EU landscape of Collaborative 6G R&I activities

The 6G series workshop by Hexa-X-II

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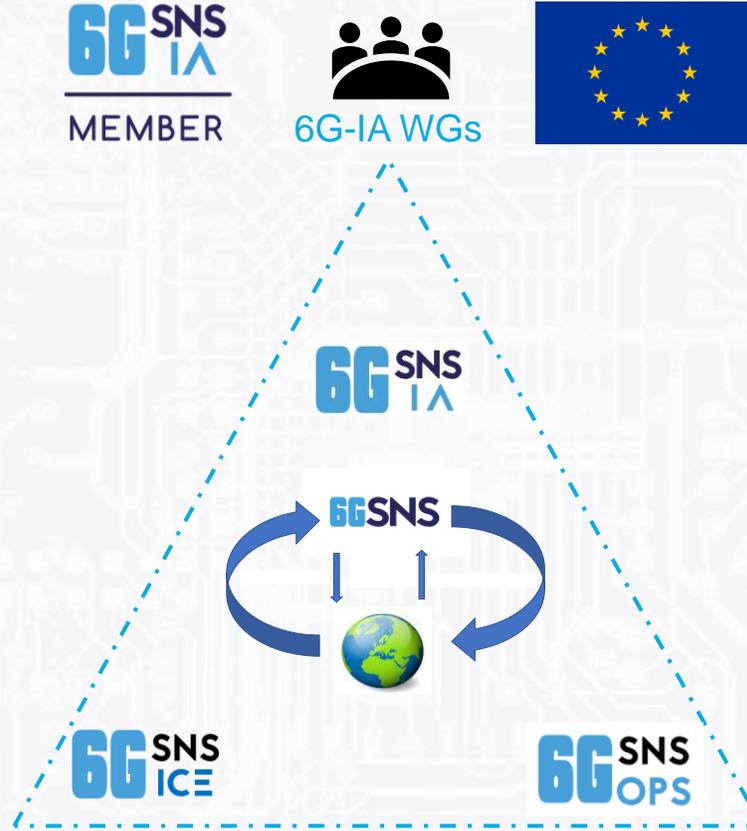*EuCNC & 6GSummit 2024, Antwerp, Belgium – 3rd June 2024*

smart-networks.europa.eu
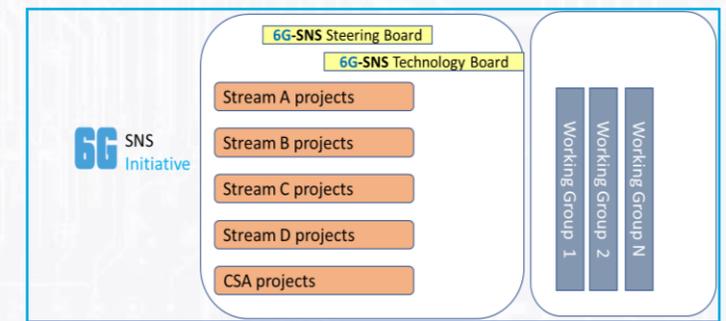
The 6G-IA / SNS OPS / SNS ICE Ecosystem

The Global 6G R&I Landscape – 6G UCs

6G Use Cases	Networld Europe SRIA 2022 [9]	5G Americas / Next G Alliance [11][12]	Huawei (China) [13]	B5G Consortium (Japan) [14]	TSDSI (India) [15][16]	MediaTek (Taiwan) [17]	Survey Paper [18]	ITU IMT-2030 [10]
Holographic Communications	√	√	√	√	√	√	√	√
Cyber-Physical Systems, Digital Twin, Manufacturing	√	√	√	√	√	√	√	√
Multi-Sensory xR, Gaming/Entertainment	√	√	√	√	√	√	√	√
Tactile/Haptic Communications	√	√	√	√	√	√		√
Medical/Health Vertical, Telesurgery	√	√	√	√	√	√	√	
Cooperative Operation among a Group of Service Robots / drones	√	√	√	√	√		√	√
Imaging and Sensing	√	√	√	√	√			√
Transportation Vertical (automotive, logistics, aerial, marine, etc.)	√	√	√	√	√		√	
Space-Terrestrial integrated network	√	√		√	√		√	√
Intelligent Operation Network	√		√		√		√	√
Critical Infra, Government/National Security	√	√		√				
First Responder/Emergency Services		√		√	√			
Smart Buildings			√	√	√			
Agriculture / Smart Farming				√	√			

