8	200 coordination messages per second, x3 for redundancy Transfer interval of 1.67 ms x0.5 to ensure enough margin for error recovery [22.104]
Reliability [%]	99.999 – 99.99999	Application-side mechanism compensate occasional packet losses and delays at link level ("survival time") Selected applications may have an even more strict reliability requirement up to 99.999999% [22.104].

PHYSICAL AWARENESS

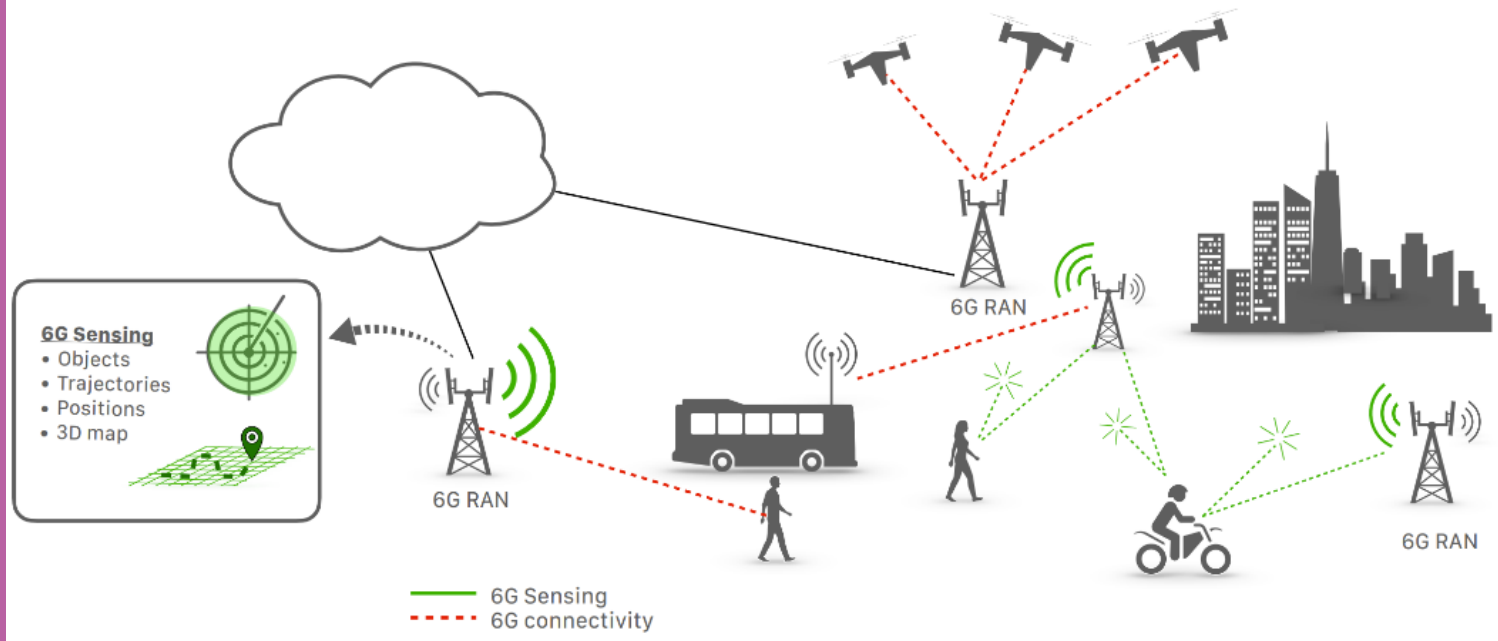
Physical Awareness use cases build on beyond-communication capabilities in networks: sensing, positioning, compute, and AI. By gathering 3D data about physical scenarios and situations, efficiency and safety can be improved.

