REPORT ON - DIGITALISATION: INDIA

Market Analysis, Key Policy incl. R&D Initiatives, Growth Drivers, Key Challenges and Standardization

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EU PROJECT SESEI

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1. Executive Summary

Digitalisation has emerged as one of the defining forces of the 21st century, reshaping economies, societies, and governance models worldwide. Moving beyond the simple adoption of information technology, it now permeates every aspect of human activity. By enabling seamless connectivity, data-driven decision-making, automation, and entirely new business models, digital transformation has become a strategic imperative for both nations and industries. It is a key driver of competitiveness, resilience, and inclusiveness in today's evolving global landscape.

In September 2018, Government of India released the **National Digital Communications Policy-2018 (NDCP2018)**[1] to achieve the goal of digital empowerment and well-being of the people of India; and towards this end, attempts to outline a set of goals, initiatives, strategies and intended policy outcomes. The **National Digital Communication Policy (NDCP) 2018** sets forth a bold vision of transforming India into a digitally empowered society and knowledge economy. Anchored in the objectives of **"Connect India," "Propel India," and "Secure India,"** the policy envisions providing universal broadband connectivity, fostering innovation, ensuring digital sovereignty, and catalysing socio-economic development through robust digital communication infrastructure.

1. **Connect India: Creating Robust Digital Communications Infrastructure.** To promote Broadband for All as a tool for socio-economic development, while ensuring service quality and environmental sustainability.

2. **Propel India**: **Enabling Next Generation Technologies and Services through Investments, Innovation and IPR generation.** To harness the power of emerging digital technologies, including 5G, AI, IoT, Cloud and Big Data to enable provision of future ready products and services; and to catalyse the fourth industrial revolution (Industry 4.0) by promoting Investments, Innovation and IPR.

3. **Secure India: Ensuring Sovereignty, Safety and Security of Digital Communications.** To secure the interests of citizens and safeguard the digital sovereignty of India with a focus on ensuring individual autonomy and choice, data ownership, privacy, and security, while recognizing data as a crucial economic resource.

Ministry of Communications has started framing **National Telecom Policy 2025 (NTP-25)**[2] and is builds on the NDCP 2018. NTP-2025 is targeted to be an India's strategic blueprint for transforming its telecom sector into a globally competitive, secure, and inclusive digital ecosystem to reinforce India's long-term vision for a robust telecom sector for the next five year. Key points of this draft NTP 2025 are:

- Serves as a roadmap for transforming and modernizing India's telecom sector.
- Advances the goals of National digital communication policy 2018**.**
- Addresses next-generation technologies and evolving telecom challenges.
- Emphasizes use of artificial intelligence for securing telecom networks.
- Aims to position India as a global hub for digital innovation.
- Accelerate digital transformation, economic boost, affordable connectivity and creating next gen technologies such as 5G/6G, IoT, AI, cybersecurity, big data and quantum communication while integrating rural sector.

[1] https://dot.gov.in/sites/default/files/EnglishPolicy-NDCP.pdf
[2] https://dot.gov.in/sites/default/files/NTP 2025.pdf?download=1

- Universal connectivity; innovation; domestic Manufacturing; secure telecom network; ease of living and doing business; sustainable telecom
- Integration of satellite systems; Regulatory and policy reforms; Infrastructure modernizations and expansion; Rural and digital inclusion; Schemes / approach for implementation; promote renewable and sustainable technologies

The Department of Telecommunications (DoT) had released drat NTP-2025 for public consultation on July 24, 2025, and is currently consolidating the feedback received and as per Ministry remarks, it shall be released in Q4' 2025.

In line with these national priorities, this report is structured into three comprehensive sections:

Section I: Digital technologies – Trends, Policy Framework, and Challenges

This section focuses on the Government of India's key Tech initiatives aimed at establishing a robust, inclusive, and future-ready digital infrastructure. These efforts directly contribute to the realisation of:

- Digitally Connected Society
- Digitally Empowered Economy
- Inclusive Socio-Economic Development

Key initiatives through this report includes:

- **Digital Public Infrastructure**: developed across various domains, aimed at enhancing accessibility, efficiency, and inclusivity. its large-scale, foundational implementation in India is considered a breakthrough, serving as a model for other nations.

- **BharatNet**: Bridging the urban-rural digital divide through high-speed optical fibre connectivity to Gram Panchayats.

- **National Broadband Mission:** Government of India launched National Broadband Mission 2.0 on January 17, 2025, with the vision of fast-tracking the rapid expansion of digital communications infrastructure, bridging the digital divide, ensuring High-Speed Broadband and Connectivity for all.

This section also provides a comprehensive overview of ***Technologies Driving Digital Transformation.*** The acceleration of Digital transformation is powered by the convergence of innovations across multiple domains such as:

- **5G and 6G** – Deliver ultra-reliable, low-latency connectivity to support advanced applications such as autonomous mobility, immersive experiences, and industrial automation.
- **Internet of Things (IoT) & Machine-to-Machine (M2M) Communication** – Extend the digital footprint of physical assets, creating hyper-connected ecosystems in smart cities, agriculture, and logistics.
- **Satellite Communications –** Bridge connectivity gaps in remote and underserved regions, extending the reach of digital transformation beyond urban centers.
- **Artificial Intelligence (AI)** – Enables intelligent systems to analyze massive datasets, augment human decision-making, and drive innovation across sectors like healthcare, finance, and manufacturing.
- **Blockchain –** Reinforces trust and transparency through decentralized architectures that reduce reliance on intermediaries.

- **Quantum Technologies –** Though still emerging, hold the potential to transform computing, cryptography, and sensing, with profound implications for security and competitiveness.
- **Cybersecurity –** A foundational necessity to safeguard assets, infrastructure, and personal data, ensuring trust and stability in the digital era.
- **Semiconductors –** Form the backbone of the digital economy, powering devices, and platforms across every layer of technology.
- **E-Signature:** An online service that generates legally valid signatures after authenticating the signer through Aadhaar-based e-KYC
- **E- Accessibility:** ensuring digital content and services are accessible to all users, including those with disabilities.
- **Digilocker Platform**: a government-backed initiative under the Digital India program that provides a secure, cloud-based platform for citizens to store and share their authentic digital documents and certificates.

On these technologies driving Digital Transformation in India, report also explores:

- **Key Policy and Regulatory Initiatives:** Analysis of the Government of India's strategic approach to enabling innovation, Research & Development and enabling frameworks for next-generation technologies.
- **Challenges:** Identification of key roadblocks including digital divide, infrastructure bottlenecks.
- **Growth Drivers:** Highlighting enablers such as Digital India, Start-up India, public-private partnerships (PPPs), increased FDI in telecom, and expanding rural connectivity.
- **Standards Development:** Overview of the key actors involved in standardisation and the latest update on the standards development work carried out in each of the technologies.

This section sets the stage by providing the technological context and policy landscape needed to understand India's transformation into a digitally connected economy.

Section II: Key "Make in India" initiatives by the Government of India to promote self-reliance (Atmanirbhar Bharat) in production and manufacturing

This section highlights the Government of India's policy measures and strategic initiatives aimed at boosting indigenous production, reducing import dependency, and building a globally competitive manufacturing ecosystem under the Atmanirbhar Bharat Abhiyan.

Aimed at positioning India as a global hub, by encouraging innovation, facilitating investment, and supporting micro, small, and medium enterprises (MSMEs), the government aims to build a resilient industrial ecosystem that can cater not only to domestic demands but also compete internationally.

A major step in this direction has been the introduction of Production-Linked Incentive (PLI) Schemes, designed to attract investment, enhance domestic capacity, and foster innovation. The PLI schemes cover key sectors critical for India's digital transformation and industrial growth.

- **PLI Scheme for Large Scale Electronics Manufacturing:** The PLI for large-scale electronics manufacturing, particularly mobile phones and components, offers 4% to 6% incentives on incremental sales over a base year. Introduced to attract global players and strengthen the electronics value chain in India, the scheme has successfully brought in companies like Apple suppliers and promoted domestic value addition. A second-round targets specific components and aims to deepen the ecosystem further.

- **PLI Scheme for Telecom Products:** Launched in 2021 with an outlay of INR 12,195 crore (approx. €1.2 billion), the PLI scheme for telecom and networking products aims to boost domestic manufacturing and reduce imports in the sector. It offers financial incentives based on incremental sales of locally made products like routers, switches, and radio access equipment. The scheme also encourages design-led manufacturing and supports MSMEs through lower investment thresholds.

- **PLI for IT Hardware**: The Scheme shall extend an incentive of 4% to 2% / 1% on net incremental sales (over base year) of goods manufactured in India and covered under the target segment, to eligible companies, for a period of four (4) years. The Target Segment under PLI shall include (i) Laptops (ii) Tablets (iii) All-in-One PCs and (iv) Servers.

- **PLI Scheme for Semiconductors and Displays:** With a massive budget of INR 76,000 crore (approx. €7.6 billion), this PLI initiative focuses on developing a robust semiconductor and display manufacturing ecosystem in India. It covers fabs, chip design, packaging, and compound semiconductors. The scheme aims to position India as a global hub for electronics by reducing dependence on imports and fostering strategic technological capabilities.

Section III: EU -India Cooperation and Projects Instruments around Digital Technologies

This section provides an overview of major EU–India projects and initiatives in the digital sector, aimed at fostering cooperation on connectivity, innovation, standards, and digital governance. These initiatives complement India's Digital India vision while advancing the EU's objective of building secure, open, and inclusive digital ecosystems.

This shared vision is reflected in their deepening political and strategic engagement, particularly under the framework of the **EU–India Strategic Partnership: A Roadmap to 2025**, which outlines joint priorities in digital transformation, connectivity, and inclusive development. This political alignment was further strengthened through the establishment of the **EU–India Trade and Technology Council (TTC)** in 2022—a high-level platform that enables both partners to coordinate on critical digital and technological issues, including artificial intelligence, semiconductors, digital governance, and secure connectivity among other topics. Additionally, the EU's **Global Gateway Initiative** serves as a strategic investment vehicle that supports sustainable digital infrastructure projects in India and across the Indo-Pacific.

The recent adoption of 'New Strategic EU-India Agenda'[3] by the European Commission marks yet another milestone in EU – India relations. This New Strategic EU – India Ageda emphasises and creates more opportunities for cooperation on shared vision for a **resilient, innovative, and sustainable future**, jointly supported by the EU and India. Key areas of cooperation include supporting critical emerging technologies; advancing a conducive digital environment; and promoting research cooperation, harmonising digital, EV, and hydrogen safety standards to ease tech deployment and market access.

This section also provides brief overview of the "**EU Projects active in India, with India or for India**" on strengthening the ties between the two regions on Digitalisation and sustainable development of emerging technologies.

2. Status of Digital Technologies in India

The Government of India's vision to digitize the country is centred around transforming India into a digitally empowered society and knowledge economy. This vision is primarily encapsulated in the

[3] https://www.eeas.europa.eu/eeas/joint-communication-new-strategic-eu-india-agenda_en

Digital India[4] initiative, launched by the Government of India on 1 July 2015 to ensure that Government services are made available to citizens electronically by improved online infrastructure and by increasing Internet connectivity or by making the country digitally empowered in the field of technology. The programme is centred around three key areas, namely,

- Digital Infrastructure to every citizen,
- Digital services & governance on demand
- Digital empowerment of citizens.

The Ministry of Electronics and Information Technology (MEITY) is the nodal agency to implement the program. The initiative includes plans to connect rural areas with high-speed internet networks. Digital India consists of three core components i.e., Development of secure and stable Digital Infrastructure, Delivering government services digitally and Universal Digital Literacy.

Several initiatives envisioned under the programme have been implemented and many are under implementation. Some prominent achievements of Digital India are:

2.1. BharatNet Project

BharatNet is one of the biggest rural telecom projects in the world, aimed at providing broadband connectivity to all Gram Panchayats (GPs) in the country. This enables access providers like mobile operators, Internet Service Providers (ISPs), Cable TV operators, and content providers to launch various services such as e-health, e-education, and e-governance in rural and remote India. The project is being executed by a Special Purpose Vehicle (SPV) namely Bharat Broadband Network Limited (BBNL)[5]. In April 2016, the Telecom Commission approved to implement the project in three phases.

- Phase I: Focused on laying optical fibre cables to connect 100K Gram Panchayats by utilising existing infrastructure. This phase was completed in December 2017.

- Phase II (ongoing): Expanded coverage to an additional 1.5 lakh (150K) Gram Panchayats using optical fibre, radio, and satellite technologies.

- Phase III (ongoing): Aims at future-proofing the network by integrating 5G technologies, increasing bandwidth capacity, and ensuring robust last-mile connectivity. This phase is ongoing.

In August 2023, the government has approved "**Amended BharatNet Program (ABP)**[6]". The ABP is a design improvement aiming for Optical Fibre (OF) connectivity to 2.64 lakh (264K) GPs in ring topology (a network design where connected devices form a circular data channel) and Optical Fibre connectivity to the remaining non-GP villages on demand. It includes features like IP-MPLS (Internet Protocol Multi-Protocol Label Switching) network with routers at Blocks and GPs, operation and maintenance for 10 years, power backup, and Remote Fibre Monitoring System (RFMS).

2.2. National Broadband Mission 2.0[7]

The National Broadband Mission (1.0) focussed on collaborating with States/UTs and local bodies to address the major bottleneck for telecom infrastructure deployment across the country which is the Right (RoW) issues. It also facilitated the rollout of 5G networks across the country, making India's 5G rollout one of the fastest in the world. Additionally, the development of the "Call Before u Dig" (CBuD)

[4] https://blog.mygov.in/editorial/digital-india-the-vision-and-the-mission/
[5] https://bbnl.nic.in/index.aspx
[6] https://usof.gov.in/en/bharatnet-project
[7] https://eservices.dot.gov.in/sites/default/files/user-mannual/NBM 2-0 Vision Document_Final_RoW-compressed.pdf

mobile app was another step in the direction of enhancing the safety of underground telecommunication infrastructure.

The National Broadband Mission 2.0 builds upon the strengths and experiences gained from the NBM 1.0, aiming to propel India into a new era of digital transformation and global competitiveness. It envisions India as a global knowledge society through the provision of high-speed broadband and meaningful connectivity for all. This vision prioritizes rapid digital infrastructure growth, narrowing the digital divide for comprehensive empowerment, and ensuring affordable and meaningful broadband access in rural areas.

2.3. Digital Public Infrastructure

Digital Public Infrastructure (DPI) refers to foundational digital systems that are accessible, secure, and interoperable, supporting essential public services. In India, DPI has been instrumental in transforming the digital economy, much like traditional infrastructure for industrial growth. Key achievements include **Aadhaar**, **Unified Payment Interface (UPI)** etc. Digital Public Infrastructures (DPI) has been developed across various domains, aimed at enhancing accessibility, efficiency, and inclusivity. The progress made in few of such DPIs is as follows:

- **Aadhaar:** Aadhaar is the world's largest digital identity programme that provides biometric and demographic-based unique digital identity, which can be authenticated anytime, from anywhere and eliminates duplicate and fake identities. As of April 2025, 142 crore (1.42 billion) Aadhaar IDs have been generated[8].

- **Unified Payment Interface (UPI):** It is India's leading digital payment platform. Nearly 460 million people and 65 million merchants use UPI. According to the ACI Worldwide Report 2024, India handled 49% of global real-time transactions in 2023. UPI is now live in over seven countries, boosting global digital payments and financial inclusion.

- **DigiLocker**: It is a platform for issuance and verification of documents & certificates digitally. It has facilitated approx. **54 crore** (540 million) users and made available **675 crore (6.75 billion) issued documents**. Several fintech companies, working in the banking and financial sector, are using DigiLocker for easy on boarding of users.

- **UMANG**: Launched in 2017, UMANG (Unified Mobile Application for New-age Governance) is developed to drive Mobile Governance in India. UMANG provides a single platform for all Indian Citizens to access pan India e-Gov services ranging from Central to Local Government bodies.

- **Government e-Marketplace (GeM):** Launched in 2016, Government e Marketplace (GeM), facilitates online procurement of common use Goods & Services required by various Government Departments / Organisations / PSUs.

2.4. 5G/6G

The conversation about 5G networks in India started in 2017 when the government of India constituted a High-Level Forum on 5G India 2020[9] to articulate the Vision for 5G in India and to recommend policy initiatives and action plans to realize this vision. In August 2018, the High-Level Forum released a report titled as "Making India 5G ready"[10] suggesting measures in the area of Spectrum Policy, Regulatory Policy, Education and Awareness Promotion Program, Application & Use Case Labs, Development of

[8] https://www.pib.gov.in/PressNoteDetails.aspx?ModuleId=3&NoteId=154788
[9] https://dot.gov.in/internationalcooperation/constitution-high-level-forum-5g-india-2020
[10] https://dot.gov.in/sites/default/files/5G Steering Committee report v 26.pdf

Application Layer Standards, Major Trials and Technology Demonstration and Participation in International Standards.

The Telecom Regulatory Authority of India (TRAI) also released a White Paper on 'Enabling 5G in India'[11] on 22nd February 2019. This White Paper highlights the specifications of the 5G technology, discusses the potential use cases and architecture of 5G network, deliberates those areas that will require investment for 5G deployment, covers the spectrum requirements for 5G networks, and tries to identify regulatory challenges that need to be addressed for the deployment of 5G in India.

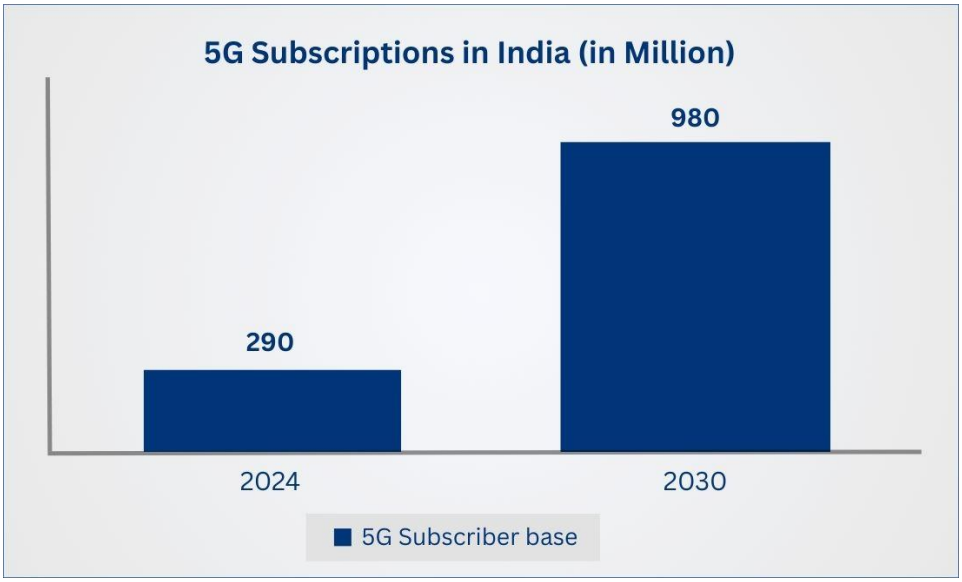
In July-August 2022, the Department of Telecommunications (DoT) allocated spectrum to telecom operators, paving the way for launch of 5G services. The telcos spent over INR 1.5 lakh cr. (~€17 Bn) in acquiring the 5G spectrum.

5G services were formally launched by Government of India in October 2022. 5G has been a success in India in terms of rollout. 5G services have been rolled out in all States/ UTs across the country and presently it is available in 99.8% of the districts in the country. The rollout is being spearheaded by major telecom operators like Jio, Airtel, and Vodafone Idea, with coverage expanding rapidly across urban and semi-urban areas.

Further, as on 30th May 2025, 4.86 lakh (486K) 5G Base Transceiver Stations (BTSs) have been installed by the Telecom Service Providers (TSPs) across the **country**[12].

According to a report from Swedish telecom gear maker **Ericsson**[13], India's 5G subscriber base is estimated to grow by over three-fold to around 98 crore (980 million), and the number of 4G users is likely to decline by about 60% to 23 crore (230 million) by 2030.

"By the end of 2024, 5G subscriptions in the country reached 290 million, representing 24% of total mobile subscriptions. This figure is projected to climb to around 980 million by 2030, accounting for 75% of all mobile subscriptions," the report said.



As 5G technology gains inroads, India has also started taking necessary steps to move beyond the deployment of 5G technology. India is planning to launch 6G services by 2030 subject to eco-system

[11] https://www.trai.gov.in/sites/default/files/2024-08/PR_No.16of2019.pdf

[12] https://www.pib.gov.in/Pressreleaseshare.aspx?PRID=2147766

[13] https://economictimes.indiatimes.com/industry/telecom/telecom-news/india-5g-subscriber-base-to-reach-98-cr-mobile-data-consumption-may-fall-to-62-gb-by-2030-emr/articleshow/122051869.cms?from=mdr

readiness and has set an eye of being a global leader with the network technology & Standards contribution from India. The country aims to contribute 10% of global 6G patents, reinforcing its ambition to become a leader in next-gen telecom innovation.

Major telecom operators (Reliance Jio, Airtel, Vodafone Idea) and global OEMs (Nokia, Ericsson, Samsung) are central to deployment, while COAI and BIF play a key role in industry advocacy. TSDSI ensures India's active participation in global standardization bodies such as 3GPP and ITU. Indigenous R&D efforts led by C-DOT, IITs, IISc, and C-DAC form the backbone of the Bharat 6G Mission.

Category	Key Players
Government Ministries / Departments	• Department of Telecommunications (DoT), Ministry of Communications • Telecom Engineering Centre (TEC), DoT • Ministry of Electronics and Information Technology (MEITY) • NITI Aayog • Department of Science & Technology (DST)
Industry Associations	• COAI; • Broadband India Forum (BIF); • CII; • FICCI; • NASSCOM; • MAIT; • ICEA; • Operators (Jio, Bharti Airtel, Vodafone Idea); • OEMs (Nokia, Ericsson, Samsung); • Chip/Infra (Qualcomm, Intel, Mediatek)
Standard Development Organizations	• BIS (LITD/ETD) • TSDSI (represents India in global forums such as 3GPP and ITU) • TEC (specs & MTCTE)
R&D Organizations	• C-DOT; IITs; IISc; C-DAC etc.

i. Key policy including R&D initiatives

a) 6G Technology Innovation Group (TIG)

In Nov. 2021, DoT formed a 6G Technology Innovation Group (TIG) with an aim to give a boost to the development activities of 6G technology at the national and global levels.

- To frame a roadmap for R&D activities, pre-standardization, development of applications on 6G technology.
- To identify the area of work and build synergy to innovate, create IPR, standardize, contribute to global standards, create regulations, run pilots, and manufacture, test, and supply at a global scale.

Under 6G TIG, Telecom Department (DoT) has formed six task forces making industry representation symbolic.

- task forces are headed by various academia from across the country. Directors of IIT-Madras, IIT-Kanpur, IISc among others.
- deliverables include Mapping of global 6G activities; India's competencies and potential pre-Standardization activities; Mission 6G program; Research views on IMT for 2030 about Networks, Devices, Spectrum, multi-disciplinary innovative solutions.

Based on the reports of the Six Task Forces, in March 2023, Government of India unveiled a "Bharat 6G Vision"[14] document prepared by the Technology Innovation Group on 6G. The objective of this vision document is to create and deploy 6G network technologies that provide secure, intelligent, and pervasive connectivity, enabling people all over the world to live better lives. The Vision statement emphasises India's commitment to socioeconomic prosperity, as well as the potential benefits of India's pioneering 6G technology.

As per the document, the government is planning to address 6G in two phases, Phase 1 (2023–2025 research, PoCs, and building core technologies) and Phase 2 (2025–2030 Commercial deployment, IP creation, and global standardization). The government has also appointed an apex council to oversee the project and focus on issues such as standardization, identification of the spectrum for 6G usage, create an ecosystem for devices and systems, and figure out finances for research and development, among other things.

b) Bharat 6G Alliance - B6GA[15]

In July 2023, the Department of Telecommunications (DoT) under the Ministry of Communications launched the Bharat 6G Alliance (B6GA) to foster innovation and leadership in 6G technology. The Bharat 6G Alliance is an alliance of domestic industry, academia, national research institutions, and standards organisations facilitated by the Government, and is expected to chart its own course of action based on the Bharat 6G Vision Document and further developments. B6GA focuses on the following:

- To help grow 5G Advanced/6G IPs and essential patents from India.
- Design and build Indian 5G Advanced/6G products and solutions;
- Support and energise Indian participation in 3GPP/ITU;
- To help build consortia of Indian Startups and companies;
- To facilitate market access for Indian 5G/6G technology products;
- Build coalition with like-minded 6G Global Alliances.

