JOINT REPORT

PROGRESS TOWARDS THE 6G PRINCIPLES OF THE NEW DELHI DECLARATION:

ACTIONS, OUTCOMES AND OUTLOOK

OCTOBER 2026

JOINT REPORT

Joint Statement Endorsing Principles for 6G

Progress towards the 6G Principles of the New Delhi Declaration: Actions, Outcomes and Outlook

3rd International Bharat6G Symposium 2026
New Delhi, India

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Foreword

On 10 October 2025, at the International Bharat6G Symposium in New Delhi, leading organisations from across the global telecommunications ecosystem endorsed the **New Delhi Declaration**. They agreed that 6G should be built from the outset as a *global public good* — secure, open, resilient, inclusive, affordable and sustainable by design — and set out nine principles to guide its research, development, standardisation and deployment. The Declaration was jointly endorsed by the **Bharat 6G Alliance; the 6G Smart Networks and Services Industry Association (6G-IA); ATIS' Next G Alliance; XGMF; 6G Forum; the UK Federated Telecoms Hubs (FTH) and its partner hubs CHEDDAR, HASC, JOINER and TITAN; 6G Flagship; 6G Brasil; and the EPSRC UK–India Future Networks Initiative (UKI-FNI).** In addition**, the Bharat 6G Alliance and the NGMN Alliance signed a separate bilateral agreement.** The text mattered, but the convergence mattered more: organisations with different mandates, on different continents, chose to state a common position at the same time and in the same place.

The Declaration did not endorse any particular technology, and it is *non-binding* by design. Its value depends on whether, a year later, anyone can point to what has changed. This first Joint Report, *Progress towards the 6G Principles of the New Delhi Declaration: Actions, Outcomes and Outlook*, is our attempt to answer that question honestly. Partners shared their contributions voluntarily and chose which initiatives to highlight; the report is therefore a record of progress, not a compliance assessment, and the inclusion or omission of any initiative implies no judgement about its importance.

The evidence gathered here is encouraging. The Declaration's themes have been carried into the forums where 6G is actually being decided. European partners have coordinated more than 2,000 contributions to standards bodies through the Smart Networks and Services Joint Undertaking. UK partners have helped make security by design an overarching requirement in 3GPP discussions, and seven governments have launched 6G Security and Resilience Principles. The NGMN Alliance has given operators a clear voice on how networks should migrate from 5G to 6G. XGMF has published seventeen technical documents, and 6G Flagship has advanced the understanding of resilience and AI-native radio. UKI-FNI has challenged all of us to make our commitments specific and testable — a challenge this report takes seriously.

For India, this has been a year of steady building and first delivery. The Telecom Technology Development Fund has approved 104 6G research projects, two national 6G testbeds are operating, and the new Technology Development and Investment Promotion scheme will support standards participation, testing and pilots over 2026–31. Indian participation in 3GPP has grown roughly fifteen-fold in contributions since 2020, and Alliance members report more than 7,500 patent applications. Research is becoming hardware and products: an indigenous 270 GHz radio chain, quantum-secure communication products, India-designed Open RAN radios and CPE shipped in millions. India has taken an open-source mobile core into cooperation with partner countries

through the ITU, and joint field demonstrations with the European Space Agency and UK partners have shown satellite–5G telemedicine and smart-village services working together.

Much remains to be done, and the time to do it is short. The first normative 6G release in 3GPP will be defined between now and 2029, and the World Radiocommunication Conference in 2027 will settle important spectrum questions. The principles we endorsed will endure only if they are written into requirements, test cases and spectrum conditions during this window. The hardest questions are still open: how 6G will pay for itself, how it will reach those hardest to serve, and how its trustworthiness will be demonstrated rather than asserted. The closing chapter of this report offers an independent assessment of these gaps and a set of suggestions for the period ahead.

We invite our partners to treat this report as a starting point rather than a summary. We would welcome the opportunity to agree, together, a small common framework for measuring progress, to pursue a few shared priorities jointly in the standards bodies, and to open our testbeds and trials to one another. We thank the organisations, research institutions, experts, engineers and policymakers who contributed to this report, and above all the work it documents. Their partnership will be essential as the global community moves from defining the principles of 6G to demonstrating them in practice.

Bharat 6G Alliance

New Delhi, October 2026

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Executive Summary

A year after the New Delhi Declaration was endorsed, this report brings together what its signatories have done to advance its nine principles. The overall picture is of a partnership that has moved from shared intent to substantial technical work — **research is maturing into standards contributions, testbeds and products** — but has not yet converted that work into shared outcomes that can be measured across partners. The report sets out the evidence, principle by principle, and ends with an assessment of the gaps and a set of suggested next steps.

The year in numbers

Area	Selected reported outcomes
European programme (SNS JU / 6G-IA)	79 projects and more than €500 million of EU investment; 920 standards contributions in 2025 and more than 2,000 cumulatively; more than 460 experiments, over 180 of them mature trials; 1,747 researchers trained in 2025
UK partners and governments	Secure by Design raised as an overarching 6G requirement in 3GPP SA; 10+ IEEE 802.11 contributions; 20+ problem statements validated with 27+ industry partners; six proof-of-concept projects at TRL 4–6; engagement with five major UK seed-investment venture capital firms; and a venture-readiness programme underway; India–UK Connectivity & Innovation Centre with £24 million over four years; 6G Security and Resilience Principles launched by seven governments
Japan, Finland and NGMN	XGMF: 17 public technical documents across eight projects; 6G Flagship: 6G Resilience White Paper and AI-RAN testbed; NGMN: operator guidance recommending Multi-RAT Spectrum Sharing as the 5G–6G migration baseline, sent to 3GPP
India: national programme	104 TTDF 6G projects worth INR271 crore; two national 6G testbeds; TDIP scheme of INR203 crore (2026–31); 100 5G laboratories; Bharat 6G Alliance of 90 members and 12 MoUs
India: standards and IP	3GPP contributions from Indian members up from 196 (2020) to 2,943 (2025); chair of the IMT FWA Drafting Group in ITU-R WP 5D; one of the first RIS standards globally (TSDSI); 7,510+ patent applications by Alliance members, 4,495 of them abroad
India: technology and trials	Indigenous 270 GHz THz radio chain; 14 C-DOT quantum-secure products; 32TR Open RAN radio licensed for production; more than one million India-designed 5G CPE units; open-source core adopted through ITU Partner2Connect; satellite–5G and smart-village demonstrations with ESA and UK partners

Table 1: Headline outcomes reported in this edition (details and sources in the partner chapters)

A shared starting point

The Declaration rests on a simple premise: the qualities societies will want from 6G — security, resilience, openness, affordability and wide coverage are far easier to build in at the design stage than to add later, and easier still if countries and industries agree on them early. The nine principles are the form that agreement took.

The Bharat 6G Alliance works with twelve partner organisations under memoranda of understanding, spanning North America, Europe, Japan, the Republic of Korea, Brazil, the United Kingdom and the global operator community. The MoU partners that contributed written material to this report are:

- **the 6G Smart Networks and Services Industry Association (6G-IA), as the private counterpart of the Smart Networks and Services Joint Undertaking (SNS JU);**

- **6G Flagship at the University of Oulu;**
- **the Federated Telecoms Hub (FTH), the ACT hub dedicated to research translation, commercialisation, standardisation and impact, which coordinates with the other ACT hubs—CHEDDAR, HASC, JOINER and TITAN—to translate research into impact (this involves more than 35 UK Universities);**
- **XGMF (XG Mobile Promotion Forum, Japan);**
- **the NGMN Alliance; and**
- **the EPSRC UK–India Future Networks Initiative (UKI-FNI).**

The Indian contributors are **Reliance Jio; HFCL; Tejas Networks; the IIITB COMET Foundation; the IOS-MCN consortium (IISc, IIT Delhi and C-DAC); SAMEER and the 6G THz Testbed consortium; TTDF beneficiaries (IIT Roorkee; IIT Dharwad; IIIT Kalyani); and Freestream Technologies, together with national programmes of the Department of Telecommunications, MeitY and C-DOT**.

What has been achieved against the nine principles

Trust, security and resilience (Principles 1–2). Security has moved from an add-on to an architectural argument. A multi-stakeholder contribution supported by UK partners calls for Secure by Design as an overarching 6G requirement in 3GPP, and seven governments have issued shared 6G Security and Resilience Principles. India has moved quantum-safe communication into products, with C-DOT's fourteen QKD and PQC products and India's first TEC-approved QKD, while operators treat security as a product portfolio operating at national scale. On resilience, 6G Flagship has defined the concept for 6G, European programmes have demonstrated it in mature trials, and Indian operators show what population-scale availability requires in practice.

Standards and openness (Principles 3–4). This is where progress is clearest. European projects contributed 920 items to standards bodies in 2025 alone; Indian contributions to 3GPP rose from 196 to 2,943 between 2020 and 2025, with Indian leadership in ITU-R WP 5D and a national RIS standard among the first anywhere. The NGMN Alliance has given 3GPP an early, operator-backed view on migration. Openness has been shown in practice through India-designed Open RAN radios, multi-vendor operation at national scale, AI-RAN testbeds in Finland and an Indian open-source mobile core now being taken up through the ITU with Thailand and the Philippines.

Value, affordability and reach (Principles 5–7). Operators are already monetising network slicing, quality-on-demand and private networks, and India-designed CPE has shipped in millions. Energy and cost are being engineered: AI-driven energy management across hundreds of thousands of sites, lower-complexity coding, energy-saving mechanisms in 3GPP and low-cost access through fixed wireless, broadcast-based delivery and intelligent surfaces. Terrestrial and non-terrestrial integration has moved into the field, with India–UK demonstrations of satellite–5G telemedicine and smart-village services, and rural phygital service pilots under way.

Spectrum, supply chain and skills (Principles 8–9). Spectrum planning has become concrete, with the Bharat 6G Alliance's roadmap, DoT's phased roadmap to 2035, XGMF's mid-band recommendations and 6G-IA input to ITU-R. Indigenous capability now spans a 270 GHz radio chain, massive-MIMO platforms and specialised components. Skills are being built through structured curricula including a 500-hour IOS-MCN programme proposed for the ITU Academy — industry certificate programmes, 100 academic 5G laboratories and training of more than 1,700 European researchers in a single year.

Key gaps

The report also shows where progress is thin. Most evidence describes activity — projects funded, contributions submitted, prototypes built rather than outcomes such as requirements adopted, interoperability achieved or services sustained. Maturity is uneven: standardisation and openness are well advanced, while commercial models for distinctly 6G capabilities remain the least developed, even though they will determine how much investment the other principles attract. Several principles also pull against each other — openness and security, supply-chain sovereignty and global harmonisation, sensing and privacy, performance ambition and affordability and these trade-offs are not yet managed explicitly. Finally, partners lack shared facilities for multi-vendor interoperability, joint terrestrial–non-terrestrial and resilience testing, and a common basis for reporting energy, cost and progress.

What should happen next

The next thirty months are decisive. 3GPP will approve the scope of the first normative 6G release in March 2027 and complete it by 2029, and WRC-27 will decide on new mid-band IMT spectrum and satellite direct-to-device connectivity. The closing chapter of this report suggests that the signatories consider:

- agreeing a **small number of shared standards priorities** for Release 21 and pursuing them through jointly sourced contributions;
- working towards **mutually recognised security assurance** for 6G network functions and a coordinated post-quantum migration roadmap;
- establishing a **federated network of interoperability laboratories** with common test profiles, and sustainable governance for open-source platforms;
- coordinating **evidence and positions for WRC-27**, and running joint terrestrial–non-terrestrial and resilience trials with agreed success criteria;
- prioritising **demand-led use cases** with public-sector anchor customers, and adding user-side affordability measures to network metrics;
- launching **standards fellowships** and mutual recognition of skills certifications; and

- adopting a **common, outcome-oriented progress framework**, with principle champions drawn from different regions, reported each year at the International Bharat6G Symposium.

The Declaration set out to treat 6G as a global public good. The year since shows that intention being translated into technical work in the places where it counts. The task for the coming year is to turn parallel effort into coordinated results — and to be able to show it.

Introduction

The New Delhi Declaration and the Partnership behind it

Why the Declaration matters

Every generation of mobile technology has been shaped by decisions taken years before the first network was switched on. Those decisions are made in standards bodies, in research programmes and in national policy, and once made they are expensive to revisit. The question the New Delhi Declaration addresses is what should guide those decisions for 6G.

Its answer is that certain qualities should be treated as design requirements rather than as improvements to be made later. A network that is secure by design is different from a network secured afterwards. A network designed for affordability reaches people that a network optimised only for performance does not. Coverage that includes satellites and high-altitude platforms from the start behaves differently from coverage where they are added on. The nine principles set out these qualities in a form that research programmes and standards delegations can work from.

The Declaration's second contribution is that it was made jointly. Any one alliance advocating for affordability or for security by design carries the weight of its own membership. Several alliances advocating together, from different regions and with different industrial interests, carry considerably more. This is the practical significance of the signing: it created a common position that each signatory can refer to when arguing its case at home and in international forums.

It was also a statement about who 6G is for. The Declaration describes 6G as a global public good, and commits its signatories to a network fabric that, in its words, “uplifts societies, accelerates digital economies, and ensures no one is left behind”. Principles on affordability, on bridging digital divides and on skills sit alongside those on security and spectrum. That breadth is unusual among technology declarations and is one reason the New Delhi declaration has been useful to organisations whose priorities differ.

The organisations that endorsed the Declaration

The Bharat 6G Alliance has built its international relationships through memoranda of understanding with counterpart organisations. The signatories of New Delhi Declaration are

- Bharat 6G Alliance
- 6G Smart Networks and Services Industry Association (6G-IA)
- ATIS’ Next G Alliance
- XGMF

- 6G Forum
- UK TIN
- UK Federated Telecoms Hubs – FTH – together with CHEDDAR, HASC, JOINER and TITAN
- 6G Flagship
- 6G Brasil
- The EPSRC UK-India Future Networks Initiative UKI-FNI

In addition, Bharat 6G Alliance and NGMN signed a separate agreement on bilateral basis.

These organisations are not alike, and that is the point of the arrangement. Some are public research programmes; others are industry associations or national forums. Between them they cover fundamental research, industrial requirements, operator priorities, standardisation and skills development. A declaration signed across that range of institutions reaches further than one signed within a single category of organisation. Contributing organisations were asked to describe their work against the nine principles, naming the projects and initiatives involved, the organisations taking part, and any measurable outcomes. It is a record of submitted activity, not an audit. Where contributors described work as proposed, planned, under consideration or in progress, that status is preserved.

Contributions repeatedly describe work at different points of a common progression — from analysis, through protected intellectual property and physical prototypes, to standards contributions and adopted specifications. Each stage is represented in the material gathered here.

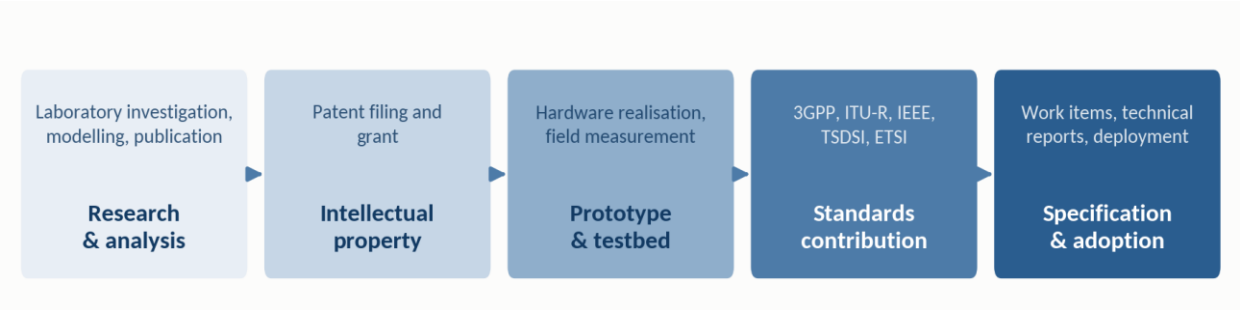

Figure 2. The research-to-standards progression described across the submitted contributions.

The signatories declared a shared intention to align research, development, standardisation and deployment around nine principles. The Declaration does not assign responsibility for any principle, set a target against any of them, or specify how compliance would be demonstrated.

The nine principles

The **New Delhi Declaration** sets out nine principles to guide the research, development, standardisation and deployment of 6G. Each chapter of this report takes one principle and describes what has been contributed towards it.

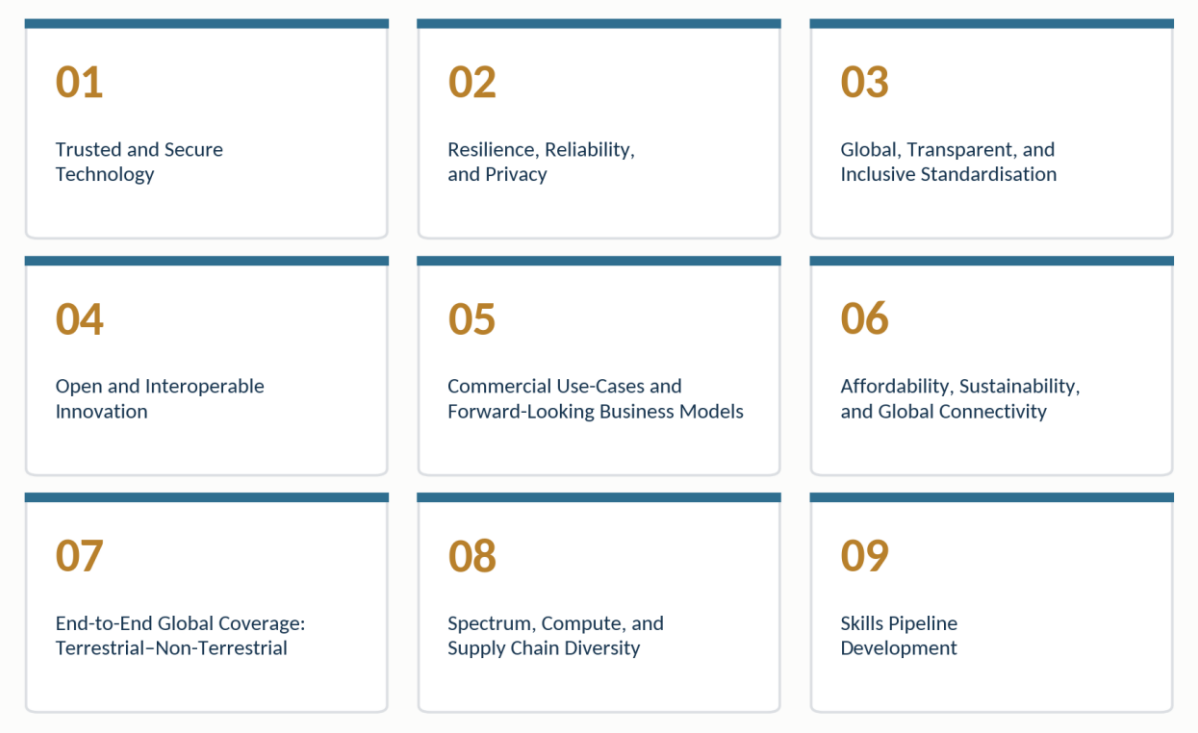

Figure 1. The nine principles endorsed in New Delhi on 10 October 2025. The full text of the Declaration is provided at Annexure A.

> **IN THE WORDS OF THE DECLARATION**
>
> "By working together, we can ensure that 6G is secure, open, resilient, inclusive, affordable, and sustainable — a global public good that empowers every nation and citizen."
>
> "At the International Bharat6G Symposium 2025 in New Delhi, this joint declaration marks a milestone: a unified global step toward making 6G a truly universal, trustworthy, and inclusive intelligent network."

6G SNS JU Progress Overview

Contribution to New Delhi Declaration

Executive Summary

The Smart Networks and Services Joint Undertaking (SNS JU)[1] is Europe's flagship public-private partnership driving the research, innovation and large-scale validation of next-generation communication technologies. By bringing together industry, research organisations, universities, SMEs and public authorities, the programme is strengthening Europe's position in the global development of 6G while supporting broader policy objectives related to digital sovereignty, sustainability, resilience and competitiveness.

In recent years, the SNS JU has evolved from foundational research towards the integration and validation of complete 6G technology building blocks. By 2025, the programme comprised 79 active projects, with cumulative EU investment exceeding €500 million (to date) and progressing towards a portfolio of around 100 projects in 2026. The 2025 Key Achievements exercise collected **188 Key Achievements** from 63 projects, demonstrating both the breadth and maturity of the European 6G research ecosystem.

The programme has also demonstrated a growing capacity to translate research into tangible innovation. During 2025 alone, SNS JU projects reported 920 contributions to Standards Development Organisations, bringing the cumulative total to more than **2,000 standardisation contributions** since the programme began. The programme has also generated more than **200 patent applications**, **2700 peer-reviewed scientific publications**, and executed more than **800 Test and Trials**, illustrating the programme's contribution to both scientific excellence and industrial innovation.

Technically, SNS JU has delivered significant advances across the key technological pillars expected to underpin future 6G systems. Recent achievements include trustworthy AI, cloud-native network architectures, integrated sensing and communications, distributed intelligence, digital twins, advanced radio technologies, secure edge-cloud infrastructures, energy-efficient networking and novel spectrum management techniques. Increasing emphasis has also been placed on end-to-end system integration, large-scale experimentation and realistic validation environments, accelerating the transition from individual technology components towards deployable 6G platforms.

Beyond technology development, the programme continues to strengthen Europe's wider innovation ecosystem through international standardisation, open-source collaboration, SME participation and skills development. In 2025, SNS JU activities involved **1,747 researchers in training and upskilling activities**, reinforcing Europe's long-term capacity to develop, deploy and operate future communication systems.

The achievements presented in this report are organised around nine strategic dimensions that together characterise Europe's vision for trustworthy, intelligent and sustainable smart networks and services. Collectively, they demonstrate how the SNS JU is laying the technological, industrial and scientific foundations for Europe's leadership in the global evolution towards 6G.

[1] The 6G-IA, which is a signatory of the New Delhi Declaration, is the private counterpart (50%) of the SNS JU, with the other 50% belonging to the European Commission.

1. Trusted & Secure Technology

Trust is a fundamental prerequisite for the successful deployment of 6G. Future communication infrastructures will support critical services across industry, healthcare, transport, energy and public administration, requiring networks that are secure, resilient and capable of protecting sensitive data while increasingly relying on artificial intelligence and distributed cloud infrastructures. For Europe, trust is also closely linked to technological sovereignty, ensuring that future digital infrastructures are developed according to European values of security, privacy, openness and transparency.

Recent SNS JU activities have therefore placed trustworthiness at the core of 6G system design, as evidenced by the **2025 Key Achievements**[2] exercise, which gathered 188 achievements from 63 projects. Rather than addressing cybersecurity as a standalone function, the programme has promoted integrated approaches combining trustworthy AI, confidential computing, privacy-preserving data management and secure cloud-native architectures. The **SNS JU Technology Board** identified 6G trustworthiness and AI/ML for 6G networks as strategic priorities, publishing dedicated white papers[3] that consolidate European research and identify future technological directions.