AI-generated image (Dall-E)

Use Cases

Network Assisted 3D Mobility | Network Physical Data Exposure | Wide-area surveillance/Smart Crowd Monitoring | Environmental Radio Sensing

Network-Assisted 3D Mobility



Leverages aggregated knowledge of physical scenarios and connected devices

Autonomous drone transport

Safe and efficient guidance of robots

- Using reliable communication links to feed optimal collision-free paths to ground or air drones

Assisted vehicles

Supporting road users with timely traffic data

- Conveying data on connected and unconnected objects in the vicinity

Network-Assisted 3D Mobility

Physical Awareness

Functional Requirements

- Reliability
- Sensing
- Positioning
- Privacy & Security
- AI/ML/Compute

KPIs

Data rates [Mb/s]	1-10	Depends on service type
Location accuracy [m]	1m	Reliable 3D positioning with high availability
Mobility [km/h]	Up to 300	Speed of vehicles (cars, drones, trains) in urban areas
E2E Latency [ms]	1-20	Similar to V2X services.
Reliability [%]	99.99%	Fraction of packets within latency bound E2E
Coverage [%]	99.9%	Fraction of defined 3D service space
Availability [%]	99.99%	Probability to get communication service when requested

DIGITAL TWINS

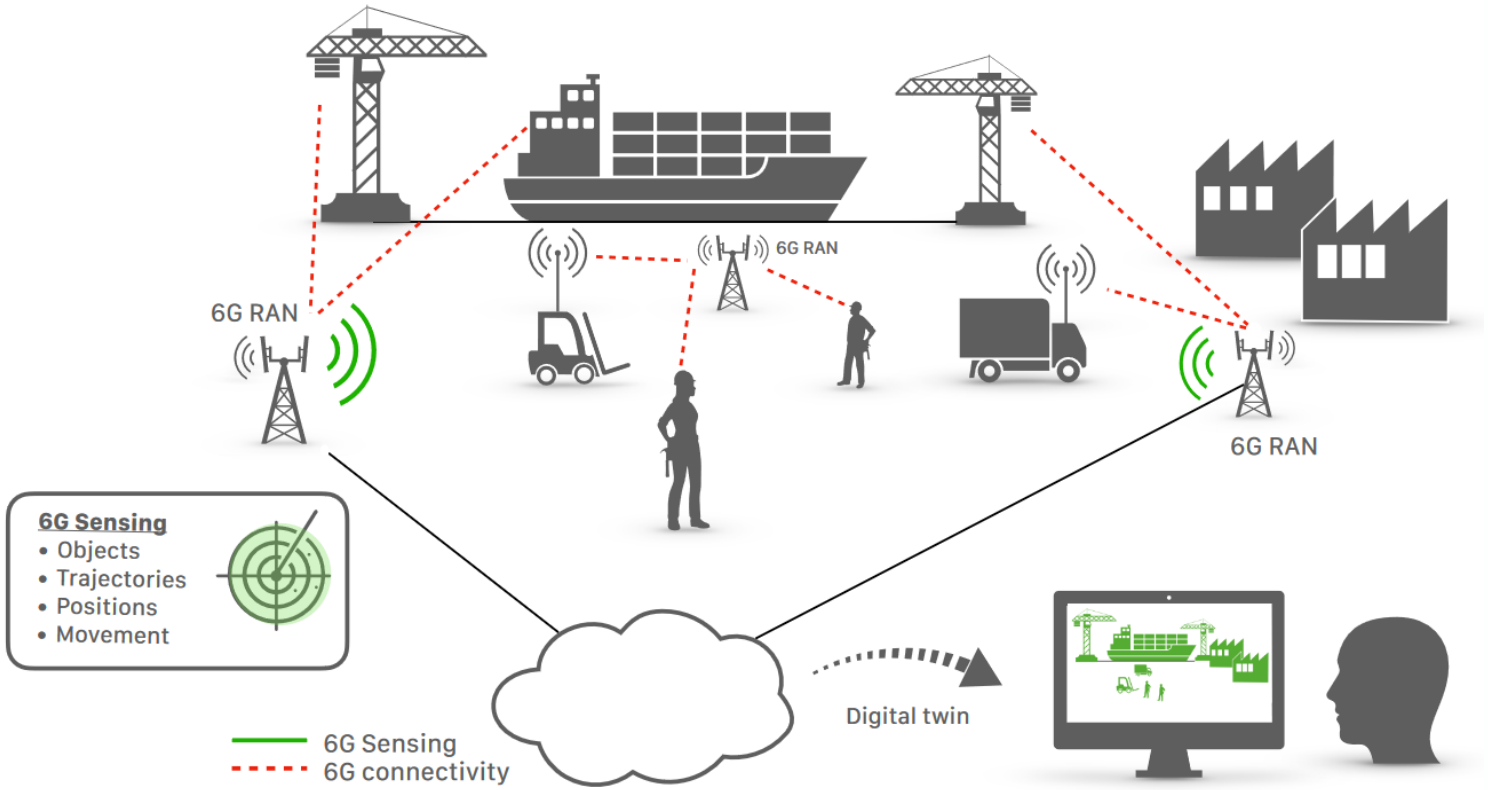
Digital Twins is a set of use cases where digital equivalents of the real world are created and displayed for interaction, control, maintenance, as well as process and component management.

