Indian ICT Sector Profile Report

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November'2021

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1. Executive Summary

In line with the priority sector deliverables of the project SESEI, this report is prepared to provide a comprehensive view of the Telecom, IT and BPM sector in India covering Market Size, Key Players, Growth Drivers, various policy initiatives around Digital Infrastructure, 5G, M2M/IoT, Artificial Intelligence, Blockchain, Security & Data Privacy and active Standardization bodies.

With the fifth highest Gross Domestic Product (GDP) in the world, 1.35 billion citizens, and a rising middle class, India is a top market offering tremendous opportunities.

India's Information and Communication Technology (ICT) sector is major economic driver powering the growth and modernization of India's economy and contributes over 13% to India's GDP and India's digital economy generates about $200 billion annually from business process management (IT-BPM), e-commerce, domestic electronics manufacturing, digital payments, digital communication services (including telecom), etc. India aims to achieve a $1 trillion digital economy and a $5 trillion GDP by 2025.

ICT sector in India has demonstrated excellent growth over the last two decades. Today, India is recognized as a global leader in ICT sector on account of its low operation cost, availability of large talent pool and remote delivery model. The pervasiveness of the ICT sector impacts several different sectors in India.

The ICT industry can be broadly divided into two sectors, information technology (IT) and Telecommunications.

India is the leading sourcing destination across the world, accounting for approximately 55% market share of the US$ 200-250 billion global services sourcing business in 2019-20. The global sourcing market in India continues to grow at a higher pace compared to the IT-BPM industry. Presently, IT & BPM industry's revenue is about ~US$ 194 billion in FY21, an increase of 2.3% YoY. The domestic revenue of the IT industry is about US$ 45 billion and export revenue are about US$ 150 billion in FY21. According to Gartner estimates, IT spending in India is estimated to reach US$ 93 billion in 2021 (7.3% YoY growth) and further increase to US$ 98.5 billion in 2022[1].

Indian IT's core competencies and strengths have also attracted significant investment from major countries. The computer software and hardware sector in India attracted cumulative foreign direct investment (FDI) inflows worth US$ 71.05 billion between April 2000 and March 2021. The sector ranked 2nd in FDI inflows as per the data released by Department for Promotion of Industry and Internal Trade (DPIIT).

Leading Indian IT firms like Infosys, Wipro, TCS and Tech Mahindra are diversifying their offerings and showcasing leading ideas in blockchain and artificial intelligence to clients using innovation hubs and research and development centers to create differentiated offerings.

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[1] https://www.ibef.org/industry/information-technology-india.aspx#:~:text=The%20domestic%20revenue%20of%20the,US%24%2098.5%20billion%20in%202022

Major ICT centres in India include Bengaluru (formerly Bangalore, also known as the Silicon Valley of India), Hyderabad & Chennai in South India, New Delhi & Gurugram in North India, and Mumbai & Pune in West India.

Currently, India is the second-largest telecommunications market in the world, and it has emerged as the second largest manufacturer of mobile handsets in the world. At 1.2 billion (1.18 billion wireless and 20 million wired), India has the second largest number of telecom subscribers in the world. India has 778 million (755 million wireless and 22 million wired) broadband subscribers.

The liberal and reformist policies of the Government of India have been instrumental along with strong consumer demand in the rapid growth of Indian telecom sector. The Government has enabled easy market access to telecom equipment and a fair and proactive regulatory framework, which has ensured availability of telecom services to consumer at affordable prices. The deregulation of Foreign Direct Investment (FDI) norms has made the sector one of the fastest growing and the top five employment opportunity generator in the country.

As the world has entered the era of modern technological advancements in the Telecom Sector such as 5G, loT/M2M, AI, Blockchain etc., a need was being felt to introduce a 'customer focused' and 'application driven' policy for the Indian Telecom Sector, which in turn can form the main pillar of Digital India by addressing emerging opportunities for expanding not only the availability of telecom services but also the telecom-based services. The National Digital Communication Policy 2018 was one of the key initiatives of Telecom Department (DoT) to cater to the modern technological advancements in the Telecom Sector.

To boost domestic manufacturing and attract large investments in IT and Telecom sector, government has also approved its Performance Linked Incentive (PLI) scheme. The Department of Telecommunications (DoT) will consider the incremental investment and production for the companies which would be selected under PLI scheme for telecom equipment manufacturing.

India is also gearing up for 5G Technology rollouts, which is expected to begin in early-2022 after conclusion of the much-awaited spectrum auction. A high-level forum was constituted by DoT to evaluate and approve the roadmaps and action plans to bring 5G in the country and it comprised of members from academia, industry stakeholders and secretaries of ministries of telecom, IT, and science and technology and agreed to set aside a corpus of Rs 500 crore (€59 million) for R&D activities. Further, DoT approved a grant for a multi-institute collaborative project to set up an indigenous "5G Test Bed" in the country. On this subject of 5G, Telecom Regulatory (TRAI) also released a white paper titled as "enabling 5G in India', highlighting the specifications of the 5G technology, potential use cases and architecture of 5G networks in India.

Government of India has already taken various initiatives in respect of IoT/M2M policy such as Internet of Things Policy 2016, National Telecom M2M Roadmap, 13-digit numbering scheme for SIM based M2M devices etc. Recently, India through TEC has adopted OneM2M specifications as the national standards for IoT/M2M technologies in India. Adoption of these specifications post its transposition by TSDSI, as national IoT standards is a big milestone for India and it shall provide a framework to support applications and services in areas such as smart city, smart grid, connected car, home automation, public safety, health and many more.

Govt think tank NITI Aayog, and DoT are also working on the topic of Artificial Intelligence (AI). In June 2018, NITI Aayog unveiled its discussion paper on national strategy on AI which identified five sectors — healthcare, agriculture, education, smart cities and infrastructure and transportation — to focus its efforts on implementation of AI in India. The paper also focuses on how India can leverage these

transformative technologies to ensure social and inclusive growth. DoT's standardisation committee has also released its Indian AI Stack discussion paper, with the intention of mitigating impediments in AI deployment and essentially make AI stack as uniform for application across sectors. On this, DoT has set up various working group to address the AI stack and its implementation in the country.

In January 2021, the Ministry of Electronics, and Information Technology (MeitY) has released a draft National Strategy on Blockchain. The draft strategy identifies the potential for the adoption of blockchain in India and envisages the creation of a *'National Level Blockchain Framework'*.

The new National Cyber Security Strategy (NCSS) document is expected to be rolled out soon. The NCSS task force has held consultations and collected inputs from stakeholders to formulate the new strategy document. The new strategy document aims to ensure a safe, secure, trusted, resilient, and vibrant cyber space.

In the standardization front, three recognised standardisation bodies are active in the ICT sector. The Telecommunications Standards Development Society, India (TSDSI), which federates the industry (manufacturers, service provider and R&D units), academia and Government of India within its membership and aims at developing standardized solutions for meeting Indian requirements. TSDSI is an organisational partner in 3GPP and Partner type 1 in oneM2M Partnership Project. The Bureau of Indian Standards (BIS) is also actively involved in the ICT area through its Information Technology Division Council (LITDC) taking care of electronics, telecommunications & information technology related standardisation activity in coordination with ISO/IEC/JTC1. The 3rd is Telecommunication Engineering Centre (TEC) under Department of Telecom, Ministry of Communication which works TSDSI for 3GPP and oneM2M adoption as National Standards and with ITU-T/R along with Industry through National Working Group mirroring to WG at ITU-T.

Through this report it has been our endeavour to provide you with the holistic overview of the Indian IT and Telecom sector. The report is mainly divided into three main parts i.e.

- Market trends for both IT and Telecom sector with future projections and key market players.
- The new policy and regulatory approach by the government for augmentation of these sectors
- The key standards development bodies in India responsible for the ICT sector

2.   IT & BPM Industry in India

The Information Technology & Information Technology Enabled Services (IT-ITeS) is a field, which is undergoing rapid evolution and is changing the shape of Indian business standards. This sector includes software development, consultancies, software management, online services and business process outsourcing (BPO).

Indian IT industry has more than 17,000 organisations, of which over 1,000 are large Organisations with over 50 delivery locations in India. The country's cost competitiveness in providing IT services, which is approximately 3-4 times more cost-effective than the US, continues to be its unique selling proposition in the global sourcing market.

The IT industry's revenues at an estimated $190 billion, growing at 7.7 per cent on a year-on-year basis and by 2025, it is expected to reach $350 billion. The industry contributed around 7.7% to the country's GDP and is expected to contribute 10% to India's GDP by 2025. It has also generated 4 million jobs and provided indirect employment to 10 million.

The computer software and hardware sector in India attracted cumulative foreign direct investment (FDI) inflows worth US$ 71.05 billion between April 2000 and March 2021. The sector ranked 2nd in FDI inflows as per the data released by Department for Promotion of Industry and Internal Trade (DPIIT)[2].

2.1   Market Size

- India has emerged as the world's largest BPM destination with the IT-BPM sector having a staggering share of 45% in the total Indian services export.
- The sector is the largest employer within the private sector, employing 4.1 million people. It is, therefore, not surprising that the government has eased foreign investment policies in order to encourage more FDI in the IT sector in India.
- According to the IT industry trade body, National Association of Software and Service Companies (Nasscom), the Indian IT industry is pegged to report revenue of $194 billion in FY21 at a growth rate of 2.3% year on-year[3].
  - ✓ BPM industry registered a growth of 2.3% contributing $38bn to overall revenues.
  - ✓ IT services grew 2.7% to $99 billion,
  - ✓ Hardware segment led the overall year-on-year growth at 4.1% to $16bn,
  - ✓ Software products grew 2.7% to reach $9bn and
  - ✓ engineering R&D de-grew 0.2% to $31 bn.
- IT exports now stand at $150bn compared to $147bn last year, domestic demand also grew from $43bn last year to $45 bn this year.
- The Indian IT industry now accounts for 8% of the national gross domestic product (GDP) and has a 52% share in services exports from the country.
- IT industry has been comprising more than 18,000 firms that directly employ 4.47 million people.
- The three key areas of technology that the IT industry will focus on building offerings are in artificial intelligence, cybersecurity, and internet of things.

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[2] https://www.investindia.gov.in/sector/it-bpm

[3] https://www.livemint.com/news/india/indian-it-industry-s-revenues-to-grow-2-3-to-194-billion-this-fiscal-nasscom-11613392106701.html

- The power demand by data centres in the country between 2021-25 is expected to touch over 2,500 MW with the adoption of 5G, Internet of Things (IoT), artificial intelligence (AI), increasing use of cloud services and in smart cities.

2.2 Key players

India is Home to biggest IT companies and the list of **Top 5 IT companies in India based on** total revenue in FY21 as shown in the chart with their revenues in FY' 20 & 21 are **Tata Consultancy Services (TCS), Infosys Technologies, HCL Technologies, Wipro Technologies and Tech Mahindra**.

