



SNS-OPS Survey Results on Technical, Vision and Market aspects of Phase 1 SNS Projects

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23rd November 2023

THIS WEBINAR WILL BE RECORDED!

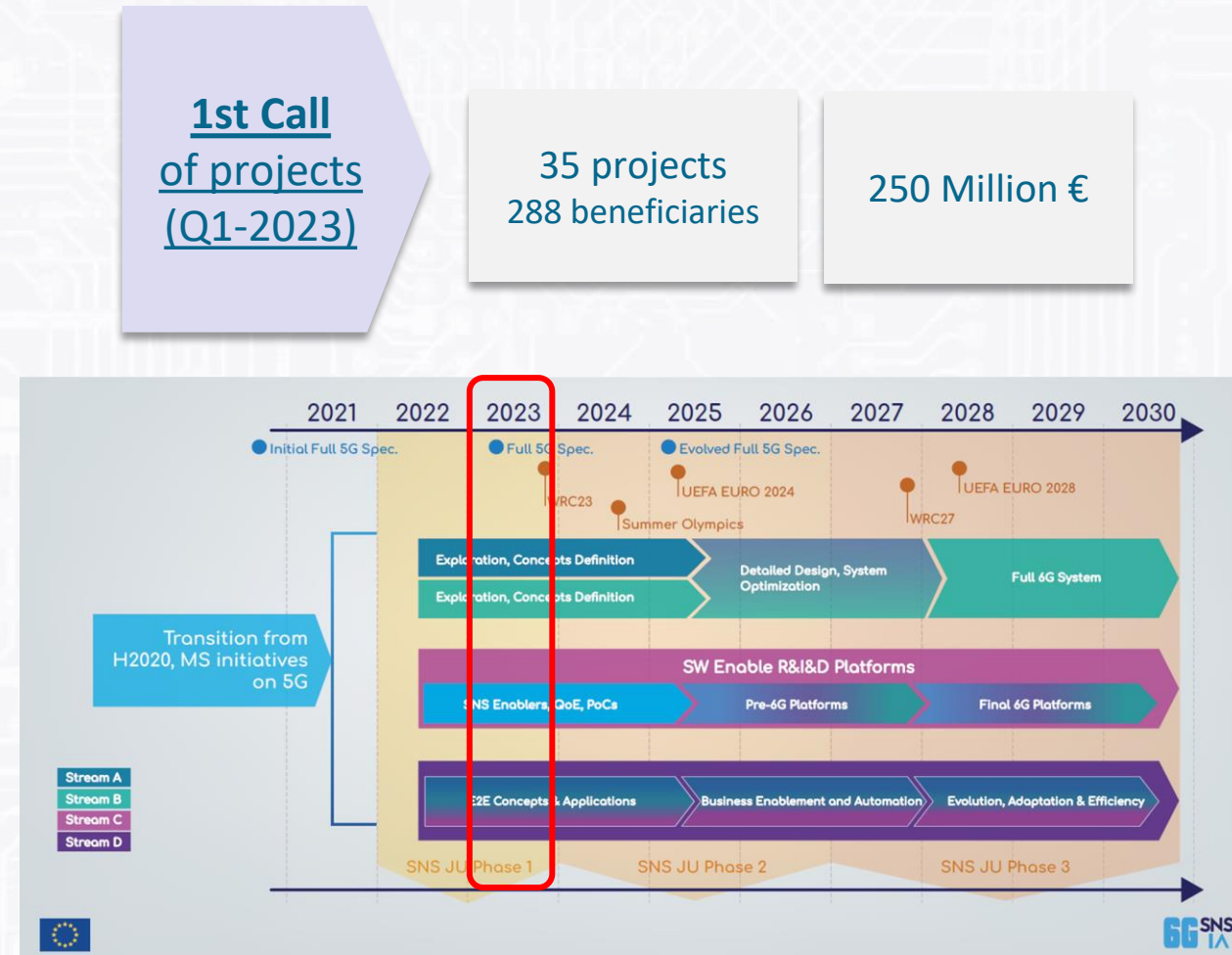


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Welcome

- **Welcome** to the SNS OPS Webinar on the **Technical, Vision & Market aspects of Phase 1 SNS Projects**
- The SNS JU journey has kicked-off with 35 projects in Q1 2023 (**33 R&I projects + 2 CSA**)
- All projects addressing the challenges & topics mentioned in the **SNS Work Programme 2022**
- Important to get a more **comprehensive view of their work & goals**, after they have had a chance to consolidate their approach.



- A questionnaire was created by SNS OPS project and addressed to all 33 SNS R&I call 1 projects, as part of the **SNS Monitoring & Analysis Framework** (*SNS OPS Deliverable D1.1*)
- The goal of the questionnaire is to get a better understanding of the work planned to be performed in each of the projects, the challenges being addressed and the expected outcomes.
- The questionnaire consists of three sections, i) **Technical** section (15 questions), ii) **Vision** section (6 questions) and iii) **Market** section (8 questions).
- All 33 projects provided their answers in the period April-May 2023
- The key insights extracted from the project answers are provided here.
- The questionnaire will be re-issued on an annual basis addressing all active SNS JU projects.
 - -1 Version for new (incoming) projects (targeting insights on work plans, vision and market aspects)
 - -1 Version for old (existing) projects (targeting insights on results of ongoing work)
- **Q&A**: please ask your questions in the chat-box, identifying the question and speaker addressed

Agenda



Time (CET)	Presenter	Subject	Presenter Affiliation
14.00 - 14.05	Colin Willcock	Welcome	SNS JU GB chairman
14.05 - 14.10	Uwe Herzog	SNS OPS Questionnaire Introduction	Eurescom, SNS OPS Project Coordinator
14.10 - 14.40	Kostas Trichias	SNS Phase 1 Projects – Technical Insights	6G-IA, SNS OPS WP1 Leader
14.40 - 14.55	Per Hjalmar Lehne	SNS Phase 1 Projects – Vision	Telenor, SNS OPS WP1 Vision Task Leader
14.55 - 15.15	Jessica Carneiro	SNS Phase 1 Projects – Market Insights	Australo, SNS OPS WP4 Leader
15.15 - 15.30	Uwe Herzog (moderation)	Way forward & Q&A	
15.30	End of Event		



TECHNICAL SECTION

Technical Section



Key Performance Indicators (KPIs)

B5G/6G Technological Enablers

Network Aspects Addressed

Verticals

Use Cases & Applications

Use of AI/ML

Standardisation Targets

Validation Methodologies

End User Equipment

Trials & Pilots (Planning)

Energy Efficiency

Technical, T1:

What is the main planned technology outcome or the key technological improvements targeted by your project?



- Projects' input was matched to the Specific Objectives (SO) of each stream (as defined in the SNS JU R&I WP 2022)
- The SNS projects' technology contributions towards the SOs was categorized into **Primary** & **Secondary**
- Results indicate:
 - **Good coverage** of all SOs of SNS JU WP 2022
 - **Good distribution** between Primary & Secondary objectives (all SOs in Streams A & B have at least 1 project treating them as primary)
 - Stream C & D projects well **aligned in their mission** (similar approach)

[Stream A](#)

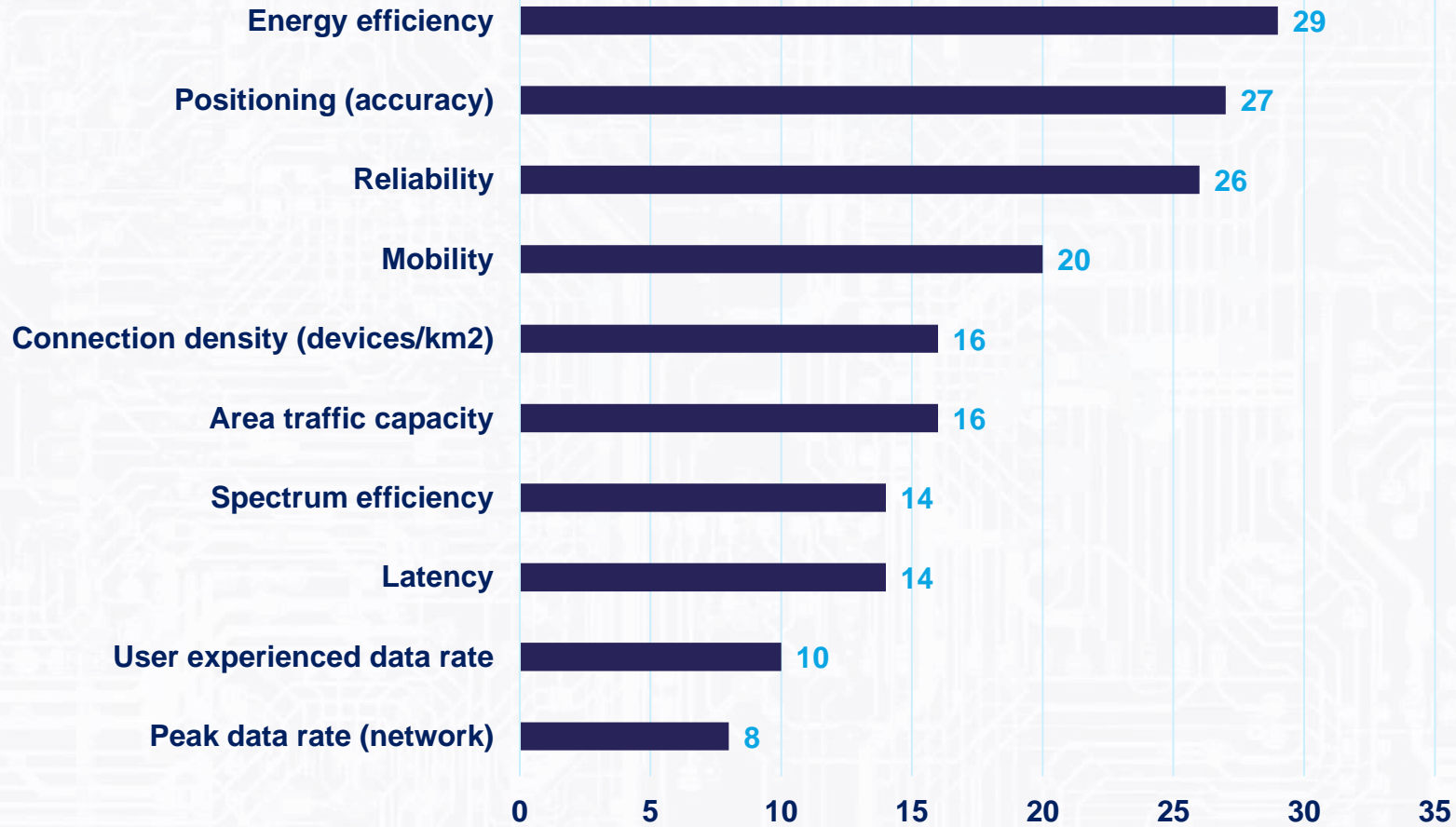
[Stream B](#)

[Stream C](#)

[Stream D](#)

Detailed results (SO matching per project) will become available with deliverable D1.2 of SNS OPS (Jan 2024)

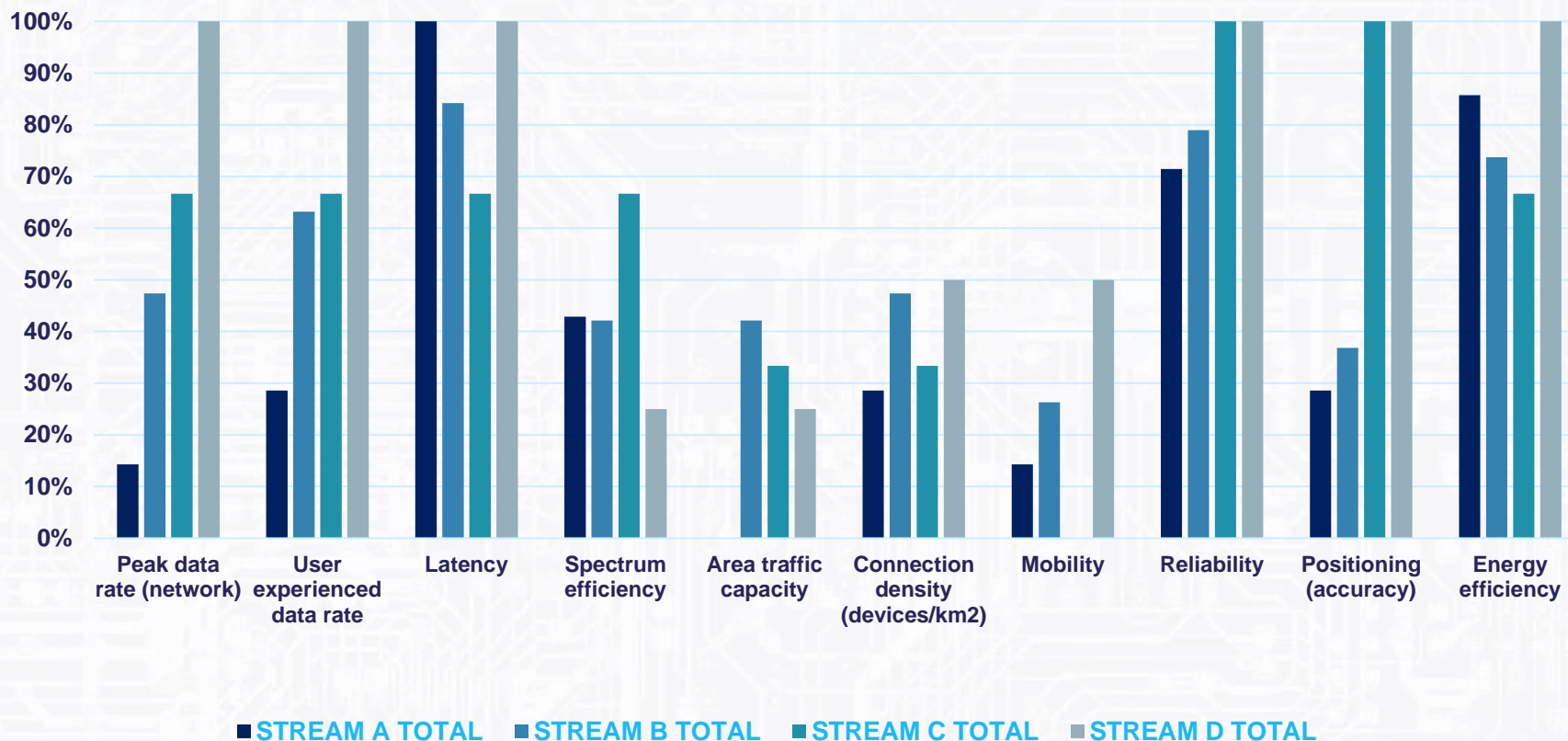
Technical, T2:
Which of the following main KPIs will your project address?



Key Insights

- Good coverage of all main KPIs
- URLLC type KPIs & Energy Efficiency are the most popular

Technical, T2: Main KPIs per Stream

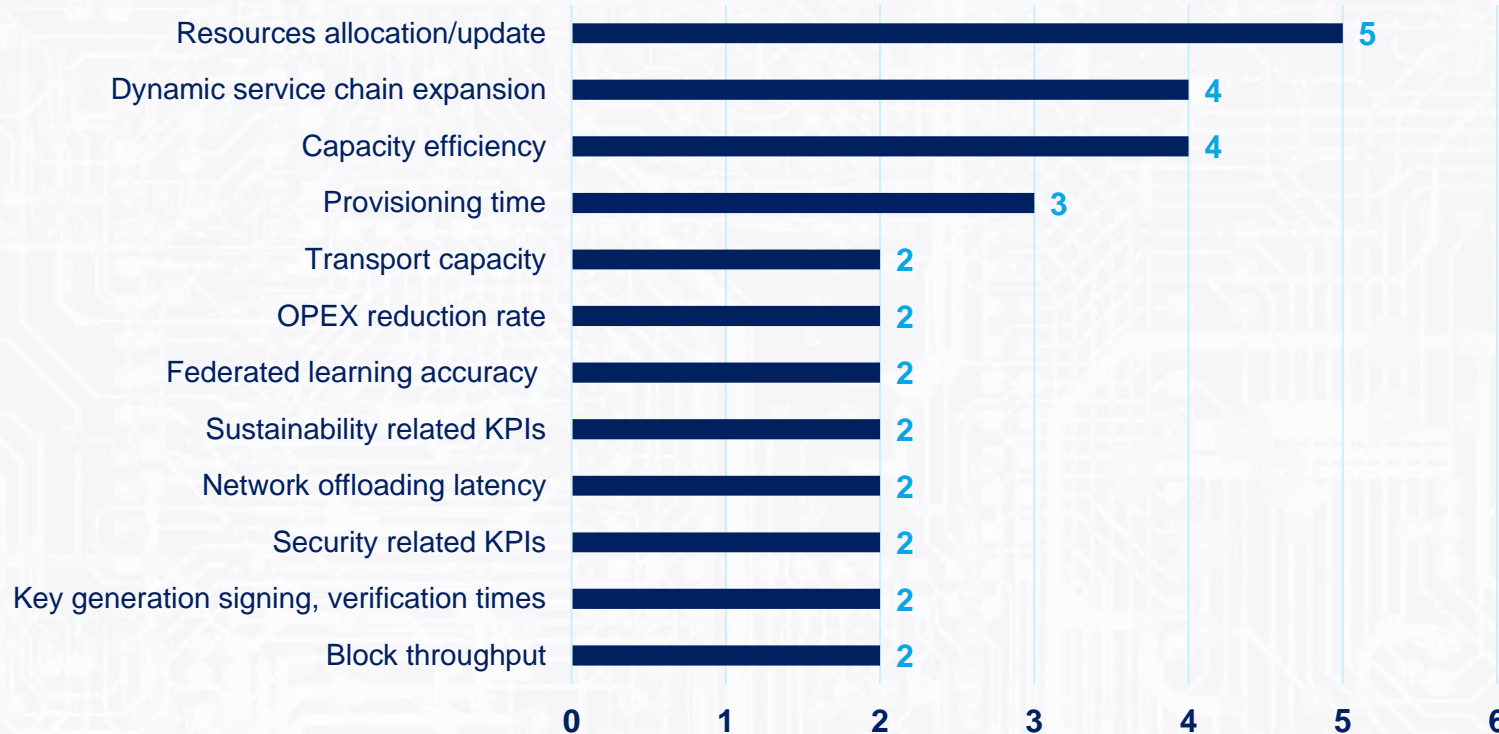


Key Insights

- Most KPIs are well covered by all streams
- Stream D projects seem to cover almost all basic KPIs (offering them to experimenters)
- Latency, reliability and Energy Efficiency are the most covered KPIs

Technical, T3:

Will your project address additional KPIs? If yes, which ones?