AI-generated image (Dall-E)

Use Cases

Realtime Digital Twins | Cloud Continuum | Smart Maintenance | Digital Twins (Building Model) | PPDR Digital Twin

Realtime Digital Twins



Production plant control

- End-to-end process control (from arrival of the materials, over the production chain, up to the product shipment)
- Expand the DT beyond monitoring and simulating into realtime control of the production, enabled by the low latency and reliable network coverage

Overall Smart City twin

- Seamless, full network coverage over the city (including obstructed areas, both indoor and outdoor)
- Network sensing introduces environment awareness minimizing the need for external sensors

Realtime Digital Twins

Digital Twins

Functional Requirements

- E2E latency
- Coverage
- Interoperability
- Privacy & Security
- AI/ML/Compute
- Sensing

KPIs

Area density [Mb/s/m²]	1-10	High to cope with the high-volume of sensors (with very dispersed data rate needs)
E2E Latency [ms]	< 1	Very low latency for the Realtime aspect
Reliability [%]	99.99999	Very high: The control of Realtime industrial processes requires very high service reliability. Can be lower for non-realtime Digital Twin
Location accuracy [m]	≤ 0.1	High. Accurate Positioning to enrich the Digital Twin model

FULLY CONNECTED WORLD

*Ensuring connectivity **everywhere**, expanding beyond purely traditional terrestrial networks to deliver the benefits of communications to everybody.*

Besides expanding coverage cost-effectively, it also enables network function availability for crisis management, earth monitoring, digital health services, virtualisation of device functionalities, or support of autonomous supply chains.

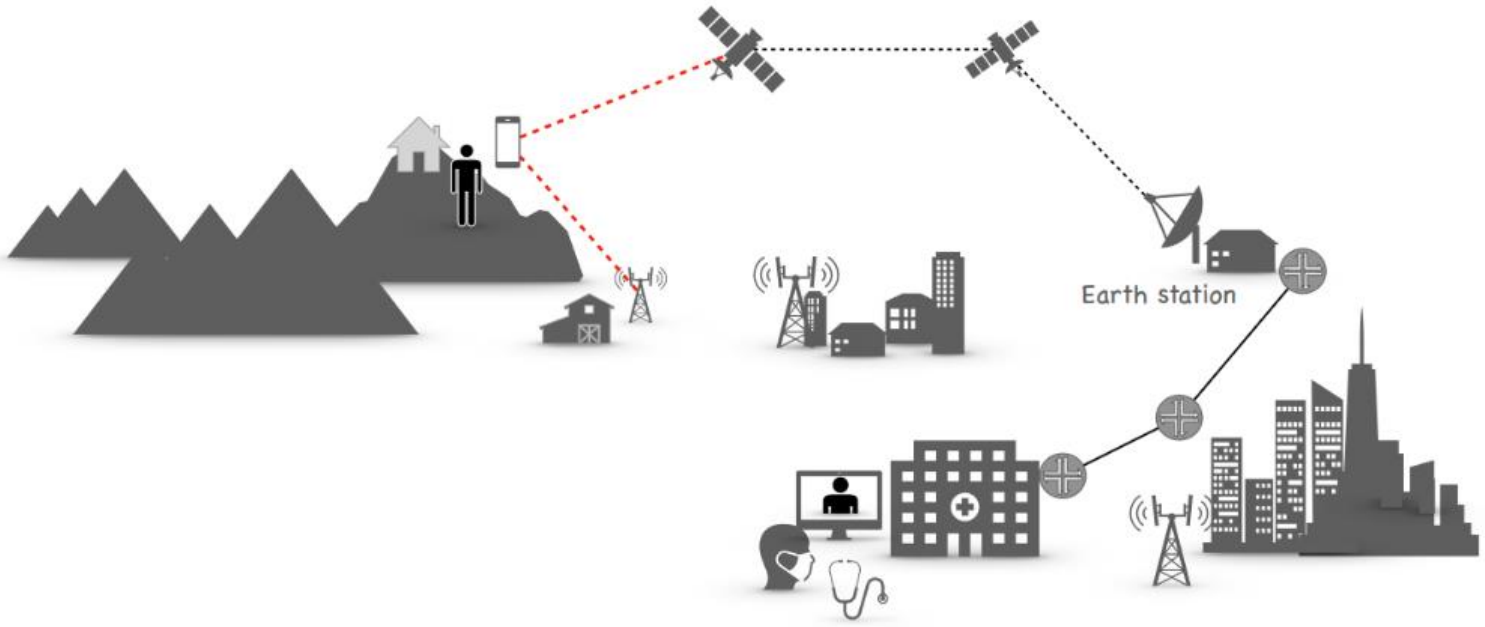
AI-generated image (Dall-E)