Top 5 IT companies based on reveanue FY21 (in Crore)

Company	FY20	FY21
Tata Consultancy Services (TCS)	164,177	156,949
Infosys Technologies	100,472	90,791
HCL Technologies	75,379	70,678
Wipro Technologies	61,943	61,023.20
Tech Mahindra	37,855.10	36,868
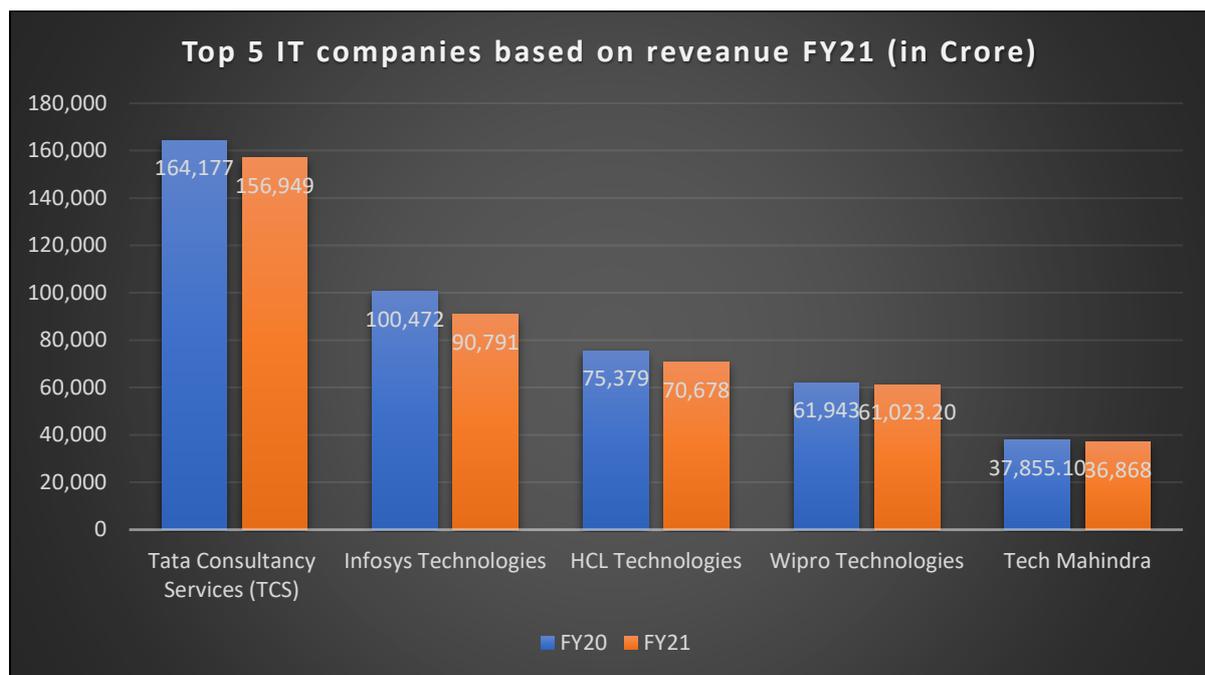
- **Tata Consultancy Services (TCS):** Tata Consultancy Services is an IT services, consulting and business solutions organization that has been partnering with many of the world's largest businesses in their transformation journeys for over 50 years. TCS offers a consulting-led, cognitive powered, integrated portfolio of business, technology and engineering services and solutions. TCS is the Largest IT company in India in terms of Revenue and it has registered revenue from operations at Rs 164,177 crore (€19.3 billion) during FY21, up 4.6% from Rs 156,949 crore (€18.4 billion) in FY20. For more information please click here

- **Infosys Technologies:** IT major Infosys reported a 16.6% YoY increase in its consolidated net profit at Rs 19,351 crore (€2.3 billion) for the financial year FY20-21. The company's revenue rose 10.7% YoY to Rs 1,00,472 crore (€11.8 billion) during the fiscal under review. Operating margin during the fiscal expanded 320 basis points to 24.5%. Infosys expects FY22 revenue to grow 12-14% in constant currency. For more information, please click here

- **HCL Technologies**: HCL Technologies is a leading global IT services company that helps global enterprises re-imagine and transform their businesses through Digital technology transformation. For FY21, HCL Tech's net profit rose 17.6% YoY to Rs 13,011 crore (€1.5 billion), while revenue grew 6.7% to Rs 75,379 crore (€8.8 billion). The company expects its revenue to grow in double digits in constant currency terms in FY22, while EBIT margin is seen between 19 per cent and 21 per cent during the year. For more information, please click here

- **Wipro Technologies:** Wipro Limited is a consulting and business process services company. The Company harness the power of cognitive computing, hyper-automation, robotics, cloud, analytics, and emerging technologies to help clients adapt to the digital world and make them successful. For FY21, the company's consolidated net profit grew by 11% to Rs 10,796.4 crore (€1.27 billion) from Rs 9,722.3 crore (€1.14 billion) in the previous fiscal. The annual revenue increased by 1.5% to Rs 61,943 crore (€7.3 billion) from Rs 61,023.2 crore (€7.2 billion) in 2019-20. For more information, please click here

- **Tech Mahindra:** Tech Mahindra represents the connected world, offering innovative and customer-centric information technology experiences, enabling Enterprises, Associates, and the Society to Rise. For FY21, the net profit was up 9.8% to Rs 4,428 crore (€521 million), while revenue from operations was higher by 2.7% to Rs 37,855.1 crore (€4.5 billion) as compared to FY20. For more information please click here

Other companies are Cognizant, Yahoo!, Google, HP, Capgemini, iGATE Patni, Accenture, L&T, EY, Convergys, MphasiS, Genpact, Godrej Infotech etc.

2.3 Major IT hubs

India is one of the largest destinations for Information Technology (IT) in the world. IT sector is one of the fastest developing sectors in India and Cities like Bengaluru, Hyderabad, Chennai, Pune, Delhi, Noida, and Gurgaon are some of the places which have developed into potential IT hubs of the country. These key locations have contributed to the growth of the Indian economy through telecommunication, software development, design, mobile commerce, e-commerce, BPO and knowledge process outsourcing (KPO).

Source: https://www.fdi.finance/sectors/it-and-bpm
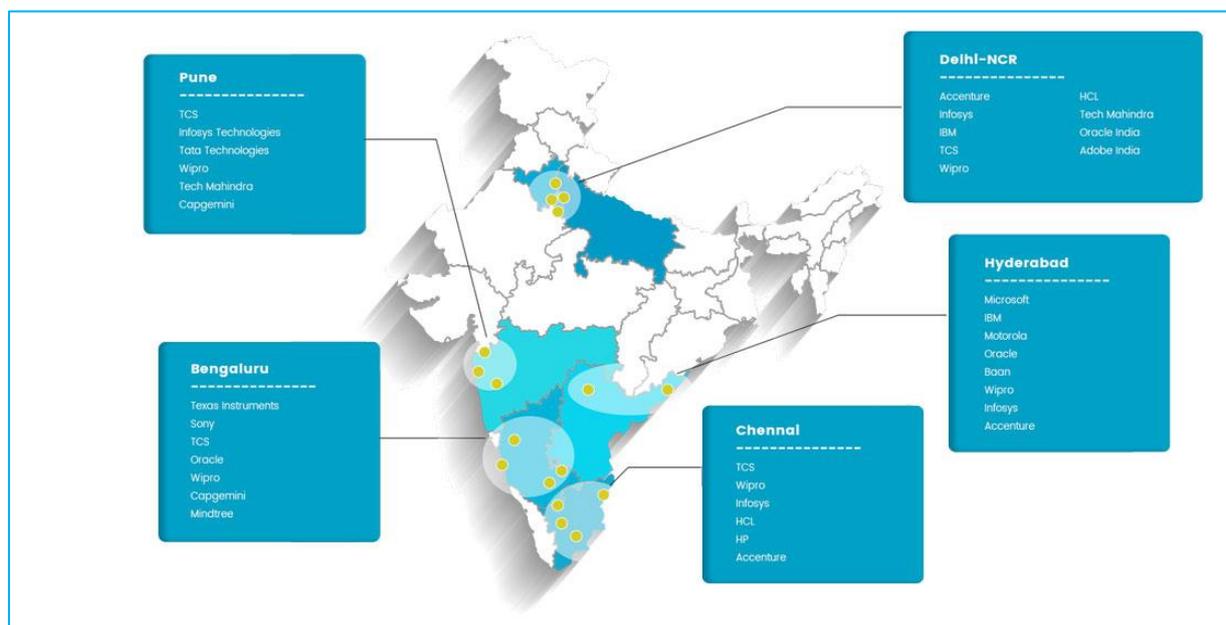
1. **Bengaluru - Silicon Valley of India:** Bengaluru, the capital of Karnataka state, is the IT capital of the Country and is a Global IT hub in India. The city is also known as the Silicon Valley of India with large number of software companies in India and many top Indian firms like Infosys, Wipro,

Mindtree are headquartered in Bangalore. Bangalore is presently a home to 30% of all IT start-ups in India and 535 of IoT start-ups out of ~970 across India.

2. **Hyderabad – Cyberabad:** Hyderabad, the capital of southern India's Telangana state, is second-highest IT hub in India. It is among the global centres of IT in the world with the evolution of IT Hub commonly called Cyberabad. Microsoft's largest R&D campus outside the US is in Hyderabad. Also, the major IT services firms of India like TCS, Wipro, HCL, Tech Mahindra, Cognizant have development centres in the city.

3. **Chennai**: Chennai, the capital of the state of Tamil Nadu, has a world-class IT infrastructure and fast emerging as a destination for IT outsourcing in India. Tamil Nadu has dedicated expressway called as IT expressways and is a favoured spot for IT industries.

4. **NCR - Delhi Noida and Gurgaon:** The National Capital Region of Delhi, Noida and Gurgaon are home to many multinational IT companies. Giant software development companies having operation in Delhi-NCR are Cognizant, Infosys, HCL Technologies, Oracle and Mphasis.

5. **Mumbai and Pune:** Mumbai, the financial capital of India, is home to the headquarters of leading IT organisations such as Tata Consultancy Services (TCS), Oracle Finance Services and Larsen & Toubro Infotech. Located on the western fringes of Mumbai, Rajiv Gandhi Infotech Park in Hinjewadi has emerged as one of the biggest IT hubs in the city. Further, the iGate knowledge park, Airoli in Navi Mumbai has developed a strong IT ecosystem - employing thousands of IT professionals from across the country. Pune, which is another city in Maharastra is also one of the major IT hubs of India and has many International IT companies like Aundh IT park, EON Free Zone, Magarpatta Hinjewadi.

Other important IT & BPM hubs in India are:

- Chandigarh city, which is one of the largest technological hubs of Northern India with abundance of skilled human resource - with 102 engineering colleges, 193 polytechnics and 369 ITI's imparting necessary education and training across industries and sector.
- Kochi (also known as Cochin), which is the commercial hub of Kerala and is one of the leading IT centers of India. Cochin SEZ (CSEZ) in Kakinada is the state's second largest IT park.
- Ahmedabad Gujarat, Kolkata, and Techno parks in Thiruvananthapuram also has world-class IT infrastructure facilities[4].

2.4 Growth drivers

- **The use of IT in emerging verticals** such as retail, healthcare, utilities etc. are driving growth in the Indian IT industry.

- **Availability of technically skilled manpower**: Availability of highly qualified manpower at lower cost helps in cutting the cost for about 60-70 % to sourcing countries. With about 75 percent of the world's digital talent concentrated in India, the country has become the world's digital capabilities hub.

- **Skill development and R&D:** Government of India (GoI) envisions a digitally equipped India and emphasizing on activities to promote programmes for skill development and uplifting

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[4] https://www.investindia.gov.in/team-india-blogs/indian-it-bpm-industry

infrastructure capabilities. R&D programmes are being supported by GoI at every possible level to maintain India's strategic advantage in IT and IT-enabled Services in the global market.

- **Emerging technologies adoption**: new-age technologies like Artificial Intelligence (AI), Robotics, Big Data and Analytics, Internet of Things (IoT), and 5G communications are opening new possibilities and new opportunities for IT industry.

- **Government policy support**: Government of India has launched various policies/initiatives to promote the ICT sector such as Performance Linked Incentives (PLI) scheme for IT & Hardware, BharatNet (Connecting India through Fibre) etc. India's Ministry of Home Affairs and the National Critical Information Infrastructure Protection Centre (NCIIPC) are also developing a new national strategy to strengthen the country's cybersecurity. In Budget 2021, the government has allocated Rs. 53,108 crore (US$ 7.31 billion) to the IT and telecom sector.

