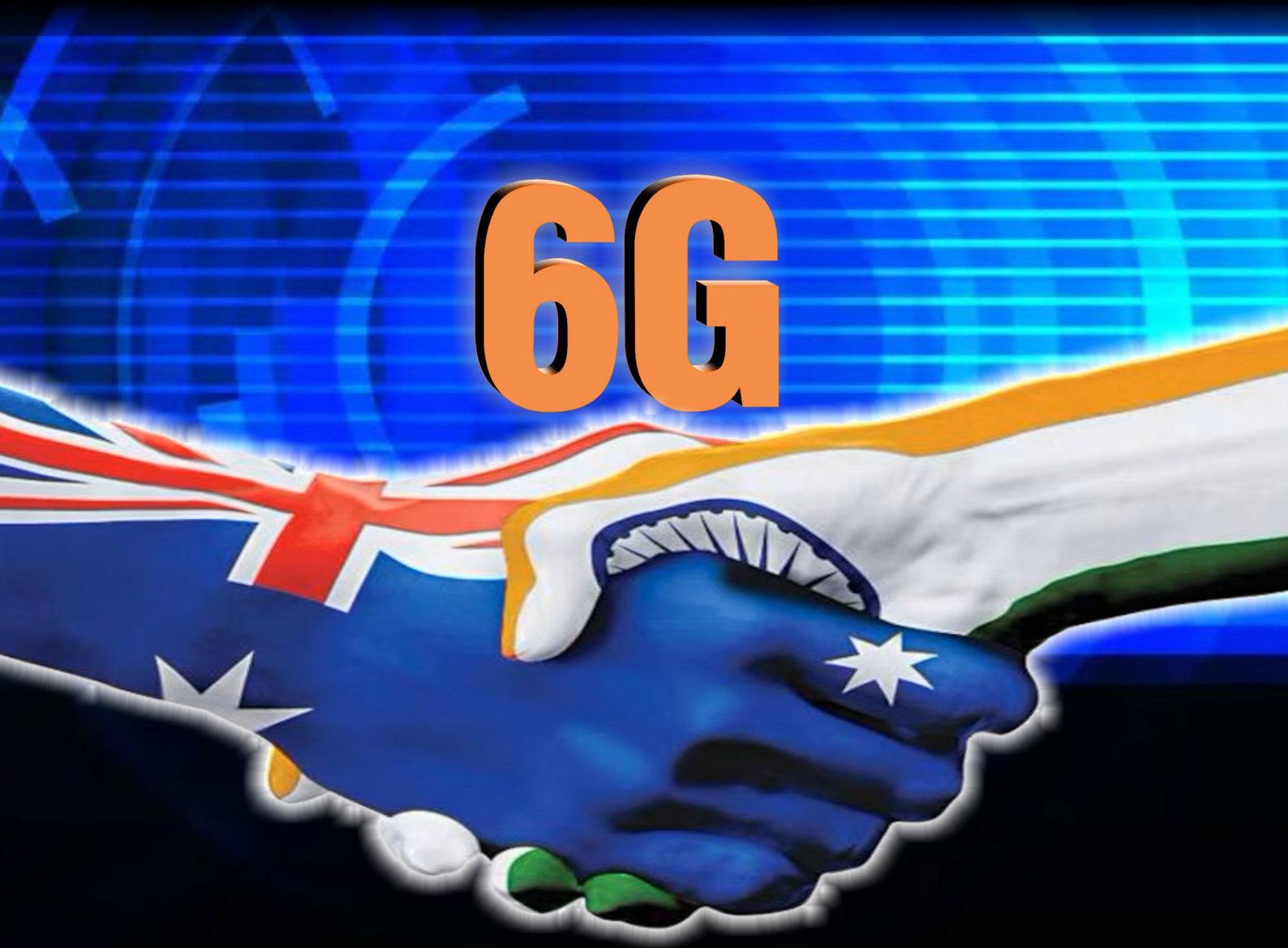# Strategic Opportunities for Australia and India from 6G

6G

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Acknowledgement

Abbreviations

AI:	Artificial Intelligence
AICCTP:	Australia-India Cyber and Critical Technology Partnership Grants
AI-ECTA:	Australia-India Economic Cooperation and Trade Agreement
AISRF:	Australia-India Strategic Research Fund
CECA:	Comprehensive Economic Cooperation Agreement
CERT-In:	Indian Computer Emergency Response Team
DFAT:	Department of Foreign Affairs and Trade
FDI:	Foreign Direct Investment
FTA:	Free Trade Agreement
G-20:	Group of Twenty
GCC:	Global Capability Centres
GDP:	Gross Domestic Product
ICT:	Information and Communications Technology
IoT:	Internet of Things
IPEF:	Indo-Pacific Economic Framework for Prosperity
IPOI:	Indo-Pacific Oceans Initiative
IT:	Information Technology
IT Act:	Information Technology Act, 2000
ITES:	IT-enabled services
ITU:	International Telecommunication Union
mm wave:	millimetre wave
MoU:	Memorandum of Understanding
MSP:	Mineral Security Partnership
NSDTS:	National Security Directive on the Telecommunication Sector
PLI:	Production Linked Incentives
Quad:	Quadrilateral Security Dialogue
QUIN:	Quad Investors Network
RF:	Radio Frequency

SCRI: Supply Chain Resilience Initiative

TSSR: Telecommunication Sector Security Reforms

UNCTAD: United Nations Conference on Trade and Development

VET: Vocational Education and Training

WIPO: World Intellectual Property Organisation

Executive Summary

Australia and India are potential partners for a strategic alliance to develop niche solutions to country-specific sixth-generation telecommunications (telecom) technology (6G) issues. The two countries are emerging as significant powers in the Indo-Pacific region, with complementary technological strengths. While Australia and India have their strengths, they need to catch up in technology innovation and readiness for technology. In 2020, the two countries elevated their strategic partnership to a Comprehensive Strategic Partnership. As part of the technology-related initiatives of the partnership, the Australia-India Cyber and Critical Technology Partnership Grants (AICCTP) was announced. The current report was produced as part of a project supported by an AICCTP grant.

The two countries have collaborated on issues such as critical and emerging technologies, cyber security, critical minerals and skills gaps in international fora, namely the Quadrilateral Security Dialogue (or the Quad), Group of Twenty (G-20), and Indo-Pacific Economic Framework for Prosperity (IPEF). The two countries have been collaborating or inclined to cooperate in multilateral platforms such as the United Nations, including the International Telecommunications Union, in developing international standards, norms, and frameworks for cyberspace and critical and emerging technologies.

Despite these initiatives, there are challenges in furthering Australia-India technology and telecom partnerships, including the respective countries' perspectives on international alliances, still-to-mature technological cooperation, and a lack of enforceability and remedial measures of the bilateral and multilateral initiatives through dispute resolution mechanisms. Enforceable provisions could be ensured through the free trade agreement (FTA) signed by Australia and India in April 2022, formally titled Australia-India Economic Cooperation and Trade Agreement (AI-ECTA).

Even though the AI-ECTA, seen as an interim FTA, does not cover telecom and technology-related areas to the desired extent, there is scope for the emerging 6G ecosystem to benefit directly or indirectly through its provisions. Various issues related to critical and cyber technologies, including 6G and associated issues, are more

comprehensively covered in the Framework Arrangement on Cyber and Cyber-Enabled Critical Technology Cooperation (the "Framework Arrangement").

The report discusses the status of collaboration between Australia and India in major technology and telecom sectors- Firstly, in the area of cybersecurity, India and Australia, both sensitive to national security matters and having taken steps to ensure the cyber security of their citizens, are organising annual bilateral Cyber Policy Dialogues. Secondly, skill shortages, especially in the area of telecom and cyber technologies being significant challenges for both India and Australia, have been taken up under the AI-ECTA framework in the form of facilitation of bilateral conversations regarding the occupational skill sets and standards in specific regulated or licenced occupations.

In addition, bilateral initiatives such as Australia-India Future Skills Initiative and Australia-India Innovation Network have components of collaboration and access to skill development initiatives. Thirdly, semiconductors, a major geopolitically significant issue, have been part of the conversation on telecom and technologies between Australia and India, but perhaps the conversation needs to be strengthened. Lastly, quantum computing has been featured in the work programme of the Framework Arrangement, as part of which India could tap into Australia's relative expertise in this field.

A few recommendations for Australia and India included in the report are as follows:

1) deepen the bilateral relationship in these areas: student training, transitioning basic research into applied research, designing collaborative projects, and technology commercialisation;

2) collaborate to establish dual institution delivery across borders system and best practice sharing and capacity building for institutions:

3) collaborate to develop critical mineral value chains and commercial tie-ups for indigenous technologies:

4) deepen collaborations on semiconductors, cybersecurity, artificial intelligence (AI), quantum computing etc., bilaterally and within Quad-plus countries, including looping in industry and academia;

5)   collaborate deeply to develop more cyber-skilled human resources in both countries; and

6)   undertake greater outreach to publicise the benefits of the bilateral relationship.

Thus, the strategic opportunities for India and Australia, both known and potential, are unlimited in scope and imagination, from individual welfare and prosperity to national and regional stability, harmony, advancement, growth, security and sustainability. Australia and India can become the 'drivers and connectors' constituting a model and regional 'hub' for world adoption.

About the Project

The project, titled "Ethical 6G: Identifying Elements of an Ethical Framework for 6G and Creating Opportunities for India and Australia," is a collaborative effort between CUTS International, the Australian Risk Policy Institute (ARPI), and the International Institute of Information Technology, Bangalore (IIITB). This initiative is supported by the Department of Foreign Affairs and Trade (DFAT), Australia, under the Australia-India Cyber and Critical Technology Partnership (AICCTP) Grant.

Recognising the critical importance of cyber technologies and their growing influence on international relations, the AICCTP was formed to foster an open, secure, free, accessible, stable, peaceful, and interoperable cyberspace. Emerging technologies like Artificial Intelligence, next-generation telecommunications, the Internet of Things, quantum computing, synthetic biology, blockchain, and big data are central to this partnership.

The project is grounded in the comprehensive strategic partnership between India and Australia, signed in June 2020. It fosters cooperation between both countries, particularly developing next-generation networks such as 5G and 6G, emphasising security, resilience, and diverse technology supply chains.

The project aims to identify elements for an ethical framework for future 6G technology, create an enabling environment for Indian and Australian institutions to participate in the 6G standard-making process, and develop opportunities for firms in both nations to invest in and promote 6G in the Indo-Pacific region.

The research outputs are divided into four components:

1. Understanding 6G: Development and Challenges
2. Strategic Opportunities for Australia and India from 6G
3. Standardising Standard Setting for 6G
4. Identifying Elements of an Ethical Framework for 6G.

Methodology

We used a two-stage methodology to investigate the challenges and issues related to 6G deployment. In the first stage, we reviewed recent literature, including research papers, industry reports, and government regulations and policies, focusing on key techno-social aspects of 6G. This included examining standards, cooperation between Australia and India, and ethical frameworks addressing issues such as privacy, trust, competition, and sustainability.

In the second stage, based on the insights gained from this literature survey, we conducted structured interviews with experts in the technical, socio-economic, legal, and regulatory fields from August 2022 to February 2024. These interviews were carried out both online and during workshops held in Delhi and Bangalore, India, as well as at the Australian National University in Australia.

Category	Number of Experts: Technical	Number of Experts: Social science, economics, legal, policy
Academia (Researchers and Faculty at Universities and Institutes)	9	5
Industry (Mobile Network Operators, Mobile Chip Design firms, Network Equipment Manufacturers, Telecom start-ups, Enterprise service providers)	4	4
Civil Society/Policy Advocates	1	7
Industry Associations (of Telecom operators, Internet companies)	3	4
Government representatives/ Regulatory bodies	2	6
Total	**19**	**26**

1 Strategic Horizon Scans: Australia and India

A strategic alliance or partnership is a commitment to work together on a project that will benefit all parties involved, producing results that a single partner operating alone could not achieve. In the present context, Australia and India can collaborate to develop niche solutions to country-specific problems with 6G, facilitating effective development and deployment of 6G, strengthening supply chains, and expanding trade and investment opportunities.

1.1 Australia and India as Natural Partners in the Indo-Pacific

Both Australia and India are emerging powers in the Indo-Pacific region with complementary technological strengths. India has the world's second-largest telecommunications market, with 1.18 billion subscribers (wireless + wireline) as of September 2023.[1] India has an overall teledensity of 84.76 percent, with the rural market (largely untapped) having a teledensity of 58.05 percent and the urban market having a teledensity of 133.54 percent.

India's digital economy is expected to be worth US$1tn by 2025. It is a significant provider of information technology (IT) and IT-enabled services (ITES). Indian IT and ITES companies have established over 1,000 global delivery centres in 80 countries.[2] Through initiatives like **Make in India**, the **National Semi-Conductor Mission**, the **National Quantum Mission**, and **Production Linked Incentives (PLI)**, India is investing more and significantly emphasising developing national capabilities in important sectors.