B6GA has signed MoU with leading global 6G alliances such as 6G Smart Networks and Services Industry Association (6G-IA), Europe[16] to enhance global collaborations for the development of 6G wireless technologies.

c) 6G testbed

Telecom Department (DoT) has funded two next-generation testbeds namely 6G THz Testbed & Advance Optical Communication Test Bed to advance the 6G research.

d) Academic and Startup Ecosystem

In the financial year 2023-24, the Government has sanctioned 100 - 5G labs in academic institutions across India to build a strong foundation for a 6G-ready workforce and entrepreneurial ecosystem.

e) Research Projects

As of June 2025, a total 110 projects related to 5G and 6G amounting to Rs. 304.70 Crores (approx. €30.47 million) have been approved under Telecom Technology Development Fund (TTDF) scheme.

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[14] https://dot.gov.in/sites/default/files/Bharat 6G Vision Statement - full.pdf
[15] https://bharat6galliance.com/index.php
[16] https://6g-ia.eu/

The duration of these R&D projects ranges from 1 to 5 years. These projects are currently in the initial stages of development. For 5G and 6G advancements, **TTDF scheme is supporting various technological domain funding involving government & private institutions, MSMEs, start-ups etc**.[17]

ii. Growth Drivers

- **Adoption of emerging technologies**: 5G enables businesses to integrate advanced technologies like IoT/M2M, augmented reality (AR), virtual reality (VR), Artificial Intelligence (AI) and edge computing, enhancing customer experiences, automating processes and improving operational efficiency across sectors.

- **Rising demand for High-Speed Data:** The surge in video streaming, cloud-based applications, remote work, and IoT services is driving the need for high bandwidth and ultra-fast, reliable connectivity—capabilities that 5G networks are designed to deliver.

- **Enabling IoT and Industry 4.0:** With its ultra-low latency and high device density, 5G is a key enabler of Industry 4.0, supporting automation, real-time data exchange, and smart systems in sectors like manufacturing, agriculture, healthcare, logistics and urban/smart cities.

- **Government support and policy initiatives** – Initiatives like **BharatNet, National Broadband Mission (NBM)** along with other policies on infrastructure sharing and street furniture usage, will enable smoother network service from telecoms.

- **Driving Innovation and Startups:** 5G's capabilities are expected to drive innovation across sectors, giving rise to new services, applications, and business models, which can benefit startups and technology ecosystems.

iii. Challenges

- **Infrastructure:** Deploying 5G infrastructure requires significant investments in new cell towers, fiber optic networks, and other equipment.

- **High Costs:** Building 5G networks involves substantial costs, including spectrum acquisition, infrastructure deployment, and technology upgrades. Balancing these costs with potential revenues can be complex.

- **Device Compatibility:** Not all devices are 5G-compatible, which can lead to a lag between network deployment and device availability. Many users will require to change their devices, and it will result in a financial burden on some users and thus will contribute to challenges in its rollout.

iv. Standardization 5G/6G

TSDSI (Telecommunications Standards Development Society, India) and **TEC (Telecommunication Engineering Centre)** are the **two main bodies responsible for 5G standardisation in India**, each playing distinct yet complementary roles in shaping the country's 5G ecosystem.

TSDSI is India's recognized telecom **Standards Development Organization (SDO)**. It represents India in global standard-setting forums such as **3GPP (3rd Generation Partnership Project)** and the **ITU (International Telecommunication Union)**. TSDSI has been actively transposing the 3GPP

[17] https://www.pib.gov.in/PressReleasePage.aspx?PRID=2153062

specifications and making them available to TEC for adoption as the Indian national standards in a timely manner. The core 5G standard in India is based on the globally accepted **3GPP 5G NR (New Radio) & SA (Stand Alone)** framework.

TSDSI is also responsible for **developing and contributing Indian requirements** to global telecom standards. Its most notable contribution is the **5Gi standard**, designed to improve rural 5G coverage. Through TSDSI, India became a contributor to the global 5G ecosystem, with 5Gi being part of **3GPP Release 17**, ensuring **global interoperability** with India-specific enhancements.

TEC plays a critical role in the **standardisation and regulatory framework** for 5G in India. As the **technical arm of the Department of Telecommunications (DoT)**, TEC is responsible for formulating and enforcing standards, specifications, and guidelines to ensure that telecom networks and equipment deployed in India meet national and international benchmarks for quality, interoperability, and security.

TEC develops **Essential Requirements (ERs)**, **Generic Requirements (GRs)**, and **Interface Requirements (IRs)** for telecom equipment, including those used in 5G networks. It is responsible for the **Mandatory Testing and Certification of Telecom Equipment (MTCTE)**, ensuring 5G equipment meets Indian performance and security standards. TEC works in coordination with TSDSI on their transposed 3GPP international standards to make them National Standards in India and as well publish 5G policy from a technical standpoint.

6G Standardization:

India, through the Telecommunication Engineering Centre (TEC), has taken a proactive role in shaping the global 6G framework at the ITU-T through its National Study Group (NSG) and carried out extensive work in submitting regular Indian contributions towards the development of the ITU 6G framework – IMT 2030. The inclusive approach adopted by TEC has resulted in wide stakeholder participation in the National Study Group with involvement of major industries, startups, academia, and R&D organizations.

Over the past few years, the TEC-led NSG has contributed consistently to the development of the ITU's IMT-2030 (6G) framework, advocating for India-specific requirements. India has played a key role in securing the inclusion of six usage scenarios for 6G TPR. Additionally, India has emphasized coverage, interoperability, and sustainability as critical capabilities for next generation 6G technologies.

TSDSI is also at the forefront of India's 6G standardisation efforts, by submitting inputs to ITU-R's IMT-2030 framework—including future technology trends, performance indicators, and studies on frequencies beyond 100 GHz. TSDSI contributed to ITU-R reports and is steering efforts in architectures for interoperability ("compossibility"), RIS (Reconfigurable Intelligent Surfaces), and cloud interoperability standards tied to Smart Cities. TSDSI Roadmap 3.0 for (2024–2026), includes workstreams on integrated sensing and communication, AI-enabled networks, ubiquitous connectivity, waveforms, security, and open systems/hardware[18].

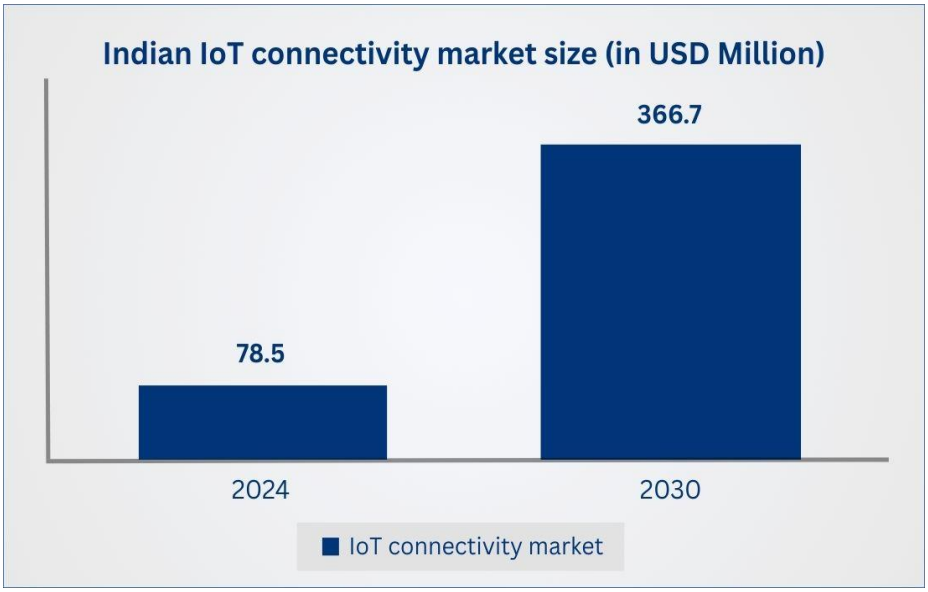
2.5. IoT/M2M

The Indian government has identified M2M communications and the Internet of Things (IoT) among the fastest emerging technologies across the globe, providing enormous beneficial opportunities for the society, industry, and consumers. It is being used to create smart infrastructure in various verticals such as power, automotive, safety and surveillance, remote health management, agriculture, smart

[18] https://tsdsi.in/wp-content/uploads/2022/10/6G-White-Paper-12-Pages-Digital.pdf , https://www.pib.gov.in/PressReleasePage.aspx?PRID=2159196

homes, Industry 4.0, and smart cities, to name a few, using connected devices. M2M communication is going to play a major role and will contribute significantly towards the government initiatives 'Digital India' and 'Make in India'.

The India IoT connectivity market size reached **USD 78.5 Million** in 2024. Looking forward, IMARC Group expects the market to reach **USD 366.7 Million** by 2033, exhibiting a growth rate **(CAGR) of 17.74%** during 2025-2033.



The emerging automation trend in industrial processes, the increasing sales of connected cars, and the widespread adoption of IoT-enabled devices in the healthcare industry represent some of the key factors driving the market[19].

The IoT/M2M sector in India is regulated by the Department of Telecommunications (DoT) and supported by MeitY and MoHUA (particularly for Smart Cities). Industry associations such as COAI, BIF, NASSCOM, and FICCI promote adoption and ecosystem development. Standards are developed by TEC (adopting oneM2M specifications), TSDSI, and BIS. R&D efforts are led by C-DOT, C-DAC, IITs, IIITs, and other academic and research institutions.

Government Ministries / Departments	• DoT • MeitY • DST. • MoHUA (smart city IoT). • WPC (spectrum)
Industry Associations	• COAI • BIF • FICCI • NASSCOM etc.
Standard Development Organizations	• BIS (LITD 27 and LITD 28) • TEC (adoption of oneM2M specifications) • TSDSI (transposition of oneM2M specifications)

[19] https://www.imarcgroup.com/india-iot-connectivity-market

R&D Organizations	• C-DOT; C-DAC; IITs; IIITs

i. Key policy including R&D initiatives

To strengthen the M2M ecosystem and to facilitate wider proliferation and innovation in the sector, the government has taken the following actions recently:

a) **National Telecom M2M Roadmap:**[20] National Telecom M2M Roadmap was released by the Ministry of Communications (MoC) on 12 May 2015. It seeks to assimilate various M2M standards, outline policy and regulatory approaches and measures for increased M2M proliferation.

b) **On 17 January 2022, DoT Introduced new license for UL(M2M) and UL-VNO(M2M) under UL and UL-VNO licenses and amended the guideline for UL and UL (VNO)[21]:** Though the existing Access Service Providers were already enabled to provide connectivity to the M2M/IoT networks, through the new licenses, an independent category of Service Providers has been enabled to create, operate and provide Network for Interconnection of M2M/IoT devices. In this license, applicants can apply for different categories like Category A (For PAN India), Category B (Service Area) and Category C (SSA/District area).

c) **On 8 February 2022, DoT issued Guidelines for registration of M2MSP Service Providers and WPAN/WLAN Connectivity Providers[22]:** Applicants need to register themselves to provide SIM and WPAN/WLAN based M2M Communication. This will help in addressing concerns like connectivity with TSPs, KYC, traceability, and encryption. Registration shall be carried out at field offices of DoT spread across the country.

d) **On 16 February 2022, Networks and Technologies wing, DoT set up two M2M committees:** Two committees have been set up: 1) the M2M Policy Reform Committee and 2) the M2M Consultative Committee. They discuss, analyse issues, and suggest initiatives relating to the M2M ecosystem.

e) **Released 13-digit numbering plan exclusively for M2M/IoT devices** connected through mobile networks.

f) **Features of the SIMs used only for M2M communication services**[23] have been defined and related KYC instructions for issuing M2M SIMs to entity/organization providing M2M communication under bulk category have also been issued.

g) DoT has also permitted use of embedded SIMs by allowing telecom service providers to configure them over the air (OTA). This has enabled availability of sufficient numbering resources and led to a robust framework for mobile M2M ecosystem in the country.

h) Telecom Engineering Centre (TEC) has also released recommendations on IoT/ M2M security[24] in January 2019, Code of Practice for securing consumer IoT[25] in August 2021, Technical report

[20] https://dot.gov.in/sites/default/files/National Telecom M2M Roadmap.pdf
[21] https://dot.gov.in/sites/default/files/UL VNO guidelines with M2M without INSAT MSS R dated 17012022_1.pdf?download=1
[22] https://dot.gov.in/sites/default/files/M2MSP Guidelines .pdf?download=1
[23] https://dot.gov.in/sites/default/files/M2M SIMs Relaxation_0.PDF?download=1
[24] https://www.tec.gov.in/pdf/M2M/TECHNICAL REPORT Recommendations for Iot M2M Security.pdf
[25] https://www.tec.gov.in/pdf/M2M/Securing Consumer IoT _Code of pratice.pdf

on Framework of National Trust Centre for M2M/ IoT Devices and Applications[26] in March 2022 and Technical Report on Security by design for IoT device manufacturers[27] in March 2023. These documents suggest ways to have safe and secure IoT deployments. Similarly, TEC has published various technical reports[28] in IoT/M2M domain.

- TEC code of practice for securing consumer IoT is developed based on **EN 303 645.**

i) In April 2025, TRAI released "**Recommendations on the Issues Related to Critical Services in the M2M Sector and the Transfer of Ownership of M2M SIMs**"[29]. TRAI recommended that the classification of critical IoT services of a particular domain/ sector should be done by the ministry/ regulatory body concerned in consultation with Department of Telecommunications (DoT). TRAI also emphasized a technology-agnostic approach for the provision of critical IoT services. Specifically, TRAI has recommended that any wireless M2M communication technology (utilizing unlicensed spectrum, or licensed spectrum) or wired M2M communication technology should be permitted to be used for the provision of critical IoT services if it meets the prescribed service performance benchmarks.

j) **Addition of 1MHz spectrum to unlicensed 865-867 MHz band**[30]: To have additional availability of spectrum for M2M/IoT applications, 1MHz additional spectrum is added in the earlier unlicensed 865-867MHz band, making it 865-868MHz. Also, radiated power, channel bandwidth, and duty cycle have been defined for different use cases.

k) C-DOT has developed a common services platform (CCSP)[31] for IoT/M2M communication based on oneM2M Release 3 standards.

The above regulatory enablement for M2M services is expected to reduce cost, enhance the productivity, provide faster response time, optimize the resource consumption, and increase the revenues for businesses, leading to ease of living for the common citizens.

ii. Growth Drivers

- **Rising adoption of Smart technologies across industries:** Industries such as healthcare, transportation, and manufacturing, energy and retail are increasingly adopting IoT and M2M solutions to enable real-time data monitoring, predictive maintenance, process automation, and operational cost reduction.

- **Development of Smart cities and Smart homes:** The rise of smart cities and smart homes is driving the adoption of M2M/IoT communications, as it enables the integration of various systems, such as lighting, heating, and security, to improve the quality of life for citizens.

- **Low-cost sensors:** Low-cost and energy efficient sensors, declining cost of connectivity as well as reduced cost and time of processing will play a key role in rise and adoption of IoT.

- **Integration with Big Data Analytics and Cloud Computing** – IoT deployments generate massive amounts of unstructured data. The combination of IoT with big data analytics and cloud

[26] https://tec.gov.in/pdf/M2M/Framework of National Trust Centre for M2M-IoT Devices and Applications TEC 31188_2022_after.pdf
[27] https://tec.gov.in/pdf/M2M/Security by Design for IoT Device Manufacturers.pdf
[28] https://tec.gov.in/M2M-IoT-technical-reports
[29] https://www.trai.gov.in/notifications/press-release/trai-releases-recommendations-issues-related-critical-services-m2m
[30] https://dot.gov.in/sites/default/files/The use of low power equipment in the frequency band 865-867 MHz for short range devices %28Exemption from License%29 Rules%2C 2021.pdf?download=1
[31] https://www.cdot.in/cdotweb/web/product_page.php?lang=en&catId=4&pId=13

computing enables organisations to process this data efficiently, derive actionable insights, and shift from reactive decision-making to predictive and prescriptive strategies.

- **Increasing consumer adoption:** Growing smartphone penetration, affordable internet access, and the popularity of wearables, home automation devices, and connected appliances are fuelling consumer interest and driving mass-market IoT adoption.

iii. Challenges

- **Robust connectivity**: It is very important for timely transmission of the data. Latency, availability, coverage, and cost are some of the factors deciding the appropriate communication technology.

- **Security and Privacy:** With billions of devices and sensors connected to the internet, protecting sensitive data has become a critical challenge. IoT/M2M security challenges include various aspects of IoT such as authentication, confidentiality, privacy, access control etc.

- **Fragmentation of standardization:** The standardization of the IoT/M2M ecosystem will significantly reduce numerous problems like interoperability, security, data sharing, changing vendors etc. faced by the IoT/M2M ecosystem in the country. It would enable users and application service providers in various domains like Smart Cities, Smart Grids and Meters, Transportation, Health, Energy, Water Resources, Waste Management etc. to use "vendor agnostic" end-to-end interoperable IoT/M2M platforms.

- **Need for Sustainable Power Solutions for Sensors** – Many IoT devices, especially remote sensors, require long-life, energy-efficient power sources. Advancements in low-power technologies, energy harvesting, and battery longevity are essential to reduce maintenance costs and improve the scalability of IoT deployments.

iv. Standardization

Bureau of Indian Standards (BIS):

Bureau of Indian Standards (BIS) through its technical committee "LITD 27 on IoT and digital twin"[32] is developing standards in the field of Internet of Things and related technologies including sensor networks. LITD 27 is mirror committee of ISO/IEC/JTC1 TC 41 / SC 41 - Internet of Things and related technologies.

TSDSI and TEC:

Telecommunication Engineering Centre (TEC), the technical wing of telecom department (DoT), has adopted oneM2M specifications (Release 2 and Release 3[33]) as national standards. TSDSI, as partner type 1 of oneM2M has transposed oneM2M Release 2 and Release 3 specifications and had provided these transposed documents to TEC for adoption as national standards. These specifications address the need for common M2M service layer that can be readily embedded within various hardware and software, relied upon to connect the myriad of devices in the field with M2M application servers worldwide. These transposed documents cover M2M functional architecture, requirements, service layer control protocols, Management enablement etc. oneM2M provides a fast-track and future proof IoT based smart city.

These TEC standards have also been included by Bureau of Indian Standards (BIS) in its standards IS 18004 (Part 1):2021 on IoT System Part 1 Reference Architecture released in June 2021 by LITD-28 on Smart Infrastructure.

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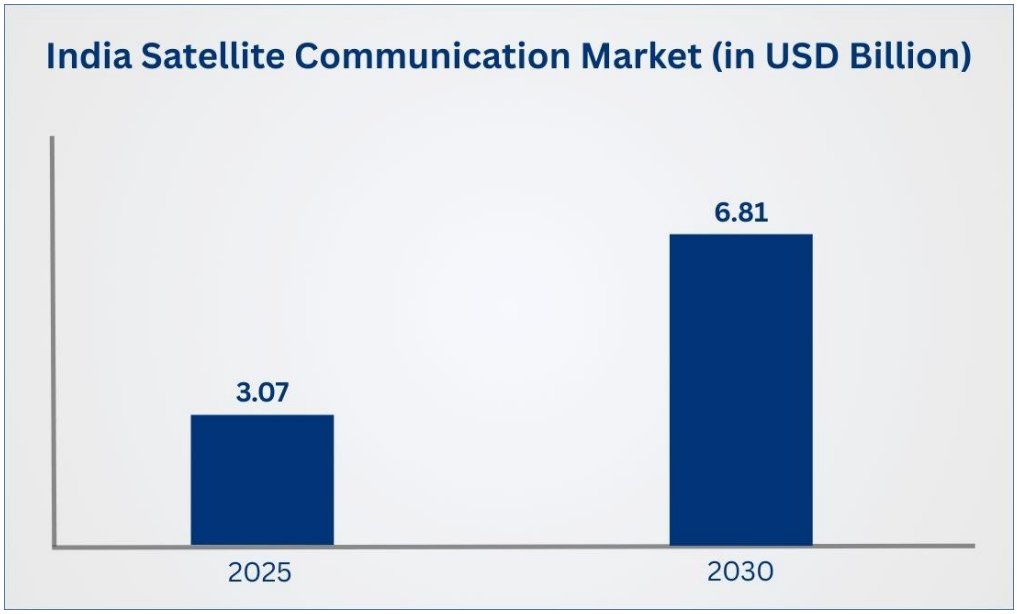
[32] https://www.services.bis.gov.in/php/BIS_2.0/bisconnect/pow_details
[33] https://tsdsi.in/onem2m/

2.6. Satellite Communication

The satellite communication (SATCOM) market in India is experiencing substantial growth, driven by increasing demand for connectivity, government support, and private sector investments. According to Mordor Intelligence, the India Satellite Communication Market size is estimated at USD 3.07 billion in 2025, and is expected to reach USD 6.81 billion by 2030, at a CAGR of 17.27% during the forecast period (2025-2030)[34]. This growth is further fuelled by the adoption of satellite-based applications across various sectors, including defense, disaster management, and remote connectivity.



India's satellite communications (satcom) ecosystem is led by Indian Space Research Organisation (ISRO), the Department of Space (DoS), and IN-SPACe, with spectrum management and licensing overseen by DoT and TRAI. Industry associations include the Indian Space Association (ISpA) and SIA-India, alongside major players such as Eutelsat OneWeb, Jio-SES, and the upcoming Starlink services. Standards are developed by BIS, TEC, and TSDSI, while research is driven by ISRO centres and IITs.

Government Ministries / Departments	Department of Space (DoS)/ISRO; IN-SPACe; NewSpace India Ltd (NSIL); DoT; TRAI
Industry Associations	Indian Space Association (ISpA); SIA-India; Operators/Players (Eutelsat OneWeb and Jio SES, Starlink etc.)
Standard Development Organizations	BIS; TEC (satcom specs); and TSDSI
R&D Organizations	ISRO Centres (SAC, VSSC, URSC etc.); IITs

Many operators have applied for authorization for providing satellite communication over India, including connectivity in remote and under-served areas. Total 5474 Gram Panchayats have been connected through satellite[35].

- In July 2025, Starlink has received a Unified Licence to launch satellite internet services in India. Alongside the licence, the government has finalized regulatory frameworks for spectrum

[34] https://www.mordorintelligence.com/industry-reports/india-satellite-communication-market
[35] https://www.pib.gov.in/PressReleasePage.aspx?PRID=2080648

allocation and gateway setup to ensure a smooth rollout. Starlink to provide Broadband internet service with targeted speeds of 25-220 Mbps, primarily to rural and remote areas. It has also signed non- exclusive reselling agreements[36] with RJio and Airtel and as well approached to PSU Operator BSNL and ISPs - NELCO[37] and Hughes[38] to sale satellite broadband internet services in India.

- Bharti Group-backed Eutelsat OneWeb and Jio SES are also awaiting spectrum allocation for their satellite communication services. Airtel with Starlink also plans to offer broadband services for enterprise and government customers across land, sea, and air.
- Jio Space SES after obtaining license is also entering in multiple satellite technologies[39] – LEO, MEO and GEO. Jio has also signed with Starlink for reselling their satellite broadband internet services in India.
- Amazon Plans Satellite Internet Launch in India with Project Kuiper as Amazon has applied for a GMPCS license from India's Department of Telecommunications (DoT).
- Ananth Technologies[40] founded by Ex ISRO Scientist and backed by Government of India plans to offer speeds of up to 100 Gbps also plans to deploy a 4-ton geostationary (GEO) communication satellite into space, with an initial investment target of 30 billion Euro. They have also Signed MoU with ReOrbit[41] (specializing in software-enabled satellites for secure communications).
- Apple subsidiary Globalstar have also submitted the Application for licence recently

i. Key Policy including R&D initiatives

a) Satellite Services Division- Department of Telecommunications (DoT)

The Satellite Division is entrusted with the role of coordinating all policy matters pertaining to SATCOM planning/operations/monitoring, introduction of new Satellite Technologies, Grant of satellite related licenses/ permissions, SATCOM network permissions and coordination etc.

b) Satellite Communication Reforms-2022

Satellite Communication Reforms-2022 by the government have simplified the regulatory procedures and reduced financial charges on the licensees. The recent space sector reforms further enabled larger participation of non-government entities for building/leasing, owning and operating the satellite systems for providing satellite-based services.

c) DoT guidelines for establishing satellite-based communication networks-2022

In October 2022, the Department of Telecommunications (DoT) has released guidelines for establishing satellite-based communication networks[42]. These guidelines outline the licensing regime for satellite-based communication services and the process for obtaining approvals. The guidelines are divided into two chapters, focusing on licensing and the process for seeking approvals. For more information on various rules and guidelines, please visit DoT satellite services division[43]. The Department of Telecommunications (DoT) is also working to streamline regulations for satellite-based services.

