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Confederation of Indian Industry

Digital Reset
Touching a billion Indians

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Foreword - CII

India's telecommunication sector is not only one of the largest but also amongst the fastest-growing networks in the world. Communications is the fastest growing sector within India's economy. The Indian telecommunication sector has undergone a major transformation through significant policy reforms. The Government of India (GOI), through its National Digital Communications Policy, foresees investment worth US$100 billion in the telecommunication sector by 2022. The government is encouraging global telecom network of manufacturers to manufacture their equipment in India with 100 percent local products. The PLI scheme has already triggered the entry of several global players manufacturing mobile devices and components to expand their existing operation in India for global supply chain under the PLI scheme. Similarly, global vendors have shown interest in setting up the newly announced PLI scheme.

As a much-awaited relief, the government approved a blockbuster relief package for the country's cash-strapped telecom sector, along with several structural reforms, to strengthen the sector.

These reforms are deep, broad, and structural and will bring significant changes today, tomorrow, and in the future. I am sure, going forward, the steps taken will clearly take away some of the uncertainties looming in the sector.

Mr Umang Das
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Foreword - Deloitte

The Indian telecommunication industry is one of the most benchmarked sectors in the world with 1,209 million subscribers, as in July 2021. There has been enormous growth and transformation in the consumer subscription and services provided by the telecommunication ecosystem over the past two decades. COVID-19 has made this industry even more critical to meet our day-to-day requirements. The industry is now gearing up to shift its focus from coverage and voice, to applications that affect the lives of a billion Indians.

In the 'new-normal', telecommunication companies and their services have become the buttresses for consumer demand and supply. Major industries, such as healthcare, education, fintech, e-commerce, and entertainment, have been able to serve their consumers, using platforms (at the core) supported by telecommunication operators. These changing times have created a plethora of opportunities for telecommunication companies to move towards the role of a service enabler from just being a service provider. This also creates an opportunity for Telecom Service Providers (TSPs) to diversify into wider horizons for business innovation.

GOI has also supported this digital transformation by launching/announcing numerous initiatives that propagate the overall sectoral growth. Such initiatives are meant to support incumbent and new players across the Indian telecommunication ecosystem. These initiatives also drive the Indian telecommunication ecosystem towards developing innovate services and reducing dependencies on equipment import.

The Aadhar Enabled Payment System (AePS), Pradhan Mantri Gramin Digital Saksharta Abhiyan (PMGDISHA), and the participatory governance initiative through MYGOV are some of the programmes that the government initiated to take this transformation to the hinterland and empower the rural society. The government is also committed to connect 250,000 gram panchayats and subsequently villages with high-speed broadband through the world's largest rural broadband project BHARATNET.

GOI has recently launched Ayushman Bharat Digital Mission (ADBM), to change the outlook of the Indian healthcare industry. It provides a new platform for Indian citizens to experience a digitalised healthcare industry. This digital ecosystem will provide digital consultation, connect different hospitals to discuss solutions, and help collate an individual's health information for faster access.

Ease of access is the core of changing consumer demands. Consumers desire that everything should be just a click away – be it meetings from home, grocery shopping, or transferring money. Amalgamation of telecommunication services with upcoming industries and technologies (such as Internet of Things (IoT), 5G, and private networks) has the potential to change the storefront of the telecommunication ecosystem. In these imminent times, telecommunication players will be defined by leaders who diversify, differentiate, and focus on both short and long-term opportunities. These opportunities will be ignited by collaborations and convergence, to provide exciting and innovative services to consumers.

The future of the telecommunication industry brings along prospects and challenges across the ecosystem. Numerous factors underwrite the present unprecedented change. We can expect nothing but innovation and more change in the next few years with an ever-growing telecommunication ecosystem. Upcoming launch of 5G services in India are bound to be a game changer for the telecommunication industry, consumers, and the larger ecosystem.

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Executive summary

The Indian telecommunication industry's ecosystem has transformed over the last few years. It has come a long way from the traditional landlines to future-ready 5G. In the past two decades, we witnessed how telecommunication connected people by penetrating the most remote locations, which in turn has started to change the lives of a billion Indians. From phone applications to home automation to cashless commerce, digital disruption is the new normal for consumers Affordability of services has always been a dominating factor for telecommunication adoption in India. Today such services are within the economic reach of customers. This transformation had a positive impact on customer experience as well. With new technological advancements, majority of services can be delivered virtually.

Evolution of telecommunication capabilities also fueled digitised transformation of industries such as gaming, banking, healthcare, education, e-commerce, entertainment, manufacturing, fintech, real estate, and automobile. This push has been driven by a model where the telecommunication sector has become the connectivity backbone for other industries. These sectors restructured their business models as the technology evolved and developed digitised revenue portfolios. In India, internet consumption has increased across youth, lower socio-economic classes, female population, tier-2 cities, tier-3 cities, and the rural sector. New untapped customer segments and markets have unlocked for operators to create customised solutions and promote internet adoption through collaborations with government and other solution providers.

Digital transformation requires ultra-low latency and high transmission speed which is expected to be enabled by technologies such as satellite broadband communication (Satcom). Satcom will also enable massive machine type communication (mMTC) amongst IoT devices. The upcoming 5G mobile network will be the technology to provide broader coverage across borders. As 5G architecture needs significant investments, adoption of enablers such as Open Radio Access Network (ORAN), cloud computing, and edge computing will help operators reduce capital expenditure and optimise network throughput. As we move towards an era of internet-enabled machines and seamless connectivity, private networks are expected to witness a huge demand from enterprises in the near future. This will be driven by requirement of security and high-speed connectivity within their operating environment.

In the future, enterprises will use IoT to cater diversified customer needs. This will also help manage enterprise operations, optimise costs, and reduce human interference. Advancements in technology and data management go hand in hand. Hence, managing data is imperative for organisations. Cloud computing shall offer tailored products for data storage and facilitate business operations by integrating devices online without owning physical assets.

Artificial Intelligence and Machine Learning (AI/ML) will play an instrumental role in deriving a meaningful output with real-time reporting, problem solving, and decision-making capabilities. Agile decision-making shall be supported by Virtual Reality (VR), which will allow users to have a real-life experience of taking on-ground business decisions. IoT's strong push will also enable machine-to-machine communication that requires information and data transfer at very high speed with low latency within a secure operating environment. Edge computing will manage these hindrances by processing the data close to the source and encrypting before transfer amongst nodes.

In the upcoming 5G era, blockchain is another technology that will be critical for Indian telecommunication operators. It will help solve long-standing issues (such as identity management, frauds, and SLA monitoring for the industry) that will drive growth and enhance revenues. Digital transformation has led to rapid evolution in terms of urban infrastructure. Smart cities are not just a futuristic concept or a pipe dream. A smart city framework predominantly comprises Information and Communication Technologies (ICT). ICT is responsible for developing, deploying, and promoting sustainable development practices in response to growing urbanisation challenges. Telecommunication services are expected to be the nucleus for achieving infrastructure transformation in both the urban and rural areas.

The Government of India (GOI) has played a significant role in supporting these technologies to foster and digitise the domestic market. GOI has time and again stepped in, to support the cash-strapped telecommunication sector. On the back of its past decisions and larger goal of building a digital India, the government has announced critical structural and procedural reforms.
The definition of Adjusted Gross Revenue (AGR) has been rationalised and the recently announced four-year moratorium on AGR payment will ease the liquidity stress of telecommunication companies. These reforms will pave the way for 5G auctions. GOI has also removed penalties and reduced interest rates and bank guarantee requirements to enable the sector to attract more Foreign Direct Investment (FDI) for advancements. GOI has also come up with Private Partnership Models (PPP) to connect gram panchayats with internet across India. As 'Make in India' continues to gain momentum, the government is also promoting local manufacturing of network equipment by providing incentives to manufacturers.

As the telecommunication industry becomes the key driver of industry-wide convergence, new revenue streams (leveraging industry-wide collaborations) have opened for TSPs to bank upon. In India, the entertainment sector is the primary consumer of the internet. Demand for OTT and gaming is rising exponentially, giving telecommunication providers an opportunity to collaborate with such industries or develop products indigenously. Growth of OTT platforms and gaming industry will receive a thrust due to high speed broadband and AGR definition rationalisation.
The next few years will witness new business models and thereby new alliances will emerge between the telecommunication service providers and content providers. Digital Media advertising spends will surpass the conventional media expenditure due to the rise of on-demand content
Enterprises are expected to bring in a major share of revenue with the emergence of 5G technology. Internet usage pattern varies across demographics, hence customised solutions should be designed to promote internet adoption within a niche and untapped consumer segments based on their needs and aspirations.

Telecommunication operators understand the digitisation opportunity that they have in hand. The game-changing technology revolution has started, and multiple industries are about to witness this journey. The telecommunication sector must continue to build capabilities and act as the backbone in shaping the Indian economy. It will play a key role in bringing the change in the economy with larger alliances and broad basing the telecommunication ecosystem.

Evolution of the telecommunication sector in India

The massive reach of telecommunication in India is a product of persistent advancements and breakthroughs in the industry. Over the years, this industry has achieved historic landmarks and played a multi-faceted role in transforming services, consumers, and industrial dynamics. The telecommunication industry continues to widen its horizon by creating a stable and reliable digital ecosystem for users across the country.