The Indian government launched the Telecom Technology Development Fund scheme in early 2022 to support start-ups involved in designing, developing and commercialising applications based on 5G and 6G. In 2023, the Indian government expanded the PLI scheme for IT gear, allocating Rs17,000 crore.[3] This initiative aims to attract global IT hardware manufacturers to set up operations in India, promoting domestic production of laptops, servers, and PCs, consequently stimulating

investment, fostering local manufacturing, generating jobs, and enhancing competitiveness. This rapid indigenisation drive aims to gain control and maximise supply chain security and trust.[4]

Australia, on the other hand, has comparative global strengths in research, education, and training. Australia has areas of technical strength like design capability in radio frequency (RF), millimetre wave (mm-wave), semiconductors, photonics and radar; research expertise in quantum computing, communications, nanotechnology, and many more.[5] The country has vast reserves of critical minerals, such as lithium and cobalt, which are crucial for sustainable energy technology- examples include batteries and electric vehicles, alongside mobile phones and computers. Australia also has rich deposits and reserves of silica and rare earth minerals like hafnium, bismuth, indium and rhenium[6], which are essential for the semiconductor industry.

The Australian government heavily invests in the defence and strategic technology sectors. The public sector in Australia is increasing its investment in technology policy expertise, and policymaking in that area is gradually becoming more strategic and long-term. The country also has a significant edge in quantum computing technology. Australia's role as a first mover in making sensitive critical technology policy decisions ahead of the rest of the world, such as banning 'high-risk' vendors from its 5G network in 2018, has resulted in governments worldwide looking to Australia for policy insight and advice.[7] Australia is also heavily promoting domestic tech start-ups.

However, Australia and India lag behind their counterparts in technology innovation and readiness for technology. According to Global Innovation Index 2022 rankings by WIPO (Figure 1), Australia is ranked 25th in the world while India is ranked at 40th position.[8] The Readiness for Frontier Technologies Index, 2021 by UNCTAD[9] evaluates countries based on their readiness in areas such as artificial intelligence (AI), robotics, Internet of Things (IoT), and blockchain. Australia and India's respective rankings, while showcasing their progress in frontier technology readiness, also exhibit the gap between the two nations' readiness between themselves and *vis-à-vis* other nations.

Figure 1: Readiness for Frontier Technologies Index, 2022
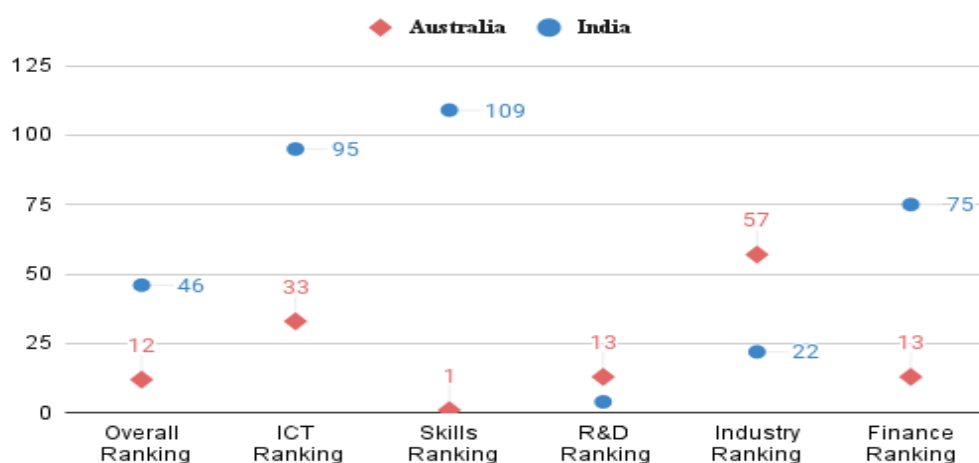
Source: Technology and Innovation report, 2022, UNCTAD

Australia and India share a strong bilateral relationship, supported by continuing collaboration across many areas of mutual interest to advance security and stability in the Indo-Pacific region. Table 2 provides some examples of Australia-India strategic collaborations.

Table 1: Australia-India Strategic Collaborations in Different Fora

Australia-India Collaboration	Detail
Australia-India Framework for Security Cooperation	To deepen and expand security and defence engagement between Australia and India and to intensify cooperation and consultation in areas of mutual interest.[10]
Regular Strategic Dialogues	Defence Policy Talks, Australia-India Maritime Dialogue, Annual 1.5 Track Defence Strategic Dialogue, etc.
Indo-Pacific Oceans Initiative (IPOI)	To enhance the management of the shared oceanic domains, including in crucial areas of cooperation such as preserving maritime ecology and reducing the impact of marine pollution (particularly plastics); maritime security; sustainable use of marine resources; capacity building and resource sharing; disaster risk reduction and management; science, technology, and academic cooperation; and trade, connectivity, and maritime transport.[11]

Source: Authors' Compilation

1.2 Australia-India Bilateral Cooperation in Technologies

In 2020, Australia and India elevated their strategic partnership to a Comprehensive Strategic Partnership. The Australia-India bilateral cooperation in technology is supported by government and academic collaborations (Table 3).

Table 2: Australia-India Bilateral Cooperation in Technology

Collaborative efforts	Detail
Australia-India Cyber and Critical Technology Partnership Grants (AICCTP)	• US$12.7mn investment by the Australian government. • To foster the collaboration of Australian and Indian organisations to contribute to the global development of ethical standards for crucial and emerging technologies.
Establishment of a new consulate and the Australia-India Centre of Excellence in Bengaluru	An Australia-India Innovation Network, at the recent Bengaluru tech summit.[12]
The Australia-India Strategic Research Fund (AISRF)	• Assist research institutions in Australia and India collaborating on strategically focused, cutting-edge scientific research and technology projects. • The fund will support research collaboration across more than 20 mutual priority areas, with information and communication technology being one of them.[13]
Cyber-Tech Women Entrepreneur Programme for Indian and Australian women entrepreneurs	• Australian Department of Foreign Affairs, in collaboration with the Government of Telangana, India • Provide market access and business pathways programme for women-led technology businesses in Australia and India.[14]

In July 2022, Australia and India decided to strengthen their partnership in projects and supply chains for critical minerals. The Khanij Bidesh India Limited (KABIL), a joint venture between three public sector companies and Australia's Critical Minerals Facilitation Office (CMFO), signed a memorandum of understanding (MoU) to ensure a consistent supply of critical and strategic minerals to the Indian domestic market.[15]

1.3 Australia-India Regional and Multilateral Cooperation on Cyber and Critical Technologies

Australia and India actively collaborate in multilateral and regional platforms in the Indo-Pacific. Among these, the Quadrilateral Security Dialogue, commonly known as the Quad, is a semi-formal but strategically significant grouping of four countries - the United States, Australia, India, and Japan – and is one of the most important. This is because Quad resolved to "begin cooperation on the critical technologies of the future to ensure that innovation is consistent with a free, open, inclusive, and resilient Indo-Pacific" (Table 4).[16]

In the Quad Leaders Meeting of September 2021, the leaders announced the formation of sector-specific contact groups to create technical standards for new technologies. With the intention of "leading not only the region but the world towards responsible, open, high-standards innovation," they established the Quad Principles on Technology Design, Development, Governance, and Use.[17]

Recognising supply chain vulnerabilities, the Quad leaders decided to "map the supply chain of critical technologies and materials" and diversify it. Another regional initiative that looks at the supply chains of critical technologies is the Supply Chain Resilience Initiative (SCRI), which India, Japan, and Australia launched to counter the Chinese dominance of the supply chains in the region.[18]

Table 3: Quad Initiatives on Critical and Emerging Technologies

Quad agreement	Detail
Quad Senior Cyber Group	To work on government-industry collaboration in areas such as shared cyber standards; development of secure software; workforce and talent development; and promoting the scalability and cyber security of secure and trustworthy digital infrastructure, etc.[19]
Quad Leaders' Summit in May 2022	• Issued a joint statement stating that the Quad countries will advance interoperability and security by signing a new Memorandum of Cooperation on 5G Supplier Diversification and Open RAN. • Convening industry partners through a Quad Investors Network and through advancing technical standards

Quad agreement	Detail
	cooperation through the International Telecommunication Union's Telecommunication Standardisation Sector and the new International Standards Cooperation Network.
Common Statement of Principles on Critical Technology Supply Chains	To speed up cooperation on semiconductors and other critical technologies. Similar efforts are being made to align the common interests of other like-minded countries and further expand the agenda of a free and open Indo-Pacific through initiatives such as Quad Plus.[20]
Quad Joint Statement	Cooperation to Promote Responsible Cyber Habits.[21]

In the latest Quad summit convened by Australia in May 2023, among other things, understanding the following positive, practical agenda[22] came out:

- Stepping up efforts to strengthen supply chain resilience and improve the region's digital connectivity through access to critical and emerging technologies and advanced telecommunications technology, including 5G networks.

- A commitment to ensure that regional countries are not left behind as telecommunications markets and network architectures evolve; support for the access to innovations, such as Open RAN, that enable greater vendor choice for countries to expand and modernise their telecommunications networks; and the release of the Open RAN Security Report which is expected to promote industry investment in approaches to telecommunications that are demonstrably open, interoperable, trusted and secure.

- The Quad International Standards Cooperation Network and the Quad Principles on Critical and Emerging Technology Standards were released, reflecting support for industry-led, consensus-based multi-stakeholder approaches to the development of technology standards.

- Launch of the private sector-led Quad Investors Network (QUIN), which aims to facilitate investments in strategic technologies, including clean energy, semiconductors, critical minerals, and quantum.

Other regional groupings in which Australia and India cooperate for broader economic developments include the Group of Twenty (G-20) and the Indo-Pacific Economic Framework for Prosperity (IPEF). A brief description of the groups is as follows:

- Group of Twenty (G-20): An intergovernmental forum of 19 countries and the European Union (EU). Initially focused largely on broad macroeconomic issues, it has since expanded its agenda to *inter-alia*, including trade, climate change, sustainable development, health, agriculture, energy, environment, and anti-corruption (GOI n.d.).

- Indo-Pacific Economic Framework for Prosperity (IPEF): Launched by the United States of America (US) in May 2022, it aims to advance resilience, sustainability, inclusiveness, economic growth, fairness, and competitiveness through cooperation, stability, prosperity, development, and peace within the region (USTR n.d.).

- Supply Chain Resilience Initiative (SCRI): Australia, Japan, and India launched the initiative in 2021 to strengthen supply chains and promote strong, sustainable, balanced, and inclusive growth in the region. The trade ministers met in 2021 and decided to undertake certain initiatives and meet once a year (DFAT 2022).

Telecommunications technologies and their associated issues, such as critical and emerging technologies, cybersecurity, critical minerals, and skills gaps, are becoming increasingly important in the plans of countries and regional groupings. Table 4 illustrates that these issues have been addressed through work programmes of relevant G-20 and Quad working groups. They have been included under one of the pillars of the IPEF and discussed by the respective trade ministers under the SCRI.

Table 4: Common Country/Regional Groupings between Australia and India

	Relevant Initiative	Details	Members
G-20	Digital Economy Working Group	Offers inspiration and broad guidance to policymakers on harnessing the digital potential of economies. The Working Group aims at digital transformation to enhance public participation and realise inclusive social and economic growth	Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Republic of Korea, Mexico, Russia, Saudi Arabia, South Africa, Türkiye, United Kingdom, United States and the European Union
Quad	Working Group on Critical and Emerging Technologies	Mapped collective capacity and vulnerabilities in global semiconductor supply chains and launched Common Statement of Principles on Critical Technology Supply Chains, providing a cooperative foundation for enhancing regional supply-chain resilience. Quad partners are exploring ways to collaborate on deploying open and secure telecommunications technologies in the region, working with industry through Open RAN Track 1.5 dialogues	United States, Japan, India, and Australia
IPEF	Supply Chains	Aims to secure access to key raw and processed materials, semiconductors, critical minerals and clean energy tech, particularly for crisis response measures and ensuring business	Australia, Brunei Darussalam, Fiji, India, Indonesia, Japan, the Republic of Korea, Malaysia, New Zealand, the Philippines,

	Relevant Initiative	Details	Members
		continuity by mapping critical mineral supply chains	Singapore, Thailand, and Vietnam
SCRI	Trilateral meeting between Trade Ministers	Adopt risk management and continuity plans through policy measures to support the enhanced use of digital technology and trade and investment diversification	India, Japan and Australia

Source: Author's Compilation, 2022

In addition, Australia and India have expressed a willingness to collaborate to strengthen mutual interests on various multilateral fora, such as the United Nations and the International Telecommunications Union, in developing international standards, norms, and frameworks for cyberspace and critical and emerging technologies, the Ad Hoc Committee to Elaborate a Comprehensive International Convention on Countering the Use of Information and Communication Technologies for Criminal Purposes, the UN Group of Governmental Experts on Advancing responsible State behaviour in cyberspace and the UN Open-Ended Working Group on developments in Information Telecommunications etc.[23]

1.4 Potential Roadblocks for Australia and India's Cooperation on Cyber and Critical Technologies

There are several potential roadblocks to the development of a strong Australia-India partnership.[24] India has long maintained its strategic autonomy and has not chosen any particular side to preserve and expand its freedom of action. Australia, on the other hand, has always been a member of the Western alliance system, raising the prospect of its political positions on global fora being influenced by this alliance.[25]

Some challenges that can hinder Australia-India collaboration in cyberspace include differences in regulatory and intellectual property rights frameworks, as evidenced by varying approaches to data protection and privacy laws. Furthermore, a lack of shared understanding of technology standards poses a barrier. The absence of standardised norms complicates interoperability and seamless collaboration in developing and deploying cyberspace technologies.[26]

Despite facing challenges, Australia and India are witnessing notable advancements in recent bilateral cooperation, evident through the signing of AICCTP. Technological collaboration, though in its initial stages, holds significant potential to advance national interests and thereby contribute to strengthening the regional order. Opportunities abound in areas like artificial intelligence, quantum computing, and 6G networks, offering avenues for strengthened collaboration in the future.