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[36] https://www.bbc.co.uk/news/articles/cqx0qpy3204o
[37] https://www.nelco.in/
[38] https://www.hughes.in/
[39] https://telecom.economictimes.indiatimes.com/news/portal-in-portal/satcom/ses-awaits-security-approval-for-new-meo-satellites-to-enhance-reliance-jios-enterprise-offerings/122877927
[40] https://ananthtech.com/
[41] https://www.reorbit.space/
[42] https://dot.gov.in/sites/default/files/Guidelines for establishing Satellite-based Communication Netwroks.pdf?download=1
[43] https://dot.gov.in/node/25973

d) TRAI recommendations on spectrum pricing and allocation- 2025

In May'25, the Telecom Regulatory Authority of India (TRAI) submitted its recommendations[44] on spectrum pricing and allocation, proposing a model based on administrative allocation with a 4 per cent fee on adjusted gross revenue (AGR) for five years. This approach aligns with international standards set by the International Telecommunications Union (ITU), which advocates for assigned spectrum for satellite services rather than auctions. The DoT is expected to finalize these guidelines soon[45].

ii. Growth Drivers

- **Government Support:** The Indian government is actively fostering the growth of the satellite communication (Satcom) sector by streamlining regulations, implementing policy reforms, and promoting private sector participation.

- **Private Sector Participation:** Increased investments from both domestic and international players in Satcom infrastructure and services are fuelling competition, innovation, and market expansion.

- **Rising Demand for Connectivity:** The surge in demand for high-speed, reliable internet—especially in underserved and remote regions is accelerating the adoption of Satcom solutions.

iii. Key Challenges

- **High Initial Cost:** High initial costs have been a barrier to widespread adoption, but advancements in technology and increased competition are helping to lower prices.

- **Regulatory and Policy Framework:** While progress has been made, further streamlining and clarity in regulations, licensing, and foreign investment norms are essential to foster innovation and attract sustained investment in the Satcom sector.

- **Spectrum Availability:** Ensuring adequate spectrum availability is essential for the deployment of satellite-based services.

iv. Standardization

In India, standardization activities for satellite communication (Satcom) are driven by a mix of government agencies, standards bodies, and industry associations, ensuring interoperability, safety, and alignment with global best practices.

- **Bureau of Indian Standards (BIS):** BIS, through its technical committee **LITD7: Audio, Video And Multimedia Systems And Equipments**[46] has developed many standards for Satellite Receiver.

- **Telecommunication Engineering Centre (TEC):** Under the Department of Telecommunications (DoT), TEC has mandated the testing and certification of satellite communication (satcom) equipment, including gateways and user terminals, as India prepares to roll out satellite communication services.

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[44] https://www.trai.gov.in/sites/default/files/2025-05/Recommendtion_09052025.pdf

[45] https://swarajyamag.com/news-brief/starlink-has-received-satellite-internet-permit-spectrum-norms-ready-scindia

[46] https://www.services.bis.gov.in/php/BIS_2.0/bisconnect/pow_details

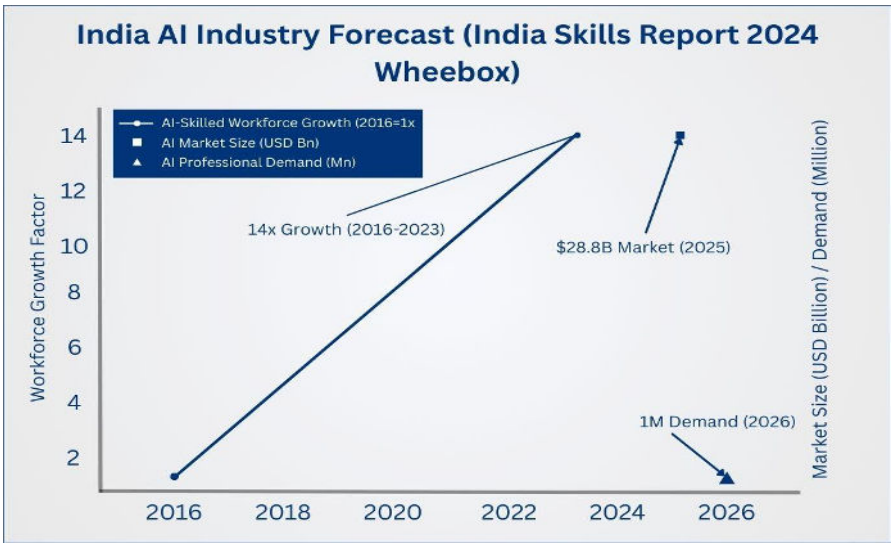
- **Telecommunication Standards Development Society, India (TSDSI):** TSDSI works on incorporating satellite communication standards into the Indian telecom ecosystem, ensuring compatibility with 3GPP specifications and enabling integration with terrestrial networks such as 5G and beyond.

- **Indian Space Research Organisation (ISRO):** While ISRO focuses on R&D and deployment, it also contributes to standardization through mission-specific specifications and by participating in international forums like the ITU.

2.7. Artificial Intelligence (AI)

Indian government is relentlessly working towards building a robust growth ecosystem to ensure healthy development of AI in India and its applications in various components of governance and social development.

The India Skills Report 2024 by Wheebox forecasts that India's AI industry will reach USD 28.8 billion by 2025, with a CAGR of 45%. The AI-skilled workforce has seen a 14-fold increase from 2016 to 2023, making India one of the top five fastest-growing AI talent hubs, alongside Singapore, Finland, Ireland, and Canada. The demand for AI professionals in India is projected to reach 1 million by 2026[47].



Global rankings such as Stanford AI rankings Index 2024, India ranks first globally in AI skill penetration with a score of 2.8, ahead of the US (2.2) and Germany (1.9). AI talent concentration in India has grown by 263% since 2016, positioning the country as a major AI hub. India also leads in AI Skill Penetration for Women, with a score of 1.7, surpassing the US (1.2) and Israel (0.9).

India has emerged as the fastest-growing developer population globally and ranks second in public generative AI projects on GitHub. The country is home to 16% of the world's AI talent, showcasing its growing influence in AI innovation and adoption.

AI growth in India is being driven by the Ministry of Electronics and Information Technology (MeitY), with NITI Aayog and the Department of Science & Technology (DST) playing key roles in shaping AI policies and research roadmaps. Industry associations such as NASSCOM, CII, and FICCI are fostering AI adoption across sectors. On the standards front, BIS (LITD 30) collaborates with international bodies like ISO/IEC JTC 1/SC 42. Research and innovation are spearheaded by IITs, IISc, and MeitY Centres of Excellence, with a strong focus on open-source AI and enabling India's linguistic diversity.

[47] https://www.pib.gov.in/PressReleasePage.aspx?PRID=2108810

Government Ministries / Departments	• MeitY (IndiaAI Mission) • NITI Aayog • DoT • DST
Industry Associations	• ASSOCHAM • NASSCOM • CII • FICCI
Standard Development Organizations	• BIS (LITD 30 AI). • TEC
R&D Organizations	IITs; IISc; MeitY Centres of Excellence; CDAC; IIITs

i. Key policy including R&D initiatives

Currently, India does not have any specific law regarding application of AI. The **Ministry of Electronics and Information Technology (MeiTY)** is the regulatory body of AI in India. It has the responsibility development, implementation and management of AI laws and guidelines in India. There are certain provisions mentioned under Intellectual Property Law and several provisions as Section 43A & 72A of Information Technology Act, 2000 which implies that if anyone commits crime by using AI, then he/she will be liable under IT Act, criminal law, and other cyber law. Information Technology (Intermediary Guidelines and Digital Media Ethics Code) Rules 2021[48] obligates the social media platforms to exercise greater diligence regarding content on their platforms.

Government of India has taken several steps to drive the adoption of Artificial Intelligence (AI) which include the following: -

a) Task Force on Artificial Intelligence (AI)

On 24th August 2017, Ministry of Commerce and Industry had constituted a Task Force on Artificial Intelligence (AI)[49] for India's Economic Transformation. The Task Force gave its report on 19th January 2018. It has recommended an Inter-Ministerial National Artificial Intelligence Mission to act as a nodal agency for coordinating AI related activities in India. The recommendations of the Task Force have been shared with various Ministries and Departments of the Government of India.

b) National Strategy for Artificial Intelligence (AI) 2018[50]

In June 2018, the government think-tank, National Institution for Transforming India (NITI) Aayog has released a discussion paper on National Strategy for Artificial Intelligence (AI) which aims to guide research and development in new and emerging technologies.

- This strategy document is premised on the proposition that India, given its strengths and characteristics, has the potential to position itself among leaders on the global AI map.
- NITI Aayog has identified five sectors — **healthcare, agriculture, education, smart cities and infrastructure and transportation** — to focus its efforts on implementation of AI.
- The paper focuses on how India can leverage the transformative technologies to ensure social and inclusive growth.

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[48] https://www.meity.gov.in/static/uploads/2024/02/Information-Technology-Intermediary-Guidelines-and-Digital-Media-Ethics-Code-Rules-2021-updated-06.04.2023-.pdf

[49] https://www.aitf.org.in/

[50] https://www.niti.gov.in/writereaddata/files/document_publication/NationalStrategy-for-AI-Discussion-Paper.pdf

As a follow up to National Strategy for AI, NITI Aayog has published following discussion papers on Responsible Artificial Intelligence (RAI):

- NITI Aayog's paper titled "**Responsible AI for All: Approach Document for India: Part 1 – Principles for Responsible AI**[51]" was the 1st in the series of its publication on RAI. The paper incorporates insights, feedback and experiences consolidated through inter - ministerial consultations, large-scale global multi-stakeholder consultations and a series of 1-1 consultations with AI ethics experts in India and globally, as well as wider public consultations. This paper is meant to serve as an essential roadmap for the AI ecosystem, encouraging adoption of AI in a responsible manner in India and building public trust in the use of this technology, placing the idea of 'AI for All' at its very core.

- NITI Aayog's 2nd paper titled "**Responsible AI for All: Approach Document for India: Part 2 - Operationalizing Principles for Responsible AI**[52]". This paper identifies a series of actions that the ecosystem must adopt to drive responsible AI. These actions are divided among three stakeholders: governments, the private sector and research institutions. Among these stakeholders, the actions are further divided into areas, with each area identifying a series of related measures for implementing the AI principle.

- NITI Aayog brings the third paper titled "**Responsible AI for All: Adopting the Framework – A use case approach on Facial Recognition Technology**[53]". This Paper establishes a framework for responsible and safe development and deployment of facial recognition technology (FRT) within India.

c) India AI: National Program on Artificial Intelligence

In March 2024, Government of India has approved an allocation of over Rs 10,300 crore (approx. €1.03 billion) for the IndiaAI Program, marking a significant step towards bolstering India's AI ecosystem. India AI program is envisioned as an umbrella programme by the Ministry of Electronics and Information Technology (MeitY) for leveraging transformative technologies to foster inclusion, innovation, and adoption for social impact.

This substantial financial infusion, slated over the next five years, is poised to catalyse various components of the IndiaAI Mission, including pivotal initiatives like:

- **IndiaAI Innovation Centre**: This centre is dedicated to developing and deploying indigenous Large Multimodal Models (LMMs) and domain-specific foundational models in critical sectors.
- **IndiaAI Application Development Initiative**: This initiative promotes AI applications in critical sectors by addressing problem statements from Central Ministries, State Departments, and other institutions. It focuses on developing, scaling, and promoting the adoption of impactful AI solutions with the potential for large-scale socio-economic transformation.
- **AIKosh Platform**: Unified hub center for datasets, models, AI sandbox and more to enable AI Innovation
- **IndiaAI Compute Capacity**: Focuses on building a scalable AI ecosystem with 10,000+ GPUs via public-private partnerships, offering AI services and resources
- **IndiaAI Startup Financing**: This pillar supports and accelerates deep-tech AI startups by providing streamlined access to funding for innovative AI projects

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[51] https://www.niti.gov.in/sites/default/files/2021-02/Responsible-AI-22022021.pdf
[52] https://www.niti.gov.in/sites/default/files/2021-08/Part2-Responsible-AI-12082021.pdf
[53] https://www.niti.gov.in/sites/default/files/2022-11/Ai_for_All_2022_02112022_0.pdf

- **IndiaAI FutureSkills**: This pillar aims to reduce barriers to entry into AI programs by increasing AI courses at the undergraduate, master's, and Ph.D. levels. Data and AI Labs will be established in Tier 2 and Tier 3 cities to offer foundational courses.
- **Safe & Trusted AI**: This pillar focuses on ensuring the responsible development, deployment, and adoption of AI by implementing Responsible AI projects, developing indigenous tools and frameworks, self-assessment checklists for innovators, and other guidelines and governance frameworks.

The overarching aim of this financial outlay is to ensure a structured implementation of the IndiaAI Mission through a public-private partnership model aimed at nurturing India's AI innovation ecosystem[54].

d) AIRAWAT[55]

C-DAC has implemented AI Research Analytics and Knowledge Dissemination Platform (AIRAWAT) of 200 AI Petaflops at Centre for Development of Advanced Computing (C-DAC), Pune under the initiative of Ministry of Electronics and IT, Government of India.

The system has been ranked seventy-five in the world. It was declared so in the 61st edition of Top 500 Global Supercomputing List at the International Supercomputing Conference (ISC 2023) in Germany. It puts India on top of AI Supercomputing nations worldwide.

The system will act as a common computational cloud platform for Big Data Analytics and Assimilation with a large, power-optimized AI cloud infrastructure connecting all Centres for Research Excellence in Artificial Intelligence (COREs), Indian Centres for Transformational AI (ICTAIs), and other Academic, Research Labs, Scientific Community, Industry, and the Start-Ups institutions with the National Knowledge Network.

In alignment with the Atmanirbhar Bharat initiative of the Government of India, 'AIRAWAT' will empower the Academia, Research Labs, Scientific Community, Industry, and Start-Ups to develop indigenous AI-enabled products & solutions, especially for solving India-specific grand challenges, complex real-life problems, and for the world in Natural Language Processing, Surveillance and Image Processing, Education, Agriculture, Finance, Healthcare, National Security, Defence, Automotive industry, Anomalous Behavior detection from video analytics, Supply Chain Management, Human Resource Development.

e) Reports by MEITY Committees on AI

To create a policy framework and to develop the ecosystem for Artificial Intelligence, Meity has constituted four committees covering all the aspects of AI. Meity has released following Committees reports on AI:

- Report of committee - A on platforms and data on AI[56]
- Report of committee - B on leveraging AI for identifying national missions in key sectors[57]
- Report of committee - C on mapping technological capabilities, key policy enablers required across sectors, skilling, reskill[58]
- Report of committee - D on cyber security, safety, legal and ethical issues[59]

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[54] https://www.pib.gov.in/PressReleasePage.aspx?PRID=2012375
[55] https://airawat.cdac.in/airawat/
[56] https://meity.gov.in/writereaddata/files/Committes_A-Report_on_Platforms.pdf
[57] https://meity.gov.in/writereaddata/files/Committes_B-Report-on-Key-Sector.pdf
[58] https://meity.gov.in/writereaddata/files/Committes_C-Report-on_RnD.pdf
[59] https://meity.gov.in/writereaddata/files/Committes_D-Cyber-n-Legal-and-Ethical.pdf

ii. Growth Drivers

- **Rising Enterprise Adoption of AI** – Businesses across industries—such as BFSI, manufacturing, retail, logistics, and telecom—are increasingly integrating AI into operations to enhance productivity, improve customer experience, and enable predictive decision-making. According to BCG, 80% of Indian companies consider AI a core strategic priority, surpassing the global average of 75%. Additionally, 69% plan to increase their tech investments in 2025, with one-third allocating over USD 25 million to AI initiatives. This growing enterprise adoption is creating large-scale, sector-specific AI opportunities.

- **Abundant Data for AI model training**: India's rapidly expanding digital ecosystem generates massive and diverse datasets, which are essential for training accurate and robust AI models. This data richness provides strong foundation for developing advanced AI solutions across sectors.

- **Increasing professionals in AI:** Over the past few years, India has seen a significant growth of professionals skilled in AI. According to India Skills Report 2024 by Wheebox, the demand for AI professionals in India is projected to reach 1 million by 2026.

- **Surge in AI Startups**: India has seen a surge in AI startups across domains such as healthcare, agriculture, fintech, and education. These startups receive support from investors, accelerators, and incubators, fuelling innovation. According to data sourced from market intelligence firm Tracxn, the Indian AI sector includes 7,114 start-ups that have collectively raised $23 billion in equity funding so far[60].

- **Supportive Government initiatives**: The Indian government has also recognized the potential of AI and has launched several initiatives such as National AI Strategy to promote adoption, research, and responsible AI deployment[61].

iii. Challenges

- **Data quality:** While data availability is an advantage, **Data** quality is **crucial** in AI because it directly impacts the performance, accuracy, and reliability of **AI** models. High-quality data enables models to make better predictions and produce more reliable outcomes, fostering trust and confidence among users.

- **Data security and privacy:** AI systems rely on large amounts of confidential data, which are often sensitive and personal in nature. Along with automation, AI also brings a range of security and privacy vulnerabilities, which can subsequently exacerbate any organisation's exposure to cyber risk and geopolitical risk.

- **Limited AI expertise:** Talent is one of the biggest challenges to AI. AI requires highly trained and skilled professionals, but being an emerging technology, the talent pool is limited. India is home to only 16% of the world's AI talent, but it is showcasing its growing influence in AI innovation and adoption.

- **Insufficient AI and cloud computing infrastructure:** AI and cloud are inseparable because AI is data hungry, and cloud is the only possible solution. There are endless possibilities to scale up AI with its convergence with cloud computing. However, despite the potential, India lacks access to specialised compute and storage facilities which forms the backbone of AI. A beginning has been

[60] https://www.newindianexpress.com/business/2025/May/02/investors-are-now-more-focused-on-ai-start-ups-tracxn#:~:text=India's%20AI%20sector%20includes%207%2C114,in%20equity%20funding%20so%20far.
[61] https://www.blueweaveconsulting.com/report/india-artificial-intelligence-market

made with India's own AI-first compute infrastructure, AIRAWAT, being implemented by C-DAC, which is a cloud platform for Big Data analytics with advanced AI processing capabilities.

- **Lack of integrity and ethics with AI/ML solutions:** With the advent of AI products and algorithms and their increasing role in decision making, ethics and morality have emerged as a major challenge for the AI solution providers. An AI algorithms work based on training given to it, meaning the AI solution predicts instances based on the data being fed into it and based on the self-learning capability. However, in a few instances, the AI algorithm overlooks the correctness of the data and give an ambiguous result. It is also possible for the results to be skewed due to tampering of the dataset itself[62].

iv. Standardization

Bureau of Indian Standards (BIS):

BIS LITD 30 is responsible for standardization around Artificial Intelligence and Big Data. It is the National Mirror Committee for ISO/IEC JTC1/SC42 with same Title & Scope. LITD 30 has developed more than 20 standards[63] so far:

1. **IS/ISO/IEC/TR 24028: 2020**: Information technology Artificial intelligence Overview of trustworthiness in artificial intelligence.
2. **IS/ISO/IEC/TR 24029-1: 2021**: Artificial Intelligence AI Assessment of the robustness of neural networks Part 1: Overview
3. **IS/ISO/IEC/TR 24030: 2021**: Information technology Artificial intelligence AI Use cases.
4. **IS/ISO/IEC/TR 24368: 2022**: Information Technology Artificial Intelligence Overview of Ethical and Societal Concerns
5. **IS/ISO/IEC/TR 24372: 2021**: Information technology Artificial intelligence AI Overview of computational approaches for AI systems
6. **IS/ISO/IEC 24668: 2022**: Information technology Artificial intelligence Process management framework for big data analytics
7. **IS/ISO/IEC 38507: 2022**: Information technology Governance of IT Governance implications of the use of artificial intelligence by organizations.
8. **IS/ISO/IEC/TS 25058:2024**- Systems and Software Engineering- Systems and Software Quality Requirements and Evaluation (SQuaRE) -Guidance for Quality Evaluation of Artificial Intelligence (AI) Systems
9. **IS/ISO/IEC 5338:2023**- Information Technology- Artificial Intelligence- AI System Life Cycle Processes
10. **IS/ISO/IEC 5339:2024**- Information Technology -Artificial Intelligence- Guidance for AI Applications
11. **IS/ISO/IEC/TR 5469:2024**- Artificial Intelligence -Functional Safety and AI Systems
12. **IS/ISO/IEC 8183:2023**- Information Technology - Artificial Intelligence - Data Life Cycle Framework

Department of Telecommunications (DoT):

The Department of Telecommunications, Ministry of Communications has formed a committee on standardisation in AI technologies to develop necessary AI standards. The scope of the committee will be mainly to identify the gaps and challenges towards developing the standards in different areas of AI; develop these AI standards with India specific requirements and formulate the framework for AI Indian stack. There are five working groups working towards standardisation of AI framework.

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[62] https://indiaai.gov.in/article/five-challenges-for-ai-adoption-in-india-and-what-are-we-doing-about-them

[63] https://www.services.bis.gov.in/php/BIS_2.0/bisconnect/pow_details

- **Working Group-1-** Standardisation of the functional network architectures; AI architecture; data structures.
- **Working Group-2-** Standardisation of the type of interfaces and protocols; Technologies employed; Systems deployed; Benchmarking practices.
- **Working Group-3**- Standardisation in Trustworthiness; digital rights and ethical standards in AI; preserving algorithm openness; Security and compliance aspects.
- **Working Group-4-** Standardisation in Interoperability Standards; technological mapping and leveraging AI for national missions.
- **Working Group-5-** Development of Indian AI Stack.

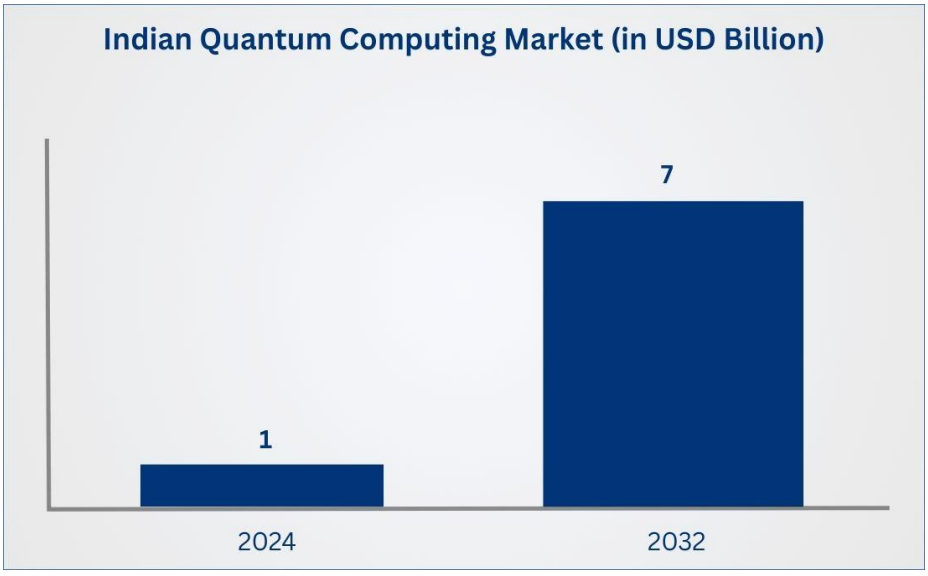
DoT's AI Standardisation Committee released its Indian AI Stack discussion paper[64] on September 2, 2020, with the intention of mitigating impediments in AI deployment and essentially make AI uniform for application across sectors. The AI Stack paper highlighted five major horizontal pillars and one main vertical pillar - thus covering some of the most crucial aspects in AI deployment today including security, data storage, privacy, customer experience and computing.

In July 2023, Telecommunication Engineering Centre (TEC), DoT has also unveiled a Standard (No. TEC 57050:2023) for "Fairness Assessment and Rating of Artificial Intelligence Systems"[65]. This Standard enumerates detailed procedures for accessing and rating artificial intelligence systems for fairness.