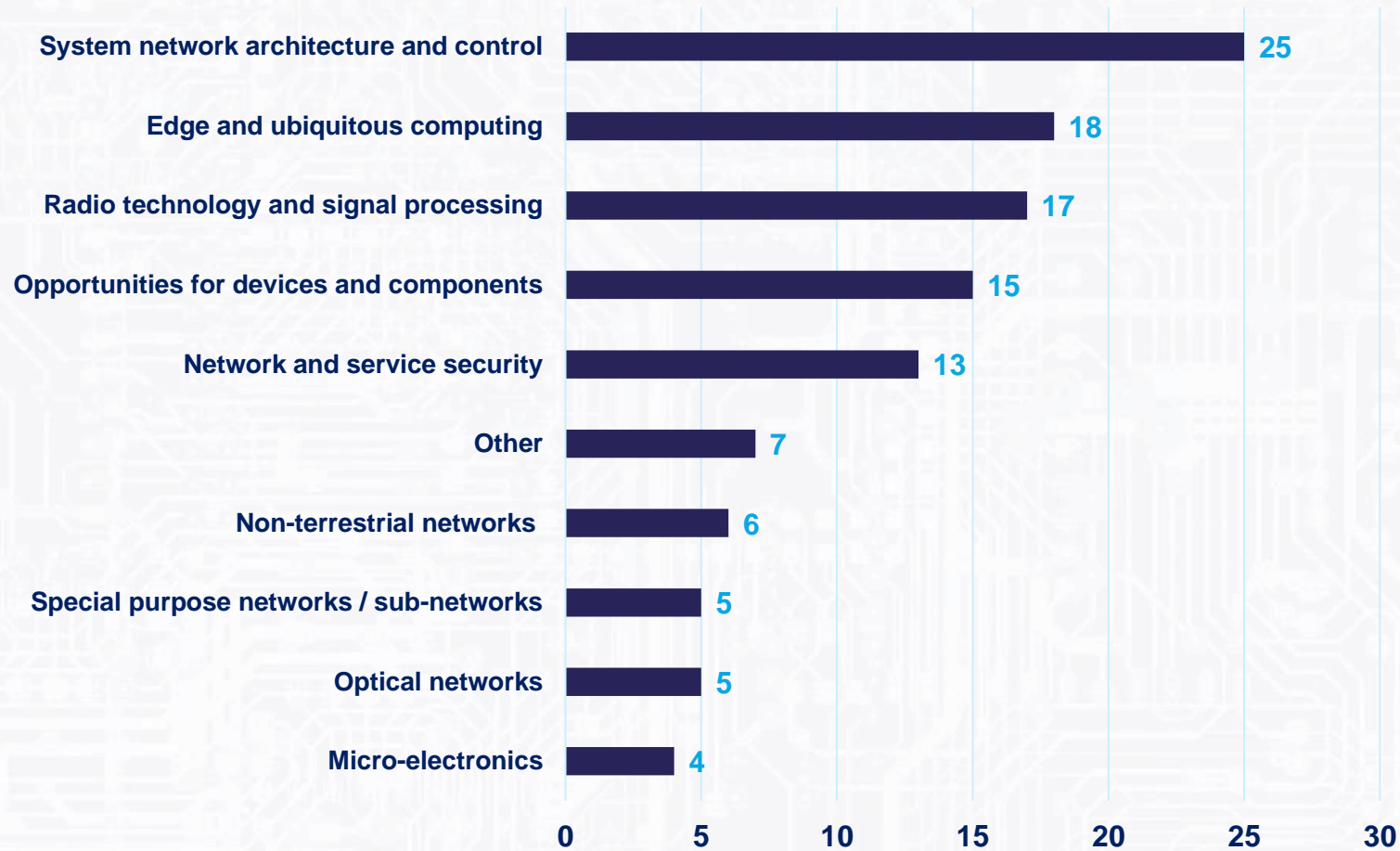
Key Insights

- **31 additional KPIs** are investigated by projects
- **19 additional KPIs** are investigated by single projects (not shown)
- Wide-spread coverage of network aspects and novel technologies evaluation by Phase 1 projects

- **Security Related KPIs:** cyberattack detection rate, Resistance to adversarial attacks, etc.
- **NTN terminal related KPIs:** antenna aperture, power consumption, frequency agility, etc.
- **AI/ML related KPIs:** accuracy, AI training performance, inference latency, AI safety, etc.
- **Sustainability related KPIs:** resource utilization rate/efficiency, signalling overhead, Scalability
- **NTN constellations KPIs:** number of flying nodes, feeder links capacities, link budgets, etc.
- **Determinism:** packet delay variation, predictability

Technical, T4:

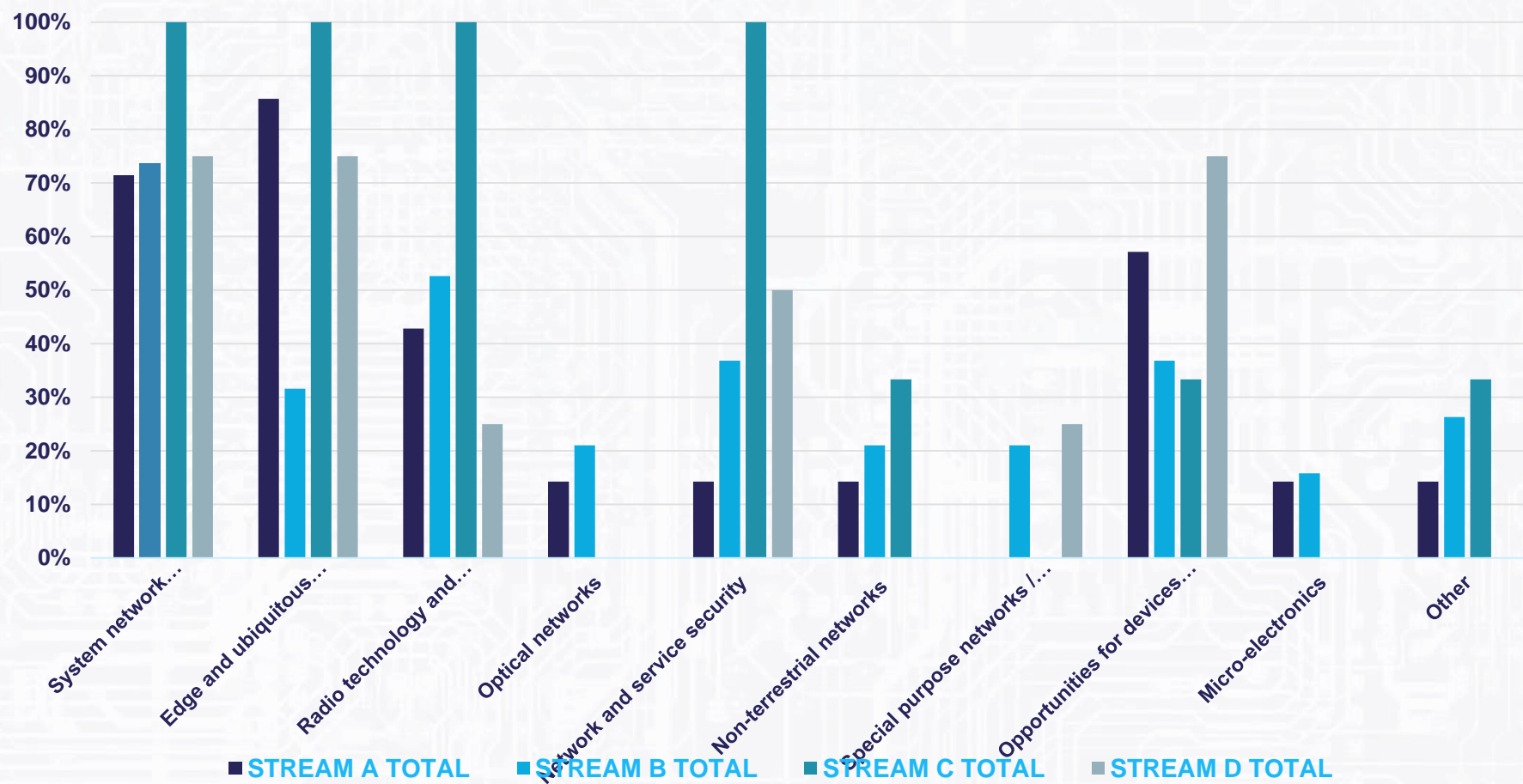
Which B5G/6G network part / aspect and/or technology will your project address?



Key Insights

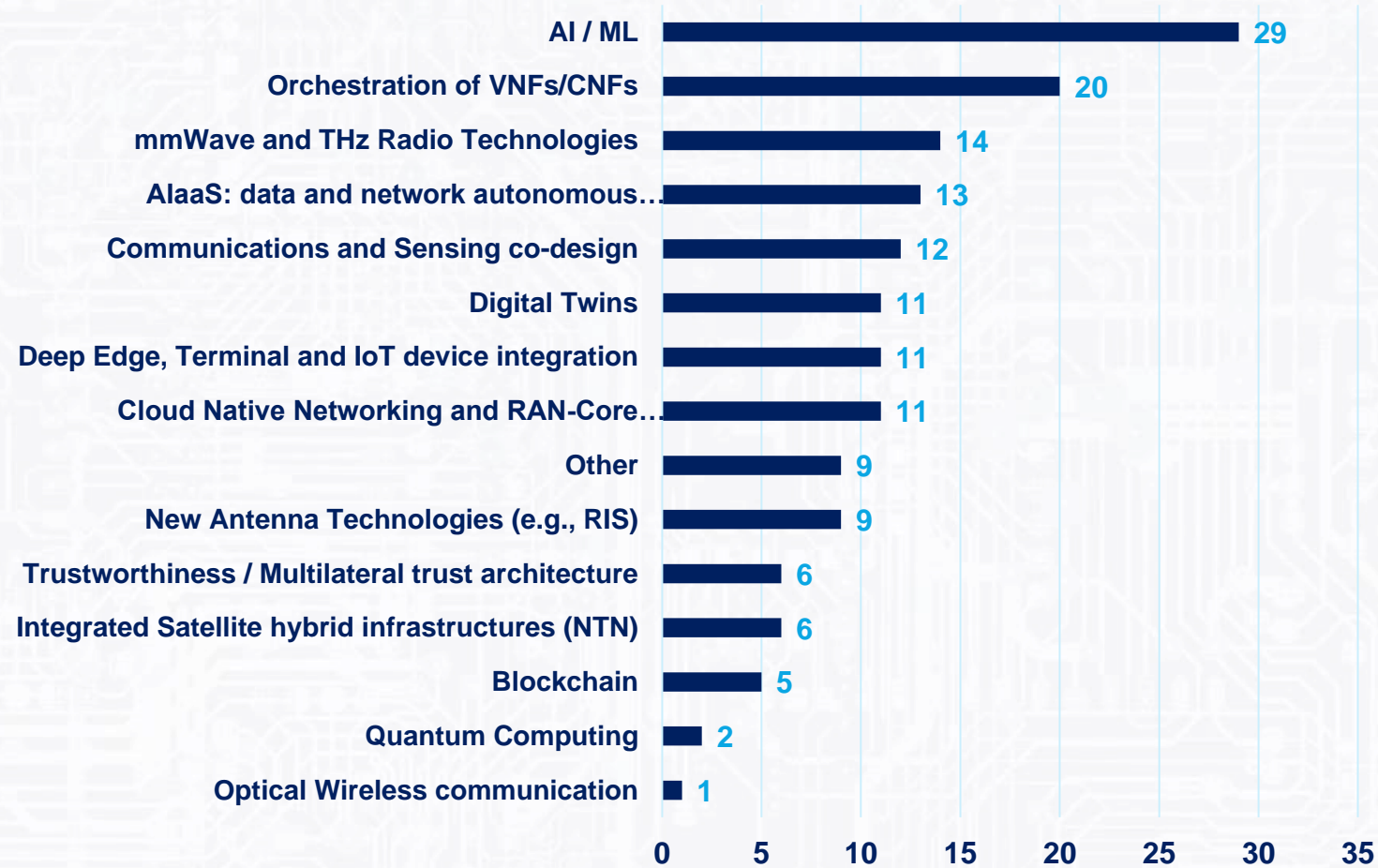
- Distribution matches nicely the SNS-JU stream focus
- Low coverage on micro-electronics addressed with Stream_B-01-05 project in WP2023 & Microelectronics Lighthouse project in WP 2024
- Additionally, the use of Digital Twinning technology was mentioned by multiple projects

Technical, T4: B5G/6G network part/technology addressed per stream



Key Insights

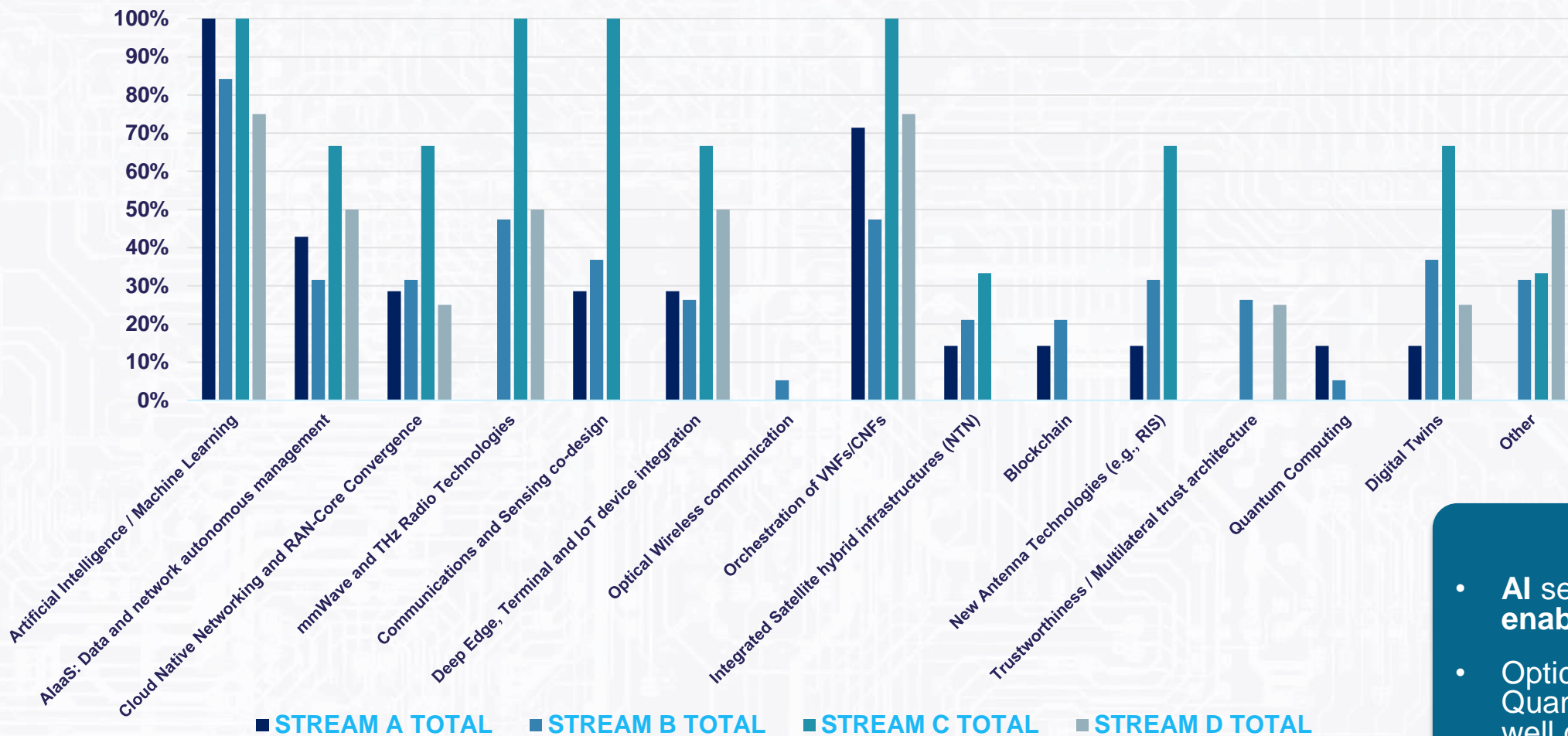
- **Addressed technologies** follow the respective stream guidelines
- **All 3 Stream C projects** address Network Architecture, Edge computing, RAN & signalling aspects & security issues.