- Overview of the *14 most strategic 6G-enabled UCs* per global region

- 6G expected to address a broad portfolio of Use Cases

- The most anticipated 6G UCs globally are found to be *Holographic Communications, Cyber-Physical Systems/Digital Twins, Multi-Sensory xR, Tactile/Haptic, Medical/Health & Cooperative Drones/Robots*

Source: 6G Global Landscape: A Comparative Analysis of 6G Targets and Technological Trends (**SNS ICE** paper)

The Global 6G R&I Landscape – 6G Enabling Technologies

6GSNS

Enabling Technologies	Networld Europe SRIA 2022 [9]	5G Americas / Next G Alliance [11][12]	Huawei (China) [13]	B5G Consortium (Japan) [14]	TSDSI (India) [15][16]	MediaTek (Taiwan) [17]	Survey Paper [18]	ITU IMT-2030 [10]
Artificial Intelligence at the Network Edge	√	√	√	√		√	√	√
AI/ML in the RAN	√	√	√	√	√	√	√	√
AI as a Service: Data / network autonomous management	√		√	√	√	√	√	√
Fully Service Based – Cloud Native Networking and RAN-Core Convergence	√	√	√	√	√	√		√
mmWave and THz Radio	√	√	√	√	√	√	√	√
Communications and Sensing co-design (ISAC)	√	√	√	√	√	√	√	√
Spectrum Migration	√	√	√	√	√	√	√	
Integrated Satellite hybrid infrastructures (NTN)	√	√	√	√	√	√	√	√
New Antenna Technologies (RIS)	√	√	√	√		√	√	√
Trustworthiness / Multilateral trust architecture		√	√	√	√	√		√
Deep Edge, Terminal and IoT device integration	√				√	√		
Optical Wireless communication	√			√	√		√	√
Blockchain	√			√	√		√	
Quantum Computing				√	√	√	√	

- **14 Enabling Technologies** considered crucial/strategic around the globe

- Very good coverage of these enablers observed among global stakeholders

  - Expectation that multiple technological advancements are needed to fulfil the 6G vision

- Most popular technologies are *AI*, *Cloud Native Networks*, *mmWave* & *THz Radio*, *ISAC*, *NTN*, *RIS*, etc.

  - Spectrum migration & security / trustworthiness also considered critical

- ITU recommendations directly reference most of these technologies

Source: 6G Global Landscape: A Comparative Analysis of 6G Targets and Technological Trends (***SNS ICE*** paper)

The EU 6G R&I Landscape

6G SNS

Member States R&I Initiatives & Research Programmes

Large National Research Programmes
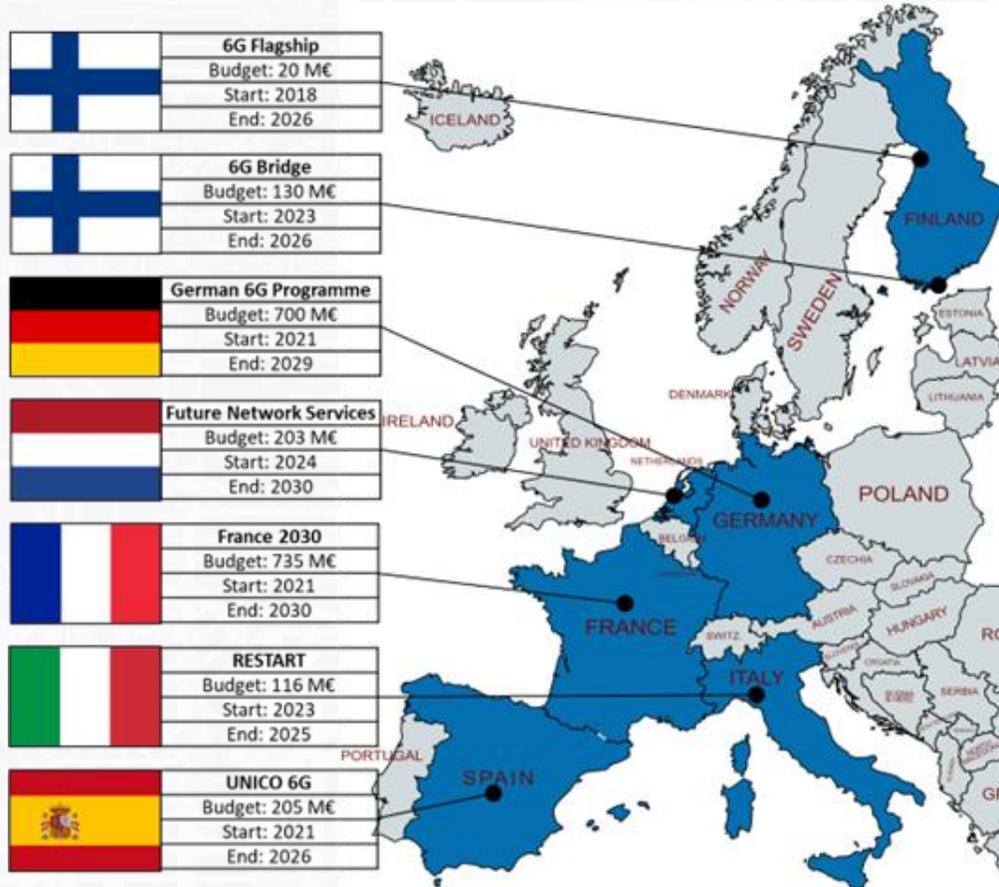
Member States Initiatives (Trials WG)