Technological advancement and key milestones of the telecommunication sector

In India, the telecommunication industry is 165+ years old. First landlines were made operational by the government in Kolkata in 1851. After independence, the Indian telecommunication industry introduced a drastic change by shifting from cable telegraph to wireless telegraph, trunk dialing, and radio telephone.

After the year 2000, telecommunication sector advanced multifold and moved beyond the traditional routes. The matrix on the next page reflects the key milestones achieved by the telecommunication sector through technological advancements:[1]

1980-1989

- Formation of Mahanagar Telephone Nigam Limited (MTNL) and Videsh Sanchar Nigam Limited (VSNL)[1]
- Launch of 1G with analog voice, providing a data transmission speed of 2.4kbps[1]
- The government introduced an in-dialing scheme. Private Automatic Branch Exchange (PABX) provided services only within a building or in adjoining buildings[2]

1990-1999

- Private-sector participation in providing value-added services, such as Cellular and paging services[1]
- Launch of 2G marked the initiation of digitisation. The technology allowed call and text encryption, SMS, picture messaging, and MMS with data transmission speed of 64kbps[1]
- Establishment of Telecommunication Regulatory Authority of India (TRAI) in 1997[1]
- Telecommunication equipment manufacturing opened to the private sector. Major international players such as Alcatel, AT&T, Ericsson, Fujitsu, and Siemens entered the equipment manufacturing market[2]
- Radio paging licences issued for circles and cities[2]

2000-2002

- Launch of mobile services by Bharat Sanchar Nigam Limited (BSNL)[1]
- Launch of National Long Distance (NLD) and International Long Distance (ILD) calling[1]
- Launch of Code-division multiple access (CDMA) technology[1] and Internet telephone
- Reduction on license-fee and privatisation of VSNL[1]

2003-2007

- Launch of 'PARTY Pays regime' where subscribers do not have to pay for incoming calls[1]
- Access Deficit Charge (ADC) on long distance calls reduced by 60% and ADC on internal calls reduced to 0
- Launch of 3G with introduction to broad bandwidth CDMA, Internet Protocol (IP) technology, and packet network. 3G evolved the transmission speed to 2Mbps[1]

2007-2012

- The Indian telecommunication sector created a global record of fastest growth in the subscriber base – 45 million in four months
- Launch of cheapest mobile handset and the world's most affordable colour phone with the support of equipment manufacturing partnership done with private sectors
- Launch of 4G with mobile data and enriched user experience in multiple factors, such as Wi-Fi calling, gaming, and video calling

After 2010, the telecommunications ecosystem evolved to cater the changing customer requirements. These evolutions were focused towards coverage, mobile/ internet penetration, and enhancement of quality of service.

Achievement of high penetration, adoption of telecommunication, and low costs were on account of progression of infrastructure and technology. Annexed is the eyeshot of wireless technological capabilities that telecommunication companies launched in India:[3]

Type of wireless network	1G wireless network	2G wireless network	3G wireless network	4G wireless network	5G wireless network
Year of launch	1984	1991	2008	2012	Not launched yet
Capabilities[4]	• Provides basic voice services • Analog Technology • Limited capacity	• Designed for voice and SMS • Improved coverage and capacity • First digital standard Global system for Mobile ((GSM) and CDMA)) • Use of digital signals • Access to GPRS and mobile internet using 2.75/edge network	• Designed for voice with data considerations, such as multimedia, SMS, and internet • First wireless internet via mobile internet • Combined aspects of the 2G network with new technologies and protocols to deliver significantly faster data and transfer rates • Send/receive large email messages • Large capacities and broadband capabilities • 3G introduced media streaming	• Designed primarily for data, 4G carries 3X the data 3G Universal Mobile Telecommunication System (UMTS) carried and 6X the data 2G GSM network carried • IP-based protocols • True mobile broadband • Quality that enriched user experience with advanced gaming services, HD mobile TV, video-conferencing, 3D TV, IP telephony, and other services that demand higher speed	• Faster data rates • Higher connectivity density • Lower latency and extremely high transmission speed • Enabling reliable wireless IoT connectivity at transport hubs • Bringing immersive, virtual customised shopping experiences anywhere to consumers
Technology[5]	• Networks were based on the Frequency Division Multiple Access (FDMA) technology	• Global System for Mobile Communications (GSM) • Employed two new access technologies: Time Division Multiple Access (TDMA) and Code Division Multiple Access (CDMA) • IS-95 known as CDMA One; IS-95 was the first-ever CDMA-based mobile network and designed to support mobile data	• Uses Universal Mobile Telecommunication System (UMTS) as its core network architecture • Based on CDMA2000 (Code Division Multiple Access) and EDGE technologies (EDGE was superior enough to pave the path and need for the 3G network)	• LTE is based on Orthogonal Frequency Division Multiple Access (OFDMA) • Introduction of another backhaul technology i.e. Worldwide Interoperability for Microwave Access (WiMAX) which provided high speed data over a wide area	• Technology New Radio (NR) that is based on OFDMA • Active antenna 5G encapsulated with 5G massive Multiple Input Multiple Output (MIMO) is used for providing better connections and enhanced user experience • Architecture, clubbed with network slicing, enables telecommunication operators to offer on-demand tailored connectivity to their users
Data Speeds[5]	2 kbps	14.4 kbps to 384 kbps	2Mbps to 42Mbps	300 Mbps to 3Gbps	10Gbps
Frequency[3]	30KHz	1.8GHz	1.6 - 2 GHz	2-8 GHz	3-30GHz

With evolving technologies and industry-centric policies being launched by GOI, the telecommunication industry emerged as a springboard for the Indian economy. Per the TRAI's annual subscription reports, there was over 200 percent growth in consumer subscription from 2008 until July 2021. A quick snapshot of the growth of subscribers accomplished by the telecommunication ecosystem in India from 2008 to 2021 is as follows[6]:

Year	Telephone subscription (MN)	Tele-density (%)	Wireless Subscriber (MN)	Wireline (MN)	Broadband (MN)
2008	384.79	33.23	346.89	37.90	5.45
2009	562.21	47.89	525.15	37.06	7.83
2010	787.28	66.16	752.19	35.09	10.92
2011	926.53	76.86	893.84	32.69	13.30
2012	895.51	73.34	864.71	30.79	14.98
2013	915.19	74.02	886.30	28.89	55.20
2014	970.97	77.58	943.97	27.00	85.74
2015	1,036.41	81.83	1,010.89	25.52	136.53
2016	1,151.78	89.90	1,127.37	24.40	236.09
2017	1,190.67	91.90	1,167.44	23.23	362.87
2018	1,197.87	91.45	1,176.00	21.87	518.55
2019	1,172.44	88.56	1,151.44	21.00	661.94
2020	1,173.83	86.38	1,153.77	20.05	747.41
2021*	1,209.45	88.51	1,186.84	22.61	808.60

* data published as at 31 July 2021

The evolution of telecommunication services and advancements in technology have helped the country to connect better and much faster. This made life easier for millions of people, boosted the economy with employment, and introduced numerous revenue generating opportunities. Demand for digitisation is currently exploding in India, as Indians continue to opt for advanced technology and smart services. Usage and user growth have immensely increased in tier 1, 2, and 3 cities across India.

Telecommunication now requires a digital reset to help connect millions of subscribers and run daily lives and business operations with ease. Further, this digital reset is only possible if the telecommunication ecosystem and other industries (healthcare, education, gaming, entertainment, and fintech) focus on reaching the masses with a different set of services and facilities that can result from 'never seen before' partnerships.

Advancement in service offerings

Changing needs and high consumer demand have led the telecommunication industry to evolve its services with time. This has led to the development of innovative offerings that cater to telecommunication needs and consumers' end-to-end digital requirements.

In the early days, the plans and tariffs provided to customers were costlier and stringent than the affordable and consumer usage-based prices available today. From the time when One Giga Bytes (GB) data was priced at INR 255 to INR 50 today, the Indian telecommunication sector has come a long way.

The sector started offering OTT services in 2008 and transformed into a 'one-bill plan' mechanism where consumers were provided unlimited texts, entertainment channel memberships, cashback offers, and much more. These advancements were possible with the help of smart partnerships, and industrial and technological convergence.