SNS JU developments in trusted technologies have been demonstrated across a broad range of application domains, including:

- Secure industrial automation and collaborative manufacturing based on trusted edge-cloud infrastructures.
- Privacy-preserving AI for distributed network management and service orchestration.
- Secure digital twins supporting the operation and optimisation of communication infrastructures.
- Trusted communications for public safety and critical infrastructure applications.
- Confidential processing of sensitive data across distributed cloud and edge environments.

[2] https://smart-networks.europa.eu/sns-ju-projects-key-achievements-2025/
[3] https://smart-networks.europa.eu/sns-publications/

Recent SNS JU activities have demonstrated significant progress in trusted and secure technologies, including:

- ***Trustworthy AI for network management***, improving the robustness, explainability and security of AI-assisted network automation while reducing vulnerability to malicious manipulation.
- ***Secure distributed cloud and edge computing***, through confidential computing, trusted execution environments and secure workload migration supporting sensitive industrial and public-sector applications.
- ***Privacy-preserving collaborative intelligence***, including federated learning and secure data-sharing mechanisms that enable organisations to collaborate without exposing proprietary or personal information.
- ***Security-by-design integration*** across emerging 6G technologies, including cloud-native networking, digital twins and integrated sensing and communications, ensuring that trust is embedded throughout future system architectures.
- ***Strong innovation output***, with SNS JU projects reporting 49 patent applications, 14 granted patents and contributing to 920 international standardisation contributions during 2025, demonstrating the programme's ability to translate research into industrial and technological impact.

Recent SNS JU activities demonstrate that trusted technologies are progressing from research concepts towards deployable 6G capabilities. The programme's extensive engagement in international standardisation—with more than 2,000 contributions overall—helps ensure that European approaches to trustworthy AI, cybersecurity and secure network architectures are reflected in future global standards. Together with continued scientific output, patent generation and the participation of 1,747 researchers in programme activities[4], these achievements are strengthening Europe's capacity to develop secure and globally competitive communication infrastructures. Experience gained through large-scale demonstrations further confirms that embedding trust from the design stage significantly simplifies the integration of AI, distributed computing and autonomous network management into future 6G systems.

2. Resilience, Reliability and Privacy

As communication networks evolve into critical digital infrastructures supporting industrial automation, connected mobility, healthcare and public services, ensuring their continuous and reliable operation becomes increasingly important. Future 6G systems must not only withstand failures and cyber threats but also adapt autonomously to changing operating

[4] SNS JU Annual Activity Report 2025: https://smart-networks.europa.eu/wp-content/uploads/2026/06/snsju_aar25.pdf

conditions while safeguarding the privacy of users and organisations. For Europe, resilient and privacy-preserving networks are essential to supporting critical services, strengthening digital sovereignty and building confidence in increasingly AI-driven communication systems.

Recent SNS JU activities have therefore focused on developing self-adaptive, cloud-native and AI-enabled network architectures capable of maintaining service continuity under highly dynamic conditions. By combining distributed intelligence, predictive network management and privacy-enhancing technologies, the programme is laying the foundations for communication infrastructures that are both highly dependable and capable of supporting the stringent requirements of future digital applications. The SNS JU Technology Board highlighted eight mature trials and pilots demonstrating advanced 6G capabilities in representative environments[5], providing valuable evidence of the programme's transition from laboratory research towards integrated system validation. These large-scale demonstrations have enabled the assessment of reliability, service continuity and operational robustness across diverse application domains.

Recent SNS JU developments have demonstrated resilient and privacy-preserving networking across a broad range of application domains, including:

- Mission-critical communications supporting public safety and emergency response through highly reliable and adaptive network operation.
- Industrial automation and smart manufacturing, where AI-assisted resource management and distributed edge computing improve operational continuity and minimise service disruption.
- Connected mobility applications requiring seamless service continuity across heterogeneous network environments.
- Distributed cloud and edge platforms enabling secure workload migration and uninterrupted service delivery during infrastructure failures.
- Privacy-preserving collaborative AI, allowing organisations to jointly develop intelligent network functions without exchanging sensitive operational or proprietary data.

[5] SNS JU Large Scale Trials & Pilots Brochure No2: https://smart-networks.europa.eu/wp-content/uploads/2026/06/tp-v8.pdf

Based on these activities, project output has resulted in significant advances in resilient and reliable network operation, including:

- ***AI-assisted network resilience***, enabling predictive fault detection, autonomous optimisation and rapid service recovery through intelligent network management.
- ***Cloud-native resilience mechanisms***, supporting dynamic orchestration, distributed resource management and workload migration across edge and cloud infrastructures to maintain service continuity.
- ***Privacy-enhancing technologies***, including federated learning, secure data spaces and distributed AI approaches that strengthen data protection while enabling collaborative network intelligence.
- ***Large-scale system validation***, eight mature trials and pilots demonstrating integrated 6G capabilities under realistic operating conditions.

SNS JU activities demonstrated that resilience is evolving from traditional fault tolerance towards autonomous, self-managing communication infrastructures capable of anticipating and adapting to changing operational conditions. Through extensive experimentation, scientific dissemination and standardisation, the programme is helping establish the technical foundations for highly dependable 6G systems that can support Europe's future critical digital services. Implementation experience has further highlighted the importance of combining AI-native management with cloud-native architectures, allowing communication services to recover rapidly from failures while maintaining stringent performance and privacy requirements.

3. Global, Transparent and Inclusive Standardisation

International standardisation is fundamental to ensuring the global interoperability, scalability and commercial success of future communication networks. For Europe, active participation in standards development is also a strategic instrument for strengthening technological leadership, promoting open and interoperable solutions, and ensuring that future 6G systems reflect European priorities on trust, sustainability and innovation. The SNS JU has therefore embedded standardisation throughout the research and innovation lifecycle, enabling scientific advances to contribute directly to the development of future global specifications.

Recent SNS JU activities demonstrate a mature and coordinated European approach to standardisation, combining technical excellence, large-scale experimentation and close collaboration between industry, academia and research organisations. The SNS JU spearheaded the efforts to align all European stakeholders from SNS JU projects and EU National Initiatives and deliver a unified European view on 6G Use Cases to be further developed for 6G towards ***3GPP SA1 in their dedicated WS in May 2024***. As a result, European stakeholders were the only ones that appeared as a common front, succeeding in pushing

through to standardization 6G Use cases that are critical for the European economy and Digital Innovation (five out of six use cases adopted in 3GPP TR22.870).

SNS JU contributions to standardisation have been supported through implementation and validation activities across multiple technology domains, including:

- AI-native network management and autonomous network operation.
- Integrated sensing and communications for future 6G systems.
- Cloud-native network architectures and distributed edge-cloud infrastructures.
- Open, virtualised and software-defined network architectures supporting interoperability.

Recent SNS JU activities have significantly strengthened Europe's contribution to global 6G standardisation through:

- ***920 contributions to international Standards Development Organisations during 2025***, bringing the programme's cumulative contribution to more than 2,000 standardisation contributions since its launch. Figure 3 provides additional details on the SNS JU SDO contributions to standardization for 2025
- ***Active engagement across major international bodies, including 3GPP, ETSI, ITU, O-RAN Alliance, IETF and oneM2M***, helping shape future 6G specifications and interoperability frameworks.
- Strong innovation output supporting commercialization of solutions, with ***119 patent applications*** within 2025, out of which 14 are already granted.
- Secure and trustworthy communication frameworks addressing cybersecurity, privacy and resilient network operation.

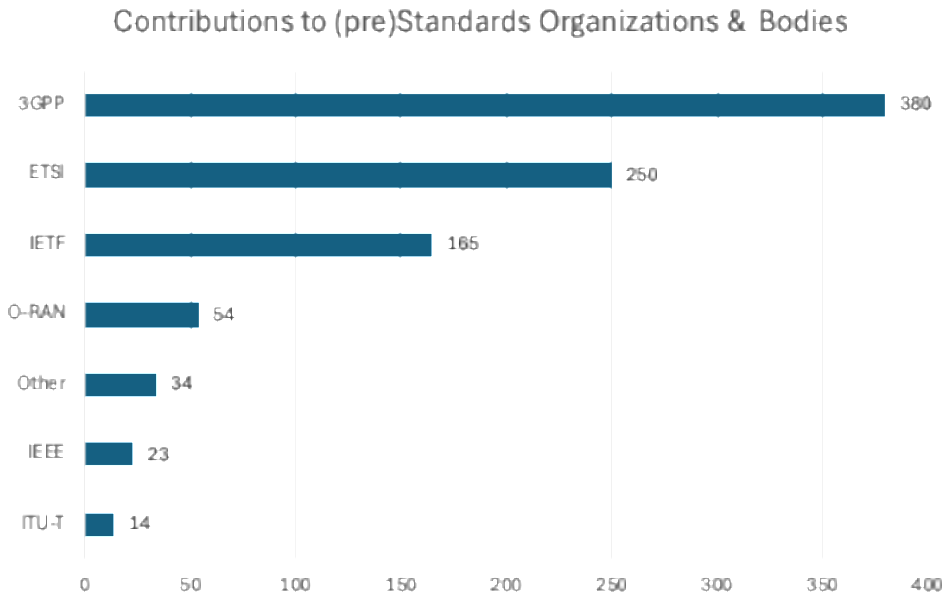

Figure 3: Contributions to SDOs by SNS JU projects within 2025

SNS JU demonstrates that successful standardisation depends on close interaction between research, experimentation and international collaboration. Large-scale validation activities provide practical evidence supporting new technical specifications, while coordinated European engagement ensures that research results are translated efficiently into globally adopted standards. This integrated approach strengthens Europe's influence on the future evolution of 6G while promoting open, interoperable and internationally compatible communication technologies.

4. Open and Interoperable Innovation

Openness and interoperability are central to Europe's vision for future communication networks. As 6G systems become increasingly software-driven, cloud-native and distributed, open architectures and common interfaces are essential to accelerate innovation, avoid vendor lock-in and enable the rapid integration of new technologies. For the SNS JU, openness extends beyond technology to encompass collaborative research, open-source development and close cooperation between industry, academia, SMEs and research organisations, creating a dynamic innovation ecosystem capable of responding to rapidly evolving technological and market needs.

Recent SNS JU activities have reinforced this vision by promoting modular network architectures, software-defined platforms and interoperable technology building blocks that can be integrated across heterogeneous infrastructures. The programme has also encouraged collaboration through shared experimentation facilities, common software frameworks and coordinated technical activities, enabling innovations developed by different organisations to be combined into coherent end-to-end 6G solutions. These efforts contribute to a more competitive and resilient European communications ecosystem while facilitating faster technology uptake and industrial exploitation.

SNS JU has demonstrated open and interoperable approaches across a wide range of technology domains, including:

- Open and virtualised Radio Access Network (Open RAN) architectures supporting multi-vendor interoperability.
- Cloud-native network platforms enabling modular deployment and lifecycle management of network functions.
- Open software frameworks and shared experimentation platforms supporting collaborative technology development.
- Interoperable edge-cloud infrastructures enabling seamless integration of communication and computing resources.
- Common APIs and service-based architectures facilitating integration across heterogeneous communication environments

Recent SNS JU activities have strengthened Europe's open innovation ecosystem through:

- The identification, use and integration of more than ***310 Open-Source Solutions*** just within 2025, including Kubernetes, Open5GS, Prometheus, PyTorch, Grafana, OpenCAPIF and more.
- Extensive dissemination of research results through more than ***1400 publications within 2025, 80% of which are available in open-access***, supporting knowledge sharing and accelerating technology uptake across the European research community.
- ***Almost 200 contributions towards open-source communities*** within 2025 alone, such as ETSI TeraFlowSDN, ETSI Open Slice, ETSI OPenCAPIF and more.
- Strategic Technology Board white papers providing common technical guidance on key enabling technologies, helping align research activities and reduce fragmentation across the European 6G ecosystem.

The SNS JU demonstrates that openness is not simply a technological characteristic but a catalyst for innovation. By combining interoperable architectures, collaborative research, shared experimentation and coordinated standardisation, the programme is enabling faster technology development while strengthening Europe's industrial competitiveness and strategic autonomy. Experience gained through large-scale collaborative research has also shown that common architectures and open interfaces significantly simplify technology integration, facilitating the transition from individual research results to interoperable end-to-end 6G platforms.

5. Support for Commercial Use Cases and Forward-Looking Business Models

A key objective of the SNS JU is to ensure that European 6G research translates into technologies and services capable of delivering tangible economic and societal value. Beyond advancing enabling technologies, the programme seeks to accelerate their adoption by validating solutions in realistic environments, engaging end users from multiple industrial sectors and supporting the development of sustainable business models. This market-oriented approach is helping reduce the gap between research and commercial deployment while strengthening Europe's competitiveness in future communication markets.

Recent SNS JU activities demonstrate a clear progression from technology development towards integrated end-to-end validation. The programme has expanded its focus from individual technical components to complete solutions combining communications, computing, artificial intelligence and sensing, allowing future services to be assessed under

representative operational conditions. The Vertical Engagement Tracker[6] of the SNS JU is a testament to the continued progress of 6G innovation from Proof of Concepts and lab tests to high-TRL Trials and Pilots, as it includes details of ***more than 460 experiments/tests*** performed by the SNS JU projects so far, out of which more than ***180 represent mature Trials & Pilots in realistic environments*** (TRL 5-6 and above).

SNS JU technologies have been validated across a broad range of application domains, demonstrating the potential of future 6G networks to support new digital services, including:

- Smart manufacturing and industrial automation, enabling flexible production, predictive maintenance and collaborative robotics.
- Connected and automated mobility, supporting cooperative transport systems and highly reliable vehicle communications.
- Public safety and emergency response, through resilient mission-critical communications and enhanced situational awareness.
- Healthcare and remote medical services, enabled by secure, ultra-reliable connectivity and distributed edge computing.
- Smart infrastructure, including energy networks, environmental monitoring and intelligent cities, integrating communications, sensing and AI to improve operational efficiency.

Recent SNS JU activities have strengthened the commercial readiness of European 6G technologies through:

- ***Validation of integrated end-to-end solutions*** in increasingly realistic environments, addressing more than 12 vertical sectors including Smart Manufacturing, Media & Entertainment, PPDR, Automotive/Logistics, Smart Energy and more.
- ***Extensive experimentation, with more than 460 experiments*** perfomred across different maturity levels (TRL1-7), encompassing and integrating state of the art technologies and addressing real commercial use cases form vertical sectors.
- ***A research portfolio comprising almost 100 R&I projects***, supporting innovation across the full communications value chain and fostering collaboration between industry, SMEs, research organisations and academia.

The SNS JU demonstrates that successful commercialisation requires close interaction between research, technology validation, industrial participation and standardisation. By combining large-scale experimentation with strong engagement from end users and technology providers, the programme is creating favourable conditions for the future

[6] SNS JU Vertical Engagement Tracker: https://sns-trackers.sns-ju.eu/vertical-engagement-tracker/vertical-cartography

deployment of European 6G solutions across multiple sectors. Experience gained through these implementation activities also highlights the importance of validating technologies within complete end-to-end ecosystems, where communications, computing and AI can be assessed together against real operational and business requirements.

6. Affordability, Sustainability and Global Connectivity

Future 6G networks must deliver substantially improved performance while remaining economically viable, energy-efficient and accessible to users across Europe and beyond. Achieving these objectives requires innovations that reduce infrastructure costs, optimise the use of network and computing resources, minimise environmental impact and extend high-quality connectivity to underserved areas. The SNS JU has therefore placed sustainability and affordability alongside performance as key design objectives, ensuring that future communication systems support both Europe's Green Deal ambitions and its Digital Decade targets.

Recent SNS JU activities demonstrate a growing emphasis on holistic system optimisation. Rather than improving individual network components in isolation, the programme has developed integrated approaches combining AI-native network management, cloud-native architectures, advanced radio technologies and distributed computing to reduce energy consumption while maintaining high levels of performance and service quality.

SNS JU technologies have demonstrated more sustainable and cost-effective networking solutions across several application domains, including:

- Energy-efficient radio access and transport networks using intelligent resource management and dynamic optimisation.
- Cloud and edge computing platforms that optimise computing resource utilisation while reducing operational energy consumption.
- Smart energy and utility networks enabled by reliable, low-power communication infrastructures.
- Rural and underserved connectivity solutions combining terrestrial and non-terrestrial technologies to improve service availability.
- AI-assisted network operation supporting automated resource optimisation and reduced operational costs.

Through the work of the SNS JU, sustainability has been shaped into a core programme value, which penetrates all aspects of technology development and is an integral part of all SNS JU solutions. The importance of sustainability for SNS JU is depicted in the fact that the SNS JU Steering Board has initiated an official Working group on Sustainability, where common methodologies, terminologies, approaches and cross-validation campaigns take place among

the projects. Moreover, significant output is already available both from the WG itself[7] as well as other collaborations among the SNS JU projects working on Sustainability aspects such as Key Values and Key Value Indicators (KVIs)[8]. The WG has clearly defined the ***three main pillars of Sustainability, Environmental, Economic and Societal***, paving the way for global developments.

Recent SNS JU activities have advanced sustainability through:

- ***The publication of the Sustainability methodologies, targets, trade-offs and lessons learned*** based on relevant project work.
- The definition, further evolution and attempted linking of ***Key Value Indicators (KVIs)*** to KPIs and how to extrapolate them from additional Use Cases.
- The numerous ***Sustainability oriented events***, promoting SNS JU work and interacting with key stakeholders on Sustainability needs.
- Research and development of novel ***Energy Efficiency solutions*** applicable in multiple domains.

The SNS JU demonstrates that sustainability and affordability can be addressed alongside ambitious performance objectives through intelligent system design rather than technological compromise. By integrating AI, cloud-native networking and advanced resource management into future 6G architectures, the programme is helping create communication infrastructures that are both economically sustainable and environmentally responsible. Experience gained through system-level validation further confirms that optimising communications, computing and energy resources jointly delivers greater efficiency than treating these domains independently, providing an important foundation for the large-scale deployment of future European 6G networks.

7. End-to-End Global Coverage

One of the defining ambitions of 6G is to provide ubiquitous connectivity, ensuring that users and services can access reliable communications regardless of geographical location or deployment environment. Achieving this vision requires the seamless integration of terrestrial and non-terrestrial networks, enabling continuous service delivery across urban, rural, maritime, airborne and remote environments. For Europe, end-to-end global coverage is essential to support digital inclusion, strengthen strategic autonomy and enable new services that depend on uninterrupted connectivity.

[7] https://smart-networks.europa.eu/wp-content/uploads/2025/05/sns_ju_sustainabilitytf_whp_june2025_v1.0-1.pdf
[8] https://smart-networks.europa.eu/wp-content/uploads/2025/05/sns-ju-white-paper-6g-kvis-survey-2025_final-1.pdf

Recent SNS JU activities have significantly advanced this vision by developing integrated network architectures capable of combining terrestrial mobile networks with Non-Terrestrial Networks, i.e., satellite systems (TN-NTN integration), high-altitude platforms and other non-terrestrial communication technologies. Rather than treating these infrastructures as independent systems, the programme has focused on their coordinated operation, enabling users and applications to move seamlessly across heterogeneous communication environments while maintaining consistent service quality.

SNS JU has demonstrated integrated connectivity solutions across a range of deployment scenarios, including:

- Hybrid terrestrial and satellite communications providing seamless broadband connectivity in rural and remote regions.
- Maritime communications supporting reliable connectivity for vessels operating beyond the reach of terrestrial mobile networks.
- Airborne and unmanned aerial platforms extending network coverage during temporary events, emergency situations and disaster recovery operations.
- Connected transport corridors requiring uninterrupted service continuity across different communication infrastructures.
- Integrated communication and sensing solutions supporting environmental monitoring and infrastructure management across geographically dispersed areas.

Recent SNS JU activities have strengthened Europe's capabilities for global connectivity through:

- Development of integrated terrestrial and non-terrestrial network architectures supporting seamless service continuity across multiple communication domains, by ***16 SNS JU proj***ects working on state of the art solutions.
- ***Six dedicated experimental campaings on TN-NTN integration*** in realistic environments as reported in the Vertical Engagement Tracker
- Validation of multi-layer network orchestration mechanisms enabling intelligent coordination between terrestrial, satellite and edge infrastructures.
- Advances in AI-assisted resource management, supporting dynamic optimisation of heterogeneous communication resources while maintaining service quality.

The SNS JU demonstrates that achieving global connectivity requires the convergence of communications, computing and intelligent network management across multiple infrastructure layers. Through coordinated research, large-scale experimentation and active engagement in international standardisation, the programme is establishing the foundations for seamless end-to-end connectivity capable of supporting future global digital services. Implementation experience has also highlighted the importance of treating terrestrial and non-terrestrial networks as components of a single integrated communication ecosystem,

enabling more efficient resource utilisation and significantly improving service continuity across diverse deployment environments.

8. Spectrum, Compute and Supply Chain Diversity

Future 6G networks will rely on the efficient integration of communication, computing and sensing resources while operating across an increasingly diverse technology landscape. Ensuring flexible access to spectrum, distributed computing capabilities and a diversified supply chain is therefore becoming essential for both network performance and Europe's strategic autonomy. The SNS JU has addressed these challenges by promoting open architectures, intelligent spectrum management, cloud-edge integration and technology diversification, reducing dependence on single technologies or suppliers while improving the adaptability of future communication infrastructures.

Recent SNS JU activities demonstrate significant progress towards AI-native, software-driven infrastructures capable of dynamically managing radio, computing and networking resources. At the same time, the programme has supported European efforts towards open hardware and software ecosystems, interoperable network components and distributed computing platforms, creating the technological foundations for more resilient and competitive 6G value chains.

SNS JU projects have demonstrated advances in novel spectrum use, computing and edge infrastructure diversity across multiple domains, cloud native computing and more, as depicted in Figure 4. Some application domains that can be mentioned as highlights are:

- AI-assisted spectrum management and dynamic spectrum sharing to improve the efficient use of scarce radio resources.
- Distributed cloud-edge computing platforms supporting latency-sensitive applications and flexible workload placement.
- Open and virtualised network infrastructures enabling multi-vendor deployment and greater supply chain diversity.
- Integrated communication, computing and sensing platforms supporting next-generation industrial and public-sector applications.
- Software-defined network architectures enabling flexible deployment of services across heterogeneous computing environments.

The work performed by the European R&I community in the context of the SNS JU is already paying off, with several novel solutions and applications taking advantage of new frequency bands and utilizing (deep)edge and cloud networking alongside state of the art terminals. The EU community has also played a significant role in global developments on spectrum use for 6G, as the 6G-IA Spectrum WG, with the participation of SNS JU experts, has created and submitted a liaison statement to ITU-R Working Party 5D regarding “Minimum requirements

related to technical performance for IMT-2030 Interfaces"[9]. This statement ensured that the European priorities regarding the use of the 6G spectrum, were aggregated and consolidated and able to influence global developments.

