



Survey of Initial SNS KPI metrics

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Definition

This aggregated list of Key Performance Indicators (KPIs) has been produced as part of Milestone 1.1 of the 6G Start CSA project. Two types of KPIs are identified as part of this exercise:

- i. Network and Service Performance KPIs based on a) the work of previous and ongoing 5G PPP and SNS JU research and Innovation (R&I) EU funded projects on key B5G/6G technological areas and various verticals' services, and b) targeted 6G values identified by European (e.g., Networkworld Europe) and global organizations
- ii. SNS JU Programme KPIs (indicating metrics measuring the success and impact of the SNS JU Partnership) measured by the impact on various areas (e.g., fulfilment of EU societal and sovereignty policies, EU success on providing competitive 6G solutions and smart services, dissemination, standardization, etc.).

This aggregated list of KPIs is meant to provide an overview (snapshot) of the research achievements, in terms of performance, via the use of (B)5G connectivity in various vertical sectors, and act as a starting point to measure the evolutionary/revolutionary path towards the development of 6G networks.

Important Disclaimers

1. This list of KPIs is simply a first aggregation & grouping of KPIs considered important for 6G development by current Research projects & relevant organizations. This list will continuously be updated, to reflect more accurate and mature information, as the EU based 6G research also matures.
2. The list does not reflect official positions of organizations nor projects, it simply indicates the current research directions.
3. Some KPI definitions used for technical KPIs are originating from different projects. As such there may be no complementarity between the various KPIs as defined.
4. The architecture and performance of 6G are still theoretical and work in progress. As such, the 6G KPI target values (wherever mentioned), are simply an initial estimation from various projects, and are expected to change/ be updated as research progresses.

List of Abbreviations

Abbreviation	Explanation
5GPPP	5G Public Private Partnership
AI	Artificial Intelligence
BLER	Block Error Rate
CSA	Coordination and Support Action
DL	Down Link
E2E	End to End
EC	European Commission
EMF	Electromagnetic Field
EU	European Union
HO	Handover
IA	Innovation Action
KPI	Key Performance Indicator
LCM	Life Cycle Management
ML	Machine Learning
ms	milliseconds
NTN	Non-Terrestrial Networks
QoS	Quality of Service
R&I	Research and Innovation
RIA	Research and Innovation Action
SDO	Standards Development Organization
SINR	Signal to Interference and Noise Ratio
SME	Small to Medium Enterprise
SNS JU	Smart Networks and Services Joint Undertaking
SSE	Secrecy spectral efficiency
UL	Uplink
WG	Working Group

6G Network KPIs – Initial investigations & Grouping [1]

Reflects the currently considered most important KPIs to take into account for 6G development, and their grouping in different categories.

KPI Family	KPI Name
Latency	E2E Service Latency
	User Plane Latency
	Control Plane Latency
	Mission critical QoS of services - Latency
Capacity	Peak Data Rate
	User Data Rate (sub-THz)
	Bandwidth
	User Density – Connection Density
Packet Loss	Packet Error Rate @ network layer
	Layer2/3 packet transmission success rate
	Packet Loss Rate
	Frame Loss
	Signal Packet Loss
Compute (New KPIs, not considered in previous generation networks)	Edge computational resource usage
	Operation expenditure @edge
	Delta in network management decision
	Availability
	Resource utilization
	Scale-out latency
	Computing resource utilization
Energy	Network Energy Efficiency
	Device Energy Efficiency
	VNF Energy consumption reduction
	Channel Energy Efficiency
Security	Security conformance
	Tenant data privacy
	Secrecy spectral efficiency (SSE)
Channel	Communication reliability (SINR)
	Channel estimation accuracy
Spectral efficiency	Spectral Efficiency (Peak)
	Spectral efficiency (Average)
	Spectral efficiency (5 th percentile)
Electromagnetic Field (EMF)	Self EMF exposure
	Inter EMF exposure
Localisation	Localisation accuracy (3D)
	Direction/Orientation accuracy
	Localisation related delays
	Localisation (error) integrity
Service Availability and Reliability	Service availability
	Service reliability
	Service safety, integrity, maintainability
	System memory load
	Runtime Delay @ any LCM operation
Non-Terrestrial Networks (NTN)	Coverage
	Latency

Networld Europe 2022 SRIA [2]

Reflects aspiring target values for 6G KPIs by Networld Europe.

Target KPI	SRIA Update 2022
Bandwidth	10 GHz
Peak Data Rate	1 Tb/s
User Data Rate	10 Gbps
Density	10 devices / m ²
Reliability [BLER]	>1-10 ⁻⁸
U-Plane Latency	<0.1 ms
C-Plane Latency	<2 ms
Energy Efficiency (Network/Terminal)	>100% gain vs IMT-2020
Mobility	<1000 Km/h
Positioning accuracy	<1 cm

Relevant Vertical KPIs [4][5][6]

Reflects aspiring 6G KPI categories, and target values where available, as considered by different vertical industries for their specific use cases.