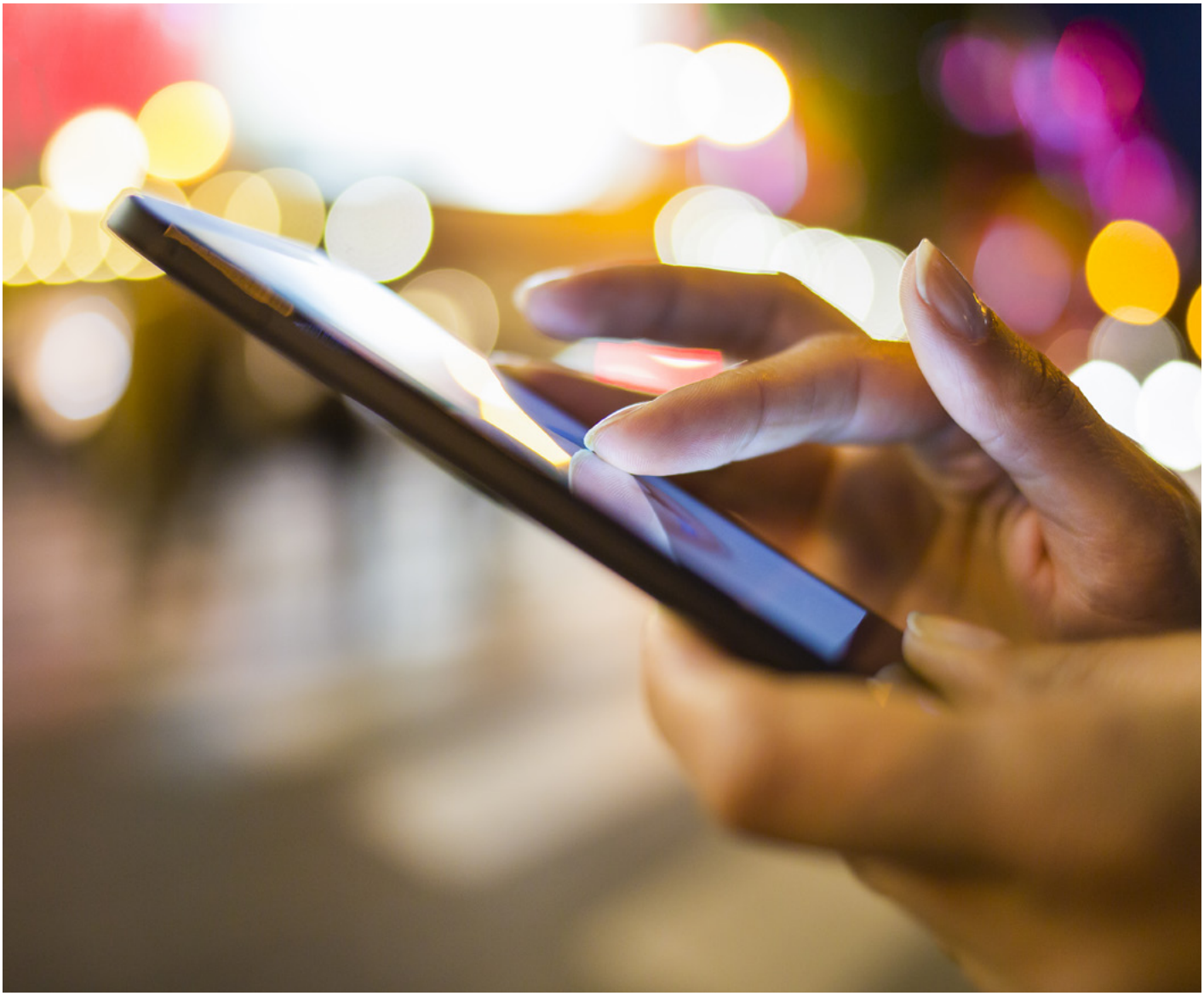
The assessment aims to throw light on how the services evolved with evolving user generations, and corresponding consumer needs in India:

Type of customer demand	User Generation seeking "necessities of life" (Year 1991 to 2001)	User Generation seeking to upscale the "standard of life" (Year 2002 to 2012)	User Generation seeking to enhance the "quality of life" (Year 2013 to 2021)
Service and Consumer need advancement	• Launch of first mobile phone with Global Positioning System (GPS) in 1999[7]	• Launch of virtual map by a leading search engine in 2005 • Launch of the world's first commercially available Voice Over Long-term Evolution (VoLTE) Service and VoLTE- Capable 4G LTE Smartphone enabling good connectivity and call quality[8] • Implementation of first blockchain as the public ledger for transactions made using bitcoin in 2009[9] • Launch of stock-brokering applications for handsets in 2010[10] • Launch of a virtual wallet by Google to make use of Near Field Communication (NFC) for making payments in 2011	• Introduction to One-time password (OTP) based cash withdrawal in 2009 via a partnership between the banking industry and the digital payment platform[11] • Launch of multiple OTT services by global entertainment platforms in 2015. Entertainment platforms now suggest series and shows, customised per consumer usage and preference, and have 300 million active users as at July 2020[12] • Launch of mobile handset supported games by international and local players in 2017 after which, online multiplayer games saw a boom due to high-speed internet and cloud storage (enabling players to play with others in real time on a virtual platform)[13] • Boom in e-commerce industry, one of the leading players achieved net revenue more than US$ 386 Billion in 2020[14] • Launch of big grocery delivery startup in 2021 that made food and utilities available in one click and raised funding of US$120 million[15]
Customer on-boarding	• Visit a walk-in store of the respective telecommunication operator • Fill a manual form • Provide the relevant hard copy of Know Your Customer (KYC) documents • Request catered in 5-7 working days	• Visit a walk-in store of the respective telecommunication operator • Fill a computer-based form at the store • Provide relevant hard copy of KYC documents • Request catered in 2-3 working days	• Raise a request and fill relevant information fields follow • Submit KYC documents online • Request catered within 24 hours
Customer plans and tariff	• Charged INR 16/min for incoming and outgoing calls • Charged INR 24/min for STD calls	• Charged INR 4/min for outgoing calls • Free incoming calls • Charged INR 2-4/min for STD calls • Charged INR 50/min for 1GB data • Limited data services	• Bundled packages in the range of INR 250 to INR 800 with the following services: – Unlimited incoming and outgoing calls – 1GB per day for 60 days or 30GB plan for 30 days – Unlimited texts
Customer services	• Incoming and outgoing voice calls	• Incoming and outgoing voice and data calls • Text messages, MMS, GPRS • International calling	• Incoming and outgoing voice and video calls • Subscription with entertainment platforms • International calling • Cashback offers
Customer complaint registration	• Visiting walk-in store of telecommunication operators • Register complaints • Turn Around Time (TAT) of 4-5 business days	• Call customer care centre or visit a walk-in store • Register complaint • TAT of 24-28 hours	• Call contact centre or register complaint online • TAT for 12-24 hours

Consumer demands have always been directly proportionate to evolving technologies and infrastructure of the telecommunication ecosystem. Since the onset of the COVID-19 pandemic, customer needs are not limited to connecting people but to ease life and complete tasks with one click. Be it booking a cab or shopping online, consumer preference has moved from call-driven services to data-driven services. Furthermore, with an ever increasing and enormous mobile applications library, consumers prefer 'easy to use' applications in comparison to websites or call centres.

The advent of technology and shift in consumer demand should push operators to start the journey of adapting the customer demands if they want to succeed tomorrow. Customisation, innovation, and convergence are the three pillars that will support the revenue models for the industry.

OTT is expected to cater to the needs of every age group and economical society. It will be a smart-technological partnership with other industries and upcoming technologies (such as 5G, blockchain, IoT, and AI/ML) to introduce the relevant and advanced services. This new era of consumers that possesses evolved usage needs due to the pandemic, has reversed its lens towards the outlook of life. This evolved consumer expects services from operators to support the 'new-normal'.



Changes in customer usage pattern

Despite booming growth and increasing consumer subscription, telecommunication operators witnessed a revenue decline in India during 2016 to 2019. The telecommunication and its dependent industries act as a backbone for the digital transformation in the country across industries such as online education, entertainment, content creation, and online gaming. The industry has seen a massive shift in consumer usage patterns. The up and down hill journey of the telecommunication industry over the past decade is shown in the adjacent table. From phone applications to home automation to cashless commerce, digital disruption is the new normal for consumers.

Year	Gross revenue (US$ mn)[16]
2010–2011	22,844
2011-2012	26,000
2012–2013	28,281
2013–2014	31,105
2014–2015	33,863
2015–2016	35,082
2016–2017	36,526
2017–2018	33,862
2018–2019	31,081
2019–2020	33,634
2020–2021	36,379

Due to a fierce competition in the market, operators decreased their tariff which led to a decline in revenues from 2017 to 2019. The gross revenue saw a decline of seven percent from 2017 to 2018 and eight percent from 2018 to 2019. Since the onset of the pandemic, the consumer usage patterns have significantly adopted digitisation. This has led to a rise in consumers' data usage, and accordingly acted as a relief to the pressured revenue flow of operators.[17]

Telecommunication has played a significant role in bringing a change in customer usage pattern. Major industries, such as healthcare, education, gaming, fintech, entertainment, and e-commerce, have recorded revenue growth by providing innovative digital services to consumers, with the telecommunication being the backbone by providing data services.

Healthcare

The telemedicine industry is one of the most sought after industries in the current pandemic era. The pandemic times have broken consumers' old rituals and created a new pathway for virtual healthcare. Telemedicine has seen the fastest adoption in consumer usage, where millions of patients that preferred visiting doctors switched their preference overnight to tele services, such as teleconsultation, teleradiology, telepathology, and e-pharmacy. The swift shift in consumer usage, rise in the income level, better awareness, and multiple digitalised solutions have led to 13.7 percent year-on-year (YOY) growth in gross written premiums to US$8 billion (FY 2021).[18]

Due to the pandemic, GOI established 420 e-hospitals across the country as part of the Digital India initiative (as on February 2021). GOI introduced digital platforms, such as eSanjeevani telemedicine service, which crossed six million teleconsultations (June 2021). During the pandemic, multiple factors have given exponential growth to the healthcare industry. This has significantly improved telemedicine market size. Tele-medicine industry is expected to grow at an annual growth rate of 31 percent (compound annual growth) from 2020 to 2025.[19] The latest initiative of Ayushman Bharat Digital Mission will digitise healthcare to a level which will catapult to improve the healthcare of the billion Indians.