3.   Telecom Industry in India

Currently, India is the second-largest telecommunications market in the world. As per the regulator - TRAI report, the number of telephone subscribers in India has increased to 1,187.90 million at the end of February-2021 as compared to 1,180.84 million at the end of Feb 2020.

Indian telecom industry has registered strong growth in the last decade. In 2019, the India smartphone market surpassed the USA for the first time on an annual level, becoming the second-largest smartphone market globally, reaching 158 million shipments in 2019 with 7% YoY growth, according to the research from Counterpoint's Market Monitor service[5].

The liberal and reformist policies of the Government of India have been instrumental along with strong consumer demand in the rapid growth in the Indian telecom sector. The Government has enabled easy market access to telecom equipment and a fair and proactive regulatory framework, that has ensured availability of telecom services to consumer at an affordable price. The deregulation of Foreign Direct Investment (FDI) norms has made the sector one of the fastest growing and the top five employment opportunity generator in the country.

3.1   Market Size

- India is the world's second-largest telecommunications market and contributes 6.5% to India's GDP.
- As per subscriber data released by Telecom regulator, TRAI, the total number of telephone subscribers stood at 1209.53 million at the end of August 2021.
  - ✓ The total wireless subscribers increased to 1,186.72 million
  - ✓ Wireless subscription in urban areas stood at 650.39 million, while in rural areas wireless subscription increased to 536.33 million
- The overall Tele-density in India decreased from 88.51% at the end of July-21 to 88.45% at the end of August-21.
  - ✓ The Urban Tele-density decreased from 141.62% at the end of July-21 to 141.52% at the end of August-21 and
  - ✓ Rural Tele-density decreased from 60.33% to 60.27% during the same period.
  - ✓ The share of urban and rural subscribers in total number of telephone subscribers at the end of August-21 was 55.50% and 44.50% respectively.
- The total number of Internet users in the country has reached to 825.30 million at the end of March 2021.
  - ✓ Of these 825.30 million internet subscribers, the number of wired Internet users is 26 million and that of wireless subscribers is 799.31 million.
- The number of broadband subscribers increased to 813.47 million at the end of August 2021. Top five service providers constituted 98.75% market share of the total broadband subscribers at the end of August-21. These service providers were Reliance Jio (447.57 million), Bharti Airtel (205.96 million), Vodafone Idea (123.53 million), BSNL (24.28 million) and Atria Convergence (1.95 million).
- As of 31st August 2021, the private access service providers held 90.09% market share of the wireless subscribers

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[5] https://www.counterpointresearch.com/india-surpassed-usa-become-second-largest-smartphone-market-world-reaching-158-million-shipments-2019/

- ✓ BSNL and MTNL, the two PSU access service providers, had a combined market share of only 9.91%.
- ✓ Reliance Jio had the highest market share of 37.40% followed by Airtel with 29.85%, Vodafone Idea with 22.84%.
- ✓ BSNL and MTNL fared comparatively well when it came to market share in wireline subscribers. The PSU service providers held 46.91% of the wireline market share as of 31st August 2021.
- Over the next five years, rise in mobile-phone penetration and decline in data costs is expected to add 500 million new internet users in India, creating opportunities for new businesses.
- Gross revenue of the telecom sector stood at Rs. 68,228 crore (€8 billion) in the third quarter of FY21.
- According to the data released by Department for Promotion of Industry and Internal Trade (DPIIT), FDI inflow into the telecom sector during April 2000 – March 2021 totalled US$ 37.66 billion[6].
- To ease the cash flow issues being faced by some players in the industry, government has allowed 100% FDI (Foreign Direct Investment) in telecom via the automatic route[7].

3.2   Key Players

Reliance Jio, Bharti Airtel, Vodafone Idea (Vi) and state-run BSNL are the major telecom players in the country.

Wireless operators:

According to Telecom Regulatory Authority of India (TRAI), there are 1186.72 million wireless subscribers including inactive users in India as of August 2021. Wireless subscription in urban areas was 650.39 million while that in rural areas was 536.33 million.

The private access service providers held 90.09% market share of the wireless subscribers whereas BSNL and MTNL, the two PSU access service providers, had a market share of only 9.91%.

- Reliance Jio: 37.40% (443.8 million)
- Bharti Airtel: 29.85% (354.19 million)
- Vodafone Idea (Vi): 22.84% (271 million)
- Reliance Com.: 0.001% (0.011 million)
- BSNL: 9.63% (114.3 million)

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[6] ibef.org/industry/telecommunications.aspx
[7]   https://www.business-standard.com/article/economy-policy/cabinet-allows-100-fdi-in-telecom-sector-via-automatic-route-vaishnaw-121091500845_1.html

- MTNL:0.28% (3.32 million)

Access Service Provider-wise Market Shares in term of Wireless Subscribers as on 31st August, 2021

Vodafone Idea, 22.84%

BSNL, 9.63% Reliance Com., 0.001%

MTNL, 0.28%

Bharti Airtel, 29.85%

Reliance Jio, 37.40%

Pvt : 90.09%   PSU: 9.91%
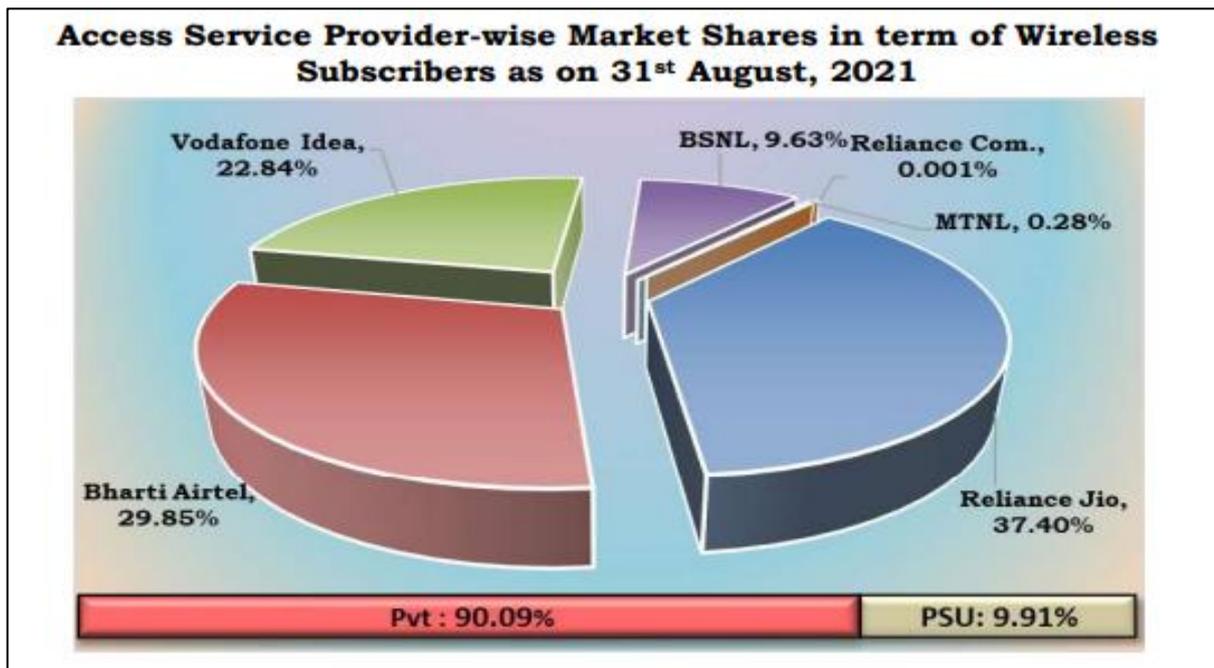
Out of the total wireless subscribers (1,186.72 million), 991.71 million wireless subscribers were active on the date of peak VLR in the month of August-21. The proportion of active wireless subscribers was approximately 83.57% of the total wireless subscriber base.

Active users:

- Bharti Airtel: 346.84 million (97.92%)
- Vodafone Idea (Vi): 236.49 million (87.26%)
- Reliance Jio: 350.63 million (79%)
- Reliance Com.: 0.005 million (45.45%)
- BSNL: 57.15 million (50%)
- MTNL: 0.61 million (18.37%)

Bharti Airtel has the maximum proportion (97.92%) of its active wireless subscribers (VLR) as against its total wireless subscribers (HLR) on the date of peak VLR in the month of August-21 and MTNL has the minimum proportion of VLR (18.55%) of its HLR during the same period.

Wireline operators:

As per TRAI, there are 22.86 million wireline subscribers including inactive users in India as of August 2021. The share of urban and rural subscribers in total wireline subscribers were 91.46% (20.91 million) and 8.53% (1.95 million), respectively.

BSNL and MTNL, the two PSU access service providers, held 46.91% of the wireline market share as on 31st August 2021, whereas the private access service providers held 53.09% market share of the wireline subscribers.

- BSNL: 7.89 million (34.55%)
- Airtel: 5.17 million (22.63%)
- MTNL: 2.82 million (12.36%)

- Reliance Jio: 4.4 million (19.28%)
- Tata Teleservices: 1.59 million (6.99%)
- Vi: 0.56 million (2.46%)
- Quadrant: 0.20 million (0.88%)
- Reliance Communications: 0.19 million (0.84%)

Access Service Provider-wise Market Share of Wireline Subscribers as on 31st August 2021
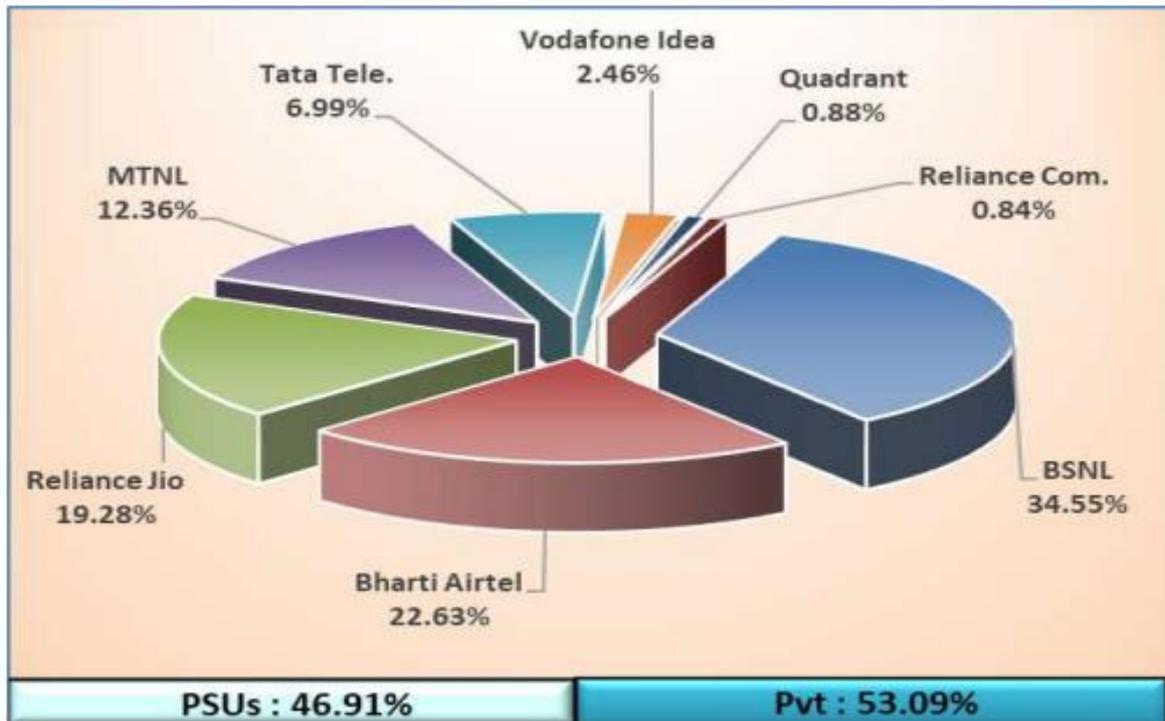
Broadband:

As of August 2021, the number of broadband subscribers stood at 813.47 million (including 789.18 million wireless and 24.29 million wireline subscribers). Top five service providers constituted 98.75% market share of the total broadband subscribers. These service providers were Reliance Jio Infocomm Ltd (447.57 million), Bharti Airtel (205.96 million), Vodafone Idea (123.53 million), BSNL (24.28 million) and Atria Convergence (1.95 million).