2.8. Quantum Technologies and High-Performance Computing (HPC)

Quantum technologies are among the most exciting and rapidly developing emergent technologies of the 21st century. India is poised to play a pivotal role in the quantum technology revolution and is leaving no stone unturned to empower the country's scientific community to take quantum science ahead.

The Indian quantum computing market is still in its infant stages but is poised for considerable growth. Industry sources estimate the market reached $1 billion in 2024 and is projected to reach nearly $7 billion by 2032, reflecting a Compound Annual Growth Rate (CAGR) of 27%.



[64] https://www.tec.gov.in/pdf/Whatsnew/ARTIFICIAL INTELLIGENCE - INDIAN STACK.pdf
[65] https://tec.gov.in/pdf/SDs/TEC Standard for fairness assessment and rating of AI systems Final v5 2023_07_04.pdf

This growth is driven by government initiatives, rising interest from domestic and international players, and the potential of quantum computing to revolutionize various industries[66].

In India, the Department of Science & Technology (DST) and the Ministry of Electronics and Information Technology (MeitY) are central ministries to building capacity in quantum computing, communications, and cryptography. Key industry associations include CII and FICCI. Standards are overseen by BIS, TSDSI, and TEC. Research leadership comes from C-DAC, IISc, and IITs.

Government Ministries / Departments	• MeitY • DST
Industry Associations	• CII; FICCI
Standard Development Organizations	• BIS (LITD-38 on Quantum Technologies and Applications) • TSDSI • TEC
R&D Organizations	• C-DAC, IISc; IITs etc.

i. Key policy including R&D initiatives

a) National Quantum Mission 2023[67]

With the announcement of National Quantum Mission, India is on the global quantum map. In April 2023, the government has approved the National Quantum Mission (NQM) at a total cost of Rs.6003.65 crore (approx. €680 Million) from 2023-24 to 2030-31, aiming to seed, nurture and scale up scientific and industrial R&D and create a vibrant & innovative ecosystem in Quantum Technology (QT). Through this mission, India has joined an elite club of 6 other nations that have a dedicated quantum mission. These countries include the US, Canada, France, Finland, China, and Australia.

Four Thematic Hubs (T-Hubs) have been set up in top academic and National R&D institutes on the domains of:

- Quantum Computing,
- Quantum Communication,
- Quantum Sensing & Metrology and
- Quantum Materials & Devices

The core activities undertaken by these hubs include technology development, human resource development, entrepreneurship development, industry engagement, and international collaborations. Guidelines to support startups around quantum technologies have also been formulated under NQM. These guidelines were adopted by the Technology Innovation Hub (TIH) – I-HUB Quantum Technology Foundation at Indian Institute of Science Education and Research (IISER), Pune; established under the National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS). In alignment with these guidelines, the TIH at IISER Pune has supported eight startups in the field of quantum technologies.

This mission is being implemented by the Department of Science and Technology (under the Ministry of Science and Technology) in collaboration with others.

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[66] https://www.trade.gov/market-intelligence/india-information-technology-quantum-computing-market

[67] https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1917888

b) National Supercomputing Mission[68]

The National Supercomputing Mission (NSM) was launched by Government of India in 2015 and is being implemented jointly by Ministry of Electronics and Information Technology (MeitY), Department of Science and Technology (DST) with Indian Institute of Science, Bangalore and C-DAC being the executing agencies. The National Supercomputing Mission envisages empowering the national academic and R&D institutions spread over the country by installing high-performance computing facilities across the country.

Application areas:

- Climate Modelling
- Weather Prediction
- Aerospace Engineering including CFD, CSM, CEM
- Computational Biology
- Molecular Dynamics
- Atomic Energy Simulations
- National Security/ Defence Applications
- Seismic Analysis
- Disaster Simulations and Management
- Computational Chemistry
- Computational Material Science and Nanomaterials
- Discoveries beyond Earth (Astrophysics)
- Large Complex Systems Simulations and Cyber Physical Systems
- Big Data Analytics
- Finance
- Information repositories/ Government Information Systems

The systems and facilities created as part of the infrastructure under this mission are divided into three phases: Phase I, Phase II, and Phase III.

- **Phase 1**: This phase focused on creating a basic supercomputing infrastructure by installing six supercomputers across various institutions, with a significant portion of the components being assembled domestically. The aim was to build an ecosystem for the assembly of system components within the country.
- **Phase 2**: Building on Phase 1, this phase aimed to move towards indigenous manufacturing of supercomputers, including developing a local software stack. This phase also saw an increase in the value addition from India to 40%.
- **Phase 3**: This phase focuses on complete indigenization of supercomputing, including the design, development, and manufacturing of key components within India. The plan includes installing supercomputers at various academic and research institutions, as well as establishing a national facility with a high-performance computing capability.

Under NSM, as of March 2025, a total of 34 supercomputers with a combined compute capacity of 35 Petaflops, have been deployed across various academic institutions, research organizations, and R&D labs, including prominent institutions like IISc, IITs, C-DAC, and other institutions from Tier-II and Tier III cities of the country under NSM. The supercomputing systems commissioned under NSM have achieved an overall utilization rate of over 85%, with many systems exceeding 95%, demonstrating a high level of usage and efficiency in their computational capacity.

In parallel, under the NSM, C-DAC has developed the indigenous high-speed communication network, "Trinetra," to enhance data transfer and communication between computing nodes, strengthening

[68] https://nsmindia.in/infra

India's supercomputing capabilities. Trinetra is being implemented in three phases: Trinetra-POC, a proof-of-concept system to validate key concepts; Trinetra-A (100 Gigabits per second), a network with advanced connections, successfully deployed and tested in the 1PF PARAM Rudra at C-DAC Pune; and Trinetra-B (200 Gigabits per second), an upgraded version with improved capabilities, set to be deployed in the upcoming 20PF PARAM Rudra supercomputer at C-DAC Bangalore.

In 2024, the Prime Minister dedicated three PARAM Rudra supercomputers to the young researchers, scientists and engineers of nation facilitating advanced studies in physics, earth sciences, and cosmology. These supercomputers have been deployed in Pune, Delhi and Kolkata to facilitate pioneering scientific research. PARAM Rudra supercomputers are built using indigenously designed and manufactured HPC servers, known as "Rudra", along with an indigenously developed system software stack. "Rudra" Server is the first of its kind in India which is at par with globally available other HPC class Servers[69].

PARAM Shivay, the first supercomputer assembled indigenously, was installed in IIT (BHU) in 2019, followed by PARAM Shakti, PARAM Brahma, PARAM Yukti, PARAM Sanganak, PARAM Pravega, PARAM Seva, PARAM Smriti, PARAM Utkarsh, and PARAM Ganga.

c) Quantum-Enabled Science & Technology (QuEST) program[70]

In 2018, India's Department of Science & Technology has set up a program called Quantum-Enabled Science & Technology (QuEST) to develop quantum technology. In what is being described as the Phase 1 of India's quantum computing program, the country will be laying out the basic infrastructure that is needed to promote research in this field. The government believes this will help in improving the state of national security as quantum-level encrypted information becomes a common communication standard.

Following the QuEST programme, India established a national quantum hub — the I-HUB Quantum Foundation or I-HUB QTF[71] in Pune in 2020 under the dedicated National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS)[72] with a budget of INR 170 crore (approx. €19 million) dedicated to the development of QT[73].

d) Quantum Computing Applications Lab (QCAL)

Quantum Computing Applications Lab (QCAL)[74] was launched by the Ministry of Electronics and Information Technology (MeitY) in collaboration with AWS. QCAL aims to accelerate the adoption of quantum computing in India by providing access to quantum computers, tools, and resources to researchers and developers.

e) QSim- Quantum Computer Simulator Toolkit

The Quantum Computing Toolkit Project[75] is one of the first initiatives in the country to address the common challenge of advancing the Quantum Computing research frontiers in India. The project is

[69] https://www.pib.gov.in/PressReleasePage.aspx?PRID=2124920
[70] https://www.quest-dst.in/home
[71] https://www.quantech.org.in/
[72] https://nmicps.in/
[73] https://blog.mygov.in/editorial/india-ready-to-take-the-lead-in-quantum-tech/#:~:text=Following%20the%20QuEST%20programme%2C%20India,to%20the%20development%20of%20QT.
[74] https://quantumcomputing.negd.in/
[75] https://qctoolkit.in/

accomplished by multidisciplinary groups of academicians, scientists, engineers and industry from various leading organizations including – IISc, IIT-Roorkee and C-DAC.

The QSim is like a playground for anyone passionate to learn or experiment in quantum computing, be it students, faculty or researchers. The QSim offers a robust QC Simulator integrated with a GUI based workbench in which you can create quantum circuits and quantum programs, view the outputs, online help, solved examples and related literature/material.

f) Centre of Excellence (CoE) in Quantum Technology

Ministry of Electronics and Information Technology (MeitY) has established a Centre of Excellence (CoE) in Quantum Technology and has also deployed the Metro Area Quantum Access Network (MAQAN) in Chennai, establishing a secure quantum communication testbed.

ii. Growth Drivers

- **Increasing adoption of quantum technology in various sectors:** The manufacturing, high tech, banking, and defense sectors will lead the charge of adopting quantum technologies for critical and large-scale use cases.

- **Favorable Government policies and support:** Policy initiatives such as National Quantum Mission will help to create a vibrant & innovative ecosystem in Quantum Technology (QT).

- **Awareness and Education:** Increased awareness of the transformative potential of quantum technologies, coupled with academic and industry-led training programmes, is helping to build a skilled workforce and encourage early adoption across research institutions and enterprises.

- **Global Collaboration and Research Partnerships** – India is increasingly engaging in international collaborations with research institutes, technology companies, and innovation hubs worldwide. Under the EU–India Trade and Technology Council (TTC), Quantum and High-Performance Computing (HPC) technologies have been identified as key focus areas for joint R&D. Such partnerships accelerate knowledge sharing, strengthen research capabilities, and provide access to global expertise, advanced infrastructure, and funding opportunities.

iii. Challenges

- **Research and Development:** Quantum technology is a complex and rapidly evolving field, requiring extensive research and development efforts. Factors such as funding R&D, expertise, and access to advanced infrastructure and equipment pose challenges in adopting quantum technologies.

- **Lack of Skilled Workforce:** Quantum technology demands a highly skilled workforce with expertise in quantum physics, engineering, and related disciplines. Developing and retaining a talented pool of researchers, scientists, and engineers proficient in quantum technologies is a challenge, as it requires specialized training programs, educational initiatives, and collaboration between academic and industry.

- **Insufficient Infrastructure and Resources**: Quantum technology requires advanced infrastructure, including specialized laboratories, fabrication facilities, and high-performance computing resources. Establishing and maintaining such infrastructure is a challenge, as it requires substantial investments and ongoing upgrades to keep pace with advancements in the field.

- **Lack of Standardization and Interoperability:** Quantum technology is still in its nascent stage, and there is a lack of standardized protocols and frameworks. Achieving interoperability among different quantum systems and ensuring compatibility across platforms is a challenge.

- **Ethical and Societal Implications:** Quantum technology raises ethical, legal, and societal considerations. The development and application of quantum technologies, such as quantum computing and cryptography, may have significant societal implications, including data privacy, cybersecurity, and societal disruption. Addressing these concerns and establishing ethical frameworks and guidelines is a challenge.

iv. Standardization

Bureau of Indian Standards (BIS):

Recently BIS established a new technical committee **LITD-38 on Quantum Technologies and Applications**[76] which is responsible Standardization in the field of quantum technologies, including quantum information technologies (quantum computing and quantum simulation), quantum metrology, quantum sources, quantum detectors, quantum communications, and fundamental quantum technologies. This technical committee is a national mirror committee of ISO/IEC JTC3 - Quantum technologies. Currently there is no standard that has been developed by this technical committee.

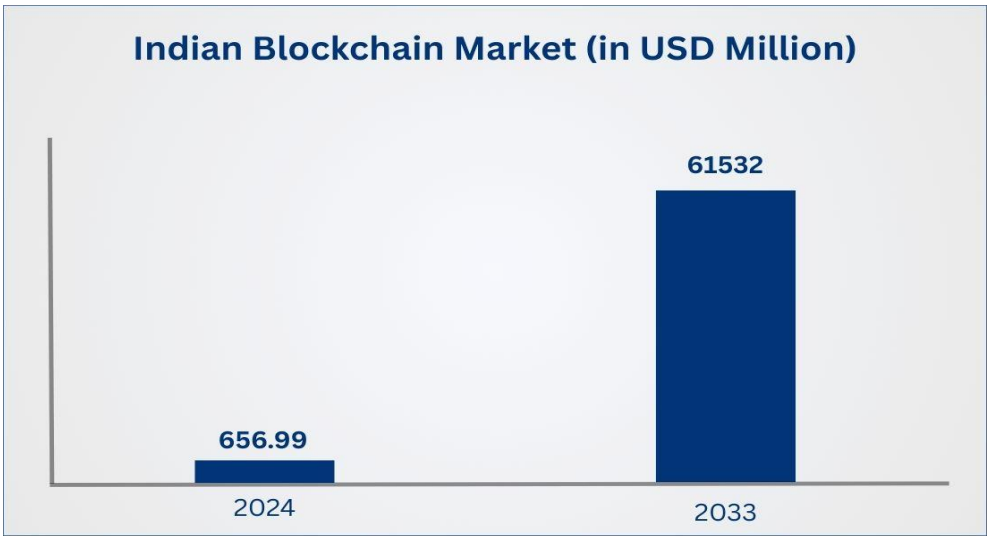
Telecom Engineering Centre (TEC): Telecom Engineering Centre (TEC), wing of Telecom Department (DoT) has released following standards in the field of quantum technologies.

- **TEC 91010:2023: Standard for Generic Requirements- Quantum-Safe and Classical Cryptographic Systems**[77]**:** The standards for Post Quantum Cryptography system provide the specifications for a cryptographic mechanism to ensure secured communication against vulnerabilities posed with the advent of Quantum computing.
- **TEC 91000:2022: Standard for Generic Requirements- Quantum Key Distribution System**[78]**:** This document describes the generic requirements and specifications for Quantum Key Distribution (QKD) systems as per, ITU-T Y.3801-3804 Recommendations for use in Indian telecom network.
- **TEC 91020:2024: Quantum Random Number Generator**[79]- This document describes the generic requirements and specifications for Quantum Random Number Generator.

2.9. Blockchain

India is also making excellent progress in this sector and participates effectively on a global scale. The Indian blockchain market is experiencing substantial growth, with significant increases expected in the coming years. The market is projected to grow from an estimated $656.99 million in 2024 to $61,532.00 million by 2033, with a high CAGR of 65.60% during 2025-2033 according to IMARC Group[80].

[76] https://www.services.bis.gov.in/php/BIS_2.0/bisconnect/pow_details
[77] https://tec.gov.in/pdf/6GT/GR_91010_2023_for_Publish.pdf
[78] https://www.tec.gov.in/pdf/Whatsnew/QKD_ Final_Draft_TEC_Standard_GR - 15.07.2022.pdf
[79] https://www.tec.gov.in/pdf/GRs/Standard_GR_QRNG_TEC_91020_2024_Final%20(1).pdf
[80] https://www.imarcgroup.com/india-blockchain-market



This growth is fuelled by increasing adoption in financial services, government initiatives, and the need for transparency in supply chains. By leveraging the power of blockchain, India can drive significant social impact across various sectors, including healthcare and governance

i. Key policy including R&D initiatives

a) National Strategy on Blockchain

In December 2021, Ministry of Electronics and Information Technology (MEITY) released "National Strategy on Blockchain[81]" with the vision to create trusted digital platforms through shared Blockchain infrastructure; promoting research and development, innovation, technology and application development; and facilitating state of the art, transparent, secure and trusted digital service delivery to citizens and businesses.

This strategy document lays out overall vision towards development and implementation strategies for a National Blockchain Platform covering the technology stack, legal and regulatory framework, standards development, collaboration, human resource development and potential use cases. It is envisaged that this strategy document would provide the necessary guidance and support for realizing the vision and creating a nationwide ecosystem for creating the National Blockchain Platform and development of relevant applications using this platform in various domains.

b) Discussion Paper on Blockchain: The India Strategy[82]

The leading policy think tank working for the government of India, NITI Aayog, has come out with a strategy document recognising many crucial areas blockchain technology can significantly benefit the country. Known as Blockchain: The India Strategy — Towards Enabling Ease of Business, Ease of Living and Ease of Governance, the 59-page policy paper is the first of two-part papers to be published by NITI Aayog. The first discussion paper covers the basics of distributed technology, its potential framework for India, the implementation challenges, lessons from NITI Aayog's own PoCs, its use cases, and recommendations for India's national blockchain strategy. Here are the main takeaways from the Niti Aayog's discussion Paper:

- **Understanding Blockchain for Government of India**: As part of the document, NITI Aayog recognised Blockchain technology by giving an explainer. It said, "new data can be added to a blockchain only with an agreement between the various nodes of the blockchain network, a mechanism known as distributed consensus. Every node of the distributed network has its own

[81] https://www.meity.gov.in/writereaddata/files/National_BCT_Strategy.pdf
[82] https://niti.gov.in/sites/default/files/2020-01/Blockchain_The_India_Strategy_Part_I.pdf

copy of blockchain's data and checks the other nodes' data authenticity – if one node changes its local copy, the other nodes reject it. New data is added to the new block, and once added, it is immutable. Older data can neither be deleted nor modified because a snapshot of it is captured in the blocks of data that come after it." NITI Aayog has conducted PoCs in four areas to assess the power of distributed ledgers in providing enhanced efficiency and improved possible hurdles in execution, like Track and trace' of drugs in the pharma drug supply chain, claim verification and approval in the disbursement of fertiliser subsidies, verification of university certificates, and transfer of land record ownership. In one of the PoCs for the fertiliser subsidy pilot undertaken by NITI Aayog, the challenge was minimising the turnaround period for reimbursement of subsidies payments and freight claims. The existing workflow was filled with inefficiencies, including multiple systems of record, limited visibility for inventory stocks and low trust in the data created for claim processes.

- **Blockchain Upskilling in India**: According to the paper, there is a dearth of blockchain developers. It said that based on the most aggressive evaluation worldwide, the number of qualified blockchain developers is not more than 10,000 in total, which NITI Aayog discussion paper identifies both as a challenge as well as an opportunity.

- **Blockchain In Healthcare**: Using blockchain technology for a unified data system, NITI Aayog had another blockchain PoC in India with different partners in the healthcare industry domain. In this context, the pilot was different from the previous pilots as the process was not completely 'captive' to one institution and needed large scale coordination for its successful execution.

c) Centre of Excellence for Blockchain Technology[83]

The Centre of Excellence in Blockchain Technology operates as a coordinated, interoperable blockchain ecosystem across the country. It is a gateway to test and develop best solutions for projects undertaken by National Informatics Centre (NIC) at the Centre and State levels.

ii. Growth Drivers

- **Digital Transformation Initiatives:** Businesses across sectors are accelerating their digital transformation journeys to enhance efficiency, security, and transparency. Blockchain's ability to provide tamper-proof, verifiable, and decentralized transaction records makes it a natural fit for these initiatives, especially in sectors like finance, supply chain, healthcare, and logistics.

- **Government Support and Initiatives**: Initiatives such as the National Strategy on Blockchain aim to leverage blockchain for various sectors, including governance, finance, and supply chain.

- **Rising number of Blockchain Startups and Innovation:** India has seen a rise in Blockchain startups working on innovative solutions. These startups play a crucial role in driving experimentation and adoption across various industries.

- **Increasing Enterprise Adoption in BFSI and Supply Chain Sectors** – Large enterprises, particularly in banking, financial services, and insurance (BFSI), as well as logistics and manufacturing, are exploring blockchain for fraud prevention, trade finance, cross-border payments, and end-to-end supply chain transparency.

[83] https://www.nic.gov.in/centre-of-excellence-for-blockchain-technology/

iii. Challenges

- **Lack of Regulation and Compliance frameworks:** The absence of clear and comprehensive regulatory guidelines for blockchain use creates uncertainty for businesses and investors. Issues around legal recognition of smart contracts, cross-border data exchange, and compliance requirements remain unresolved, slowing large-scale adoption.

- **Low Awareness and Limited Understanding** – Many businesses, policymakers, and consumers still have an incomplete or inaccurate understanding of blockchain technology, its potential applications, and its limitations. This lack of clarity delays decision-making and adoption, particularly outside the tech sector.

- **Security and data privacy:** The lack of individuals' understanding as to how blockchain-based applications and services can ensure personal data privacy and security reduces their perceived benefits and the public's willingness to adopt them.

- **Shortage of Skilled Professionals:** There is a shortage of skilled professionals in India who are well-versed in blockchain technology. Training and development programs are needed to bridge this gap.

iv. Standardization

Technical committee "LITD 29: Blockchain and Distributed Ledger Technologies[84]" within Bureau of Indian Standards (BIS) is responsible for developing standards for Blockchain and Distributed Ledger Technologies.

- **IS/ISO/TS 23258: 2021**: Blockchain and distributed ledger technologies Taxonomy and Ontology
- **IS/ISO 23257: 2022**: Blockchain and distributed ledger technologies Reference Architecture
- **IS/ISO/TS 23635: 2022**: Blockchain and distributed ledger technologies Guidelines for governance.
- **IS/ISO/TR 3242: 2022**: Blockchain and distributed ledger technologies- Use cases.

2.10. Electronic/Digital Signature

The Indian government is actively promoting the use of electronic and digital signatures through policy initiatives and legal frameworks, particularly under the Digital India campaign, with the aim of creating a digitally empowered society and a paperless economy.

The India Digital Signature Market is set to grow significantly, expanding from USD 189.00 million in 2024 to USD 2,175.33 million by 2032, with a CAGR of 35.72%.[85]

[84] https://www.services.bis.gov.in/php/BIS_2.0/bisconnect/pow_details
[85] https://www.credenceresearch.com/report/india-digital-signature-market

The digital signature ecosystem in India is governed by MeitY and the Controller of Certifying Authorities (CCA). Licensed Certifying Authorities (CAs) such as eMudhra, C-DAC, and (n)Code Solutions are key industry players. Standards are developed by BIS (SSD-10), while R&D and assurance functions are undertaken by C-DAC, NIC, and STQC.

Government Ministries / Departments	MeitY; Controller of Certifying Authorities (CCA); NIC; UIDAI (eKYC linkages)
Industry Associations	Certifying Authorities (C-DAC, eMudhra, Capricorn, (n)Code solutions) etc.
Standard Development Organizations	BIS (SSD-10)
R&D Organizations	C-DAC; NIC; STQC

i. Key Policy including R&D initiatives

In India, electronic and certificate-based digital-signatures are regulated by the Information Technology Act, 2000 (IT Act) and the following rules made under this Act:

- Information Technology (Certifying Authorities) Rules, 2000[86];
- Digital Signature (End Entity) Rules, 2015[87]; and
- Information Technology (Use of Electronic Records and Digital Signature) Rules, 2004[88]

The IT Act distinguishes between electronic signatures and certificate-based digital signatures, but both have the same status as handwritten signatures under Indian law.

Valid electronic signatures must include an electronic authentication technique or procedure specified in the Second Schedule of the IT Act. The Second Schedule currently specifies the following e-KYC (Know Your Customer) authentication techniques and procedures:

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86 https://upload.indiacode.nic.in/showfile?actid=AC_CEN_45_76_00001_200021_1517807324077&type=rule&filename=rules_2000_it(certifying_authority)gsr788-89-17102000.pdf

87 https://cca.gov.in/sites/files/pdf/ACT/GSR660.pdf

88 https://cca.gov.in/sites/files/pdf/ACT/GSR582.pdf

1. Aadhaar e-KYC
2. Other e-KYC services (e.g. e-KYC using Permanent Account Number (PAN)).

Under Indian law, reliable electronic and digital signatures carry a presumption of validity compared to other "non-recognized" electronic signatures. However, in common with other jurisdictions, Indian law will not consider an agreement invalid solely on the grounds that it was formed with such non-recognised electronic signatures.