2   Australia and India Trade and Investment Opportunities

2.1 Australia-India Trade and Investment Relations: An Overview

Australia and India have disparate economies and population sizes. As per World Bank Country and Lending Groups classification for the fiscal year 2023, Australia is classified as a high-income economy and India as a lower-middle income economy (World Bank, n.d.). As per World Development Indicators, the population in Australia was 25 million, whereas that in India was 1.4 billion people in 2021. Australia is said to be India's 17th largest trading partner and India Australia's ninth largest trading partner.

Turning to investment, foreign direct investment (FDI) Australia has been a net investor in India, but its FDI flows peaked in 2010 and have been declining since then, experiencing negative FDI flows in 2020 and 2021 (i.e. during the COVID-19 Pandemic). Data on India's FDI flows to Australia from 2012 shows that these flows fluctuated between positive and negative.[27]

Australia and India signed a free trade agreement (FTA) in April 2022, formally titled Australia-India Economic Cooperation and Trade Agreement (AI-ECTA) that includes a range of issues, namely trade in goods, trade in services, trade remedies, rules of origin, customs procedures and trade facilitation, sanitary and phytosanitary measures, technical barriers to trade, transparency, and dispute settlement. Arguably, the AI-ECTA does not go far enough in terms of liberalising trade between the two countries in terms of both the depth of the agreement and coverage of issues. Indeed, AI-ECTA is termed an interim agreement, and the parties are working out a Comprehensive Economic Cooperation Agreement (CECA) between the two countries (DFAT, 2022).

2.2 Australia-India Trade and Investment Partnership in Telecom and Critical Technologies

Despite the growing trade and investment relations, bilateral trade and investment volumes between Australia and India remain relatively low (Mukhopadhyay and Saha, 2022). The trends are not too optimistic for the specific segment of technology and

telecommunications (telecom). Bilateral trade between the two countries in technology goods fluctuated between 2010 and 2021. Bilateral trade in technology goods was US$7.84bn in 2010 and US$4.26bn in 2021. Though there is a slightly upward linear trend, there have been wide fluctuations in between, with bilateral trade falling to US$0.24bn in 2011 and rising to US$11.42bn in 2016. As the percentage of the respective country's total trade in technology goods, bilateral trade in technology goods remains low for India (less than 1 percent for the period under consideration), and slightly higher for Australia (between 0.5 percent-2.5 percent for the period under consideration).[28]

Figure 2: Bilateral Trade in Telecom, Computer, and Information Services
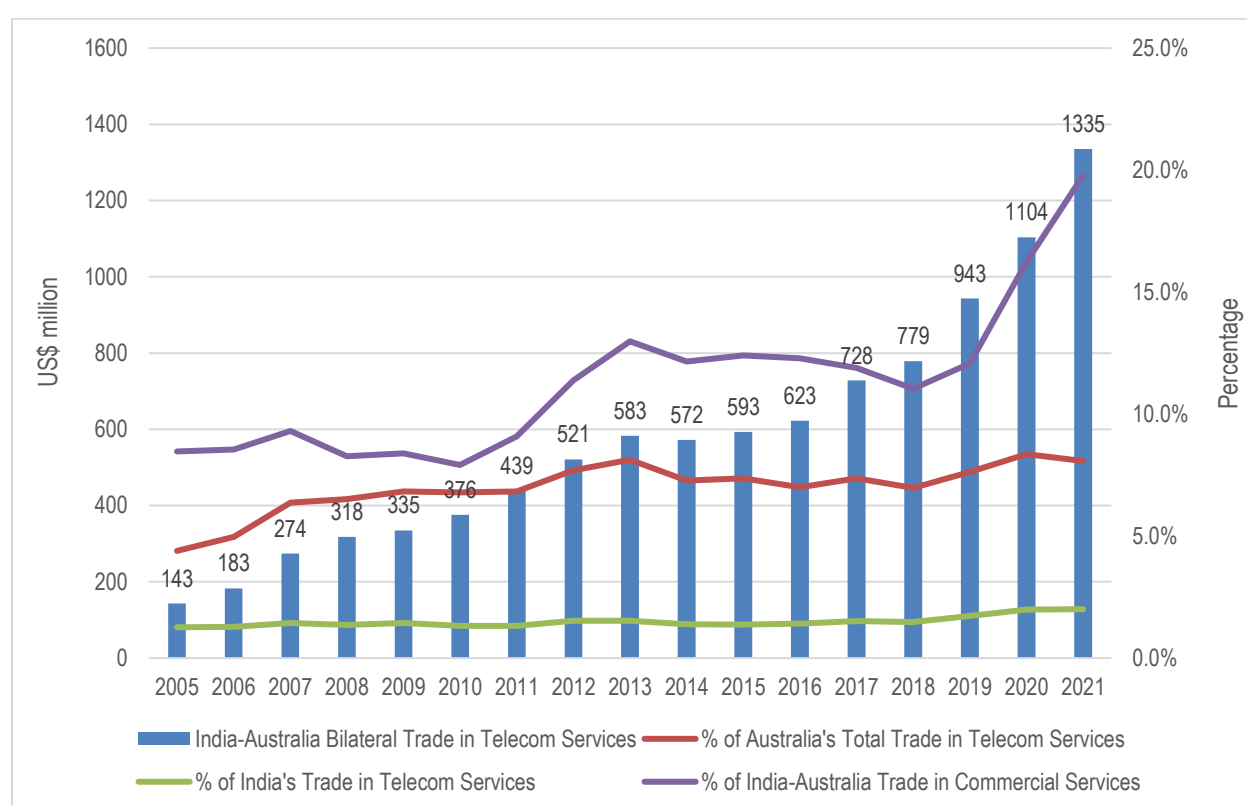
Note: The Percentage of total trade figures are measured against the secondary vertical axis; bilateral trade in US$mn is measured against the primary vertical axis

Source: Adapted from WTO Stats

Similarly, bilateral trade in telecom equipment fluctuated between 2010 and 2021 despite an upward linear trend. In 2010, bilateral trade in telecom equipment was US$16.2mn, and in 2020, the same was US$35.5mn but fell to US$15.5mn in 2021. In terms of shares in respective countries' total trade in telecom goods, the percentages varied from 3 to 21 per cent for India and 6 to 39 per cent for Australia, indicating

bilateral trade in telecom goods is a more important component of trade between the two countries than that in technology goods.[29]

Table 5: Bilateral Trade between Australia and India in Telecom, Computer, and Information Services

Year	Australia-India Bilateral Trade in Telecom Services (US$mn)	% of Australia's Total Trade in Telecom Services	% of India's Trade in Telecom Services	% of Australia-India Trade in Commercial Services
2005	143	4.4%	1.3%	8.5%
2006	183	5.0%	1.3%	8.5%
2007	274	6.4%	1.4%	9.3%
2008	318	6.5%	1.4%	8.3%
2009	335	6.8%	1.4%	8.4%
2010	376	6.8%	1.3%	7.9%
2011	439	6.8%	1.3%	9.1%
2012	521	7.7%	1.5%	11.4%
2013	583	8.1%	1.5%	13.0%
2014	572	7.3%	1.4%	12.1%
2015	593	7.4%	1.4%	12.4%
2016	623	7.0%	1.4%	12.3%
2017	728	7.4%	1.5%	11.9%
2018	779	7.0%	1.5%	11.0%
2019	943	7.6%	1.7%	12.1%
2020	1104	8.4%	2.0%	16.2%
2021	1335	8.1%	2.0%	19.8%

Source: Adapted from WTO Stats

Services trade data shows a more optimistic picture. Bilateral trade between Australia and India in telecom, computer and information services has steadily increased since 2005. Bilateral trade in 2005 was US$143mn and in 2021 was US$1335mn, an increase of 923 per cent (Figure 2 and Table 6). Data on bilateral sectoral investment between Australia and India is not readily available. There is anecdotal evidence of the growing importance of the technology sector. Reportedly, 40 Australian companies are active in India now in the mining equipment, technology and services sector. This includes BHP Billiton and Telstra. Similarly, Indian companies, such as Indian IT companies Tata Consultancy Services and Infosys, have shown interest in Australia in the technology sector (Invest India n.d.).

Telecom and technology, particularly 6G and its associated issues such as critical technologies, cyber security, and essential minerals and skills gaps, are increasingly featured in the country's and regional groupings' plans. The previous chapter discusses the issues that have been taken up through work programmes of relevant G-20 and Quad working groups, have featured under one of the pillars of the IPEF, and have been discussed by the respective trade ministers under the SCRI.

Further, India joined the Mineral Security Partnership (MSP) in June 2023 during Prime Minister Narendra Modi's visit to the United States. India's Mineral Security Partnership (MSP) entry will enhance critical mineral supply chains, support clean energy transition, boost global leadership, and foster strategic investments.

In contrast to the regional and geo-political groupings detailed in the previous section, the AI-ECTA has binding commitments on the areas agreed upon by Australia and India. The AI-ECTA includes certain provisions that could strengthen Australia-India relations on 6G and associated issues such as critical technologies, cyber security, critical minerals, skills development, etc. The exhaustive list of provisions under the agreement which have the potential to benefit areas of critical technology is provided in Table 7. While 6G or advanced technologies have not been mentioned in the main texts, the annexes or the side letters, the AI-ECTA gives scope for these to be taken up or for the sector to benefit directly or indirectly. It should be noted that some of the provisions are on a best-effort basis or provide for further negotiations on the terms that could benefit the sector.

"The success of ECTA speaks to the complementary nature of our economies. Put simply: India has what Australia needs; Australia has what India needs. We have the critical minerals India requires to fuel the transition to net zero and hit its ambitious export targets. Australia has the high-quality universities India needs to educate the roughly 70 million young Indians looking for a tertiary qualification by 2030. India has a skilled workforce that can take two-way investments between our countries and transform them into the manufacturing supply chains of the future. When it comes to our economies, our resources, and our skills, Australia and India are a match. A perfect fit."[30] - Philip Green, Australia's High Commissioner to India.

Table 6: Provisions of the AI-ECTA Relevant for Critical Technologies

Sector	Detail	Implications for commercial use
Trade in Goods	Reduction of tariff or zero tariff on critical and rare minerals: aluminium, lithium, rutile (titanium), zircon (zirconium), cobalt, manganese, antimony, tungsten, vanadium, niobium, manganese etc. Binding commitments, i.e., countries must reduce tariffs as per their tariff commitment schedules.	Crucial minerals can be exported at lower cost from Australia to India. Potential use in telecom and electronics, renewable energy, metals, chemicals, and automobiles in India. The large captive market for Australian minerals.
Trade in Services	Annexe on telecom services – a provision for further cooperation on communication networks, infrastructure and technologies. Cooperation provision is on a best endeavour basis, i.e. not binding.	Issues related to 6G may be taken up for further cooperation between Australia and India as part of this chapter to the benefit of companies from respective countries
Side Letter on Work Visas	Indian graduates studying in Australia in STEM (Science, Technology, Engineering and Mathematics) fields including Indian Information and Communications	Satisfy demand for technically qualified professionals in Australia on a short-term basis.