The top five Wired Broadband Service providers were BSNL (5.49 million), Reliance Jio Infocomm Ltd (3.71 million), Bharti Airtel (3.69 million), Atria Convergence Technologies (1.95 million) and Hathway Cable & Datacom (1.08 million). The top five Wireless Broadband Service providers were Reliance Jio Infocom Ltd (443.86 million), Bharti Airtel (202.27 million), Vodafone Idea (123.52 million), BSNL (18.19 million) and Tikona Infinet Ltd. (0.30 million).

Service Provider-wise Market Share of Broadband (wired + wireless) Services as of August 2021
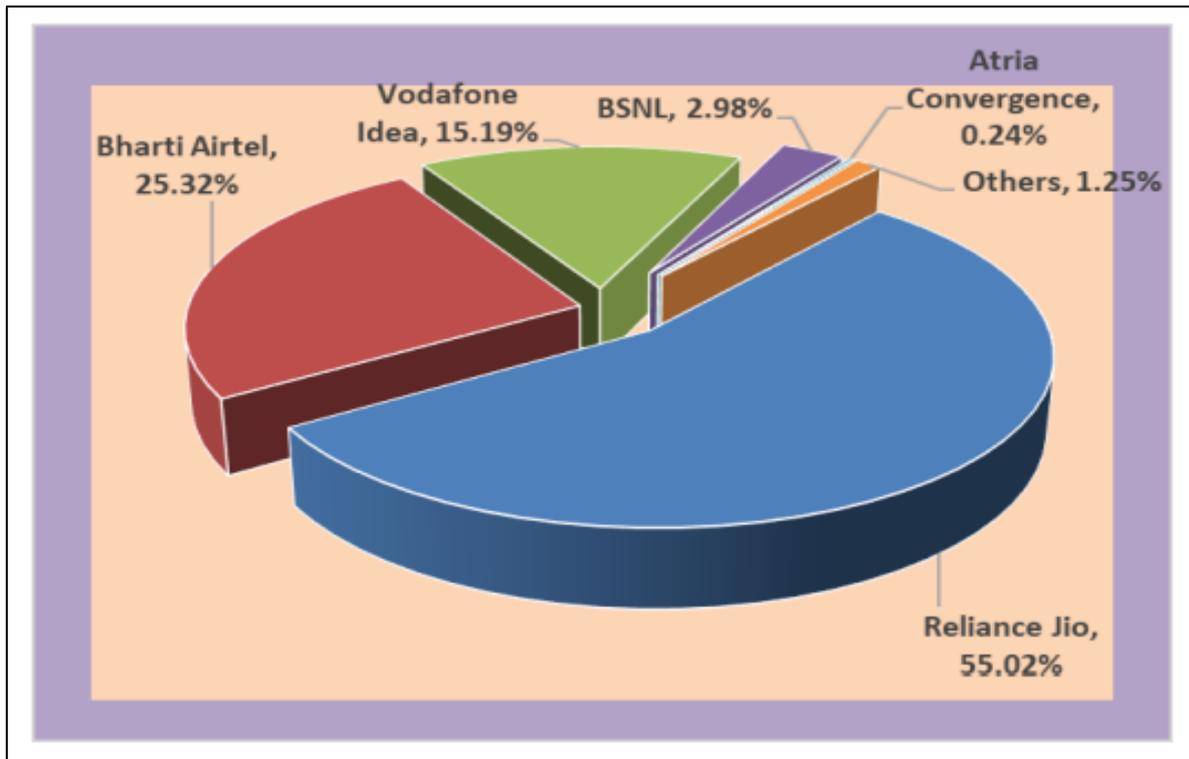
3.3   Growth drivers

- **Performance Linked Incentive (PLI) Schemes under Atmanirbhar Bharat Abhiyan (Self – Reliant India):** Production Linked Incentive schemes worth INR 12,195 crore (€1.43 billion) for manufacturing of telecom and networking products.

- **Growing demand**: Nominal per capita income recorded a CAGR of 10.4% during 2012-17

- **Increasing internet revenues**: Mobile value-added service industry is expected to grow at a CAGR of 18.5% during the period 2015-2020 and reach US $23.0 Billion by 2022

- **Increased equipment manufacturing**: 268 mobile and mobile components manufacturing units set up across the country.

- **Make in India**: The government announced Phased Manufacturing Program (PMP) to promote domestic production of mobile handsets.

- **Bharatnet project**: Optical fiber cables laid over 100,000-gram panchayats.

4   Policy Initiatives

4.1   Digital Infrastructure

4.1.1   Digital India

Digital India is a campaign launched by the Government of India on 1st 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 Ministry of Electronics and IT is the nodal agency to implement the program and it is working closely with Ministry of Communication.

The initiative includes plans to connect rural areas with high-speed internet networks. Digital India consists of three core components. They are:

1. Development of secure and stable Digital Infrastructure
2. Delivering government services digitally
3. Universal Digital Literacy

With the above vision, the Digital India program aims to provide:

- Broadband Highways
- Universal Access to Phones
- Public Internet Access Programme
- e-Governance - Reforming government through Technology
- e-Kranti - Electronic delivery of services
- Information for All
- Electronics Manufacturing
- IT for Jobs
- Early Harvest Programmes

For more information, please click here

4.1.2   National Digital Communications Policy, 2018: DoT

The National Digital Communications Policy, 2018 seeks to unlock the transformative power of digital communications networks - to achieve the goal of digital empowerment and improved 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 Communications Policy aims to accomplish the following Strategic Objectives by 2022:
- Provisioning of Broadband for All
- Creating 4 million additional jobs in the Digital Communications sector
- 8% of India's GDP from ~ 6% in 2017
- Propelling India to the Top 50 Nations in the ICT Development Index of ITU from 134 in 2017
- Enhancing India's contribution to Global Value Chains
- Ensuring Digital Sovereignty

Vision:

To fulfil the information and communication needs of citizens and enterprises through the establishment of a ubiquitous, resilient, secure, accessible, and affordable Digital Communications Infrastructure and Services, and in the process, support India's transition to a digitally empowered economy and society.

Missions:

In pursuit of accomplishing targeted objectives by year 2022, the National Digital Communications Policy, 2018 envisages three Missions:

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.

Read more/Download>>

4.1.3 Data Centre Policy 2020

Ministry of Electronics and Information Technology (MEITY) has drafted a Data Centre policy to benefit the Data Centre Park developers/Data Centre operators as well as the allied ecosystem of Data Centre sector.

Vision:

Making India a Global Data Centre hub, promote investment in the sector, propel digital economy growth, enable provisioning of trusted hosting infrastructure to fulfil the growing demand of the country and facilitate state of the art service delivery to citizens.

Mission:

• Ensure sustainable and trusted Data Centre capacity in the country to meet the enormous demand generated in one of the fastest growing economies.
• strengthen India's position as one of the most favourable countries for data centres by incentivizing and facilitating establishment of state-of-the-art Data Centres.
• Encourage domestic and foreign investments in the sector.
• Promote R&D for manufacturing and development of Data Centre related products and services for domestic and global markets.

- Promote domestic manufacturing, including non-IT as well as IT components, to increase domestic value addition and reduce dependence on imported equipment for Data Centres.

Objectives:

- 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.
- Facilitate access to uninterrupted and cost-effective power, which forms one of the most critical aspects for operating the Data Centre.
- Measures to bring in necessary improvement in network backhaul, domestic as well as international.
- Meet the data security needs by promoting investments in trusted (safe and secure) Data Centres in India.
- Facilitate standardization in the development of Data Centres.
- Promote capacity building in the sector through association with various skilling /human resource development programs.

This policy framework shall be followed by a detailed scheme with implementation guideline document providing the particulars of various fiscal and non-fiscal incentives to be provided to the sector by the Central and State Government.

Read more/Download>>

4.1.4 Production Linked Incentive (PLI) Scheme for Telecom & IT Sector

Production Linked Incentive (PLI) Scheme for Telecom Sector

The Union Cabinet has approved the Production-Linked Incentive (PLI) scheme for the telecom sector with an outlay of Rs. 12,195 crores (€1.43 billion) over five years. This Scheme is for domestic manufacturing of telecom and networking products such as switches, routers, 4G/5G radio access network, wireless equipment, and other internet of things (IoT) access devices.

The scheme has come into force on April 1, 2021. The eligibility for the scheme is subjected to achieving a minimum threshold of cumulative investment and incremental sales of manufactured goods.

It stipulates a minimum threshold of Rs 10 crores (€1.17 million) for MSMEs with incentives ranging between 7% to 4% of incremental sales (with FY 2019-20 considered as the base year). For others, the threshold is INR 100 crores (€11.7 million) with incentives between 6% to 4%.

The government expects that this scheme will result in an incremental production of Rs 2 lakh crore (€23.5 billion) over the next five years and give India a sizeable foothold in the Rs 100 billion (€1.17 billion) telecom and networking products exports market.

The Department of Telecommunications (DoT) will consider the incremental investment and production starting April 1 for the companies which would be selected under the Production Linked Incentive (PLI) for telecom equipment manufacturing. Notably, global equipment makers such as

Cisco, Nokia, Ericsson, Jabil as well as contract manufacturers Flex, Dixon Technologies, and Foxconn have expressed their interest in applying for the scheme.

Read more>>

Production Linked Incentive (PLI) Scheme for IT hardware

The Union Cabinet has approved the Production Linked Incentive (PLI) Scheme for IT Hardware with an outlay of approximately Rs.7,350 crore (€864.7 million) over 4 years, which includes an incentive outlay of Rs.7,325 crore (€861.7 million) and administrative charges of Rs.25 crore (€3 million). The scheme proposes production linked incentive to boost domestic manufacturing and attract large investments in the value chain of IT Hardware. The Target Segments under the proposed Scheme include Laptops, Tablets, All-in-One PCs, and Servers.

The Scheme shall, extend an incentive of 4% to 2% / 1% on net incremental sales (over base year i.e., 2019-20) of goods manufactured in India and covered under the target segment, to eligible companies, for a period of four (4) years.

The scheme is likely to benefit 5 major global players and 10 domestic champions in the field of IT Hardware manufacturing including Laptops, Tablets, All-in-One PCs, and Servers. This is an important segment to promote manufacturing under AtmaNirbhar Bharat as there is huge import reliance for these items at present.

The scheme will enhance the development of electronics ecosystem in the country. India will be well positioned as a global hub for Electronics System Design and Manufacturing (ESDM) on account of integration with global value chains, thereby becoming a destination for IT Hardware exports. The scheme has an employment generation potential of over 1,80,000 (direct and indirect) over 4 years. The Scheme will provide impetus to Domestic Value Addition for IT Hardware which is expected to rise to 20% - 25% by 2025.

A total of 19 companies have filed their application under the PLI scheme for IT Hardware. Incentives are applicable under the scheme from 01.04.2021.

The electronics hardware manufacturing companies that have applied under category IT Hardware Companies are Dell, ICT (Wistron), Flextronics, Rising Stars Hi-Tech (Foxconn) and Lava.