For an electronic signature to be considered reliable and presumptively valid under the IT Act:

1. It must be unique to the signatory.
2. at the time of signing, the signatory must have control over the data used to generate the electronic signature.
3. any alteration to the affixed electronic signature, or to the document to which the signature is affixed, must be detectable.
4. there should be an audit trail of steps taken during the signing process; and
5. The signer certificates must be issued by a certifying authority (CA) recognized by the Controller of Certifying Authorities appointed under the IT Act. A list of licensed CAs is available at http://www.cca.gov.in/licensed_ca.html[89].

ii. Growth Drivers

- **Growth in paperless transactions**: The trend towards paperless transactions and the reduction of paper-based processes has led to an increase in the demand for digital signatures.

- **Awareness among consumers:** With the increasing awareness about the benefits of digital signatures, more businesses are adopting this technology for their transactions.

- **Cost-effectiveness and time saving** of digital signatures compared to traditional paper-based signatures, as they reduce the need for printing, mailing, and storage of physical documents. Businesses can also save on courier and postage expenses.[90].

- **Cross-border mutual recognition of digital signatures under trade agreements:** India is pursuing mutual recognition of digital signatures under trade agreements to boost e-governance and cross-border trade. For instance, in 2014, India and South Korea signed an MoU for mutual recognition of Digital Signature Certificates. More recently, India and the EU agreed to work towards interoperability of their Digital Public Infrastructures (DPIs), ensuring respect for human rights, privacy, and intellectual property. Both sides also committed to promoting DPI solutions globally and advancing mutual recognition of e-signatures to enhance cross-border transactions and economic growth.

iii. Challenges

- **Lack of User awareness & digital literacy among small businesses and citizens:** There seems to be lack of awareness and education about digital signature, digital signature certificates and their adoption and usage. Raising awareness and providing education on their use is crucial.

- **Security & privacy concerns:** Risks associated with the security and integrity of digital signatures, such as unauthorized access, data breaches, or forged signatures, pose challenges

[89] https://helpx.adobe.com/legal/esignatures/regulations/india.html
[90] https://www.globenewswire.com/en/news-release/2023/01/30/2598004/0/en/Digital-Signature-Market-Size-Growing-at-35-4-CAGR-Set-to-Reach-USD-48-4-Billion-by-2030.html#:~:text=Growth%20in%20paperless%20transactions%3A%20The,friendly%2C%20leading%20to%20increased%20adoption.

to their widespread adoption. The misuse of digital signatures can have serious consequences, as it can lead to fraud and identity theft. Implementing robust security measures and encryption protocols helps address these concerns.

iv. Standardization

Within BIS, technical committee **SSD10: IT & IT enabled Services** is responsible for Standardization in the field of Services, Processes, Supporting Frameworks, Management and Governance for the provisioning of IT and IT Enabled Services in areas such as (but not limited to), contract management, performance management, procurement management, customer satisfaction, contact centre, covering existing and emerging digital and automation technologies.

This technical committee through its panel 4 on digital signature is in the process of adopting the complete library of ETSI standards on digital signature and has adopted the following ETSI standards as national standards:

- IS 18595:2024/ ETSI TS 119 101 - Electronic Signatures and Infrastructures (ESI) Policy and Security Requirements for Applications for Signature Creation and Signature Validation
- IS 19155:2025/ ETSI EN 319 401 - Electronic Signatures and Infrastructures (ESI) General Policy Requirements for Trust Services Providers
- IS 19156:2025/ ETSI TS 119 312 - Electronic Signature and Infrastructure (ESI) Cryptographic Suites

2.11. e-Accessibility

As India's digital landscape continues to grow and evolve, ensuring that digital content and services are accessible to all users, including those with disabilities, has become increasingly important. As per Indian Census 2011, 2.21% of India's population are PwDs.

India's accessibility ecosystem is guided by MeitY and the Department of Empowerment of Persons with Disabilities (under the Ministry of Social Justice & Empowerment). Industry advocacy is driven by NASSCOM, CII, and FICCI. Standards are developed by BIS, while research and innovation are led by C-DAC, IITs, and IIITs.

Government Ministries / Departments	• MeitY • DEPwD (MSJE);
Industry Associations / Players	• NASSCOM. • CII; and • FICCI
Standard Development Organizations	BIS LITD-35: Active Assisted Living (AAL)
R&D Organizations	CDAC; IITs; IIITs

i. Key policy including R&D initiatives

The Government of India has taken following step to improve e-accessibility and promote a more inclusive digital ecosystem in the country.

a) National Policy for Persons with Disabilities, 2006[91]

[91] https://depwd.gov.in/en/policy/national-policy/

Recognizing that the Persons with Disabilities constitute a valuable human resource for the country and that a majority of such persons can lead a better quality of life if they have equal opportunities and effective access to rehabilitation measures, the Government, with a view to create an environment that provides such persons equal opportunities for protection of their rights and full participation in society, formulated and brought out the National Policy for Persons with Disabilities in 2006. The policy outlines specific measures and strategies for ensuring protection of rights of PwDs and their inclusion in the society.

b) Guidelines for Indian Government Websites and App

The Ministry of Electronics and Information Technology (MeitY) has issued guidelines for Indian government websites (GIGW) to ensure that they are accessible to people with disabilities. Public entities in India must follow the "Guidelines for Indian Government Websites, 2009[92], which include considerations for accessibility along with guidance intended to standardize the on-page experience across different government websites.

These Guidelines are based on International Standards including ISO 23026, W3C's Web Content Accessibility Guidelines (WCAG 2.0) Rights of Persons with Disabilities Act 2016 as well as Information Technology Act of India.

Many of WCAG criteria closely correlate with these standards, and sites that conform with WCAG Level AA can meet the document's accessibility requirements. However, because the Guidelines for Indian Government Websites contain specific requirements for page design, CSS implementation, and information architecture, WCAG conformance does not ensure full compliance.

The second version of GIGW (GIGW 2.0) was developed in 2019, considering feedback from and consultations with industry, society and government organisations. GIGW 2.0 took note of the standards evolved by international bodies like the world-wide web consortium (W3C) and advancements in technology. It also included guidance on mobile apps.

This version is the third version of GIGW (GIGW 3.0). While the earlier versions were formulated in-house with external inputs, GIGW 3.0 has been formulated jointly with Standardisation Testing and Quality Certification (STQC) Directorate of the Ministry of Electronics and Information Technology and Indian Computer Emergency Response Team (CERT-In), so that the experience of conformity with GIGW gathered by the STQC Directorate auditors and the cybersecurity experience and knowledge of CERT-In also inform the GIGW. As in earlier versions, GIGW 3.0 too has also been formulated in association with industry and experts.

The key thrust of GIGW 3.0 is on offering specific guidance to government organisations on how to improve the user interface and user experience (UI and UX), by incorporating features such as intuitive page loading (using AI and analytics) based on user journey and user profile, using state-of-the-art content management system (CMS), user-centric information architecture (IA), centralised monitoring dashboard to identify and provide alerts on non-conformity and technical enablement of all content creators and publishers.

c) Accessible India Campaign (Sugamya Bharat Abhiyan)[93]:

Department of Empowerment of Persons with Disabilities (DEPwD) launched Accessible India Campaign (Sugamya Bharat Abhiyan) as a nation-wide Campaign for achieving universal accessibility

[92] https://www.stqc.gov.in/sites/default/files/Guidelines for Indian Govt Websites - GIGW2018_Released version.pdf

[93] https://depwd.gov.in/en/accessible-india-campaign/

for Persons with Disabilities (PwDs) on December 3,2015. It has three important verticals, namely - the Build Environment, the transportation sector, and the ICT ecosystem.

Components of Accessible India Campaign:

- **Built Environment Accessibility:** The Accessible India Campaign aims to provide an accessible physical environment to everyone. To achieve this, measures need to be undertaken to eliminate obstacles and barriers to indoor and outdoor facilities including schools, medical facilities, and workplaces. The built environment not only covers buildings, but also steps and ramps, corridors, footpaths, curb cuts, parking, entry gate, emergency exits, toilets and obstacles that block the flow of pedestrian traffic.

- **Transportation System Accessibility:** Transportation is a vital component for independent living. The term transportation covers several areas including air travel, buses, taxis, and trains. Inaccessible transportation system restricts mobility, denies freedom of movement and active participation, for much of the population who may need accessible transportation. The Accessible India Campaign focuses on providing persons with disabilities an equal right to travel and use public and private transportation infrastructure with dignity and independence.

- **Information and Communication Eco-System Accessibility:** Access to information creates opportunities for everyone in society. Access to information refers to all information. This can range from actions such as being able to read price tags, to physically enter a hall, to participate in an event, to read a pamphlet with healthcare information, to understand a train timetable, or to view webpages. The Accessible India Campaign aims to take measures to curb all societal barriers of infrastructure, and inaccessible formats that stand in the way of obtaining and utilizing information in daily life.

d) The Rights of Persons with Disabilities Act, 2016[94]

In India, the Rights of Persons with Disabilities Act, 2016 (RPWD Act, 2016) mandates equal rights and opportunities for people with disabilities and requires the government to take measures to promote accessibility. It covers various aspects, including physical infrastructure, transportation, and ICT.

As per the RPWD Act, 2016 twenty-one (21) types of disabilities have been recognized and listed. The Act clearly states that the central government shall, in consultation with the chief commissioner, formulate rules for PwDs, laying down the standards of accessibility for physical environment, transportation, Information and communication, including appropriate technologies and systems, and other facilities and services provided to the public in urban and rural areas.

The RPWD Act mandates to notify standards for accessibility of technologies and communication and promote universal design in electronics goods.

ii. Growth Drivers

- **Digital Economy and Market Expansion** Making digital platforms accessible opens a large, underserved market segment. There are over 26 million PwDs in India (as per the 2011 Census, and possibly more today), many of whom are potential users of online services if accessibility is ensured. Recognizing this, businesses and service providers are gradually adopting accessibility practices for economic opportunity and user base expansion.

[94] https://depwd.gov.in/en/acts/

- **Government's Push for Digital Inclusion:** Under initiatives like Digital India, the Indian government is actively working toward universal digital access. This includes an emphasis on making digital platforms inclusive for all, including PwDs.

- **Global Influence and Standardization** India's increasing integration into the global digital economy and exposure to international accessibility standards (like WCAG, ISO 30071-1, and the EU Accessibility Act) are influencing domestic policies and practices. Indian companies, especially those working with international clients, are under pressure to meet global accessibility norms.

- **Increased Advocacy and Awareness by Disability Rights Groups:** Disability rights organizations, NGOs, and accessibility activists are raising awareness about the need for digital inclusion. These groups are also key stakeholders in policy development and implementation, keeping the issue visible in public discourse.

- **Technological Advancements and Assistive Tech Innovation** Rapid innovation in assistive technologies is making it easier to design accessible platforms. Indian startups and tech companies are increasingly building solutions localized to Indian languages and contexts.

iii. Challenges

- **Non-Compliant Websites and Applications** Many websites and mobile applications in India, are not designed in accordance with internationally accepted accessibility standards such as the **Web Content Accessibility Guidelines (WCAG 2.1)**. These platforms often lack features like keyboard navigation, proper labelling for screen readers, alt-text for images, and sufficient color contrast.

- **Limited Availability of Assistive Technologies** Although assistive technologies such as screen readers, speech-to-text software, and Braille displays exist, their availability in India is limited—especially for those who need support in regional languages. Most of these tools are either too expensive or not localized to Indian linguistic and cultural contexts.

- **Lack of Awareness Among Developers and Designers** One of the root causes of poor digital accessibility is the lack of awareness and training among developers and UI/UX designers. Many tech professionals are unfamiliar with accessibility guidelines or fail to prioritize inclusive design when creating digital products. Accessibility is often viewed as an afterthought or an additional cost rather than a fundamental requirement.

- **Economic and Social Barriers** Economic hardship is a major barrier to e-accessibility in India, especially for people with disabilities who are more likely to be unemployed or underemployed. The cost of smartphones, internet access, and assistive devices can be prohibitively high. In addition, **social stigma** and exclusion often discourage PwDs from engaging with digital tools or participating in online spaces.

- **Low Digital Literacy Among PwDs** A significant barrier to digital accessibility in India is the **low level of digital literacy** among PwDs, particularly in rural and underprivileged communities. Many individuals with disabilities have never received training in how to use computers, smartphones, or the internet, let alone how to operate assistive technologies.

iv. Standardization

Bureau of Indian Standards (BIS) through its technical committee LITD-35: Active Assisted Living (AAL) is developing standards in the field of accessibility. LITD 35 is responsible for standardization

around accessibility, interoperability of AAL systems, services, products, and components; and standardization of system level aspects of AAL such as safety, security, and privacy.

- IS 17802 (Part 1): 2021[95]: Accessibility for the ICT Products and Services Part 1: Requirements
- IS 17802 (Part 2): 2022[96]: Accessibility for the ICT Products and Services Part 2: Determination of Conformance
- IS 1885 (Part 89): 2023/IEC 60050-871: 2021[97]: Electrotechnical vocabulary Part 871: Active assisted living AAL.
- IS/IEC/TS 63134: 2020[98]: Active assisted living AAL use cases.

The Indian standard IS 17802 (part 1 and 2) is based on the European Standard EN 301 549 v 3.2.1. In May 2023, the Department of Empowerment of Persons with Disabilities (Divyangjan), under the Ministry of Social Justice and Empowerment mandated the implementation of IS 17802 (Part 1 & Part 2) for Public Procurement.

2.12. Digilocker Platform

DigiLocker is a flagship initiative of Ministry of Electronics & IT (MeitY) under Digital India programme. DigiLocker aims at 'Digital Empowerment' of citizen by providing access to authentic digital documents to citizen's digital document wallet. The issued documents in DigiLocker system are deemed to be at par with original physical documents as per Rule 9A of the Information Technology (Preservation and Retention of Information by Intermediaries providing Digital Locker facilities) Rules, 2016 notified on February 8, 2017, vide G.S.R. 711(E).

i. Key Policy including R&D initiatives

The **DigiLocker platform**, launched under the **Digital India initiative**, is a secure and legally recognised digital document storage and verification system.

At the legal and regulatory level, the DigiLocker platform is backed by the **Information Technology Act, 2000**, and the **Digital Locker Rules, 2016**. According to **Rule 9A** of these rules, documents issued or shared via DigiLocker are considered legally at par with original physical documents. These rules also define the roles and responsibilities of various stakeholders, including **issuers** (e.g., government departments, universities), **requesters** (e.g., passport services, banks), and **subscribers** (citizens).

ii. Growth Drivers

- **Benefits to Citizens**
  - Important Documents Anytime, Anywhere.
  - Authentic Documents, Legally at Par with Originals.
  - Digital Document Exchange with the consent of the citizen.

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95 https://www.services.bis.gov.in/php/BIS_2.0/bisconnect/standard_review/Standard_review/Isdetails?ID=MjY3NTI%3D

96 https://www.services.bis.gov.in/php/BIS_2.0/bisconnect/standard_review/Standard_review/Isdetails?ID=Mjc0MjM%3D

97 https://www.services.bis.gov.in/php/BIS_2.0/bisconnect/standard_review/Standard_review/Isdetails?ID=Mjg3MTE%3D

98 https://www.services.bis.gov.in/php/BIS_2.0/bisconnect/standard_review/Standard_review/Isdetails?ID=MjcxNTE%3D

- Faster service Delivery- Government Benefits, Employment, Financial Inclusion, Education, Health.

- **Benefits to Agencies**
  - **Reduced Administrative Overhead**: Aimed at the concept of paperless governance. It reduces the administrative overhead by minimizing the use of paper and curtailing the verification process.
  - **Digital Transformation:** Provides trusted issued documents. Issued Documents available via DigiLocker are fetched in real-time directly from the issuing agency.
  - **Secure Document Gateway:** Acts as a secure document exchange platform like payment gateway between trusted issuer and trusted Requester/Verifier with the consent of the citizen.
  - **Real Time Verification:** Provides a verification module enabling government agencies to verify data directly from issuers after obtaining user consent.

iii. Challenges

- **Security, Privacy & Authentication Risks: SIM-related vulnerability, resulting in** previous user's KYC details, exposing a serious flaw in delinking and authentication processes. **Fragility of OTP-based login** tied to mobile numbers makes the system vulnerable to SIM swapping, interception, and other fraud vectors. DigiLocker, as a component of India Stack, is subject to phishing, data breaches, and deepfake attempts.

- **Service outages**: causing significant disruption to digital KYC processes for fintechs. **Persistent bugs and login issues with u**sers continue to report frequent login failures, is another big limitation reported.

- **Limited Adoption Due to Awareness & Digital Divide:** Despite its potential, researchers note low utilization due to poor digital literacy, mistrust in government platforms, and unfamiliarity with its full capabilities. Reliable internet access and digital skills also remain barriers—especially in rural areas.

iv. Standardization

Standardisation for DigiLocker Platform in India, is under Ministry of Electronics and Information Technology (MeitY), aimed at providing a secure, paperless, and authentic digital document storage and verification system for Indian citizens.

To ensure interoperability, security, scalability, and uniform adoption, standardisation plays a crucial role in the DigiLocker ecosystem. Below is an overview of the standardisation efforts and frameworks related to the DigiLocker platform in India:

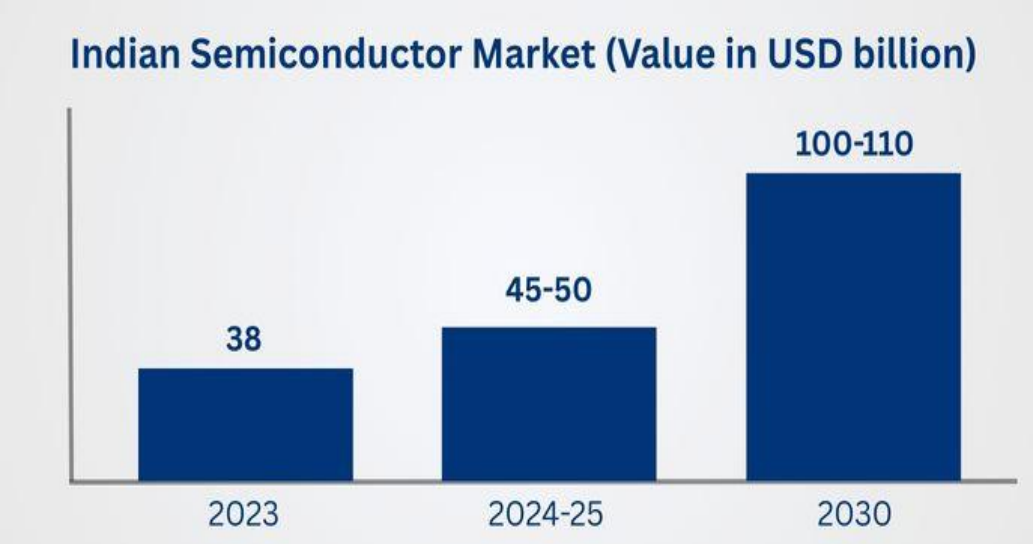
- **e-Governance Metadata & Document Format Standards (MDDS):** Meit8596Y has instituted **Meta Data and Data Standards (MDDS)** to enable consistent data exchange across e-governance applications. DigiLocker follows these MDDS specifications, ensuring that documents issued in a standardized format (often XML) can be reliably interpreted by issuers and requesters across platforms. DigiLocker publishes these as "DigiLocker XML Certificate Formats" through its APIs.

- **Security & Infrastructure Standards**. The platform uses strong encryption (256-bit SSL or 2048-bit RSA), OTP-based login, consent mechanisms, timed logouts, and frequent security audits—consistent with MeitY-advised cybersecurity protocols. **S**STQC (Standardisation Testing and Quality Certification Directorate), under MeitY, ensures DigiLocker adheres to national and

international QA standards—including ISO 27001, Common Criteria (ISO/IEC 15408), biometric/cyber device certifications, and e-governance system evaluations.

2.13. Semiconductor

India is rapidly emerging as a major force in the global semiconductor landscape, with its domestic market aimed to grow from $38 billion in 2023 to between $100 and $110 billion by 2030. This projection comes as the global semiconductor industry is set to touch the $1 trillion mark by the end of the decade[99].



India's role in the global supply chain is already visible. In 2022, India exported semiconductor devices worth $516 million, primarily to US, Hong Kong, and South Africa. However, imports remained much higher at $4.55 billion, with China, Singapore, and Vietnam being the key suppliers.

Two-thirds of this demand is likely to come from telecom and industrial applications, with mobile, IT, consumer electronics, and industrial segments driving the growth. It is also expected that India's first indigenously developed semiconductor chip will be available in the market by the end of 2025. Technologies such as 5G, AI, and EVs are further expected to fuel demand[100].

i. Key Policy including R&D initiatives

a) India Semiconductor Mission

India Semiconductor Mission[101] was approved by Indian Government in December 2021 with an outlay of INR 76,000 crore (approx. €7.6 billion). The mission aims to build a strong semiconductor and display ecosystem, positioning India as a global hub for electronics manufacturing and design, while serving as the nodal agency for the efficient and seamless implementation of semiconductor and display schemes.

Objectives of ISM:

- **Strategy**: Formulate a long-term strategy for developing sustainable semiconductors and display manufacturing facilities and semiconductor design eco-system in India.

[99] https://www.pib.gov.in/PressNoteDetails.aspx?id=154968&NoteId=154968&ModuleId=3
[100] https://manufacturing.economictimes.indiatimes.com/news/hi-tech/indias-semiconductor-industry-set-to-surge-to-100-billion-by-2032/123363782
[101] https://ism.gov.in/

- **Supply Chain**: Facilitate the adoption of secure microelectronics and developing trusted semiconductor supply chain, including raw materials, specialty chemicals, gases, and manufacturing equipment.
- **Design & Startups**: Enable a multi-fold growth of Indian semiconductor design industry by providing requisite support in the form of Electronic Design Automation (EDA) tools, foundry services, and other suitable mechanisms for early-stage start-ups.
- **Intellectual Property**: Promote and facilitate indigenous IP generation.
- **Partnership**: Enabling collaborations and partnership programs with national and international agencies, industries, and institutions for catalysing collaborative research, commercialization, and skill development.

India Semiconductor Mission operates under the guidance of Ministry of Electronics and Information Technology (MeitY) and other relevant government bodies.

Various Schemes under the Indian Semiconductor Mission:

I. **Semiconductor Fabs Scheme[102]:**
- This scheme provides up to 50% fiscal support for setting up semiconductor wafer fabrication (fab) units in India.
- It targets advanced nodes such as 28nm or below, as well as mature technologies.
- The goal is to establish high-tech, large-scale fabs that serve both domestic and global demand.

II. **Display Fabs Scheme[103]:**
- Offers financial assistance of up to 50% of project cost to set up display fabrication units in India.
- It covers technologies such as AMOLED and LCD displays, aiming to reduce import dependence and promote domestic innovation in next-gen display manufacturing.

III. **Compound Semiconductors and ATMP/OSAT Scheme[104]:**
- Supports setting up units for compound semiconductors, silicon photonics, MEMS/sensors, and discrete semiconductors.
- It also includes ATMP/OSAT facilities (chip packaging and testing), with up to 50% capital support, to complete the downstream value chain.

IV. **Design Linked Incentive (DLI) Scheme[105]:**
- With a total outlay of Rs. One thousand Crore (approx. €100 million) promotes semiconductor design startups and MSMEs by offering financial support across product development stages.
- Scheme includes reimbursement of R&D costs, access to state-of-the-art design tools.
- Incentives up to ₹15 crore (approx. €1.5 million) per company to encourage innovation in chip design.
- Government of India has sanctioned 23 chip-design projects under the Design Linked Incentive (DLI) Scheme as part of its effort to boost the country's semiconductor design capabilities. These projects, led by domestic startups and MSMEs, are receiving support to develop indigenous chips and System-on-chip (SOC) solutions for areas such as surveillance cameras, energy meters, microprocessor IPs, and networking applications[106].

[102] https://www.ism.gov.in/semiconductor-fab
[103] https://www.ism.gov.in/display-fab
[104] https://www.ism.gov.in/compound-semiconductor
[105] https://www.ism.gov.in/design-linked-incentive
[106] https://www.pib.gov.in/PressReleasePage.aspx?PRID=2159727

ii. Growth Drivers

- **Government Support –** The India Semiconductor Mission, along with PLI/DLI schemes and state-level incentives, is driving investments in fabs, ATMP, OSAT units, and design startups.

- **Large-Scale Investments –** Leading players such as Tata, Micron, CG Power, HCL and Foxconn are establishing semiconductor fabs and advanced packaging facilities across Gujarat, Assam, Uttar Pradesh, Odisha, Punjab, and Andhra Pradesh. Government has approved a total of 10 projects under ISM with cumulative investments of around Rs.1.60 lakh crore (approx. €16 billion) in these states.