Technical, T5:**Which technological enablers will your project work on / make use of?****Key Insights**

- Use of AI/ML is almost universal for Phase 1 projects (29/33)
- The “Other” category mostly covers very project specific technologies/enablers

Technical, T5:

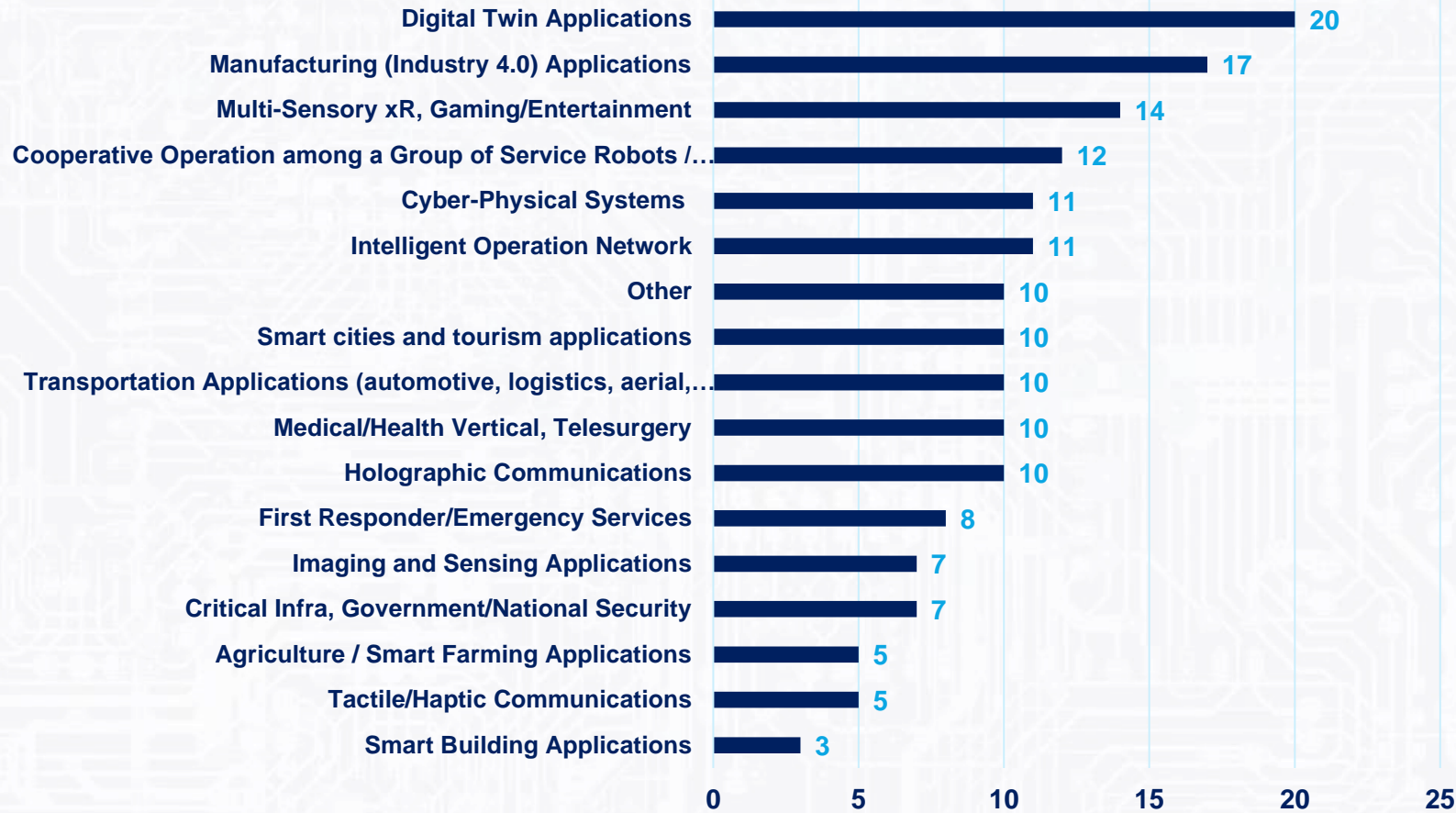
Which technological enablers will your project work on/make use of?
Per stream

**Key Insights**

- AI seems to be a global enabler
- Optical wireless and Quantum computing are less well covered

Technical, T6:

Which of the following use cases / applications will your project support?

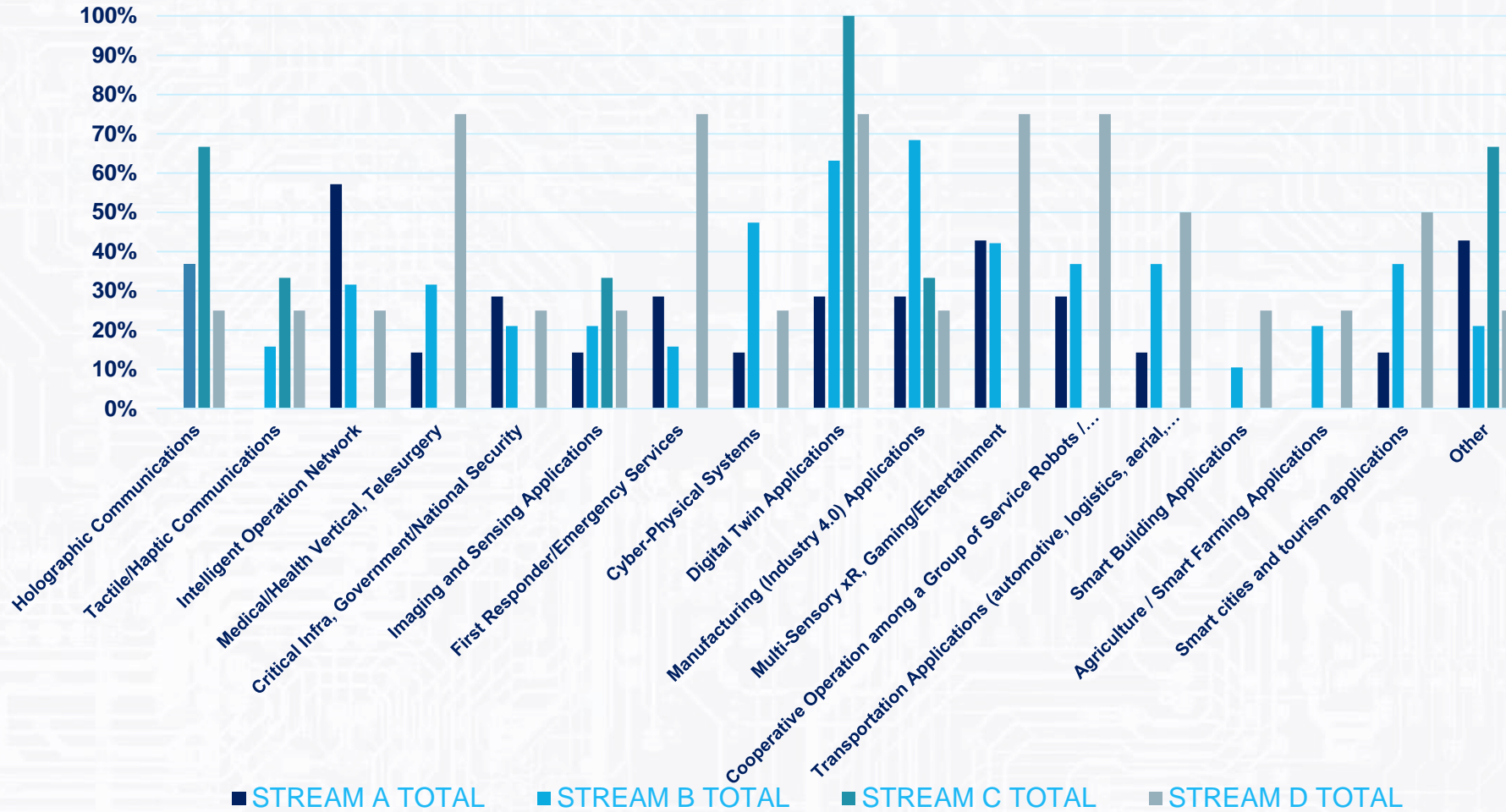


Key Insights

- **Digital Twin** applications are very popular
- Additional UCs mentioned:
 - Predictive maintenance (airline fleet), End to end energy measurement and conservation system, etc.
- Additional UCs expected from **open calls** (Streams C & D)

Technical, T6:

Which of the following use cases / applications will your project support (per stream)?

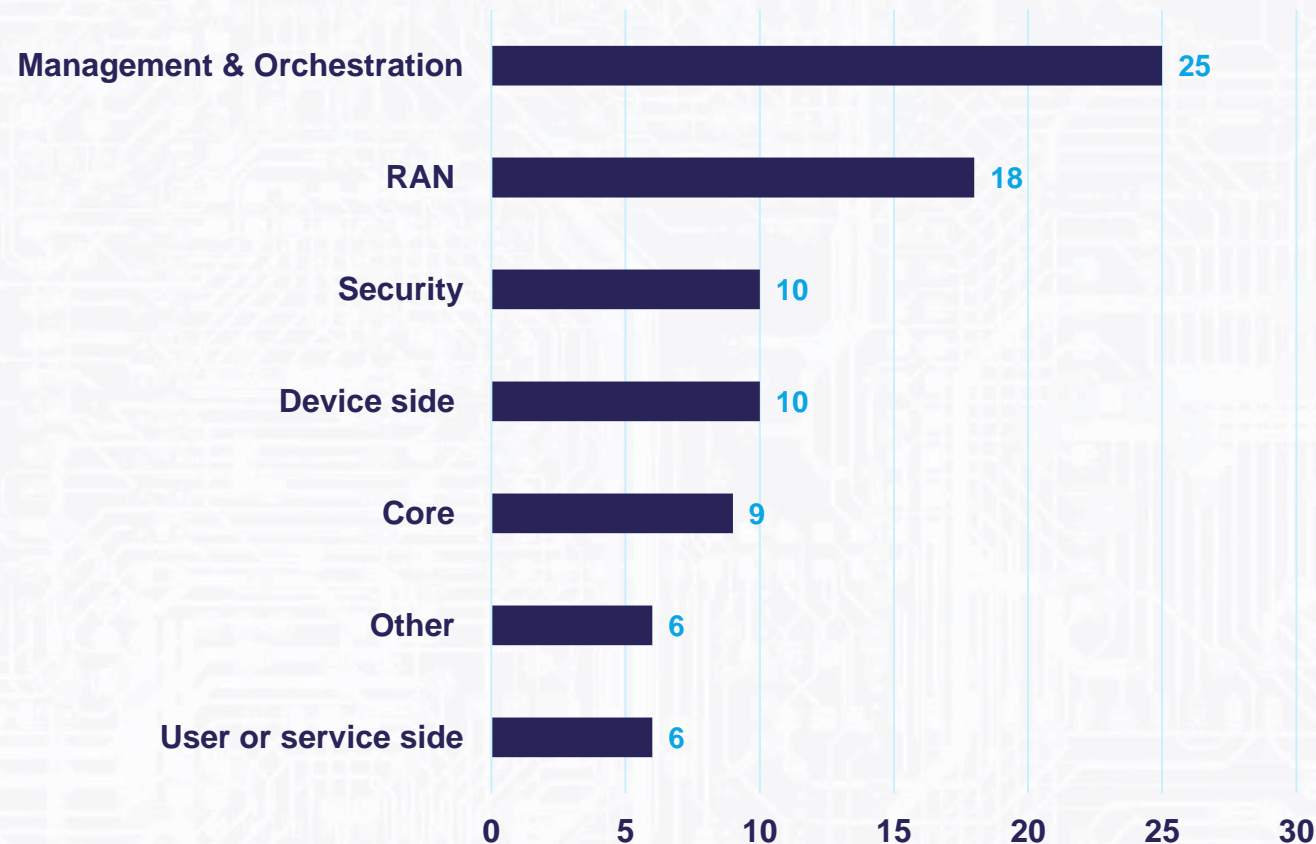


Key Insights

- **Good coverage** for multiple UCs / Applications across all streams
- **Digital Twin** Applications seem to be the most popular

Technical, T7:

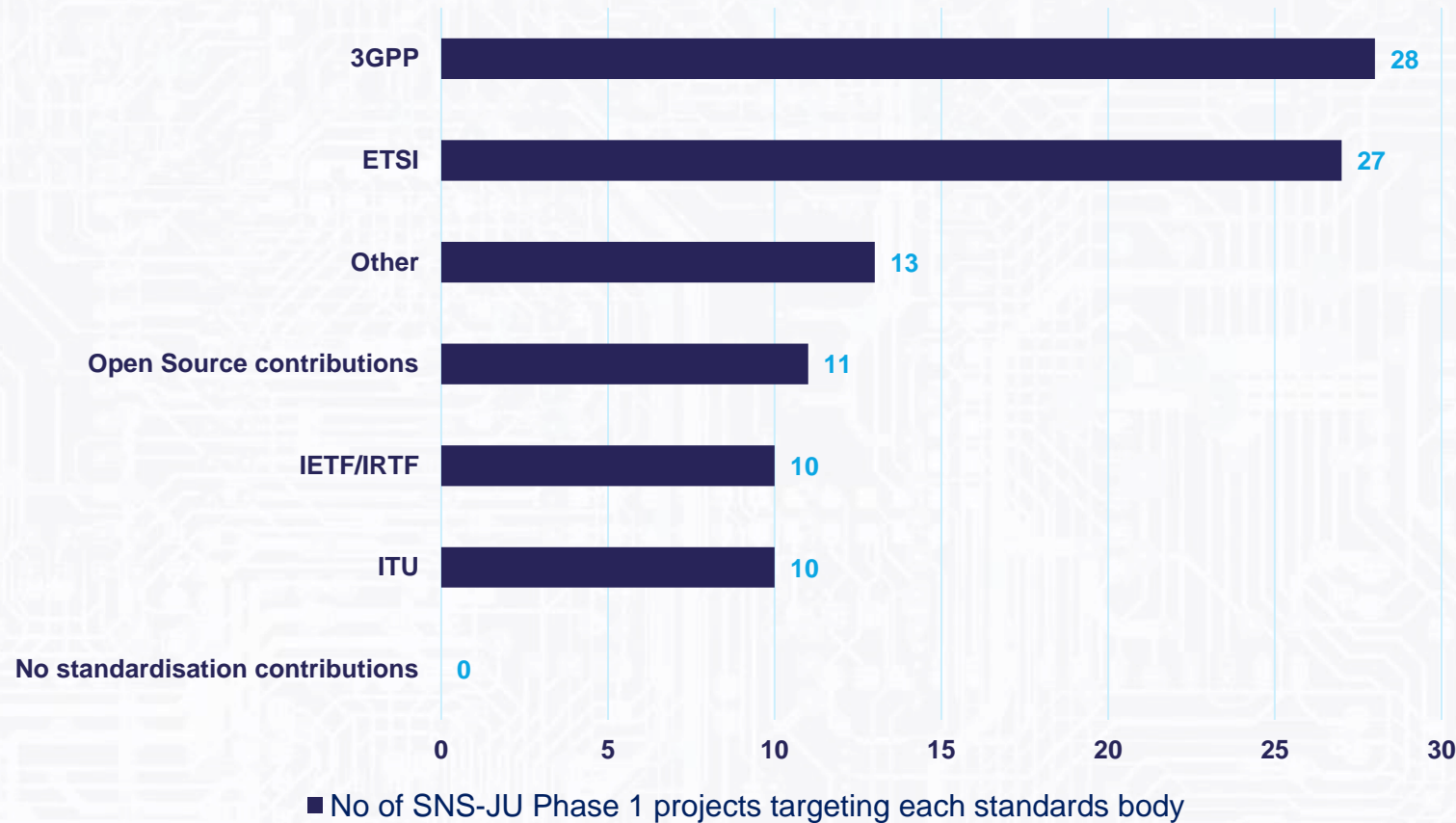
Will your project make use of AI/ML? if yes, on which part of the system will your project use AI or which AI services will you develop?



Key Insights

Some specific examples of the **use of AI** have been mentioned by some projects:

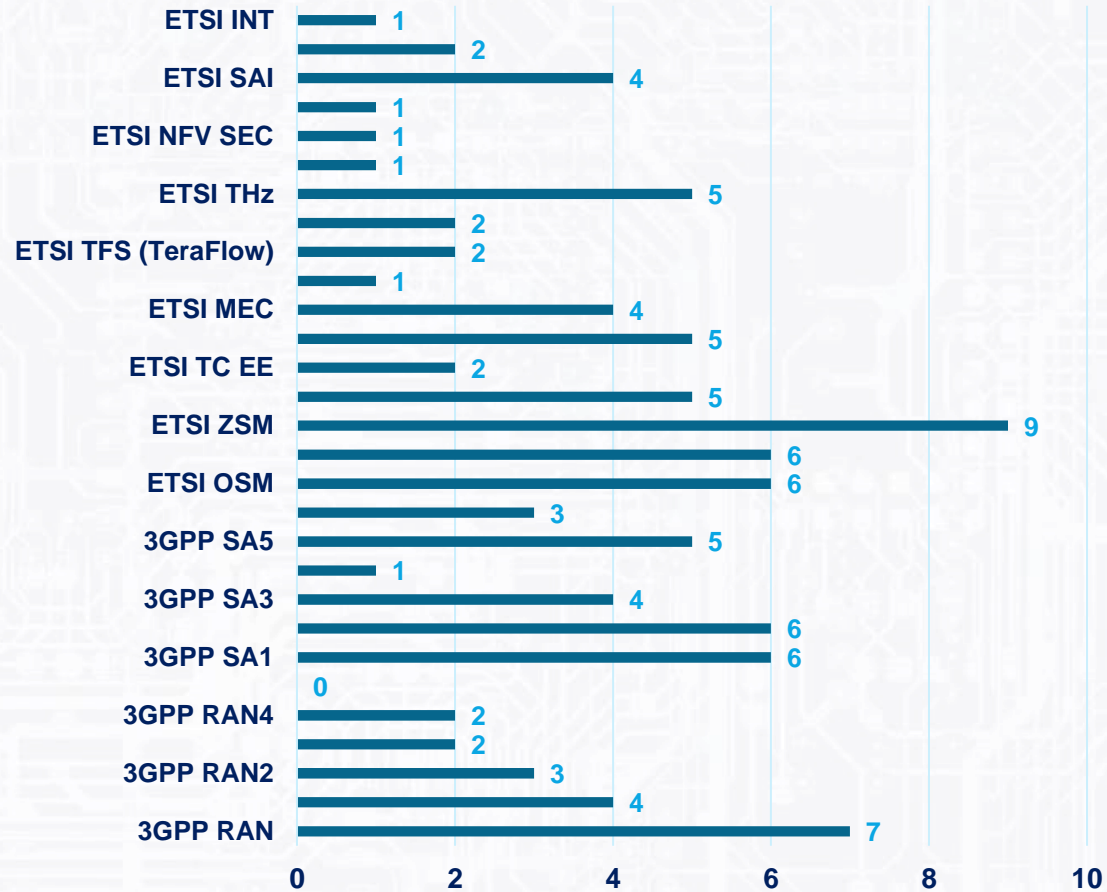
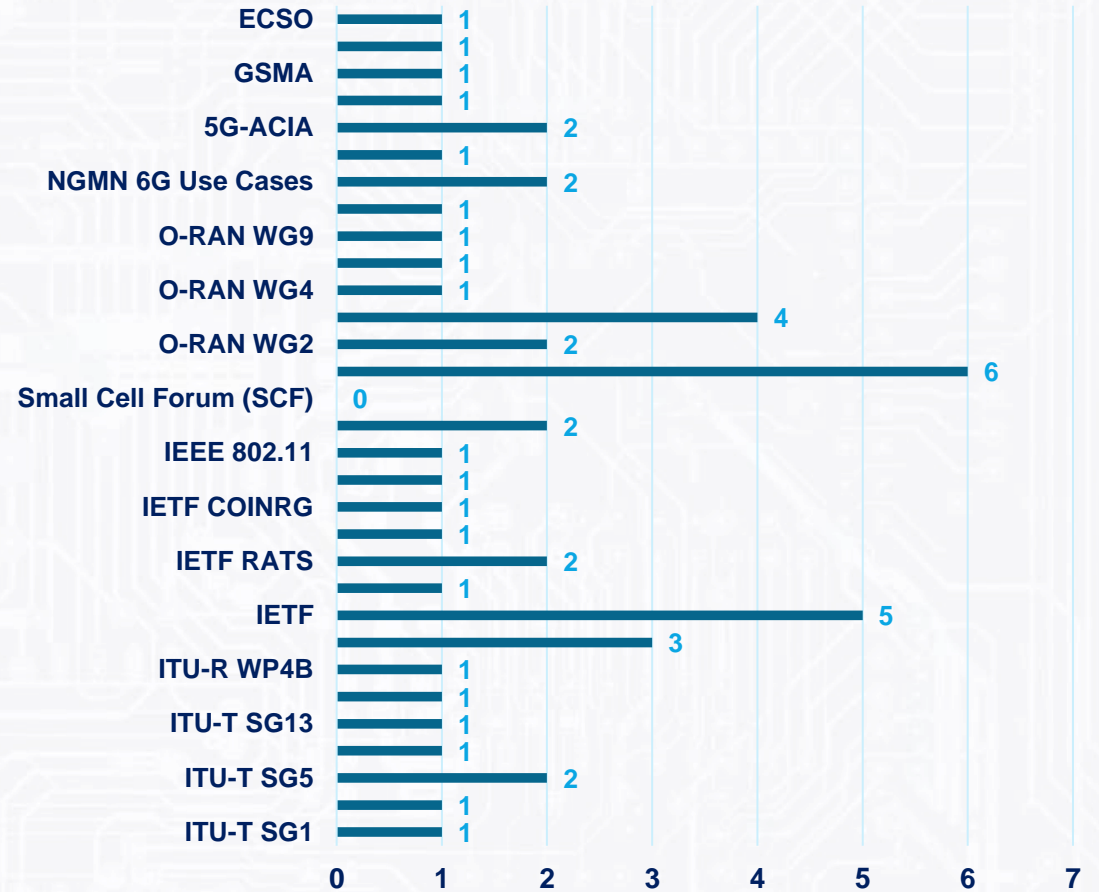
- Near-real time resource allocation,
- Interference management
- Predictive scheduling
- Jamming detection and mitigation
- Network performance prediction (e.g., predicted latency)
- Intent-based
- Beam forming/tracking management

Technical, T8:**Which standardisation bodies will your projects target for contributions?****Key Insights**

- **3GPP & ETSI** are by far the most popular SDOs
- When looking at specific WG contributions, slightly more contributions towards ETSI are envisioned than 3GPP (more ETSI groups are targeted)
- A more detailed analysis per group was necessary for additional insights

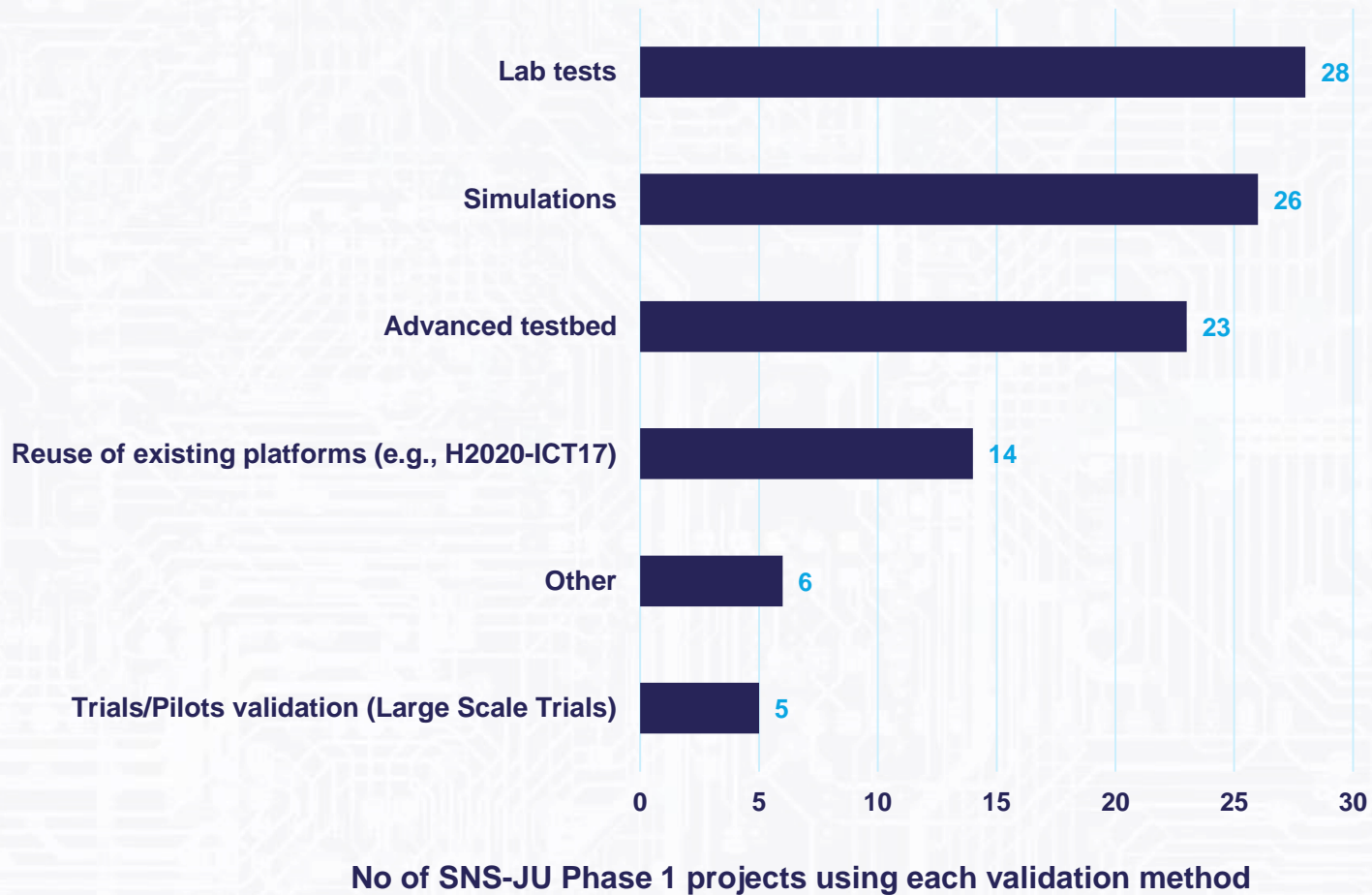
Technical, T8:

Which standardisation bodies will your projects target for contributions?

**T8 - SDO Targetted Bodies (Part A)****T8 - SDO Targetted Bodies (Part B)**

Technical, T9:

Which methods will your project use to validate the technologies to be developed?

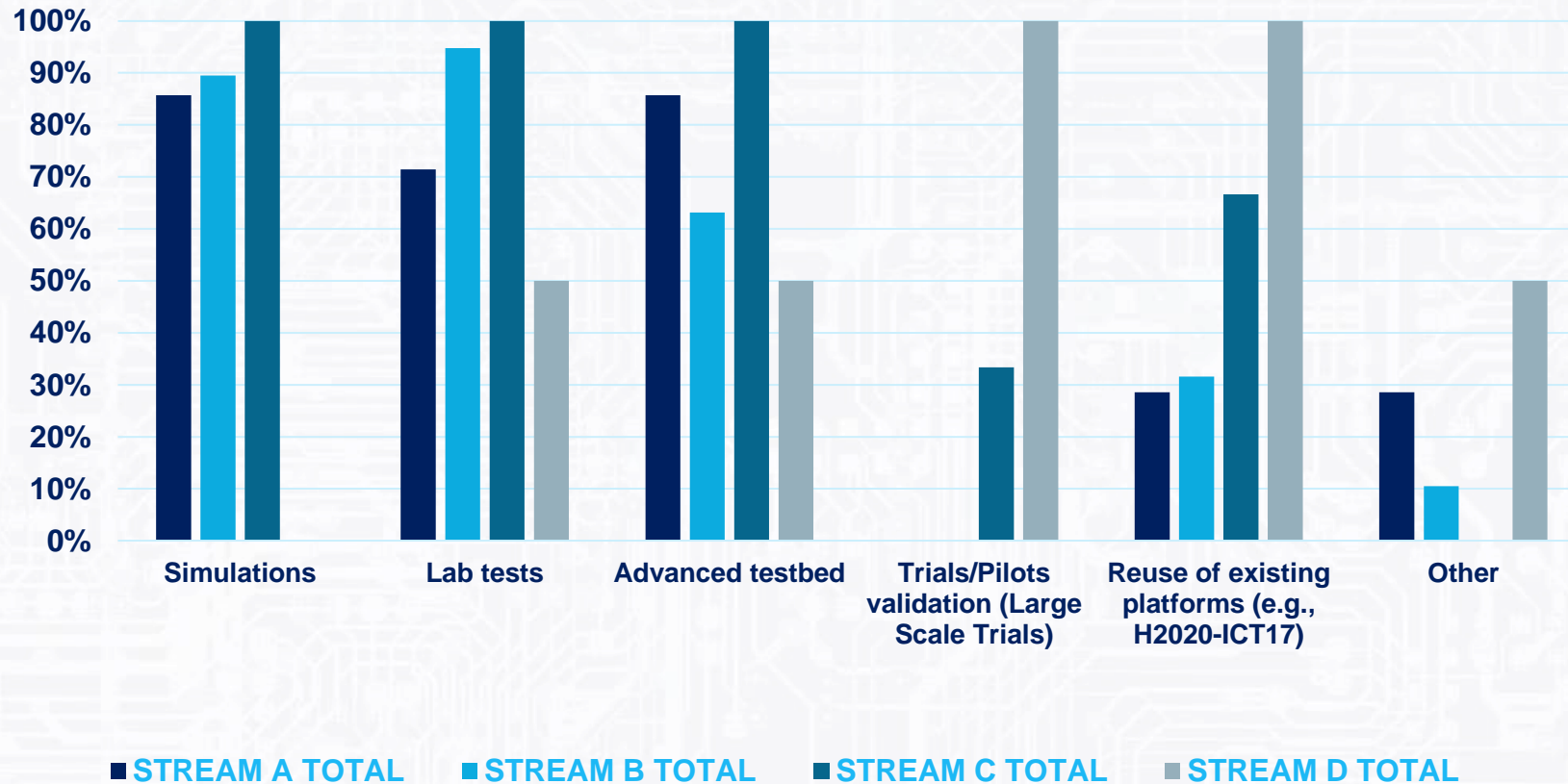


Key Insights

- **Simulations & Lab tests** are very popular due to early experimentation stage
- Significant **re-use & upgrade of existing experimentation facilities** is important
- More advanced Trials and Pilots are expected in the follow up phases of SNS-JU

Technical, T9:

Which methods will your project use to validate the technologies to be developed? *Per stream*

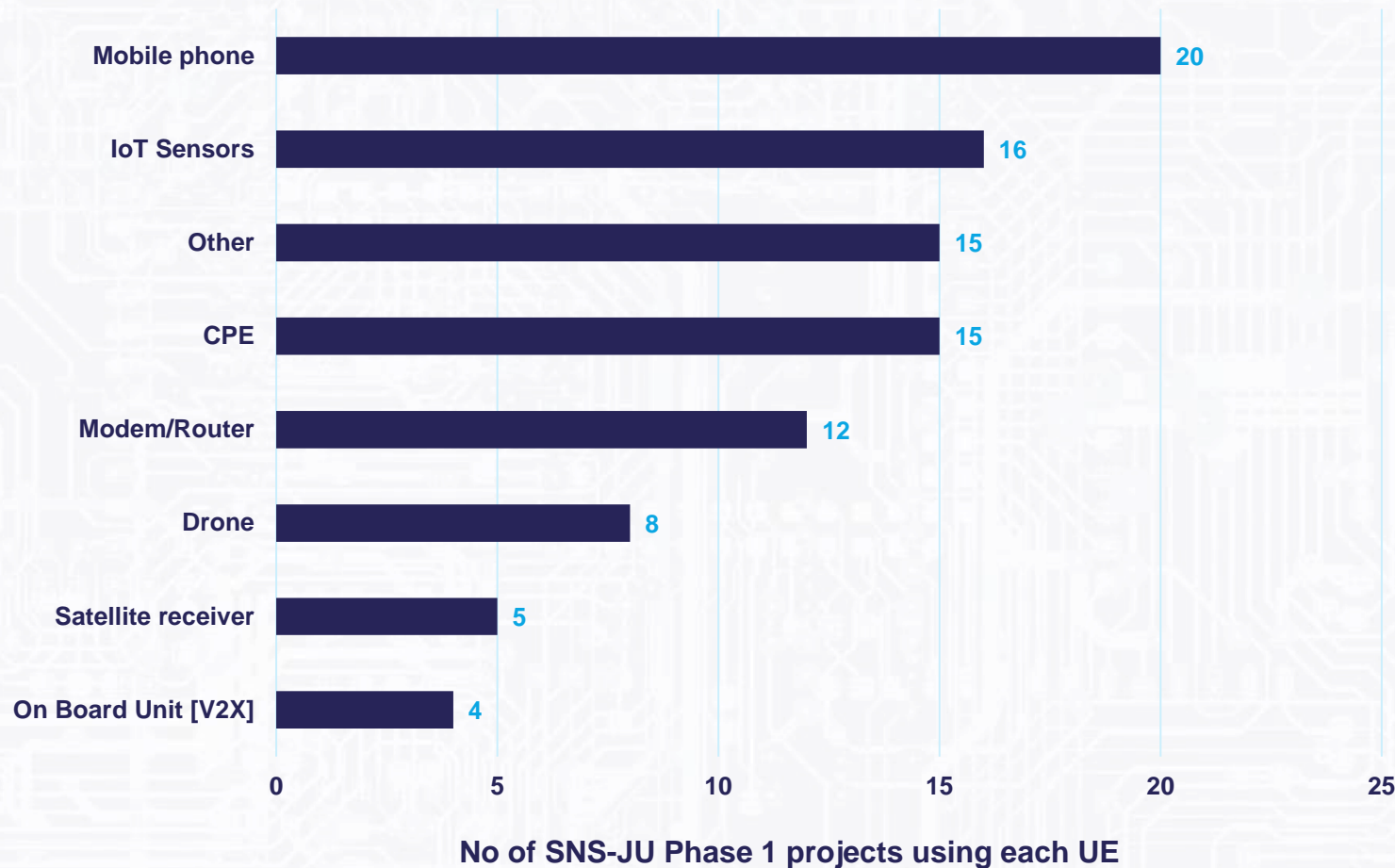


Key Insights

- **Stream A & B** projects support relatively “simpler” validation methods
- **Stream C & D** projects support almost all validation methods and offer more advanced capabilities.

Technical, T11:

What type of (End User) Equipment will be used for testing/trialling in your project?

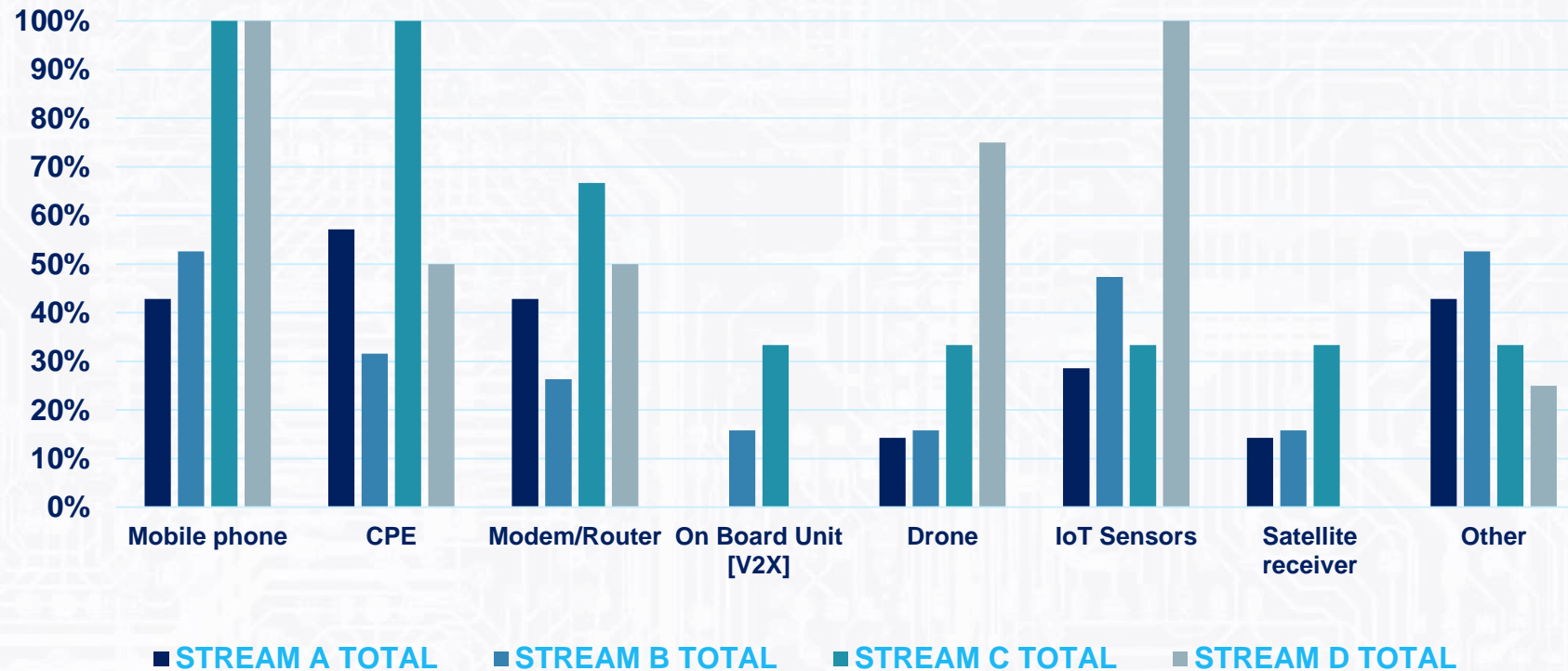


Key Insights

- Mobile phones (UEs), IoT sensors and CPEs are the most popular devices
- Multiple devices offered by SNS projects to experimenters
- Most prominent answers under “other” were:
 - Smart glasses, XR user equipment, Robots/Cobots, Software Defined Radio, smart gateways

Technical, T11:

What type of (End User) Equipment will be used for testing/trialling in your project (Per Stream)?