14 companies have filed applications under the category Domestic Companies which include Dixon, Infopower (JV of Sahasra and MiTAC), Bhagwati (Micromax), Syrma, Orbic, Neolync, Optiemus, Netweb, VVDN, Smile Electronics, Panache Digilife, HLBS, RDP Workstations and Coconics. These companies are expected to expand their manufacturing operations in a significant manner and grow into national champion companies in IT Hardware production.

For more information about PLI scheme on IT hardware, please click here and for guidelines for the Operation of PLI scheme for IT Hardware, please click here

4.1.5 BharatNet Project

Government of India renamed *National Optical Fibre Network (NOFN) as BharatNet Project in 2015.* BharatNet Project is the world's largest rural broadband connectivity programme using optical fibre. It is a flagship mission implemented by Bharat Broadband Network Limited (BBNL) – a special purpose

vehicle under the Telecom Ministry and is the Government of India's ambitious rural internet connectivity programme.

Objectives:

- To facilitate the delivery of E-governance, E-health, E-education, E-banking, Internet, and other services to rural India.
- To connect all the 2,50,000-gram panchayats in the country and provide 100 Mbps connectivity to all gram panchayats.
- To achieve this, the existing unused fibres (dark fibre) of public sector undertakings (PSUs) (BSNL, Railtel and Power Grid) were utilised and incremental fibre was laid to connect to Gram Panchayats wherever necessary.

For more information please click here>>

4.2 IT-BPM Policy Initiatives

Information Technology (IT) has been considered as one of 12 prominent and promising service sectors and the Government has set up a Rupees 5, 000 Crore (~581M Euro) fund for executing and bringing up the potential of these champion service sectors.

IT & BPM has played a key role in the overall development of the country. The government of India has been constantly supporting the IT & BPM industry through many of its policies, schemes, and awards. Some of the worthiest ones to make a mention are[8] in following sub-sections:

4.2.1 National Policy on Software Products

National Policy on Software Product was approved by the Union Cabinet on February 28, 2019. This policy aims to support many of the Government initiatives including Make in India, Skill India, Digital India etc. Through this policy, a sustainable Indian Software product industry can be created including 10,000 technology start-ups. An upskilling of 1,000,000 IT professionals and the development of 20 software product development clusters is also proposed.
For more information please click here>>

4.2.2 Indian Software Product Registry (ISPR)

Indian Software Product Registry (ISPR) was created and launched by MeitY and it provides a complete database of Software Products Companies and the products developed in India along with details of domains, sectors, regions currently serviced and its features etc. Apart from this, it also gives information regarding annual turnover, export and domestic revenue, location, type of the company, etc
For more information please click here>>

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[8] Vijayakumar, Suchetha, & Nethravathi, P. S., (2021). The Growth of IT & BPM Industry Services and its Journey towards 'Make in India' – A Case Study. International Journal of Case Studies in Business, IT, and Education http://doi.org/10.5281/zenodo.5081648

4.2.3   Software Technology Parks Scheme (STPI)

Software Technology Parks Scheme (STPI) was set up in 1991 as an autonomous body under the Ministry of Electronics and Information Technology. Through this scheme, 60 STPI (Software Technology Parks of India) operational centres are set up among which 51 of them are in Tier II and Tier III cities. Through this scheme software companies can set up their operations and business in convenient locations with minimal investments. Other benefits include exemptions from Custom duty, Excise duty, Central Sales Tax, Corporate tax on 90% export turnover as per Section 10A of Income Tax Act. It has also permitted Sales in the Domestic Tariff Area (DTA) and many more.
For more information please click here>>

4.2.4   Domain-Specific Centres of Entrepreneurship (CoE)

To build leadership and to build next wave of budding entrepreneurs in the emerging sectors of technology like Internet of things (IoT), Block Chain, FinTech, Artificial Intelligence (AI), Augmented & Virtual Reality (AR/VR), ESDM, Data Science & Analytics, Medical Electronics & Healthcare, Gaming & Animation, Machine Learning, Cyber Security etc., Government of India had announced setting up of CoEs by STPI in specific domains spread across India. STPI CoEs enable a 360 degree support ecosystem in the form of Infrastructure (Hardware & Software labs), Knowledge & handholding, Funding & Investment opportunities, Mentoring & Networking to nurture innovative start-ups in emerging technologies and make India a "Product Nation".
For more information please click here>>

4.2.5   Simplified Other Service Provider' (OSP) guidelines

Simplified Other Service Provider' (OSP) guidelines was put forth in 2020 to enhance the way of doing business in all IT related fields.
For more information please click here>>

4.3   5Th Generation (5G)

4.3.1   5G India – DoT Initiative for deployment of 5G Technologies

The 5G technology has been conceived as a foundation for expanding the potential of the Networked Society. A digital transformation brought about through the power of connectivity is taking place in almost every industry. The landscape is expanding to include massive scale of "smart things" to be interconnected. Therefore, the way future networks will cope with massively varied demands and a business landscape will be significantly different from today. The economic benefits from the 5G technology are also quite immense. As per the OECD (Organization for Economic Cooperation and Development) Committee on Digital Economic Policy, it has been stated that 5G technologies rollout will help in Increasing GDP, Creating Employment, Digitizing the economy.

For India, 5G provides an opportunity for industry to reach out to global markets, and consumers to gain with the economies of scale. Digital Transformation through 5G will fundamentally impact other national Mission Mode projects. 5G will also provide a new dimension to the Digital India, Smart Cities & Smart Village missions. 5G has potentially large contributions to Make in India and Start-Up India

missions as well. The objective is to position India as a globally synchronized participant in the Design, Development and Manufacturing of 5G based technology, products, and applications.

To steer 5G in India, a High-Level Forum was constituted, with an aim to evaluate, approve roadmaps & action plans for 5G in India. Forum produced a report "Making India 5G ready"

Based on the Report, the Government is creating an enabling framework for development of 5G services in India. 5G services are expected to be introduced gradually and advance to a full range of services as ecosystem and demand for services grows. 5G can unleash new economic opportunities and societal benefits giving it the potential for being a transformational force for Indian society. It can help the country leapfrog the traditional barriers to development as well as advance the Digital India Mission.

The Department of Telecom (DOT) have also recently approved applications from Telecom Service Providers (TSPs) to conduct trials for the use and application of 5G technology. While field trials begin here in India, 5G as a technology has been commercially available for a few years in over 50 countries such as France, South Korea, the US, etc. and there are valuable lessons that India can take from launches, successes, and failures in these markets. Indian operators could learn from their counterparts' experience and avoid or rather not repeat the same mistake which their counterparts might have made.

4.3.2   TRAI Recommendation on 5G Spectrum Pricing

In August 2018, Telecom Regulatory Authority of India (TRAI) has announced its recommendations on auction of Spectrum in 700 MHz, 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2300 MHz, 2500 MHz, 3300-3400 MHz, 3400-3600 MHz Bands. TRAI has recommended that the reserve price for 800 MHz, 900 MHz, 1800 MHz, and 2100 MHz bands should be higher of the two figures: 80% of the average valuation of spectrum band in the licensed service area (LSA) or the price realised in the October 2016 auction. The government is yet to finalize the timing of the next round of auction. Airwaves in the 3,300-3,600 MHz 5G band will be auctioned in the block size of 20 MHz

Read more/Download

4.3.3   TRAI white Paper on Enabling 5G in India

To create an enabling environment for the timely rollout of 5G in India, telecom regulatory (TRAI) has released a white paper on "Enabling 5G in India'. TRAI's white paper highlights the specifications of the 5G technology, discusses the potential use cases and architecture of 5G networks.

The white paper considers those areas that will require investment for 5G deployment, and it also covers the spectrum requirements for 5G networks. The purpose of the white paper is to identify the probable challenges, including regulatory ones, in the deployment of 5G Networks in India and to initiate a discussion with all stakeholders for finding implementable solutions.

Read more/Download

4.3.4   Building an End-to-End 5G Test Bed

The Government has launched a program titled 'Building an End-to-End 5G Test Bed' to advance innovation and research in 5G. This three- year program began in March 2018, with a budget

authorization of Rs 224.01 crore (€26.4 million). The program has been awarded to [IIT Madras](), [IIT Hyderabad](), [IIT Delhi](), [IIT Kanpur](), [CEWIT](), SAMEER and [Indian Institute of Science (IISc), Bangalore](). The program envisages close collaboration between the universities and small technology companies. The goal of the program is to build proof-of-concept 5G prototypes that are broadly compliant with the 3GPP standards.

As per the ministry, the test bed is planned to be realized in stages over four versions — version 0 (V0) to version 3 (V3). The initial two stages have been completed. The design of next version (V2) has started. Significant progress has been made by the Institutes in system hardware and algorithm design. It is anticipated that the third version (version 2) and final version (version 3) by October 2021.

With the launch of 5G test beds, India will be in the category of the US, the UK, European Union, Sweden, Finland, Thailand, China, Japan, and South Korea which are among some of the countries that have announced the launch of 5G.

Ericsson has also installed the first public access 5G test bed at IIT Delhi in July 2018 for developing applications in the broadband and low latency areas and has provided access to the industry and institutions to work on India specific usage scenarios and applications.

4.3.5   3GPP Specification as National Standard

TSDSI, which is an Organizational Partner (OP) of 3GPP along with six other Regional Standardisation bodies have [transposed 3GPP releases associated with 5G Standards]() in India, and in turn asked TEC to make them as National Standards. TEC, which is the technical wing of Department of Telecommunications (DoT) under Ministry of Communication and is responsible for developing/adopting standards in telecommunications sector in India, and to ensure development of world class telecom infrastructure and smooth interconnection of individual network. TEC has approved for adoption as national standards, TSDSI transposed 3GPP standards ([402 nos., same as recommended in ITU R M.2012-4]()). These radio interface standards detail the features and parameters of IMT Advanced like compatibility, international roaming, and access to high-speed data services. TEC also refers various 3GPP standards and specifications in its various specifications like Generic Requirements (GR), Interface Requirements (IR), System Requirements (SR) and Essential requirements (ER) for telecom equipment, networks, systems, and services.

4.3.6   TSDSI's 5G Radio Interface Technology "5Gi"

TSDSI's 5G Radio Interface Technology named as "5Gi" has claimed to be cleared the rigorous processes of International Telecommunication Union (ITU) and approved by the SG5 of ITU as a part of Draft Recommendation M. [IMT-2020.SPECS] in its meeting held on 23rd November 2020.

However, Top trade and technology bodies from the US and UK have told the Indian government that adoption of globally harmonized standard - the 3GPP 5G standard, will give a much-needed push to electronic manufacturing in India as companies will be encouraged to set up their operations in India. They also urged the government to allow Indian telcos to independently choose to deploy technologies conforming to the 5G standard of their choice. Indian telcos, multinational vendors chipset and smartphone makers have already made their submission to the government, urging it to avoid making the Indian 5G standard, 5Gi, mandatory as the technology is not proven and may impact rollout of the next gen technology and disrupt the entire ecosystem by delaying the roll out and jack up prices.

4.4 Artificial Intelligence (AI)

4.4.1 AI initiatives by Ministry of Commerce and Industry[9]

The Union Ministry of Commerce and Industry set up an Artificial Intelligence Task Force in August 2017 with a view to 'embed AI in our Economic, Political and Legal thought processes so that there is systemic capability to support the goal of India becoming one of the leaders of AI-rich economies'.