Education

Even before the pandemic, the education sector started to witness a shift in consumer usage where students showed interest in taking online classes as a supplementary source of education. Currently, e-education has become the mode of imparting primary and supplementary education. Professionals prefer learning ad hoc skills in parallel to their regular jobs. This has been made possible through a rapidly growing online platform provided by edutech players. The pandemic crisis gave boom to this industry where consumers were forced to shift their usage pattern to a digital platform overnight. About 90 million students from colleges and schools had to immediately start online classes. Edutech companies saw significant growth in their user base in 2020.[20]

There have been considerable investments in the edutech sector in India. For instance, a leading global e-commerce giant launched ML summer school in India (June 2021). The digital reset of edutech is expected to grow the market by 6.3 times for classes 1 to 12 in the upcoming year and develop a market of US$1.7 billion[20]. India now has four edutech unicorns with over US$4 billion funds flowing in since 2020 [21].

Gaming

The young and tech-savvy population has made India the fifth-largest gaming hub in the world. Easy availability of affordable smartphones led to rise in internet penetration, and the COVID-19 crisis led to significant growth in the online gaming industry in India.

During the pandemic, the internet gaming saw a whopping 50 percent growth. The national average time spend by Indian consumers on online gaming was 4.1 hours. In May 2020, about 150 million online games were downloaded in India[22]. Mobile users accounted 85 percent share of the online gaming industry, followed by 11 percent users playing games on their personal computers and four percent using their tablet devices[23]. The affordable mobile data has helped the customer reach the gaming industry with great ease and convenience. The online gaming industry is expected to achieve a compound annual growth rate (CAGR) of 22 percent to US$2 billion by 2023.[23]

Fintech

Financial Technology Firms (fintech) have digitalised the conventional mode of transactions, such as cheque payments, and ATM withdrawals. Online transactions are faster and easier due to OTP-based authentication. This has eliminated the need of cash payments and has led to a change in mode of expenditure. The financial sector has witnessed a phenomenal transformation with the growth of financial technology firms. Consumers have easily adapted to new ways of financial transactions. Due to demonetisation and the COVID-19 pandemic, there has been a substantial increase in the usage of technology over the traditional forms of financial transaction. Financial awareness in 'millennials' has also given birth to many online broking firms that provide seamless stock trading experience and eliminate the hassle of lengthy paperwork.

During the pandemic, many e-commerce firms also adopted cashless payment methods, such as Unified Payments Interface (UPI) and net banking, to promote public safety. India recorded 3,435 crore digital payments in 2019-20. According to the 'Global Fintech Adoption Index 2019', adoption of fintech services globally progressed from 16 percent in 2015 to 64 percent in 2019.[24]

AEPS has helped fill the void of low penetration of bank branches in rural India by enabling basic banking transactions, increasing the adoption of digital financial services in rural India, and bringing them into the formal financial system.

"The fintech ecosystem in India is starting a behemoth opportunity with enough space for all players. On the financial inclusion side, while good progress has been made in the last decade, significant gaps still exist at the last mile."

Sameer Mathur - Managing Director, ROI Net Solution Pvt Ltd

Entertainment

The entertainment industry was heavily dependent on cable TV, advertisement, and movie theatres for its revenue. Consumers' vast appetite for entertainment led to growth of Direct to Home (DTH) and subsequently digital content in India. Adoption of digital content further grew because of affordable smartphones and high internet speed.

OTT platforms have played an instrumental role in re- imagining the entertainment industry due to 4G technology adoption. Video on demand started gaining popularity in India after the launch of local OTT platforms in 2015, due to affordable plans compared with cable TVs and DTH. Consumers prefer OTT due to availability of monthly and annual packs. One of the leading global OTT platforms came up with a mobile only pack in 2020. As the majority of consumers stream OTT content on their smartphones, this led consumers to migrate to the global OTT platform.

A report by the Federation of Indian Chambers of Commerce and Industry (FICCI) in 2019 projected 30–35 million OTT subscribers in India by 2021. OTT is set to surpass the traditional entertainment mediums. With ease of accessing content online and work from home in 2020-2021, there has been a tremendous growth in online media consumption, which is expected to increase in future.[25]

E-commerce

Buying and selling goods and services was a tedious and time-consuming process. Consumers' constant desire of expecting quality and easy delivery of product and services led to introduction of e-commerce. This sector enabled exchange of goods and services through the internet. It allowed consumers to book hotels and flights, reserve a table in a restaurant, order groceries, etc., in a faster and efficient manner. Consumers have rapidly adapted smartphone and 4G, which in turn has led to mass migration towards e-commerce.

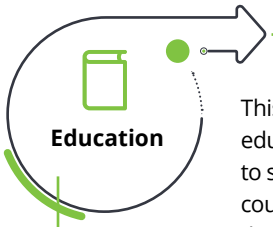
E-commerce grew exponentially and continues to grow. One of the leading global e-commerce players was launched in 1995 but it gained momentum in the past decade. Market capitalisation doubled from 2018 to 2020.[26] Two major segments of e-commerce saw significant growth during the pandemic. January 2021 saw a substantial rise in the number of for household products by 28.7%, jewelry and watches by 26.4%, sporting goods by 26.2%.[27] With ease of doing online business in India and consumers demand for 'every product to be available online', this sector is poised to grow significantly.

Changes in industrial usage pattern

In an era of telecommunication domination, we have noticed how definitions and demarcations continue to shift to more efficient, and digitised platforms. Evolution of the telecommunication industry has changed the operating models and revenue streams of numerous Indian industries. Eight percent contribution to the Gross Domestic Product (GDP) is predicted by the telecommunication sector in FY 2021-22.[28] As the various industries transcend from 'digital-first' to 'digital- throughout', they are a ubiquitous presence in our lives. Telecom's journey from a 'service' to a 'means to a service', tied with technological advancements, has fueled maximum transformation and convergence across various industries. In this section we would throw some light on the changes in industrial usage patterns.

Healthcare

The telecommunication industry and its expansion played a key role in facilitating easier access to healthcare facilities 24*7 across the country, especially during the pandemic. According to former Union Minister for Health and Family Welfare, Health ministry's Sanjeevani telemedicine services crossed over six million teleconsultations since its inception in April 2020. Online consultations and digital health records have empowered health specialists to offer digital medical consultations and conduct a safer diagnosis. Per Indian Brand Equity Foundation (IBEF), the digital healthcare market in India stood at US$116.61 billion in 2018. It is projected to increase at a CAGR of 27.41 percent to US$485.43 billion by 2024[29]. Due to telecom's reach in India, the central government successfully launched its vaccination portal, CoWin, which empowered citizens to get hassle-free vaccinations. This portal managed India's inoculation drive by efficiently locating vaccination centres in users' vicinity and offered instant online slot booking and universally verifiable digital certificates. It further provided a glitch-free and convenient experience by validating citizens' eligibility and identity in real-time. It also provides real time tracking for registration and a breakdown of number of doses. India set a world record by administering over 25 million vaccination doses on September 17, 2021. [30]

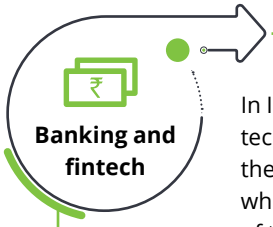


Education

This industry has witnessed a drastic facelift during the pandemic when it adapted to digital means of offering education across the country. Top edutech companies have vitally provided online classes and content to smartphone users in different fields of education. Leading educational and research institutions in the country are focusing on building voice-based applications in various vernacular languages to aid and enhance the efficiency of offering digital education. According to TRAI's publication on 31 May 2021, about 400 Unviersities and 19,851 colleges across India are now connected to BSNL's IP-based cloud.[31] Due to this shift, India's edutech segment is expected to reach US$ 10.4 billion by 2025.[32] This growth is driven by technological growth led by the telecommunication industry.

E-commerce

India's e-commerce industry continues to witness a multi-dimensional expansion. This is evident by the sectors 36% order volume increase in the last quarter of 2020. This growth is due to the domination in the business to customer (B2C) sector by apparel and electronics goods. Another key growth factor is the rising business to business (B2B) e-commerce. B2B e-commerce has multiple emerging start-ups, which plan to enhance and transform the digital trade ecosystem. The future of e-commerce is driven by expansion of internet facilities across the country, including remote regions that will bolster sales. Telecommunication reach will also provide consumers opportunities to become a part of the e-commerce ecosystem and generate income. The Indian e-commerce market's revenue is projected to rise to US$111.40 billion by 2025, from US$46.2 billion in 2020.[33]

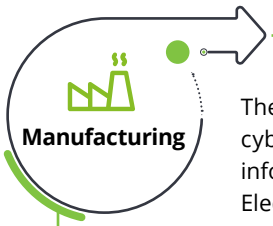


Banking and fintech

In India, digital banking offered limited scope of services with restricted access, coupled with technological and service interruptions. However, a gigantic shift in core banking solutions, enhanced the comfort and convenience for customers. This led to gradual growth in the digital banking industry, which now offers mechanisms to avail almost every banking service without visiting the bank. The year of the pandemic witnessed a heavy surge in digital transactions and thus, a strong telecommunication presence was necessary to make digital banking services accessible to everyone. With the availability of UPI payments and Aadhar Enabled Payment Service (AEPS), digital transactions are easily facilitated by linking users' bank accounts with their mobile numbers. Mobile authentication of payments further provides security and convenience.