Sector	Detail	Implications for commercial use
	Technology (ICT) professionals with First Class Honours, including ICT fields, will be granted extended post-study visas for two to three years in Australia. The side letter's commitments will be consistent with those made under the Temporary Movement of Natural Persons chapter.	Skills development for Indian professionals, which Indian industries can tap into once professionals return to India.
Technical Barriers to Trade	Provisions on Mutual Recognition Agreements are needed for the results of the conformity assessment and further cooperation on MRAs. The next step is to negotiate MRAs have to be negotiated between the countries	Future MRAs on relevant standards for 6G and other critical and advanced technologies can be taken up between Australia and India. Reduce barriers to trade in advanced technology goods between the countries

Though those mentioned above will benefit future work on the 6G ecosystem between Australia and India and set a head start, the AI-ECTA still needs to fill the vacuum. The said agreement does not include chapters on investment, competition, intellectual property rights, and public procurement, nor does it signal any intent to work on advanced technologies, cyber security, critical minerals, etc., i.e. the areas which would exert significant influence on 6G partnerships between the two countries.

Table 7: Areas of the Comprehensive Strategic Partnerships Relevant to Critical Technologies

Area	Details	
Science, Technology and Research Collaboration	Digital economy, cyber security and critical and emerging technologies identified by the *Framework Arrangement on Cyber and Cyber-Enabled Critical Technology Cooperation*	Resources partnership through a *Memorandum of Understanding (MOU) on Cooperation in the field of Mining and Processing of Critical and Strategic Minerals*
Economic cooperation	Engage in a bilateral *Comprehensive Economic Cooperation Agreement (CECA)*	Taxation of offshore income of Indian firms through the use of the *Australia-India Double Taxation Avoidance Agreement*
Innovation & Entrepreneurship	Enhance cooperation in the Micro, Small and Medium Enterprises sector.	
Education, Culture, Tourism and People-to-People ties	Cooperation in policy development, programme delivery and information exchange through *Memorandum of Understanding on Cooperation in Vocational Education and Training*	

Source: DFAT, 2020

Issues related to critical and cyber technologies, including 6G and associated issues, are more comprehensively covered through other bilateral initiatives outside of the AI-ECTA but within the Comprehensive Strategic Partnership. As part of it, cyber policy dialogues are being held by the two countries, which discuss issues such as strategic priorities, cyber threat assessment, next-generation telecom, capacity building and cooperation in the Indo-Pacific region and the UN. It also includes the AICCTP, as part of which three rounds of grants have been provided for practical cooperation and collaboration on cyber and critical technologies.

Among others, the Cooperation in the field of Mining and Processing of Critical and Strategic Minerals is a significant one. A notable cooperation component is a memorandum of understanding (MOU) signed on the Australia-India Critical Minerals Investment Partnership. The partnership aims to ensure reliable supplies of critical and strategic minerals to India.

As part of the Cooperation in the Fields of Education, Training, and Research between Australia and India, two initiatives were launched in 2022 on upskilling the Indian workforce and accessing the Indian innovation ecosystem by Australian technology companies—both of which are relevant to the field of critical and cyber technologies (Table 9).

Table 8: Other Bilateral Initiatives between

Australia and India Relevant for Critical Technologies

Name of the Initiative	Details	Recent Outcomes
Framework	1. Plan of Action 2020-25 2. Cyber policy dialogues 3. Grants as part of the Australia-India Cyber and Critical Technology Partnership	5th cyber policy dialogue organised in November 2022: - explore further opportunities for further collaboration with the private sector and academia - conduct a cyber bootcamp - conduct cyber and tech policy exchanges.[31] 3rd round of AICCTP grant awarded
Cooperation in the field of Mining and Processing of Critical and Strategic Minerals	1. MOU on Australia-India Critical Minerals Investment Partnership; Australia to commit US$5.8mn to the three-year partnership	Outcome of the MOU: - Identify companies in Australia in the critical mineral space for acquisition by Indian companies after a cooperative due diligence

Name of the Initiative	Details	Recent Outcomes
	2. Australia-India Critical and Strategic Minerals Joint Working Group	on Australian mining assets for lithium and cobalt
Cooperation in the Fields of Education, Training and Research	1. MOU on Vocational Education and Training (VET) to establish new pathways between the two countries to share information and best practices between the respective VET systems. 2. Biennial meetings of Australia-India Education Council	Launched in 2022: - Australia India Future Skills Initiative to support skilling capacity in India by upskilling India's workforce. - The Australia India Innovation Network will support Australian technology companies to access India's innovation ecosystem. Meeting of Australia-India Education Council in 2022: - Establish a working group on transnational education to strengthen institutional partnerships and collaborations between universities.

Source: Author's Compilation from Various Sources

However, neither the AI-ECTA nor the bilateral initiatives outside the FTA have included a few other issues crucial for developing 6G. These include inadequate development of critical mineral value chains in India and the absence of commercial-scale local technologies in India to process critical minerals in its downstream industries.

3   Australia and India's Cyber Security Landscape

Australia and India are both sensitive to national security matters. In 2018, Australia became the first country to ban Huawei and ZTE from participating in its 5G rollout, instead partnering with global industry leaders such as Ericsson, Nokia, and others.[32] The 2020 Defence Strategic Update for Australia recognises cyber warfare as a key enabler of "grey zone activities," and calls for enhanced cyber capabilities. The 2023-2030 Australian Cyber Security Strategy[33] envisages a stronger cyber defence, keeping Australian citizens and businesses at its core. The Government will work with industry to reinforce these shields and achieve national cyber resilience.

India has also acknowledged the significance of cybersecurity and privacy, which is evident in its recent implementation of data protection legislation. Additionally, there are plans to introduce a Digital India bill that may encompass provisions related to cyber security. According to the ITU's Global Cyber Security Index 2020,[34] India is ranked 10th and Australia 12th in the world and is classified as having a "high commitment" to cyber security (Table 7).

Table 9: ITU's Global Cyber Security Index 2020

Country Name	Score	Rank	Country Name	Score	Rank
United States of America	100	1	**India**	97.5	10
United Kingdom	99.54	2	Turkey	97.49	11
Saudi Arabia	99.54	2	**Australia**	97.47	12
Estonia	99.48	3	Luxembourg	97.41	13
Korea (Rep. of)	98.52	4	Mauritius	96.89	17
Singapore	98.52	4	Brazil	96.6	18
Spain	98.52	4	Indonesia	94.88	24
Russian Federation	98.06	5	Viet Nam	94.59	25

Country Name	Score	Rank
United Arab Emirates	98.06	5
Malaysia	98.06	5
Lithuania	97.93	6
Japan	97.82	7
Canada	97.67	8
France	97.6	9

Country Name	Score	Rank
China	92.53	33
Thailand	86.5	44
New Zealand	84.04	48
Philippines	77	61
Myanmar	36.41	99
Papua New Guinea	26.33	118

Source: Adopted from Global Cyber Security Index 2020, by the International Telecommunication Union (ITU)

3.1 India's Case of Cyber Security

The speed and sheer scale of India's digitisation are outpacing its capacity to manage cybersecurity. The 2023 Cyber Defence Index report by MIT Technology Review ranked India 17th among the 20 largest and most advanced digital countries. It mentioned that India is making slow and uneven progress or commitment toward creating a cyber defence environment.

Measures taken by the Indian government to enhance national cyber security resilience include the Cyber Swachhta Kendra (Botnet Cleaning and Malware Analysis Centre) to detect malicious programmes and provide free removal tools, the Cyber Crime Prevention for Women and Children (CCPWC) Scheme, as part of which the Government of India has established Cyber Forensic cum Training Laboratories and instituted capacity-building programmes related to cyber awareness and cybercrime investigation, and dedicated Cyber Diplomacy Divisions, as well as a New and Emerging Strategic Technologies Division set up by India's Ministry of External Affairs.[35]

In December 2020, the Cabinet Committee on Security, led by the Prime Minister, approved the ***National Security Directive on the Telecommunication Sector (NSDTS)*** in response to increasing technology-related risks to national security. The NSDTS aims to safeguard the telecom supply chain by establishing a list of trusted sources and products for installation in the country's networks while also identifying prohibited procurement sources. Entities meeting the Department of Telecom's

preferential market access scheme (PMA) criteria will be certified as "India Trusted sources."[36] Furthermore, the Department of Telecommunications has set ***Indian Telecom Security Assurance Requirements (ITSARs)*** and ***Security Assurance Standards (SAS)*** for mobile and network communications devices and equipment.[37]

India does not have a standalone cyber-security regulation. ***National Cyber Security Policy, 2013*** aimed at creating a secure cyberspace ecosystem, protecting digital data and infrastructure, reducing vulnerabilities, building capabilities to prevent and respond to cyber threats, and minimising damage from cyber-attacks. The policy had limited success in achieving its stated objective, which led the Indian government to notify a new Cyber Security Strategy, though it has not been formalised yet. Two major legislations have provisions related to cyber governance – the Information Technology Act and the Indian Penal Code (Table 11 has more details).

Table 10: Indian Regulations with Provisions on Cyber Security

Regulation	Detail
A. *The Indian Penal Code 1860*	• Provides punishments for certain offences committed in cyberspace, such as defamation, cheating, criminal intimidation and obscenity.
B. *The Information Technology Act, 2000*	• According to Section 43A of the IT Act, Indian companies and organisations must have "reasonable security practices and procedures" to guard against the loss, theft, alteration, disclosure, or abuse of sensitive data. • According to Section 72A of the IT Act, any intermediaries or individuals that disclose personal data without the owner's authorisation (with malicious intent and inflicting harm) are subject to a maximum three-year prison sentence, a maximum fine of Rs500,000, or both.
a. *IT Act (as amended in 2008)*	With over nine chapters and 117 sections, the Act covers crucial information security procedures for preventing cybercrime and protecting personal data. It involves - enhancing forensics and cybersecurity measures - preventing the use of computers for illegal or unauthorised purposes

Regulation	Detail
	- defending sensitive data and information against identity theft, phishing, malware, and cyberterrorism - legal recognition of organisational cybersecurity - e-payment and electronic transaction security, as well as tracking and decrypting electronic records - creating a framework for legalising digital signatures - identifying and controlling intermediates Section 69 permits the Indian government to swiftly intercept, monitor, decrypt, block, and erase data and material at its discretion.
b. *Information Technology (Reasonable Security Practices and Procedures and Sensitive Personal Data or Information) Rules, 2011* (SPDI rules) (u/IT Act)	• Requires companies to implement reasonable security practises and procedures when dealing with data. • Allows people to edit their information, establish disclosure and data transfer limitations, and take security precautions. • Includes clauses governing intermediaries, revised fines and violations for cheating, slander, releasing private photographs without consent, and censoring/restricting particular speech.
c. *Information Technology (The Indian Computer Emergency Response Team and Manner of Performing Functions and Duties) Rules, 2013 (u/IT Act)*	• Notified the Computer Emergency Response Team (CERT-In) as the administrative agency responsible for collecting, analysing, and disseminating information on cyber security incidents and responding to emergencies. • Also impose obligations on intermediaries and service providers to report cyber security incidents to the CERT-In.
d. *Information Technology (Information Security Practices*	• Requires companies having protected systems, as defined under IT Act, to put in place specific information security measures

Regulation	Detail
and Procedures for Protected System) Rules, 2018 (u/IT Act)	
e. The Information Technology (Guidelines for Intermediaries and Digital Media Ethics Code Rules, 2021) (u/IT Act)	Requires intermediaries to implement reasonable security practices and procedures to secure their computer resources and information, maintaining safe harbour protections.

India also has sector-specific laws that incorporate provisions on cybersecurity. These include the Companies (Management and Administration) Rules 2014, cyber security rules by the Reserve Bank of India, the Insurance Regulatory and Development Authority of India, the Securities Exchange Board of India, and the National Health Authority of India. Likewise, multiple cybersecurity regulating bodies are involved in the application of cybersecurity-related rules and regulations (Table 12).

Table 11: Cybersecurity Regulating Bodies

Cybersecurity Regulating Bodies	Details
Computer Emergency Response Team (CERT-In), under the IT Act, 2000	CERT-In operates as the principal task force that analyses cyber risks, vulnerabilities, and warning information, responds to data breaches and cybersecurity issues, coordinates adequate incident response to cyber threats and conducts forensics for incident handling, identify, defines, and implements appropriate countermeasures to cyber hazards, recommend best practices, rules, and safeguards to enterprises for cyber incident management so that they can respond effectively.
National Critical Information Infrastructure	NCIIPC must track and report threats to critical information infrastructure at the national level. Among the crucial sectors are power and energy, banking,

Cybersecurity Regulating Bodies	Details
Protection Centre (NCIIPC), under Section 70A of the IT Act, 2000	financial services, insurance, telecommunication and information, transportation, government, strategic industries, and public companies.
National Cyber Security Coordinator (NCSC)	The NCSC is a specialised agency within the Prime Minister's Office that coordinates and oversees the implementation of India's cybersecurity initiatives. It works closely with various government agencies and stakeholders to enhance the country's cybersecurity preparedness.
Cyber Crime Investigation Cell (CCIC)	The CCIC is a specialised unit within the Indian police force investigating and tackling cybercrime cases. It focuses on identifying and apprehending cybercriminals and providing support to cybercrime victims.