6G SNS

1st Call (Q1-2023)	35 projects 288 beneficiaries
2nd Call (Q1-2024)	27 projects 218 beneficiaries
3rd Call (Q1-2025)	16 projects TBC

The EU 6G R&I Landscape - Member States

Finland	**6G Flagship**
	Budget: 20 M€
	Start: 2018
	End: 2026

Finland	**6G Bridge**
	Budget: 130 M€
	Start: 2023
	End: 2026

Germany	**German 6G Programme**
	Budget: 700 M€
	Start: 2021
	End: 2029

Netherlands	**Future Network Services**
	Budget: 203 M€
	Start: 2024
	End: 2030

France	**France 2030**
	Budget: 735 M€
	Start: 2021
	End: 2030

Italy	**RESTART**
	Budget: 116 M€
	Start: 2023
	End: 2025

Spain	**UNICO 6G**
	Budget: 205 M€
	Start: 2021
	End: 2026

Source: 6G Research & Innovation Activities in Europe: An Overview of EU & Nationally funded Programmes (*SNS ICE* paper)

Topic	Relative Importance						
	Netherlands	Spain	Italy	France	6G Bridge Finland	6G Flagship Finland	Germany
5G evolution R&I	-	**	***	***	***	***	**
System network architecture and Control	***	**	***	***	***	***	***
Edge and Ubiquitous computing	**	**	***	***	***	***	***
Radio technology and Signal processing	***	**	***	***	***	***	***
Optical networks	-	**	***	**	–	*	***
Network and Service security	*	**	*	**	***	***	***
Non-terrestrial networks	*	**	***	***	**	*	***
Special purpose networks/sub-networks	*	-	***	***	***	**	***
Opportunities for	**	-	*	**	*	***	***
Policy aspects	**	-	*	**	*	***	**

> System architecture, Edge and Ubiquitous computing and Radio technology and signal processing seem to attract most of the interest from the National Initiatives

The EU 6G R&I Landscape - SNS Projects (SNS OPS survey)

6GSNS

Call 1+ Call 2 – KPIs

Main KPIs addressed within the Projects

KPI	Number of Call 2 projects
Energy efficiency	46
Latency	44
Reliability	42
Peak data rate (network)	31
User experienced data rate	28
Spectrum efficiency	28
Positioning (accuracy)	26
Connection density (devices/km²)	18
Mobility	17
Area traffic capacity	16
Provisioning time	9