Mission:
- Leverage AI for Economic Benefits
- Creation of policy and legal framework to accelerate deployment of AI technologies
- Concrete 5-year horizon recommendations for specific Government, Industry and Research programs

Vision: Embed AI in our Economic, Political and Legal thought processes so that there is systemic capability to support the goal of India becoming one of the leaders of AI-rich economies

Domains of Focus:
- Manufacturing
- Fintech
- Healthcare
- Agriculture/Food Processing
- Education
- Retail/Customer Engagement
- Human and Robot interaction/intelligent automation
- Aid for Differently Abled/Accessibility Technology
- AADHAAR/Big Data
- Environment
- National Security
- Enablers for AI Technology development
- Enablers for AI entrepreneurship
- Enablers for AI product commercialization
- General/other issues related to AI
- Public Utility Services

The Task Force gave its report on 19th January 2018, in which 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. Click here to view the Report of the Task Force>>

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[9]https://tec.gov.in/public/pdf/Studypaper/AI%20Policies%20in%20India%20A%20status%20Paper%20final.pdf

4.4.2 Discussion paper on National Strategy on AI by NITI Aayog

In June 2018, the government think-tank, National Institution for Transforming India (NITI) Aayog released a discussion paper on National Strategy for Artificial Intelligence (AI). Artificial Intelligence presents opportunities to complement and supplement human intelligence and enrich the way people live and work. India, being the fastest growing economy with the second largest population in the world, has a significant stake in the AI revolution. Recognising AI's potential to transform economies and the need for India to strategize its approach, NITI Aayog was mandated to establish the National Program on AI.

In pursuance of the above, NITI Aayog adopted a three-pronged approach – undertaking exploratory proof-of-concept AI projects in various areas, crafting a national strategy for building a vibrant AI ecosystem in India and collaborating with various experts and stakeholders.

NITI Aayog unveiled its discussion paper on national strategy on 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.
The paper also discusses five barriers to be addressed: lack of research expertise, absence of enabling data ecosystems, high resource cost and low awareness for adoption, lack of regulations around privacy and security, and absence of a collaborative approach to adoption and applications. The paper includes several recommendations but is purposefully positioned as an "essential pre-read" intended merely to begin the conversation for what will be an evolving National Strategy for Artificial Intelligence.

Government of India plans to start National programme on AI to harness the benefits of emerging technologies in identified areas. NITI Aayog had reportedly requested for ₹7,500 crore (~8.8B Euro) in funding for creating a new cloud platform and sponsoring new research institutes. Government of India has cleared the spending of INR 7,000 crore (~8.1B Euro) till 2024-25 for NITI Aayog's artificial intelligence (AI) programme.

Download Niti Aayog Discussion Paper on Artificial Intelligence>>

4.4.3 AI initiatives by Ministry of Electronics & IT (Meity)

To create a policy framework and to develop the ecosystem for Artificial Intelligence, Meity constituted four committees covering all the aspects of AI and these committees have finalised following reports:

- ✓ Report of committee – A: Platforms and data on AI Read more/Download
- ✓ Report of committee – B: Leveraging AI for identifying national missions in key sectors Read more/Download
- ✓ Report of committee – C: Mapping technological capabilities, key policy enablers required across sectors, skilling, reskill Read more/Download
- ✓ Report of committee – D: Cyber security, safety, legal and ethical issues Read more/Download

4.4.4 AI initiatives by Department of Telecom, Ministry of Communication

The Department of Telecommunications (DoT) under Ministry of Communications have 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.

- ✓ **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.

The Committee has come up with a discussion paper on Indian AI Stack, with the intention of mitigating impediments in AI deployment and essentially make AI uniform for application across sectors. AI Stack paper highlights 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.

Download AI stack discussion paper here>>

4.4.5 National AI Portal

The Indian Government launched National Artificial Intelligence Portal called www.ai.gov.in on 30 May 2020. The portal will work as a one-stop digital platform for AI related developments in India, sharing of resources such as articles, start-ups, investment funds in AI, resources, companies, and educational institutions related to AI in India. The portal will also share documents, case studies, research reports etc. It also has a section about learning and new job roles related to AI[10].

4.4.6 Centre of Excellence for AI

National Informatics Center (NIC) has established the Centre of Excellence in Artificial Intelligence with a focus on exploring AI applications in governance. It provides ready-to-use AI infrastructure for proof of concepts and pilots on the application of AI in service delivery by Government Departments. It facilitates state-of-art technology support with supercomputing facilities for prototyping in the fields of Image & Video Analytics, Speech Synthesis & Recognition, and Natural Language Processing. List of Centre for AI at Academia/Institute and Centres:

- ✓ Centre for Artificial Intelligence IIT Kharagpur
- ✓ Centre for Artificial Intelligence & Robotics (CAIR), DRDO
- ✓ Robert Bosch Centre for Data Science and Artificial Intelligence, IITM

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[10] https://pib.gov.in/PressReleasePage.aspx?PRID=1627950

- ✓ The Artificial Intelligence Group (AI@IISc)
- ✓ Department of AI @ IITH
- ✓ Academia-industry Collaboration on Artificial Intelligence
- ✓ Laboratory of Statistical AI and Machine Learning (LSAIML), IITR

NIC has also build a platform that helps AI users to start work on Data Annotation using open-source tools for creating the training dataset and then facilitate users for training the model using a supercomputing development platform and open-source AI development frameworks. AI work can be categorized under 4 major groups:

- ✓ AI – Manthan: Development Platform to Build, Train and Test AI based Deep Learning Models
- ✓ AI – Tainaatee: Inference Testbed for production ready AI Manthan trained Models
- ✓ AI – Satyapikaanan: API based Face Verification & Liveness Detection Services
- ✓ AI – VANI: Chatbot, Voicebot & Matra Transliteration Services

For more information please click here

4.5 Internet of Things (IoT)/ Machine to Machine (M2M)

4.5.1 National telecom M2M Roadmap

Department of Telecommunications (DoT), Ministry of Communications published its National M2M roadmap in May 2015. The roadmap covers global scenario on M2M Standards, Regulation and policies and initiatives such as "Make in India" supported through M2M Adoption and Approach & Way Forward including set of recommendation as below:

- ✓ To facilitate M2M communication standards including encryption, quality, security, and privacy standards from Indian Perspective and to recognize such standards for India.
- ✓ To release national M2M Numbering Plan.
- ✓ Address M2M Quality of Service aspects.
- ✓ To address M2M specific Roaming requirements.
- ✓ To formulate M2M Service Provider (MSP) registration process.
- ✓ To issue guidelines for M2M specific KYC, SIM Transfer, International roaming etc.
- ✓ Formation of APEX body involving all concerned stake holders.
- ✓ To address M2M specific spectrum requirements.
- ✓ To define frequency bands for PLC communication for various Industry verticals
- ✓ Finalization of M2M Product Certification process and responsibility centres.
- ✓ Facilitating M2M Pilot projects.
- ✓ Measures for M2M Capacity building.
- ✓ To establish Centre of Innovation for M2M.
- ✓ To assist M2M entrepreneurs to develop and commercialize Indian products by making available requisite funding (pre-venture and venture capital), management and mentoring support etc.
- ✓ Inclusion of M2M devices in Preferential Market Access (PMA) Policy.
- ✓ To take up matters with relevant ministries to boost M2M products and services.
- ✓ Define procedures for energy rating of M2M devices and implementation of same.
- ✓ To evolve suitable guidelines of EMF radiation of M2M devices based on research and studies by relevant bodies.

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4.5.2   Centres of Excellence (CoE) for Internet of Things (IoT)

The Centre of Excellence for IoT was announced by the Prime Minister of India in July 2015 as a part of Digital India Initiative to jump start the IoT ecosystem taking advantage of India's IT strengths and help the country attain a leadership role in the convergent area of hardware and software. The main objective of the is to create innovative applications and domain capability by harnessing the innovative nature of startup community and leveraging the experience of corporate players.

Under the Digital India initiative, Ministry of Electronics and Information Technology (MeitY) along with NASSCOM and State Governments set up CoE on Internet of Things at Bengaluru, Gurugram and Gandhi Nagar and Visakhapatnam. CoE-IoT in Bengaluru was established in year 2016, in Gurugram Year 2018 and in Gandhi Nagar in year 2019.

CoE on IoT, connects various entities such as startups, enterprises, venture capitalists, government, and academia. It enables start-ups in areas of IoT, Big Data, AR/VR, AI, and Robotics to reach their maximum potential. One of the objectives of these centers is to enable India to emerge as innovation hub in IoT through democratization of innovation and realization of prototypes. The focus areas of these centers are on Healthcare, Industry 4.0, Agriculture, Automobiles etc. For more information please click here

4.5.3   Internet of Things (IoT) Policy 2016

Ministry of Electronics and Information Technology (MeitY) drafted India's first 'Internet of Things Policy' in October 2016 with a.

Vision: To develop connected and smart IoT based system for our country's Economy, Society, Environment, and global needs.

Objectives:

- ✓ To create an IoT industry in India of USD 15 billion by 2020. It has been assumed that India would have a share of 5-6% of global IoT industry.
- ✓ To undertake capacity development (Human & Technology) for IoT specific skill sets for domestic and international markets.
- ✓ To undertake Research & development for all the assisting technologies.
- ✓ To develop IoT products specific to Indian needs in all possible domains.

The Policy framework of the IoT Policy has been proposed to be implemented via a multi-pillar approach. The approach comprises of five vertical pillars (Demonstration Centres, Capacity Building & Incubation, R&D and Innovation, Incentives and Engagements, Human Resource Development) and 2 horizontal supports (Standards & Governance structure).

India's Internet of Things Policy released at a time when country is moving towards digitalization and a policy like this will support the initiatives taken by the Government of India such as Smart Cities project and Digital India Program and it shall lead to a rapid growth of IoT industry.

Read more/Download

4.5.4 Draft Guidelines for Registration Process of M2M Service Providers (M2MSP)

The Department of Telecommunications ("DoT"), on June 26, 2021, released its draft guidelines for Registration Process of M2M Service Providers (M2MSP) and WPAN/WLAN Connectivity Provider for M2M Services ("Draft Guidelines") for comments from the public.

General Conditions:

M2MSP and WPAN/WLAN Connectivity Provider registrations must be granted to any entity in India that is registered under the Limited Liability Partnership Act, 2008, Companies Act, 2013, or the Shops and Establishment Act. M2MSPs should provide details of incorporation while registering.

Registration for M2M service provision and WPAN/WLAN (wireless personal/local area network) connectivity solutions are separate.

Technical Conditions:

The Draft Guidelines permit the use WPAN/WLAN technologies in unlicensed spectrum/frequency exempt band to provide M2M services and connectivity for M2M services. All devices sold in India which have embedded SIM inside the device, the packaging/ instructions/ supporting leaflet is to include instruction that "This device is having embedded SIM inside. At the time of re-sale/ loss/ transfer of this device, change of ownership details will be shared with respective M2M Service provider/ Telecom service provider".

Security Conditions:

Under the Draft Guidelines, Applicants are required to provide necessary facilities depending upon the specific situation at the relevant time to the government to counteract espionage, subversive act, sabotage, or any other unlawful activity. Applicants' equipment should meet norms set by international and Indian standardisation bodies, such as the ITU, ETSI, IEEE, ISO, and TEC. Additionally, mandatory testing of equipment must be done before deployment in accordance with the Indian Telegraph (Amendment) Rules, 2017.

For more information please [click here](#)

4.5.5 13-digit numbers for the trial of machine-to-machine (M2M) communications

In February 2018, Department of Telecom (DoT) issued 13-digit numbers to telecom operators for the trial of M2M communications like swipe machines, smart electric metres, and car tracking devices etc. that communicate through a SIM card.

The 13-digit numbers have been allocated to state-run firm BSNL and private telecom operators Bharti Airtel, Reliance Jio, Idea Cellular and Vodafone for testing purposes only. According to a letter sent by the DoT to operators, the authority has approved allocation of "1 million codes for testing purpose for each LSA (licence service area)" to service providers.