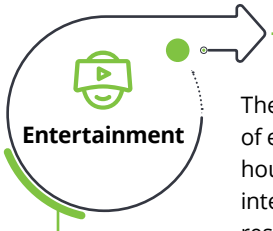
In July 2021, India's UPI recorded 3.25 billion transactions worth US$81.48 billion.[34] Digital lending stood at US$75 billion in FY 2018. It is estimated to reach US$1 trillion by FY2023[34] driven by the five-fold increase in digital transactions. The Indian fintech industry's growth has been undeterred and persistent as telecommunication players have played a vital role in the transformation to a cashless economy. Established and emerging mobile wallet platforms will witness a sharp rise, as users continue to adopt and switched to digital means of payments. India's mobile wallet industry is projected to grow at a CAGR of 150 percent to reach US$4.4 billion by 2022, while mobile wallet transactions will cross US$492.6 billion during the same period.[35]

The future is looking towards an 'all-in-one' payment solution to simplify digital banking and improve financial inclusion. With emergence of new applications and technologies, Fintech companies will broaden their portfolios to incorporate innovative services, such as cryptocurrency management, digital credit cards, and larger penetration of the rural population that lacks banking services.



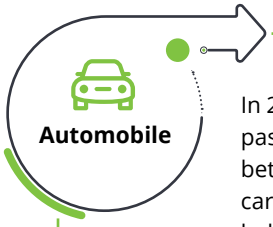
Manufacturing

The fourth industrial revolution, Industry 4.0, is going to be driven by hi-tech innovations that combine cyber and physical systems. Smart machines are expected to be capable of exchanging real-time information over the Industrial Internet of Things (IIoT) for decision-making. Appliances and Consumer Electronics (ACE) market in India is projected to reach US$21.18 billion by 2025, from US$10.93 billion in 2019,[36] with a focus on developing and servicing the needs of upcoming businesses. Industry 4.0 is the sphere of various modern technologies, such as cloud computing, IoT, artificial intelligence, big data science, 5G, and drones which will work in tandem do enhance productivity and automation of the manufacturing processes. This sector has the potential to reach US$1 trillion by 2025[36] in India.



Entertainment

The entertainment industry saw a massive shift in its business model as theatres and in-person modes of entertainment were and continue to be significantly impacted due to the pandemic. Many production houses launched their applications to gain viewership. A high number of smartphone users and affordable internet are driving an increase in content consumption across tier-2 and tier-3 cities. Geographical restrictions over the entertainment content has led to an increase in Virtual Private Network (VPN) usage. This is an opportunity for local industry players to explore collaborations with global content producers and capture the VPN wallet space of consumers. Telecommunication players and OTT platforms are collaborating to use their consumer bases. This industry is projected to reach US$29 billion by 2023.[37] The OTT video market (video on demand and live) in India is projected to post a CAGR of 29.52 percent to reach US$5.12 billion by FY2026, triggered by high demand for diverse and quality content.[37]



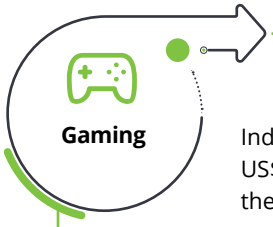
In 2020, India was the fifth-largest auto market in the world, with about 3.49 million units sold in the passenger and commercial vehicle categories.[38] Domestic production increased at a CAGR of 2.36 percent between FY2016 and FY2020.[38] The sector is shifting towards adopting smart cars in the country. These cars enable drivers to use various services, such as virtual assistance and live traffic mapping (with the help of an in-built eSIM). They also offer features such as voice-based navigation, voice-assisted phone calls, and in-car air quality monitoring. One of the world's best known electric vehicle manufacturer surpassed US$1 billion in its Q2 2021 net income,[39] a 10-fold increase from a year ago. Electric vehicles are infusing the concept of smart cars with energy conservation to create an environmentally sustainable ecosystem.

These new-age vehicles are also capable of over-the-air software updates, just like our smartphones, thus making cars safer and convenient. Indian Automobile industry is projected to reach about US$283 billion by 2026 as it recovers from the effects of COVID-19.[38] The future holds a higher demand for regular connectivity and advanced technological applications in cars. As the industry moves to electric cars and smart cars, it is expected to be one of the significant contributors to the telecommunication industry's revenue.

"The auto industry is already experiencing tremendous disruption in the form of connected, shared and autonomous vehicles. While about 50 percent of the cars sold today are connected, this number is likely to grow to 95 percent in the next five years. The boom in 5G technology will act as an ideal catalyst and will unlock many more powerful use cases around safety, infotainment, and autonomous driving. Overall, 5G has the potential to revolutionise the way people and goods move in future."

Rajeev Singh, Partner and Automotive Sector Leader, Deloitte India

Telecommunication infrastructure inside a building has seen a significant growth as people have started accepting the concept of smart homes – an infusion of home automation and home security solutions. As homeowners are becoming more conscious of energy and time consumption, the trend of home automation is on the rise. Hence, many companies offer services ranging from smart lighting to thermostat sensors (controlled from a user's smartphones), which is a testament to the significant dependency over the telecommunication industry. The future of real estate foresees appliances and devices that will seamlessly gauge and understand homeowners' likes, routines, and preferences through AI/ML and IoT. Revenue in the smart home market in India is projected to reach US$4.16 billion by end of FY2021.[40] The number of active households in the smart homes sector is expected to reach 44.2 million users by 2025, household penetration will be 6.3% in 2021 and is expected to hit 12.8% by 2025.[40]



India is one of the largest and fastest-growing gaming markets in the world, with a current valuation of US$930 million and a userbase of over 500 million online gamers. It is projected to grow at 41 percent in the next few years.[41] Over the past few years, the online gaming industry has engaged huge user traffic and diversified into numerous segments of digital gaming, such as online gaming tournaments, e-sports, and fantasy sports. Due to the extensive internet penetration at affordable prices, tier 2 and tier 3 cities are becoming a large chunk of the increasingly digitised online gaming community. Numerous online gaming websites and applications provide ample training to millennials to master skill-based gaming. These companies also aim to increase outreach using social media user bases and offer appropriate and affordable gaming experiences. A unified policy at a central level is required to avoid litigation and boost the confidence of investors.

"Telecommunications advancements such as 5G will aid the growth of esports and gaming platforms, whether by providing low-latency gameplay, high-quality graphics, or robust cloud connectivity. Another area that will benefit greatly is the broadcasting of esports tournaments. We saw how 4G data penetration, particularly the availability of low-cost data and low-cost smartphones, energised the sector. Similarly, 5G will be critical in driving the next phase of growth"

Naman Jhawar - SVP, Strategy and Operations - Mobile Premier League (MPL)

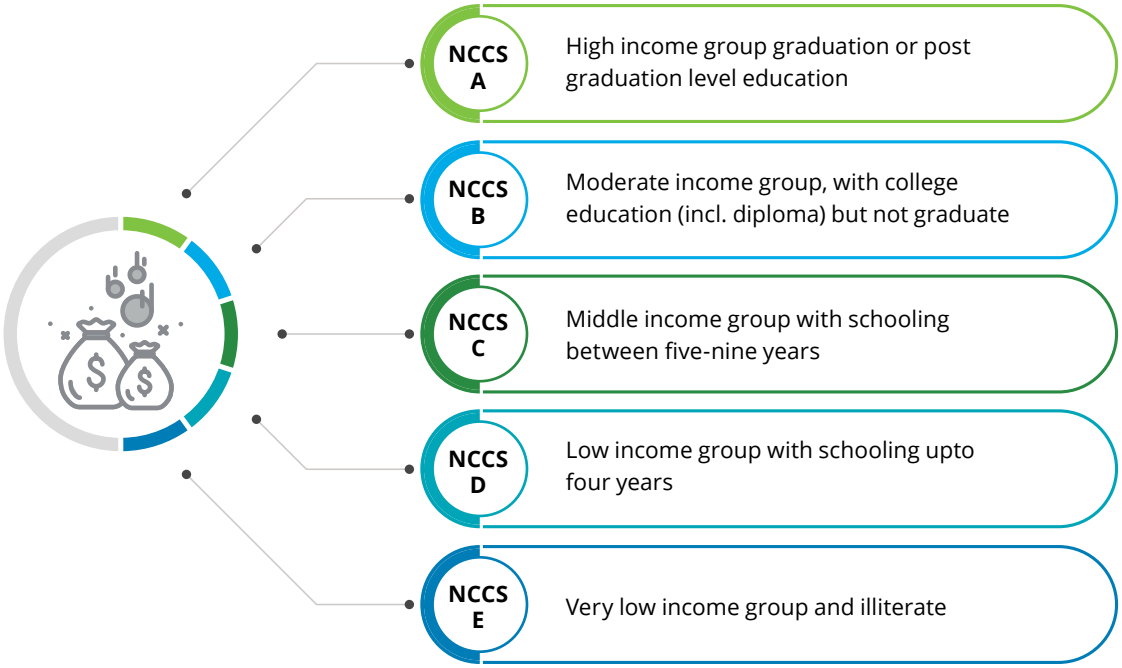
Impact of digitisation on consumer demography

The Indian population has seen a significant rise over the past decade in terms of internet adoption. Launch of affordable 4G handsets, affordable internet services, and significant expansion in mobile network enabled the immense adoption of e-commerce, healthcare, education, hospitality, online banking, and payment applications. As India evolved into the 'one-nation-one-network' paradigm, urban tele-density in India reached 141 percent in March 2021 (from 157 percent in 2011)[42, 43] with telecommunication operators eliminating roaming. Alternatively, in rural India, the adoption of telecommunication services increased and tele density almost doubled from 33.79 percent[42, 43] in 2011 to 60.27 percent in 2021.