- **Expanding Domestic Demand –** Rapid growth in smartphones, EVs, 5G infrastructure, AI applications, and the broader digital economy is fueling semiconductor consumption.

- **Global Partnerships –** Collaborations with Lam Research[107], NXP, Renesas[108], Foxconn[109], and initiatives like MoU b/w EU and India on semiconductor as part of EU-India TTC[110] are enabling technology transfer, supply chain resilience, and ecosystem development.

- **Skilled Workforce & R&D Ecosystem –** India's strong STEM talent pool, premier institutes (IITs, IISc), and many chip design startups under the DLI scheme are fostering innovation and R&D.

iii. Challenges

- **High Cost of Fab Establishment –** Setting up semiconductor fabs requires multi-billion-dollar investments with long gestation periods. India is still building investor confidence, as advanced fabrication carries risks such as initial production hurdles, quality control issues, and achieving economies of scale.

- **Infrastructure Gaps –** Reliable access to uninterrupted power, abundant water, and advanced logistics is essential for fabs but remains underdeveloped in several states.

- **Bureaucratic Inefficiencies** – Establishing an indigenous semiconductor facility involves approvals from multiple government departments. Procedural complexities and bureaucratic delays at various stages often discourage investors from setting up manufacturing units.

- **Skilled Workforce Shortage** – While India has 20% of the world's semiconductor design workforce, there is a shortage of highly specialized talent required for semiconductor fabrication, assembly, testing, and packaging.

- **Supply Chain Dependence** – India remains heavily reliant on imports of key raw materials like silicon wafers, high-purity gases, specialty chemicals, and ultrapure water—all critical for semiconductor manufacturing.

- **Global Competition** – India faces stiff competition from well-established semiconductor hubs such as Taiwan, South Korea, Singapore, Malaysia, and China, which have built strong ecosystems over decades.

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[107] https://newsroom.lamresearch.com/indian-institute-science-semulator3D?blog=true

[108] https://www.renesas.com/en/about/newsroom/renesas-partners-indian-government-drive-innovation-through-startups-and-industry-academia?srsltid=AfmBOoo0Z9dgmw8Q9x94FlYETGWZ_UJCPn2nCEcAzzeaaQ_xgVnD9pt

[109] https://www.reuters.com/world/india/india-approves-hcl-foxconn-joint-venture-semiconductor-unit-2025-05-14/

[110] https://ec.europa.eu/commission/presscorner/detail/en/ip_23_4380

iv. Standardization

Within BIS, technical committee LITD 5: Semiconductor And Other Electronic Components And Devices[111] is responsible for developing Indian standards relating to: a) Semiconductor devices & integrated circuits. b) Capacitors, resistors, allied component c) Discrete semiconductor devices & micro-electromechanical systems d) Electronic assembly technologies and printed board assemblies. e) Capacitors resistors and inductors for use in electronics equipment. It is a mirror technical committee of IEC TC 40 (P), IEC TC 47 (O), TC 47/SC 47A (O), IEC TC 91 (P). LITD 5 had published following standards:

- IS 12970 (Part 1): 2010 - Semiconductor devices integrated circuits: Part 1 general
- IS 12970 (Part 2): 2021 / IEC 60748-2: 1997 - Semiconductor devices - Integrated circuits: Part 2 Digital integrated circuits essential ratings and characteristics Sec 1 General
- IS 12970 (Part 3): 2021/ IEC 60748-3: 1994 - Semiconductor devices Integrated circuits Part 3 Analogue integrated circuit
- IS 14901 (Part 1): 2010 / IEC 60747-1: 2006 - Semiconductor devices - Discrete devices and integrated circuits: Part 1 general (First Revision)
- IS 14901 (Part 2): 2020 / IEC 60747-2: 2016 - Semiconductor Devices Part 2 Discrete Devices — Rectifier Diodes (First Revision)
- IS 14901 (Part 3): 2016 / IEC 60747-3: 2013 - Semiconductor Devices Discrete Devices Part 3 Signal, Switching and Regulator Diodes
- IS 14901 (Part 5): 2004 / IEC 60747-5 - Semiconductor devices - Discrete devices and integrated circuits: Part 5 optoelectronic devices
- IS 14901 (Part 7): 2020 / IEC 60747-7: 2010 - Semiconductor Devices — Discrete Devices Part 7 Bipolar Transistors (First Revision)
- IS 14901 (Part 8): 2020 / IEC 60747-8: 2010 - Semiconductor Devices — Discrete Devices Part 8 Field-Effect Transistors (Second Revision)
- IS 5001: 2018 / IEC 60191-1: 2007 - Mechanical standardization of semiconductor devices - General rules for the preparation of outline drawings of discrete devices (First Revision)
- IS 5001 (Part 1): 1969 Reviewed In: 2021 - Guide for Preparation of Drawings of Semiconductor Devices

2.14. Smart Cities/Urban Development

India is undergoing a rapid urban transformation, with the urban population expected to reach 675 million by 2035 and 70 million more residents by 2045. This rapid urbanization will shape the economic and social trajectory of India for decades to come. Indian urban areas are vital to the nation's economy, generating about 63% of the GDP while accommodating around 31% of the population, according to the 2011 Census data. By 2030, they are projected to host 40% of the population and contribute nearly 75% of the GDP. Major cities such as Mumbai, Delhi, Bengaluru, Chennai, and Hyderabad serve as key economic hubs, with forecasts suggesting they could add an additional 1.5% to GDP growth by 2047[112].

The Ministry of Housing and Urban Affairs (MoHUA) and the Ministry of Electronics and Information Technology (MeitY) are the key ministries driving digital urban transformation in India. Industry partners include C-DOT, CII, FICCI, and NASSCOM. Standards are overseen by BIS (LITD 28), TEC, and TSDSI, while R&D efforts are led by C-DAC, IITs, IIITs, and NIC.

[111] https://www.services.bis.gov.in/php/BIS_2.0/bisconnect/pow_details

[112] https://www.drishtiias.com/daily-updates/daily-news-analysis/urban-centres-as-catalysts-of-india-s-growth

Government Ministries / Departments	• Ministry of Housing & Urban Affairs (MoHUA). • MeitY (digital platforms). • National Institute of Urban Affairs (NIUA). • Bureau of Energy Efficiency (BEE)
Industry Associations	• C-DoT, • CII. • FICCI. • NASSCOM
Standard Development Organizations	• BIS (LITD 28). • TEC • TSDSI
R&D Organizations	• IITs, IISc, IIITs; C-DAC; NIC

i. Key policy including R&D initiatives

To improve the quality of life in cities and towns across the nation, Government of India has launched various initiatives as given below:

a) Smart City Mission[113]

The Government of India launched the Smart Cities Mission on 25th June 2015, with an objective to promote sustainable and inclusive cities that provide core infrastructure and give a decent quality of life to its citizens, a clean and sustainable environment and application of 'Smart' Solutions. The government has selected 100 cities[114] through a City Challenge Process. As of July 2025, a total of 7,549 projects—93.58% of the total 8,067 projects—have been completed, amounting to INR 1,51,258 crore (approx. €15.12 billion). Additionally, 518 projects worth INR 13,142 crore (approx. €1.31 billion) are in the advanced stages of implementation. This amounts to overall 8,067 multi-sectoral projects valued at ₹1.64 lakh crore (approx. €16.4 billion).

For more details on the commencement of Smart City Mission in India, please refer / download previous SESEI report on "Smart City Mission, India"[115].

b) Open Data Platform/India Urban Data Exchange (IUDX)[116]

The 'India Urban Data Exchange (IUDX)' initiative is a collaboration between the Smart Cities Mission and the Indian Institute of Science (IISc), Bengaluru. IUDX has been developed to facilitate secure and authenticated exchange of data amongst various data platforms, 3rd party applications, data producers and consumers, both within a city to begin with, and scaled up across cities eventually at a national level, in a uniform & seamless way. The platform will provide full control to the data owners as to what data to expose and to whom. Built-in accounting mechanisms will enable it to connect with payment gateways which will form the foundation for a data marketplace. The whole platform will be developer friendly, via definitions of open APIs and data schema templates (formats for interpreting data), so that a whole new application ecosystem gets created.

c) National Urban Digital Mission[117]

[113] https://smartcities.gov.in/
[114] https://smartcities.gov.in/index.php/mission-dashboard
[115] https://smartcities.gov.in/index.php/about-the-mission
[116] https://iudx.org.in/
[117] https://smartcities.gov.in/nudm

On February 23, 2021, the central government launched the 'National Urban Digital Mission' to establish a digital infrastructure to formalise a citizen-centric and ecosystem-driven approach to urban governance and service delivery in cities. It is built as a public good and provides the ecosystem actors the foundational digital building blocks, ready-to-use platforms, standards, specifications, and frameworks. Examples include India Urban Data Exchange (IUDX), which is an open-source platform that will provide data on numerous urban indicators. **Smart Cities Open Data Portal** is another example, being created to develop products and build solutions and SmartCode, which will serve the software development demand of cities, providing data and solutions for various urban problems.

d) Smart City Living Labs[118]

The Smart City Living Lab is an open-innovation ecosystem designed to discover, source, validate, and scale Smart City innovations, solutions, and products. It brings together key stakeholders—including governments, research institutions, start-ups, technology companies, smart city developers, and policymakers—to drive collaborative development and deployment.

e) Common Service Platform developed by C-DOT (Centre for Development of Telematics)[119]

The Centre for Development of Telematics (C-DoT), an Indian Government owned telecommunications technology development centre, has also developed CCSP (C-DOT Common Service Platform), the oneM2M standards compliant common service platform which can be deployed on any off-the-shelf generic server platforms or cloud infrastructure. The business application providers can deploy their oneM2M compliant applications in either co-located infrastructure or on any public or private cloud.

The Ministry of Housing and Urban Affairs (MoHUA), Government of India has also initiated several other programmes to support the Smart City Mission and Urbanization in the country[120].

ii. Growth Drivers

- **Economic Development and rapid urbanization:** Smart Cities can attract businesses, increase economic growth, and create job opportunities with the use of technology and data-driven decision making. As India has a rapidly growing urban population, there is growing need for efficient and sustainable urban infrastructure and services.

- **Adoption of new and emerging technologies**: There has been a rapid increase in the adoption of new and emerging technologies in India, including AI, IoT/M2M, Big Data, cloud computing etc. to improve urban efficiency.

- **Government initiatives and policy support:** Government Support and technological advancements have been key drivers for smart cities in the country. The government has made significant investments and has launched several initiatives such as Smart city Mission to modernize cities and improve the quality of life for citizens.

- **Sustainability and Climate-Resilient Urban Planning**: Smart Cities place strong emphasis on green infrastructure, renewable energy integration, EV charging infrastructure, energy-efficient buildings, and smart grids. These cities serve as key enablers of India's climate goals, including the Net Zero emissions target by 2070.

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[118] https://smartcityresearch.iiit.ac.in/
[119] https://www.cdot.in/cdotweb/web/product_page.php?lang=en&catId=4&pId=13
[120] https://smartcities.gov.in/index.php/Initiatives

- **Public-Private Partnerships (PPPs) and Investments**: PPPs play a vital role in driving innovation, operational efficiency, and financial sustainability for smart city projects. Private sector involvement is growing across areas such as urban mobility, clean energy, waste management, and the development of smart buildings and utilities.

iii. Challenges

- **Privacy and Data security**: The extensive use of sensors, cameras, and connected devices in smart cities generates vast amounts of data about citizens' movements and activities. Ensuring that this data is collected, stored, and used ethically and securely is essential to prevent misuse and safeguard individual' rights.

- **Interoperability and standardization**: Smart cities involve multiple systems and services from various vendors and stakeholders. The lack of common standards can cause compatibility issues, hindering the seamless integration of these technologies, which, in turn, might limit the effectiveness of smart city initiatives.

- **Advanced Technology Solutions**: Most smart city initiatives rely on advanced technologies such as IoT-based data acquisition and analysis, advanced data analytics using AI/ML, integration of large volumes of data from diverse domains into a central command-and-control system, and advanced video and real-time monitoring technologies. While implementing agencies may not need deep technical expertise, they do require at least a working knowledge of these technologies. However, such familiarity is often lacking among many smart city practitioners, impacting effective decision-making and oversight.

- **Aging urban infrastructure:** In many Indian cities, existing infrastructure is inadequate to support smart city solutions. Upgrading and retrofitting legacy systems is both complex and expensive. Additionally, resource constraints in areas such as water, energy, and waste management create further challenges[121].

iv. Standardization

The Bureau of Indian Standards (BIS) has embraced the vision of Smart Cities and has embarked on an ambitious journey to develop a comprehensive set of standards for Smart cities, covering all aspects of the Information and Communication Technologies (ICT), pertaining to Smart Cities. These include an overall master document, the ICT Reference architecture, followed by a host of standards to cover, Data and associated technologies, Geographical Information Systems (GIS), Internet of Things (IoT) technologies, Communication protocols, E-governance Systems and Data models and Taxonomy standards for all the relevant domains for Smart Cities.

So far BIS, with the help of the Ministry of Housing and Urban Affairs, and other stakeholders such as system integrators, vendors, solution providers has published 10 indigenous standards[122] under one of its technical committees, namely, "Smart Infrastructure Sectional Committee LITD 28". Following are the standards published so far[123]:

1. **IS 18000:2020** Unified Digital Infrastructure – ICT Reference Architecture (UDI-ICTRA)
2. **IS 18002 (Part 1):2021** Unified Digital Infrastructure — Data Layer Part 1 Reference Architecture

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[121] https://egov.eletsonline.com/2023/09/smart-cities-and-digital-transformation-building-a-sustainable-future/

[122] https://www.services.bis.gov.in/php/BIS_2.0/bisconnect/pow_details

[123] https://www.services.bis.gov.in/php/BIS_2.0/BISBlog/indian-standards-on-smart-cities-triggering-standards-based-technology-adoption-in-smart-cities/#:~:text=These%20include%20an%20overall%20master,models%20and%20Taxonomy%20standards%20for

3. **IS 18003 (Part 1):2020** Unified Data Exchange Part 1 Architecture.
4. **IS 18003 (Part 2):2021** Unified Data Exchange Part 2 API Specifications
5. **IS 18004 (Part 1):2021** IoT System Part 1 Reference Architecture
6. **IS 18006 (Part 1):2021** Municipal Governance Part 1 Reference Architecture
7. **IS 18006 (Part 3/Sec 1):2021** Municipal Governance Part 3 Property Tax Section 1 Taxonomy
8. **IS 18008 (Part 1):2021** Smart Cities — GIS Part 1 Reference Architecture
9. **IS 18010 (Part 1):2020** Unified Digital Infrastructure – Unified Last Mile Communication Protocols Stack Part 1 Reference Architecture.
10. **IS 18010 (Part 5/Sec 1):2020** Unified Digital Infrastructure – Unified Last Mile Communication Protocols Stack – Part 5 Network Access Layer (IEEE 802.15.4) Section 1 Specification.

IoT Reference Architecture, **IoT RA IS 18004 (Part 1): 2021** is based on oneM2M CSF and Unified Data Exchange Part 2 API specifications (IS 18003: Part 2: 2021) includes NGSI-LD (ETSI CIM).

The Bureau of Indian Standards (BIS) through its technical committee "CED 59 on Smart Cities" under the Civil Engineering Department, has also formulated standards in the field of Smart Cities terminology, components, planning, design, integration, implementation, operation, maintenance, and assessment. Following are the standards published[124] so far:

1. **IS 17000: 2019**: Sustainable Development of Habitats - Indicators.
2. **IS 17451: 2020**: Smart Community Infrastructure - Best Practices for Transportation – Guidelines
3. **IS 17456: 2020**: Smart Community Infrastructure - Guidance on Smart Transportation for Allocation of Parking Lots in Cities
4. **IS 17457: 2020**: Sustainable Development of Habitats – Vocabulary
5. **IS 17738: 2022**: Sustainable development of habitats - Indicators for smart cities.
6. **IS 17785: 2022**: Sustainable development of habitats - Indicators for resilient cities.

Two other standard developing organizations in ICT/Telecom sector in India i.e., TSDSI and TEC, DoT have also been working towards developing standards in the field of ICT/Smart Cities.

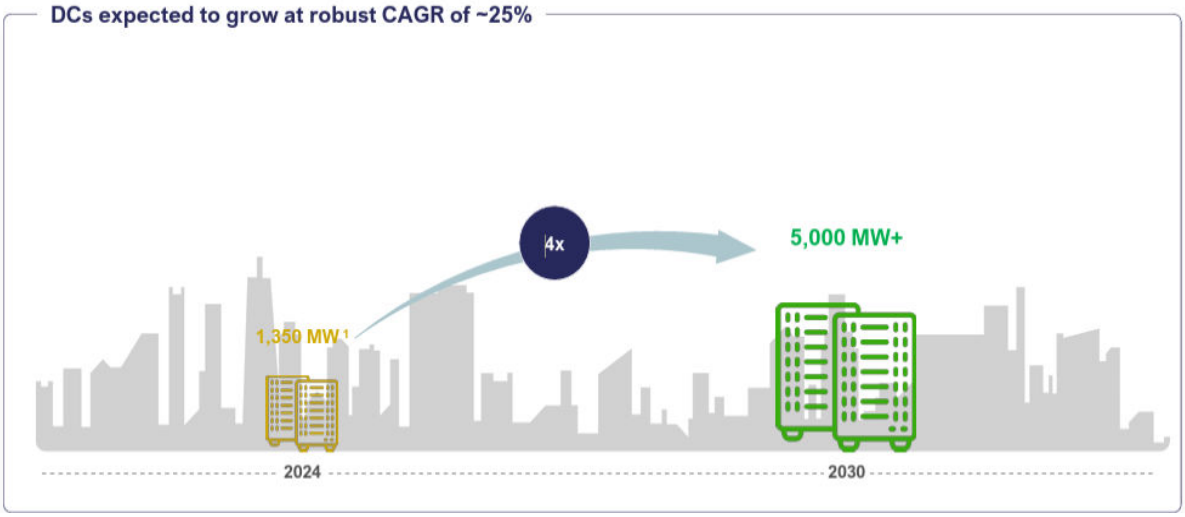
TSDSI works closely with global standards' bodies (3GPP, oneM2M, ETSI, etc.) to reflect Indian requirements into international telecom/ICT standards. TSDSI has transposed[125] oneM2M Release 2 and Released 3 specifications and submitted these specifications to TEC/DoT for considering them for National adoption / ratification. TEC, after complying with the due consultation process and as per the Standardization guide, adopted TSDSI-transposed oneM2M Release 2 and Release 3 specifications as National standards. These standards will be quite useful for the development of interoperable ecosystem for IoT domain, especially for Smart cities.

These national standards shall remain voluntary unless made mandatory for its use, reference, or adoption by regulation / Govt. directive.

2.15. Data

India's data market is experiencing rapid expansion, driven by surging digital consumption, increased cloud adoption, and strong government support for digital infrastructure. With the country's data center capacity expected to grow from 1.3 gigawatts (GW) in 2024 to 5 GW by 2030, the sector is set to witness capital investments of around $20–22 billion during this period, according to a report by Avener Capital. This growth is being fueled by the rollout of 5G, rising demand for AI and IoT applications, and data localization policies that are encouraging companies to store data within India.

[124] https://www.services.bis.gov.in/php/BIS_2.0/bisconnect/pow_details
[125] https://tsdsi.in/onem2m/



Source: Avener Capital

Major global and domestic players are investing in hyperscale data centers across key cities like Mumbai, Chennai, Hyderabad, and Bengaluru. As India solidifies its position as a digital powerhouse, the data market is expected to become a critical driver of economic growth and technological advancement over the next decade.

The report, titled Data Centres: Anchors of the New Age Digital Economy, said India's data centre market is currently valued at around $10 billion, growing at a compound annual growth rate (CAGR) of 25%. Capacity utilisation stands at 85%. India ranks 14th globally in terms of the number of data centres and is the second-fastest growing market in the Asia-Pacific region[126].

DATA POLICIES

i. Key policy including R&D initiatives

The central government has established several policies to guide the data sector:

a) Digital Personal Data Protection Act 2023

The Digital Personal Data Protection (DPDP) Act, 2023 is India's first comprehensive data privacy law, enacted on August 11, 2023, to protect individuals' personal data by establishing principles like obtaining consent for data use, limiting data collection, and ensuring data accuracy.

- The Act applies to digital personal data processed within India, whether collected digitally or digitized later, and to data processing outside India if done for offering goods or services in India. It does not apply to personal data used for personal purposes or data made public by the Data Principal or under a legal obligation.
- Personal data can be processed only for a lawful purpose with the consent of the Data Principal, who may withdraw consent anytime. For children or persons with disabilities, it must be given by a parent or legal guardian.
- Data Principals (individuals whose personal data is being processed) have the right to access information, request correction, or deletion, seek grievance redressal, and nominate a representative in case of death or incapacity.

[126] https://avener.in/wp-content/uploads/2025/06/Data-Centre_Industry-Report_April-2025_v1-1.pdf

The Digital Personal Data Protection (DPDP) Act, 2023 and the European Union's General Data Protection Regulation (GDPR) share common principles but differ in several key areas. The DPDP Act, 2023 applies exclusively to digital personal data, whereas the GDPR covers personal data in both digital and non-digital formats. Unlike the GDPR, the DPDP Act does not differentiate between personal data and sensitive personal data. Both laws grant similar rights to individuals but differ in their approach to legal bases for data processing.

The Ministry of Electronics and Information Technology (MeitY) has also released the draft Digital Personal Data Protection (DPDP) Rules 2025[127] for implementing the Digital Personal Data Protection (DPDP) Act, 2023[128].

b) **National Data Governance Framework Policy 2022**

MeitY released the Draft National Data Governance Framework Policy[129] on 26th May 2022. the draft Policy aims to ensure that non-personal data and anonymized data from both Government and Private entities are safely accessible by Research and Innovation eco-system.

The policy aims to provide an institutional framework for data/datasets/metadata rules, standards, guidelines, and protocols for sharing of non-personal data sets while ensuring privacy, security, and trust.

An "India Data Management Office (IDMO)" shall be set up under the Digital India Corporation ("DIC") under MeitY and shall be responsible for framing, managing and periodically reviewing and revising the Policy. The IDMO shall be responsible for developing rules, standards, and guidelines under this Policy that shall be published periodically.

c) **India Data Accessibility and Use Policy 2022**[130]

Ministry of Electronics and Information Technology (MEITY) released draft "India Data Accessibility and Use Policy" in February 2022. This policy aims to radically transform India's ability to harness public sector data for catalysing large scale social transformation. Any data sharing shall happen within the legal framework of India, its national policies and legislation as well as the recognized international guidelines.

The objectives of the Draft Policy include, among others,

- Maximizing access and use of quality non-personal data available with the public sector
- Enhancing the efficiency of service delivery
- Streamlining inter-government data sharing while maintaining privacy
- Facilitating the creation of public digital platforms
- Protecting the privacy of all citizens
- Increasing the availability of datasets of national importance
- Improving overall compliance to data sharing and privacy policies and standards

[127] https://www.meity.gov.in/static/uploads/2025/02/f8a8e97a91091543fe19139cac7514a1.pdf
[128] https://www.meity.gov.in/static/uploads/2024/06/2bf1f0e9f04e6fb4f8fef35e82c42aa5.pdf
[129] https://mcrhrdi.gov.in/cio2022/presentations/law/National Data Governance Framework Policy_26 May 2022.pdf
[130] https://egovstandards.gov.in/node/742

d) **Open Government Data (OGD) Platform India**[131]

The Open Government Data Portal is designed, developed, and hosted by the National Informatics Centre (NIC), a premier ICT organization of the Government of India under the aegis of the Ministry of Electronics & Information Technology.

The Objective of Open Government Data Platform India is to facilitate the access to Government owned shareable data and information in both human readable and machine readable forms in a proactive and periodically updatable manner, within the framework of various related policies, Acts and Rules of Government of India, thereby promoting wider accessibility and application of government owned data and unlocking the potential of data for national development.

DATA CENTRE POLICIES

e) Data Centre Policy 2020

The Ministry of Electronics & Information Technology (MeitY), through its e-Governance Division, released the "Data Centre Policy 2020[132] (draft)" with the objective of positioning India as a global data centre hub.