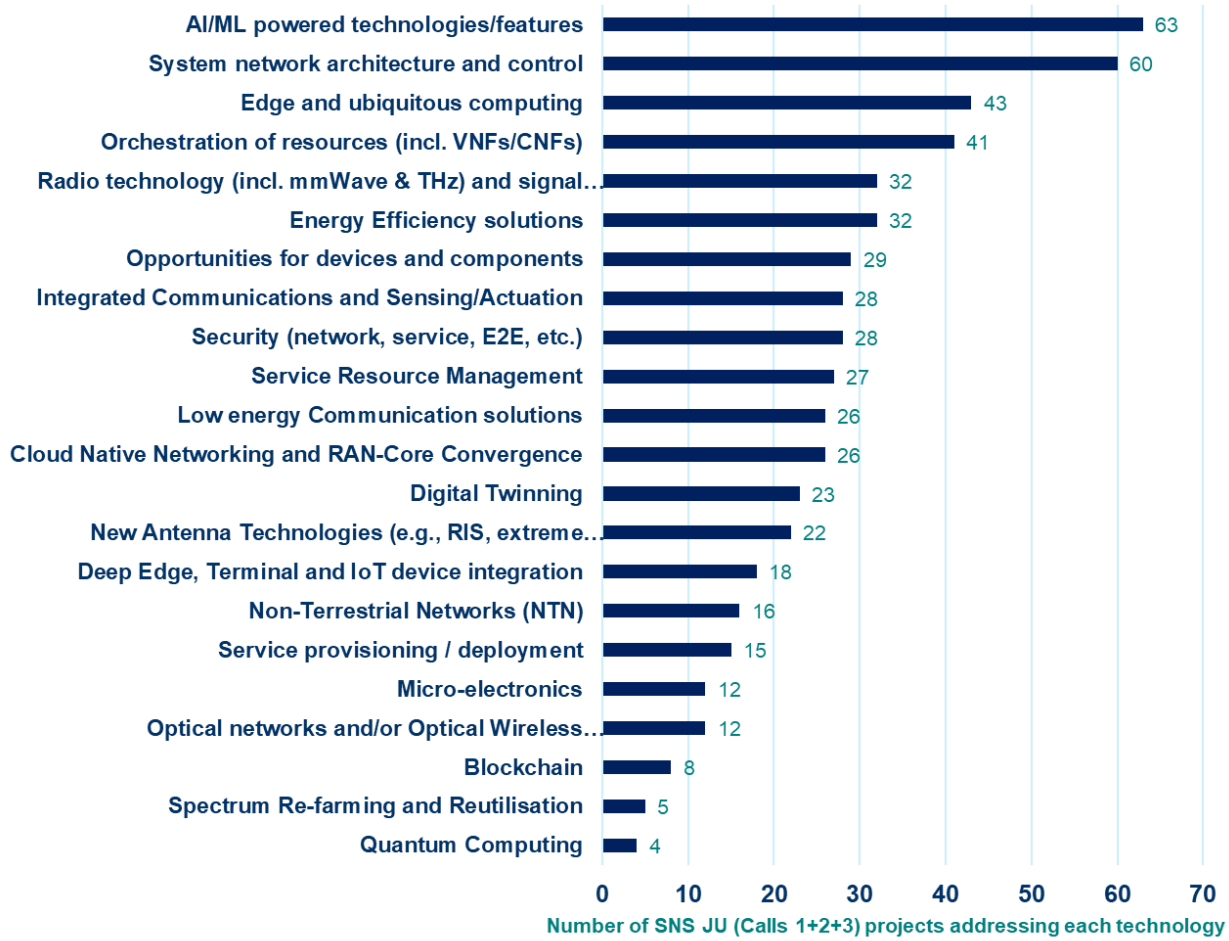

Figure 4: Technological aspects investigated by SNS JU projects (Calls 1, 2 and 3)

Besides this significant milestone, additional breakthroughs and relevant achievements can be mentioned based on recent SNS JU activities:

- Significant and continuous contributions towards ***ITU-R and EU regulatory and policy bodies*** regarding new spectrum and spectrum use for 6G.
- ***30 experimental activities*** (test, PoC, Trials, Pilots) on Cloud-Native Architecture in realistic environments[5].
- ***34 experimental activities*** (test, PoC, Trials, Pilots) on Multi-Access Edge Computing in realistic environments[5].
- ***18 experimental activities*** (test, PoC, Trials, Pilots) on TeraHertz Communications in realistic environments[5].

[9] https://6g-ia.eu/wp-content/uploads/2025/06/6g_ia-contribution_wp5d-120625.pdf

The SNS JU demonstrates that Europe's future competitiveness depends not only on advances in radio technologies but also on the intelligent integration of spectrum, computing and software-defined infrastructures. Through coordinated research, large-scale experimentation and active contributions to international standards, the programme is helping establish diversified and resilient technology ecosystems capable of supporting future European digital infrastructure. Experience gained through the programme further highlights that open architectures and distributed computing significantly improve infrastructure flexibility, enabling communication resources to be allocated more efficiently while strengthening resilience across the entire 6G value chain.

9. Skills Pipeline Development

Europe's leadership in 6G will depend not only on technological innovation but also on the availability of a highly skilled workforce capable of developing, deploying and operating increasingly complex communication systems. Future networks will require expertise spanning telecommunications, artificial intelligence, cloud computing, cybersecurity, microelectronics, software engineering and data science, making skills development a strategic priority for both the SNS JU and the wider European digital agenda.

Recognising this challenge, the SNS JU has embedded skills development across its research and innovation portfolio. By bringing together industry, universities, research organisations and SMEs, the programme creates multidisciplinary learning environments that expose researchers and engineers to the full 6G innovation lifecycle, from fundamental research to experimentation, standardisation and technology transfer. This collaborative approach helps strengthen Europe's long-term capacity to maintain global leadership in advanced communication technologies.

SNS JU has supported skills development through a wide range of activities, including:

- Multidisciplinary research programmes combining communications, AI, cloud computing, cybersecurity and sensing technologies.
- Large-scale experimental platforms providing hands-on experience with integrated 6G systems and emerging digital infrastructures.
- Collaboration between universities, research organisations, industry and SMEs, promoting knowledge transfer and researcher mobility.
- Active participation in international standardisation, exposing researchers to global technology development processes.
- Dissemination of scientific knowledge through publications, workshops, white papers and technical community activities.

Recent SNS JU activities have strengthened Europe's 6G skills base through:

- ***1,747 researchers*** participating in education, training and upskilling activities across the programme during 2025.
- A collaborative research ecosystem comprising almost ***100 projects*** working together via collaborative bodies such as the Steering Board, the Technology Board and 13 Working Groups (SNS JU and 6G-IA) providing multidisciplinary training opportunities across the European communications value chain.
- Broad dissemination of research through ***2700 peer-reviewed publications***, supporting knowledge exchange between academia, industry and the wider research community.
- Strong engagement with international standardisation, with more than 2000 contributions to Standards Development Organisations, enabling researchers and engineers to contribute directly to the development of future global 6G standards.

The SNS JU demonstrates that developing Europe's future communications workforce requires close integration between research, innovation, education and industrial collaboration. Beyond generating new technologies, the programme is strengthening the human capital needed to sustain Europe's long-term competitiveness in 6G. Experience gained through collaborative research, large-scale experimentation and international standardisation confirms that multidisciplinary cooperation is essential for preparing the next generation of researchers and engineers to address the increasingly integrated nature of future communication systems.

Conclusions

The SNS JU has established itself as Europe's leading collaborative initiative for the development of next-generation communication technologies. In only a few years, the programme has evolved from supporting foundational research to demonstrating increasingly mature, integrated 6G solutions capable of addressing societal, industrial and strategic priorities. Across the nine strategic dimensions presented in this report, the programme has consistently combined scientific excellence with practical validation, helping bridge the gap between research, standardisation and future commercial deployment.

A defining characteristic of the SNS JU is its holistic approach. Rather than developing individual technologies in isolation, the programme has promoted integrated solutions combining communications, artificial intelligence, cloud and edge computing, sensing, cybersecurity and sustainability. This systems perspective is enabling Europe to address the complexity of future 6G networks while ensuring that technological innovation remains aligned with European values of openness, trustworthiness, resilience and interoperability.

The programme has also demonstrated Europe's capacity to influence the global evolution of 6G through sustained contributions to international standardisation, coordinated research and broad stakeholder collaboration. By bringing together industry, academia, SMEs and research organisations within a common European framework, the SNS JU is strengthening both technological sovereignty and industrial competitiveness while creating the skills and innovation ecosystem needed to support future deployment.

The progress achieved to date is reflected in a number of programme-wide indicators:

- 79 research and innovation projects through the first three calls, progressing towards a portfolio of around **100 projects** (with Call 4 and 5) and representing more than €500 million of EU investment in 6G research and innovation.
- **188 Key Achievements** identified within the first three years of operations, demonstrating the breadth and increasing maturity of European 6G technologies.
- More than **2000 contributions to international SDOs** since the programme's launch and reinforcing Europe's leadership in shaping future global 6G standards.
- **200 patent applications** demonstrating the programme's strong innovation performance and ability to turn research into applicable rea-life solutions.
- **More than 2700 peer-reviewed publications,** highlighting the programmes strong scientific basis and international impact.
- **468 experimental implementations** in real-life environments ranging from early experimentation (lab tests / PoCs – low TRL) up to validation of almost market-ready solutions in relevant vertical enviornments (Trials/Pilots – High TRL).
- **1,747 researchers** participating in education, training and upskilling activities, helping develop the multidisciplinary workforce required for Europe's future communication ecosystem.

Looking ahead, the SNS JU is well positioned to continue supporting Europe's transition towards 6G. As technologies mature and move closer to large-scale deployment, the programme's integrated approach—combining research excellence, experimental validation, standardisation and industrial collaboration—provides a strong foundation for maintaining Europe's global leadership in smart networks and services. The achievements presented in this report demonstrate that the SNS JU is not only developing the technologies of future communication networks, but also creating the innovation ecosystem, industrial capabilities and human expertise that will enable Europe to shape the next generation of global digital infrastructure.

6G Flagship Progress Overview

Contribution to New Delhi Declaration

Executive Summary

6G Flagship at the University of Oulu, Finland, is one of the signatories of the New Delhi Declaration. 6G Flagship aims to combine near-instant unlimited wireless connectivity, distributed computing and intelligence and circuits & devices for future sustainable services and applications to be utilized globally. It's aim is to develop secure, open and resilient 6G technologies. Its contribution to this report draws on white papers, collaborative projects, testbed infrastructure and peer-reviewed research under four of the Declaration's principles: resilience, reliability and privacy; open and interoperable innovation; affordability, sustainability and global connectivity; and end-to-end global coverage.

On resilience, the Flagship published the **6G Resilience White Paper** (6G Research Visions, No. 15), which sets out definitions, architectures, technical enablers and the techno-economics of resilient 6G systems, and has started the **6G-FiSRE** project with Finnish and Swedish academic, industrial and public-sector partners to develop resilient-by-design 6G technologies.

On open and interoperable innovation, the University of Oulu joined the **AI-RAN Alliance** in 2024 as the first Finnish academic institute and is active in its AI-for-RAN working group. A work item with NVIDIA on multimodal sensing-enabled digital twins has been demonstrated at NVIDIA GTC 2025, the Brooklyn 6G Summit 2025 and Mobile World Congress Barcelona 2026, and the University's test network has been upgraded with a GPU-accelerated NVIDIA ARC-OTA-based AI-RAN testbed for over-the-air testing.

The Flagship also contributes to international collaboration through the EU–Republic of Korea **6GARROW** project and the European **Hexa-X-II** project, and continues a long-standing programme on sustainable networks, connectivity for remote areas and terrestrial–non-terrestrial integration, including the **6G-SatMTC** project on satellite-based machine-type connectivity.

1. Resilience, Reliability and Privacy

The University of Oulu views resilience as a fundamental 6G design goal, alongside sustainability and efficiency. Networks will need to anticipate, withstand, adapt to, recover from and continuously learn from disruptions across technology, architecture and economics.

The *6G Resilience White Paper* discusses the motivation for resilience, resiliency definitions, architectures, technical enablers and the techno-economics of resilient 6G systems. It identifies edge-native and locality-aware designs, open interfaces and programmability — enabling islanded operation, fallback modes and multi-layer diversity — as the main architectural components. Key enablers include AI-native control loops with verifiable

behaviour, zero-trust security rooted in hardware and supply-chain integrity, and networking techniques that prioritise critical traffic, time-sensitive flows and inter-domain coordination.[10]

Related 6G Flagship activities include:

- The newly started **6G-FiSRE** project, which unites leading Finnish and Swedish academic, industrial and public-sector partners to develop resilient-by-design 6G technologies — networks that maintain critical services even during cyberattacks, disasters or intentional interference.
- Research on reliable, future-oriented communication systems, such as advanced machine-type communication networks for factory scenarios, and reconfigurable intelligent surfaces and stacked intelligent metasurfaces operating in complex and dynamic environments.

Recent 6G Flagship research on resilient and reliable 6G networks includes:

- ***Resilient-by-design framework***, built on four building blocks — predict, preempt, protect and progress — with an example scenario. N. H. Mahmood, S. Samarakoon, P. Porambage, M. Bennis and M. Latva-aho, "Resilient-by-Design: A Resilience Framework for Future Wireless Networks," *IEEE Communications Magazine*, vol. 63, no. 11, pp. 158–164, Nov. 2025, doi: 10.1109/MCOM.001.2400517.
- ***Resilience-oriented business models for 6G.*** S. Yrjölä, M. Matinmikko-Blue and P. Ahokangas, "Resilience-Oriented Business Model Designs in 6G," *EuCNC/6G Summit 2026*, Málaga, Spain, pp. 616–623, doi: 10.1109/EuCNC/6GSummit68295.2026.11577282.
- ***Data-driven multi-user detection for dynamic factories.*** T. Sivalingam, F. V. Schoettler, P. Susarla, N. H. Mahmood, E. Lyczkowski, N. Rajatheva and M. Latva-aho, "Empirical Data-Driven Multiple User Detection for Dynamic Indoor Factory Settings," *IEEE Wireless Communications Letters*, vol. 14, no. 9, pp. 2917–2921, Sept. 2025.
- ***Channel prediction for beyond-diagonal RIS***, with low-overhead, high-accuracy joint channel estimation and prediction for BD-RIS-assisted MIMO under correlated fast fading with channel aging. N. Ginige, A. S. de Sena, N. H. Mahmood, N. Rajatheva and M. Latva-aho, "Efficient Channel Prediction for Beyond Diagonal RIS-Assisted MIMO Systems with Channel Aging," *IEEE Transactions on Vehicular Technology*, vol. 74, no. 8, pp. 12658–12672, Aug. 2025.
- ***Max-min fairness for stacked intelligent metasurfaces***, with joint power allocation and wave-based beamforming that maximise the minimum user rate, guaranteeing reliable, fair service for all users. N. Ginige, P. Dharmawansa, A. Sousa de Sena, N. Huda Mahmood, N. Rajatheva and M. Latva-aho, *IEEE Open Journal of the Communications Society*, vol. 6, pp. 5639–5656, 2025.

This work treats resilience as a property to be designed into 6G across architecture, radio technology and business models, rather than added during operation.

[10] Alves, H., Mahmood, N. H., López, O., Samarakoon, S., Yrjölä, S., Latva-aho, M., Juntti, M. & Pouttu, A. (Eds.) (2025). 6G Resilience White Paper. 6G Research Visions, No. 15. University of Oulu. https://urn.fi/URN:NBN:fi:oulu-202510276446

2. Open and Interoperable Innovation

The University of Oulu joined the AI-RAN Alliance in 2024 as the first Finnish academic institute and is actively involved in its AI-for-RAN working group. AI-RAN Alliance white papers published to date include the *AI-RAN Alliance Vision and Mission White Paper*; *Integrating AI/ML in Open-RAN: Overcoming Challenges and Seizing Opportunities*; *AI-RAN Architecture Overview and Component Definitions*; *State-of-the-Art AI/ML Applications for Improvements in RAN Performance*; *AI-RAN Platform and Infrastructure Orchestrator*; and *AI-on-RAN: Enabling Monetizable Differentiated Connectivity for AI*.[11]

6G Flagship activities supporting open and interoperable AI-native networks include:

- An ongoing AI-RAN Alliance AI-for-RAN technical work item, in collaboration with NVIDIA, on **multimodal sensing-enabled digital twins**, one of the enabling technologies for AI-RAN. An initial proof of concept was showcased at NVIDIA GTC 2025 in Washington D.C. and the Brooklyn 6G Summit 2025, and a further demonstration at Mobile World Congress Barcelona 2026 showed the viability of the concept.[12]
- An upgrade of the University of Oulu test network with a **GPU-accelerated NVIDIA ARC-OTA-based AI-RAN testbed**, enabling over-the-air testing and implementation of the AI-RAN solutions developed.
- The ongoing **6GARROW** project, which fosters collaboration between the European Union and the Republic of Korea on radio access networks and integrated device-network approaches, with innovations expected to become foundational elements of AI-native RAN.[13]
- The European **Hexa-X-II** project view on the 6G AI-driven air interface, covering the motivation for AI in the physical layer, selected applications for communication and sensing, achieved performance, open challenges and relevant standardisation activities.[14]

Recent 6G Flagship AI-RAN research includes:

- ***Neural channel estimation over the air*** — real-time over-the-air evaluation of neural channel estimation for the 5G NR physical uplink shared channel in a fully integrated hardware testbed. A. Sanath, D. Marasinghe, T. Sivalingam, N. Rajapaksha and N. Rajatheva, *IEEE INFOCOM 2026*, Tokyo, doi: 10.1109/INFOCOM59046.2026.11571185.
- ***Multimodal sensing-enabled digital twin for 6G RAN*** — a digital-twin framework for channel characterisation, with over-the-air experiments showing the potential of sensing-aided channel

[11] AI-RAN Alliance publications: https://ai-ran.org/publications

[12] Demo video: https://www.youtube.com/watch?v=nsLqUH6Aesg

[13] E. C. Strinati et al., "AI-Native 6G Networks: The 6GARROW Integrated Device-Network Approach," EuCNC/6G Summit 2025, Poznań, Poland, pp. 115–120, doi: 10.1109/EuCNC/6GSummit63408.2025.11037138. Project website: https://6garrow.com/

[14] H. Farhadi et al., "6G AI-Driven Air Interface — Hexa-X-II View," IEEE Communications Magazine, vol. 63, no. 10, pp. 118–125, Oct. 2025, doi: 10.1109/MCOM.001.2400394.

characterisation. S. Gimhana et al., *IEEE INFOCOM 2026*, Tokyo, doi: 10.1109/INFOCOM59046.2026.11571255.

- ***Energy-efficient soft demodulation (spkLLR)*** — a spiking-neural-network-based soft demodulation scheme showing the potential of SNN-based demapping for low-power, high-efficiency systems. G. Attanayake, D. Marasinghe, N. Rajapaksha, T. Sivalingam and N. Rajatheva, *IEEE ICC Workshops 2026*, Glasgow, doi: 10.1109/ICCWorkshops63917.2026.11586197.
- ***Waveform learning for sub-THz*** — a phase-noise-robust, low-PAPR single-carrier waveform and neural receiver design. D. Marasinghe, L. H. Nguyen, J. Mohammadi, Y. Chen, T. Wild and N. Rajatheva, *IEEE Transactions on Communications*, vol. 73, no. 1, pp. 117–131, 2025, doi: 10.1109/TCOMM.2024.3430982.

Combining alliance-level work on AI-RAN architecture with an over-the-air testbed allows AI-native RAN concepts to be taken from specification to measured performance in open, shareable settings.

3. Affordability, Sustainability and Global Connectivity

6G Flagship research on affordability and sustainability addresses both who can deploy networks and how much energy they use:

- **Local 5G and future 6G networks**, which can provide geographically confined connectivity and enable a broad range of stakeholders to deploy mobile networks tailored to local requirements, complementing nationwide mobile network operator networks.
- **Transmit-antenna muting for multi-user massive MIMO**, where a low-complexity machine-learning algorithm has been shown to significantly reduce base-station power consumption while meeting users' QoS requirements.

Selected publications:

- ***Spectrum sharing for local networks.*** T. Weththasinghe, A. Basaure, T. Sivalingam, D. Marasinghe, N. Rajapaksha and M. Matinmikko-Blue, "Minimum Separation Distances for Local 5G/6G Networks in the 3.8–4.2 GHz Frequency Band," *IEEE DySPAN 2026*, Washington, DC, doi: 10.1109/DySPAN69846.2026.11571102.
- ***Energy-efficient massive MIMO.*** N. Rajapaksha, J. Mohammadi, S. Wesemann, T. Wild and N. Rajatheva, "Minimizing Energy Consumption in MU-MIMO via Antenna Muting by Neural Networks With Asymmetric Loss," *IEEE Transactions on Vehicular Technology*, vol. 73, no. 5, pp. 6600–6613, May 2024, doi: 10.1109/TVT.2023.3339340.

4. End-to-End Global Coverage: Terrestrial and Non-Terrestrial Integration

6G Flagship has a long-standing programme on connectivity for remote areas and on integrating terrestrial and non-terrestrial networks:

- The **6G White Paper on Connectivity for Remote Areas** (2020), written by an international expert group led by 6G Flagship and chaired by Harri Saarnisaari, covers terrestrial backhaul networks, non-terrestrial solutions, local operations and spectrum issues for closing the digital divide.[15]
- The **White Paper on Broadband Connectivity in 6G** (2020) envisions terrestrial networks integrated with satellite networks, with enablers such as ultra-massive MIMO, intelligent reflecting surfaces, cell-free networking, integrated access and backhaul, and integrated space and terrestrial infrastructure.[16]
- The **6G-SatMTC** project explored satellite-based machine-type connectivity for remote regions, developing a RedCap-based radio access solution operating over non-terrestrial infrastructure, to bring broadband and IoT services where terrestrial networks are not economically feasible.[17]

Selected research on terrestrial–non-terrestrial integration:

- ***5G NR over satellite links*** — feasibility of using 5G NR over satellite links and the corresponding changes needed in the standard, device algorithms and system operation (EU H2020 SaT5G project and the Academy of Finland 6Genesis Flagship). H. Saarnisaari and C. de Lima, *Int. J. Satell. Commun. Network.*, 39: 445–454, 2021, doi: 10.1002/sat.1378.
- ***Security of satellite-terrestrial communications*** — existing security challenges, potential solutions and research directions for open security gaps. I. Ahmad, J. Suomalainen, P. Porambage, A. Gurtov, J. Huusko and M. Höyhtyä, *IEEE Access*, vol. 10, pp. 96038–96052, 2022, doi: 10.1109/ACCESS.2022.3205426.
- ***NTN for crisis resilience*** — satellites and HAPS providing coverage for user devices and backup backhaul to base stations during crises, and NTN integration for ubiquitous coverage in 6G. H. Saarnisaari, M. Höyhtyä, H. Rantanen and J. Mäkelä, "Military Communications in the 6G Era: Finnish Perspective," *MILCOM 2024*, pp. 135–140, doi: 10.1109/MILCOM61039.2024.10773716.

Conclusions

6G Flagship's contribution combines foundational white papers, international collaborative projects and an AI-RAN testbed with a steady stream of peer-reviewed research. Its work on resilience-by-design, open AI-native RAN, energy-efficient and locally deployable networks,

[15] Saarnisaari, H., Dixit, S., Alouini, M.-S., Chaoub, A., Giordani, M., Kliks, A., Matinmikko-Blue, M. & Zhang, N. (Eds.) (2020). 6G White Paper on Connectivity for Remote Areas. 6G Research Visions, No. 5. University of Oulu. http://urn.fi/urn:isbn:9789526226750

[16] Rajatheva, N. et al. (2020). White Paper on Broadband Connectivity in 6G. 6G Research Visions, No. 10. University of Oulu. http://urn.fi/urn:isbn:9789526226798

[17] H. Alves, K. Mikhaylov and M. Höyhtyä (Eds.), Integration of MTC and Satellites for IoT toward 6G Era, Wiley. Publisher page

and integrated terrestrial and non-terrestrial coverage speaks directly to four of the Declaration's principles.