The Indian government is considering the Digital India Bill and the Indian Telecommunication Bill. **The Digital India Bill** will replace the 22-year-old Information Technology (IT) Act and strengthen the country's digital ecosystem and cyber-security.[38]

The Parliament also enacted the Digital Personal Data Protection Act 2023,[39] aiming to protect the personal data of citizens in India. The key features of the Act include its applicability to the processing of digital personal data within India, extending jurisdiction to data processed outside India for goods or services within the country. Emphasising consent and lawful processing, the Act outlines exemptions and specifies legitimate uses. Individuals are granted rights such as information access, data correction, erasure, and grievance redressal, with corresponding duties. Data fiduciaries must ensure data accuracy, security, and proper deletion, with government entities having specific exemptions. The Act establishes a Data Protection Board to oversee compliance, impose penalties, and handle grievances related to data transfer, outlining conditions and exemptions.

Further, the recently enacted Telecommunications Act 2023 encompasses key sector regulation provisions. Notably, authorisation from the Central Government becomes mandatory for telecommunication services, network operations, and possession of

radio equipment. Spectrum assignment would be primarily through auctions. The act permits re-purposing frequency ranges and facilitates spectrum sharing, trading, leasing, and surrender. Special provisions cater to satellite Internet providers. The Central Government will be able to specify telecom components and infrastructure standards. The legislation also addresses the right of way for telecom infrastructure on public or private property on a non-discriminatory basis. Additionally, the act upholds the Digital Bharat Nidhi, formerly the Universal Service Obligation Fund, allowing its utilisation for research and development and telecom services in underserved areas.

3.2 An Assessment of Australia's Cyber Security Resilience

Like India and Australia, there is no unified cyber law for managing cyber risks or cyber security incidents. Identification of cyber risks has been reactive, fragmented, and often too late. Cyber security regulations were divided among a mix of sector and/or conduct-specific obligations, such as the Privacy Act 1988, the Crimes Act 1914, the Security of Critical Infrastructure Act 2018, and the Telecommunications (Interception and Access) Act 1979.

However, with growing cyber-attack incidents against Australia from criminals and state-sponsored groups, the Australian Government has recently taken proactive measures to enhance cyber security. One such measure was Australia's ***Cyber Security Strategy 2020***, which aims to strengthen national cyber security regulations and be more resilient to cyber security threats. The strategy was to invest US$1.67bn over 10 years to achieve its larger objective through enacting mandatory governance standards for large businesses, cyber security codes, and mandatory standards requiring manufacturers and suppliers to disclose software vulnerabilities.

In November 2023, the Australian Government released the 2023-2030 Australian Cyber Security Strategy.[40] In this strategy, Australia's vision is to become a global leader in cyber security by 2030. The objective seems to be humanising cyber and making it appealing and accessible to everyday Australians. The strategy outlines the creation of six 'cyber shields' to strengthen Australia's defence against cyber threats, making it a more formidable target. In addition to fortifying defences, the strategy focuses on investing in national cyber resilience for swift recovery from cyber-attacks. Emphasising proactive measures, it leverages Australia's advanced cyber capabilities to deter malicious actors. An international collaboration effort is highlighted to disrupt the business model of ransomware and cybercrime.

The primary emphasis is strengthening businesses and citizens through initiatives like free cyber health checks for small and medium-sized businesses and establishing a cyber-security resilience service. Businesses are invited to participate in designing regulations addressing issues such as ransomware reporting, cyber incident review, and standards for smart devices. Proposed measures to address information-sharing gaps include a 'no fault, no liability' ransomware reporting proposal. The strategy also aims to facilitate industry-government threat intelligence sharing through platforms. Implementing the strategy, which includes a two-year horizon with accountability measures, is crucial to success.

There have been two recent amendments to the **Security of Critical Infrastructure Act, 2018** – a law that helps to build resilience and protect Australia's critical infrastructure. The first amendment to this Act was done in December 2021 and the second in April 2022. These cyber security reforms introduced two concepts – critical infrastructure risk management programmes and systems of national significance. It also expanded the list of infrastructure sectors deemed 'critical'. It also imposes strict obligations on operators and those holding direct interests in critical infrastructure assets to report on operational and ownership information, and cyber security incidents. The new framework includes the following features: a positive security obligation, government assistance measures, and enhanced cyber security obligations.[41]

The **Privacy Act 1988** was also recently reviewed, and some amendments were made, which came into effect in December 2022. These amendments increased penalties for serious and repeated interferences with privacy and strengthened the Information Commissioner's investigative and enforcement powers.

In 2018, a regulatory framework under Part 14 of the Australian Telecommunication Act, 1997 – also called the **Telecommunication Sector Security Reforms (TSSR) –** was introduced.[42] TSSR is a regulatory framework that manages the national security risks of espionage, sabotage, and foreign interference in Australia's telecommunications networks and facilities. It provides security and notification obligations to all carriers, carriage service providers, and carriage intermediaries, along with powers to gather information and issue directions to the Department of Home Affairs against such service providers.[43]

A Parliamentary Committee reviewed TSSR and provided some recommendations in its report of February 2022. The Committee recommends that relevant departments

conduct a joint environmental analysis of current national and international telecommunications markets and networks, which can guide future security of critical infrastructure legislative reform related to telecommunications. It also recommends better regulatory coordination between the Security of Critical Infrastructure Act, 2018 and TSSR to avoid overlap and duplications.[44]

Further, the **Telecommunications Amendment (Disclosure of Information for the Purpose of Cyber Security) Regulations 2022** was introduced. It contains measures to protect consumers who are victims of a significant data breach, including giving the right for Telco companies, under certain circumstances, to temporarily share sensitive data (e.g. government IDs) with financial institutions for up to 12 months following a breach. There are also the **Telecommunications (Carrier License Conditions – Security Information) Declaration** and **Telecommunications (Carriage Service Provider – Security Information) Determination 2022,** which creates new carrier licence conditions and service provider rules that together impose positive security obligations on carriers and eligible carriage service providers.[45]

Furthermore, the Australian government has established the Australian Cyber Security Growth Network (AustCyber) which has produced a Sector Competitiveness Plan, which is updated annually, catering to the needs and opportunities of different sectors of the economy. There is also the Academic Centres of Cyber Security Excellence (ACCSE), a programme launched in 2016, which established Centres of Cyber Security Excellence at the University of Melbourne and Edith Cowan University. In addition, Australia has a dedicated Ambassador for Cyber Affairs and Critical Technology since 2017, leading Australia's international engagements in cyberspace and critical technology. Further, the Australian Cyber Security Centre is a centralised centre bringing together all government cyber security assets and serves as an interface for collaboration and information-sharing.

But, in the wake of recent cyberattacks such as Optus and Medibank breaches, the Australian government has overhauled its cyber security strategy. The 2023-2030 Australian Cyber Security Strategy introduces six cyber shields to enhance cybersecurity, manage risks, and support citizens and businesses. This roadmap aims to make Australia a global cybersecurity leader by 2030, focusing on citizen protection, safe technology, threat sharing, critical infrastructure protection, sovereign capabilities, and global leadership for a resilient region.[46]

The Australian government's intention to ensure an effective cybersecurity regime is evident in the Cyber Defence Index, which ranked Australia as the number one country in terms of the relative maturity of its vital infrastructure and digital economy assets and its dedication to upholding and modifying the policies governing its multi-stakeholder digital transformation effort (Table 13).

Table 12: Cyber Defence Index Country Rankings, 2022-2023

Country Name	Score	Rank	Country Name	Score	Rank
Australia	7.83	1	Italy	6.37	11
Netherlands	7.61	2	China	6.27	12
South Korea	7.41	3	Germany	6.24	13
United States	7.13	4	Spain	6.13	14
Canada	6.94	5	Saudi Arabia	5.55	15
Poland	6.91	6	Mexico	5.31	16
United Kingdom	6.79	7	**India**	4.87	17
France	6.78	8	Brazil	4.75	18
Japan	6.71	9	Turkey	4.26	19
Switzerland	6.45	10	Indonesia	3.46	20

Source: MIT Technology Review Insights

3.3 Australia and India Collaboration on Cyber Security

Australia and India organised annual Cyber Policy Dialogues under the auspices of the Australia-India Framework Arrangement and Plan of Action 2020-2025. The **Cyber Policy Dialogue** provides a bilateral forum for Australia and India to discuss various high-profile issues of mutual interest, facilitating discussions for developing comprehensive and deeper cyber cooperation. Discussions at this dialogue included strategic priorities, cyber threat assessment, next-generation telecommunications capacity building, including 5G technology, cooperation in the Indo-Pacific region, and the latest developments in cyber at the United Nations, among other things.[47] In November 2022, the two sides agreed to jointly conduct a cyber-boot camp and cyber and tech policy exchanges with Indo-Pacific partners.[48]

The two countries also agreed to form a new cyber framework, including a five-year plan for collaboration on the digital economy, cybersecurity, and key and emerging technologies supported by AU$9.7mn funds for bilateral research.[49]

Australia established a new Consulate-General and a Centre of Excellence for Critical and Emerging Technology Policy in Bengaluru, India, to further strengthen its technology partnership with India. The new Consulate-General will focus on strengthening ties between Australia and India's vibrant innovators, technologists, and entrepreneurs. The Centre of Excellence for Critical and Emerging Technology Policy will bring together technologists, policy practitioners, academics, researchers, and thought leaders from Australia and India. It is a multi-stakeholder initiative that will aid in the responsible development and application of critical technologies and promote stronger investment and cutting-edge innovation. It will amplify Australia's and India's global policy impact while visiting fellows from across the Indo-Pacific will expand the Centre's reach.[50]

The Australian Government has launched Australia's International Cyber and Critical Technology Engagement Strategy to create a safer, more secure, and prosperous cyberspace for Australia, the Indo-Pacific, and the world. In accordance with this strategy, La Trobe University, the Indian Institute of Technology (IIT) Kanpur, and the Indian Institute of Technology Gandhinagar were awarded a grant by DFAT to fund new research aimed at identifying and improving current practices and associated gaps in data protection policies in various industry sectors across supply chains. The project will improve ethical policy and practice for Australian and Indian businesses when outsourcing technology to Indian providers. It will also help them better understand how they translate being signatories to Ethical Codes into their practice.[51]

Australia and India have also established joint working groups on cyber security and ICTs. India is also included in the International Cyber Engagement Strategy. This core Australian initiative began in 2017 to actively conduct capacity-building arrangements in Indonesia, Singapore, and Thailand and support similar activities in Malaysia, Vietnam, and Cambodia. Australia added critical technologies to the initiative in 2021, making it important to the bilateral relationship with India and the Quad.[52]

Technology and cyber-related cooperation initiatives between Australia and India have accelerated, while they are still relatively few. Australia possesses a professional approach to attributing cyber-attacks, as exhibited when it overhauled its cyber security policy, and India can gain insights from its attribution system. Both nations can engage in bilateral initiatives, including collaborations on cyber security and standards setting. To reap long-term benefits and capitalise on this technological revolution, both countries must engage in far greater and much more active cooperation.

4 Upskilling of Cyber Talent: Australia and India

The **shortage of cyber security professionals** is a glaring problem faced by Australia and India. India is expected to have a shortage of 1.5 million cyber security professionals by 2025,[53] while for Australia, the number is expected to be around 30,000 by 2026.[54] India particularly saw the highest increase in the cybersecurity workforce gap with a staggering 630.9% year-over-year increase.[55] On the other hand, Australia also witnessed an increase of 57.5% year-over-year increase in cybersecurity workforce gap.[56]

As per the Trellis report data, sixty per cent of Indian respondents identified a lack of implementation expertise as one of the biggest barriers to the implementation of new cybersecurity solutions.[57] Forty-nine per cent of Australian respondents identified a lack of in-house staff resources as one of the biggest barriers to the implementation of new cybersecurity solutions.[58]

Table 13: Worldwide Cybersecurity Workforce Gap (2023)

Country	Estimated Cybersecurity Workforce Gap	Year-over-year increase	Country	Estimated Cybersecurity Workforce Gap	Year-over-year increase
USA	482,985	+17.6%	Japan	110,254	+97.6%
Canada	38,842	+53%	China	1,720,941	+16.1%
UK	73,439	+29.3%	**Australia**	27,756	-29.7%
France	59,117	-2.9%	**India**	789,793	+40.2%
Germany	104,660	+0.4%	Singapore	3,961	-34.8%
South Korea	17,611	+5.8%			

Source: (ISC)2 Cybersecurity Workforce Study

4.1 India's Up Skilling Programme on Cyber Skills

The Indian government has proactively undertaken various initiatives to develop requisite cyber skills to improve overall cyber security resilience. For instance, the Common Services Centres, under the Ministry of Electronics & IT, and Kyndryl (NYSE: KD), the world's largest IT infrastructure services provider, have partnered to launch Cyber Rakshak, a cyber-security training initiative to equip women in rural and remote areas with new technology skills and help them emerge as cyber security ambassadors.[59] India Cyber Games (ICG) has taken up the mantle of training, recruiting and launching an elite India Cyber Team as a part of the International Cyber Security Challenge Initiative. ICG will conduct India's first national-level cyber challenge in February 2024.[60]

In February 2023, the Indian Computer Emergency Response Team (CERT-In) conducted the G20 Cyber Security Exercise and drills for 400 participants from more than 12 countries.[61] Further, to bridge this cyber security skills gap in India, Microsoft, in collaboration with the National Institute of Electronics & Information Technology (NIELIT), will train underserved youth in cyber security skills. Under this collaboration, Cyber Shikshaa and Ready4Cybersecurity programmes will be deployed in 30 training centres of NIELIT in Tier 2 and Tier 3 towns, with a special focus on Jammu & Kashmir, Ladakh and states in the North-East region of India.[62]

CERT-In under the Ministry of Electronics & IT, Government of India, in collaboration with the Cyber Security Agency of Singapore (CSA), successfully designed & conducted the Cyber Security Exercise "Synergy" for 13 Countries as part of the International Counter Ransomware Initiative - Resilience Working Group which India is leading under the leadership of National Security Council Secretariat (NSCS) in 2022.[63]

4.2 Australia's Strategy Towards Developing Cyber Talent

The Australian government, realising the urgent need in the face of ever-increasing cyber threats, has developed different programmes and incentives to support cyber security resilience. The persistent shortage in the cyber workforce is acknowledged in the Cyber Security strategy, which focuses on building local skills and increasing skilled migration.