The following are some of the key objectives to be driven through this policy:

- Drive necessary regulatory, structural, and procedural interventions for enabling ease of doing business in the sector, towards attracting investments and accelerating the existing pace of Data Centre growth in the country.
- Promote sector competitiveness through various fiscal and non-fiscal incentives.
- Promote domestic start-ups, MSMEs and other Indian IT companies and provide impetus to indigenous manufacturing of IT and non-IT equipment.
- Measures to bring necessary improvement in network backhaul, domestic as well as international.
- Facilitate standardization in the development of Data Centres.

i. Growth Drivers

- **Accelerated Digital Transformation**: Rapid digitalization across sectors like finance, healthcare, and education—alongside the adoption of cloud computing and emerging technologies such as AI, IoT, and Big Data analytics—is generating unprecedented volumes of data and driving the need for scalable, high-performance data center infrastructure.

- **Surging Digital Consumption**: Affordable data plans and widespread smartphone penetration have triggered a massive rise in internet usage. This has fueled the popularity of data-heavy online services such as video streaming, social media, e-commerce, and online gaming, significantly increasing data consumption and bandwidth requirements.

[131] https://www.data.gov.in/about
[132] https://www.nitiforstates.gov.in/public-assets/Policy/policy_files/PNC510C000384.pdf

- **Next-Generation Infrastructure**: The nationwide rollout of 5G, with its high-speed and low-latency capabilities, coupled with the rapid growth of IoT devices, is intensifying demand for localized processing. This is accelerating the development of edge data centers to support real-time applications and services.

- **Supportive Government Policies**: Initiatives such as Digital India are promoting digital adoption, while regulatory measures like data localization requirements (e.g., mandatory storage of financial data within India) are spurring investment and strengthening the domestic data center ecosystem.

ii. Challenges

- **Infrastructure and Power Deficit**: The most pressing challenge is the unreliable power supply and limited availability of suitable land in key hubs like Mumbai and Chennai, coupled with difficulties in securing reliable last-mile fiber connectivity.

- **High Capital and Operational Costs**: High land acquisition costs, dependence on imported equipment, and complex construction requirements create significant financial barriers. On the operational side, steep electricity tariffs, and the heavy cooling demands of India's tropical climate drive OPEX upward, consistently squeezing profitability.

- **Complex Regulatory Environment:** Securing approvals and clearances across land, environment, power, and construction involves multiple agencies and frequently delays projects. The evolving data protection and privacy regime adds yet another compliance burden for operators.

- **Talent Shortage and Sustainability Demands**: Shortage of skilled professionals with expertise in designing, building, and operating modern high-density facilities. Simultaneously, data centres are under pressure to achieve sustainability goals on Power Usage Effectiveness (PUE), adopting renewable energy, and efficient water management, demanding specialized knowledge and additional investment.

iii. Standardization

Bureau of Indian Standards (BIS):

BIS, through its various Technical Committees, is actively developing standards related to data, data exchange, and data quality etc., in alignment with international practices to support India's digital transformation.

- **LITD 15 Data Management System:** LITD 15 is responsible for preparing Indian Standards relating to: a) Data Management and Interchange b) Document Description and Processing Languages c) Programming languages, their environments and system software interfaces
    - IS/ISO/IEC 11179 (part 1 to part 6): Information Technology — Metadata Registries (MDR)
    - IS 18743: 2024 / ISO/IEC TR 9789: 1994 Information technology - Guidelines for the organization and representation of data elements for data interchange Coding methods and principles.
    - IS/ISO/IEC 21778: 2017 Information Technology - The JSON Data Interchange Syntax

- **LITD 16 Identification & Data capture techniques, Cards and Security Devices:** LITD 16 is responsible for standardization in: a) Smart Cards, Identification cards, security devices and interface associated with their use in inter-industry applications and international interchange. b) Data formats, data syntax, data structures, data encoding, and technologies for the process of automatic identification and data capture and of associated devices utilized in inter-industry applications and international business interchanges and for mobile applications.
    - IS 14202 (Part 6): 2018/ ISO/IEC 7816-6:2016 Identification cards — Integrated circuit cards — Part 6: Interindustry data elements for interchange.
    - IS/ISO/IEC 18004:2015: Information technology Automatic identification and data capture techniques QR Code bar code symbology specification.

- **LITD-25 Digital Governance**: LITD 25 is responsible for developing Indian standards related to Software applications for seamless sharing of data and services for e-Governance namely data, security, network, semantics, metadata and language and ensuring their integrity.

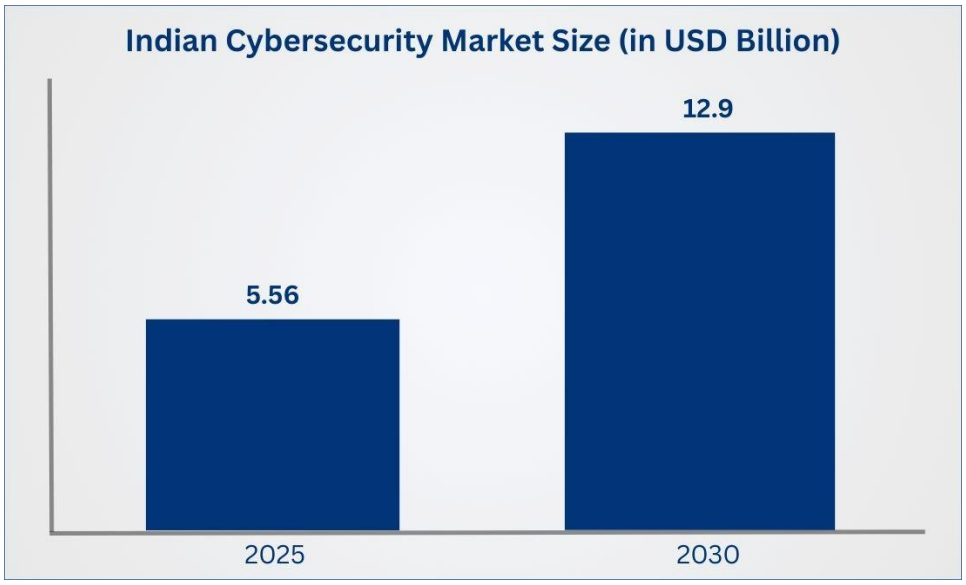
- **LITD 31- Cloud Computing, IT and Data Centres Sectional Committee:** LITD 31 is responsible for standardization in the field of a) Cloud Computing and Distributed Platforms including Foundational concepts and technologies, Operational issues, and Interactions among Cloud Computing systems and with other distributed systems b) Assessment methods, design practices, operation and management aspects to support resource efficiency, resilience and environmental sustainability for and by information, data centres and other facilities and infrastructure necessary for service provisioning
    - IS/ISO/IEC 19944-1:2020: Cloud computing and distributed platforms – Data flow, data categories, and data use — Part 1: Fundamentals
    - Parts of IS/ISO/IEC 22237: Information Technology Data Centre Facilities and Infrastructures
    - Parts IS/ISO/IEC 30134: Information Technology Data Centers Key Performance Indicators

2.16. Cybersecurity

The cybersecurity and data privacy sector in India has emerged as a critical enabler of the country's digital economy, contributing significantly to GDP through its role in safeguarding digital infrastructure, enabling secure transactions, and building trust in e-governance and digital services.

Valued at approximately USD 5.56 billion in 2025, the Indian cybersecurity market is witnessing rapid growth driven by increasing cyber threats, and the accelerated adoption of cloud, IoT, and AI technologies. According to Mordor Intelligence, the cybersecurity market in India is projected to reach USD 12.90 billion by 2030, with a compound annual growth rate (CAGR) of 18.33% from 2025[133].

[133] https://www.mordorintelligence.com/industry-reports/india-cybersecurity-market#:~:text=India%20Cybersecurity%20Market%20Analysis%20by,budgets%20toward%20zero%2Dtrust%20controls.



Cybersecurity in India is coordinated by MeitY, CERT-In, and NCIIPC under NTRO, with sectoral oversight from regulators such as DoT. Industry associations including DSCI, NASSCOM, and FICCI, together with private firms, play a key role in strengthening the cybersecurity ecosystem. Standards are developed by BIS (LITD 17) and TEC, while research and innovation are driven by C-DAC, IITs, and IISc.

Government Ministries / Departments	• MEITY. • DoT • NCIIPC (under NTRO);
Industry Associations / Players	• DSCI • NASSCOM. • CII. • FICCI. • BIF etc.
Standard Development Organizations	• BIS (BIS LITD 17 on Information Systems Security and Privacy). • TEC (security requirements)
R&D Organizations	• C-DAC; CERT-In empanelled labs; IITs; IISc etc.

i. Key policy including R&D initiatives

Government of India is cognizant of the increasing frequency and sophistication of cyberattacks in the country. Government has taken several legal, technical, and administrative policy measures for addressing cyber security challenges in the country. The Government has also institutionalized a nationwide integrated and coordinated system to deal with cyber-attacks in the country which, inter alia, includes:

a) The Information Technology Act 2000

The Information Technology Act, 2000 was enacted by the Indian Parliament in 2000. It is the primary law in India for matters related to cybercrime and e-commerce. An amendment was passed by Parliament in December 2008 ("Amendment Act").

b) National Cyber Security Policy-2013[134]

[134] https://www.meity.gov.in/writereaddata/files/downloads/National_cyber_security_policy-2013%281%29.pdf

Government of India released National Cyber Security Policy in 2013 with aims at (1) facilitating the creation of secure computing environment (2) enabling adequate trust and confidence in electronic transactions and (3) guiding stakeholders' actions for the protection of cyberspace.

The salient features of the policy cover the following aspects:

- A vision and mission statement aimed at building a secure and resilient cyber space for citizens, businesses, and the Government.
- Enabling goals aimed at reducing national vulnerability to cyber-attacks, preventing cyber-attacks and cybercrimes, minimizing response and recover time and effective cybercrime investigation and prosecution.
- Focused action at the level of Government, public-private partnership arrangements, cyber security related technology actions, protection of critical information infrastructure and national alerts and advice mechanism, awareness & capacity building and promoting information sharing and cooperation.
- Enhancing cooperation and coordination between all the stakeholder entities within the country.
- Objectives and strategies in support of the National cyber security vision and mission.
- Framework and initiatives that can be pursued at the Govt. level, sectoral levels as well as in public private partnership mode.
- Facilitating monitoring key trends at the national level such as trends in cyber security compliance, cyber-attacks, cyber-crime, and cyber infrastructure growth.

c) The Indian Computer Emergency Response Team (CERT-In)

CERT-In is India's national agency for cybersecurity. In IT Amendment ACT 2008, CERT-In has been designed to serve as the national agency to perform the following functions around cyber security:

- Collection, analysis, and dissemination of information on cyber incidents
- Forecast and alerts of cyber security incidents.
- Emergency measures for handling cyber security incidents
- Coordination of cyber incident response activities
- Issue guidelines, advisories, vulnerability notes and whitepapers relating to information security practices, procedures, prevention, response and reporting of cyber incidents.
- Such other functions relating to cyber security as may be prescribed.

National Cyber Coordination Centre (NCCC) implemented by the CERT-In serves as the control room to scan the cyberspace in the country and detect cyber security threats. NCCC facilitates coordination among different agencies by sharing with them the metadata from cyberspace for taking actions to mitigate cyber security threats.

CERT-In[135] has also issued "Guidelines on Information Security Practices" for Government Entities for Safe & Trusted Internet"[136]. These guidelines are a roadmap for the Government entities and industry to reduce cyber risk, protect citizen data and continue to improve the cyber security ecosystem in the country. They will serve as a fundamental document for audit teams, including internal, external, and third-party auditors, to assess an organisation's security posture against the specified cybersecurity requirements. The guidelines include various security domains such as network security, identity and access management, application security, data security, third-party outsourcing, hardening procedures, security monitoring, incident management, and security auditing.

d) Cyber Surakshit Bharat

[135] https://www.cert-in.org.in/

[136] https://www.cert-in.org.in/guidelinesgovtentities.jsp

An initiative from MeitY in association with National e-Governance Division (NeGD) and industry partners, Cyber Surakshit Bharat aims to ensure awareness about cybercrime and adequate safety measures for Chief Information Security Officers (CISOs) and frontline IT staff across all government departments. This first public-private partnership also includes a series of workshops to help officials become knowledgeable about cybersecurity and equip them with toolkits for fighting cyber-threats.

e) National Critical Information Infrastructure Protection Centre (NCIIPC)

As a part of Indian Government Initiatives on Cybersecurity to safeguard critical information relevant to national security, economic development, and public health, India established in 2014 the National Critical Information Infrastructure Protection Centre. Information Technology (IT) Act, 2000, Section 70A, amended this provision. Cybersecurity exercises are conducted by this organization to make sure the government and critical sectors are prepared in terms of cybersecurity.

f) Cyber Swachhta Kendra (Botnet Cleaning and Malware Analysis Centre)[137]

The " Cyber Swachhta Kendra " (Botnet Cleaning and Malware Analysis Centre) is a part of the Government of India's Digital India initiative under the Ministry of Electronics and Information Technology (MeitY) to create a secure cyber space by detecting botnet infections in India and to notify, enable cleaning and securing systems of end users to prevent further infections. The " Cyber Swachhta Kendra "is set up in accordance with the objectives of the "National Cyber Security Policy", which envisages creating a secure cyber eco system in the country. This centre operates in close coordination and collaboration with Internet Service Providers and Product/Antivirus companies. This website provides information and tools to users to secure their systems/devices. This centre is being operated by the Indian Computer Emergency Response Team (CERT-In) under provisions of Section 70B of the Information Technology Act, 2000.

ii. Growth drivers

- **Growing no. of cybersecurity startups:** India has a thriving startup ecosystem, and there is a growing number of companies focused on providing cybersecurity solutions to individuals and organizations. These startups have the potential to not only address the cybersecurity needs of the country but also to become global leaders in the field.

- **Increasing use of technology in various sectors**: With the proliferation of the internet and the adoption of digital technologies, every sector in the country is now reliant on technology. This includes sectors such as finance, healthcare, transportation, Energy, and manufacturing etc., which are particularly sensitive to cyber-attacks. As a result, there is a growing demand for cybersecurity solutions to protect against these threats.

- **India is emerging as a hub for cyber GCCs (Global Capability Centres)**: With more than 1,800 GCCs established and a market value exceeding $46 billion, India has consolidated its position as a global hub for GCCs. India, home to more than half of the world's GCCs, offers unmatched advantages, including a sizable skilled workforce, cost-effective operations, and cutting-edge technological infrastructure[138].

- **Increased contribution of private sector**: In India, the private sector is leading the way in developing strong policies and standards in the areas of cybersecurity. The DSCI, which

[137] https://www.csk.gov.in/

[138] https://economictimes.indiatimes.com/news/india/advantage-india-global-capability-centres-gccs/articleshow/123087709.cms?from=mdr

promotes best practices and standards for cybersecurity and privacy, undertakes capacity-building projects with a focus on training and certification, including for the government sector.

iii. Challenges

- **Ransomware on the Rise**: India faces a unique ransomware threat that arises from the widespread adoption of technologies that lack proper security. The scale of ransomware attacks in India is unprecedented. A recent study by CERT-In (Indian Computer Emergency Response Team) revealed that ransomware attacks surged by 51% in 2023 alone. This sharp rise reflects how lucrative and easy these attacks have become for cybercriminals, who exploit the vulnerabilities in India's IT systems[139].

- **Lack of Infrastructure –**The cybersecurity infrastructure in India is still developing, and there is a need for robust systems and frameworks to address emerging threats effectively. This includes implementing strong network security, data protection measures, and incident response capabilities.

- **Lack of Comprehensive Cybersecurity Regulations**: While India has made progress in enacting cybersecurity-related laws, significant gaps remain in creating and enforcing a unified, comprehensive legal framework. Existing provisions often lack clarity on emerging threats, sector-specific requirements, and cross-border data flows. Strengthening regulations around data protection, privacy, critical infrastructure security, cybercrime prevention—alongside ensuring effective enforcement, is a key challenge for safeguarding India's digital ecosystem.

- **Rapid adoption of Emerging Technologies**: The rapid adoption of emerging technologies, such as IoT/M2M, cloud computing, and AI etc., introduces new vulnerabilities and challenges. Ensuring the security of these technologies and addressing the associated risks is a significant concern.

- **Shortage of skilled professionals**: Report by NASSCOM states that India needs at least one million cybersecurity professionals but currently has less than half that number. The demand is outpacing supply at alarming rate, leaving organizations vulnerable to cyber sophisticated threats[140].

- **Lack of awareness and education**: Many individuals and organizations in the country still do not fully understand the risks and implications of cyber-attacks, leaving them vulnerable to exploitation. This is particularly true for smaller businesses and startups that may not have the resources to invest in robust cybersecurity measures.

iv. Standardization

BIS LITD 17 on Information Systems Security and Privacy

Bureau of Indian Standards (BIS) through its technical committee "LITD 17 on Information systems security and privacy" is developing standards in the field of Security and Privacy aspects of Information Systems. LITD 17 is the national mirror committee for ISO/IEC TC-JTC 1 SC-27 (P) on *Information security, cybersecurity, and privacy protection and ISO/IEC JTC1 /SC 44 - Consumer protection in the field of privacy by design - Participating (P)*

BIS LITD 17 has adopted following standards:

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[139] https://www.livemint.com/mint-lounge/business-of-life/ransomware-surge-india-digital-security-11730013128459.html

[140] https://www.livemint.com/mint-lounge/business-of-life/india-cybersecurity-skill-gap-11754807365228.html

- **ISO 27000 series of standards** for Information technology - Security techniques - information: Security management systems
- **IS/ISO/IEC 27032: 2012**- Information Technology - Security Techniques - Guidelines for Cyber Security
- IS/ISO/IEC 24745: 2022[141]- Information security cybersecurity and privacy protection Biometric information protection
- IS/ISO/IEC/TR 27103: 2018[142]- Information Technology - Security Techniques - Cybersecurity and ISO and IEC Standards
- Series **of IS 14990/ISO/IEC 15408**- Information Security, Cybersecurity and Privacy Protection - Evaluation Criteria for IT Security
- **IS/ISO/IEC 27400:2022**- Cybersecurity - IoT Security and Privacy – Guidelines
- **IS/ISO/IEC 27402:2023-** Cybersecurity - IoT Security and Privacy - Device Baseline Requirements

For complete list of standards published by LITD 17[143].

3. Major "Make in India" initiatives by Government of India

3.1 PLI Scheme for Large Scale Electronics Manufacturing[144]

In India, "PLI in mobile" refers to the Production Linked Incentive (PLI) Scheme for Large Scale Electronics Manufacturing, a government initiative offering financial incentives to boost domestic mobile phone and component manufacturing, attract investment, and increase exports.

Launched by the Ministry of Electronics and Information Technology (MeitY), the scheme provides incentives on incremental sales to companies, including global leaders like Apple and Samsung's contract manufacturers, encouraging them to invest in India and meet production targets. This has led to significant growth in India's electronics manufacturing sector and positioned the country as the world's second-largest manufacturer of mobile phones.

PLI Scheme for Large Scale Electronics Manufacturing has significantly impacted Mobile manufacturing sector in India particularly in transforming India from a net importer to a net exporter of mobile phones. Bharat is now the second largest mobile manufacturing country in the world. Growth of electronics goods production and exports are hereunder:[145]

Details of incentive schemes	2014-15	2024-25	Remarks
Production of electronics goods (Rs.)	1.9 Lakh Cr (approx. €19 billion)	11.3 Lakh Cr (approx. €113 billion)	Increased 6 times
Export of electronics goods (Rs.)	38 thousand Cr (approx. €3.8 billion)	3.27 Lakh Cr (approx. €32.7 billion)	Increased 8 times

141 https://www.services.bis.gov.in/php/BIS_2.0/bisconnect/standard_review/Standard_review/Isdetails?ID=MjgyMjc=

142 https://www.services.bis.gov.in/php/BIS_2.0/bisconnect/standard_review/Standard_review/Isdetails?ID=MjQ2NjM=

143 https://www.services.bis.gov.in/php/BIS_2.0/bisconnect/pow_details

144 https://www.meity.gov.in/offerings/schemes-and-services/details/production-linked-incentive-scheme-pli-for-large-scale-electronics-manufacturing-gNyMDOtQWa

145 https://www.pib.gov.in/PressReleasePage.aspx?PRID=2147394

Mobile manufacturing units	2	300	Increased 150 times
Production of mobile phones (Rs.)	18 thousand Cr (approx. €1.8 billion)	5.45 Lakh Cr (approx. €54.5 billion)	Increased 28 times
Export of mobile phones (Rs.)	1,500 Cr (approx. €150 million)	2 Lakh Cr (approx. €20000 million)	Increased 127 times
Mobile phone imported (units)	75% of the total demand	0.02% of the total demand	

The PLI Scheme for LSEM has already attracted a cumulative investment of INR 12,390 Cr (approx. €1.23 billion), led to a cumulative production of INR 8,44,752 Cr (approx. €84.47 billion), with exports of INR 4,65,809 Cr. (approx. €46.58 billion) and generated additional employment of 1,30,330 (Direct jobs) till Jun'25.

Total FDI in field of electronics manufacturing in last 5 years (i.e. since FY 2020-21) is USD 4,071 Mn (approx. €3479.04 Mn), cumulative FDI of USD 2,802 Mn (approx. €2394.56 Mn) has been contributed by MeitY PLI beneficiaries.

3.2 PLI Scheme for Promoting Telecom & Networking Products Manufacturing in India[146]

With the objective to boost domestic manufacturing, investments and export in the telecom and networking products, Department of Telecommunications (DoT) notified the "Production Linked Incentive (PLI) Scheme" on 24th February 2021. The PLI Scheme will be implemented within the overall financial limits of INR 12,195 Crores (approx. 1.2 €billion) only for implementation of the Scheme over a period of 5 years. For MSME category, financial allocation will be INR 2500 Crores (approx. €250 million). Small Industries Development Bank of India (SIDBI) has been appointed as the Project Management Agency (PMA) for the PLI scheme. The scheme is effective from 1st April 2021. Investment made by successful applicants in India from 1st April 2021 onwards and up to Financial Year (FY) 2024-2025 shall be eligible, subject to qualifying incremental annual thresholds. The support under the Scheme shall be provided for a period of 5 years, i.e. between FY 2021-22 and FY 2026-27. Support under the Scheme will be provided to companies who will manufacture specified telecom and networking products in following 4 product categories in India:

1. Core transmission Equipment
2. 4G/5G, Next Generation RAN and Wireless Equipment
3. Access & CPE, IoT Access Devices and Other Wireless Equipment
4. Enterprise Equipment: Switch and Router

3.3 Production Linked Incentive Scheme – PLI 2.0 for IT Hardware[147]

The Government of India approved the Production-Linked Incentive (PLI) Scheme 2.0 for IT Hardware for Enhancing India's Manufacturing Capabilities and Enhancing Exports – Atmanirbhar Bharat in May 2023.

[146] https://dot.gov.in/pli-scheme
[147] https://www.meity.gov.in/offerings/schemes-and-services/details/production-linked-incentive-scheme-pli-2-0-for-it-hardware-wM0MDOtQWa

Production Linked Incentive Scheme 2.0 for IT Hardware offers a production linked incentive to boost domestic manufacturing and attract large investments in the value chain.

The PLI Scheme 2.0 for IT Hardware is expected to result in broadening and deepening of the manufacturing ecosystem by encouraging the localisation of components and sub-assemblies and allowing for a longer duration to develop the supply chain within the country. Additionally, the scheme provides increased flexibility and options for applicants and is tied to incremental sales and investment thresholds to further incentivise growth. Furthermore, **semiconductor design**, IC manufacturing, and packaging are also included as incentivized components of the PLI Scheme 2.0 for IT Hardware.

The PLI Scheme 2.0 for IT Hardware have attracted a cumulative investment of INR 717.13 Cr (approx. €71.8 million), led to a cumulative production of INR 12,195.84 Cr (approx. €1.2 billion) and generated additional employment of 5,056 (direct jobs) till Jun'25.

The Scheme shall extend an average incentive of around 5% on net incremental sales (over base year) of goods manufactured in India and covered under the target segment, to eligible companies, for a period of six (6) years. The Target Segment under PLI shall include (i) Laptops (ii) Tablets (iii) All-in-One PCs (iv) Servers and Ultra Small Form Factor (USFF).

Support under the Scheme shall be provided to companies based on the eligibility criteria laid down, for manufacturing of goods (covered under the target segment) in India.