Federated Telecoms Hubs Progress Overview

Contribution to New Delhi Declaration

Executive Summary

The UK's Engineering and Physical Sciences Research Council (EPSRC) has launched the next phase of the Advanced Connectivity Technologies (ACT) hubs, supported by **£97 million in funding and running until March 2030**. Within this programme, the Federated Telecoms Hub (FTH) coordinates with CHEDDAR, HASC, JOINER and TITAN (the FTH partner hubs) to translate research into impact through commercialisation, standardisation and industry engagement. Together the hubs span research, standardisation and demonstration across terrestrial, non-terrestrial, optical, quantum and AI-native networking.

FTH acts as the UK's national translation engine for Advanced Connectivity Technologies, converting research from across the hubs into **industry-validated, standards-aligned, IP-protected and investor-ready technologies** through one integrated industry Problem Book, IP pipeline, standards pathway and proof-of-concept (PoC)-to-spin-out process.

In standardisation, FTH has built a coordinated capability covering 3GPP RAN and SA, IEEE 802.11 and relevant ETSI activities. It has submitted or supported **24 standards contributions** across IEEE 802.11, 3GPP and ETSI, including **seven industry-co-authored contributions** (three IEEE 802.11 and four 3GPP), and has validated **more than 20 technical problem statements with over 27 industry partners**. FTH also supported a multi-stakeholder contribution to 3GPP SA, led by the UK NCSC, the US NSA and others, calling for **Secure by Design** to become an overarching 6G requirement.

Research across the partner hubs covers service continuity across integrated terrestrial and non-terrestrial networks, carbon-conscious architectures, low-complexity MIMO, optical satellite communications, national spectrum datasets and open-source RAN. One MIMO architecture has demonstrated the potential to reduce computational comp

lexity by several orders of magnitude and is progressing towards prototyping and commercial exploration with industry.

At government level, the UK and Indian Governments announced the **India–UK Connectivity & Innovation Centre** at India Mobile Congress 2025, with a combined initial commitment of **£24 million over four years**, and the seven governments of the Global Coalition on Telecoms launched the **6G Security and Resilience Principles** at Mobile World Congress 2026.

1. Trusted & Secure Technology

FTH supported a multi-stakeholder contribution to 3GPP SA, led by the UK National Cyber Security Centre (NCSC), the US National Security Agency (NSA) and others, calling for Secure by Design to become an overarching 6G requirement across architecture, protocols, interfaces and APIs, rather than being addressed after system design.[18]

[18] 3GPP SP-260584, "Ensuring a Secure by Design 6G System": https://www.3gpp.org/ftp/meetings_3gpp_sync/SA/Docs/SP-260584.zip

Security and privacy research across the FTH partner hubs includes:

- Formal verification of AI-generated xApps.
- Explainable AI for critical services.
- RF device authentication and anti-jamming techniques.
- Assessment of privacy leakage from pervasive sensing.

Recent FTH activities have demonstrated progress in trusted and secure technologies, including:

- ***Secure by Design in 3GPP***, through support for a multi-stakeholder contribution to 3GPP SA making security an overarching 6G requirement.
- ***ISAC security and privacy in IEEE 802.11***, through contributions on signal design for sensing security and privacy in integrated sensing and communications.
- ***Physical-layer security prototypes*** targeting field trials.
- ***Quantum-secured optical and fibre communications.***
- ***Sharing of security-assessment information***, through mechanisms for sharing actionable information with relevant research and government stakeholders.
- ***Wi-Fi security through RF fingerprinting***, an FTH-funded PoC now being supported towards investor readiness.

By raising Secure by Design at the architecture stage in 3GPP, FTH is helping to make trust a starting condition of 6G rather than a later addition.

2. Resilience, Reliability and Privacy

Projects within the FTH partner hubs are developing intelligent protection, traffic-steering and resource-management mechanisms to maintain service continuity across integrated terrestrial and non-terrestrial networks.

Resilience is being evaluated through practical use cases, including:

- Emergency-service communications.
- Adaptive machine-to-machine communications.
- Communications in resource-constrained environments.

Recent FTH activities in resilience, reliability and privacy include:

- ***Sensing privacy and quantum private access.***
- ***Explainable network automation.***
- ***Privacy-preserving approaches*** for healthcare and situational-awareness applications.

- ***Earlier security and resilience assessment in 3GPP***, promoted so that risks are considered during solution development and evaluation, before architectural or protocol decisions are finalised.

3. Global, Transparent and Inclusive Standardisation

FTH has established a coordinated standards capability covering 3GPP RAN and SA, IEEE 802.11 and relevant ETSI activities, supported by a standards contribution database and mapping of research outputs to the appropriate working groups.

FTH standards engagement has delivered:

- ***24 standards contributions*** across IEEE 802.11, 3GPP and ETSI submitted or supported, including seven industry-co-authored contributions across IEEE and 3GPP (three IEEE 802.11 and four 3GPP).
- ***More than 20 technical problem statements*** validated with over 27 industry partners, providing an evidence-based and inclusive mechanism for selecting standards priorities.
- ***Review by approximately 20 senior experts from around 15 organisations***, providing feasibility assessment and implementation guidance so that contributions reflect operator, vendor, chipset, satellite, public-sector and research perspectives.
- ***An industry Problem Book***, developed by the FTH Standards Director with the FTH commercial team and industry partners, capturing industry partners' top priorities and used to guide standards contributions, IP prioritisation and PoC selection.
- ***A standards-intelligence portal***: a secure, role-based platform that turns outputs from 3GPP, IEEE, ETSI and open-source ecosystems into structured intelligence, closing the loop from standards to research to industry and back to standards, and giving SMEs and start-ups a simpler route into UK ACT capability.

The full list of contributions submitted or supported is given at the end of this section.

4. Open and Interoperable Innovation

The FTH partner hubs are advancing open and interoperable network approaches through:

- Open RAN research and AI-RAN architectures.
- Multi-vendor fronthaul technologies.
- Convergence between terrestrial, non-terrestrial, optical and cloud-based infrastructure.

Open research assets and implementation experience include:

- ***Open-source RAN*** — the OCUDU / Linux Foundation open-source RAN ecosystem has been assessed as a potential route for translating research into deployable and reusable network components.
- ***Open research assets*** under development, including benchmark spectrum datasets, network-AI catalogues, channel models and open-source ray-tracing tools for optical wireless.
- **Open national-scale experimental infrastructure, JOINER (Joint Open Infrastructure for Networks Research)** is a national-scale open and programmable testbed platform supporting experimentation and pilots, accelerating future networks R&I, driving technology TRL advancement and evaluating adoption readiness of future connectivity solutions, supported by local ***testbeds and demonstrators***, including an open experimentation platform, USRP and neuromorphic-AI testbeds, NVIDIA-based waveform evaluation and industry-supported technology demonstrators.
- ***Open RAN governance***: an FTH-funded PoC is developing an AI governance control layer for Open RAN, supporting trustworthy multi-vendor operation.

6. Affordability, Sustainability and Global Connectivity

The FTH partner hubs are developing carbon-conscious 6G architectures using renewable energy, energy harvesting, AI-assisted optimisation and more efficient allocation of network and compute resources.

Energy-efficiency projects include:

- Low-complexity MIMO and efficient fronthaul switching.
- Energy-aware ISAC and lower-power optical communications.
- Architectures designed to reduce network operating requirements.

Highlights include:

- ***Several orders of magnitude lower MIMO complexity*** — one MIMO architecture has demonstrated this potential and is progressing towards prototyping and commercial exploration with industry.
- ***Affordable reach through NTN, optical-wireless and terrestrial integration***, investigated as a means of extending reliable connectivity to rural, remote, mobile and otherwise difficult-to-serve environments, including new turbulence-mitigation techniques and waveform designs.

- ***Energy-efficient technologies moving towards market***, including FTH-funded PoCs in energy efficiency, a self-powered connectivity venture and edge-inference technology that improves GPU utilisation and reduces latency.

7. End-to-End Global Coverage

Research projects in the FTH partner hubs are addressing:

- Terrestrial / non-terrestrial waveform design.
- Adaptive satellite-orbit control and UAV-assisted communications.
- Multi-domain orchestration and intelligent traffic steering between network domains.

Recent FTH activities in end-to-end coverage include:

- ***Optical satellite communications***, including secure ground-to-moving-platform links, turbulence mitigation and space-to-ground technologies intended to improve the reliability of high-capacity connectivity.
- ***NTN/TN integration as a standards priority*** for future 3GPP RAN and SA engagement, with emphasis on seamless service experience, resilience, sovereignty and practical deployment economics.
- ***All-fibre turbulence emulator***: an FTH-funded PoC enabling optical links, including space-to-ground links, to be evaluated under realistic atmospheric turbulence in the laboratory.

8. Spectrum, Compute and Supply Chain Diversity

FTH work on spectrum, compute and supply-chain diversity spans:

- **Spectrum** — national spectrum datasets through JOINER, dynamic-sharing models and spectrum-assignment architectures to improve utilisation, identify available capacity and support evidence-based spectrum policy.
- **Compute** — the compute continuum through AI-native RAN, edge computing, distributed orchestration, reinforcement-learning resource allocation and neuromorphic-AI testbeds.
- **Technical diversity** — work on RF, millimetre-wave, terahertz, optical, fibre, quantum, ISAC and NTN technologies, reducing dependence on a single access technology or architectural approach.

Supply-chain resilience is being strengthened through:

- ***Open-source RAN exploration.***
- ***Semiconductor and power-amplifier benchmarking.***
- ***Multi-vendor interoperability.***
- ***UK-developed waveform and network technologies.***
- ***UK-developed optical transceiver technologies***, including an FTH-funded PoC on Rayleigh-backscatter techniques and algorithms within optical transceivers.

From Research to Deployment: the FTH Translation Pipeline

FTH provides a single national pipeline from hub research to spin-out. All four partner hubs report projects into FTH. Invention disclosures are checked against the industry Problem Book. PoCs are supported with business-model, pitch and investor-readiness coaching ahead of incorporation and a first investment round. The pipeline sits within a governance framework covering collaboration agreements, IP assignment, export control and Trusted Research.

FTH translation and commercialisation progress

- ***36 invention disclosures and 17 patents filed*** by partner-university TTOs
- ***Awarded funding to six PoC projects at TRL 4–6***
- ***Industry User Group*** of senior representatives from major telecoms companies, meeting twice a year to validate market demand and feed industry priorities into the Problem Book.
- ***Cornerstone investor bench*** of five major UK early-stage deep-tech investors, engaged quarterly with the FTH portfolio.

Related Government Initiatives

UK government colleagues reported two further initiatives relevant to the Declaration.

India–UK Connectivity & Innovation Centre

- Announced by the Indian and UK Governments at India Mobile Congress 2025.
- Brings together complementary UK and Indian strengths in advanced connectivity, with a focus on AI in telecoms, non-terrestrial networks and cyber security in telecoms.
- Combined initial commitment of **£24 million over four years**.
- Delivered as part of the UK–India Technology Security Initiative, reflecting the shared ambition of the Prime Minister–Prime Minister 2035 Vision.

Global Coalition on Telecoms — 6G Security and Resilience Principles

- Launched at Mobile World Congress 2026 by the seven governments of the Global Coalition on Telecoms (GCOT) — the UK, US, Canada, Japan, Sweden, Finland and Australia — with the support of leading industry partners.[19]
- Sets out what these governments want to see from industry on the security and resilience of next-generation networks: protection from cyber and physical threats, resilient supply chains, and continuous, reliable service.[20]

Standards Contributions Submitted or Supported

#	IEEE 802.11 contributions submitted / supported
1	Use of light communication beyond 11bn
2	AI Offload Standardization
3	Signal Design for Sensing Security in ISAC
4	Signal Design for Sensing Security / Privacy in ISAC
5	AI-driven Dirty Paper Coding for Multiuser MIMO
6	Rate Splitting Multiple Access for 802.11
7	DFT-s-OFDM for PAPR reduction
8	ELC MLD Mapping Proposal
9	PAPR reduction considerations
10	TGbr operational documents
11	Ray-Tracing Based Multi-Band Channel Simulation for Warehouse Environments

[19] GCOT joint statement of intent: https://www.gov.uk/government/publications/global-coalition-on-telecommunications-joint-statement-of-intent-between-uk-australia-canada-japan-and-us

[20] 6G Security and Resilience Principles: https://www.gov.uk/government/publications/launch-of-the-global-coalition-on-telecoms-6g-security-and-resilience-principles/launch-of-the-global-coalition-on-telecoms-6g-security-and-resilience-principles

#	IEEE 802.11 contributions submitted / supported
12	Next-gen Wi-Fi and Physical AI
13	Beyond bn SG preparation

Table FTH-1: IEEE 802.11 contributions submitted or supported by FTH

Body	3GPP / ETSI contributions submitted / supported
3GPP RAN1	MIMO enhancements for the 6GR physical layer (R1-2601054)
3GPP RAN1	New Waveform for 6GR — OSDM (R1-2601539)
3GPP TSG RAN	On Downlink Multiple Access Techniques for RAN WG Study Item on 6G (RP-251270)
3GPP TSG RAN	Views on New RAN WG SI(s) on 6G (RP-250883)
ETSI	ETSI Multiple Access Techniques report (GR MAT 001)
3GPP SA2	[KI#18, Solution Variant #3 update] New separated domain from PS domain, within 6G CN (S2-2606610)
3GPP SA2	Meeting Report for S2 meeting #S2-175AHE (electronic)
3GPP TSG SA	Ensuring a Secure by Design 6G System (SP-260584)

Table FTH-2: 3GPP and ETSI contributions submitted or supported by FTH

Conclusions

FTH and the ACT research hubs report activity under seven of the Declaration's nine principles. The strongest thread is standards engagement grounded in industry-validated problem statements, from Secure by Design in 3GPP SA to ISAC security in IEEE 802.11. Alongside this, research on resilient TN–NTN operation, energy-efficient architectures, open-source RAN and spectrum data is building the evidence base, and the India–UK Connectivity & Innovation Centre gives the bilateral partnership a dedicated institutional home. A second thread is now firmly established in translation: with 36 invention disclosures, 17 patents filed, six funded PoCs, an Industry User Group and an investor bench in place, FTH is building a national pipeline that takes research from the hubs through standards and IP to deployment.

XGMF Progress Overview

Contribution to New Delhi Declaration

XG Mobile Promotion Forum

Executive Summary

XGMF (XG Mobile Promotion Forum, Japan) was established as a strategic response to the evolving demands for mobile communications by establishing a new forum that combines 5GMF and the Beyond 5G Promotion Consortium. Its primary goal is to enhance the growth potential of the information and telecommunications industry by developing groundbreaking technologies and pioneering new use cases that are not bound by conventional paradigms, with Japan taking a global leadership role in developing the 5G and Beyond 5G (6G) communications and in promoting international collaborations.

XGMF is conducting extensive studies and discussions across **eight 6G-related projects**. Each project has established Working Groups (WGs) and similar bodies to investigate and evaluate key technologies.

Project	Working Groups and similar bodies
6G Promotion Project	6G Spectrum WG; Communications and AI Integration WG; 6G Position Paper / Why 6G; 6G Business and Monetization
6G Radio Technology Project	Terminal Collaborative Technology WG; Repeater, Metasurface, and RIS/IRS WG; Radio Propagation WG; Radio Device WG; Advanced MIMO WG; Wireless Sensing WG; AI and Digital Twin WG; Millimeter-wave Technology for Mobility Systems WG
6G Network Architecture Project	—
NTN Promotion Project	—
Terahertz Wave Wireless Technology Project	—
Space-Time Synchronization Project	—
Next-Generation Telecom Issues × Material Project	—
Transportation and Public Services for 5G to 6G Project	—

Table XGMF-1: XGMF 6G-related projects and working groups

Since the New Delhi Declaration was published in October 2025, XGMF has released **17 public documents** on its website, reflecting the outcomes of these projects and working groups; they are listed in the annex to this section. The status of discussions and key achievements within XGMF against each principle of the Declaration is set out below.

1. & 2. Trusted & Secure Technology; Resilience, Reliability and Privacy

The Network Architecture Project has emphasised, through its published documents, the importance of simplifying network architectures and enabling a smooth migration path from 5G, drawing on lessons learned from the increasing complexity of 5G networks.

As mobile networks have already become critical infrastructure, resilience and reliability are of paramount importance, and relevant projects place strong emphasis on them when examining network structures and functions.

XGMF activities under these principles include:

- ***Simpler network architectures*** and a smooth migration path from 5G, set out in the Network Architecture Project's published documents.
- ***Disaster-response applications of NTN*** — given Japan's high exposure to natural disasters, the NTN Promotion Project is advancing studies on disaster-response applications and use cases utilising Non-Terrestrial Networks.

3. Global, Transparent and Inclusive Standardisation

Recognising the importance of a single global standard, XGMF conducts its activities while closely monitoring ongoing standardisation efforts in 3GPP and ITU-R.

XGMF has promoted a global 6G ecosystem through:

- ***Workshops and collaborative activities*** with other 6G-related organisations, including 6G-IA, 6G Forum and Next G Alliance, to promote information exchange and cooperation.

4. Open and Interoperable Innovation

XGMF places strong importance on open interfaces and multi-vendor interoperability. Related projects are advancing studies on network architectures and AI-native networks, and the results are reflected in publicly available documents.

XGMF activities in open and interoperable innovation include:

- ***Shared experimental results*** — for radio technologies, XGMF consolidates and publishes the results of numerous experiments conducted by members of the 6G Radio Technology Project, enabling industry, academia and government to share insights on the performance and optimisation of various technologies.
- ***AI-native network studies*** published by the Network Architecture Project, including *Convergence of AI and communication — AI native 6G networks*.

5. Support for Commercial Use Cases and Forward-Looking Business Models

The 6G Promotion Project examines the necessity of 6G, future use cases, business opportunities and monetisation models, incorporating lessons learned from 5G and

considering future needs and trends. The findings are shared within XGMF, and selected results are made publicly available.

XGMF activities on use cases and business models include:

- ***6G Position Paper / Why 6G*** and ***6G Business and Monetization*** workstreams within the 6G Promotion Project.
- ***Transportation and public services*** — the Transportation and Public Services for 5G to 6G Project, led primarily by members from the transportation sector, is exploring 5G/6G use cases and applicable technologies for railway and road transportation systems.

7. End-to-End Global Coverage: Terrestrial and Non-Terrestrial Integration

TN–NTN integration is regarded as a highly important topic within the NTN Promotion Project. The Project is actively studying this area, and the outcomes have already been incorporated into publicly available documents, including the *NTN Technology Company Catalog*.

8. Spectrum, Compute and Supply Chain Diversity

XGMF activities on spectrum, compute and technology diversity include:

- ***Spectrum efficiency*** — the Working Groups under the Radio Technology Project have published documents covering a wide range of technologies, including AI-enabled approaches to improve spectrum utilisation efficiency, incorporating numerous validation and experimental results contributed by members.
- ***Global spectrum harmonisation*** — the Spectrum WG has investigated domestic and international developments and published a white paper containing recommendations for future 6G spectrum allocations (*XGMF Recommendations for Securing Mid-band Spectrum for the 6G Era*).
- ***Networking–computing convergence*** — study results have been incorporated into public documents issued by the Network Architecture Project and the Communications and AI Integration WG.

9. Skills Pipeline Development

As part of cooperative activities among various 6G organisations, XGMF is promoting research through international funding initiatives. Within these efforts, human resource development and skills cultivation are recognised as important priorities and are being actively addressed.

Conclusions

Through eight projects and their working groups, XGMF has turned a year of study into 17 public documents covering spectrum, radio technology, network architecture, NTN, synchronisation and transport use cases. Its emphasis on a single global standard, shared experimental evidence, simpler architectures and disaster-resilient NTN aligns closely with the Declaration's principles.

Annex: XGMF Public Documents Released since the New Delhi Declaration

Project / Working Group	Date	Document
6G Promotion / Spectrum WG	2026.05	XGMF Recommendations for Securing Mid-band Spectrum for the 6G Era ver2.1
6G Promotion / Spectrum WG	2026.01	XGMF Recommendations for Securing Mid-band Spectrum for the 6G Era — Summary
6G Promotion / Communications and AI Integration WG	2026.05	Trends in the Integration of Communications and AI
6G Promotion / Communications and AI Integration WG	2026.05	Overview of Trends in the Integration of Communications and AI
6G Radio Technology / Terminal Collaborative Technology WG	2026.04	Terminal-Cooperative MIMO Technology Version 2.0
6G Radio Technology / Repeater, Metasurface, and RIS/IRS WG	2026.04	Repeater, Metasurface, and RIS/IRS Version 2.0
6G Radio Technology / Radio Propagation WG	2026.04	Radio Propagation Technology Version 2.0
6G Radio Technology / Advanced MIMO WG	2026.04	Advanced MIMO Technology Version 2.0
6G Radio Technology / Wireless Sensing WG	2026.04	Sensing Technologies Version 2.0
6G Radio Technology / AI and Digital Twin WG	2026.04	AI/ML and Digital Twin Technologies Version 2.0
6G Radio Technology / Millimeter-wave Technology for Mobility Systems WG	2026.04	Millimeter-wave Technologies for Mobility Systems Version 1.0
6G Network Architecture Project	2026.05	Network architecture evolution in 6G era
6G Network Architecture Project	2026.05	Convergence of AI and communication — AI native 6G networks
6G Network Architecture Project	2026.05	Summary of the Study on 6G Platform Evolution (Japanese only)
NTN Promotion Project	2026.04	NTN Technology Company Catalog
Space-Time Synchronization Project	2026.03	Space-Time Synchronization Project: FY2025 Activity Report (Japanese only)
Transportation and Public Services for 5G to 6G Project	2026.05	Transportation and Public Sector 5G to 6G Project: FY2025 Activity Report (Japanese only)

Table XGMF-2: XGMF public documents (source: XGMF Download Center; dates as year.month)

NGMN Alliance Progress Overview

Contribution to New Delhi Declaration

Executive Summary

The Next Generation Mobile Networks Alliance (NGMN) is a global, operator-driven organisation that contributes operator requirements to standards development organisations and provides industry guidance to enable innovative, sustainable and affordable mobile telecommunication services. Its contribution to this report centres on how networks should migrate from 5G to 6G — a question that will largely determine what 6G costs to deploy.

Following its June 2026 publication *6G Architecture and Migration Options — An Operator View*, NGMN issued **Updated Key Messages** on 8 September 2026, approved by the NGMN Board on 3 September 2026. The update was provided as operator guidance for the 3GPP plenary meeting in Madrid (14–18 September 2026), with a focus on study priorities in the ongoing 6G study phase, and its content was also sent to 3GPP through a Liaison Statement.[21]

NGMN recommends that **Multi-RAT Spectrum Sharing (MRSS) remain the baseline approach for 5G–6G migration**, while noting that more evidence is still required on its efficiency, implementation feasibility, performance capabilities and hardware requirements. Any migration option beyond MRSS should be justified by deployment need, hardware impact, implementation feasibility, total cost of ownership (TCO) and overall commercial viability. NGMN also urges the industry to consider whether the 6G Core is an evolution of the 5G Core or a more distinct architecture.[22]

3. Global, Transparent and Inclusive Standardisation

NGMN brings a consolidated, operator-driven view into 3GPP at the point where 6G migration options are being studied. Its central message is to converge early on a primary migration approach, so as to limit fragmentation and reduce long-term complexity across user equipment, radio access and core networks.