The Cyber Security Skills Partnership Innovation Fund provides AU$70mn to upskill and diversify staff in cyber security. The Australian government has also introduced the Australian Defence Force Cyber Gap Programme, which offers cyber students financial support, mentoring, and defence work experience opportunities. Australian universities pursued a "dramatic shift" in strategy to fill the skills gap, with approximately 87 dedicated tertiary qualifications—up from just eight in 2018—and 58 additional qualifications offering a cyber-security major.

Businesses are not far behind, recent industry efforts have blended practical experience and educational training, including a Microsoft/AustCyber traineeship programme, a joint university/industry-backed Cyber Academy that pays trainees, increasing cyber training through TAFEs, La Trobe University's US$2.35mn micro credential investment, the six-month CyberCX Academy, and widespread buy-in to a public-private jobs plan.[64] At the state level, many measures are also being taken. For example, the New South Wales (NSW) Government announced two new initiatives to increase the number of women working in leading roles. The NSW government also plans to incorporate relevant cybersecurity studies into the school curriculum.[65]

4.3 Australia and India to Co-Develop Requisite Cyber Talents

The need to work together to develop cyber skills has been recognised in the Australia-India bilateral cooperation initiatives. Under the AI-ECTA framework, both countries agreed to coordinate in facilitating bilateral conversations regarding the occupational skill sets and standards in certain regulated or licenced occupations and to strive towards the exchange of knowledge regarding the skill shortage and skill sets required for those jobs.[66]

The provisions of the ECTA are expected to facilitate the relocation of qualified IT personnel between the two nations, encourage the expansion of Indian technical service providers into Australia in light of the country's new domestic tax laws, give graduates and workers more opportunities to fill in skill gaps and encourage reciprocal cooperation in the exchange of information.

In addition, the **Australia-India Future Skills Initiative** aims to build a digital platform in collaboration with industry to connect Australian vocational education, training, and skills providers to Indian businesses, government, students, and employers. The **Australia-India Innovation Network**, on the other hand, will assist Australian

technology companies in gaining access to India's rapidly growing innovation ecosystem and forging stronger ties with Indian customers, partners, and investors.[67] These initiatives facilitate collaboration and training to develop cyber skills between Australia and India.

The private sector has been involved in the initiatives. Austrade recently signed a Memorandum of Understanding (MoU) with the Confederation of Indian Industry (CII) to collaborate on Technical Vocational Education and Training (TVET) programmes as part of the Australia-India Future Skills Initiative. According to an official release, the MoU aims to focus on Australian training standards and delivery in sectors such as automotive, allied health, mining, IT, cyber security, renewable energy, logistics, supply chain, and water management.[68]

The Australian government also heavily relies on the Australia India Business Exchange (AIBX), a platform for building investment alliances and enabling commercial results, to strengthen its commercial ties with India.[69] As a part of the AIBX 2022 Business Mission, the Austrade launched the Australia-India Cyber security Hackathon Challenge. Austrade also sent a delegation of Australian talent providers to India in early 2023 to exchange ideas and collaborate with Indian counterparts for success.[70]

Additionally, Austrade has launched Study Australia's "India Student Hub (Digital Education Hub) toolkit," which gives Indian students access to course search tools, an employability hub, and a masterclass library to help them identify their strengths, explore career options, and develop their employability skills. Students will also have access to course information, which will help them choose the best courses for their careers. Further, Curtin University in Australia has partnered with TEXMiN, the IIT-Indian School of Mines Dhanbad's technology innovation hub. This collaboration will promote developing and commercialising cyber-physical system-based exploration and mining services and products. The agreement also calls for establishing a world-class centre on the IIT-ISM Campus in Dhanbad.[71]

Universities in Australia and India are working closely together to develop world-class capabilities. For example 2008, IIT Bombay and Monash University founded a joint research academy focusing on advanced computational engineering, infrastructure engineering, clean energy, etc. UQIDAR, a joint research academy between IIT Delhi and the University of Queensland, was established in 2018. Through this academy, IIT Delhi and the University of Queensland are helping students develop deep-tech

entrepreneurial skills while concentrating on areas of strategic importance to India. The University of Melbourne has also established significant research collaborations with Indian universities and businesses in ICT (Data Analytics) and biomedicine.

Deakin University, one of the first universities to establish operations in India, has recently opened a university campus in GIFT City, Ahmedabad, Gujarat. The focus is on bridging and building capacity in technology and business to prepare postgraduate students for the rapidly advancing digital economy.

5   Semiconductor Chip Manufacturing and Australia-India Cooperation

Semiconductors have become yet another major geopolitical issue confronting advanced economies, as the risks associated with its supply chains have direct implications for national economies and security.

India's semiconductor consumption is about 20 percent of all the microprocessors manufactured in the world[72] and is expected to reach US$110bn by 2030.[73] India has developed a specialisation in the analogue chip design aspect and technical services like networking, microprocessors, and memory subsystems with up to 20 percent of the world's semiconductor design and a high number of design Patents/ IPRs registered in India.[74]

However, India is dependent on imports for its semiconductor consumption, and its share in the manufacture is almost zero. This is because the semiconductor industry is capital-intensive, investment returns are delayed, and extensive power and water usage is required.[75]

Australia is more a consumer than a producer when it comes to semiconductors. Its import in 2021 stood at US$1.5bn , while exports were worth US$69mn.[76] There are many small Australian companies, but they are scattered[77] leading to no significant value creation. Australia also faces challenges in building a semiconductor industry such as shortage of local capital and large companies, limitation of research professionals, IP barriers, etc.[78]

5.1 India's place in the Semiconductor Industry

The Indian government decided to catalyse India's rapidly expanding innovation ecosystem and intensify its chip-making with localised manufacturing, thereby realising the goal of "*Atmanirbhar Bharat*" (self-reliant India). The government released the **Production and Design Linked-Semiconductor Fab Ecosystem Programme** with an outlay of over US$10bn and four schemes.[79] It aims to provide financial

support to companies investing in semiconductors, display manufacturing and design ecosystem. The four schemes are:

   i.   *The scheme for setting up Semiconductor Fabs in India* provides fiscal support for setting up semiconductor wafer fabrication facilities in the country.

   ii.   *The scheme for setting up Display Fabs in India provides fiscal support for setting up* TFT LCD/AMOLED-based display fabrication facilities.

   iii.   *The scheme for setting up of Compound Semiconductors / Silicon Photonics / Sensors Fab and Semiconductor Assembly, Testing, Marking and Packaging (ATMP)/OSAT facilities in India*, which provides fiscal support for setting up of Compound Semiconductors/Silicon Photonics (SiPh)/Sensors (including MEMS) Fab and Semiconductor ATMP/OSAT facilities in India.

   iv.   *The Design Linked Incentive (DLI) Scheme offers financial incentives, design infrastructure support, and deployment of semiconductor design for Integrated Circuits (ICs), Chipsets, Systems on Chips (SoCs), Systems and IP Cores,* and semiconductor-linked design.

India also established a specialised and independent "India Semiconductor Mission (ISM)" to ensure the efficient and smooth Development of the Semiconductor and Display Ecosystem.[80]

Enabling activities in this area include different schemes, such as Chips to Startups (C2S), and the Scheme for Promotion of Electronic Components and Semiconductors (SPECS). The Skills Acquisition and Knowledge Awareness for Livelihood Promotion (SANKALP) programme has been created to deliver training to about US$10mn individuals across various industries, including the ESDM/semiconductor sector. Under the National Skill Development Corporation (NSDC) direction, the Pradhan Mantri Kaushal Vikas Yojana (PMKVY) scheme has also been introduced to offer skill development training to youngsters nationwide.[81]

The India Electronics and Semiconductor Association (IESA)[82] is driving the expansion of India's semiconductor and electronics manufacturing sector by promoting regional, national, and international alliances, skilling up, and assisting startups, MSMEs, and academic institutions.

Moreover, India has also been engaging in silicon diplomacy with partners like the USA, Taiwan, Quad, and EU for capacity building, financing, and infrastructure building[83].

Box 1: India's Silicon Diplomacy

i. Established fab facilities in partnership with major semiconductor industries, such as the Taiwan Semiconductor Manufacturing Company (TSMC), the United Microelectronics Corporation (UMC) from Taiwan, and Intel from the US.[84]

ii. Signed **Quad Semiconductor Supply Chain Initiative** in September 2021 to strengthen the global semiconductor supply chain's capacity, pin down vulnerabilities and build resilience.[85]

iii. Launched the U.S.-India initiative on Critical and Emerging Technology (iCET)[86] in January 2023 to leverage the complementary strengths of the two countries. It focuses on:

   - enhancing bilateral collaboration to ensure resilient semiconductor supply chains;
   - supporting India's efforts to establish a design, manufacturing, and fabrication ecosystem for semiconductors; and
   - developing a skilled workforce to play a bigger role in the global chip industry.

iv. Signed an MoU between India and the US in March 2023 under the India-US Commercial Dialogue to "establish a collaborative mechanism on semiconductor supply chain resiliency and diversification."[87] The India Semiconductor Mission signed a MoU with Purdue University for capacity building, research and development, and industry participation.[88] Significantly, both parties have decided to collaborate on organising their incentive programmes for semiconductors.

5.2 Australia's Place in the Semiconductor Industry

The Australian National Fabrication Facility (ANFF) under the National Collaborative Research Infrastructure Scheme (NCRIS)[89] was founded in 2007 to research, develop, and commercialise micro and nanofabrication facilities. ANFF has

become the bedrock of the semiconductor research environment in Australia. Governments and partner organisations have invested more than AU$400mn (more than US$277mn) in research infrastructure.

The New South Wales government also started a new US$6mn initiative- **the Semiconductor Sector Service Bureau (S3B),** to intensify semiconductor capability in Sydney. S3B will focus on collaboration, skills and connectivity to foster connectivity and collaboration and help Australia play an important role in global supply chains.

Further, Australia is leveraging silicon diplomacy as part of the Quad Semiconductor Supply Chain Initiative, which aims to ensure market competitiveness and strengthen the global supply chain. Australia's signing of the **AUKUS trilateral security pact** and **Five Eyes alliance** intelligence sharing ensures it bolsters Australia's semiconductor industry.[90]

5.3 Australia-India Cooperation in Semiconductor Technology

Both Australia and India share a common vision of a multilateral world order that is secure, open, and competitive.[91] The cooperation between the two countries becomes all the more important due to the face-off between the US and China and growing **techno-nationalism**[92] i.e., intervention by the state in technological capabilities for national security, economic prosperity and social stability.

For example, the United States' CHIPS and Science Act 2022[93] aims to curb the growing Chinese clout in the semiconductor industry (Box 3). Netherlands and Japan have joined the US in imposing export restrictions on semiconductor technology, thereby limiting China's access to advanced semiconductor technology.[94]

Box 2: The Evolving Landscape of China's Semiconductor Industry

China's semiconductor policy 2014 aimed to reduce reliance on foreign suppliers, acquire technology and attract investments. Through acquisitions, its back-end manufacturing and fabless design share increased. Registered companies grew from 1,300 in 2011 to 22,800 in 2020, but they focused on producing larger, less advanced chips. The industry is dominated by chips measuring 24 nanometres or higher.[95] The 14th five-year plan emphasises technology independence, with the government supporting indigenisation through insurance and subsidies for local suppliers.