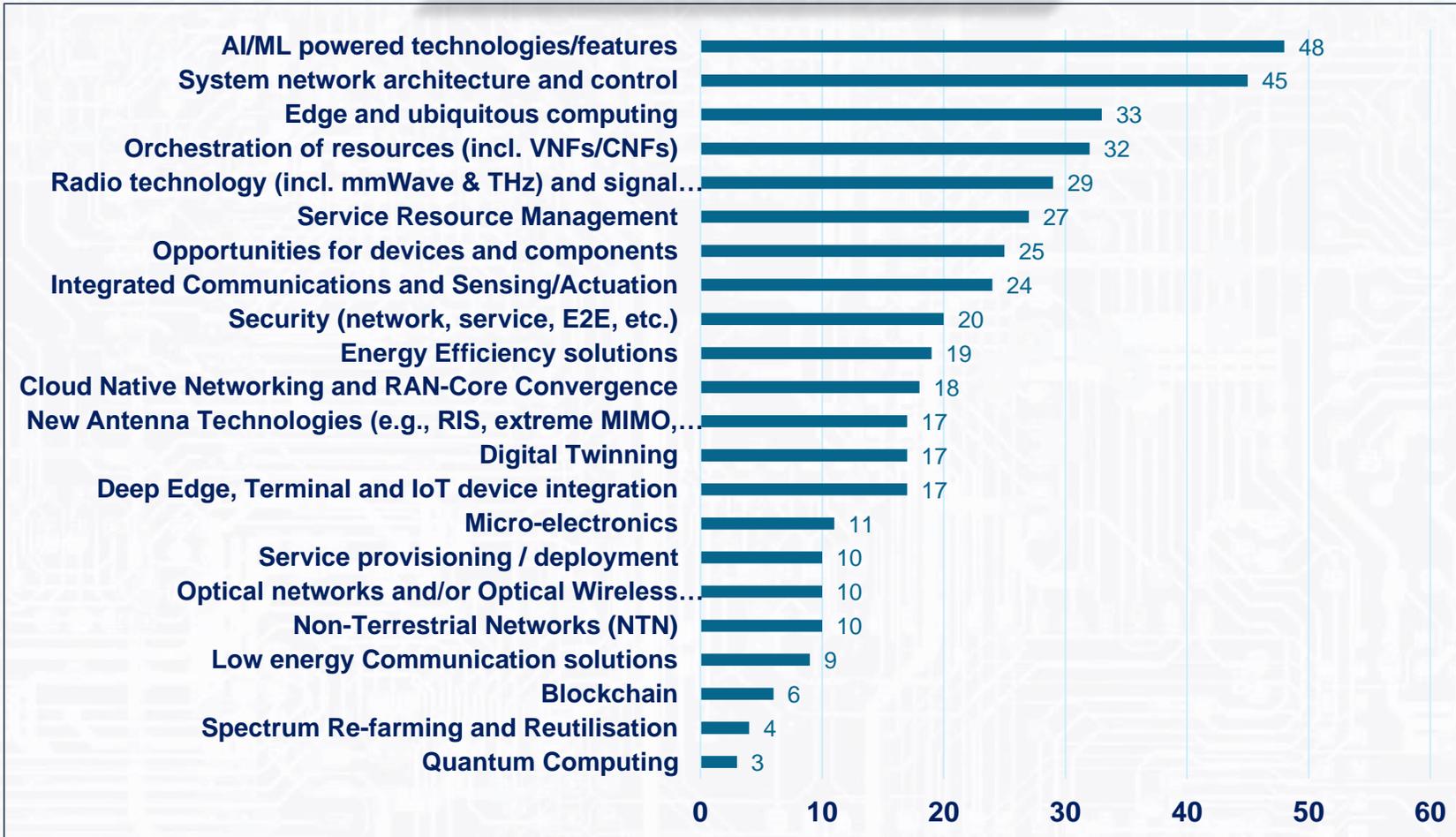**Number of Call 2 projects addressing each KPI**
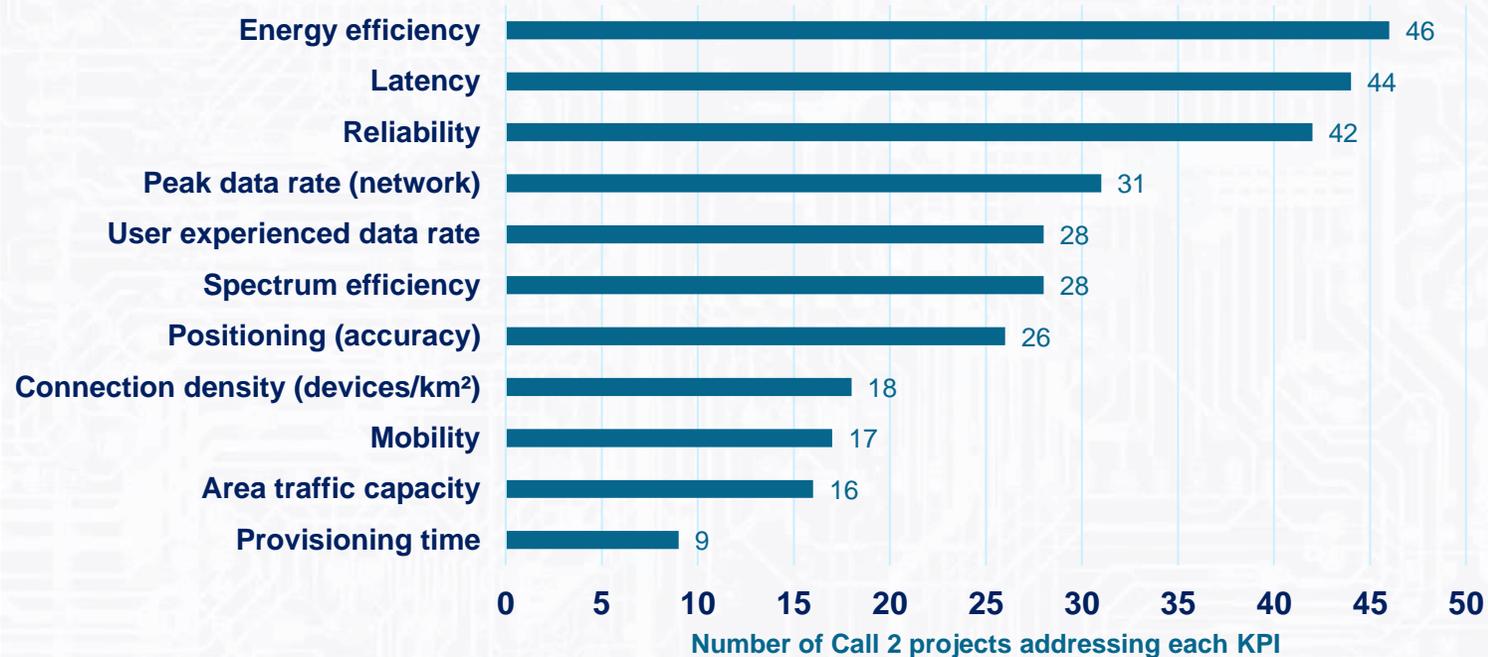
Key Insights