NGMN Updated Key Messages (September 2026):

- ***Converge early on a primary 6G migration approach*** — narrow down migration options as early as an informed decision can be made, with MRSS as the baseline solution.
- ***Focus the MRSS study on real performance and implementation feasibility*** — prioritise MRSS efficiency, including control-channel overhead, dynamic allocation between 5G and 6G users, dynamic baseband resource sharing, support for both FDD and TDD carriers, and support for 6G carrier aggregation.

[21] NGMN, 6G Architecture and Migration Options — An Operator View: Updated Key Messages, V1.0, 8 September 2026: https://www.ngmn.org/publications/updated-key-messages-6g-architecture-and-migration-options-an-operator-view-3.html

[22] NGMN press release, 8 September 2026: https://www.ngmn.org/highlight/ngmn-issues-updated-operator-driven-guidance-ahead-of-key-discussions-on-6g-migration-approaches.html

- ***Recognise the dependencies still under study*** — MRSS efficiency, implementation feasibility, hardware impact, TCO implications and 6G Core architectural evolution — when assessing whether any option beyond MRSS justifies its additional complexity.
- ***Keep alternative migration options conditional*** on clear deployment need and incremental value, pursuing them only where they address well-defined gaps that MRSS cannot satisfactorily support.
- ***Account for 6G Core evolution*** — consider explicitly whether 6GC is an evolution of 5GC or a more distinct architecture, and how this affects UE, RAN, core network and operational complexity.
- ***Base decisions on evidence*** — where alternatives are studied, use explicit evaluation criteria to support active down-selection as evidence becomes available.

> *"5G taught us a hard lesson: too many migration options led to fragmentation, delayed rollouts, and costly retrofits. For 6G, let's not repeat that — with 6G Standalone as the target, MRSS should be our baseline, and any alternative needs to prove it is worth the extra complexity."*
>
> — Guangyi Liu, Chief Expert of China Mobile and NGMN Board Director

5. Support for Commercial Use Cases and Forward-Looking Business Models

NGMN ties the choice of migration path directly to the economics of 6G. In its view, operators may be reluctant to deploy solutions whose migration complexity and cost are not justified by sufficiently material benefits, and NGMN will continue to provide operator context on commercial viability, deployment complexity and TCO as the technical assumptions on MRSS, hardware impact and 6G Core evolution become clearer.

> *"The 5G to 6G migration path is an essential component of the 6G design, because it will determine the cost of the 6G deployment and hence the economic viability of the associated new features and capabilities. MRSS is the most promising mechanism as it allows flexible reuse of the legacy 5G spectrum for deploying 6G services, with limited impact on 5G capacity and user experience."*
>
> — Laurent Leboucher, Chairman of the NGMN Alliance Board and Orange Group CTO and EVP Networks

6. Affordability, Sustainability and Global Connectivity

By favouring a smooth, software-driven upgrade that reuses deployed 5G spectrum and hardware, NGMN's guidance aims to avoid unnecessary replacement of infrastructure — a direct lever on the affordability of 6G.

> *"6G must build on the strong foundations of 5G and not trigger unnecessary replacement of deployed infrastructure. Efficient spectrum sharing allows new 6G radio capabilities to be introduced as a smooth, software driven upgrade in existing frequency bands. MRSS technology is fundamental to this goal, and it must be delivered with low operational overhead and a demonstrable ability to maximise hardware reuse."*
>
> — Luke Ibbetson, Head of R&D at Vodafone and NGMN Board Director

Conclusions

NGMN's contribution gives the Declaration an operator perspective on a decision that will shape the cost of every 6G network: how to migrate from 5G. Its recommendation — MRSS as the baseline, with any alternative required to prove its value — links standardisation choices directly to affordability and commercial viability. NGMN intends to publish an updated version of the full publication in the coming months and has welcomed an exchange of views with the Bharat 6G Alliance on 6G architecture and migration pathways.

UKI-FNI Progress Overview

Contribution to New Delhi Declaration

Executive Summary

The UK-India Future Networks Initiative (UKI-FNI) explores advanced innovations in supply chains for hardware and software systems. Providing connectivity and services for future digital networks, and a joint vision and research strategy in Beyond 5G and 6G. The project has been funded by the UK Engineering & Physical Sciences Research Council (EPSRC).

The EPSRC UKI-FNI responded to this Joint Report with observations and recommendations intended to give sharper focus to the objectives of the Joint Statement. Their input looks forward: it identifies where the Declaration's principles could be made more specific, more testable and more complete.

Contributors: Professor Gerard Parr, University of East Anglia (Lead of the UKI-FNI Project); Professor Steve Hailes, University College London; Professor Rahim Tafazolli, 6G Innovation Centre, University of Surrey; Professor Lajos Hanzo, University of Southampton; Professor Chandra Murthy, Indian Institute of Science, Bengaluru; and Professor Toktam Mahmoodi, King's College London.

The recommendations centre on operational technology and critical infrastructure, safe degraded operation, hidden common dependencies, timing and positioning security, identity at scale, agent-to-agent and hardware security, post-quantum cryptography for constrained devices, AI traffic engineering, consistent user experience, sub-sea cable interconnects and a sustainable skills pipeline.

Making Commitments Specific and Testable

UKI-FNI recommends that the Joint Statement:

- ***Be more specific about commitments*** — for each principle, state which organisation or group of organisations will take it forward, what success would look like, and when there is expected to be something tangible to show.
- ***Make its claims testable*** — terms such as "secure by design" and "resilient" are of limited use unless there is a replicable way of showing that the claims stand up.

1. Trusted & Secure Technology

If 6G is to support factories, energy systems, transport and other critical infrastructure, failures are not just about lost data or poor service — they can affect physical equipment, public safety and essential services, including the management and connectivity of utilities such as gas, water, power, telecoms and nuclear or chemical plants.

UKI-FNI recommends greater attention to:

- ***Operational Technologies (OT)*** across terrestrial and non-terrestrial network boundaries.
- ***Timing and positioning security*** — 6G will depend heavily on accurate timing and location, so spoofing, jamming or loss of those signals could be serious.
- ***Identity and access control at scale*** — for very large numbers of devices, services and AI agents.
- ***Agent-to-agent security*** and coordination control between agents, as future networks become agentic-AI based; and ***hardware security*** alongside software security.
- ***Post-Quantum Cryptography (PQC) for wireless systems***, in forms suited to energy-, compute- and spectrum-constrained devices.

2. Resilience, Reliability and Privacy

UKI-FNI recommends that resilience work address:

- ***Safe degraded operation*** — OT systems often need to run for years, cannot always be patched quickly, and must fail safely if connectivity, cloud services or AI control disappear; business continuity for services is key.
- ***Hidden common dependencies*** — many networks relying on the same cloud platform, satellite system, timing source, software component or AI model create a single point of failure that may not be immediately apparent.
- ***Edge computing and its security*** (for both TN and NTN), particularly for mission-critical services where low-latency protocols, semantic communication, edge intelligence and edge computing come into play.
- ***AI traffic management and engineering*** — AI-native networks and AI personal-assistant services are expected to generate more traffic than humans, with direct consequences for reliability and resilience.

6. Affordability, Sustainability and Global Connectivity

UKI-FNI recommends more attention to **consistent user experience**: beyond rural and urban coverage, cell-edge and uplink data-rate performance — key pain points of 5G — should be

addressed, with a specific focus on remote rural populations to tackle the digital divide and empower citizens.[23]

7. End-to-End Global Coverage

As part of global coverage, UKI-FNI highlights the interplay with **sub-sea telecoms cables**, which form a strategic interconnector for international traffic between India and the rest of the world. The interconnects between submarine cables and optical, wireless and satellite networks will be crucial for the security, resilience and reliability of future networks.

8. Spectrum, Compute and Supply Chain Diversity

UKI-FNI recommends that the Joint Statement:

- ***Define supply-chain components explicitly*** from a TN and NTN viewpoint — from the hardware and firmware protocols required for switching, routing and flow control to SLAs, spectrum and bandwidth management.
- ***Aim for a simplified architecture*** — 5G had too many options, adding complexity and compatibility challenges.
- ***Name latency*** as one of the drivers of 6G.
- ***Address the network for AI*** — framed as a "connected intelligence platform" drawing on semantic, goal-oriented and token communication — and reflect ISAC, digital twins and wireless for AI under a top-level theme of ***Network-Enabled AI Services***.

9. Skills Pipeline Development

UKI-FNI calls for a more sustainable skills pipeline for telecoms and for wider recognition of India–UK collaboration:

- Building on examples such as the **BT India–IISc Faculty Development Programme in Cyber Security for Telecoms**, facilitated by the UKI-FNI Project.[24]
- Recognising Indian projects alongside UK ones such as UKI-FNI and CHEDDAR — for example **IOS-MCN**, a federated telecom hub between C-DAC Thiruvananthapuram, IIT Delhi and IISc, and the **India–UK ICON** project.[25]

[23] UKI-FNI, "Revolutionary future telecoms and rural research initiative facilitate unique linkup between India and UK": https://www.ukifni.org/revolutionary-future-telecoms-and-rural-research-initiative-facilitate-unique-linkup-between-india-and-uk/

[24] https://www.ukifni.org/indian-institute-of-science-iisc-bengaluru-and-the-british-asian-trust-india-supported-by-bt-group-in-india-partner-to-deliver-advanced-cybersecurity-training-for-stem-faculty/

[25] IOS-MCN: https://ios-mcn.org/

Conclusions

UKI-FNI's response turns the Declaration's principles into a set of practical tests: who is accountable, how claims will be verified, and whether the hardest cases — operational technology, degraded operation, shared dependencies, timing, identity and AI agents — are covered. The UKI-FNI team stands ready to collaborate with the Bharat 6G Alliance on further enhancement of the Joint Statement and looks forward to future engagement.

Professor Gerard Parr, PI of the UKI-FNI Project — www.ukifni.org

Partner Contributions at a Glance

The table below shows which of the nine principles each MoU partner addressed in the material it submitted for this edition. It reflects the scope of each submission, not the full breadth of each organisation's work; a blank cell means only that no update was submitted under that principle.

Principle	SNS JU / 6G-IA	6G Flagship	UK FTH	XGMF	NGMN	UKI-FNI
1. Trusted & Secure Technology	●		●	●		●
2. Resilience, Reliability and Privacy	●	●	●	●		●
3. Global, Transparent and Inclusive Standardisation	●		●	●	●	
4. Open and Interoperable Innovation	●	●	●	●		
5. Commercial Use Cases and Business Models	●			●	●	
6. Affordability, Sustainability and Global Connectivity	●	●	●		●	●
7. End-to-End Global Coverage (TN–NTN)	●	●	●	●		●
8. Spectrum, Compute and Supply Chain Diversity	●		●	●		●
9. Skills Pipeline Development	●			●		●

● = principle addressed in the partner's submission. UKI-FNI entries reflect recommendations rather than reported activity; NGMN entries reflect the principles its migration guidance bears on most directly.

Bharat 6G Alliance Progress Overview

Contribution to New Delhi Declaration

Executive Summary

India's 6G effort has moved from vision-setting to execution. The **Bharat 6G Vision**, released in March 2023, set the goal of India becoming a frontline contributor to the design, development and deployment of 6G by 2030, with **affordability, sustainability and ubiquity** as its guiding principles. The **Bharat 6G Alliance (B6GA)** is the industry-led, government-facilitated platform through which telecom service providers, industry, equipment manufacturers, academia, research institutions and start-ups pursue that goal together.

As of February 2026, the Department of Telecommunications (DoT) had approved **104 6G research projects worth INR 271 crore** under the **Telecom Technology Development Fund (TTDF)**.[26] Two national testbeds, the **6G THz Testbed** and the **Advanced Optical Communication Testbed**, are in operation. **One hundred 5G use-case laboratories** have been set up in academic institutions, and the MeitY-funded **IOS-MCN** open-source mobile core has completed its first stage. B6GA has grown to **90 members** working through **seven working groups**. It has signed MoUs with **12 national and international organisations**.

Indian participation in global standards has grown sharply. Between 2020 and 2025, Indian individual-member participation in 3GPP meetings rose from **717 to 1,787** and contributions from **196 to 2,943**. B6GA members report **more than 7,510 patent applications, including 4,495 filed abroad**, in advanced telecom technologies during 2020–2026. Members now chair drafting groups in ITU-R Working Party 5D and edit ITU-T work items. They have also delivered one of the first national standards for reconfigurable intelligent surfaces (RIS) through TSDSI.

B6GA and its partners are also validating 6G-relevant services in the field. In December 2025, joint demonstrations with ESA and UK partners showed **telemedicine over an integrated satellite–5G network** between IISc Bangalore and the ESA Harwell Campus, and **smart-village services over BharatNet and public 5G** at Satnavari, Maharashtra.

Indicator	Status (latest reported)
TTDF 6G research projects approved	104 projects, INR271 crore (February 2026)
National 6G testbeds	6G THz Testbed; Advanced Optical Communication Testbed
5G use-case laboratories in academia	100 (sanctioned 2023–24)
Bharat 6G Alliance membership	90 members; seven working groups
B6GA MoUs	12 national and international organisations
Indian participation in 3GPP (individual members)	717 → 1,787 participants; 196 → 2,943 contributions (2020 → 2025)
Patent applications by B6GA members (2020–2026)	7,510+, including 4,495 foreign filings
Open-source mobile core (IOS-MCN)	Stage 1 complete; 5 public releases; campus pilots at IISc and IIT Delhi

Table 1: India's 6G programme at a glance

[26] Press Information Bureau / Communications Today, "Centre approves 104 projects worth INR271 crore for 6G tech research," 13 March 2026: https://www.communicationstoday.co.in/centre-approves-104-projects-worth-%E2%82%B9271-crore-for-6g-tech-research/

The Department of Telecommunications (DoT), Government of India has initiated the **Technology Development and Investment Promotion (TDIP) Scheme** with a total outlay of INR 203 crore for 2026–31. It promotes indigenous telecom technology development, innovation and global standardisation. It provides targeted financial support to start-ups, MSMEs, academia, industry and Standards Development Organisations (SDOs). The support covers standards development, testing and certification, commercialisation and participation in global standards bodies. TDIP is designed to strengthen India's competitiveness in 5G-Advanced and 6G, in line with the vision of the Bharat 6G Mission.[27]

This section first describes the national programmes, testbeds and platforms that underpin India's 6G work. It then presents the contributions of B6GA members against each of the nine principles of the New Delhi Declaration. Contributing members are Reliance Jio, HFCL, Tejas Networks, the IIITB COMET Foundation, the IOS-MCN consortium (IISc, IIT Delhi and C-DAC), SAMEER, IIT Roorkee, IIT Dharwad, IIIT Kalyani and Freestream Technologies.

National Programmes, Testbeds and Platforms

Bharat 6G Alliance and its working groups

B6GA's seven working groups cover 6G technologies, spectrum, applications, use cases and revenue streams, devices and components, green and sustainability, and outreach. They identify priority technology areas, prepare roadmaps and coordinate Indian participation in 3GPP and ITU-R. Their recommendations reach Government as technical reports and white papers. B6GA has also submitted a **Detailed Project Report** to Government, setting out a programme of research, innovation, testbeds and ecosystem development. It has hosted more than ten 6G Tech Talks by leading experts.

Reports and actions published by the Bharat 6G Alliance include:

- ***Spectrum Roadmap for 6G in India*** (Version 1.0, 16 October 2024; Version 2.0, 8 October 2025).
- ***Recommendations on 6G Applications***, ***Green and Sustainability***, and ***6G Use Cases & Revenue Streams***.
- ***Accelerating India's 6G Developments*** and the ***National 6G Roadmap 2025–2030*** (August 2025), together with a detailed roadmap for 6G in India 2025–30 and Gantt charts of each working group's deliverables.
- ***Calls for proposals*** for pre-standard testbeds in AI/ML, NTN, FWA, O-RAN, ISAC and massive MIMO, and for indigenous components.

[27] DoT, TDIP Scheme: https://www.dot.gov.in/offerings/schemes-and-services/details/technology-developmentinvestment-promotion-tdip-scheme-EDOwITNtQWa; scheme guidelines: https://www.dot.gov.in/static/uploads/2026/07/4232f549a2eb2b6d8288221a0ad2897c.pdf

B6GA has signed MoUs with NextG Alliance, 6G-IA, 6G Flagship (University of Oulu, Finland), the NGMN Alliance, 6G Forum, 5G-ACIA, UKI-FNI and UK TIN, 6G Brasil, XGMF, the European Space Agency, TSDSI and NASSCOM. These agreements support cooperation towards globally harmonised Beyond-5G and 6G standards.

Telecom Technology Development Fund: 6G Research Projects

The TTDF scheme of DoT funds research, testbeds, innovation and commercialisation of emerging telecom technologies. As of February 2026, it had approved **104 projects worth INR 271 crore** specifically for 6G research and development. Projects reported by B6GA members for this report include:

- ***6G THz Testbed with Orbital Angular Momentum (OAM) and Multiplexing*** — SAMEER with IIT Madras, IIT Guwahati and IIT Patna; a prototype indigenous 6G testbed at 270 GHz (see below).
- ***AI-Native Radio for 6G Semantic Communications: From Theory to Chips ("ShadG")*** — IIT Dharwad, TTDF/6G/492.
- ***Design and Development of Post-Quantum Cryptography Algorithms and Security Analysis: Code Based*** — IIIT Kalyani, TTDF24QT062, started 13 March 2026.
- ***Sub-Terahertz Sensor for Real-Time Skin Hydration Monitoring using GapWave Technology*** — IIT Roorkee, DoT-funded, about INR134.55 lakh, 2025–2027.

National 6G Testbeds

DoT has funded two national 6G testbeds: the **6G THz Testbed** and the **Advanced Optical Communication (AOC) Testbed**.

The **6G THz Testbed**, "6G: THz Test bed with Orbital Angular Momentum (OAM) and Multiplexing", is being built by a consortium of SAMEER, IIT Madras, IIT Guwahati and IIT Patna. All required subsystems have been developed. At India Mobile Congress 2024, the consortium demonstrated an indigenously built THz wireless link carrying **6.4 Gbps**, with all components, baseband and antennas designed and developed in India. A prototype indigenous testbed at **270 GHz** has since been built with four channels in the remote radio head, IF up/down converters and a baseband system. The testbed will be ready for use at **SAMEER Kolkata by the end of 2027**, targeting a **100 Gbps line-of-sight link at 270 GHz**. Its facilities are already used by researchers and academics across the country. Once complete, Indian industry will be able to test products there before bringing them to market. SAMEER has signed an MoU with Keysight Technologies to supply the testbed to the education sector.[28]

[28] SAMEER inputs, July 2026. A September 2026 report describes a further 6.39 Gbps transmission on the Bharat 6G THz Testbed by IIT Madras and SAMEER: https://www.indiandefensenews.in/2026/09/iit-madras-pulls-off-indias-biggest-6g.html

Significant achievements of the 6G THz Testbed include:

- ***Multi-gigabit radio at 270 GHz***, with THz hardware of 20 GHz RF bandwidth.
- ***Indigenous high-gain lens antenna*** at 270 GHz, alongside intelligent reflecting surface demonstrations.
- ***270 GHz IC*** designed and fabricated in a 130 nm SiGe process.
- ***Multichannel baseband*** with 8-channel uplink and 8-channel downlink and 4×4 MIMO, designed and fabricated.
- ***OAM antenna at 270 GHz*** designed and fabricated for mechanical mode multiplexing.

The **Advanced Optical Communication Testbed**, led by IIT Madras with a second facility at IIT Delhi and partners including IIIT Delhi and ERNET, provides open-access, high-capacity optical transmission infrastructure. It scales towards more than 1 Tbps in field installations and supports multi-core fibre. Industry partners include Tejas Networks, STL, Infinera and BSNL.[29]

Quantum-secure communications: C-DOT and IIT Madras

The **Centre for Development of Telematics (C-DOT)**, DoT's telecom R&D centre, develops indigenous end-to-end telecom solutions across wireless, optical (core and access), switching, 4G/5G, AI, IoT/M2M, post-quantum cryptography (PQC) and quantum key distribution (QKD). At its 43rd Foundation Day, C-DOT launched its indigenous **Quantum Series of 14 quantum-secure products**, covering both QKD and PQC, and unveiled a Quantum Products Wall. The products are designed to strengthen the security and resilience of India's communication networks in the quantum era.

Highlights of C-DOT's quantum communication work include:

- ***First TEC Technology Approval for QKD in India*** — C-DOT is the first organisation in India to secure Technology Approval from the Telecommunication Engineering Centre for its QKD solutions.
- ***India's first QKD transmission over 4-core multicore fibre (MCF)***, pointing to quantum-secure links that share fibre infrastructure efficiently.
- ***Quantum Communications Thematic Hub at IIT Madras*** — set up jointly by C-DOT and IIT Madras under the **National Quantum Mission** (outlay INR6,003.65 crore over eight years). C-DOT shares responsibility for delivering the Hub's milestones, which include inter-city QKD over 2,000 km with trusted nodes using wavelength-division multiplexing on existing optical fibre.[30]

[29] AOC Testbed: https://www.aoctestbed.in/

[30] PIB, National Quantum Mission, 3 December 2025: https://www.pib.gov.in/PressReleasePage.aspx?PRID=2198308&reg=48&lang=2

MeitY-funded open-source mobile core: IOS-MCN

The **Indigenous Open-Source Mobile Communication Network (IOS-MCN)** project is funded by MeitY, supported by DoT and led by IISc, IIT Delhi and C-DAC. It has completed its first stage. A 20-member consortium has published **five public releases** on GitHub, available through www.ios-mcn.org, and **campus pilots are operational at IISc and IIT Delhi**. A **Stage 2 proposal** of 27 work packages from 17 organisations (10 from industry), backed by 30 organisations (20 from industry), is under consideration at MeitY and DoT.[31]

IP Catalyst: from research to commercialisation (MeitY)

The **IP Catalyst** initiative, launched on 12 May 2026, is implemented by **C-DAC Pune** with support from MeitY. It aims to build a digital ecosystem covering the whole innovation lifecycle, from research and IP creation to technology transfer, commercialisation and market deployment. It seeks to close the gap between publicly funded R&D and industry adoption through stronger collaboration among MeitY organisations, start-ups, MSMEs, academia and industry.[32]

Technology Innovation Hub and 5G laboratories

The **IIITB COMET Foundation**, the Technology Innovation Hub set up by IIIT Bangalore under DST's National Mission on Interdisciplinary Cyber-Physical Systems, anchors multi-institute programmes on advanced communication systems. Its two flagship programmes are a **5G-Advanced O-RAN massive-MIMO base station** and a **RIS / Smart Radio Environments** project spanning about ten institutes. In parallel, the **100 5G use-case laboratories** established in academic institutions during 2023–24 are building competencies, supporting UG/PG projects and preparing the academic ecosystem for 6G.