Australia and India are also part of the **Quad Semiconductor Supply Chain Initiative.** The initiative's importance lies in the fact that each member has the potential to contribute to it.[96] The United States leads in chip design, research and development, and intellectual properties. Japan has expertise in the manufacturing of silicon wafers. Australia possesses vast critical elements and resources necessary for semiconductor manufacturing. India can provide a skilled, cost-effective manufacturing, assembly, and testing workforce.

However, bilateral Australia-India cooperation on semiconductor manufacturing would also be challenging given that both countries are competing in the same space and the presence of a few other global players such as Vietnam and Malaysia. In general, there needs to be more industry-academic partnerships, which is a pain point as far as enabling an environment for innovation.

Nevertheless, Australia and India can enhance collaboration in semiconductor chip manufacturing by establishing joint research and development projects, fostering industry partnerships, sharing technical expertise and best practices, promoting technology transfer, and facilitating investments and knowledge exchange between companies and institutions in both countries.

# 6   Quantum Technology in the Communication Industry

Quantum Computing has the potential to revolutionise the Information, Communication and Technology sector. Irrefutably, gaining the lead in quantum tech is essential for the nations as it will give them a strategic lead in telecom development, economic operations, cybersecurity and intelligence.[97] Thus, Australia and India must not lag in the quantum computing race.

Australia and India lag behind their peers in the global quantum race in terms of patent filing.[98] India has shown its commitment and announced the National Mission on Quantum Technologies and Applications in early 2020, with a budget of about INR60bn to be implemented over five years. India lacks the necessary quantum technology expertise to capitalise on that level of national investment.[99] Australia, which has a long history of leadership in quantum physics and quantum technology, has the potential to give India the support it needs to develop its global quantum industries.[100]

Quantum computing holds great potential for India to join the frontrunners in 6G development. In 2019, the Government of India declared quantum tech a "mission of national importance."[101] It has been reported that quantum tech will add US$310bn to the Indian economy by 2030.[102] Australia's quantum technology potential is expected to reach AU$6bn and generate more than 19000 jobs by 2045.[103]

Figure 3 provides a comparative chart of the percentage of businesses using quantum computing in Australia and India at an early or advanced stage.

Figure 3: Share of Organisations in Early or More Advanced Stages of Adopting Quantum Computing Worldwide as of December 2021, By Country
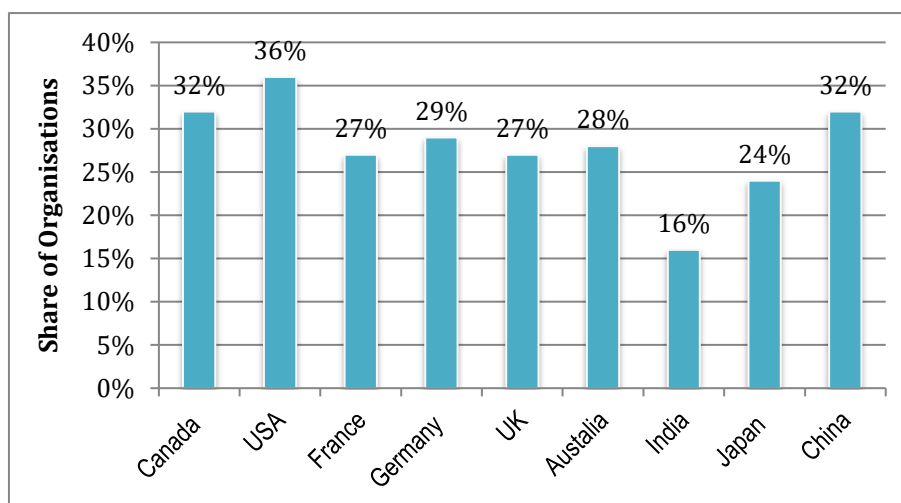
Source: Adopted from Statista

6.1 India on Quantum Technology

Numerous eminent institutions are actively conducting quantum research in India, such as the Indian Institute of Science, Bangalore; the Indian Institute of Science Education and Research (IISER), Pune; and Raman Research Institute, Bangalore, etc. These institutions help promote quantum research and technology to become prominent in the global quantum computing market.[104]

In September 2021, the Ministry of Electronics and Information Technology (MeitY) launched the Indigenous Quantum Computer Simulator (QSim) Toolkit to enable a cost-effective environment for researchers, students, and the scientific community to develop quantum technology in India.[105]

The government also funds about 92 percent of the 100 quantum projects.[106] Indian quantum start-ups are also engaged in developing quantum-based cybersecurity solutions.[107] India has seen the highest percentage increase in sovereign funding from 2015 to 2020.[108]

The cabinet approved the National Quantum Mission[109] announced in the Budget 2020-21. The mission will have a total outlay of US$730mn to accelerate research and development and establish a cutting-edge quantum ecosystem in the nation from 2023–24 through 2030–31. As part of the mission, four theme hubs (T-Hubs) — one

each for quantum computing, quantum communication, quantum sensing and metrology, and quantum materials and devices — will be established at leading university and national R&D institutions. It will facilitate the design and synthesis of quantum materials such as superconductors, innovative semiconductor architectures, and topological materials for manufacturing quantum devices. It will also aid in developing intermediate-size quantum computers and satellite-based secure quantum communications.

India, however, has not seen much success despite the increase in government investments. There are still many lacunae in India's strategies that need to be addressed. The country lacks a long-term vision plan and a comprehensive multi-stakeholder networking for quantum research. There is also a lack of skilled and trained professionals. India also lacks quantum infrastructure, manufacture, and testing, which makes research and development unproductive.[110]

6.2 Australia's Standing on Quantum Technology and Communications

Australia was one of the first countries where research and investment in quantum computing started in the 1990s.[111] The Australian Research Council (ARC) Centres of Excellence programme funded various quantum and related research projects.[112] In 2019, the Australian government announced approximately AU$77mn investment for quantum computing development, including approximately AU$48mn for the Quantum Commercialisation Hub.[113] The hub will help engage like-minded countries to commercialise quantum research.

The government also announced the formation of the National Quantum Advisory Committee in September 2022 to drive Quantum research.[114] Further, in October 2022, the government announced the formulation of the National Quantum Strategy and initiated the consultation process.[115] The Australian government also provides financial support to about 20 PhDs in quantum research.[116] Many Australian companies and start-ups have been engaged in quantum research. In 2022, Silicon Quantum Computing successfully manufactured the world's first integrated circuit at the atomic scale.[117]

The government announced the National Quantum Strategy[118] in 2023, intending to make Australia "a leader of the global quantum industry" by 2030. It focuses on facilitating investments through an AU$10bn National Reconstruction Fund,

encouraging research, applications and commercialisation through incentives and increasing Australia's influence and collaborations abroad. Apart from this, it also focuses on protecting the industry's supply chain, developing a qualified workforce, ensuring that the development of standards is in the country's interests, and ensuring the ecosystem is moral and inclusive.

In the last few years, though, Australia has fallen relatively behind in quantum research, especially investment.[119] The start-up ecosystem has not been able to thrive in quantum research, and very few start-ups have successfully attracted funding. There has been talent leakage in quantum research, as many talented Australian individuals have been successful outside the country. The country also lacks dedicated R&D programmes that would include public-private engagement.[120]

6.3 Australia-India Cooperation on Quantum Technology

Australia and India will jointly work on quantum computing as part of the Framework Arrangement. Given Australia's relative strength in quantum technologies, India could tap into Australia's expertise in this field. India has already signalled its seriousness in getting ahead on quantum technologies, and it has become just the sixth country in the world to have a national quantum mission. There will be four thematic hubs in top academic and national research and development institutes as part of the mission. Australia could work closely with India on these thematic hubs based on its strengths.

In May 2022, India, the US, Australia, and Japan, along with other Quad members, agreed to deepen cooperation in emerging technologies, including quantum technologies.[121]

India has also enhanced bilateral cooperation with other nations to enhance its quantum capabilities. In November 2022, India signed the 'Intent of Cooperation on High-Performance Computing (HPC), Weather Extremes and Climate Modelling and Quantum Technologies' with the European Union to deepen cooperation on quantum and high-performance computing. India is also planning to cooperate with countries like Israel, the US, Russia,[122] and Finland[123] to enhance its capabilities in quantum computing.

The U.S.-India initiative iCET[124] seeks to increase international collaboration in quantum technology by signing a new Implementation Arrangement for a Research

Agency Partnership between the National Science Foundation and Indian science agencies. It also emphasises establishing a joint Indo-U.S. Quantum Coordination Mechanism with participation from industry, academia, and government.

Diplomatically, Australia, too, has been engaging with like-minded countries other than India and multilateral groupings to enhance cooperation in quantum research. In 2021, Australia signed a statement of intent with the US government to cooperate and improve market access and knowledge sharing in Quantum Science and Technology. In 2022, both countries and the United Kingdom agreed to accelerate investments, cooperate, and integrate quantum technologies under the AUKUS Quantum Arrangement (AQuA).

Box 3: ARPI's Role in Promoting Australia-India Partnership

Australia and India can use ARPI's innovative and mindful 'intelligence' thinking and approaches available through adopting Strategic Risk Policy® to identify vulnerabilities and exposures in research, design and production, leading to enhanced integrity and resilience. ARPI leads the Global Risk Policy Network, rich in cyber development and security networks. Collaborative efforts among countries are essential for harnessing the benefits of technological advancements, with the Quad also recognising the importance of treating India as an equal strategic partner.

The introduction of ARPI's leadership paradigm change from silo-centric (which includes single nations) to network-centric (which includes neighbours and regional hubs) and the shift in risk-thinking from silo-reactive to network-anticipatory, thus at the point of potentiality is helping Australia and India to discover and share important information enabling informed and pre-emptive decision-making.

ARPI is continuing to encourage governments and corporations in Australia to adopt modern Strategic Risk Policy® thinking, approaches, and frames to access available network information that is currently not part of strategic decision-making, is inaccessible, and hence unknown. The move from 'reaction' to 'potentiality' is a fundamental leadership paradigm change that must be adopted and accelerated. Currently, vulnerability and risk assessments are still primarily internal processes, with whole-of-government alignment being the next stage.

ARPI and its global partner, the Electric Infrastructure Security Council, held a major resilience conference in London in April 2023, at which ARPI tended to solve a longstanding policy issue in Government by introducing a contemporary, practical and accountable definition of resilience. This is expected to lead to further, proscriptive regulatory reform, with the consequent possibility of a practical, global accreditation regime to promote accountability and assurance.

ARPI is extending access to its educational training in Strategic Risk Policy® to inform emerging and existing cyber talent, within Australia and India through the New Delhi Institute of Management – recently, establishing the Asian Centre for the Global Risk Policy Network (www.acgrpn.org). In addition, ARPI in conjunction with the Australian National University is delivering cyber-based training in Strategic Risk Policy® to neighbouring Indo-Pacific nations.

Equally, Australia through ARPI and Strategic Risk Policy® has leadership in addressing risk at the point of vulnerability rather than from reactive risk management – a recently published ARPI Perspective on Artificial Intelligence has been embraced by governments, industry and cyber professionals. This innovation can be used for causal analysis to identify vulnerabilities which have led to quantum hacking and then enhance prevention for improved resilience.

ARPI's introductory comments illustrate action underway to conduct further research, going back firstly to fundamentals of Artificial Intelligence and Quantum Computing, and exploring fundamental changes to the science involved, recognising the complementary nature of Intelligence Augmentation as a 'preventive' not a band-aid to problems such as quantum hacking.

7   Start-up Ecosystems in Australia and India

7.1. Global Capability Centres in India

Global capability centres, or GCCs or GICs, are offshore units of multinational corporations operating across the globe. These centres provide support services, such as IT, finance, human resources, and analytics, to their parent organisations. Earlier, these units were primarily established in India to offshore back-office processes. However, today, the GCCs in India handle more complex line items across the organisation's value chain. They have become centres of operational excellence, product development and innovation hubs. India is home to several GCCs due to the availability of a highly skilled engineering workforce and expertise in R&D. The Indian GCCs employ more than 1.3 million engineers across about 1900 GCCs, generating value worth US$60bn.

The number of cyber GCCs in India has been continuously growing at an annual rate of more than 30 percent. Over 40 percent of Cyber GCCs in India deliver a substantial part of the cyber security products.[125] These cyber GCCs have significant expertise in cloud security, AI security and other emerging security functions.

Like cyber GCCs, the GCCs in the telecom and networking area also play a vital role in developing emerging products and services for 5G and beyond networks. The cities of Bengaluru and the National Capital Region of Delhi attract most of the GCCs in telecom. These two cities host about 70 percent of the talent pool in the telecom and networking space. Some well-known Indian GCCs include multinational companies such as Nokia, Ericsson, Verizon, British Telecom, Juniper Networks and Orange.[126] Telstra India has recently announced the setting up of two Innovation and GCCs in Pune and Hyderabad.