- A total of 63 projects are currently active in SNS JU

- 3 main "priority" tiers can be observed

  - 1s Tier: Energy Efficiency, Reliability, Latency

  - 2nd Tier: Peak data rate, User data rate, Spectrum efficiency, Positioning

  - 3rd Tier: Connection Density, Mobility, Area traffic capacity, provisioning time

The EU 6G R&I Landscape - SNS Projects (SNS OPS survey)

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Call 1+ Call 2 – Technologies

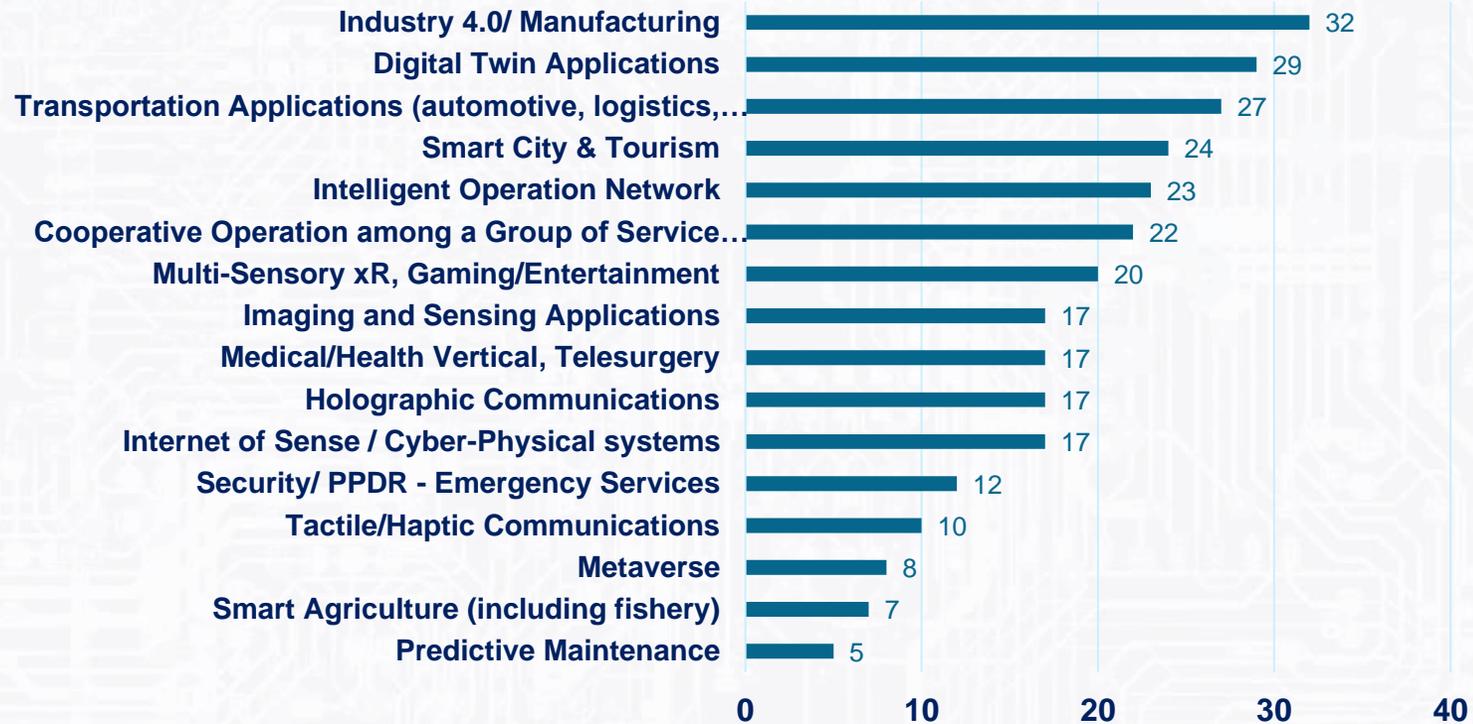| Technology	Count
AI/ML powered technologies/features	48
System network architecture and control	45
Edge and ubiquitous computing	33
Orchestration of resources (incl. VNFs/CNFs)	32
Radio technology (incl. mmWave & THz) and signal…	29
Service Resource Management	27
Opportunities for devices and components	25
Integrated Communications and Sensing/Actuation	24
Security (network, service, E2E, etc.)	20
Energy Efficiency solutions	19
Cloud Native Networking and RAN-Core Convergence	18
New Antenna Technologies (e.g., RIS, extreme MIMO,…	17
Digital Twinning	17
Deep Edge, Terminal and IoT device integration	17
Micro-electronics	11
Service provisioning / deployment	10
Optical networks and/or Optical Wireless…	10
Non-Terrestrial Networks (NTN)	10
Low energy Communication solutions	9
Blockchain	6
Spectrum Re-farming and Reutilisation	4
Quantum Computing	3