Sensing

	Gesture Recognition for Human-Machine Interface	Threat Localisation	Mapping of Industrial Environment	Operation on Objects
KPIs (sensing)	Requirements	Requirements	Requirements	Requirements
Location accuracy	1 cm	1 cm	1 cm	1 cm
Range resolution	1 cm	1 cm	1 cm	1 cm
Maximum link range	~0.4 m	~120 m	~130 m (industry floor of dimensions 120 m x 50 m)	~10 m
Angular resolution	~15 degree	sub-degree level	sub-degree level	1 degree
Velocity range	-10 m/s to 10 m/s	-30 km/h to 30 km/h	-30 km/h to 30 km/h	* 10 km/h
Velocity resolution	0.3 m/s	0.5 m/s	0.5 m/s	* 0.1 m/s
Update rate	once per 100 ms	once per 0.1 ms	once per 0.1 ms	0.1 ms
Availability	99.99%	99.99%	99.99%	99.99%

In-Network AI/ML Learning Methods

KPI	Brief description
Location accuracy and timeliness	Location estimations enhanced by intelligent fusion with further models (mobility, maps, etc.) and additional data sources - time granularity to be considered jointly with location accuracy.
AI agent availability	Availability (or readiness) of an AI agent to accept inferencing requests and address them with high accuracy.
AI agent reliability	Capability of an AI agent to accept inferencing requests and provide high accuracy output in a timely manner (within a deadline set by the requesting application).
Latency	AI/ ML components which support (near) real-time decisions also have strict time constraints for inference or training.
AI agent density	Density of devices with AI/ML components considering specific traffic patterns during data sharing.
Interpretability level	Measure of explainability, reasoning, contribution of input factors.
Network energy efficiency	Training/inference optimisation in edge/IoT ecosystem.
Inferencing accuracy	Applicable to many AI functionalities, depends on (and can be traded off for) data volume, inference latency, channel quality in data sharing.

Media & Entertainment

KPI Name	5G target value	6G target value
E2E Application Latency - for Video processing services	n/a	100 - 200 ms (Delta between camera capture and playback) <100ms for video processing
Application Access Time	0.1 - 10 s	n/a
Application Accessibility	50% - 100%	n/a
Application Availability	50% - 100%	n/a
Content load time	0.1 - 10 s	n/a
Feature Availability	50% - 100%	n/a
Content Stall	0% - 5%	n/a
Content search time	0.1 - 10 s	n/a
Content DL Throughput	1 Mbps - 1 Gbps	n/a
Content UL Throughput	1 Mbps - 1 Gbps	n/a

Transportation

KPI Name	5G target value	6G target value
E2E Latency	30 - 150 ms	n/a
Device density	up to 300 devices	n/a
Device Mobility	300 km/h	500-1000 km/h
Packet Loss	< 0.0.1% - 1%	
Data Rate	10-15 Mbps	
Availability	> 99% - 99.99%	
Area Network Capacity	1-2Gbps per Train	
Additional Service Specific KPIs	Service Setup Time, High-resolution Real-time Video/Audio Quality, Service Area, Integrated Multitype Communications, Extensive Network Coverage in Vertical Premises, Area Traffic Density	

Smart Cities & Utilities

KPI Name	5G target value	6G target value
Edge-to-edge Latency	< 100 ms	n/a
Data Rate	> 100 Mbps	n/a
Reliability	> 99%	n/a
Coverage	>99%	n/a
Device Density	1dev/m2	n/a
Positioning accuracy	< 1 m	n/a
Additional Service Specific KPIs	Total number of Active lights, Total number of active movements, Total Average illuminance, Total Active time, Total Power consumption, Light response time, Parking traffic (flow), Parking occupancy, Vehicle detection processing time, Vehicle detection response time	

SNS Program KPIs [3]

KPI Name	Unit of measurement	Baseline	Target 2023	Target 2025	Target 2027	Ambition >2027
Resources (input), processes and activities						
R1. SME innovation & participation	% of SMEs participation	0	20%	20%	20%	20%
R2. Rapid diffusion	#of end-user workshops & webinars [cumulative]	0	25	60	90	125
R3. High risk research funding	% of total funding	0	50%	40%	30%	N/A
R4. Standardization contributions	Contributions to SDOs [cumulative]	0	50	350	750	1000
R5. Share on family patents	% of patent families	0	15%	15%	15%	15%
	Patent grant rate	0	60%	60%	60%	60%
R6. Scientific excellence	# of publications [cumulative]	0	100	400	700	1000
R7. Reach an appropriate balance between research, innovation, and deployment	% RIA	N/A	78% RIA	N/A	N/A	N/A
	% IA		20% IA			
	%CSA		2% CSA			
R.8 Accelerate the development of energy efficient networks	# of related projects investigating to a significant extent energy efficiency topics: >=3	0	>=3	N/A	N/A	N/A
R.9 Ensure research on secure future digital services	# of related projects:	0	>=3	N/A	N/A	N/A
R.10 Collaboration and synergies with other Partnerships	# collaborations	0	2	5	6	6
Outcomes (SO)						

O.1 Development of energy efficient networks	White papers	GeSI report on Energy consumption by 2030	1	2	3	>3	
	[cumulative]						
O.2 Technological solutions consensus building	White papers	0	1	2	3	N/A	
	[cumulative]						
O.3 Advanced 6G solutions for verticals	#of different vertical types engaged [cumulative]	0	3	6	10	10	
O.4 Foster emergence of new actors in the 6G supply chain	KPI7: # of related projects or cross-projects WGs dealing with the investigation and potential adoption of open ecosystem principles in B5G and 6G networks	0	>=2	N/A	N/A	N/A	
Impacts (GO)							
I.1 A competitive data economy	% Market share for the communication network	40%	N/A	N/A	N/A	N/A	
I.2 Reach Programme level consensus on 6G KPIs	white papers	NetworldEurope SRIA	1	2	3	N/A	
	[cumulative]						
I.3 Uptake of digital solutions within verticals	Number of large-scale trials	0	3	6	10	>10	
	[cumulative]						
I.4 Energy efficiency of telecommunication networks	% increase of energy efficiency of cellular communications	Legacy cellular systems (4G)	N/A	N/A	N/A	N/A	

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