Hence, there is a synergy of cyber security and telecommunications in India-based GCCs.

7.2. Start-ups in Australia

Similar to the technology resources available in India, Australia is home to many telecom and cyber start-ups. Millibeam is a start-up that develops advanced chipsets for 5G and beyond networks. Byte25 is one of the start-ups that provides network security and performance. According to Tracxn, there are about 39 telecom start-ups in the city of Brisbane only. The Australian telecom Market is expected to grow from US$21.78bn in 2023 to US$23.58bn by 2028, allowing many start-ups to flourish in this space.

8   Way Forward for Australia and India to Advance 6G Development and Technologies

Bilateral relations between Australia and India have grown significantly in recent years. This collaboration and cooperation are a major result of the increased shift in geopolitics and technological shifts among others. Australia has the means to support India in its efforts to reduce emissions and meet the rising demand for critical minerals to help India strengthen its manufacturing capacity of critical electronic components. Further, given India's ground-breaking advances in 5G developments, such as the development of indigenous test beds[127] and the 5Gi standard,[128] Australia and India can co-develop their hard and soft infrastructure to better adapt these emerging technologies, particularly in the context of 6G, while maintaining their national security.

The technological cooperation between Australia and India through bilateral ties or multilateral arrangements, though still in its infancy, has a great deal of potential to advance their respective national interests effectively and thereby contribute to strengthening the regional order in the Asia-Pacific. The following are some points of consideration for both countries to enhance their partnership and achieve their goals:

1) Deepen the relationship by identifying specific areas within bilateral technological cooperation. Some of these areas can be ***student training, transitioning basic research into applied research, designing collaborative projects, and technology commercialisation***. In this context, the India-US iCET type of arrangement between Australia and India will benefit both countries.

2) Develop mutual capacities to take advantage of a large combined market for 6G services or commodities in Australia and India.[129] Australia and India must focus on targeted skill development and training to bridge the gap in the availability of cybersecurity professionals and strengthen human and institutional capacity. Australia and India could ***collaborate to establish dual institution delivery***

across borders system, and best practice sharing and capacity building for institutions teaching in-country and so on. Since India permits foreign universities to set up campuses, Australian universities should look at setting up offshore campuses in India, focusing on technology sectors.[130] Cyber security should be included in the education system to develop general cyber security awareness so that people understand threats, have the basic skills required and can protect themselves accordingly.

3) The Focus of the bilateral cooperation mechanism should include the ***development of critical mineral value chains and commercial-scale local technologies in India*** to process critical minerals in its downstream industries. Strategies must be developed on value chain development focussing on bolstering sourcing of minerals and metals, and manufacturing, and simultaneous cross-sectoral measures including tariffs, investment rules, rules of origin, standards, regulations, availability of technologies, and availability of finance. ***Future work programmes of the AI-ECTA or the future CECA could include some of these measures***, which would lead to smoother development of the 6G partnership between Australia and India.   "The next step in realising the enormous potential of our economic relationship is signing a Comprehensive Economic Cooperation Agreement, or CECA, which Australia and India are negotiating now." [131] - Philip Green, Australia's High Commissioner to India.

4) On the technological front, the focus is on building their ***strengths in the semiconductor industry.***[132] In this regard, Australia and India should:

   i. Complement and explore each other's capabilities in research,[133] adopt the PPP (public-private-partnership) model[134] and promote free and open semiconductor technologies (see box 3)

   ii. Strive towards forming Quad Semiconductor Resilience Fund, joint setting of fabrication facilities, building Centres of Excellence (CoEs), and facilitating trade and technology transfers.[135]

   iii. Launch an Indo-Pacific Technology Fund (IPTF) to promote technological cooperation in the Indo-Pacific region, with Australia and India as initial investors.[136]

   iv. Enhance cooperation with other countries in the following manner:

    a. Increase cooperation with other semiconductor powerhouses like South Korea, Taiwan, and emerging ones like Vietnam[137] and collaboration with other alliances like India-EU Trade and Technology Council (TTC),[138] and the Chip4 alliance (US, South Korea, Japan and Taiwan).

    b. Australia and India can benefit from the International Technology Security and Innovation (ITSI) Fund under the U.S. CHIPS and Science Act.[139] For example, enhancing policy cooperation between the India Semiconductor Mission and the US's Chips Programme Office (CPO) can strengthen semiconductor supply chains. Investing in ICT security can yield valuable returns as cyber resilience and trustworthy collaboration become essential in the global semiconductor industry.

    v. Australia and India can foster cooperation in chip manufacturing, with the private sector significantly facilitating this collaboration. India can also benefit from Australia's proficiency in robotics, GIS (Geographic Information System), and more.

Additionally, **India can benefit from Australia in quantum computing** by leveraging the latter's expertise in cost-effective research and development. Likewise, **Australia can benefit from India's technology sector** by utilising the latter's strengths.

5) **Australia-India cooperation in the Telecom and Cyber sector:** With the immense talent available in the form of technology centres in India and start-ups in Australia, there are opportunities for Australia and India to work together towards nurturing innovation and R&D in the telecom and cyber security sectors. With expertise available, there are opportunities for effective India-Australia collaboration in the evolution of 6G networks and associated cyber security.

6) **India can learn from Australia in enacting a comprehensive national cyber security framework** that will enable efficient threat assessment and response. Such regulatory framework should include provisions for binding cyber security standards, as well as provisions for periodic cyber audits and annual reviews of these standards by a dedicated body, among other things. This will ensure effectiveness by allowing for necessary updates regarding all developments in cyberspace and incorporating different global best practices. This must be

supplemented by establishing a ***dedicated national cyber security agency*** with a clear line of authority and functions.

In this respect, India should establish a **National Cyber Security Centre (NCSC)**, similar to the Australian Cyber Security Centre (ACSC). NCSC will aid in detecting, disrupting, and deterring high-impact cyber threats. This will allow for a preventive approach to cyber threats rather than the usual piecemeal and reactionary approach. Furthermore, Australia and India should advocate for an **Indo-Pacific Regional Cyber Defence Centre** to facilitate information sharing to build common data, research and development, and technical training for effectively detecting and mitigating cyber threats at the regional level.

7) Australia and India should work with other regional bodies and multilateral organisations to develop safe and secure cyber and critical technologies. In particular, both countries can collaborate with G20 member countries on research and development in critical areas such as cybersecurity, cyber skill development, technology infrastructure (hard and soft infrastructure), and technical component manufacturing. For example, collaborative work on the G20 Toolkit on Cyber Education and Cyber Awareness of Children and Youth can be expanded regionally, enhancing cybersecurity awareness and education. Joint efforts in R&D, cyber skill development, and technology infrastructure will strengthen regional resilience against cyber threats and foster technological innovation.

8) Further, Australia and India must ***encourage deeper multistakeholder discussions at international forums, such as ITU, to establish a model cyber security framework*** for establishing international regulations and protocols that can be incorporated into national regulatory systems.[140] International forums like the ITU have the potential to develop effective guidelines for emerging technologies like 6G and AI. Prioritising outcomes that bring positive results for development is crucial, and India can play a pivotal role by bridging the gap between Western and Eastern perspectives.

9) ***Strengthen their collaboration on AI*** (and its emerging counterfoil addressing limitations of AI – Intelligence Augmentation IA) for use in defence, space cooperation, climate change, and public health. Building on the G20 AI principles, Australia and India should prioritise domestic implementation of G20 AI principles, fostering ethical AI development, global cooperation, and policy harmonisation for

a sustainable future *and* commit to using a systemic risk management approach to address risks such as privacy, digital security, AI bias, and safety.[141]

10) There are a few other measures Australia and India can take to enhance their cooperation, such as increasing their outreach to smaller (tier 2) cities in India and increasing business-to-business collaborations. In this context, Australia and India could set up a forum linking the two countries' businesses, industry, and academia to exchange ideas and provide input for government-to-government exchanges. Australia and India should work towards jointly identifying, nurturing, and promoting deep-tech start-ups in mutually beneficial areas.

9   Stakeholder Insights

The stakeholders opined that Australia and India are positioned to play a pivotal role in advancing critical and emerging technologies, such as 6G, while shaping governance frameworks surrounding these innovations. Both nations acknowledge the potential for collaboration in artificial intelligence (AI), blockchain, and 6G, underpinned by a shared commitment to aligning technology with democratic values. This collaboration extends across the entire technological lifecycle, from development to governance and usage, ensuring that ethical principles are integrated at every stage.

Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO) is actively researching the security aspects of 6G technology. At the same time, the Department of Home Affairs is focused on establishing a secure, interoperable telecommunications network, incorporating both 6G and Open Radio Access Networks (ORAN). India, one of the few countries with a comprehensive blueprint for 6G, has transitioned from a passive adopter of international standards to an active participant in the global standard-making process. This is exemplified by its engagement with the International Telecommunication Union (ITU) and its alignment with global 6G standards.

From the stakeholders' perspective, collaboration between Australia and India promises to push technological boundaries for the greater good while addressing security concerns and aligning shared interests. As democratic nations, both are well-positioned to create a rules-based digital space that counters unethical practices. This effort requires a multi-stakeholder approach involving governments, civil society, academic institutions, think tanks, and private organisations. Such cooperation is essential for developing a safe and trusted cyberspace and shaping the global discourse on emerging technologies.

The stakeholders termed the strategic partnership between Australia and India crucial for the Indo-Pacific region, with both nations playing complementary roles in the emerging technologies sector. Australia's commitment to investment and India's evolving role in technological development enhance regional stability and present opportunities for economic growth. However, a potential risk lies in establishing

country-specific standards that diverge from international norms, undermining the global and interoperable nature of 6G. Ensuring secure and resilient communication networks through 6G is critical for defence, intelligence, and national resilience in the energy, transportation, and healthcare sectors.

Further, the stakeholders also pointed out that India's technology diplomacy, mainly through multilateral frameworks like the QUAD and the International Supply Chain Resilience Initiative, has strengthened its role in the global technological landscape. Bilateral engagements with Australia on cyberspace and critical technologies are expanding, with both nations increasingly collaborating on 5G and 6G research. The shift in focus from cybersecurity as a protective measure to a core element of national security further highlights the importance of this partnership. Enhanced collaboration among standards organisations, industry players, and academic institutions in both countries is crucial for addressing the interconnected issues of digital trade, internet governance, and public policy.

According to the stakeholders, the advent of 6G technology offers significant strategic opportunities for Australia and India. With burgeoning digital economies and aspirations to lead in the global tech landscape, 6G provides a pathway to accelerate digital transformation, improve connectivity, and foster innovation across key sectors such as agriculture, healthcare, education, and manufacturing. Joint research and development initiatives, knowledge exchange and the establishment of common standards, will position both nations as influential players in the global 6G landscape, ensuring their interests are represented in international forums.

Moreover, public-private partnerships will be essential in overcoming the high costs associated with deploying 6G networks. Governments and private entities, including telecommunications companies and tech firms, must collaborate to make 6G accessible to a broader population. Educational institutions in both countries also have a critical role in advancing 6G through research, curriculum development, and training future tech professionals. Joint academic programmes and exchanges between Australian and Indian universities will foster innovation and equip students with the skills necessary for a 6G-enabled world.

The experts also opined that India's expertise in software, combined with Australia's strengths in hardware and regulatory frameworks, presents a unique opportunity for collaboration in critical areas such as AI, quantum computing, and cybersecurity. This partnership could lead to developing innovative and ethically sound new technologies

and applications. Capacity-building programmes, including exchange initiatives and joint research, will ensure that both countries can fully harness the potential of 6G technologies.

According to stakeholders, India views 6G as a critical opportunity to leapfrog past limitations encountered in earlier telecom generations with its extensive consumer base and advanced telecom infrastructure. Collaborative R&D in AI, IoT, and real-time data analytics offers significant potential, especially in precision agriculture, where 6G can optimise crop management and resource use. 6G offers strategic advantages in the defence sector, particularly in secure communication and real-time battlefield analytics.

India can gain a competitive edge in global markets by prioritising advanced use cases like AI-driven diagnostics and smart agriculture. Strengthening public-private partnerships and investing in homegrown technologies will be crucial for both countries to accelerate the deployment and commercialisation of 6G. These efforts will reduce dependence on foreign technology providers, protect national interests, and ensure that 6G technologies are developed in alignment with ethical standards and human rights.

From the stakeholders' perspective, Australia and India can strengthen bilateral ties, enhance national security, and lead innovation in these critical areas by working together. Both nations also have the opportunity to reduce their reliance on foreign technology by investing in local manufacturing capabilities for 6G hardware and fostering software innovation, ultimately driving mutual economic growth and securing their place in the global 6G landscape.

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