X-axis: 0 10 20 30 40 50 60

Key Insights

- A total of 63 projects are currently active in SNS JU

- AI/ML functionality & System Network Architecture are by far the most investigated issues among SNS projects

- A very broad range of technologies/issues (22+) are investigated by SNS projects

- Cross-comparison of results will assist the validation of the outcomes and extraction of common insights.

The EU 6G R&I Landscape - SNS Projects (SNS OPS survey)

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Call 1+ Call 2 – Apps / UCs

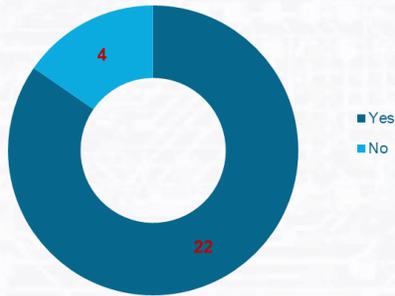| Application / Use Case	Count
Industry 4.0/ Manufacturing	32
Digital Twin Applications	29
Transportation Applications (automotive, logistics,…	27
Smart City & Tourism	24
Intelligent Operation Network	23
Cooperative Operation among a Group of Service…	22
Multi-Sensory xR, Gaming/Entertainment	20
Imaging and Sensing Applications	17
Medical/Health Vertical, Telesurgery	17
Holographic Communications	17
Internet of Sense / Cyber-Physical systems	17
Security/ PPDR - Emergency Services	12
Tactile/Haptic Communications	10
Metaverse	8
Smart Agriculture (including fishery)	7
Predictive Maintenance	5

Key Insights

- Broad coverage of vertical sectors across Call 1 & Call 2 projects (more than 16 UCs/Apps addressed)

- I4.0, Digital Twinning & Transportation Use Cases are the most popular among SNS projects

- Very good overlap among Use Cases to be used for validation of results & extraction of communal insights