Technology trials and demonstrations with MoU partners

B6GA works with its MoU and MoI partners not only on research and standards, but on validating advanced connectivity in the field. The **European Space Agency (ESA)** is a Memorandum of Intent partner of the Alliance, and the **UK–India Future Networks Initiative (UKI-FNI)** and **UK Telecommunications Innovation Network (UK TIN)** are MoU partners. On **11 December 2025**, the UK and Indian sides jointly demonstrated their innovations in two technology trials.

Joint technology demonstrations, 11 December 2025:

[31] "WTISD 2026: Building India's telecom through open-source: The IOS-MCN story," ETTelecom: https://ettelecom.com/s/wq3jmch

[32] PIB, IP Catalyst initiative, 12 May 2026: https://www.pib.gov.in/PressReleasePage.aspx?PRID=2260532&reg=3&lang=1

- ***Demonstration 1 — Telemedicine over Satellite–5G (India – ESA, UK).*** The UK side showcased a telemedicine use case over an **integrated satellite–5G network** connecting **IISc Bangalore, India** with the **ESA Harwell Campus, United Kingdom**. The trial validated real-time, high-resolution remote medical consultation using Nokia's Real-time eXtended Reality Multimedia (RXRM) solution and a Nokia 360° high-resolution medical camera deployed at IISc.
- ***Demonstration 2 — Smart Village and Tele-Applications (Satnavari Village, Maharashtra).*** India showcased real-world applications running over **BharatNet and public 5G**, integrated and monitored through a centralised **C-DOT Common Dashboard**. They covered agriculture and fisheries (including precision farming and drone-based operations), healthcare (live tele-consultation through the MangalCare platform), security and emergency response, and digital cattle-health monitoring.

Key observations from the Smart Village demonstration included:

- Operational readiness of multiple smart-village services running simultaneously.
- Integrated, centralised dashboards for monitoring services.
- Reliable rural connectivity and effective digital healthcare delivery.
- Scalability across use cases, improved digital inclusion and strong potential for replication in other rural regions.

Samriddh Gram Phygital Services Pilot

The **Samriddh Gram Phygital Services Pilot** is a pioneering "phygital" (physical + digital) services model. It combines on-ground presence with robust digital infrastructure to empower rural citizens. It uses **BharatNet** connectivity, strengthened with FTTH, a village area network and public Wi-Fi hotspots, to deliver essential services seamlessly and sustainably.[33]

DoT has identified three pilot locations, each hosting a Samriddhi Kendra as an integrated digital service hub:

- ***Ari & Umri, Madhya Pradesh.***
- ***Narakoduru, Andhra Pradesh.***
- ***Chaurawala, Uttar Pradesh.***

Services planned at the Samriddhi Kendras include smart classrooms, AR/VR-based learning and digital skilling; IoT-based soil testing, drone support and smart irrigation; teleconsultation, Health ATMs and emergency care; and e-governance, e-commerce and financial inclusion.

[33] PIB, Samriddh Gram Phygital Services Pilot, 29 October 2025: https://www.pib.gov.in/PressReleasePage.aspx?PRID=2183865&reg=3&lang=2

Together with the Satnavari Smart Village demonstration, the pilot provides field evidence on delivering digital services to rural citizens, a central concern of the Bharat 6G Vision's goal of ubiquity.

Spectrum roadmap

The B6GA Spectrum Working Group published its **Spectrum Roadmap for 6G in India** on 16 October 2024 and revised it on 8 October 2025. DoT has since published a Spectrum Roadmap for 6G services covering short-term (2025–2026), medium-term (2027–2030) and long-term (2031–2035) phases.

Key recommendations of the B6GA Spectrum Roadmap for 6G in India:

- ***Develop a national spectrum roadmap*** — review spectrum utilisation and establish a national spectrum pipeline for 5G-Advanced and 6G with clear timelines and candidate bands.
- ***Ensure adequate spectrum*** — 200 MHz of mid-band spectrum per operator for 5G-Advanced, 500–750 MHz per operator for 6G, and 1.5–2 GHz in total for nationwide 6G services.
- ***Prioritise future 6G bands*** — prepare 6–8.4 GHz (the "Golden Band") as the primary candidate, and accelerate studies on 600 MHz, 526–582 MHz, extended C-band (3.7–4.2 GHz), 4.8–4.99 GHz, L-band and other WRC-27 candidate bands.
- ***Strengthen global leadership*** — play a proactive role in WRC-27, ITU and 3GPP, supported by sharing and compatibility studies.
- ***Promote spectrum innovation through trials*** — expand experimental licensing and regulatory sandboxes, and launch national calls for prototypes, pilots and field demonstrations.
- ***Enable efficient utilisation*** — robust sharing and coordination mechanisms, and an audit of Government-held IMT spectrum to release under-used spectrum.
- ***Support 6G research*** — a dedicated 6G Research Fund, experimental spectrum access for universities, and a National 6G Research Network with interdisciplinary centres, scholarships and training.

1. Trusted & Secure Technology

For India, trust in 6G starts with control over the technology it depends on: indigenous stacks, security built into products, and cryptography that will hold up against future quantum computers. Member contributions cover all three.

B6GA member activities in trusted and secure technology include:

- ***Reliance Jio — indigenous stack and security as product architecture.*** Jio developed and deployed its 5G network stack in India at national scale. It has built **ten security products** protecting successive layers between adversaries and subscribers. They include the Cloud-Native Security Centre, which vets cloud-native software before deployment, at admission and in operation, as well as FortiFix AI for automated remediation, a 5G Security Operations Centre, a Security Edge Protection Proxy for secure roaming, and Network Guardian AI. Network Guardian AI alone has blocked **more than one billion fraudulent calls and messages**.
- ***IIITB COMET Foundation — indigenous RAN and private 5G.*** COMET has facilitated an indigenous 5G-Advanced / O-RAN massive-MIMO ecosystem spanning radio, baseband acceleration, L1 algorithms, RF front-end and AI/ML for the RAN. COMET-supported start-up **Mantiswave Networks** has developed a portable, 3GPP-compliant **private 5G network-in-a-box** for enterprise R&D, defence and civilian use, with a gateway for non-3GPP devices such as LoRa IoT sensors.
- ***HFCL with IIT Delhi — quantum-safe communications.*** Research under the PG Diploma in Wireless and Quantum Communications covers discrete-variable decoy-state QKD over free-space optical links, modelled on harvest-now-decrypt-later attacks on energy-sector SCADA networks. It also covers continuous-variable QKD over ground-to-ground FSO links, CV/DV-QKD over a HAPS-relayed FSO link, and UAV jamming detection with a risk-aware decision layer.
- ***IIIT Kalyani — code-based post-quantum cryptography (TTDF).*** The project proposes multi-point Hermitian (algebraic-geometry) code-based cryptosystems that reduce the large key sizes of classical McEliece-type schemes without lowering security. It includes software implementation and an FPGA hardware prototype, targeting TRL 6, for use as the backbone of a quantum-resistant public-key infrastructure.
- ***IIT Dharwad — integrity of AI-native payloads (TTDF).*** Semantic payloads are continuous-valued and have no natural bit-level error detection. IIT Dharwad is developing a **semantic-pilot integrity mechanism**: a fixed reference is re-encoded by the live encoder and checked at the receiver against a stored copy. Both ends must agree on the reference and threshold, so the mechanism is inherently a candidate for standardisation.
- ***C-DOT and IIT Madras — quantum-secure networks.*** C-DOT's indigenous Quantum Series of 14 QKD and PQC products, India's first TEC Technology Approval for QKD, the first QKD transmission over 4-core multicore fibre, and a joint Quantum Communications Thematic Hub at IIT Madras under the National Quantum Mission.

2. Resilience, Reliability and Privacy

Resilience for India means networks that carry national-scale traffic without interruption, stay available during disasters and mass events, and protect data over long horizons.

Operational resilience at scale

The scale figures matter here as evidence rather than as achievement. A network of 5,62,971 5G base transceiver stations reaching 99.9 per cent of districts, supporting over one hundred crore broadband subscriptions and the world's second-largest data traffic volume, constitutes a continuous demonstration of reliability engineering. The indigenous stack carries approximately four petabytes daily across more than 92,000 operational sites, much of it in rural service areas where fault restoration is slowest and redundancy thinnest.

Approximately 24,000 mobile towers were commissioned through June 2026 under Digital Bharat Nidhi funded initiatives, extending coverage into locations that commercial economics would not have reached. Coverage of this kind is a resilience investment: it is what makes a network dependable during a disaster rather than merely available during ordinary conditions.

B6GA member activities in resilience, reliability and privacy include:

- ***Reliance Jio — resilience at population scale.*** A single cloud-native converged core supports 4G, 5G, fixed broadband, IoT and Wi-Fi, with geographic redundancy across multiple data centres and ten super-cores. Network functions are engineered towards **99.999% availability**. The network handles more than **18 billion voice minutes and 11 billion messages per day** and **224 exabytes of data a year**. Post-quantum cryptography protects sensitive government, financial, healthcare and enterprise traffic. Enterprise SASE provides zero-trust access, and **Jio Malguard** extends protection to residential and mobile users.
- ***Freestream Technologies — broadcast/multicast as a resilience layer.*** Broadcast load does not grow with audience size, unlike unicast. A large-coverage broadcast/multicast layer, including **Direct-to-Mobile (D2M)**, can therefore absorb one-to-many traffic during mass events, keeping headroom on the cellular network. It can also carry emergency alerts regardless of congestion or subscriber registration. A national single-frequency D2M network of 50,000 towers could serve a concurrent national event with just 50,000 streams. Its receive-only link also lets citizens access public information without exposing telemetry, location or identity.
- ***HFCL — AI for resilient, efficient networks.*** HFCL use cases have appeared in three consecutive editions of the ITU *AI for Good — Innovate for Impact*. They are an AI-enabled power-efficient macro RU (2024, SAIL Award nominee), AI-driven RF-based object detection for 5G-Advanced and beyond (2025, Best Use Case winner, 5G category), and AI-assisted adaptive service provisioning for inclusive connectivity (2026, winner, AI Agents for Global Impact). With IIT Delhi, HFCL has proposed a sensing-aided AI-native air interface for resilient communications.

- ***IIITB COMET Foundation — redundancy and controllable propagation.*** COMET-funded start-up Benlycos' **Bloom Bonding Router** aggregates multiple Internet connections for reliable last-mile connectivity. RIS experiments have shown up to **8 dB RSRP gain** and, in the best configuration, **55% throughput improvement at 40 MHz** and 25% at 20 MHz over the no-RIS case.
- ***IIT Roorkee — secure, impairment-aware distributed MIMO.*** Research on RIS-assisted cell-free massive MIMO addresses secrecy performance under hardware impairments and electromagnetic interference, and two-fold physical-layer security for OTFS-aided RIS links.
- ***IIT Roorkee — reliable sub-THz channels.*** Indoor D-band measurements at 112 and 132 GHz have produced a dual-slope path-loss model, with a 65 cm breakpoint and exponents of 1.774 and 3.351. Height-controlled excitation improves side-lobe levels to −13.7 dB at 112 GHz and −12.8 dB at 132 GHz for interference control in dense directional deployments.
- ***CDoT with IIT Roorkee and IIT Mandi — research collaboration on development of 'Cell-Free' 6G Access Points.*** A cell-free network architecture removes the cell boundary as a single point of degradation and distributes service across cooperating access points.

3. Global, Transparent and Inclusive Standardisation

Indian stakeholders are increasingly helping to write the standards, not just adopting them. The Indian administration has spent three years shaping the IMT-2030 framework, Technical Performance Requirements and evaluation documents in ITU-R WP 5D. India's additions include measures aimed at improving rural coverage, and requirements on **AI/ML** (both AI for the network and the network for AI), **sensing/ISAC** KPIs for detecting, locating and tracking objects such as drones and people, and **energy efficiency** KPIs for low sleep ratios and long sleep durations. In 3GPP, Indian work focuses on waveform, modulation, channel coding, control-channel design, AI/ML, ISAC, coverage and mobility, together with RF and hardware aspects.

3GPP group	Participants 2020	Contributions 2020	Participants 2025	Contributions 2025
RAN	428	121	949	1,581
SA	198	62	599	1,052
CT	91	13	239	310
Total	**717**	**196**	**1,787**	**2,943**

Table 2: Indian individual-member participation and contributions in 3GPP (participation is cumulative across co-located meetings)

B6GA member activities in standardisation include:

- ***Reliance Jio.*** 934 technical contributions across 17 3GPP meetings between May 2024 and August 2026, covering AI/ML for the radio interface, network energy efficiency and massive-MIMO enhancements. Jio also hosted 3GPP meetings in Bengaluru and Goa and has declared **more than 550 standard-essential patents** from a portfolio of over 7,000 patent filings.
- ***HFCL.*** HFCL has contributed to the IMT-2030 framework in ITU-R WP 5D from Meeting #47 to #53, and **chairs the IMT FWA Drafting Group**, with sessions chaired at Meeting #52 in Geneva in June 2026. In 3GPP it has proposed a dual base-graph LDPC design for the 6G air interface (R1-2604522, R1-2606280), FWA and ISAC contributions at RAN #113, and TN+NTN FWA transport inputs at SA2 #176. HFCL is Vice-Chair of the TSDSI SGN (TR 6069 on JCAS published), Vice-Chair of the B6GA Technology WG, and chairs three B6GA white papers (FWA, ISAC, optical technologies) planned for IMC 2026.
- ***Tejas Networks.*** 160 contributions in FY25, 192 in FY26 and 170 in FY27 to date, spanning RAN1, RAN2, RAN3, RAN4, SA2 and RAN plenary. They cover the 6G air interface, architecture, spectrum sharing and migration, FWA, NTN, Ambient IoT, ISAC and AI/ML. Tejas has also worked with academia on RIS standardisation in TSDSI.
- ***IIITB COMET Foundation.*** COMET-supported researchers initiated the TSDSI activity that produced **TSDSI STD 5003 V1.0.0**, one of the first RIS standards globally. Work on Version 2, simulation benchmarking and non-IMT RIS architecture has followed. COMET also held a dedicated RIS workshop at IIIT Bangalore in March 2025 with TSDSI and B6GA.
- ***IIT Roorkee.*** Interference-resilient, SIC-free rate-splitting multiple access (ISF-RSMA) removes successive interference cancellation and inter-stream interference through signal-space diversity and phase-aligned zero-forcing precoding. It is backed by Indian patent application 202611093900 (3 August 2026) and targeted at the 3GPP Release 20 RSMA study. Separately, Slepian-sequence-based Type-2 codebook design addresses 3GPP CSI feedback.
- ***IIT Roorkee — ITU-T.*** An IIT Roorkee researcher is **Editor of the ITU-T SG20 work item Y.HealthMonID** on health-monitoring systems for digital health.

Institutional participation

TSDSI is India's interface with 3GPP, and Indian participation in 3GPP activities has grown steadily. The Telecommunication Engineering Centre (TEC) carries the Department's technical standards function, and the Wireless Planning and Coordination (WPC) wing carries India's positions into ITU-R and the World Radiocommunication Conference process. At the TSG plenary in Incheon in March 2025, TSDSI Individual Members submitted twelve 6G-related contributions. TSDSI's current 6G study areas cover artificial intelligence, fixed wireless access, RAN and core architecture, high-altitude platform systems and integrated sensing and

communication, with reports and standards expected by the third quarter of 2027 — timed to feed 3GPP Release 21, in which formal 6G standardisation work is expected to begin in 2027–28.

TSDSI developed the Low Mobility Large Cell concept to support larger cell sizes for rural and sparsely populated areas, and carried it to acceptance by the ITU as a recognised 5G variant (5Gi). TSDSI has since contributed standards work on reconfigurable intelligent surfaces, cloud interoperability and intelligent transportation systems.

At the 3GPP TSG RAN #108 meeting in Prague in June 2025, IIT Hyderabad and WiSig Networks advanced further contributions covering orthogonal time frequency division multiplexing and structural MIMO, and are now contributing to the newly approved 6G study item. The work has been supported by Qualcomm, Apple, Ericsson, Nokia and Samsung alongside the Department of Telecommunications, MeitY, the Department of Science and Technology and TSDSI.

4. Open and Interoperable Innovation

Member contributions show openness working in practice: multi-vendor interfaces in a national network, merchant O-RAN radios designed in India, and an open-source mobile core now being shared through the ITU.

CEWiT at IIT Madras coordinates what is arguably India's most significant open-innovation asset in this field: the indigenous end-to-end 5G testbed built by a pan-Indian team of eight academic and research institutions, funded by the Department of Telecommunications since April 2018. It spans user equipment nodes with NR physical layer and Layer 2/3 stacks, base stations, the 5G core, NB-IoT service support and RAN emulation. Critically, CEWiT opens or licenses testbed components to partners for use in their own research and development, with APIs and open modules for feature testing. A national testbed that other organisations can build on is the practical meaning of open innovation.

IIT Madras additionally leads the Advanced Optical Communication Testbed and participates in the terahertz consortium; IIT Hyderabad works with WiSig Networks on Open RAN and beyond-5G field demonstrations.

B6GA member activities in open and interoperable innovation include:

- ***Reliance Jio — openness at national scale.*** Four multi-vendor management platforms operate Jio-developed and third-party radios. **Twenty radio products implement the O-RAN 7.2x split**, 5G NR FAPI compliance is maintained across L2/L1, and 4G–5G N26 interoperability is regression-tested. TM Forum Open APIs and CAPIF govern exposed APIs. The cloud platform manages more than **2,500 network-function pods** across edge, core and public cloud.
- ***IIITB COMET Foundation / IIT Hyderabad — 32TR Open RAN radio.*** A 32TR O-RAN Radio Unit operates in n78 (3.3–3.67 GHz) with 100 MHz bandwidth, O-RAN 7-2x Category-B fronthaul, ULPI Class A and B, and SU/MU-MIMO beamforming. It is

3GPP and O-RAN compliant. The RIS project is developing a **generic RIS controller with standardised interfaces** across vendor tiles, integrated with OpenAirInterface.

- ***IOS-MCN consortium — open source through the ITU.*** IOS-MCN has been presented to ITU-D, leading to a **Partner2Connect pledge** joined by **Thailand and the Philippines**. Interoperability testbeds are under discussion at AIT Bangkok and DICT Philippines. ITU's Open Source Ecosystem Enabler has recommended replicating the codebase on ITU GitLab, putting it forward for Digital Public Goods Alliance certification, and establishing an **ITU Open Source Programme Office at IISc**. A web series on open source for 6G is proposed with the Linux Foundation, India.
- ***HFCL with IIT Delhi — open-platform ISAC.*** A joint 6G programme on ISAC, FWA and AI is built on open platforms, with a working ISAC prototype on USRP hardware and an RF-over-optical workstream. It targets 1–2 SEPs and 20+ standards contributions, with a demonstration planned at IMC 2026.
- ***IIT Dharwad — reconfigurable AI-native radio silicon.*** A runtime-reconfigurable streaming interconnect lets the same silicon switch between transmitter and receiver processing blocks through register writes, without a bitstream rebuild, supporting both AI-native and classical links.

HFCL notes one gap. India has **no shared national facility for multi-vendor interoperability testing against common interfaces**, and several international partners report the same need.

5. Support for Commercial Use Cases and Forward-Looking Business Models

Member inputs show 5G-era capabilities already earning revenue and moving into 6G-relevant business models.

B6GA member activities on commercial use cases and business models include:

- ***Reliance Jio — monetising network capabilities.*** Commercial traffic runs across **ten network slices** on Jio's indigenous 5G standalone core. It is sold as enterprise slices per site with assured throughput, latency and availability, quality-on-demand per session or API call, private networks by site and device, and FWA by premises and tier. The 5G core is offered in four configurations, from a compact 5GCN-in-a-Box to a fully on-premises private core. An **AI Voice Agent** implemented as an IMS Application Server makes the call itself the service interface.
- ***HFCL — installed base for 6G.*** HFCL developed the **first 5G CPE designed in India**, with **over one million units** supplied to an operator (sub-6 GHz and mmWave variants FCP-5200-O12A and FCP-5300-O11A). It is working towards **Sensing-as-a-Service**, with the CPE as a sensing receiver, for landslide early warning, contactless

health monitoring, underground utility mapping and railway track condition prediction.

- ***IIITB COMET Foundation / WiSig Networks.*** The 32TR O-RU IP has been **licensed to WiSig Networks**. The radio was unveiled at MWC Barcelona in March 2025, and **mass production is expected from mid-2027**. Mantiswave has commercialised an n78 RIS licensed by COMET. COMET's RIS programme has reached **TRL 7–8**, with applications in private networks, industrial IoT, mining, smart infrastructure, ISAC and defence.
- ***IIT Roorkee / MantisWave Networks.*** Indigenous RIS technology has progressed from a COMET-funded prototype (2022–2025) and an **Indian patent granted in March 2026** to a commercial product. It is deployed at IIT (ISM) Dhanbad, NIT Silchar, IIIT Bangalore, SRM AP and NIE Mysuru. A follow-on ANRF project on RIS-assisted ISAC runs from 2026 to 2029.
- ***SAMEER.*** An MoU with Keysight Technologies covers supply of the THz testbed to the education sector, and discussions are under way to market indigenously developed THz components worldwide.
- ***IIT Roorkee — sub-THz sensing for digital health.*** Granted Indian patents cover non-invasive blood-glucose measurement (No. 544648) and material characterisation (No. 528252), extending D-band technology into healthcare applications.

6. Affordability, Sustainability and Global Connectivity

India's principal standardisation achievement in the 6G cycle to date is the acceptance of ubiquitous connectivity as a usage scenario within the ITU's IMT-2030 framework, together with three associated core capabilities: coverage, interoperability and sustainability. By securing ubiquitous connectivity as a first-class scenario rather than a coverage footnote, India ensured that reaching the unconnected is a design objective of 6G rather than an afterthought for later releases.

Affordability, sustainability and ubiquity are the core principles of the Bharat 6G Vision. Member contributions address cost and energy at every layer, from channel coding to national energy management.

Bridging the divide

More than 2.15 lakh gram panchayats have been connected under BharatNet. Optical fibre in the ground grew from 19.35 lakh route kilometres in 2019 to 42.36 lakh route kilometres in 2025. Under PM-WANI, 4,09,111 public Wi-Fi hotspots had been deployed as at February 2026. Approximately 24,000 mobile towers were commissioned through June 2026 under Digital Bharat Nidhi funded initiatives, and the indigenous 4G network alone connected more than 26,700 villages, bringing roughly two million citizens online for the first time.