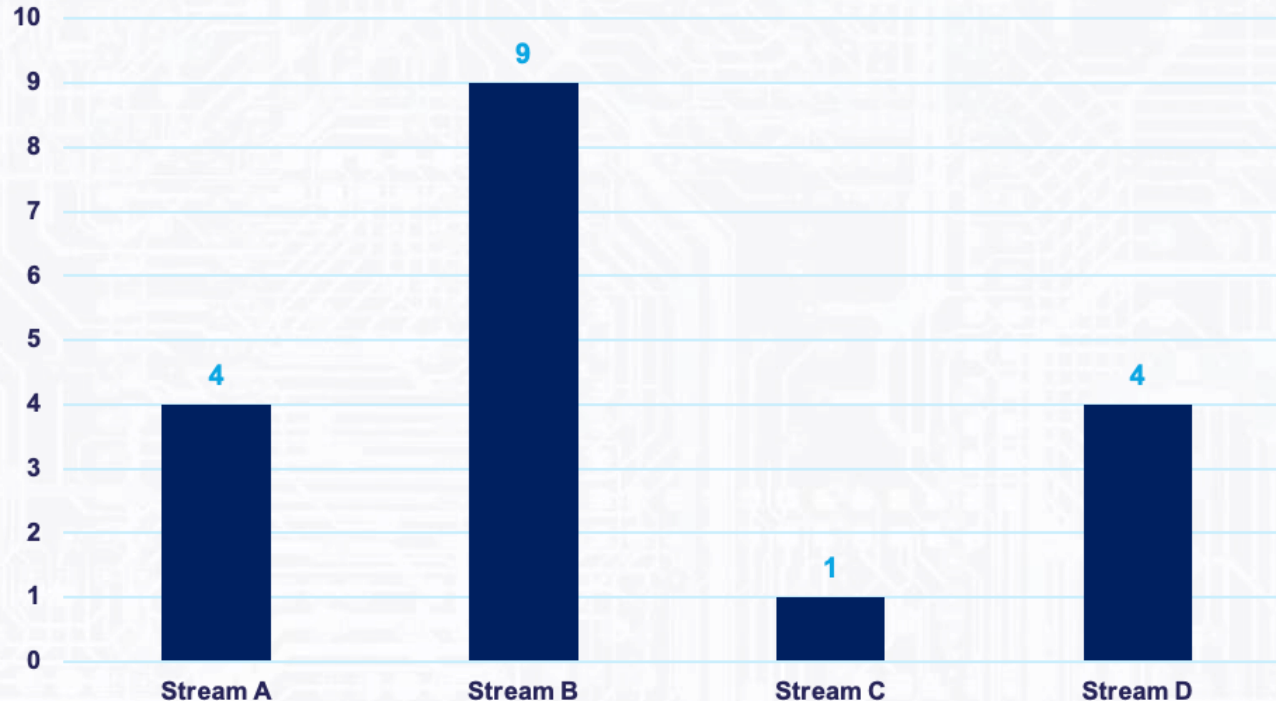
Key Insights

- **Stream C & D** projects offer a large variety of testing / trialling equipment
- **On-Board Units (OBU)** have the lowest coverage as they target a specific technological area (transport) – covered in Call 2 Stream D

Technical, T12:

Please provide information regarding your panned Trials & Pilots including the focus of each trial?

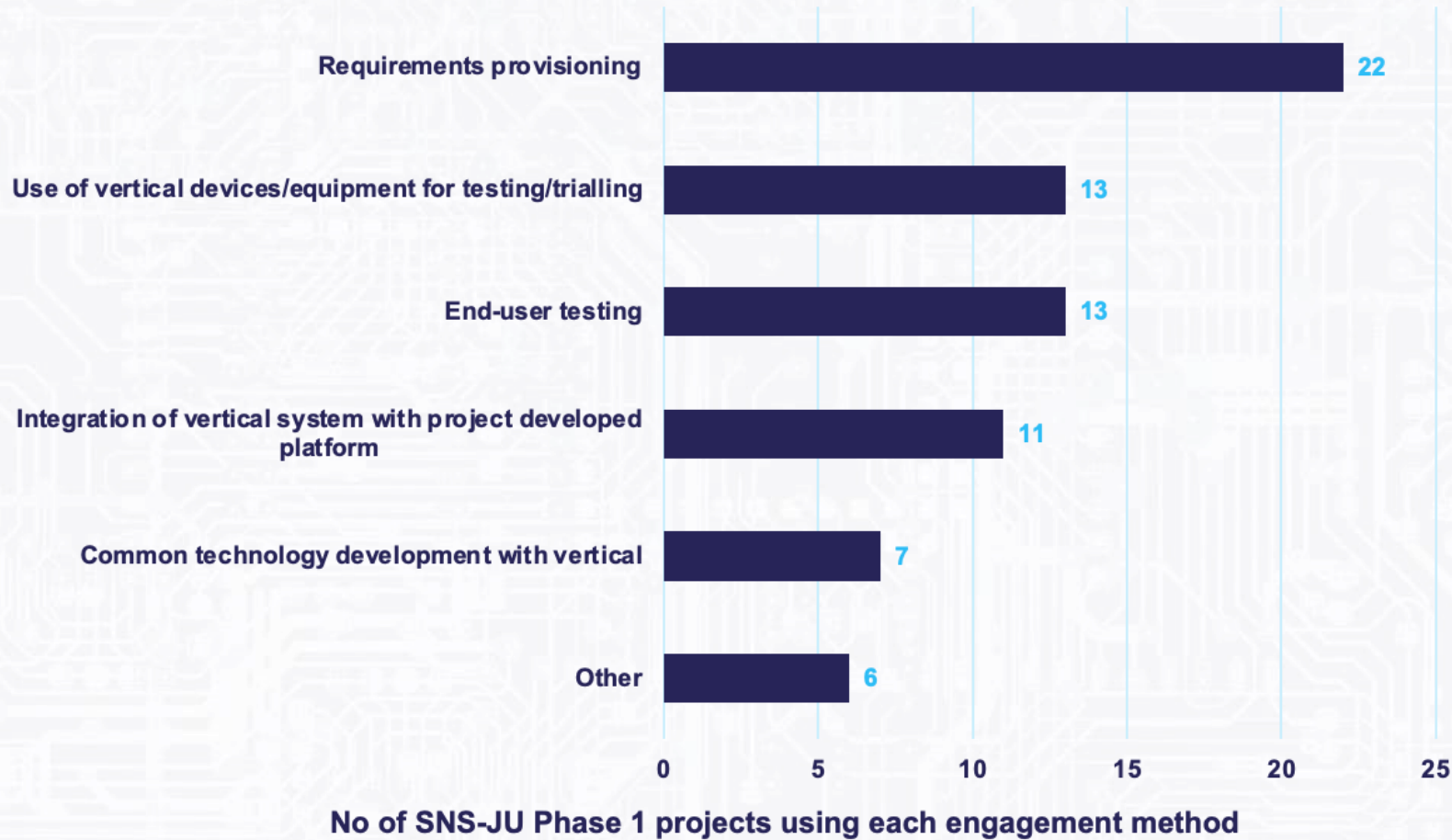
Number of Projects providing first level of information

**Key Insights**

- Some clear pre-identification of targeted dates
- Some clear identification of targeted UCs/Verticals
- Very few information on Locations
- As planned, the Stream C and Stream D Open Calls will result in additional trials

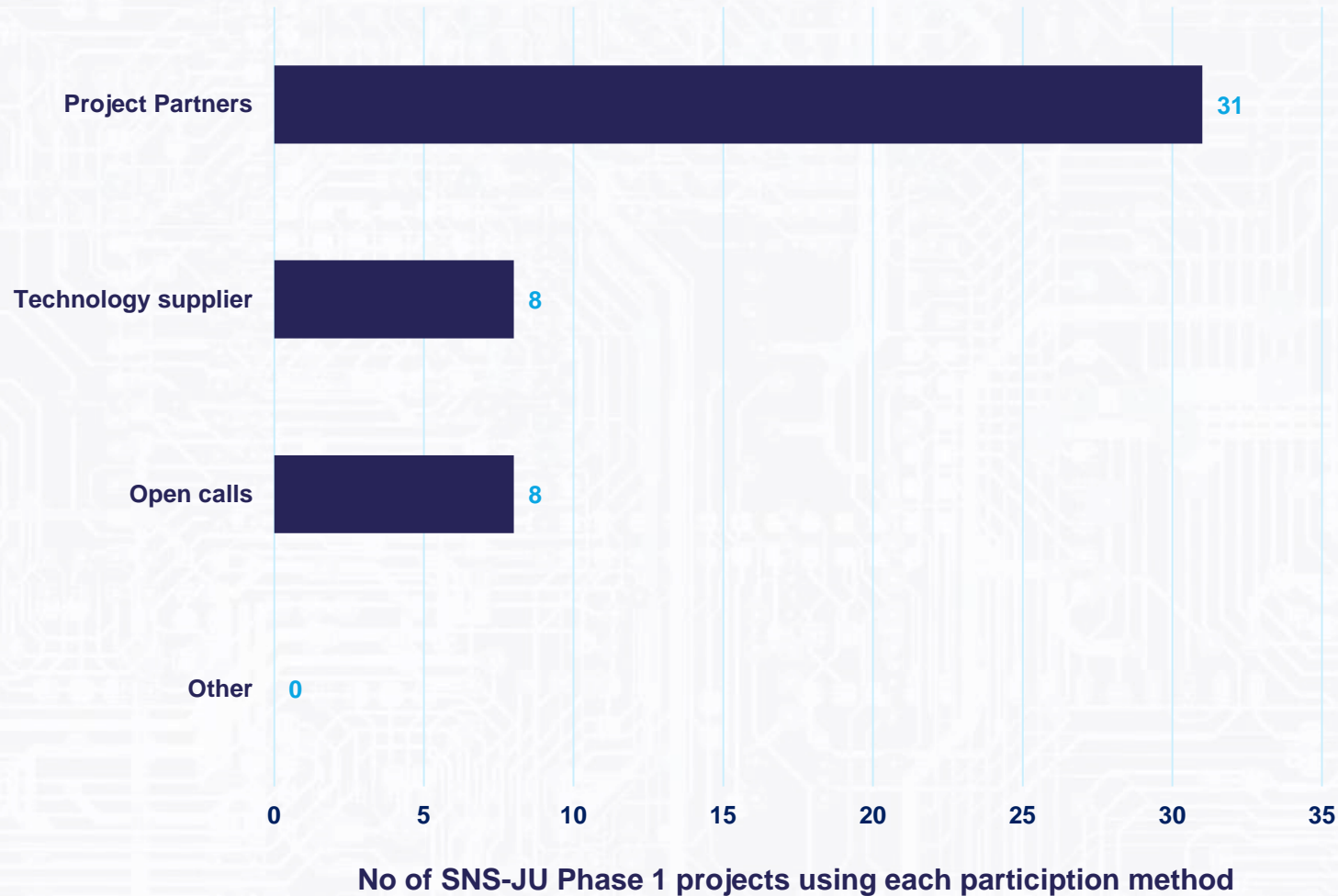
Clear need to further **synchronize on the “TRL” (level)** before any further detailed action/implementation, as Answers include Validation, Lab Demonstrators, Demonstrations, Support to Experimenters (e.g. Open Calls), Trials, Testbeds and Pilots (Taken into account for the next edition of the Questionnaire)

Technical, T13: How do you engage verticals in your project?



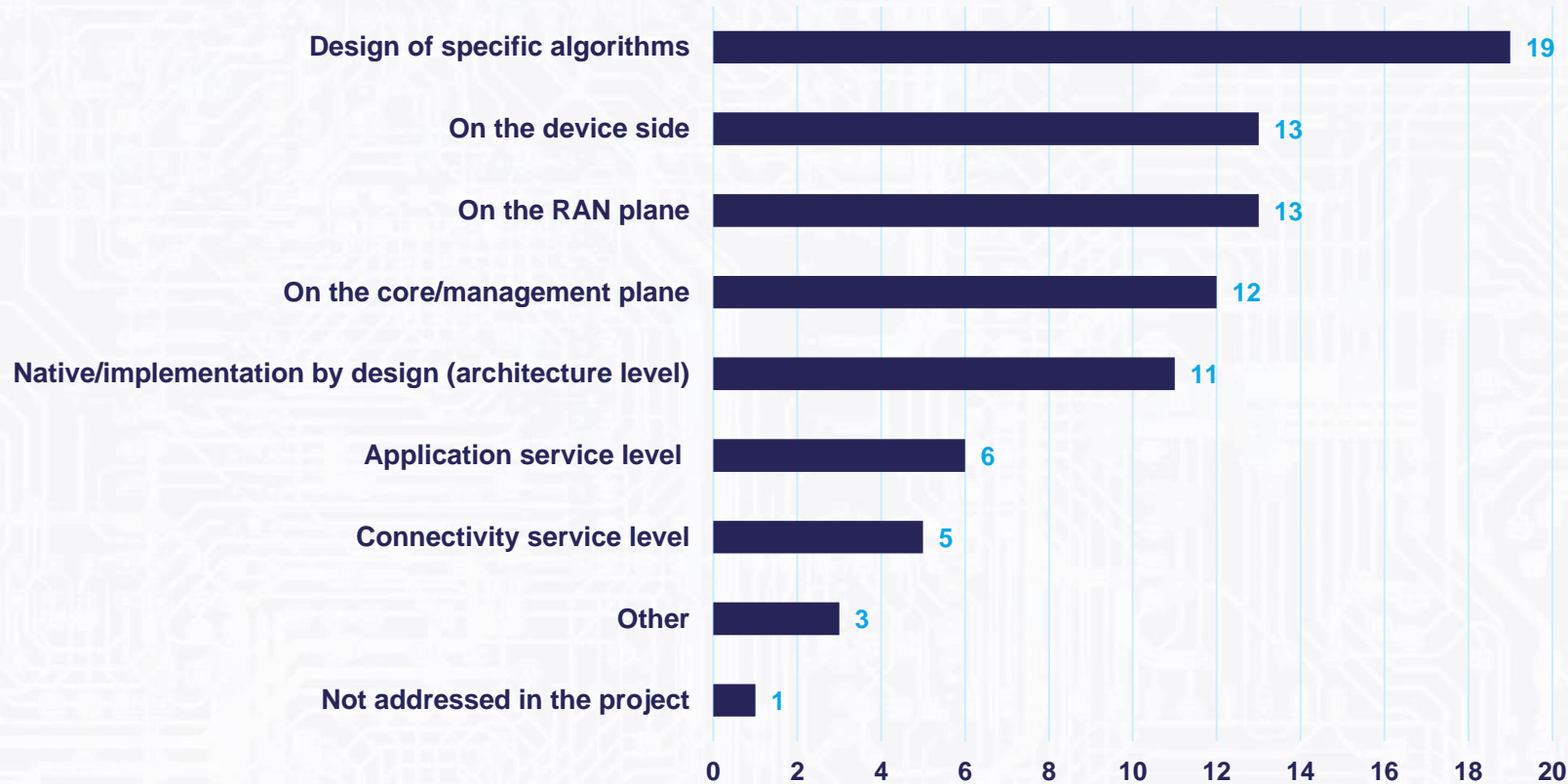
Key Insights

- Important role of verticals during the **requirements provisioning** phase
- Significant participation of verticals in the **testing & validation** phases as well
- Most prominent answer under “other”:
 - Vertical participation in Advisory Board