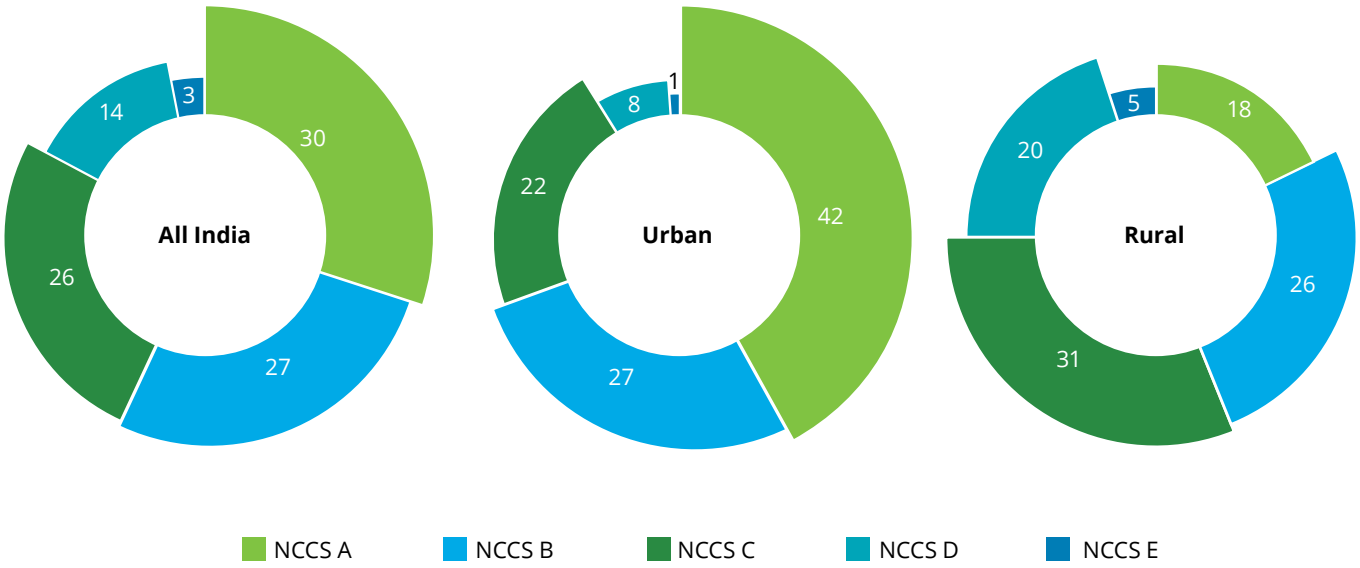
The rise in internet consumption is visible across genders, age, and socio-economic status. In India, active internet users are estimated to increase from 622 million in 2020, to 900+ million by 2025.[44] This rise will be driven by lower socio-economic classes and a change in usage patterns across various age groups.

Socio-economic classes

Availability of affordable smartphones empowered internet access, for the Indian population that was logging on the internet for the first time. Below is a breakdown of rural and urban internet penetration[45] based on our interpretation of New Consumer Classification System (developed by Market Research Society of India and Media Research Users Council) used to classify households in India.



Internet penetration



About 31 percent internet users in rural areas are from the NCCS C category,[45] which is the middle-income group. This segment is expected to continue to grow in the future. Fuelled by education and e-learning platforms, this growth is expected to open new revenue streams for TSPs through partnerships with digital learning platforms.

In urban geography, despite availability, the NCCS D and E category contributes only nine percent[45] to internet users. This will give operators a market of untapped users, to introduce customised affordable packages and 'pay-per-use' services. Additionally, the operators can launch services such as remote location money transfers for this potential customer base segment. For rural sector, TSPs should study the demand and usage pattern of five percent internet users from NCCS E category to launch products suiting their needs and promote internet adoption in this potential market.

Digital adoption vis-a-vis gender

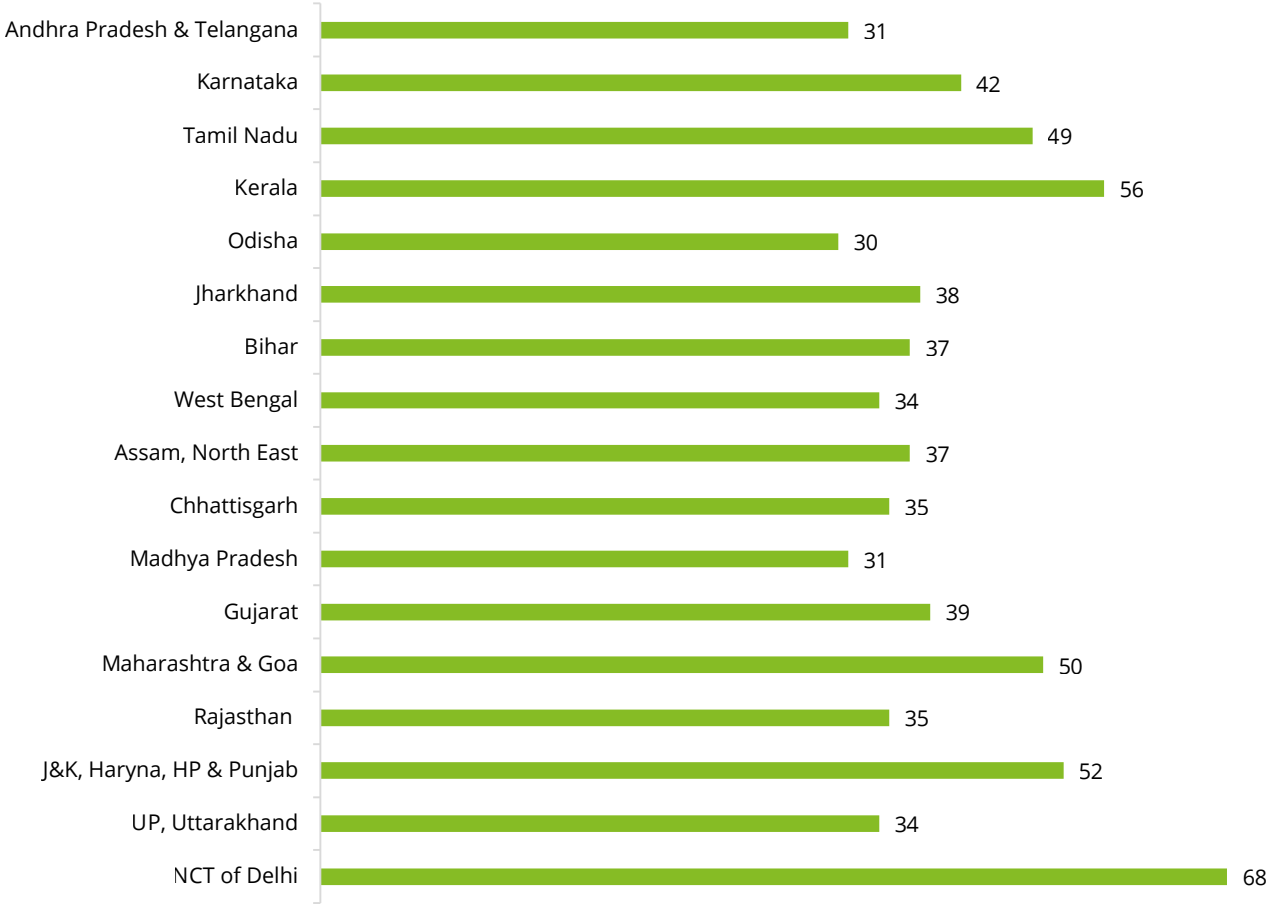
Female users are also bridging the internet usage gender divide by adopting internet at a fast pace. Below is a gender-based internet usage pattern across various internet-based solutions:[44]

All India: Gender

The year 2020 saw the count of female internet users in India reaching the 261 million user milestone[44]. Of these 261 million female internet users, the percentage of females using services (like OTT, online gaming, digital payments, digital commerce and online learning) is less than males. Females contribute to 43 percent of OTT and online gaming internet users. This 43 percent is the highest female contribution amongst other services like digital payments, digital commerce and online learning (where the contribution is average 39.3 percent)[44]. As India has a total female gender population of about 662 million[46], a demand segment of 401 million females still remains to be captured and monetised for internet usage. In order to capture this user base, telecommunication providers can collaborate with women-centric organisations and female leaders/influencers to develop and push customised products.