Use Cases

Ubiquitous and Resilient Networks | Digital Sobriety and Enhanced Awareness | Earth Monitor & Sustainable Food Production | Autonomous Supply Chain | Virtualization of Device Functionalities | Resilient Communication for Safety Critical Applications

Ubiquitous and Resilient Network

Fully Connected World



Delivers Mobile Broadband connectivity to every human on Earth, leaving no “white zones” through tight integration of TN & NTN

Connectivity at Remote Locations

Enabling connectivity in hard-to-reach areas (e.g., cost constraints, deployment difficulties)

- Access to video streaming, remote health consultations, earth monitoring, agricultural services, etc.

Connectivity during natural disasters or emergencies

- Builds resilience in the network

Ubiquitous and Resilient Network

Fully Connected World

Functional Requirements

- Coverage/ Connectivity everywhere
- Flexibility
- Resilience
- Privacy & Security
- Service continuity across diverse topologies
- Affordability

KPIs

Data rates [Mb/s]	0.1 –25 DL 2 UL	For single UE, measured on the device. Based on current standards, from 0.1 (sensor data) to 25 Mb/s (4K video).
Availability [%]	98.5	Appropriate combination of full coverage and capacity to deliver video streaming-like services is required.
Coverage [%]	TN: ≤10-15 km cell radius TN/NTN: 99.9% of human environment	Coverage means both extending the range of TN, but also the coverage % of an area, combining TN & NTN.
E2E Latency [ms]	10-100	Targeting video calls/streaming. 'Real-time' interactions are not considered.
Reliability [%]	99.9 –99.999	Associated with the service requirements, considering fallback between TN & NTN.

TRUSTED ENVIRONMENTS

Comprehends use cases in local environments (streets, hospitals, schools, retirement homes) delivering human-centric services and promoting health, well-being, safety, inclusion, and autonomy in daily life.