- New UCs added as the SNS JU programme moves forward

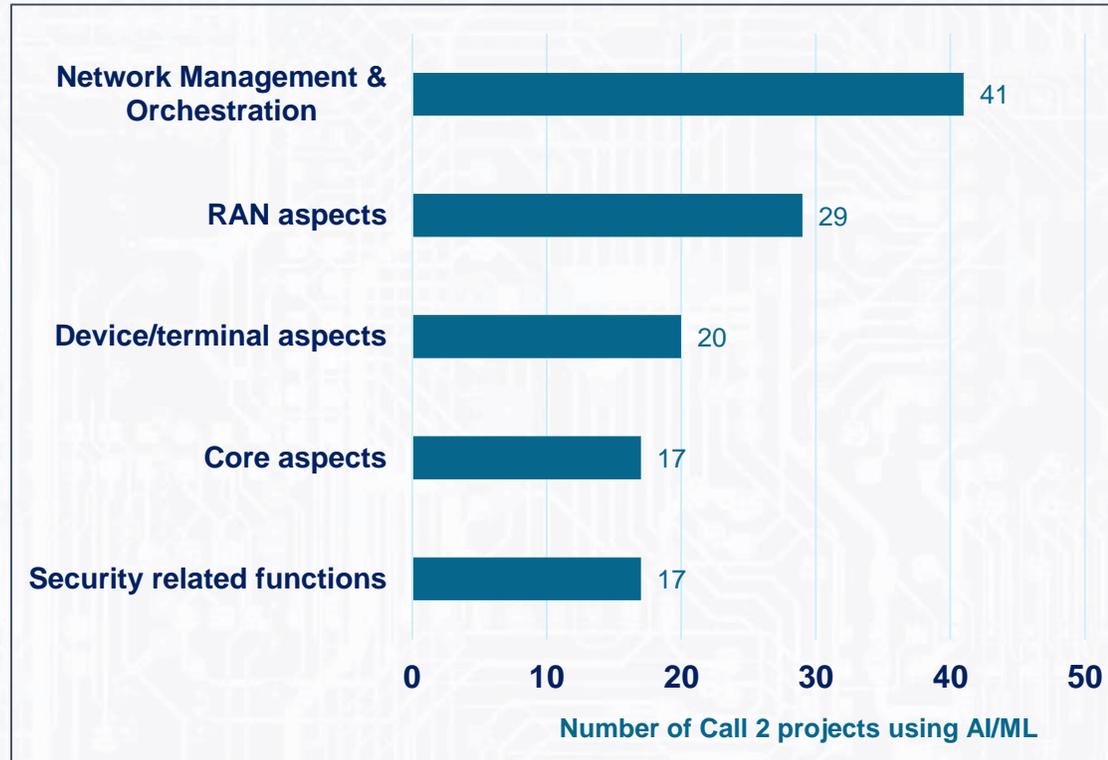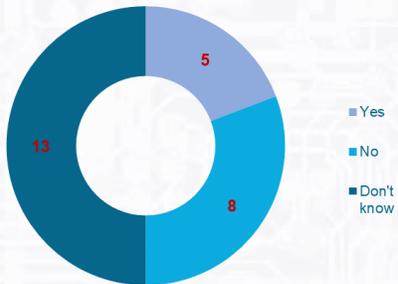# The EU 6G R&I Landscape - SNS Projects (SNS OPS survey)

6G SNS

Call 1+ Call 2 – AI/ML Functionality

Call 2 (26 projects)

Will your project make use of AI/ML?

- 4 (No)
- 22 (Yes)

Do you plan to deliver/provide access to your AI training data sets?

- 5 (Yes)
- 8 (No)
- 13 (Don't know)

Category	Number
Network Management & Orchestration	41
RAN aspects	29
Device/terminal aspects	20
Core aspects	17
Security related functions	17