Technical, T14:**Does your project promote the participation of SMEs? How?**

Key Insights

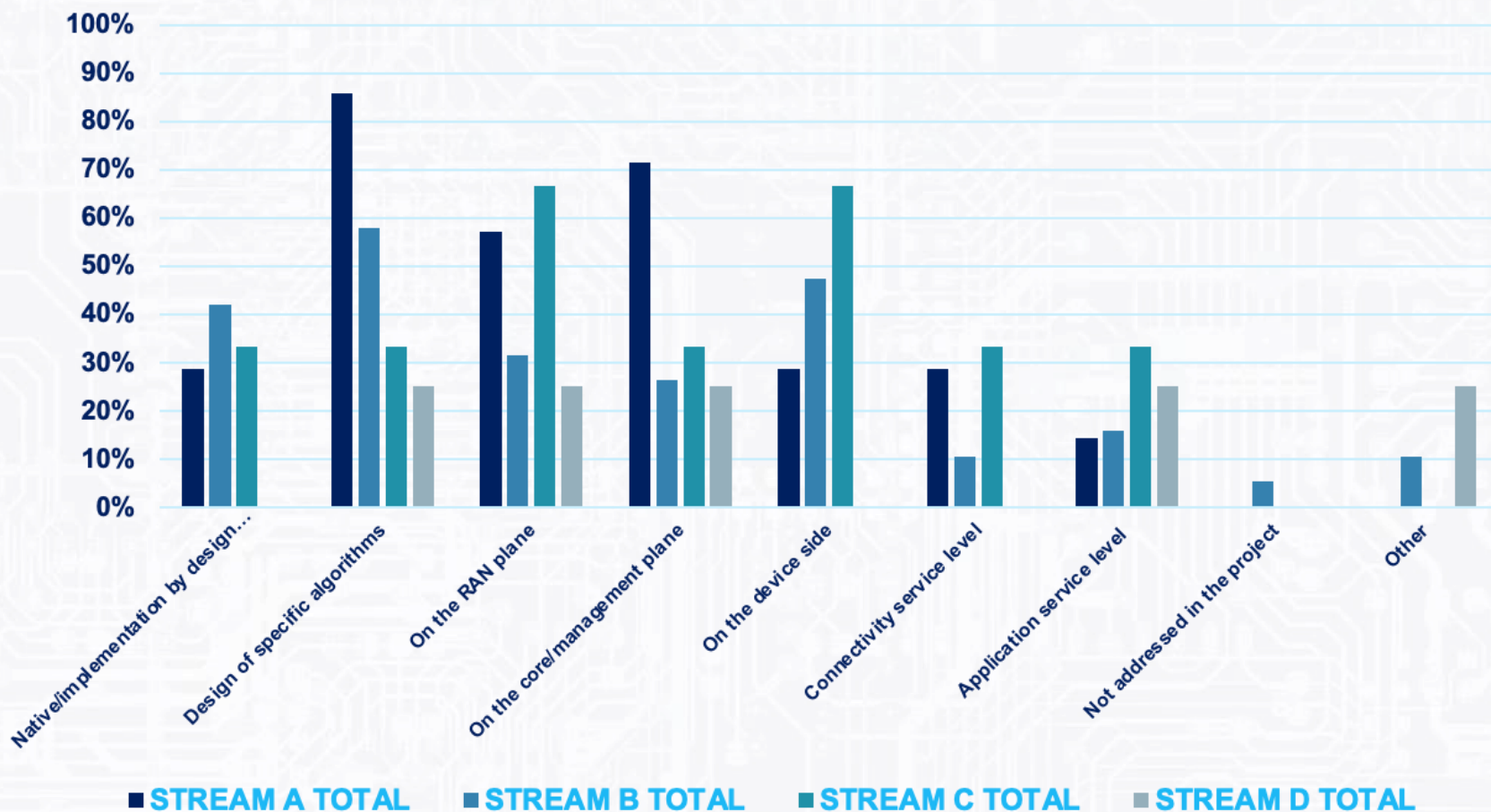
- **SME participation is critical** for almost all SNS projects as they include SMEs in their consortia
- **Stream C & D open calls** are expected to significantly increase the number of SMEs participating in the SNS JU ecosystem.

Technical, T15:**Does your project address energy efficiency, if so, how?**

No of SNS-JU Phase 1 projects using each energy efficiency approach

Key Insights

- **Most projects address Energy efficiency** via the design of specific algorithms
- Similar interest in the implementation on the RAN, core, device side or natively (about 1/3 of projects)

Technical, T15:Does your project address energy efficiency, if so, how? *Per stream***Key Insights**

- Energy efficiency is addressed in 32 out of 33 projects (**very important**)
- Especially **Stream A projects** seem to be very active in energy efficiency research
- Different approaches by different projects



VISION SECTION

Vision Section



Societal Challenges

Social Values

**Key Value Indicators
(KVI)**

6G Vision

Sustainability

Collaboration

Vision, V1:**What are your contributions to the societal challenges?**

Contributions to societal challenges

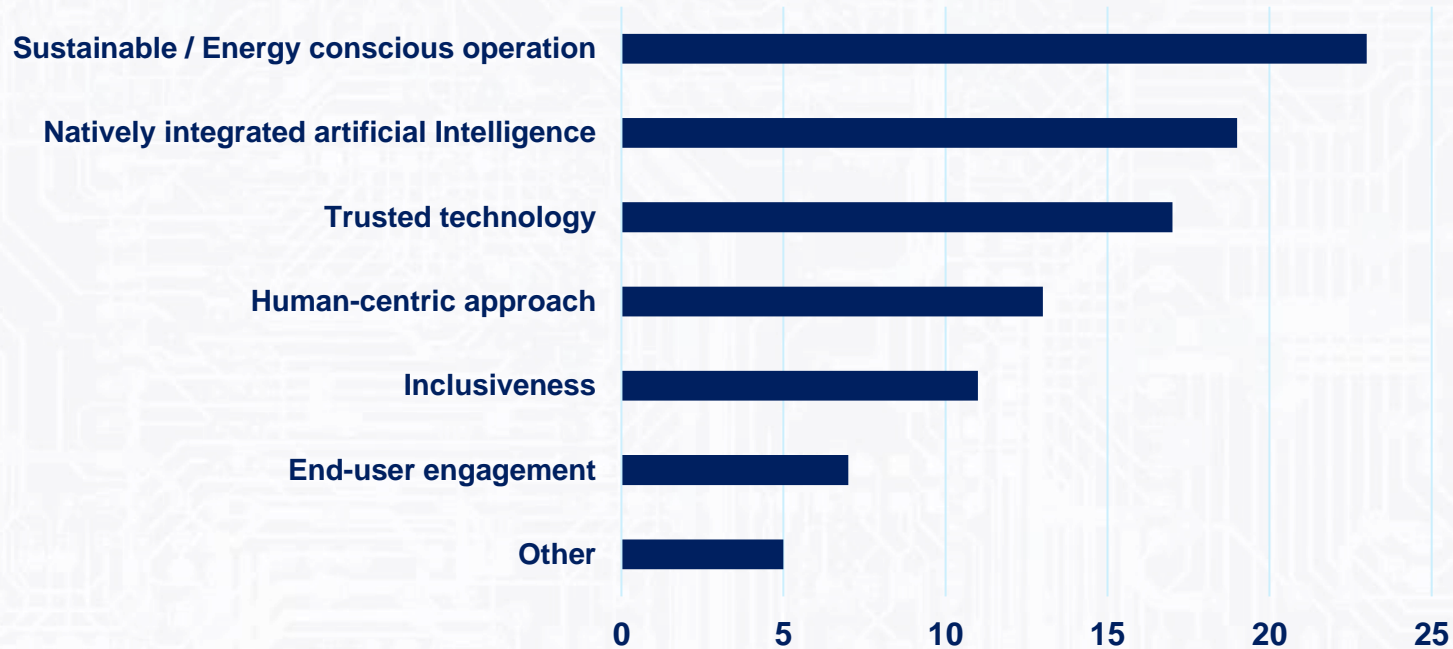
**Key Insights**

- Projects are most focused on technology challenges
- Close followers are on research, energy efficiency, and SME involvement
- Less focus on regulations and high-risk research

Stream C and D projects have the highest focus on societal challenges

Vision, V2: Which societal values are addressed in your project?

Societal values addressed



Key Insights

- Sustainability and energy consciousness are claimed by many projects
- Next comes natively integrated AI and trusted technology
- Less focus on end-user engagement and inclusiveness

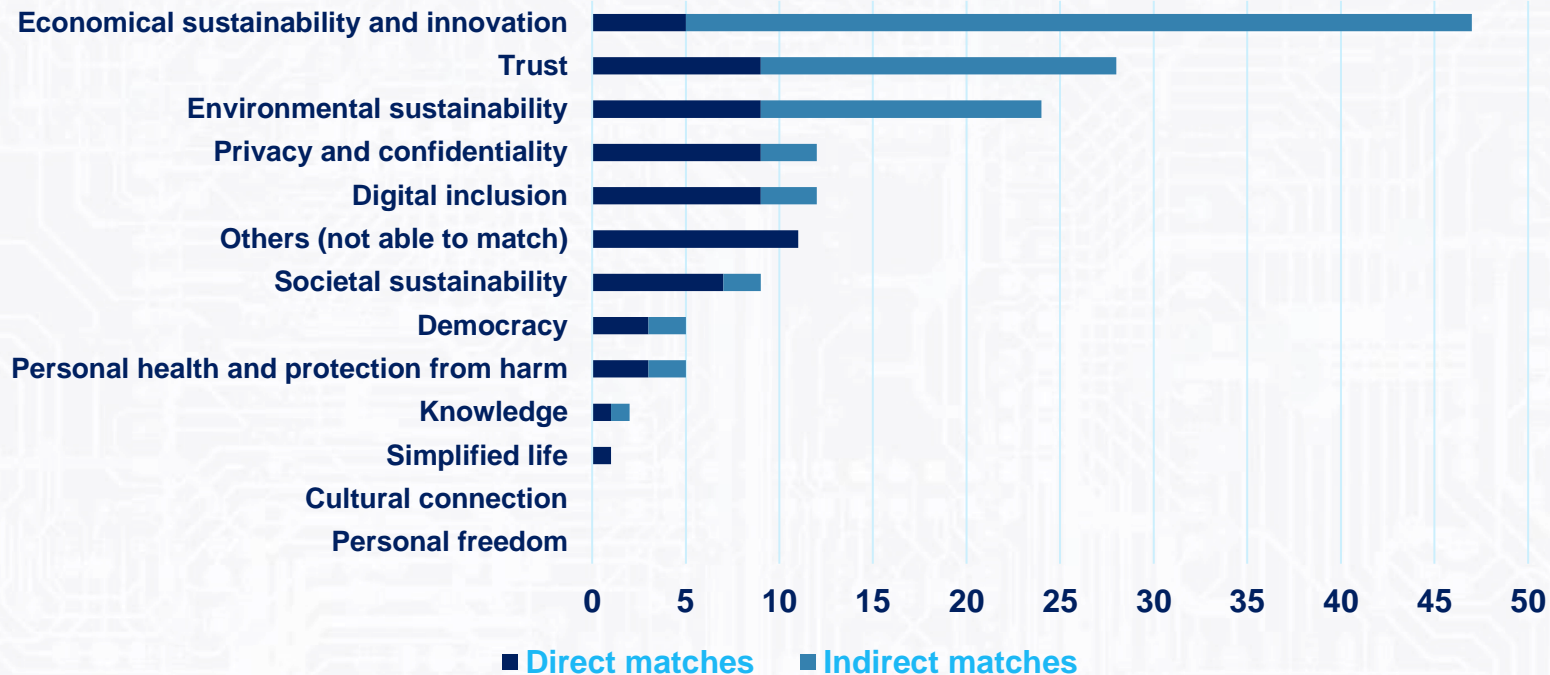
Stream D projects have the highest focus on societal values
Stream A projects have no end user focus

Vision, V3:

Does your project address Key Value Indicators (KVI)s? If yes, which ones?
Which use case/vertical do they address?



SNS Phase 1 projects Key Values Identified



Key Insights

- The notion of KVIs is still difficult to grasp for many projects
- Economical values are dominating above the others
- Low match on: Cultural connection and Personal freedom (none), Knowledge, and Simplified life

* 6G-IA. «What societal values will 6G address? Societal Key Values and Key Value Indicators analysed through 6G use cases». May 2022. URL: <https://doi.org/10.5281/zenodo.6557534>

Matching the responses with the Key Values (KVs) proposed in the 6G-IA White Paper:
“What societal values will 6G address?”* (direct and indirect)

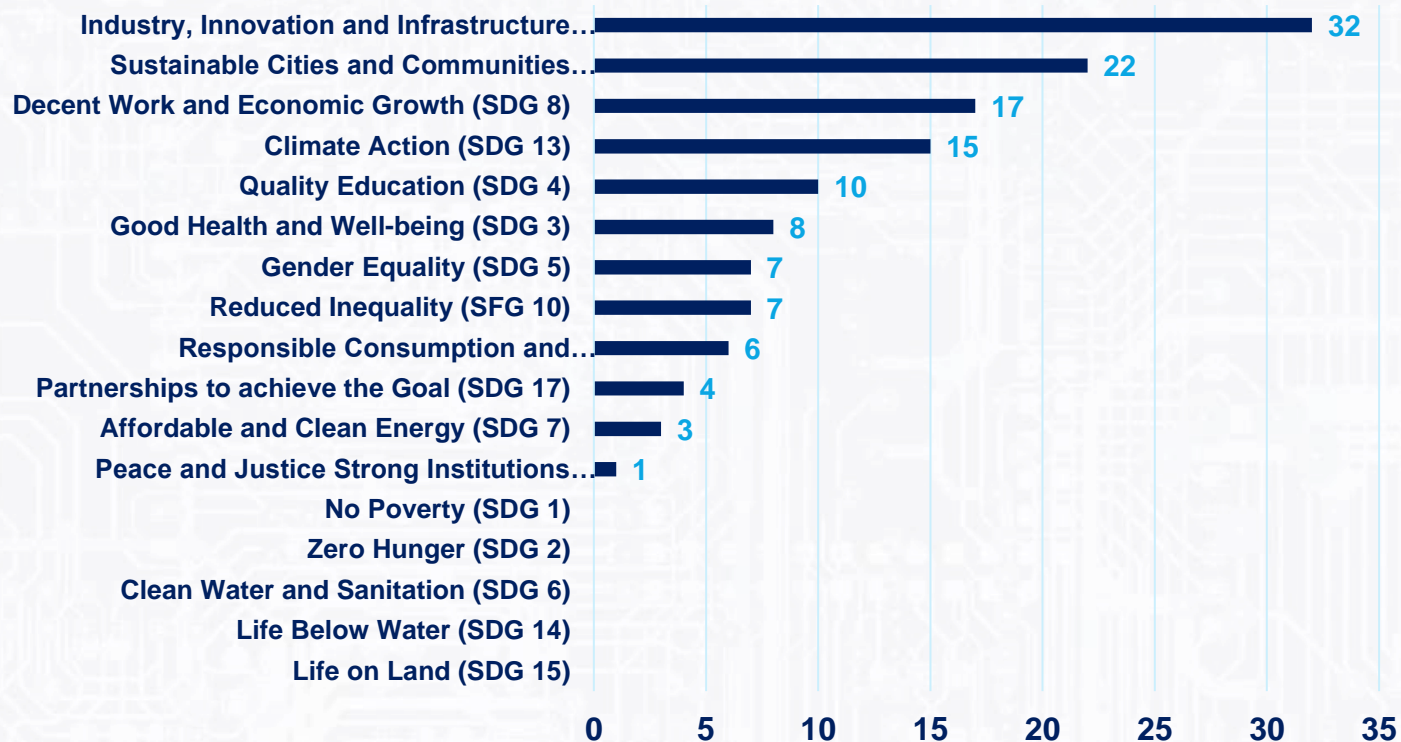
Vision, V4:**How do you contribute to the 6G Vision in your project?****6G Vision****Key Insights**

- Projects are conscious about **leadership and standards**
- Medium focus on **AI, sovereignty and security, and competence**
- Little focus on **ethic principles**

Similar focus for all Streams (A, B, C, D)

Vision, V5:

As sustainability is essential for B5G/6G networks, which UN Sustainable Development Goals (SDGs) will your project contribute to?



Key Insights

The SNS work programme is specifically asking for contributions to 4 SDGs and projects have these on top

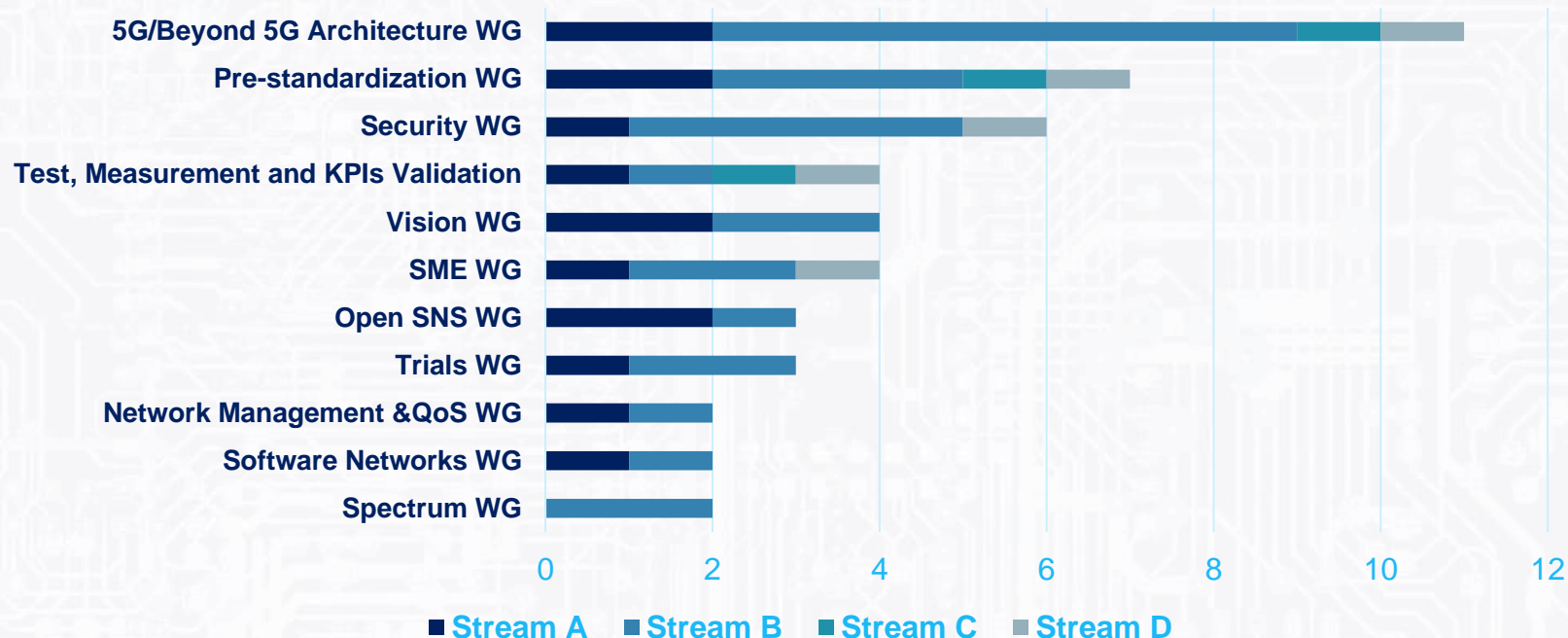
- SDG 9: Industry, Innovation and Infrastructure
- SDG 11: Sustainable Cities and Infrastructure
- SDG 8: Decent Work and Economic Growth
- SDG 13: Climate Action

Other SDGs which gain some attention are:
SDG 4: Quality Education – SDG 3: Good Health and Well-being –
SDG 5: Gender Equality – SDG 10: Reduced Inequality

Vision, V6

What type of thematic areas would be of interest to your project to commit resources and actively participate & contribute?