3.4 Scheme for Promotion of Manufacturing of Electronic Components and Semiconductors (SPECS)[148]

The Scheme for Promotion of Manufacturing of Electronic Components and Semiconductors (SPECS) aims to offset the disability for domestic manufacturing of electronic components and semiconductors to strengthen the electronics manufacturing ecosystem in the country. The scheme provides financial incentive of 25% on capital expenditure for the identified list of electronic goods that comprise downstream value chain of electronic products, i.e., electronic components, **semiconductor/ display fabrication units**, **ATMP units**, specialized sub-assemblies and capital goods for manufacture of aforesaid goods, all of which involve high value-added manufacturing.

4. EU - India Cooperation and Projects Instruments on Digital Technologies

The cooperation between the European Union (EU) and India in the field of digital technologies has grown significantly in recent years, reflecting their shared commitment to fostering an open, secure, and inclusive digital future. This partnership is grounded in strategic frameworks such as the EU–India Trade and Technology Council (TTC), which serves as a high-level platform to coordinate efforts in areas like artificial intelligence, digital public infrastructure, 6G, semiconductors, and cybersecurity. Through joint initiatives, policy alignment, research collaborations, and startup engagement, both sides are working together to address global digital challenges, promote ethical technology governance, and support innovation and sustainable development—not just for their own regions, but also for developing countries via platforms like the EU's Global Gateway[149].

[148] https://www.meity.gov.in/offerings/schemes-and-services/details/scheme-for-promotion-of-manufacturing-of-electronic-components-and-semiconductors-specs-AMxIDOtQWa
[149] https://international-partnerships.ec.europa.eu/policies/global-gateway/digital_en

4.1 EU-India Strategic Partnership: A Roadmap to 2025

The focus on trade, future technologies, standards, and sustainable development has clearly been brought out through "EU-India Strategic Partnership: A Roadmap to 2025"[150], endorsed by India and the EU, in July 2020. The key focuses of cooperation are include ICT, Artificial Intelligence, Research & Innovation, RAIL etc.

- The roadmap emphasizes working together on **harmonizing standards** across domains such as **security**, **pharmaceuticals**, **environment (circular economy)**, **ICT**, and **transport (railways)**. This includes alignment with international standards to facilitate trade, interoperability, and ease of doing business.

- Agreements made at the Leaders' Meeting in Porto on 8 May 2021 reinforced cooperation on **global digital standards**, **network security**, **5G and beyond**, **Joint Task Force on AI**, **High-Performance Computing (HPC)**, **Quantum computing**, **data protection**, and **smart & sustainable urbanization**.

- The **EU-India Connectivity Partnership** (May 2021) further supports digital, transport, and energy networks, anchored in the roadmap, with a commitment to **implementing international standards** for equitable market access.

4.2 EU-India TTC WG-01

The **EU–India Trade and Technology Council (TTC)** is a high-level strategic forum jointly established by the European Union and India to deepen cooperation at the intersection of trade, trusted technology, and strategic resilience. Announced in April 2022 by Prime Minister of India and European Commission President, it commenced with its inaugural ministerial meeting on **6 February 2023.**

The EU–India Trade and Technology Council (TTC) focuses on three key areas: (1) Strategic technologies and digital governance, including cooperation on AI, semiconductors, 6G, high-performance computing, and digital public infrastructure; (2) Green and clean energy technologies, with joint efforts on EV battery recycling, charging standards, and circular economy; and (3) Trade, investment, and resilient supply chains, aiming to enhance market access, diversify value chains, and align regulatory frameworks for mutual benefit.

- **Trade and Technology Council (TTC) – Working Group 1**

EU–India TTC Working Group 1 (WG1) focuses on Strategic Technologies, Digital Governance, and Digital Connectivity, aiming to align digital policy, advance critical tech cooperation, and promote a secure, inclusive digital future. Here's a concise breakdown of its key priorities:

i. **Emerging & Critical Technologies:**
   - ✓ **Artificial Intelligence (AI)**: Collaboration on ethical AI, governance frameworks, large language models (LLMs), and cooperation between the European AI Office and IndiaAI Mission.
   - ✓ **Semiconductors**: Joint efforts under a bilateral MoU to enhance supply chain resilience, research collaboration, and ecosystem development.
   - ✓ **6G & Advanced Connectivity**: Cooperation in next-gen telecom standards, spectrum policy, and infrastructure development.

[150] https://eeas.europa.eu/sites/eeas/files/eu-india_strategic_partnership_a_roadmap_to_2025_0.pdf

- ✓ **Quantum Technologies** & **High-Performance Computing (HPC)**: Shared initiatives for research, capacity building, and access to infrastructure.

ii. Digital Governance & Regulation

- ✓ Alignment on **data governance**, **privacy**, **cybersecurity**, and **online platforms regulation**, ensuring a **human-centric** and **trust-based** digital environment.
- ✓ Exchange on **cyber resilience**, digital trust standards / E Signatures, and interoperability.

iii. Digital Public Infrastructure (DPI)

- ✓ Promote interoperability between Indian and EU DPIs (e.g., Aadhaar, UPI vs. eIDAS, EBSI).
- ✓ Support development of **inclusive, secure, and rights-respecting DPIs**, especially for the **Global South**.

iv. Standards & Certification

- ✓ Work toward **global alignment of standards** in telecom, AI, and emerging tech.
- ✓ Explore **mutual recognition of certifications** and **harmonization of technical requirements** to ease trade and innovation.

4.3 EU-India Global Gateway initiatives

The collaboration between the EU and India from 2020 to 2025 is further steered by the Global Gateway Strategy[151] and the EU's International Digital Strategy[152]. The International Digital Strategy for the European Union places an emphasis on deepening its existing partnerships such as Digital Partnerships, Digital Dialogues, among others, through new cooperation initiatives and projects, as well as building new Partnerships and Dialogues. It will also connect these partnerships through a Digital Partnership Network. The Strategy highlights 5 key areas of cooperation with partner countries, such as:

- Emerging technologies: AI, 56/6G, Semiconductors and quantum
- Secure and trusted digital infrastructure
- Cybersecurity
- Digital identity and digital public infrastructure
- Online platforms

It aligns with EU's external priorities and global goals of

- The Paris Agreement and climate action. Publications Office of the EU+1[153]
- Sustainable Development Goals (SDGs) of the UN. Publications Office of the EU+1
- Europe's Indo-Pacific Strategy, and connectivity partnerships with key countries (India, Japan etc.)

The Joint Communication sets the strategic framework for partnerships like EU–India Connectivity and Global Gateway investment in India. Here's how the principles and priorities translate to the India–EU relationship:

- **The EU-India Global Gateway Conference for Connectivity Investments in North-Eastern India** was held in Shillong, Meghalaya, on June 1-2, 2023. Organized by the Indian Ministry of External Affairs, the EU Delegation to India, and the Asian Confluence[154], the conference aimed to identify and promote joint connectivity projects in Digital, Energy, and Transport sectors between the

[151] https://international-partnerships.ec.europa.eu/policies/global-gateway/global-gateway-overview_en
[152] https://digital-strategy.ec.europa.eu/en/policies/international-digital-strategy
[153] https://op.europa.eu/en/publication-detail/-/publication/9ed75c36-536c-11ec-91ac-01aa75ed71a1/language-en?utm_source=chatgpt.com
[154] https://www.asianconfluence.org/news-events/eu-india-global-gateway-conference

European Union, India's North-Eastern States, and their immediate neighbours. The conference sought to explore ways to boost smart, green, and secure connectivity investments in the region, building on the India-EU Connectivity partnership[155] launched in May 2021.

- **Trilateral cooperation with third countries**[156]**:** Under the Global Gateway framework, the European Union and India have committed to engaging in **trilateral cooperation with third countries**, particularly in regions such as **Africa, Central Asia, and the Indo-Pacific**. This collaboration involves jointly designing and implementing projects that promote sustainable and inclusive development, with a strong focus on areas like **digital public infrastructure, renewable energy, healthcare systems**, and **logistics corridors**. By pooling their resources, technical expertise, and diplomatic reach, the EU and India aim to offer high-standard, transparent alternatives to existing infrastructure models, thereby supporting partner countries in achieving their development goals.
- **India-Middle East-Europe Economic Corridor (IMEC**[157]**):** Launched at the G20 Summit in New Delhi, September 2023, it is a planned trans-continental economic corridor linking India, the Middle East, and Europe. It envisages a multimodal infrastructure including, shipping, rail, roads, ports, energy transmission (electricity, hydrogen pipelines), digital connectivity (high-speed data cables), etc. It aligns with the EU's *Global Gateway* and *Partnership for Global Infrastructure and Investment (PGII)* initiatives. These EU strategies aim to promote sustainable, rules-based infrastructure, resilient supply chains, digital connectivity, clean energy, etc. IMEC is seen as one way of delivering those goals in the region. IMEC is one of the major connectivity and infrastructure pillars in the EU-India strategic partnership. It strengthens trade, technology, energy, sustainability and strategic alignment.

4.4 EU Indo-Pacific Strategy

Digital governance and partnerships and Connectivity are indeed two of the seven priority areas outlined in the EU's Strategy for Cooperation in the Indo-Pacific[158], adopted in 2021.

- **Digital Governance and Partnerships:** Develops partnerships and standards for a secure, open, and human-centric digital future.
- **Connectivity**: Supports sustainable, digital, and physical connectivity to foster economic integration and links between the EU and the region

4.5 Joint Communication on 'New Strategic EU-India Agenda'

The European Commission and the High Representative adopted a Joint Communication outlining a 'New Strategic EU-India Agenda[159]' marking a significant milestone in EU-India relations. The Joint Communication is a roadmap of activities with emphasis on:

- **Standards & Interoperability**: Harmonising digital, EV, and hydrogen safety standards to ease tech deployment and market access, technical and sustainability standards, regulatory improvements, innovation, skills development, common benchmarking standards in High-Performance Computing (HPC), hybrid quantum-HPC systems, secure digital infrastructure, particularly secure and trusted 5G/6G networks and submarine and terrestrial cables, 5G Toolbox, creation of resilient and reliable 6G networks, technical interoperability between the European Digital Identity Wallet and India's Adhaar system, to facilitate cross-border trade,

[155] https://www.consilium.europa.eu/media/49522/eu-india_connectivity-factsheet_2021-05-final.pdf
[156] https://international-partnerships.ec.europa.eu/news-and-events/news/eu-and-india-agree-develop-trilateral-cooperation-2025-06-11_en?utm_source=chatgpt.com
[157] https://www.imec.international/
[158] https://www.eeas.europa.eu/eu-indo-pacific-strategy-topic_en
[159] https://www.eeas.europa.eu/eeas/joint-communication-new-strategic-eu-india-agenda_en

travel and data exchanges, Joint focus on AI, semiconductors, digital public infrastructure, and next-gen connectivity (6G) and trustworthy, secure, fair, and interoperable digital ecosystem.

- **Advancing a conducive digital environment:** Jointly create a trustworthy, secure, fair, and interoperable digital ecosystem. This includes strengthened regulatory collaboration on data governance, platform regulation, digital markets, and cybersecurity – guided by reciprocity, international standards, trusted cross-border data flows and promote a robust data protection framework and promote convergence in its implementation.

- **Sustainable Green Development:** Collaborating on clean energy, decarbonising heavy industries, sustainable mobility, sustainable aviation fuels (SAF), vehicles' energy certification methodologies and e-mobility, including knowledge exchange and harmonisation of electric vehicle charging standards, sustainable urbanisation, Carbon Credit Trading, circular economy in sectors such as textiles, electronics, e-vehicles and batteries, ship recycling and plastics.

- **Strengthening regional connectivity:** Jointly Leveraging EU's Global Gateway, EU-India Connectivity Partnership, India-Middle East-Europe Economic Corridor (IMEC) by integrating maritime, rail, digital, energy, and clean hydrogen infrastructure, promote the regional deployment of secure and sustainable digital infrastructure, including secure trusted 5G networks, submarine, and terrestrial cables and satellite connectivity.

This bold agenda by creation of Blue Valleys as dedicated platforms to accelerate private-sector engagement through investment facilitation, standard alignment, reflects a shared vision for a resilient, innovative, and sustainable future, jointly supported by the EU and India.

4.6 Seconded European Standardisation Expert (SESEI)

The Seconded European Standardization Expert in India (SESEI)[160] project was launched in March 2013 with the overarching goal of raising awareness of the European Standardization System, its values, and strategic benefits within India.

The **sixth phase of the SESEI Project VI**, commenced from August 2024 until July 2027. The project is a collaborative initiative, supported and operated by the European Committee for Standardization (CEN), the European Committee for Electrotechnical Standardization (CENELEC), and the European Telecommunications Standards Institute (ETSI), along with the European Commission's Directorate-General for International Partnership (DG INTPA) and the European Free Trade Association (EFTA).
The main objectives of the Project are:

- Enhance the **visibility of European Standardization Organizations (ESOs)** in India.
- **Strengthen cooperation** between India and Europe on **standards, technical regulations, and policy frameworks**.
- **Support European and Indian companies** in resolving standardization-related challenges that may impede **market access**.

For the **Sixth Phase of the SESEI Project**, priority areas have been carefully identified to align with the evolving strategic goals of **EU–India cooperation**, particularly under the framework of the **EU–India Trade and Technology Council (TTC)**. These focus areas aim to strengthen the **alignment of Indian standards** with **International and European standards**, especially in sectors of mutual interest and strategic importance. The key priority areas are categorized as:

- **Digitization**: Smart Cities/Urban Development, ITS, Services, High Performance Computing (HPC), Quantum Technologies, Smart Grid/Meter, Consumer Electronics, digital connectivity, Artificial Intelligence, 5G/6G, Open RAN, M2M/IoT (Cyber-Physical Systems), DECT, Data Privacy,

[160] https://sesei.eu/

Satellite Communication, Digital India, e-Health, Blockchain, Digital Services, Digital Signature, Smart Manufacturing, e-Accessibility, semiconductors, cloud systems, cybersecurity, digital skills, digital platforms including Research and Innovation etc.

- **Green & Clean technologies**: Clean Energy, Energy Efficiency (Green ICT), Environment, Circular Economy including Resource Efficiency, Waste Management, Material Efficiency, Weather Extremes & Climate Modelling, Sustainability (SDGs), Energy storage technologies, Next generation solar cell, Electric mobility; Emission, Green Hydrogen, Advanced biofuels including Research and Innovation etc.

4.7 InDiCo-Global

In June 2025, the EU and India launched a new phase of cooperation under the **Global Gateway** framework. This aims to deliver on Digitalisation for sustainable development, including **digital public goods**, **digital financial inclusion**, and **DPI projects** in third countries—extending digitization efforts beyond bilateral engagement.

InDiCo-Global[161], a Horizon Europe Coordination and Support Action, builds bridges between technical communities and policy makers globally, on topics relating to Digital policies and ICT standardisation. Powered by a strong consortium - ETSI, CEN, CENELEC, Trust-IT, Martel Innovate and COMMpla, InDiCo-Global aims to develop mutual understanding of policy, regulatory and technical approaches to ICT/digital technologies, enhance cooperation on ICT standards and alignment in policies and regulations, leading to a wider use of common standards for the benefit of European industry.

Building on the success of InDiCo, implemented by the European Telecommunications Standards Institute (ETSI), Indico Global broadens its horizons. The project focus extends beyond the European borders to a new set of targeted geographies and updated technological realms, aligning with European Union priorities. The project aims to foster awareness of the European Standardization System (ESS) and its contributions to ICT/Digital, advocating for global acceptance and interoperability.

Over its 36 months duration, InDiCo-Global will direct 40% of its €2.5 million budget to Capacity Building initiatives through a series of open calls for micro-projects focused on the targeted regions.

- **Geographical Reach:** Indico Global strategically focuses on promoting European Union (EU) standards across diverse geographies, fostering cooperation and mutual understanding. Our global outreach spans key regions, **including India**, China, South-eat Asia, African Union, Western Balkans, Eastern Partnership and Latin America and Caribbean (LAC).
- **Technological Focus:** In alignment with the Horizon Europe program, Indico Global prioritizes technologies crucial for global advancement. Project emphasis extends to key areas such as:
  - Artificial Intelligence
  - 5G and Beyond
  - Internet of Things (IoT) & Security Aspects
  - Cybersecurity
  - Data
  - eID (ELECTRONIC IDENTIFICATION)
  - Smart Cities
  - Quantum Technologies
  - Distributed Ledger Technologies (DLT)
  - Circular Economy
  - Project Investment

[161] https://indico-global.eu/

- **Duration:** Indico Global is a Coordination and Support Action Project funded by the European Commission's Horizon Europe Programme spanning a duration of 36 months, commencing in January 2024. This extended timeline allows for comprehensive engagement, impactful outcomes, and sustained contributions to global standardisation efforts.

4.8 INPACE

The **EU Project INPACE** (Indo-Pacific-European Hub for Digital Partnerships)[162] is a Horizon Europe initiative aimed at fostering **trusted digital technologies for sustainable well-being** through collaboration between the European Union and Indo-Pacific countries, including **India**. Project is also involved through the **EU-India Trade and Technology Council (TTC)** and having Indian Partners as Indian Institute of Technology Guwahati and **Centre for Development of Advanced Computing (CDAC).** Project INPACE is organized into **five thematic clusters as below and is** covering strategic areas like AI, semiconductors, and digital public infrastructure.

1. **Digital Dialogues, Policy and Education**
2. **Innovation and Entrepreneurship for Sustainable Well-being**
3. **Trustworthy Decision Support**
4. **Chips of the Future**
5. **Future Networks**

5. Conclusion

This report reviewed India's digital transformation in the context of emerging technologies and global cooperation.

Section I focused on government initiatives to build robust digital infrastructure and inclusive growth. This section also outlined key technology trends—5G, AI, IoT, Blockchain, Cloud, and Quantum—along with policies, standards, and challenges shaping their adoption. Section II highlighted Atmanirbhar Bharat and PLI schemes to boost domestic manufacturing and reduce import dependency. Section III examined EU–India cooperation in the digital sector through initiatives like the EU-India TTC WG-1, Global Gateway, IndiCo-Global, and standards cooperation through SESEI.

Together, these sections show that India's digital journey is being shaped by technology, policy, and international collaboration, creating a resilient, inclusive, and future-ready ecosystem. Sustained cooperation with global partners, especially the EU, will be crucial to ensure that emerging technologies drive innovation and growth while upholding inclusivity, sustainability, and trust.

6. Glossary

S. No.	Acronym	Expansion
1	3GPP	3rd Generation Partnership Project
2	AAL	Active Assisted Living
3	ABP	Amended BharatNet Program
4	ADN	Application Dedicated Node
5	AGR	Adjusted Gross Revenue
6	AI	Artificial Intelligence
7	AR	Augmented Reality
8	ASN	Application Service Node

[162] https://inpacehub.eu/

9	ATMPAT	Assembly Testing Marking and Packaging
10	B6GA	Bharat 6G Alliance
11	BEE	Bureau of Energy Efficiency
12	BIS	Bureau of Indian Standards
13	BTSs	Base Transceiver Stations
14	CA	Certifying Authority
15	CCA	Controller Certifying Authorities
16	CCSP	C-DOT Common Service Platform
17	C-DAC	Centre for Development of Advanced Computing
18	C-DoT	Centre For Development of Telematics
19	CED	Civil Engineering Department
20	CEM	Computational Electromagnetics
21	CERT-In	Indian Computer Emergency Response Team
22	CFD	Computational Fluid Dynamics
23	CII	Confederation of Indian Industry
24	CISO	Chief Information Security Officer
25	CMS	Content Management System
26	COAI	Cellular Operators Association of India
27	CORE	Centres for Research Excellence
28	COE	Centre of Excellence
29	CSF	Common Service Function
30	CSM	Computational Structural Mechanics
31	DEPwD	Department of Empowerment of Persons with Disabilities
32	DoS	Department of Space
33	DoT	Department of Telecommunication
34	DPDP	Digital Personal Data Protection
35	DPI	Digital Public Infrastructure
36	DSCI	Data Security Council of India
37	DST	Department of Science and Technology
38	EBTC	European Business and Technology Centre
39	ERs	Essential Requirements
40	ESI	Electronic Signatures and Infrastructures
41	ETD	Electro Technical Department
42	ETSI	European Telecommunications Standards Institute
43	EUICC	Embedded Universal Integrated Circuit Card
44	EV	Electric Vehicle
45	FICCI	Federation of Indian Chambers of Commerce & Industry
46	FRT	Facial Recognition Technology
47	GCC	Global Capability Centres
48	GDP	Gross domestic product
49	GeM	Government e Marketplace
50	GDPR	General Data Protection Regulation
51	GIGW	guidelines for Indian government websites
52	GIS	Geographical Information Systems
53	GMPCS	Global Mobile Personal Communication by Satellite
54	GRs	Generic Requirements
55	ICEA	India Cellular and Electronics Association

56	ICT	Information and Communication Technology
57	ICTAI	Indian Centres for Transformational AI
58	IEC	International Electrotechnical Commission
59	IISC	Indian Institute of Science
60	IISER	Indian Institute of Science Education and Research
61	IIT	Indian Institutes of Technology
62	IMT	International Mobile Telecommunications
63	IoT	Internet of Things
64	IPR	Intellectual Property Rights.
65	ISO	International Organization for Standardization
66	ISP	Internet Service Provider
67	ISPA	Indian Space Association
68	ISRO	Indian Space Research Organisation
69	IT	Information Technology
70	ITU	International Telecommunication Union
71	IUDX	India Urban Data Exchange
72	KYC	Know Your Customer
73	LITD	Electronics & IT department
74	LMM	Large Multimodal Model
75	M2M	Machine to Machine
76	M2MSP	Machine to Machine Service Provider
77	MAIT	Manufacturers' Association for Information Technology
78	MAQAN	Metro Area Quantum Access Network
79	MEITY	Ministry of Electronics and Information Technology
80	ML	Machine Learning
81	MN	Middle Node
82	MoC	Ministry of Communications
83	MoHUA	Ministry of Housing and Urban Affairs
84	MSMEs	Micro, Small, and Medium Enterprises
85	MTCTE	Mandatory Testing & Certification of Telecommunication Equipment
86	NASSCOM	National Association of Software and Service Companies
87	NBM	National Broadband Mission
88	NeGD	National e-Governance Division
89	NCCC	National Cyber Coordination Centre
90	NCIIPC	National Critical Information Infrastructure Protection Centre
91	NDCP	National Digital Communications Policy
92	NGSI-LD	Next Generation Service Interfaces - Linked Data
93	NIC	National Informatics Centre
94	NITI	National Institution for Transforming India
95	NM-ICPS	the National Mission on Interdisciplinary Cyber-Physical Systems
96	NQM	National Quantum Mission
97	NSG	National Study Group
98	NSM	National Supercomputing Mission
99	NTRO	National Technical Research Organisation
100	OSAT	Outsourced Semiconductor Assembly and Test

101	OTA	Over The Air
102	PLI	Production Linked Incentive
103	PoC	Proof of Concept
104	PPP	Public-Private Partnership
105	PSU	Public Sector Undertaking
106	PwDs	Persons with Disabilities
107	QCAL	Quantum Computing Applications Lab
108	QKD	Quantum Key Distribution
109	QSim	Quantum Computer Simulator Toolkit
110	QT	Quantum Technology
111	QuEST	Quantum-Enabled Science & Technology
112	R&D	Research and Development
113	RAI	Responsible Artificial Intelligence
114	RFMS	Remote Fibre Monitoring System
115	RIT	Radio Interface Technology
116	SATCOM	Satellite Communication
117	SOC	System-On-Chip
118	SPECS	Scheme for Promotion of Manufacturing of Electronic Components and Semiconductors
119	SPV	Special Purpose Vehicle
120	STQC	Standardisation Testing and Quality Certification
121	TEC	Telecommunication Engineering Centre
122	TIG	Technology Innovation Group
123	TIH	Technology Innovation Hub
124	TRAI	Telecom Regulatory Authority of India
125	TSDSI	Telecommunications Standards Development Society, India
126	TSP	Telecom Service Provider
127	TTC	Trade and Technology Council
128	TTDF	Telecom Technology Development Fund
129	UDI-ICTRA	Unified Digital Infrastructure – ICT Reference Architecture
130	UI	User Interface
131	UMANG	Unified Mobile Application for New-age Governance
132	UPI	Unified Payment Interface
133	USFF	Ultra Small Form Factor
134	UX	User Experience
135	VNO	Virtual Network Operator
136	VR	Virtual Reality
137	WCAG	Web Content Accessibility Guidelines
138	WLAN	Wireless Local Area Network
139	WPAN	Wireless Personal Area Network