Internet penetration by states (%)

In India, the internet penetration by state is extremely diversified:[45]



Out of 29 states, 19 states have internet penetration below 40 percent. This suggests the presence of potential markets that telecommunication providers can leverage by motivating a change in internet usage pattern. This internet usage can be fuelled by advancements in technology, availability of multiple applications or options, and awareness of global internet adoption trends. Operators can prioritise and focus on driving revenues from these states by developing local language content. TSPs can cater to these highly diversified geography specific consumer demands through partnerships with regional television channels.

Digital adoption vis-à-vis age

The internet usage pattern in India has completely changed in the past few years. Consumers have shifted from traditional way of life towards digital applications. The internet usage pattern significantly varies in terms of age, but interestingly Indian users from a particular age bracket have similar usage patterns across both urban and rural regions. The table given below represents the urban and rural market share in terms of internet adoption in 2019.[45]

Age bracket	12-15	16-19	20-29	30-49	50+
Urban market share	11%	14%	33%	33%	9%
Rural market share	16%	19%	36%	25%	4%

The rate of internet adoption significantly rose after the pandemic, with large number of services being digitised. Lockdown encouraged not only the youth but also senior citizens to adopt digital platforms and contribute to internet consumption of India. The table below represents some internet adoption trends amongst various age brackets for the Indian population from 2020 to 2021.

Age bracket	Internet adoption factor	Trends in the age bracket
10-20 (Gen Z)	Education	In 2020,[47] • 13.8% of private school children used live online classes • 3.2% of government school children used online platforms for classroom learning
	Gaming	• In 2020, India ranked the fifth-largest mobile gaming market globally[48] • Currently, gaming is popular amongst Gen-Z male internet users • Average daily gaming reached 1.97 hours in 2020[49]
	Social media	• About 63% internet users spent most of their time on social media apps to chat with other people[50]
21-30 (Millennials)	Entertainment	• Average daily content consumption reached 3.66 hours in 2020[49] • Additional 1.6 hours of OTT content was consumed during the lockdown in 2020[49]
	Gaming	• Average daily gaming reached 1.11 hours in 2020[49]
	Dating apps	• Millennials use dating apps to find life partners rather than casual relationships
	Banking/FinTech	• Extensive use of digital banking to get lucrative cashbacks and rewards
	Social media	• Use social media to connect with colleagues and friends during work from home or vacations
	Professional education	• Additional courses/executive MBA, along with jobs, enhance skill sets
	E-commerce	• India's e-commerce orders volume increased by 36% in Q4 2020, with the personal care, beauty, and wellness segment being the largest beneficiary[51]
31-49 (Adults)	Banking	• In 2021, 295.5 million Indian adults used digital bank accounts[52]
	E-commerce	• About 90% consumers shifted more of their spending to online shopping since the pandemic[53] • Nearly 44 percent middle-aged internet users shopped online via social media since 2020[53]
	Managing businesses	• Digitisation has brought about ease in managing businesses online due to availability of customised solutions
50+ (Elders)	Healthcare	• Monthly active users increased by 100% since the pandemic[54] • Cutting-edge health apps allow seniors and their family members to receive real-time updates on their vital health parameters
	Banking	• About 30% growth was recorded in e-wallets since the pandemic[54]
	Social media	• Video calling increased to stay connected with friends and family

Wide reach and availability of e-commerce platforms has attracted the youth of India and created a strong user base amongst elderly population where internet consumption is increasing. The consumer demands have changed across the age groups.

- **10-20 (Gen Z)**: Telecommunication operators have tapped age brackets of 12-15 and 16-19 in a limited manner. The internet adoption in this age segment is majorly focused on education, gaming, and social media. Hence, TSPs should focus on launching more bundled products around gaming and professional education to tap customers from this segment. Additionally, online games should be developed that attract young female consumers.
- **21-30 (Millennials)**: This consumer segment of either students pursuing higher education or professionals use almost every digital service. Hence it is the biggest market for TSPs to explore more service offerings as the customers are ready to adopt new digital platforms to ease their lives. Loyalty points and rewards on usage of digital payment platforms is expected to attract new customers and retain old ones. As the awareness towards healthy lifestyle is growing, consumers are willing to spend on such products. Partnerships with beauty, health and fitness brands can fetch revenues for the telecommunication sector by either offering discounts on purchase or providing bundled health packages.
- **31-49 (Adults):** E-commerce has also come a long way from online clothing to fresh groceries being delivered to the houses. This shows that customers are now comfortable using online platforms to fulfil their daily requirements. This opens a two-way opportunity where TSPs can collaborate with e-commerce companies and provide platform to support and manage small businesses.
- **50+ (Elders):** Consumers from this segment mostly have a fixed set of requirements. Hence, the usage pattern can be studied and focused products should be developed to target this segment. Here, the telecommunication operators can not only partner with healthcare and pharmacies, but also provide health insurance products for the users.

Since 2020, India has also witnessed a steep rise in average screen time majorly propelled by below genres; this has also emerged as the top three internet activities in India:

Binge watching for the entertainment sector

8.5 hours a week[55]

Online gaming

Average 8.5 hours a week[56]

Social media

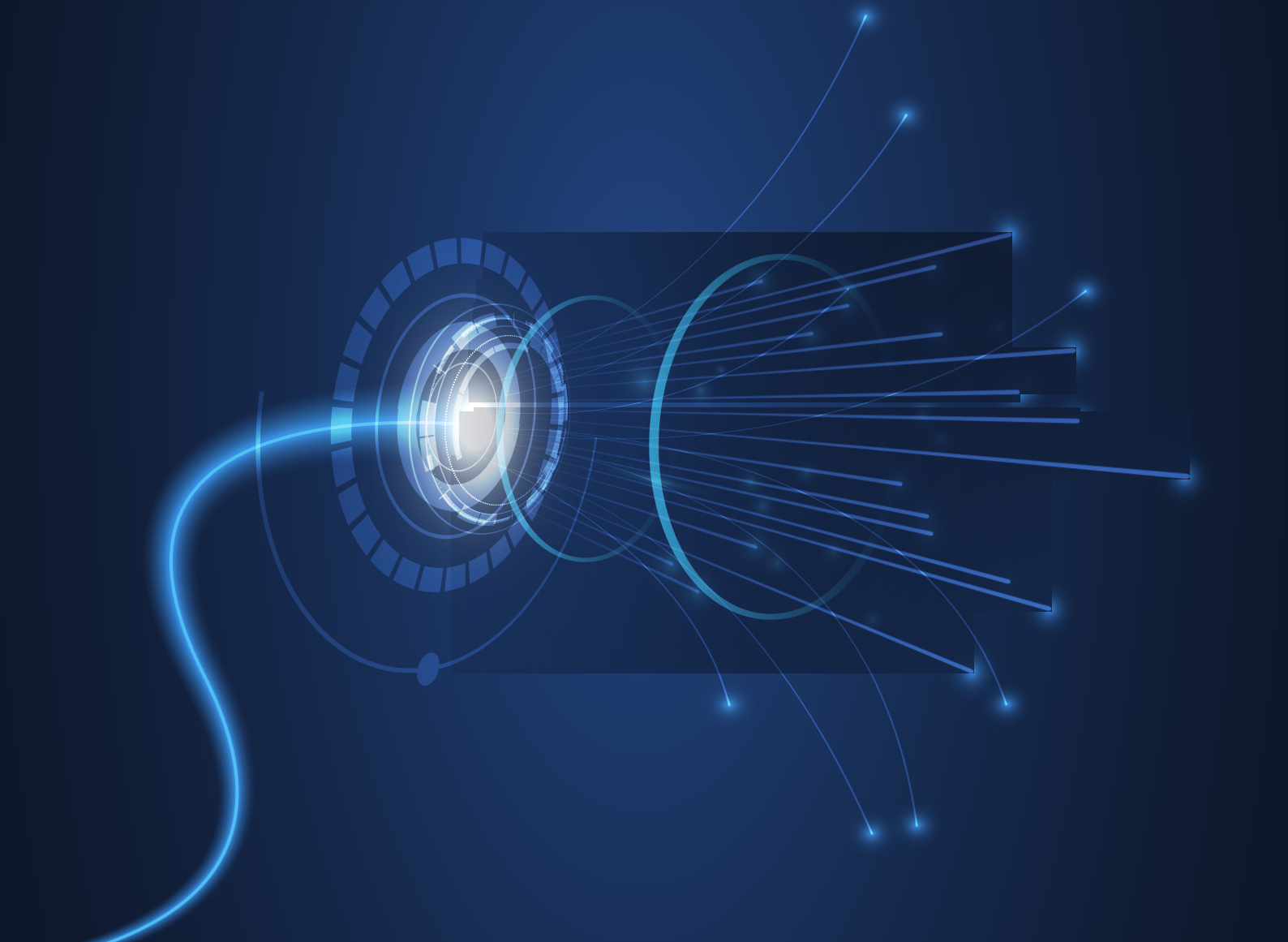
Average 18.2 hours a week[55]