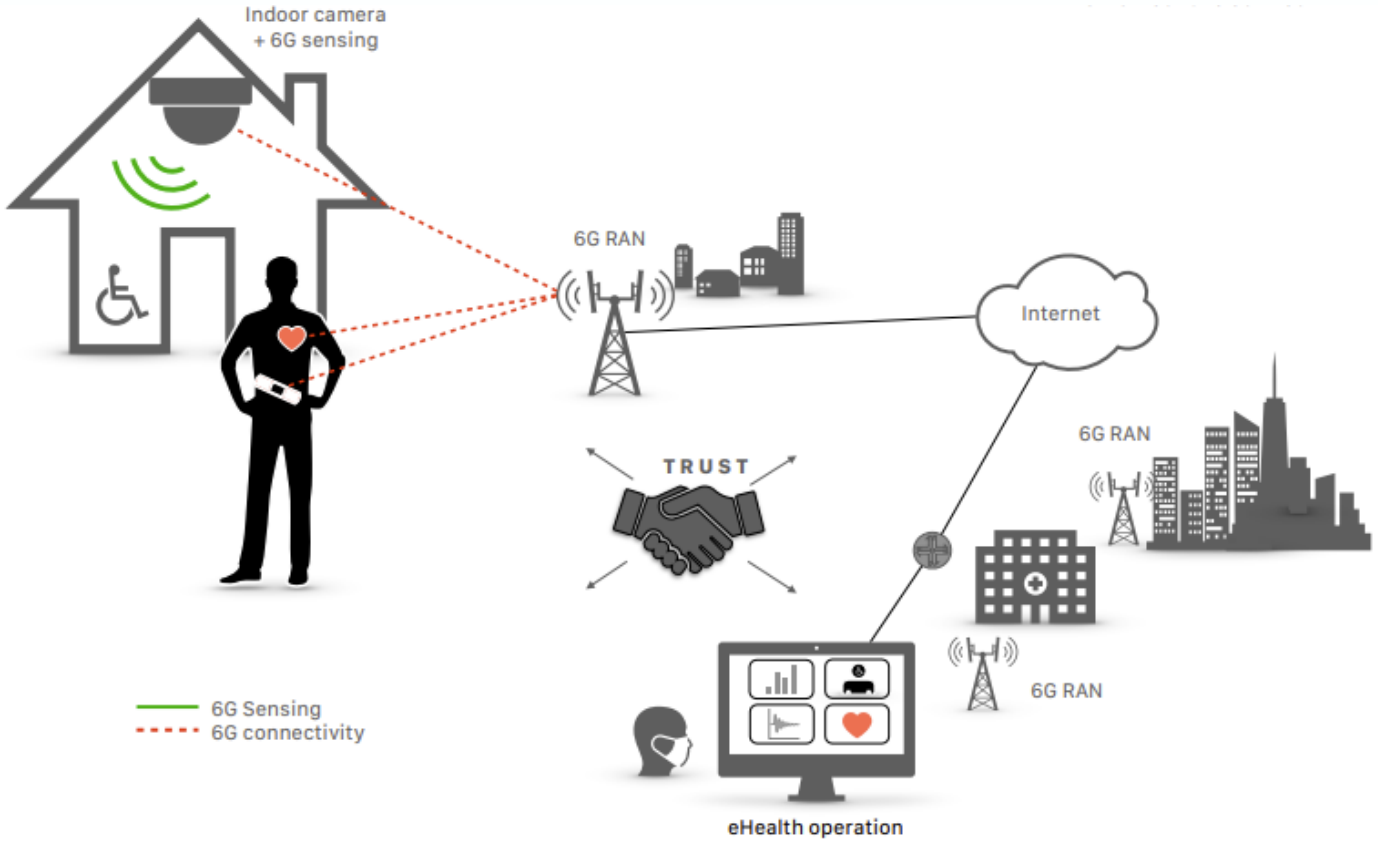
These are based on sensing technologies as well as AI/ML and compute support to create spatial and situation awareness and enable context-driven interventions.

Use Cases

Human-Centric Networks | Industrial Sensors Network for Safe Production & Manufacturing | Wireless In-Vehicle Network

Human-Centric Networks

Trusted Environments



Focuses on the human at the centre of a wide range of 6G services

Precision healthcare
Personalized monitoring, diagnosis, and treatments

Safe environments
Help prevent risky situations and accidents. Able to adapt to different scenarios/stakeholders.

Public safety during big events
Predictive mechanisms to prevent chaotic situations

Human-Centric Networks

Trusted Environments

Functional Requirements

- Privacy & Security
- Reliability
- AI/ML/Compute
- Positioning
- Sensing
- Accurate target & activity identification

KPIs

Area density [Mb/s/m²]	1 to 10 < 0.001	Indoor per floor Outdoor
Location accuracy [m]	< 10 < 0.3 to < 1 < 0.1	Location accuracy Positioning accuracy Relative positioning accuracy, e.g. collision avoidance
E2E Latency [ms]	< 250 < 1000	For AGVs and care robots, e.g. in homes for the elderly and in hospitals. Initiating an intervention in case of an evolving critical situation in a crowd.
Reliability [%]	99.9 – 99.999	High service availability is key for this use case.

Operational aspects

Important additional requirements on the 6G network

Operational aspects

Spectrum aspects

- 6G deployable in 5G bands
- Spectrum sharing support
- Robust connectivity in all frequency bands

Unified interface aspects

- Interface between any devices
- Interfaces between (comm., cloud, app.) service providers
- Intent-based management

Network of network aspects

- One standard for multiple requirements
- Improved TN/NTN convergence

Deployment aspects

- Simplified deployment & management

Migration & mobility aspects

- Smooth migration from 5G
- Smooth 5G / 6G mobility

Feature parity aspects

- 5G functionality supported in 6G

Novel services aspects

- Exposure of new 6G capabilities
- Seamless orchestration across compute continuum
- Native AI/ML capabilities

Smart Networks and Services International and European Cooperation Ecosystem

Thanks for your attention!

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https://smart-networks.europa.eu/csa-s/

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