B6GA member activities in affordability, sustainability and global connectivity include:

- ***Reliance Jio — cost and energy as design requirements.*** Radios use single-enclosure, cable-less, fan-less designs with convection cooling, and shared baseband adds coverage layers without replicating baseband. An **AI-driven energy-management platform across about 340,000 sites** delivers roughly **INR300 crore in annual energy savings**, and more than 5,000 sites have been provisioned by zero-touch processes. More than **28 million homes** are connected, and mmWave access offers an alternative to fibre where trenching is difficult.
- ***Tejas Networks — affordability and sustainability in 3GPP.*** Tejas has contributed on multi-RAT spectrum sharing and 5G–6G migration, flexible RAN–CN interfaces and **FWA as a separate 6G device type** for households that cannot afford fibre. It has also worked on network energy saving (on-demand SSB and SIB1, adaptation of common signals), OFDM-based wake-up signals and **Ambient IoT** devices that draw power from ambient RF.
- ***HFCL.*** HFCL led the **energy-efficiency capability requirement for the ITU-R TPR** from the Indian delegation. It proposed India-centric FWA deployment scenarios at 3GPP RAN1 #125 and TSDSI, reflecting outdoor CPE, shared spectrum and BharatNet backhaul. A dual base-graph LDPC scheme with IIT Delhi cuts decoder complexity by **37–60% at high code rates** in simulation.
- ***Freestream Technologies — D2M for affordable reach.*** 112 MHz (470–582 MHz) has been allocated to broadcast, part of which will be used for imminent D2M services. Offloading high-concurrency content lowers delivery cost per gigabyte. Illustrative industry modelling suggests a national D2M deployment could avoid tens of percent of incremental RAN CAPEX/OPEX during high-demand periods, while reusing broadcast towers to reach rural and low-income users.
- ***IIITB COMET Foundation — low-cost coverage.*** Passive RIS offers a cost- and energy-efficient alternative to additional active infrastructure. A modular RIS lets faulty modules be replaced individually. The 32TR radio is being integrated into an indigenous stack whose deployments include the first broadband service in Chinnapur village and a hospital carrying about 250 GB/day. Together, these deployments carry up to about 1 TB/day of live traffic.
- ***Smart Village demonstration (Satnavari, Maharashtra).*** Agriculture, fisheries, tele-health, emergency-response and cattle-health services ran together over BharatNet and public 5G, monitored on a C-DOT Common Dashboard. The trial showed reliable rural connectivity, improved digital inclusion and strong potential for replication.
- ***Samriddh Gram phygital services pilot.*** Samriddhi Kendras over BharatNet in Ari & Umri (Madhya Pradesh), Narakoduru (Andhra Pradesh) and Chaurawala (Uttar

Pradesh) deliver education, agriculture, health, e-governance and financial services to rural citizens.

7. End-to-End Global Coverage: Terrestrial and Non-Terrestrial Integration

Non-terrestrial integration is ultimately decided in spectrum allocation, and the relevant decisions fall at the World Radiocommunication Conference in 2027. Agenda items 1.12, 1.13 and 1.14 concerning mobile satellite services and direct-to-device spectrum have been identified as critical, alongside agenda item 1.7. India's Spectrum Roadmap for 6G addresses non-terrestrial networks, high-altitude platform systems, high-altitude IMT base stations, satellite direct-to-device, drone connectivity, ambient IoT and vehicle-to-everything as an integrated set, and proposes regulatory sandboxes to permit early experimentation.

Member work treats satellite, broadcast and aerial layers as parts of one network rather than separate systems.

B6GA member activities in end-to-end coverage include:

- ***Reliance Jio — one programmable network across domains.*** Jio's service-based 5G standalone architecture lets NTN-aware capabilities be added as network services. Distributed user-plane functions can sit at satellite gateways, edge sites and enterprise premises, and unified slicing can extend one SLA across terrestrial, satellite and edge. The aim is for a subscriber to keep the same identity, policy and entitlements across terrestrial radio, satellite gateway and future direct-to-device access. Terrestrial coverage already spans 700 MHz to 29.5 GHz.
- ***Tejas Networks — NTN in 3GPP.*** Contributions address GNSS-resilient NR-NTN operation, NTN requirements for 6G, HARQ for NTN, GNSS-free UE operation and terrestrial/non-terrestrial mobility.
- ***HFCL.*** At 3GPP SA2 #176, HFCL contributed on NTN links as transport for FWA and on connection management for stationary CPE (KI#10, TR 23.801-01). This work targets terrain where fibre and terrestrial backhaul are uneconomic.
- ***Freestream Technologies.*** High-power, high-tower broadcast can act as a complementary wide-area terrestrial layer, similar in role to satellite and HAPS, carrying one-to-many traffic to rural, remote and high-mobility users such as trains and highways. This frees non-terrestrial capacity for coverage gaps.
- ***IIITB COMET Foundation.*** COMET has onboarded **Astrogate Labs**, which develops laser communication systems for ground and space applications and has completed a deployment for the Indian Navy. COMET also supports research on reliable connectivity for UAV swarms and anti-drone ISAC.

- ***IIT Roorkee.*** An active research programme covers NTN, UAV and satellite-assisted communications, including an ANRF-funded NTN project with a 3GPP-compliant prototyping component.
- ***Satellite–5G telemedicine trial with ESA and UK partners.*** On 11 December 2025, an integrated satellite–5G network linking IISc Bangalore with the ESA Harwell Campus (UK) supported real-time, high-resolution remote medical consultation using Nokia's RXRM solution and a 360° medical camera.

8. Spectrum, Compute and Supply Chain Diversity

India is building its own options across all three resources: studies of new spectrum bands, distributed compute, and indigenous silicon, radios and antennas.

B6GA member activities in spectrum, compute and supply-chain diversity include:

- ***Reliance Jio.*** Jio fields eight radio categories from 700 MHz to 29.5 GHz and is developing a **6G Giga-MIMO platform with 128T128R and up to 1,024 antenna elements**, including in the upper 6 GHz band (6.425–7.125 GHz). It has **115+ edge locations**, expanding towards about 300, and Indian-designed hardware and software including an indigenous physical-layer modem. A multi-carrier baseband supports 5G-Advanced and future 6G Giga-MIMO concurrently, so installed sites can move towards 6G through software and modular upgrades.
- ***HFCL.*** B6GA Technology WG band prioritisation covers 6425–7125 MHz, 7.1–8.4 GHz and 600 MHz, with a frequency-trial platform under discussion. HFCL has carried out sustained 26 GHz (n258) coexistence analysis in TSDSI SI 170 with Reliance Jio and MediaTek, after which TEC issued provisional Generic Requirements for licensed mmWave AP–STA equipment. HFCL has also designed **six radar systems** in India alongside its CPE line.
- ***IIITB COMET Foundation.*** Development of the O-RU, DU accelerator card (IIIT Bangalore and IIT Roorkee), 3GPP-compliant L1 algorithms and RIC-related AI/ML is distributed across Indian institutions rather than a single vertically integrated vendor. RIS work spans 3.5/5.5 GHz and 24 GHz, alongside spectrum-sharing and OTFS research.
- ***SAMEER consortium.*** The testbed delivers fully indigenous 270 GHz hardware, covering sources, power amplifiers, multipliers, mixers, filters, waveguide components, RFIC, lens and OAM antennas and a 100 Gbps baseband.
- ***IIT Roorkee — D-band hardware.*** A dual-band 4×2 gap-waveguide slot array at 112/132 GHz has been fabricated and measured, with about 15 dBi baseline gain, rising to about **20 dBi** with an H-ring superstrate. A QPSK D-band link improved EVM from 9.12% to 7.28% and SNR by 2.2 dB. ML-assisted synthesis of a 133 GHz, 12-

element array reached about 17 dBi measured gain, with inference at about 0.028 s per query.

- ***IIT Dharwad.*** The on-die AI accelerator and signal-processing generator are written in portable hardware-description code, targeting FPGA prototypes now and ASIC tape-out later, and avoiding vendor IP lock-in for the compute substrate.

9. Skills Pipeline Development

A sustained 6G talent pipeline is being built through certification programmes, open curricula, standards training and in-house innovation schemes.

C-DOT is developing cell-free 6G network architecture with IIT Roorkee and IIT Mandi, and has partnered IIT Delhi on terahertz component development and IIT Hyderabad on a Centre of Excellence spanning 6G, AI and quantum communications.

The 100 5G Use case Lab's network

The principal instrument is the network of 100 5G usecase laboratories sanctioned across academic institutions in financial year 2023–24, supported by a dedicated experimental licence module operated through the Department's eServices portal so that institutions can conduct live radio experimentation lawfully. The first of these was launched at IIT Madras.

Giving a hundred institutions hands-on access to real radio equipment and an experimental licence, rather than simulation alone, is what produces engineers who can contribute to a standard rather than merely operate a network. The labs are explicitly framed as capacity building for 6G rather than for 5G alone.

Academic research capacity

Doctoral and post-doctoral capacity is concentrated in the institutions carrying the national testbeds and centres: IIT Madras, IIT Delhi, IIT Guwahati, IIT Patna, IIT Kanpur, IIT Kharagpur, IIT Hyderabad, IIT Roorkee, IIT Mandi, IISc, CEWiT and SAMEER. The Anusandhan National Research Foundation (ANRF), with a stated target of INR50,000 crore over 2023–28 including INR14,000 crore of central allocation, and the Research, Development and Innovation scheme with an announced corpus of INR1 lakh crore, provide the funding architecture within which 6G doctoral capacity can be expanded.

B6GA member activities in skills development include:

- ***IIITB COMET Foundation.*** A **Certificate Program in Future Wireless Communications** with IIIT Bangalore aims to train **at least 500 engineers**. It covers digital and embedded design, 5G core, RAN L2/L3, physical-layer implementation

and an optional AI/ML module. Regular hands-on workshops cover OFDM/MIMO/OTFS, massive-MIMO receivers, O-RAN/RIC and AI-native 6G.

- ***IOS-MCN consortium.*** A capability-building curriculum of **300 hours of lectures and 200 hours of certification** in advanced 5G and 6G communications, offered by six IOS-MCN partners, is being discussed for replication at AIT Bangkok and DICT Philippines and as part of the **ITU Academy**, with IIIT Bangalore in the lead.
- ***HFCL.*** HFCL co-chaired TSDSI Tech Deep Dive 2026 on emerging 6G architecture options (**250+ participants**) and serves on the TPC of the Standards Driven Research Workshop at COMSNETS 2027. It trains students on standards-relevant problems through simulation and IEEE-format publication.
- ***Reliance Jio.*** Jio's annual **Aavishkaar** programme treats every engineer as a potential inventor, with ambitions to exceed 10,000 patent filings by 2027 and 25,000 by 2029. **Network Sage AI** lets engineers interrogate network behaviour in natural language while keeping human approval for consequential actions. Jio's AI platforms can be transferred to other operators together with their training pipelines.
- ***Academic institutions.*** Research groups at IIT Roorkee, IIT Dharwad and IIIT Kalyani are training doctoral, postgraduate and undergraduate researchers in sub-THz design and measurement, AI-assisted antenna synthesis, 3GPP procedures, semantic communications and post-quantum cryptography.

Looking Ahead

Several strands of India's 6G work will reach visible milestones in the next reporting period:

- The **6G THz Testbed** at SAMEER Kolkata is to be ready for use by the end of 2027, targeting a 100 Gbps line-of-sight link at 270 GHz.
- The **IOS-MCN Stage 2** proposal (27 work packages, 17 organisations) is under consideration at MeitY and DoT, and ITU actions on interoperability testbeds, curriculum and an Open Source Programme Office are in progress.
- The **HFCL–IIT Delhi ISAC demonstration** is planned for IMC 2026, along with three B6GA white papers on FWA, ISAC and optical technologies.
- **Mass production of the 32TR O-RAN radio** by WiSig Networks is expected from mid-2027.
- The **ANRF RIS-assisted ISAC** programme at IIT Roorkee (2026–2029) and IIT Dharwad's path to **ASIC tape-out** will take indigenous research further into silicon and systems.
- IIT Roorkee will pursue a **3GPP study item for ISF-RSMA**, building on the Release 20 RSMA study.

- The **Smart Village model** demonstrated at Satnavari is a candidate for replication in other rural regions, and the satellite–5G telemedicine trial with ESA and UK partners provides a basis for further terrestrial–non-terrestrial service trials.

Two needs recur in member inputs. The first is a **shared national facility for multi-vendor interoperability testing** against common interfaces. The second is **stronger collaboration across companies, academia and start-ups**, so that India turns its growing standards participation into sharper, patent-linked proposals and use cases that reflect Indian conditions of scale, cost and diverse deployment environments.

Member Contributions at a Glance

Member	P1	P2	P3	P4	P5	P6	P7	P8	P9
Reliance Jio	●	●	●	●	●	●	●	●	●
HFCL	●	●	●	●	●	●	●	●	●
Tejas Networks			●			●	●		
IIITB COMET Foundation	●	●	●	●	●	●	●	●	●
IOS-MCN (IISc, IIT Delhi, C-DAC)				●					●
SAMEER (6G THz Testbed consortium)			●		●			●	
IIT Roorkee		●	●	●	●		●	●	●
IIT Dharwad	●		●	●				●	
IIIT Kalyani	●								
Freestream Technologies		●				●	●		

Table 3: Principles addressed in B6GA member submissions (P1–P9 follow the numbering of the New Delhi Declaration). IIT Roorkee covers three research groups.

Concluding Assessment: From Principles to Practice

This chapter steps back from the individual contributions to offer an overall assessment. It does not restate what partners have reported; the preceding chapters do that in detail. Instead, it asks what the body of evidence tells us as a whole — where the New Delhi Declaration has gained real traction, where the principles remain aspirations rather than engineering commitments, which of them pull against one another, and what the signatories could usefully do together in the period when the shape of 6G is still being decided.

Key messages

- ***The Declaration's influence is greatest where it meets an existing decision process.*** Principles have gained traction where they could be attached to a standards agenda, a funding programme or a deployment decision. Where no such vehicle exists — resilience metrics, commercial models, skills recognition — progress is fragmented.
- ***The next 30 months matter more than the last twelve.*** Release 21 content is being fixed between now and 2029, and WRC-27 will settle key spectrum questions in late 2027. Principles not written into requirements, test cases and spectrum conditions during this window will be difficult to retrofit.
- ***Maturity is uneven, and the least mature principle is the one that pays for the others.*** Standardisation and openness are well advanced; commercial viability is not. Without a credible business case, investment in trust, resilience and coverage will be rationed.
- ***Several principles naturally trade off against each other.*** Openness and security, sovereignty and harmonisation, sensing and privacy, ambition and affordability must be managed explicitly rather than pursued in parallel.
- ***The partnership's strengths are complementary.*** Europe brings programme breadth and methodology, India brings population-scale operating evidence and cost discipline, the UK and Japan bring security framing and structured technical output, and operators bring migration economics. The greatest value lies in combining them rather than reporting them side by side.
- ***A shared, outcome-oriented progress framework would turn an annual compilation into a management tool.*** The signatories may wish to consider a small common set of indicators, jointly owned and reported each year at the International Bharat6G Symposium.

An overall reading of the evidence

Taken together, the submissions show that the Declaration has functioned less as a set of rules than as a **shared reference frame**. Partners have not changed direction because of it; rather, they have

used it to organise, justify and communicate work that was already under way, and in several cases to sharpen it. That is not a weakness. In a pre-standardisation phase, a common vocabulary that allows research alliances, operators, governments and standards bodies on four continents to describe their priorities in the same terms is itself a coordinating mechanism. It lowers the cost of forming coalitions in 3GPP and ITU-R, and it gives national programmes an external reference point against which to justify public investment.

The evidence also shows where that reference frame is still thin. The contributions are overwhelmingly **supply-side**: research outputs, prototypes, standards submissions and testbeds. The demand side — enterprises, public services and citizens who will ultimately use and pay for 6G — appears mainly through demonstrations and pilots designed by technology providers. Similarly, most reported results describe **inputs and outputs** (projects funded, contributions submitted, papers published) rather than **outcomes** (requirements adopted, interoperability achieved, services sustained, costs reduced). This is typical for a first reporting cycle, but it defines the task for the next one.

A third observation concerns **complementarity**. The European programme demonstrates how breadth can be coordinated and evaluated across dozens of projects. Indian contributions stand out for operating evidence at population scale, for cost-driven engineering and for a willingness to take open-source infrastructure into multilateral cooperation. The UK partners contribute a security-first framing that has reached both 3GPP and a multi-government coalition, while XGMF and 6G Flagship add structured technical documentation and deep research on resilience and AI-native radio. The NGMN operator perspective anchors the whole effort in migration economics. At present these strengths are reported side by side. Their real value would come from combining them — for instance, applying European evaluation methodologies to Indian deployment data, or testing UK security assurance approaches against open-source Indian network functions.

The decisive window: 2026 to 2029

The practical significance of the Declaration depends on timing. The period covered by this report coincides with the transition from 6G study to 6G specification. 3GPP has confirmed that Release 21 will be the first normative 6G release, with the package approved and Stage 1 frozen in March 2027, Stage 3 frozen in December 2028 and the ASN.1 freeze in March 2029.[34] In parallel, WRC-27 will consider new mid-band IMT spectrum in 4.4–4.8 GHz, 7.125–8.4 GHz and 14.8–15.35 GHz (agenda item 1.7) and a possible new mobile-satellite allocation for direct connectivity to IMT user equipment (agenda item 1.13).[35]

Each principle of the Declaration becomes durable only when it is translated into one of three instruments: a **requirement** in a technical report, a **test case** in a conformance or assurance scheme, or a **condition** in a spectrum or licensing framework. The table below indicates where that translation must happen and by when. Principles that are not embedded by the end of this window

[34] 3GPP, Release 21: https://www.3gpp.org/specifications-technologies/releases/release-21

[35] WRC-27 agenda items 1.7 and 1.13: https://www.transfinite.com/content/wrc2027list

will, in practice, depend on voluntary implementation choices and national regulation — precisely the fragmentation the Declaration was intended to avoid.

Milestone	Indicative timing	Principles most affected	What must be in place
Release 21 package approval and Stage 1 freeze (3GPP)	March 2027	1, 2, 5, 6, 7	Security, resilience, energy-efficiency and coverage objectives captured as service requirements and study conclusions
WRC-27 (ITU-R)	Late 2027	6, 7, 8	Coordinated sharing-study evidence and regional positions on mid-band IMT and satellite direct-to-device spectrum
Release 21 Stage 2 and Stage 3 freezes	June and December 2028	1, 3, 4, 7	Architecture choices on migration, open interfaces, AI-native functions and TN–NTN integration settled
ASN.1 / OpenAPI freeze; IMT-2030 evaluation	From March 2029	1, 4, 5	Conformance, interoperability and security assurance test regimes ready for the first commercial products

Table C-1: Standards and regulatory milestones that determine whether the principles become binding design choices

Relative maturity across the nine principles

The contributions allow an indicative, qualitative view of how far each principle has progressed across five dimensions. The assessment below is an analytical judgement based on the evidence submitted for this edition, not a scoring of individual organisations. Its purpose is to show where effort is concentrated and where it is thin.

Principle	Research	Standards	Trials and pilots	Deployment and market	Policy and governance
1. Trusted and Secure Technology	●	◐	◐	◐	●
2. Resilience, Reliability and Privacy	◐	○	◐	●	○
3. Global, Transparent and Inclusive Standardisation	●	●	◐	◐	●
4. Open and Interoperable Innovation	●	◐	◐	◐	◐
5. Commercial Use Cases and Business Models	◐	○	◐	○	○
6. Affordability, Sustainability and Global Connectivity	●	◐	◐	◐	◐
7. End-to-End Global Coverage (TN–NTN)	●	◐	◐	○	○
8. Spectrum, Compute and Supply Chain Diversity	●	◐	○	○	◐
9. Skills Pipeline Development	◐	○	◐	◐	○

Table C-2: Indicative maturity by principle (● established; ◐ developing; ○ emerging), based on submissions to this edition

Three patterns stand out. First, **research is ahead of every other dimension for almost every principle**; the pipeline from laboratory to standard is working, but the pipeline from standard to sustained deployment is not yet visible. Second, the principles with the weakest standards footprint — resilience, commercial models and skills — are those without an obvious standards "home". They will need deliberate framing if they are to influence Release 21. Third, **policy and governance maturity varies sharply**: security and standardisation benefit from explicit government frameworks,

while resilience and TN–NTN integration are still largely left to individual operators and national regulators.

Assessment by principle

1. Trusted and Secure Technology

What has been gained. The most significant shift is conceptual: security is now argued as an architectural property of 6G rather than a feature added to it, and this argument has reached the 3GPP system-architecture level with government backing. Alongside this, the submissions show quantum-safe capability moving from research into products and approvals, and operators treating security as a product portfolio rather than a compliance function.

Where the gaps lie. Security-by-design is easier to endorse than to evidence. The emerging risks specific to 6G — AI models embedded in network control, open and disaggregated interfaces, software supply chains with many contributors, and the migration from classical to post-quantum cryptography are acknowledged but not yet matched by agreed assurance methods. Security testing today is largely national and product-specific, which raises costs for vendors that sell across the signatories' markets and gives operators little comparable evidence.

What should be considered next. The signatories could consider working towards **mutually recognised security assurance for 6G network functions**. They could also consider a **coordinated crypto-agility and post-quantum migration roadmap** for telecom networks, aligned with the NIST post-quantum standards published in 2024,[36] with particular attention to constrained IoT and satellite terminals. For AI-native functions, a common expectation of model provenance, lifecycle control and explainability in effect, an "AI bill of materials" for network intelligence would give the Declaration's trust principle practical content.

2. Resilience, Reliability and Privacy

What has been gained. The submissions move resilience beyond availability percentages towards a richer concept that includes anticipation, adaptation and recovery. They also show resilience being engineered at population scale, and new ideas such as using broadcast layers to absorb mass-event demand or bonding multiple access paths that treat resilience as a system property rather than a property of individual network elements.

Where the gaps lie. Resilience is still measured mainly as uptime in normal conditions. What matters most for critical services is how networks behave when conditions are abnormal: how gracefully service degrades, how quickly it is restored, and whether it survives the loss of shared dependencies such as power, satellite navigation timing, cloud regions or a widely used software component. Energy resilience deserves particular attention, since cell-site power remains a frequent point of failure in many geographies. Privacy, meanwhile, is discussed largely in relation to sensing and AI; the privacy implications of pervasive network telemetry are less developed.

[36] NIST FIPS 203 (ML-KEM), FIPS 204 (ML-DSA) and FIPS 205 (SLH-DSA), August 2024: https://csrc.nist.gov/pubs/fips/203/final

What should be considered next. Signatories could consider **stress-testing 6G designs against defined disruption scenarios** — loss of GNSS timing, regional cloud outage, prolonged grid failure, cyber-induced degradation — and reporting service behaviour under each. Promoting **timing diversity** (terrestrial fibre-based timing and regional satellite navigation systems alongside GNSS), cross-operator emergency roaming and power-autonomous site designs would strengthen resilience in ways that are measurable. Periodic **joint resilience exercises** among willing operators and regulators would build shared practice ahead of 6G deployment.

3. Global, Transparent and Inclusive Standardisation

What has been gained. This is where the partnership is strongest. Participation has grown markedly in volume and seniority, regional programmes are coordinating their positions, operators are giving early guidance on migration, and support schemes are lowering the cost of participation for smaller organisations. National standards bodies are producing work — for example on intelligent surfaces and telerobotics — that can feed global processes.

Where the gaps lie. Volume of contributions is an imperfect proxy for influence. What ultimately counts is the share of proposals that are agreed, the leadership roles held in work items, and the quality of the resulting essential patents. The report also shows each signatory contributing largely on its own account; there is little evidence yet of **co-sourced contributions** that combine the weight of several regions behind a single proposal. There is a further risk that national requirements, however well-founded, create divergent variants. India's 5G experience, in which a nationally developed low-mobility large-cell capability achieved global reach once it was harmonised into 3GPP specifications, is instructive: national innovation scales best when it is absorbed into the global standard rather than maintained alongside it.