Attractive WGs – per stream



Key Insights

Top three attractive WGs, matched to the list found on <https://5g-ppp.eu/5g-ppp-work-groups/>

1. 5G/Beyond 5G Architecture WG
2. Pre-Standardization WG
3. Security WG, Vision WG, SME WG

The new WG structure is still in the shaping
 A large number of thematic preferences have been put forward by the project (analysis still in progress)
The projects were notified that the response is not binding and will only be treated as an indication

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MARKET SECTION

Market Section



**Key technologies
and innovations for
6G**

**Main market trends
in the advent of 6G**

**Vertical sectors
expected to be
impacted by 6G**

**Validation of
business
opportunities**

**Main obstacles to the
development of 6G**

**Novel markets for 6G
development**

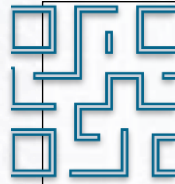
**Key exploitable
results (KER)**

Market, M1

Which are the biggest market changes you expect in your domain/market area with the advent of 6G? (I)

**Trends**

- Market fragmentation due to a more modular architecture
- A few globally dominant enterprises, perhaps emerging from current incumbents.

**Disruptors**

- IoT+ DTs
- Holographic
- Internet of Senses
- HPC and Quantum computing
- TSNs

**Vertical markets**

- PPDR
- Media and Entertainment
- Agriculture, Forestry
- Health
- Industry 4.0, manufacturing
- Transport, logistics, autonomous driving

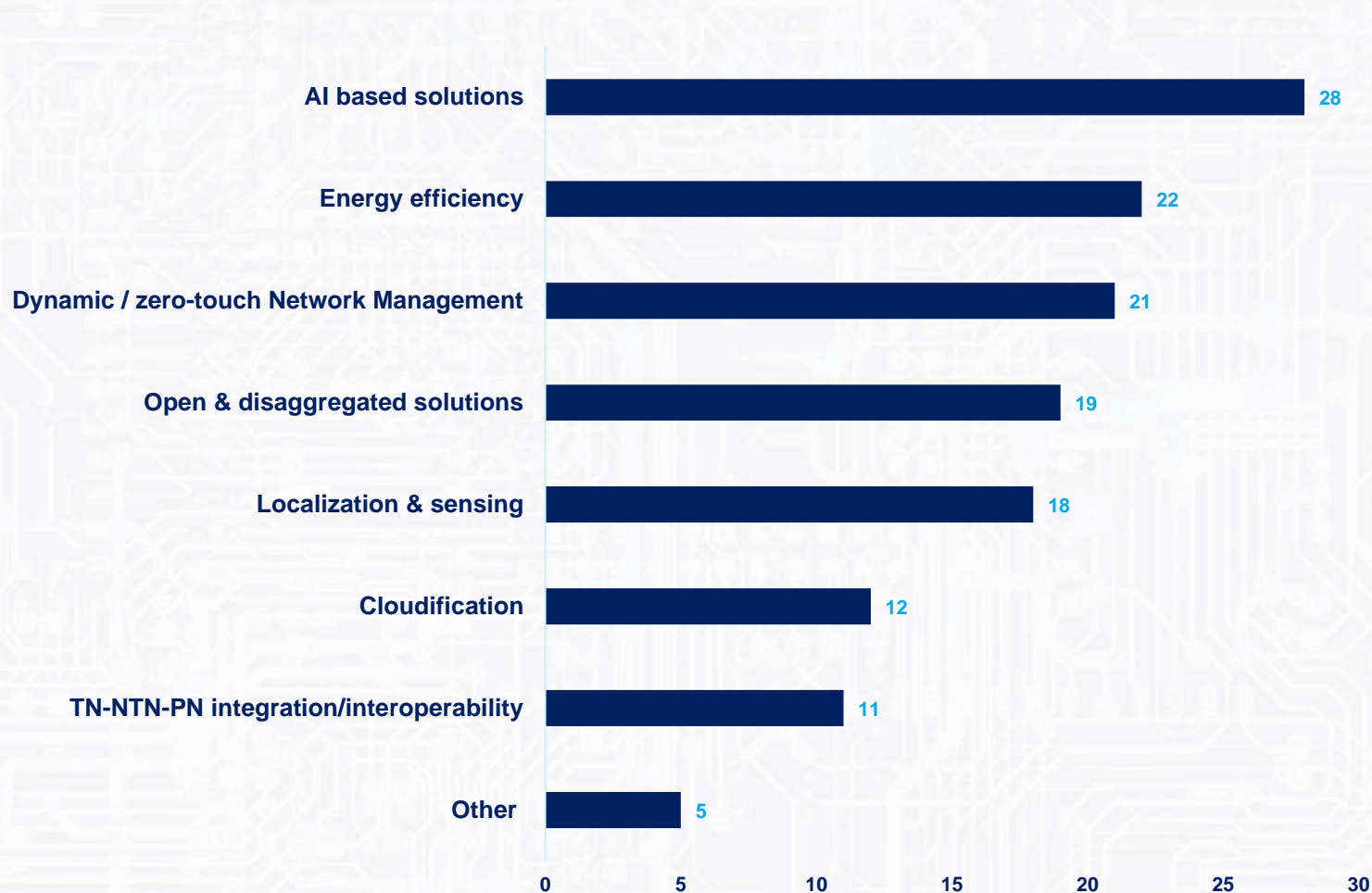
Key Insights

- The **demand for private networks/PNI-NPN will increase**, thus generating new business opportunities for MNOs.
- **AI-based solution and application providers** will gain significant benefits
- **VR/AR equipment, drones and UAVs, robots and sensors** are expected to carve out benefits for vendors and original equipment manufacturers

- Increased **integration** (= seamless connectivity), **proliferation** of wireless solutions for critical applications and **openness** of solutions (easier adoption of 5G/6G).
- **Automation and lowered technological barriers** (automated network management, virtualised and disaggregated network infrastructures, reconfigurable networks)
- **New communication technologies, AI and advanced hardware** are expected to accelerate the entry into markets that leverage massively scalable immersive environments (i.e., xR/VR, PPDR, automotive, etc.)
- **Stricter and sophisticated security controls and privacy** are necessary to guarantee trust in the new services enabled by 6G
- **Energy efficiency:** high wireless flexibility would allow for dynamic, environmentally friendly connectivity options

Market, M2

Which of the following technologies/innovations do you expect to play an important role in the telecommunications market in the coming years?

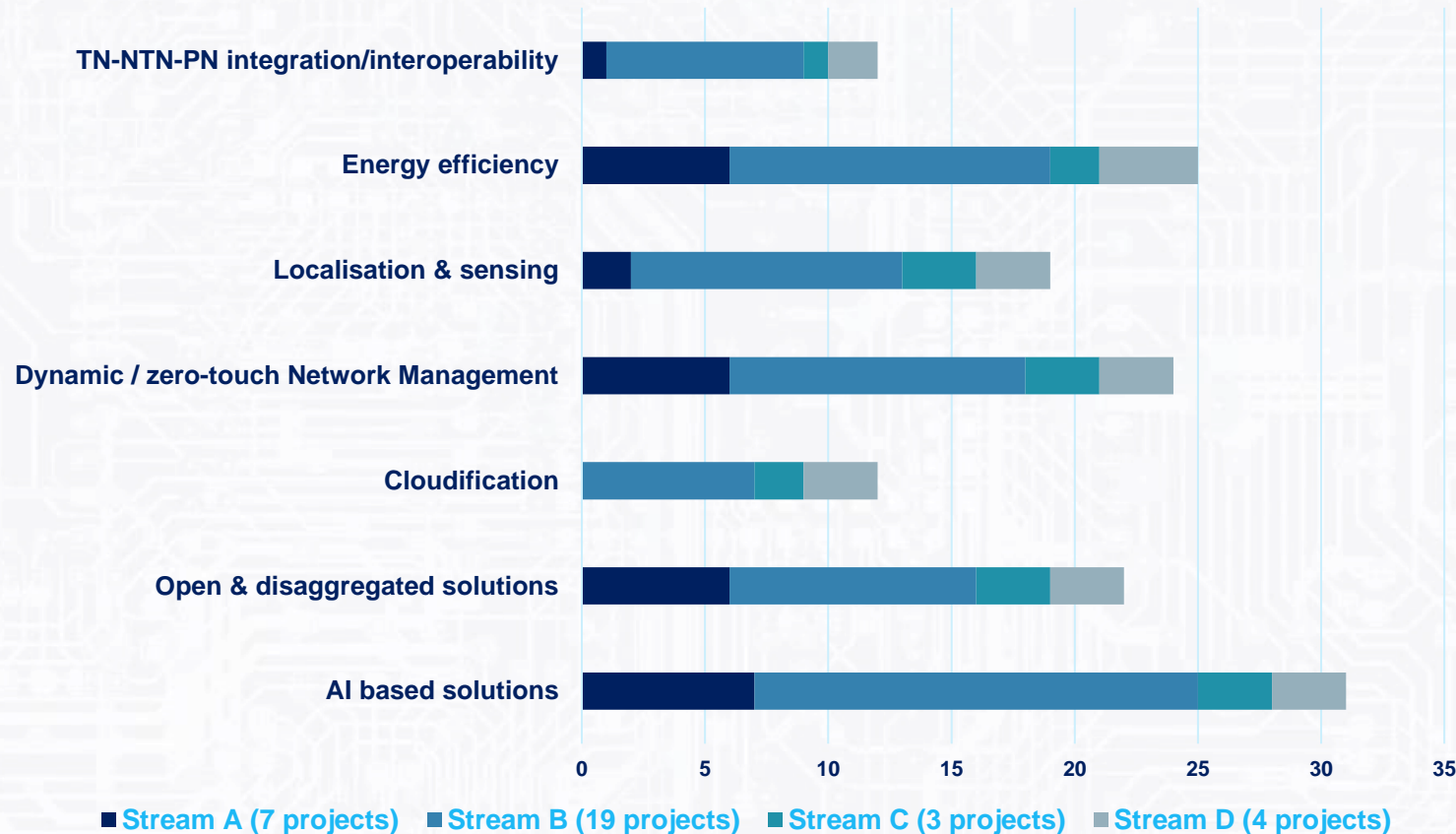


Key Insights

- **AI-based solutions** are expected to cause the greatest impact in the telecoms market across all projects and streams, followed by **Energy Efficiency solutions** and **Dynamic/Zero-touch Network Management** ones.
- **TN-NTN-PN integration/interoperability** are seen as having a lower impact.

Market, M2

Key technologies/innovations that are expected to play an important role in the telecommunications market in the coming years. *Per stream*

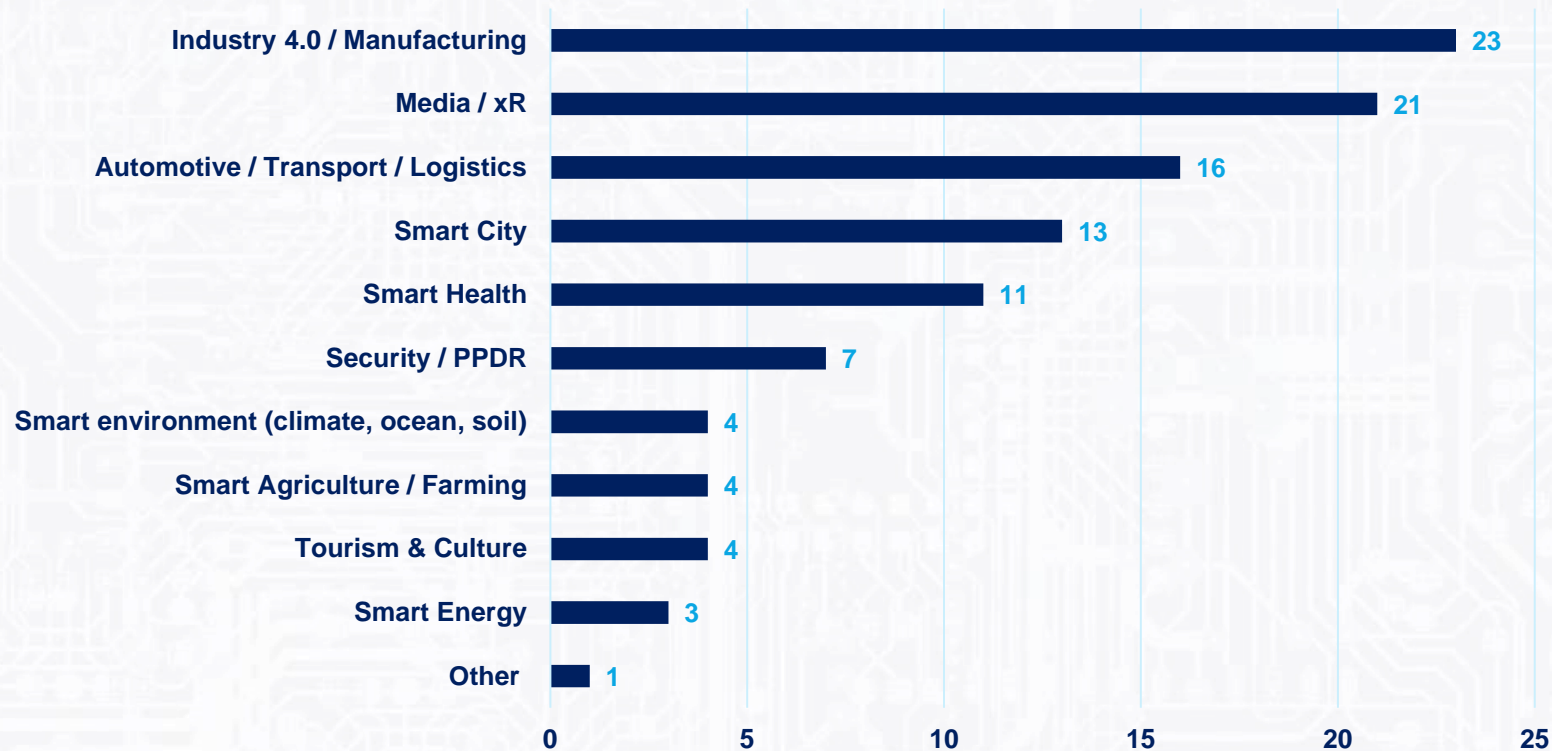


Key Insights

- Open and disaggregated solutions are rather important according to Stream A, C and D.
- Location and sensing solutions are mentioned by all projects in Stream C and 75% of projects in Stream D, as well as more than 50% projects in Stream B.
- Cloudification is mentioned by 75% of projects in Stream D and C and none in Stream A

Market, M3

Which vertical sectors do you expect to be affected the most with the advent of 6G?



Key Insights

Industry 4.0/Manufacturing and **Media/xR** are expected to be the verticals most impacted by the advent of 6G.

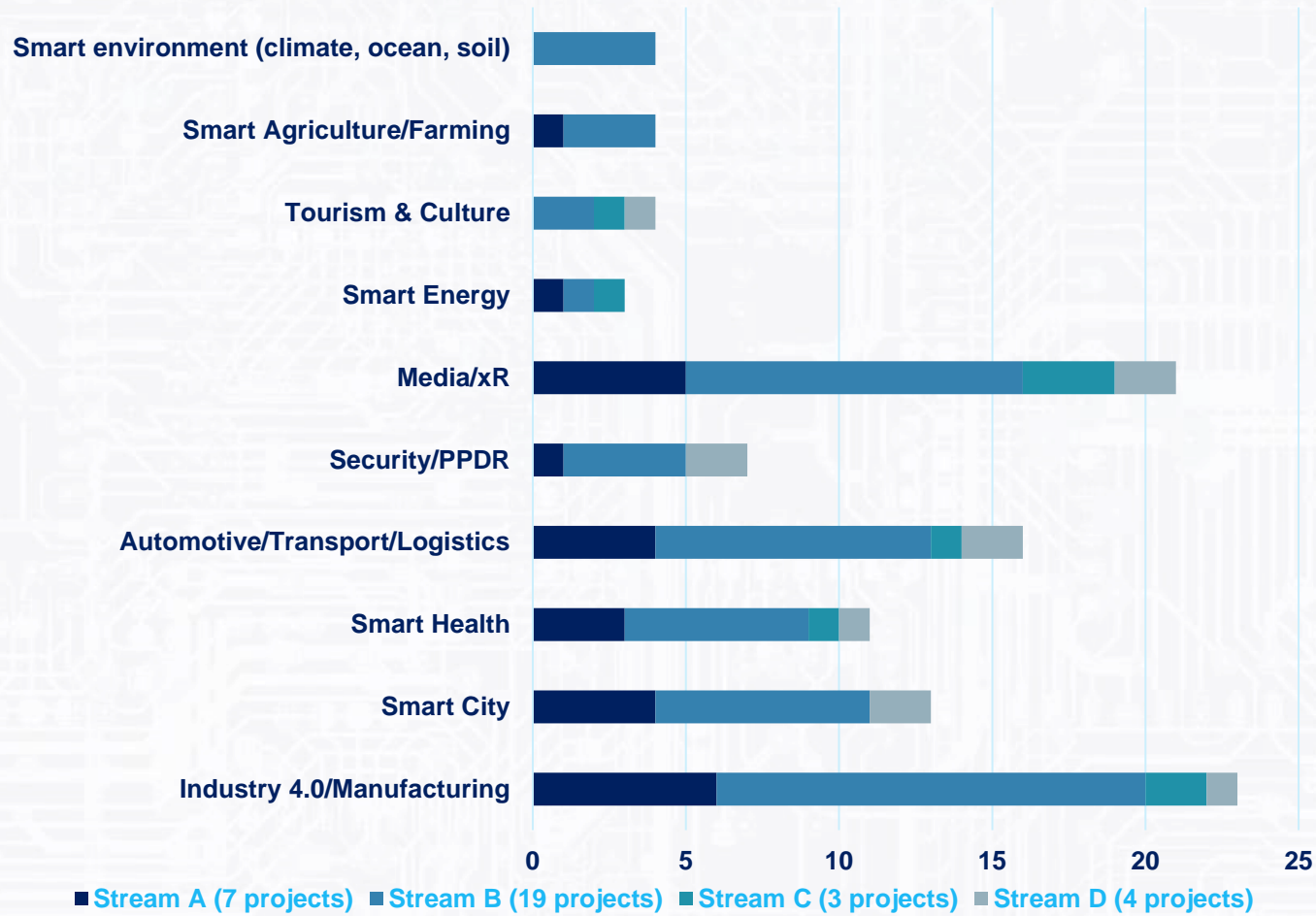
Stream A and B show a higher interest in **Industry 4.0/Manufacturing**, whereas Stream C and D do it in **media/xR**.