The Telecom Regulatory Authority of India had recommended that all telecom licence holders should be allowed to provide M2M service using any spectrum. However, notification has suggested that critical M2M services should be provided by those companies who have licensed spectrum. Read more

4.5.6 Instructions in relation to SIM cards used for M2M communication services

In May 2018, DoT issued M2M guidelines for implementing restrictive features for SIMs used only for M2M communication services (M2M SIMs) and related Know Your Customer (KYC) instructions for issuing M2M SIMs to entity/organization providing M2M communication services under bulk category and it also included instructions for Embedded SIMs (e-SIMs). Read more

4.5.7 OneM2M Specification as National Standards

Telecommunication Engineering Centre (TEC), which is the National Standardization Body for Telecom and related ICT sector in India issued its "Standardization Guide – A policy document for adoption of Domestic/ international standards into national standards" vide O.M. No. 2-1/2018/SD/TSDSI/TEC/5 dated 08-05-2020.

oneM2M released its first set of specifications (Release 1) in Jan 2015, Release 2 in March 2016, and Release 3 in Dec 2018. Work is in progress on Release 4 and Release 5.

TSDSI-transposed oneM2M Release 2 specifications and submitted it to TEC/DoT in Jan 2018 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 specifications as National standards vide O.M. No. 19-1/2019-STD/ TEC/2, dated 17-09-2020. As per the order, these national standards shall remain voluntary unless made mandatory for its use, reference, or adoption by regulation / Govt. directive.

Click here for Standards

4.6 Blockchain

4.6.1 Draft Discussion Paper on Blockchain: The India Strategy

The leading policy think tank working for the government of India, Niti Aayog, came out with a strategy document recognising many crucial areas around blockchain technology, which can significantly benefit the country. Named as "Blockchain: The India Strategy" for Enabling Ease of Business, Ease of Living and Ease of Governance, the discussion paper is the first of two-part papers to be published by NITI Aayog. The 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.

The main takeaways from the Niti Aayog's discussion Paper are:

- **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 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.

Read more/Download>>

4.6.2   National Strategy on Blockchain: MEITY

In January 2021, Ministry of Electronics & Information Technology (MEITY) released its draft of "National Strategy on Blockchain" for consultation with various stakeholders including academia, industry, and government.

The draft strategy covers:

- ✓ Overview of Blockchain Technology and Applications
- ✓ Global Efforts in blockchain technology
- ✓ National Scenario
- ✓ Challenges to the adoption of Blockchain Technology
- ✓ SWOT Analysis
- ✓ Roadmap for Blockchain Technology Adoption
- ✓ National Level Blockchain Framework
- ✓ Integration of important National Level Services to Blockchain

Recommendations as below for implementing National Level Blockchain Framework have been mentioned in this strategy:

- A plan for National Level Blockchain Framework (NLBF) with three types of participants are proposed: 1) Confident user of Technology (Application Developers) 2) Provider or Operator of Technology (Infrastructure & Services, BaaS) and c) Complete Technology Stack Builder (IP Creator). Multi-institutional model needs to be created for architecting the NLBF and organizations must be identified along with their roles & responsibilities. Involvement of innovative start-ups and industry would bring in the agility.

- As the Blockchain technology is still evolving and it has the potential for Government to adopt, it is recommended to focus on advanced research in the domain of Blockchain Technology and

contribute to addressing various challenges in adopting the technology towards building a trusted public digital platform.

- Focus on research in the domains of standards & interoperability, scalability & performance, consensus mechanisms, security & privacy, key management, secure smart contracts, and detection of vulnerabilities in Blockchain Technology based solutions is required for sustainability. This should essentially result in indigenous Blockchain platform.

- It is proposed to evolve an indigenous technology stack with open APIs, so that various use cases addressing the nation's requirements, can be built on top of it and integration with existing applications can be carried out efficiently. It is suggested to have balanced approach towards technology stack development and use cases implementation. Also focus should be on creation of infrastructure as National Resource and offering Blockchain as a Service (BaaS).

- Existing infrastructure (data centres) could be utilized for enabling BaaS, and such initiative requires planning at architecture level. Every organization should invest for infrastructure in crowd sourced model which could subsequently include infrastructure from neighbouring countries.

- Consultancy services can be offered in architecting the Blockchain based applications as different ministries / departments are showing interest in adopting Blockchain Technology. Critical applications in the domains such as oil industry, pharmaceutical industry, Government enabled Marketing and so on, can be identified to bring transparency and harness other benefits from Blockchain Technology.

- Government's Strategy for Blockchain Technology, like the Strategy for Artificial Intelligence must be evolved. Also, it is proposed to integrate Blockchain Technology with other emerging technology areas such as AI to achieve the vision of becoming global leader in these technologies.

- Capacity building in Blockchain Technology need to be promoted by conducting short term courses or bootcamps. It is proposed to create sandbox environments for development & testing of applications and for offering virtual training.

- Regulatory aspects & polices also need to be focused along with Infrastructure, Research, Technology Stack, Testing & Certification and Capacity Building. It is proposed to evolve a legal and regulatory framework for Blockchain Technology.

- Explore the potential of Blockchain Technology in the proposed public digital platforms in various sectors like Agriculture, Health, Energy etc., for more security.

Read more/Download>>

4.6.3 Centre of Excellence (CoE) in Blockchain technology

Software Technology Parks of India (STPI)— an organisation under the Ministry of Electronics and IT, has launched Apiary, a center of excellence (CoE) in blockchain technologies at STPI incubation center in Gurugram in association with the government of Haryana, Government Blockchain Association and several blue-chip companies and top-tier academic institutions.

The primary objective of the initiative is to promote and grow blockchain start-ups in India, as well as encourage the adoption of digital ledger systems across sectors such as finance, governance, healthcare, and infrastructure.

A similar Centre of Excellence for Blockchain was set up by the National Informatics Centre in Bangalore in January 2020.

Government of India has also launched an Official Portal of the Centre of Excellence Blockchain Technology designed, developed, and hosted by National Informatics Centre (NIC), Ministry of Electronics & Information Technology. The objective behind the Portal is to provide a single window access to the information and services being provided by the CoE in blockchain technology. For more information, please click here

4.7 Security & Privacy

4.7.1 National Cyber Security Policy 2013

In 2013, Ministry of Communication and Information Technology (Meity) of the Government of India released the National Cyber Security Policy to protect information, such as personal information, financial/banking information, sovereign data etc. The policy has proposed to set up different bodies to deal with various levels of threat, along with a national nodal agency, to coordinate all matters related to cyber security. The government has also proposed to set up a National Critical Information Protection Centre (NCIIPC), which will act as a 24*7 center to ward off cyber security threats in strategic areas such as air control, nuclear and space. It will function under the National Technical Research Organization (NTRO), a technical intelligence gathering agency controlled directly by the National Security Adviser (NSA) in the Prime Minister's Office. The existing agency, Computer Emergency Response Team (CERT) will handle all public and private infrastructures. As part of the policy, the government has proposed to create a workforce of around 500,000 trained in cyber security. It also proposes to provide fiscal benefits to businesses to adopt best security practices.

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.

"The Indian Government under the aegis of National Security Council Secretariat through a well-represented Task Force is reportedly in the final stages to clear a new National Cyber Security Strategy[11].

Read more/Download>>

4.7.2 Cyber Surakshit Bharat

In January 2018, Cyber Surakshit Bharat initiative was launched by Ministry of Electronics and Information Technology (MeitY), in association with National e-Governance Division (NeGD) and industry partners. Meity launched this initiative to fortify the cyber security ecosystem in India in line government's vision for a 'Digital India'.

Digitisation has rapidly transformed the governance system, and therefore the requirement of good governance is crucial. With such initiative, there would be a rise of awareness about cybercrime and capacity building for securing the CISOs and the frontline IT staff across all government departments. Apart from awareness, this first public-private partnership also includes a series of workshops to make people cognizant about the best practices and help the officials with cybersecurity health tool kits to tackle cyber threats.

Read more>>

4.7.3 Personal Data Protection Bill

In July 2017, Government of India had set up a high-level committee of experts to study various issues relating to data protection in India and make specific suggestions on principles underlying a data protection bill.

In November 2017, Committee released a White Paper that outlined its views on data protection. According to white paper, a nuanced approach towards data protection will have to be followed in India, keeping in mind the fact that individual privacy is a fundamental right limited by reasonable restrictions. The paper also highlighted that a data protection framework in India must be based on seven principles: technology agnosticism, holistic application, informed consent, data minimization, controller accountability, structured enforcement, and deterrent penalties.

In July 2018, Government of India released its draft Personal Data Protection bill 2018. The Bill sets out how the personal data of individuals is processed by the government and private entities incorporated in India and abroad. The bill is influenced by the EU's General Data Protection Regulation (GDPR).

More than a year after the government released its draft personal data protection bill, India is one step closer to passing a comprehensive data privacy law. In December 2019, after the Union Cabinet's approval, the Personal Data Protection Bill has been referred to a joint select committee of both houses of the parliament for review.

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11   https://www.business-standard.com/article/current-affairs/india-in-final-stages-of-clearing-national-cybersecurity-strategy-121102700663_1.html

5 Standardization

In ICT sector, Bureau of Indian Standards (BIS) and Telecommunications Standards Development Society, India (TSDSI), have dedicated working groups for formulating standards specific to M2M/IoT and other emerging technologies such as 5G, AI, blockchain etc. BIS is a founder member of International Organization for Standardization (ISO) and member of International Electrotechnical Commission (IEC) since 1949. TSDSI is an Organizational Partner (OP) of 3GPP and Partner Type1 of oneM2M. BIS and TSDSI are also participating and proposing India-specific requirements at global platforms to address Indian needs in global standards and facilitate harmonization of Indian ICT Standards with global standards to reap benefits of compatibility, interoperability, scale, and affordability. India through its Ministry of Electronics & IT and Ministry of Communication are responsible for framing policies in the ICT domain.

5.1 Bureau of Indian Standards (BIS)

Bureau of Indian Standards (BIS) is an autonomous body under the Ministry of Consumer Affairs, Food and Public Distribution, Govt. of India. BIS as a National Standards Body is entrusted with formulation of Indian Standards, product certification, and it also to represent India at the ISO, IEC, etc. The Bureau of Indian Standards (BIS) Act of 2016 has positioned BIS in a leadership position as the National Standards Body (NSB) of India. To effectively perform its responsibility as the NSB of India, BIS came out with its Standards National Action Plan (SNAP). The action plan has prioritized standardization topics ranging from engineering to services, IoT to AI, and smart cities to e-mobilities. Following are the Technical Committees addressing the subject of ICT at BIS.

a. **BIS LITD 17 on Information Systems Security and Privacy** is responsible for standardization in 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.

b. **BIS LITD 27: Internet of Things and Related Technologies:** is responsible for developing standards in the field of Internet of Things and related technologies including sensor networks; wearable electronic devices and technologies; and big data. LITD 27 acts as the National Mirror Committee for ISO/IEC JTC 1/SC 41 on Internet of Things and related technologies and ISO/IEC JTC 1/WG 9 on big data, IEC/TC Wearable electronic devices. It comprises of Work Groups on IoT Architecture, IoT Interoperability, IoT Applications & Wearable Devices; and Study Groups on IoT Trustworthiness, Wearables, Industrial IoT, Real Time IoT, and Industrial IoT & Aspects of IoT Use Cases.

c. **BIS LITD 29: Blockchain and Distributed Ledger Technologies** is responsible for developing standards in the field of blockchain and Distributed Ledger Technologies. LITD 29 acts as the National Mirror Committee for ISO TC-ISO TC 307 (P): Blockchain and Distributed Ledger Technologies Sectional Committee.

d. **BIS LITD 30 on AI:** is responsible for the standardization around Artificial Intelligence and Big Data. LITD 30 is the National Mirror Committee for ISO/IEC TC-JTC 1 SC-SC 42 (P): Artificial Intelligence.

e. **BIS LITD 31 on Cloud Computing, IT & Data Centers**: is responsible for establishing Indian standards 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. LITD 31 is the National Mirror Committee for ISO/IEC TC-JTC 1 SC-38 (P): Cloud Computing and SOA and ISO/IEC TC-JTC 1 SC-39 (P): Sustainability, IT and Data Centres.