What should be considered next. The signatories could consider identifying a **small number of shared standards priorities** for Release 21 — candidates suggested by the submissions include energy efficiency, rural and FWA coverage, NTN integration, security-by-design and AI governance — and pursuing them through **jointly sourced contributions**. Tracking agreed contributions, rapporteurships and co-sourced proposals, rather than submission counts alone, would give a truer picture of influence. Mentoring newer participants from start-ups and academia through the full cycle from proposal to agreed text would multiply the benefit of participation subsidies.

4. Open and Interoperable Innovation

What has been gained. Openness has moved from principle to practice: open fronthaul radios designed in India, operator-scale multi-vendor management, AI-RAN testbeds and an open-source mobile core that has entered multilateral cooperation through the ITU. These demonstrate that open architectures can be built and operated, not just specified.

Where the gaps lie. Openness shifts cost and risk to the integrator. Without shared testing, each operator must integrate and validate multi-vendor combinations on its own, which erodes the economic case for openness. Open-source projects also raise questions of **long-term stewardship**: who maintains the code, who patches vulnerabilities, and how releases are governed once initial

project funding ends. Openness at the AI-RAN and service-exposure layers is still at an early stage relative to the radio fronthaul.

What should be considered next. Rather than each partner building its own facility, the signatories could explore a **federated network of interoperability and integration laboratories**, with common test profiles and mutual recognition of results — drawing on models such as the O-RAN ALLIANCE Open Testing and Integration Centres. For open-source platforms, a **sustainable governance model** (for example, hosting under a neutral foundation with a funded security-maintenance function) would help turn successful projects into dependable infrastructure. Early work on open reference implementations for AI-RAN interfaces would allow openness to be designed into 6G from the start rather than retrofitted.

5. Support for Commercial Use Cases and Forward-Looking Business Models

What has been gained. The submissions show early mechanisms through which advanced network capabilities can be monetised — network slicing, quality-on-demand, private networks, exposed network APIs and AI services delivered through the network itself — together with emerging ideas such as sensing as a service. Operator guidance has also made the economic stakes of migration explicit.

Where the gaps lie. This is the least mature principle, and arguably the most consequential. The business case for capabilities that are distinctively 6G has not yet been demonstrated, and the use cases presented are largely supply-led. Integrated sensing in particular will raise questions of data ownership, consent and regulatory treatment that affect its commercial viability. Without a clearer demand signal, investment in the other eight principles risks being rationed.

What should be considered next. The signatories could consider **demand-led use-case prioritisation**, bringing public-sector "anchor customers" — railways, disaster management, agriculture, health and public safety — into the design of pilots with defined commercial or social outcomes. **Techno-economic models built on shared assumptions** would allow partners to compare use cases credibly across markets. Aligning exposed network capabilities with industry API initiatives such as CAMARA and GSMA Open Gateway would help avoid fragmented developer ecosystems, and **regulatory sandboxes** for sensing-based services would allow business models and safeguards to be tested together.

6. Affordability, Sustainability and Global Connectivity

What has been gained. Affordability and energy are being engineered, not just advocated: energy savings are demonstrated at national scale, complexity reductions are designed into core algorithms, and low-cost access routes such as FWA, broadcast-based delivery and passive intelligent surfaces are being actively developed. India's leadership on energy-efficiency requirements in the IMT-2030 process is a notable contribution to the global framework.

Where the gaps lie. Affordability is still viewed mainly from the network side. For many users, the **device** and the **price of service** — not the cost of the network — determine access. Environmental

assessment focuses on operational energy, while the embodied carbon of equipment, the replacement cycles implied by migration choices and the energy cost of AI workloads receive less attention. Results are also reported in different units, which limits comparison.

What should be considered next. The signatories could consider adopting **user-side affordability measures** alongside network metrics — for example, the Broadband Commission benchmark that entry-level broadband should cost less than 2% of monthly gross national income per capita[37] — and including entry-level 6G device cost in design targets. **Lifecycle assessment** covering embodied as well as operational emissions, and treating **software-upgrade migration paths** as an explicit affordability lever, would link sustainability directly to the migration decisions now being made in 3GPP.

7. End-to-End Global Coverage: Terrestrial and Non-Terrestrial Integration

What has been gained. Integration has progressed from architecture papers to working demonstrations across continents, with contributions on NTN operation, mobility and transport feeding into 3GPP. Rural digital-service pilots show how connectivity and services can be delivered together.

Where the gaps lie. Most of the remaining barriers are **regulatory and economic rather than technical**: spectrum for direct-to-device services, landing rights, lawful-interception and emergency-service obligations across domains, and the economics of serving sparsely populated areas. Service continuity across terrestrial, satellite and aerial layers — with the same identity, policy and quality commitments — has been demonstrated only in controlled settings. The role of submarine cables and their landing infrastructure, strategic for intercontinental traffic, is largely absent from the coverage discussion.

What should be considered next. Signatories could consider **coordinated preparation for WRC-27 agenda item 1.13** so that direct-to-device satellite services complement rather than fragment terrestrial IMT, and **joint TN–NTN pilots** with agreed continuity and quality criteria. Extending the coverage agenda to **submarine-cable resilience and landing diversity** would connect Principle 7 with the resilience concerns of Principle 2. Rural service models could be evaluated on sustained use and cost per connected household, rather than on demonstration success alone.

8. Spectrum, Compute and Supply Chain Diversity

What has been gained. Spectrum planning has become concrete, with national roadmaps, quantified per-operator targets and candidate-band studies. Indigenous design capability now spans sub-terahertz radio chains, massive-MIMO platforms, baseband accelerators and specialised components, and there is growing interest in distributed compute that avoids dependence on a single cloud location.

[37] Broadband Commission for Sustainable Development, Advocacy Target 2: https://www.broadbandcommission.org/advocacy-targets/2-affordability/

Where the gaps lie. Spectrum ambitions will meet coexistence realities. The mid-band ranges under study for IMT are shared with satellite, fixed and government services, and the upper 6 GHz band is contested between licensed mobile and licence-exempt use, with regions taking different approaches. On the supply side, design capability is advancing faster than the manufacturing, packaging and test capacity needed to produce components at volume. Dependence on a small number of sources for advanced semiconductors and AI accelerators is a strategic exposure the submissions note but do not quantify.

What should be considered next. The signatories could consider **pooling sharing and compatibility study evidence** for the candidate bands, so that positions at WRC-27 rest on common technical ground even where national choices differ. On supply chains, a **mapping of critical 6G components and their sources**, followed by coordinated demand aggregation for trusted and indigenous suppliers, would give the diversity principle measurable content. Encouraging **open hardware reference designs** and shared test facilities for RF and sub-terahertz components would lower barriers for new entrants.

9. Skills Pipeline Development

What has been gained. Structured curricula, certification programmes, laboratory networks and industry training schemes are in place, and at least one curriculum is being considered for multilateral adoption. Researchers are being trained at scale within research programmes.

Where the gaps lie. Two capabilities are scarce and not directly addressed. The first is **standards craft**: the ability to draft, negotiate and steer proposals through 3GPP and ITU-R, which takes years to acquire and is concentrated in a small number of large organisations. The second is **cross-disciplinary depth** at the intersection of radio, AI, security and systems engineering. Retaining trained people in the ecosystem, and recognising standards work in academic career evaluation, are also recurring constraints.

What should be considered next. Signatories could consider **standards fellowships** that pair early-career engineers and researchers with experienced delegates across organisations and regions, **exchange placements** among partner institutions, and shared remote access to testbeds and digital twins for training. **Mutual recognition of certifications** would let skills travel with people. Encouraging universities to credit standards contributions alongside publications would help retain academic talent in pre-competitive standards work.

Trade-offs between principles

The nine principles are presented as complementary, and at the level of intent they are. In implementation, several pull against one another. Acknowledging these tensions openly — and agreeing how to manage them — would make the Declaration more credible and more useful to engineers and policymakers who must make trade-offs.

Tension	Why it matters	How it could be managed
Openness (4) and security (1)	Open, disaggregated interfaces and multi-vendor integration enlarge the attack surface and complicate accountability.	Security-by-design in open interface specifications; joint security testing of multi-vendor combinations; software bills of materials.
Supply-chain sovereignty (8) and global harmonisation (3)	National stacks and requirements build capability but can fragment ecosystems and economies of scale.	Pursue national innovations through global standards; prefer interoperable indigenous products over bespoke variants.
AI-native autonomy and trust (1, 2)	Autonomous network control improves efficiency but can obscure accountability and create new failure modes.	Human oversight for consequential actions; explainability and model lifecycle governance written into requirements.
Sensing capability (5) and privacy (2)	Networks that sense their environment create valuable services and new surveillance risks.	Privacy-by-design in ISAC specifications; clear regulatory treatment of sensing data; sandboxes before scale.
Performance ambition and affordability (6)	Frontier capabilities such as sub-terahertz links and extreme MIMO can raise cost and energy use.	Prioritise migration economics and coverage; position frontier capabilities where they create clear value.
Spectrum ambition (8) and coexistence	Quantified spectrum targets must be reconciled with incumbent services and licence-exempt use.	Shared sharing-study evidence; dynamic and coordinated sharing frameworks; realistic phasing.

Table C-3: Trade-offs among the nine principles that require explicit management

Towards a shared measure of progress

A voluntary declaration gains authority when its signatories can show, year on year, that something has changed. The signatories may therefore wish to consider a **common progress framework** built on three ideas. First, it should measure **outcomes** — what has been adopted, sustained or reduced — in addition to activity. Second, it should be **light**: one or two indicators per principle, drawn wherever possible from data partners already collect. Third, it should be **jointly owned**, with definitions agreed among signatories and results reported each year at the International Bharat6G Symposium. The indicators below are offered as a starting point for that discussion, not as a finished framework.

Principle	Suggested outcome indicator	Suggested longer-term impact indicator
1. Trusted and Secure	Share of 6G security requirements with defined, testable assurance criteria; progress on post-quantum readiness of network functions	Mutual recognition of security assurance results among signatory markets
2. Resilience and Privacy	Service behaviour (degradation and time to restore) in defined disruption scenarios, measured in joint exercises	Continuity of essential services during declared emergencies
3. Standardisation	Agreed (not only submitted) contributions; leadership roles held; number of co-sourced multi-signatory contributions	Declared standard-essential patents found essential; requirements adopted from signatory priorities
4. Openness	Multi-vendor combinations passing common interoperability test profiles; health of open-source projects (active maintainers, security releases)	Share of multi-vendor and open deployments in live networks

Principle	Suggested outcome indicator	Suggested longer-term impact indicator
5. Commercial models	Pilots converted to paying or publicly funded services	Adoption of 6G-enabled services by vertical sectors and public services
6. Affordability and sustainability	Network energy per bit on a common basis; lifecycle emissions per site	Entry-level broadband price relative to 2% of monthly GNI per capita; entry-level device cost
7. Coverage (TN–NTN)	Service-continuity success across terrestrial and non-terrestrial domains in joint pilots	Share of population and territory with reliable service in underserved regions
8. Spectrum, compute, supply chain	Sharing studies completed for candidate bands; domestic or diversified value in critical components	Concentration of supply for critical components; spectrum available per operator
9. Skills	People certified under mutually recognised curricula; new standards delegates active after two years	Retention of trained professionals in the telecom ecosystem

Table C-4: A possible common progress framework for consideration by the signatories

Alongside indicators, the signatories could consider a simple governance arrangement: **principle champions**, with pairs of signatories from different regions co-leading each principle and preparing a short annual status note, and a **shared evidence repository** in which contributions, test results and datasets are recorded once and reused. This would respond directly to the call, made in partner submissions, for clarity on who takes each commitment forward and how success will be judged.

A phased way forward

The following sequence aligns the suggestions above with the standards and regulatory calendar. It is indicative and intended to help the signatories prioritise.

Horizon	Suggested priorities
Near term — to the Release 21 package approval (March 2027)	Agree a short list of shared standards priorities and pursue them through co-sourced contributions; agree the progress framework and its baselines; initiate a federated interoperability-laboratory arrangement; launch standards fellowships.
Medium term — to WRC-27 and the Release 21 Stage 2 and Stage 3 freezes (late 2027 to December 2028)	Pool sharing-study evidence and coordinate positions on agenda items 1.7 and 1.13; run joint TN–NTN and resilience exercises; open sensing and network-API sandboxes; map critical supply chains and aggregate demand for trusted components.
Longer term — to the ASN.1 freeze and first deployments (2029–2030)	Operate mutually recognised security assurance and interoperability testing; evaluate migration paths and affordability on a common basis; scale skills programmes with mutual recognition; report outcome and impact indicators annually.

Table C-5: Indicative sequencing of next steps against the 6G standards and regulatory calendar

Closing reflection

The first year of the New Delhi Declaration has shown that a diverse group of organisations can agree on what 6G should be for, and can direct substantial research, standards and deployment effort towards those ends. The harder test lies ahead. Between now and the end of the decade, the principles must either become embedded in specifications, test regimes and spectrum conditions, or they will remain statements of aspiration.

The partnership is well placed to meet that test. Its members together span the full chain from fundamental research to national-scale operation, and they bring complementary strengths that no single region possesses. What is needed now is less additional activity than **deliberate coordination**: choosing a few shared priorities, pursuing them jointly in the forums where 6G is being decided,

managing the trade-offs between principles openly, and measuring progress by outcomes. If the next edition of this report can show that shift — from parallel effort to coordinated results — the Declaration will have fulfilled its promise of making 6G a trustworthy, open, inclusive and affordable global public good.

ANNEXURE A

The New Delhi Declaration

Joint Statement Endorsing Principles for 6G: Secure, Open, Resilient, Inclusive, and Sustainable by Design

Bharat 6G; 6G Smart Networks and Services Industry Association (6G-IA); ATIS' Next G Alliance; XGMF; 6G Forum; 6G Brazil; UKI-FNI; UK TIN; UK Federated Telecoms Hubs (CHEDDAR, HASC, JOINER and TITAN); and 6G Flagship.

New Delhi: 10th October 2025

At the International Bharat6G Conference 2025 (9–10 October 2025), held at the sidelines of the India Mobile Congress (IMC) 2025, research alliances from partner countries affirm our commitment to shaping the future of 6G wireless communication systems as a shared global endeavour. Together, we recognize that 6G will serve as the connective fabric of the future digital economy, enabling intelligent networks and services, automation, and inclusion across all sectors of society.

By working together, we can ensure that 6G is secure, open, resilient, inclusive, affordable, and sustainable — a global public good that empowers every nation and citizen. Collaboration is essential to addressing pressing challenges and maximizing the opportunities available to the world for achieving our socio-economic and environmental goals.

We therefore declare our shared intention to align research, development, standardization, and deployment around the following principles for 6G by design:

1. Trusted and Secure Technology

6G networks must be secure and trustworthy-by-design, ensuring resilience across hardware, software, and supply chains.

Trusted ecosystems should safeguard national security and public safety, while protecting civil liberties and individual rights.

Risk mitigation must address growing complexity, critical infrastructure dependence, and the rise of AI-native functions in telecom systems, with safeguards for data protection, transparency, and accountability across their lifecycle.

2. Resilience, Reliability, and Privacy

6G must deliver always-on availability with rapid recovery mechanisms, fail-safe design, and proactive resilience engineering to maintain services.

Privacy-preserving architectures, cryptography, and responsible use of AI are essential to protect individuals, business and institutions.

Networks must incorporate resilience at scale, handling billions of connected devices, agents, and workloads in real-time without compromising safety.

3. Global, Transparent, and Inclusive Standardization

Standards must be developed in open, transparent, impartial, and consensus-driven forums with equitable participation across nations, regions, and stakeholder groups.

Technical specifications must promote interoperability, resilience, openness, and competition, and respect intellectual property rights while driving accessibility and innovation. Ensuring resilience, open participation by multiple providers and stakeholders is essential. Active collaboration is encouraged between international standards bodies (e.g., 3GPP, ITU, IEEE, O-RAN Alliance) and innovation alliances while maintaining a transparent, inclusive, and trustworthy 6G standards process.

4. Open and Interoperable Innovation

6G must embrace open interfaces and multi-vendor interoperability across Terrestrial and Non-Terrestrial hardware, software, and cloud-native platforms.

6G should support AI-enabled Radio Access Networks, software-defined networking, AI-native orchestration, and virtualization as catalysts of innovation and flexibility.

International collaboration on R&D, testbeds, and pilot deployments will accelerate breakthroughs in performance, security, and affordability.

5. Support for Commercial Use-Cases and Forward-Looking Business Models

6G must deliver superior commercial value by addressing valuable use-cases in an efficient and cost-effective manner. 6G should also reduce capital and operating costs compared to previous generations.

6G should improve the delivery of use-cases already supported in 5G and also support sustainable and forward-looking business models by adding use cases that enhance the value of mobile networks to the broader economy.

6. Affordability, Sustainability, and Global Connectivity

6G deployments must be energy-efficient, repairable, and recyclable, advancing environmental goals and reducing carbon footprint.

Solutions must remain affordable and accessible, leveraging economies of scale and innovative financing models to support social sustainability.

6G must bridge digital divides, delivering reliable and affordable coverage and consistent user experience across urban, rural, and remote regions.

Networks must empower industries to reduce emissions and enable green digital transformation across sectors such as energy, manufacturing, health, utilities, agriculture, and transportation.

7. End-to-End Global Coverage: Terrestrial and Non-Terrestrial Integration

6G must provide seamless, ubiquitous connectivity across land, sea, air, and space, delivering near-universal global coverage.

Integration of terrestrial infrastructure with satellites, High-Altitude Platforms (HAPS), UAVs, sub-sea and future space-based systems will ensure resilient, universal access.

The goal is a ubiquitous Internet fabric that delivers a consistent experience from a farmer in a remote village to an airplane in flight to astronauts in orbit.

8. Spectrum, Compute, and Supply Chain Diversity

6G must use spectrum efficiently, incorporating dynamic sharing, spectrum aggregation, and AI-optimized allocation to serve diverse use cases.

Networks must scale across the compute continuum from cloud to edge to device leveraging accelerators, GPUs, NPUs, TPUs and future quantum/neuromorphic systems.

Open and resilient supply chains, with multiple providers, are critical to a secure and competitive 6G ecosystem.

9. Skills Pipeline Development

The opportunities to highlight the Telecoms sector as a pathway for excellent employment prospects will be promoted.

Understanding the future needs of the industry that will develop Future Networks will be central to develop the key skills in hardware, software and standards that will be needed to design, deploy, manage and secure the future of 6G and Terrestrial and Non-Terrestrial Integration.

Call to Action

We call on all research alliances, industries, research institutions, and civil society stakeholders to join us in advancing these shared principles. By anchoring 6G in security, openness, resilience, inclusivity, affordability, sustainability, and trust, we commit to shaping a network fabric that uplifts societies, accelerates digital economies, and ensures no one is left behind.

At the International Bharat6G Symposium 2025 in New Delhi, this joint declaration marks a milestone: a unified global step toward making 6G a truly universal, trustworthy, and inclusive intelligent network.

Reproduced from the Joint Statement Endorsing Principles for 6G, New Delhi, 10 October 2025. Minor typographical corrections only; the original governs.

Abbreviations

3GPP	3rd Generation Partnership Project	**MIMO**	Multiple-Input Multiple-Output
5GC / 6GC	5G Core / 6G Core Network	**MRSS**	Multi-RAT Spectrum Sharing
6G-IA	6G Smart Networks and Services Industry Association	**MTC**	Machine-Type Communication
ACT	Advanced Connectivity Technologies (UK research hubs)	**NCSC**	National Cyber Security Centre (United Kingdom)
AI / ML	Artificial Intelligence / Machine Learning	**NGMN**	Next Generation Mobile Networks Alliance
AIT	Asian Institute of Technology, Bangkok	**NOMA**	Non-Orthogonal Multiple Access
ANRF	Anusandhan National Research Foundation	**NSA**	National Security Agency (United States)
B6GA	Bharat 6G Alliance	**NTN / TN**	Non-Terrestrial Network / Terrestrial Network
BD-RIS / SIM	Beyond-Diagonal RIS / Stacked Intelligent Metasurface	**O-RAN**	Open Radio Access Network
C-DAC	Centre for Development of Advanced Computing	**OSPO / OSEE**	Open Source Programme Office / Open Source Ecosystem Enabler (ITU)
CIC	Connectivity and Innovation Centre (India–UK)	**OT**	Operational Technology
CPE	Customer Premises Equipment	**OTA**	Over-the-Air
CSI	Channel State Information	**OTFS**	Orthogonal Time Frequency Space (modulation)
CU-DU	Central Unit – Distributed Unit	**PAPR**	Peak-to-Average Power Ratio
CV / DV-QKD	Continuous-Variable / Discrete-Variable Quantum Key Distribution	**PQC**	Post-Quantum Cryptography
D2M	Direct-to-Mobile	**PRS**	Partially Reflective Surface
DICT	Department of Information and Communications Technology, Philippines	**RAN**	Radio Access Network
DoT	Department of Telecommunications	**RIS / IRS**	Reconfigurable Intelligent Surface / Intelligent Reflecting Surface
EMI	Electromagnetic Interference	**RSMA**	Rate-Splitting Multiple Access
ETSI	European Telecommunications Standards Institute	**SDO**	Standards Development Organisation
EVM	Error Vector Magnitude	**SEP**	Standard-Essential Patent
FDD / TDD	Frequency Division Duplex / Time Division Duplex	**SIC**	Successive Interference Cancellation
FEC	Forward Error Correction	**SLA**	Service Level Agreement
FSO	Free-Space Optical	**SNN**	Spiking Neural Network
FTH	Federated Telecoms Hubs (United Kingdom)	**SNR**	Signal-to-Noise Ratio
FWA	Fixed Wireless Access	**SNS JU**	Smart Networks and Services Joint Undertaking
GCOT	Global Coalition on Telecoms	**TCO**	Total Cost of Ownership

GNSS	Global Navigation Satellite System	**TEC**	Telecommunication Engineering Centre
HAPS	High-Altitude Platform Station	**THz / sub-THz**	Terahertz / sub-Terahertz
IEEE	Institute of Electrical and Electronics Engineers	**TRL**	Technology Readiness Level
IIIT	Indian Institute of Information Technology	**TSDSI**	Telecommunications Standards Development Society, India
IISc	Indian Institute of Science, Bengaluru	**TTDF**	Telecom Technology Development Fund
IIT	Indian Institute of Technology	**UAV**	Unmanned Aerial Vehicle
IMC	India Mobile Congress	**UE**	User Equipment
IMT-2030	International Mobile Telecommunications-2030 (ITU framework for 6G)	**UKI-FNI**	UK–India Future Networks Initiative
IOS-MCN	Indigenous Open-Source 5G/6G Mobile Communication Network	**USRP**	Universal Software Radio Peripheral
ISAC / JCAS	Integrated Sensing and Communication / Joint Communication and Sensing	**WG**	Working Group
ITU / ITU-R / ITU-D / ITU-T	International Telecommunication Union and its sectors	**WP5D**	Working Party 5D (ITU-R)
KVI / KPI	Key Value Indicator / Key Performance Indicator	**WUS**	Wake-Up Signal
LDPC	Low-Density Parity-Check (code)	**XGMF**	XG Mobile Promotion Forum (Japan)
MeitY	Ministry of Electronics and Information Technology		

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