The opinions are rather divided regarding the other vertical sectors.

Projects could only select three options.

Market, M3

Which vertical sectors do you expect to be affected the most with the advent of 6G? *Per stream*



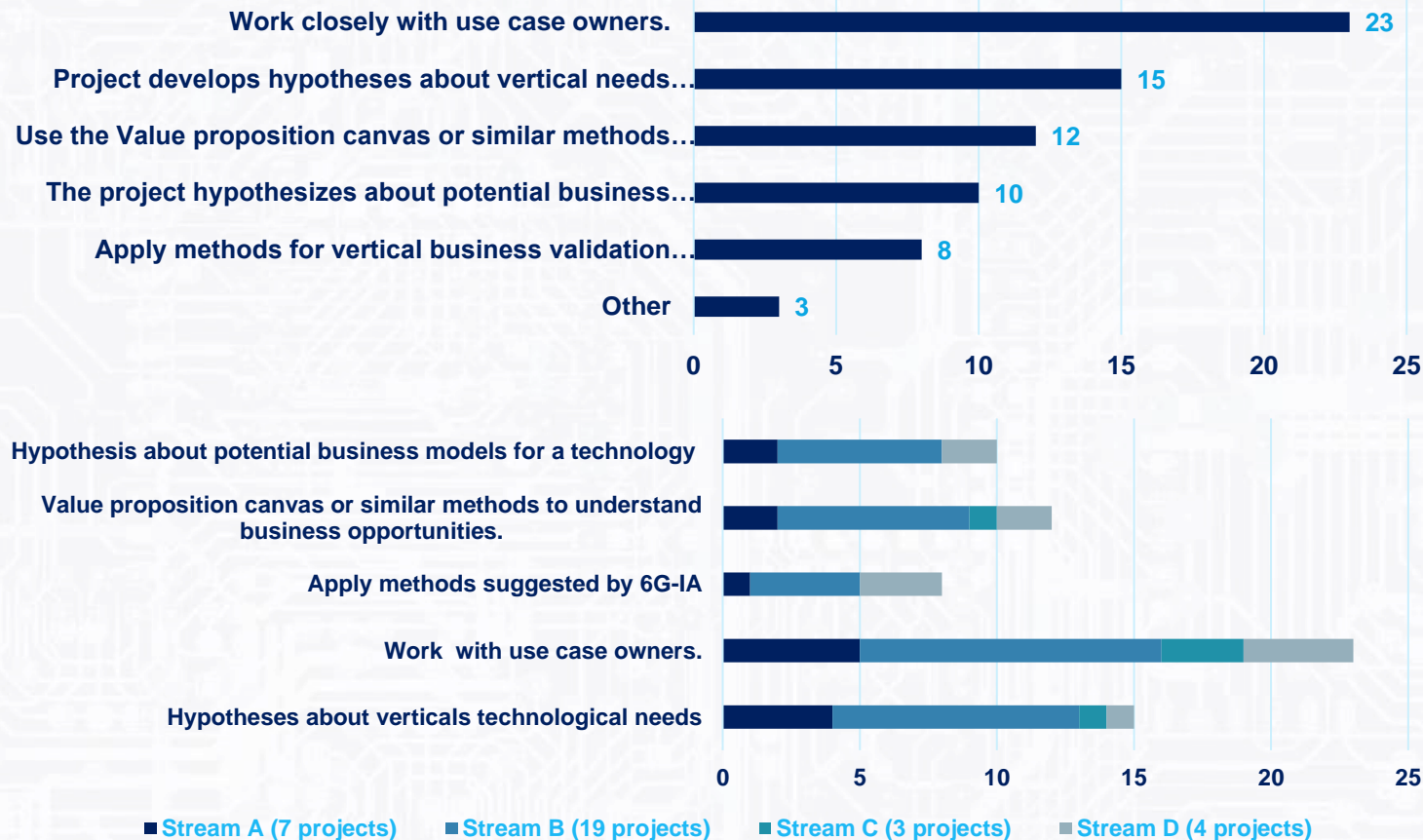
Key Insights

Top verticals per stream (+50%):

- Stream A: industry, media, smart city, automotive
- Stream B: industry, media
- Stream C: media, industry
- Stream D: smart city, automotive, security, media

Verticals expected to be the least impacted by the advent of 6G:

- Smart Energy (no Stream D projects),
- Smart Environment (only selected by Stream B projects),
- Tourism and Culture (no Stream A projects) and
- Smart Agriculture (no Streams C and D projects).

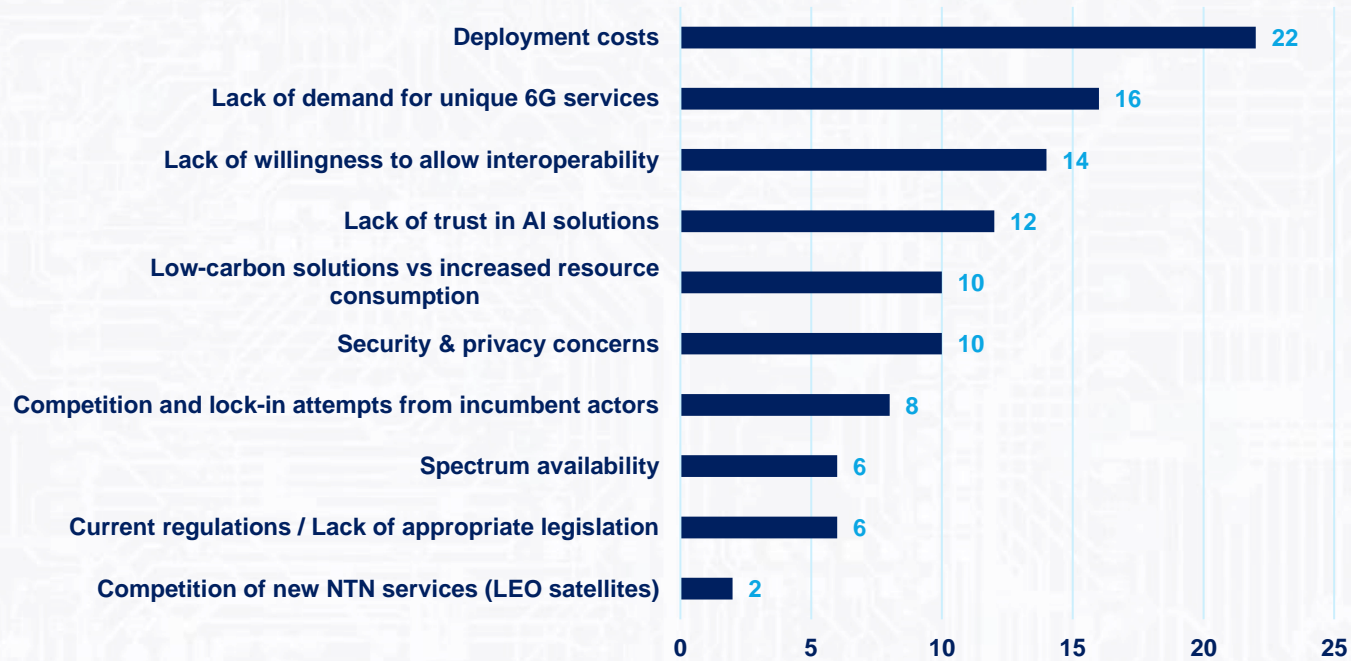
Market, M4**How do you validate business opportunities in vertical sectors?****Key Insights**

- **Working closely with the use case owners** is the preferred path for projects (70%) to validate business opportunities in vertical sectors overall and across streams.
- All Stream C and D projects chose this option.
- The formulation of **hypotheses about verticals technological needs** is very common among Stream B.
- $\frac{3}{4}$ projects in **Stream D** projects choose the application of **methods suggested by 6G-IA** (the least popular response overall).

No project in Stream C selected the hypothesis about potential business models for a technology nor the methods suggested by 6G-AI.

Market, M5

What do you consider to be the greatest obstacle for the deployment of 6G networks?



Key Insights

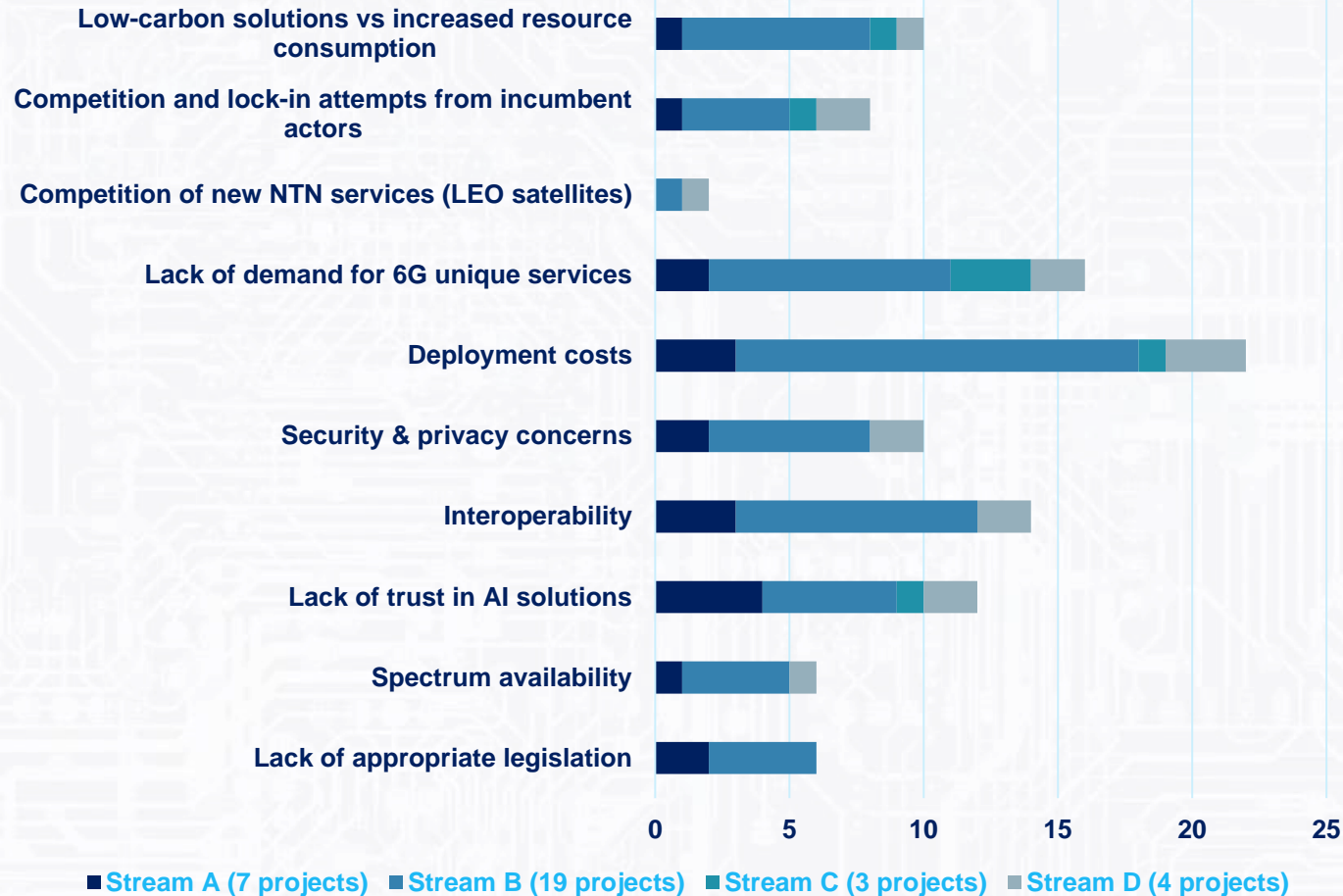
- **Deployment costs** are seen as the main obstacle by far. Projects indicate little transparency regarding the RoI.
- The **lack of demand for unique 6G services** and the **lack of willingness to allow interoperability** are also seen as notable challenges.
- The **impact of AI** is also an important concern.

Additional observations:

- **Security and Privacy:** reference to the large amount of communication interfaces and the shared nature of the wireless environment.
- **Spectrum Management:** the main concerns refer to unlicensed bands in the mmWave and THz spectrum and the spectrum scarcity in the below 10 GHz region.
- **Sustainability:** emphasis on the contradiction of low-carbon solutions proposed vs the large deployment of small cells that will heavily increase the energy consumption. The total power consumption is increasing because the data consumption increases more than the data efficiency improves.

Market, M5

What do you consider to be the greatest obstacle for the deployment of 6G networks? *Per stream*



Key Insights

- Stream B and Stream D projects indicate deployment costs as the main obstacle.
- The lack of trust in AI solutions is the top obstacle for Stream A projects, whereas the lack of demand for unique 6G services is the main concern for Stream C ones.
- Only Stream B and D indicate the competition of new NTN services as an obstacle.
- No Stream C projects indicate security and privacy, interoperability, lack of appropriate legislation, nor spectrum availability as obstacles.
- The lack of appropriate legislation is seen as a problem by Stream A and B projects

Market, M6

4G enabled the “App ecosystem”. Do you believe 6G can accomplish something similar? If yes, what would be your estimation as to the novel market section that 6G may enable?

Reliable IoT

- The levels of reliability that 6G will guarantee may help shaping a “things ecosystem”.
- Transforming large volumes of IoT data (via AI), into valuable and actionable knowledge, able to automate and optimise the decision-making process in multiple sectors.

AR/VR/XR

- 6G's could enable more immersive and realistic VR/AR experiences.
- Holographic representations are expected to become key in a wide range of scenarios.
- Accomplish an “immersive app/service ecosystem” beyond handheld devices/computer/tv screens
- Realisation of the “metaverse ecosystem”.

**New services**

- Users can provide the computational capabilities of their devices to facilitate processing in multi-access edge computing environments.
- Advanced telemedicine capabilities through remote-surgeries and real-time monitoring of patients,
- Availability of industrial and consumer robots, smart-city ecosystem; and many others.

Sustainability

- Seamless interaction between several technologies decreasing energy consumption and processing time, and increases trust, stability, robustness and performance.
- The merits of power and energy efficiency in the context of 6G could be a driver of adoption.

Market, M7**Key exploitable results (KERs) expected to be delivered by projects**

NETWORK TECHNOLOGIES	MANAGEMENT	SECURITY AND PRIVACY	OTHERS
<ul style="list-style-type: none"> Fully integrated NTN into 6G PON Solutions Packet-Optical DPUs Waveform and radio protocol design including mobility and multi connectivity 	<ul style="list-style-type: none"> Distributed domain orchestration platforms with ZTP Explainable AI/Edge System models for predicting performance of the dual carrier systems 	<ul style="list-style-type: none"> A novel security and privacy toolbox Realistic blockchain and attacks models Confidential toolkit Set of cryptographic or enablement libraries, for confidential computing and confidential networking 	<p>Sustainability</p> <ul style="list-style-type: none"> Hardware GPU based acceleration offloading of energy intensive mMIMO RAN function Energy Efficient DSP Ultra-high rate and low-energy transmitters
<ul style="list-style-type: none"> Latency-aware access in the unlicensed spectrum Centralised/distributed/hybrid radio resource management Deterministic wireless transmission Wireless-friendly TSN and DetNet 	<ul style="list-style-type: none"> SLA-Driven E2E Slice Management DRL-based Zero-Touch Resource Management Deep Data Plane Programmability 	<ul style="list-style-type: none"> Distributed AI engine for services pre-assessment Threat Detector and Mitigation Engine XAI toolbox for decentralised security analytics 	<p>AI</p> <ul style="list-style-type: none"> Intelligent and trustworthy edge computing platform supporting highly demanding XR applications
<ul style="list-style-type: none"> Photonic-based millimetre-wave/THz antenna arrays, pursuing high-gain beamformed and beam-steerable RF beams THz reconfigurable intelligent surfaces (reflective and transmissive) OpenRU platform for Cell-Free mMIMO prototyping 	<ul style="list-style-type: none"> Privacy-preserving pervasive monitoring Ultra-fast programmable high capacity switching node architecture for the back-haul Network Digital Twin 	<ul style="list-style-type: none"> Data anonymization streaming pipelines Software AI-driven decision-making mitigation framework that allows to prioritise threats and come up with a mitigation plan and create a complete threat orchestration ecosystem. 	



Q&A

6G SNS OPS

THANK YOU FOR YOUR ATTENTION



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