For more information on BIS Committees responsible for Electronics & IT standardisation please click [here](#)

5.2   Telecommunications Standards Development Society, India (TSDSI)

TSDSI is an autonomous, membership based, standards development organization (SDO) for Telecom/ICT products and services in India. TSDSI is responsible for developing standards for access, back-haul, and infrastructure systems, solutions and services that best meet India specific Telecom/ICT needs, based on research and innovation in India. Organisation work closely with global standards' bodies to reflect Indian requirements into international telecom/ICT standards. TSDSI target to play an important role in encouraging generation of Indian IPRs in this technology intensive field and get them incorporated into international standards. This in turn promotes indigenous research, product development and manufacturing. Department of Telecommunications & Ministry of Electronics and Information Technology, Govt. of India are jointly supporting TSDSI as India's Telecom/ICT SDO. Their objectives are:

- Developing, promoting, and standardizing India-specific Telecom/ICT requirements and solutions
- Taking Indian requirements to global standards organizations
- Helping create standards-based manufacturing expertise in the country
- Providing guidance and leadership to developing countries

List of Indian standards published by TSDSI is available [here](#) and List of Technical Report [here](#). TSDSI also has a working [roadmap](#) and its [IPR policy](#).

TSDSI at global Platform:

1. **3GPP:** TSDSI is an Organizational Partner (OP) of [3GPP](#) along with six other Regional Standardisation bodies. This entitles TSDSI members to become individual members of 3GPP through TSDSI and to take their work into the global arena. Membership of 3GPP enables members to contribute to the development of upcoming standards such as 5G. 3GPP transposed standards are available [here](#). TSDSI has also been mandated by Ministry of Communication (MoC) to develop Standards for Cloud Services Interoperability and adapt 3GPP specifications related to Security.

2. **oneM2M:** TSDSI is Partner Type I of [oneM2M](#), which is a leading partnership project driving M2M service layer standards. TSDSI Members such as C-DOT have been participating in the oneM2M TP and Interoperability events regularly. TSDSI has transposed oneM2M Specifications Release 2 & Release 3 into TSDSI Standards. These have been published on TSDSI website. ([click here](#))

3. **ITU:** TSDSI members' proposal on Low Mobility Large Cell (LMLC) configuration has been included as a mandatory test configuration under the Rural eMBB test environment in IMT 2020 Technical Performance Requirements (TPR) in ITU-R with an enhanced Inter Sire Distance (ISD) of 6 km.

TSDSI claims, incorporation of LMLC in IMT2020 will help address the requirements of typical Indian Rural settings and will be a key enabler for bridging the rural-urban divide with 5G rollouts. TSDSI members are now working on a proposal for submission to ITU-R on candidate Radio interface technologies for IMT2020 (5G) specifications.

4. **5G-IA:** TSDSI and 5G Infrastructure Association (5G-IA), representing the European industry in the 5G-PPP Research Programme, have signed a <u>Memorandum of Understanding</u> to foster collaboration on 5G development.

List of TSDSI partners is available [here](#)

5.3   <u>Telecommunication Engineering Centre (TEC)</u>

TEC, which is the technical wing of Department of Telecommunications (DoT) is committed to develop standards in telecommunications sector in India, to ensure development of world class telecom infrastructure and smooth interconnection of individual network. It discharges its functions as testing and certification body. In brief TEC function are listed below:

- ✓ TEC is a technical body representing the interest of Department of Telecom, Government of India.
- ✓ Prepare specification of common standards regarding Telecom network equipment, services, and interoperability.
- ✓ Specifications released as Generic Requirements (GRs), Interface Requirements (IRs) and Service Requirements (SR).
- ✓ Issuing Interface Approvals, Certificate of Approvals, Service Approvals & Type Approvals.
- ✓ Formulation of Standards and Fundamental Technical Plans.
- ✓ Interact with multilateral agencies like APT, ETSI and ITU etc. for standardisation.
- ✓ Develop expertise to imbibe the latest technologies and results of R&D.
- ✓ Provide technical support to DoT and technical advice to TRAI & TDSAT.
- ✓ Coordinate with C-DOT on the technological developments in the Telecom Sector for policy planning by DoT.

List of standards/specification published by TEC are available [here](#)

TEC also acts as a nodal agency for Mandatory testing and certification of telecom equipment (MTCTE) against respective Essential Requirements. The testing is to be carried out by Indian Accredited labs and based upon their test reports, certificate shall be issued by TEC. Market Surveillance of products under MTCTE is carried out by Licensed Service Area (LSA) field units of Department of Telecommunications.

Essential Requirements are also framed by TEC, which are a set of requirements against which Mandatory Testing and Certification of Telecom Equipment (MTCTE) and is done under MTCTE Procedure and are comprises of following:

- ✓ EMI/EMC
- ✓ Safety
- ✓ Technical requirements
- ✓ Other requirements
- ✓ Security Requirements: As per notification issued by DoT from time to time.

Essential Requirements are assigned specific numbers (details here) and the List of Essential requirements (ERs) for mandatory testing and certification are available here

TEC has established various M2M and National Working Groups to address the technological needs in India corresponding to ITU WG and desired M2M/IoT use cases in India.

M2M Working Groups (WGs):

Network cell at DoT is working on framing policy on M2M communication. TEC has been assigned the task to undertake studies through stakeholders and finalize Indian specific standards/specifications and to make contributions in International Standardization effort. To begin with, five multi stake holders Working Groups as detailed below were formed in TEC in March 2014. Working Groups are having members from TEC, DoT, Telecom Service Providers (TSPs), OEMs, R&D organizations, Vertical Industries, MNCs, IT / ITes, Semiconductor industries and standardization bodies (ETSI/SESEI, TSDSI, BIS etc.)

1. Gateway and Architecture
2. Power
3. Automotive
4. Health
5. Safety and Surveillance

Following additional working groups were created in June-2015:

1. Security (End to End security of M2M domain)
2. Smart city
3. Smart Homes
4. Smart villages and Agriculture
5. Smart Environment (Environment monitoring and Pollution Control)
6. Smart Governance

Terms of Reference for the working Groups was prepared and approved (Click here). Since 2015, TEC has been regularly releasing technical reports on various topics in M2M/IoT domain (Click here).

TEC is working on establishing its M2M/IoT device certification and based on TRAI's recommendations, it is also establishing a National Trust Centre for M2M devices.

National Working Groups (NWGs):

TEC has setup various National Working Groups (NWGs) corresponding to ITU-T Study Groups. Here is the list of these currently active NWGs:

1. NWG 5 - Environment, Climate Change, and circular economy
2. NWG 9 - Broadband cable and TV
3. NWG 11 - Signalling requirements, Protocols, test Specifications and Combating counterfeit products
4. NWG 12 - Performance, QoS and QoE
5. NWG 13 - Future networks with Focus on IMT-2020 cloud computing and trusted network infrastructures

6. NWG 15 - Transport, Access, and Home
7. NWG 16 - Multimedia
8. NWG 17 - Security
9. NWG 20 - Internet of Things (IoT) and smart cities and communities (SC&C).
10. NSG 5 - WP5D

TEC Website: https://www.tec.gov.in/

6   Conclusion

The next phase of growth in the industry is hinged on convergence of ICT. Government of India has set its vision to transform the country into a digitally empowered society and a knowledge economy. Keeping in mind the importance of digitalization, the government of India has placed renewed focus around new emerging technologies such as IoT, M2M, AI, Blockchain etc. and deployment of 5G service at the heart of India's growth story with an emphasis on policies such as Digital India, Make in India. Government has also approved its National Digital Communication Policy, with an aim to train one million people in new-age skills and sectors such as 5G, M2M, Blockchain and artificial intelligence etc. and propel India to the Top 50 Nations in the ICT Development Index of ITU.

To boost its domestic manufacturing and cut down on import bills, the central government has introduced performance linked incentive (PLI) scheme for Electronics, IT hardware and telecom sector that aims to give companies incentives on incremental sales from products manufactured in India. Apart from inviting foreign companies to set shop in India, the scheme also aims to encourage local companies to set up or expand existing manufacturing units.

Government of India is also getting future ready and has started serious work on identifying and formalizing standards for implementing new emerging technologies such as AI, IoT/M2M, Blockchain etc. and for the roll out of 5G.

7 Glossary

Sr.No.	Acronym	Expansion
1	CoE-IoT	Centre of Excellence for internet of Things
2	3GPP	3rd Generation Partnership Project
3	5G	Fifth Generation
4	AGR	Adjusted Gross Revenue
5	AI	Artificial Intelligence
6	BIS	Bureau of Indian Standards
7	BPM	Business Processing Management
8	BPO	Business process outsourcing
9	BSNL	Bharat Sanchar Nigam Limited
10	C-DAC	Centre for Development of Advanced Computing
11	CDMA	Code-Division Multiple Access
12	C-DoT	Centre for Development of Telematics
13	CEWiT	Centre of Excellence in Wireless and Information Technology
14	CII	Confederation of Indian Industry
15	DIPP	Department of Industrial Policy and Promotion
16	DoT	Department of Telecommunication
17	ETSI	European Telecommunications Standards Institute
18	FDI	Foreign direct investment
19	GDP	Gross Domestic Product
20	GoI	Government of India
21	GSM	Global System for Mobile communication
22	ICT	Information and Communication Technology
23	IEC	International Electro-technical Commission
24	IoT	Internet of Things
25	ISO	International Organization for Standardization
26	IT	information technology
27	ITeS	Information Technology enabled Services

28	ITU	International Telecommunication Union
29	JTC	Joint Technical Committee
30	KPO	Knowledge Process Outsourcing
31	LITDC	Electronics & Information Technology Division Council
32	M2M	Machine to Machine
33	Meity	Ministry of Electronics and Information Technology
34	MGS	Multiplier Grants Scheme
35	MNP	Mobile Number Portability
36	MoC	Ministry of Communication
37	MTCTE	Mandatory Testing and Certification of Telecom Equipment
38	MTNL	Mahanagar Telephone Nigam Limited
39	NASSCOM	National Association of Software and Services Companies
40	NCLT	National Company Law Tribunal
41	NDCP	National Digital Communication Policy
42	NeGP	National e-Government Plan
43	NOFN	National Optical Fibre Network
44	NOFN	National Optical Fibre Network
45	NSSO	National Statistical Survey Organization
46	NTP	National Telecom Policy
47	NWGs	National Working Groups
48	OSS	Open-Source Software
49	PMA	Preferential Market Access
50	POI	Point of Interconnection
51	QoS	Quality of Service
52	R & D	Research and Development
53	SaaS	Software-as-a-Service
54	SDOs	Standards Development Organizations
55	SETU	Self-Employment and Talent Utilization
56	SEZs	Special Economy Zones
57	SIP-EIT	Support International Patent Protection in Electronics & IT

58	SMAC	Social, Mobility, Analytics, Cloud
59	SMEs	Small and Medium Enterprises
60	STPI	Software Technology Parks of India
61	SUCs	Spectrum Usage Charges
62	TCoE	Telecom Centres of Excellence
63	TEC	Telecommunication Engineering Centre
64	TRAI	Telecom Regulatory Authority of India
65	TRs	Technical Reports
66	TSDSI	Telecommunications Standards Development Society, India
67	TSPs	Telecom Service Providers
68	USP	Unique Selling Proposition
69	WG	Working Group

8   Resources

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