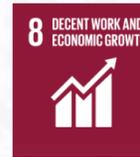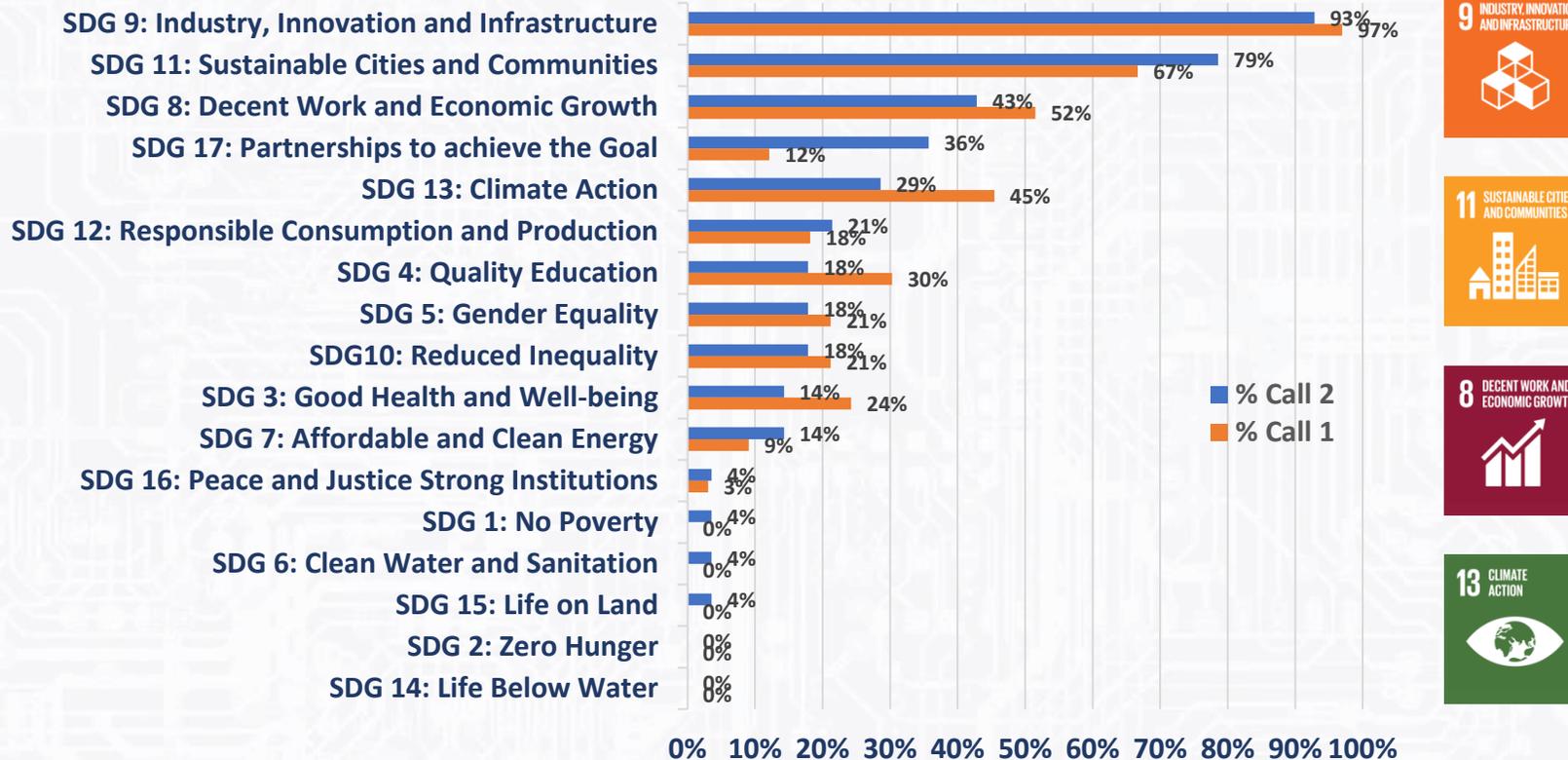**Number of Call 2 projects using AI/ML** (axis: 0, 10, 20, 30, 40, 50)

Key Insights

- A total of 63 projects are currently active in SNS JU

- Network Management & Orchestration is the most popular field of AI/ML application followed by RAN

- AI/ML is well integrated in all network & device levels

The EU 6G R&I Landscape - SNS Projects (SNS OPS survey)

6G SNS

Call 1+ Call 2 – UN SDGs

SDG	% Call 2	% Call 1
SDG 9: Industry, Innovation and Infrastructure	93%	97%
SDG 11: Sustainable Cities and Communities	79%	67%
SDG 8: Decent Work and Economic Growth	43%	52%
SDG 17: Partnerships to achieve the Goal	36%	12%
SDG 13: Climate Action	29%	45%
SDG 12: Responsible Consumption and Production	21%	18%
SDG 4: Quality Education	18%	30%
SDG 5: Gender Equality	18%	21%
SDG10: Reduced Inequality	18%	21%
SDG 3: Good Health and Well-being	14%	24%
SDG 7: Affordable and Clean Energy	14%	9%
SDG 16: Peace and Justice Strong Institutions	4%	3%
SDG 1: No Poverty	0%	4%
SDG 6: Clean Water and Sanitation	0%	4%
SDG 15: Life on Land	0%	4%
SDG 2: Zero Hunger	0%	0%
SDG 14: Life Below Water	0%	0%

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Preliminary Insights

The SNS work programme is specifically asking for contributions to 4 SDGs and three of them are on top

- SDG 9: Industry, Innovation and Infrastructure

- SDG 11: Sustainable Cities and Infrastructure

- SDG 8: Decent Work and Economic Growth