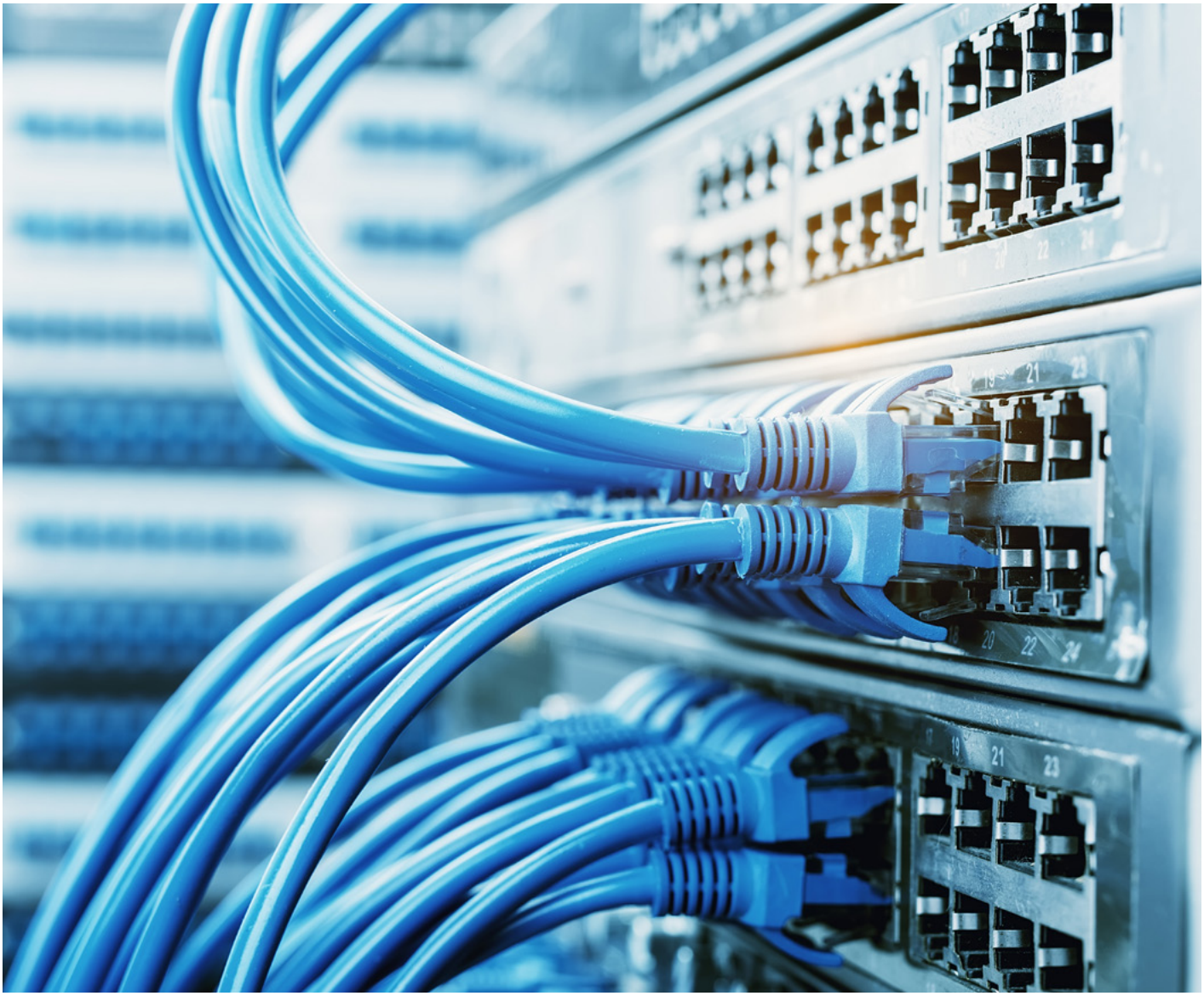
Education is another sector that is proliferating in the digital era where gap in learning standards between urban and rural is diminishing day-by-day on account of edutech organisations. The internet usage in India has a clear demarcation based on various social, economic, and age diversifications. This diversification opens multiple untapped opportunities for operators to develop and deploy customised solutions. Operators should diversify and partner with other ancillary industries to offer customised bundles for various customer segments, under a single bill.

Telecommunication players are no more targeting just 'the urban Indian millennial'. Companies have started focusing on generating revenues from the rural sector comprising about 536 million rural citizens. As mobile is becoming the primary device for internet access, we expect the rise in internet penetration to be omni-directional across the age, gender, and socio-economic segments. Rising willingness to adopt internet, awareness for online platforms, and the ability to spend online will motivate operators to focus, invest, and rely upon this huge Indian population.

Enablers for digital transformation

The interdependent growth of networks and technologies is one of the key drivers for digital transformation in India. In today's economy, organisations and customers function on the use and trade of data. Thus, it remains quintessential to form a strong foundation of data infrastructure. Numerous such key enablers have revolutionised the functioning of industries and inevitably the future of innovations in our country.





Networks enabling digital transformation

As the data requirements of industries and consumers continue to increase rapidly, networks offering low latency, security, and reliability remain vital to the development of digital India. With the emergence of 5G and upgradation of networks in the country, we foresee a unified digital ecosystem enabling innovations and facilitating exchange of information.

Satellite Broadband Communication (Satcom)

Broadband communication over satellite is well accepted as a key pier across the telecommunication industry. It is used to provide connectivity at extreme geographical locations where terrestrial networks are unavailable. Quality of satellite communication depends on the orbits of the satellite i.e., Low Earth Orbit (LEO), Medium Earth Orbit (MEO), and Geostationary Earth Orbit (GEO). The distance of orbit from the earth has an inverse relationship with signal strength and a positive relationship with a satellite's lifespan. LEO and MEO are used most frequently by satellite phone service because of their proximity to the earth.

Benefits

A key objective of telecommunication operators is now shifting towards high speed and reliable data throughput. Some operators are also targeting a latency/connectivity rate of less than one millisecond.[57] Satcom technology can assist in achieving these objectives.

Satellites are expected to play a crucial role in the future of 5G by connecting the unconnected. It shall fill connectivity void whenever a user migrates from a terrestrial coverage area. For end-users, satellites shall offer a seamless extension of 5G services from the city to airplanes, cruise liners, and other remote locations. It will also help in offloading traffic from terrestrial networks in urban and suburban locations, to alleviate congestion.

Statistics

- Adoption of satellite communication has started globally, with more than 4.5 million users in the US and over 2.1 million users in the European Union.[58]
- The current penetration of satellite users in India is 0.3 million. The user base of satellite communication in India is likely to increase to about 1.5-2 million by 2025, clocking revenue of nearly US$798 million annually[58].
- Indian Space Research Organisation (ISRO) launched 328 foreign satellites from 33 different countries and generated revenue of about US$25 million to February 2021.[59] India is all set to become the hub for the small satellite launch market, which is estimated to be valued at about US$38 billion by 2027.[60]

Use case

A backhaul is used to connect multiple network components with a core network through fibre optics or wireless components. With the arrival of satellite communication, the collection of cell tower or individual cell towers will provide backhaul connectivity through a satellite. Furthermore, satellites also have a unique advantage to connect IoT assets and offering truly ubiquitous coverage where there is no margin for connectivity gaps (i.e. limited or no access to terrestrial or regular networks).

Conclusion

A leading Indian telecommunication operator has partnered with a British telecommunication company to offer satellite-based connectivity for IoT devices. This will enable additional flexibility and coverage. We also expect to see collaborations of solutions between e-commerce and cloud computing companies with satellite internet providers for starting satellite-based internet services. For instance, a Satcom company and a global e-commerce giant are planning to launch satellite-based broadband venture in India in partnership with TSPs next year. This partnership will offer large bandwidth with speed as high as one Gbps.[61] Satcom players are expected to target customer base from railways, shipping companies, adventure tourism, aviation industry and telecommunication companies. One of the global Satcom Operator (With majority investment from Indian TSP's member firm) is building its initial constellation of 648 LEO satellites and starting services this year to the Arctic region, including Alaska, Canada, and the UK. By late 2022, the operator will offer high-speed, low latency connectivity services globally.[62]

The establishment of such new business ventures implies that satcom is gaining popularity across the world due to its extensive geographical coverage and limitless broadcasting capabilities. The demand for satcom is further accentuated due to the massive demand for data essential for 5G, Industry 4.0, and IoT, as well as for promoting the mission of 'digital India'. India's satcom potential can be further unleashed by increasing the number of communication satellites available with us. Empowering and collaborating with the private sector will fill in the lacuna and facilitate faster growth of satcom in future.

5G

The telecommunication sector has witnessed a tectonic shift within networks. Traditional 2G and 3G networks have been upgraded and replaced with 4G in most countries. However, to meet the ever-growing need of data transmission speed, roll-out of 5G is crucial. 5G shall also act as a catalyst where people and machines will communicate with each other. It will release new waves of data and open new avenues to support the telecommunication industry. 5G is expected to further empower the technological convergence, wherein machines and systems will function with intelligence levels like humans. This offers the potential to augment decision-making by delivering near real-time information and support.

Benefits

5G as a technology shall connect millions of devices with the internet network. To ensure that devices are connected seamlessly, 5G rollout should have broad, dedicated channels, ideally 50MHz or wider. This shall be achieved through high frequency of the C-band spectrum which will enable persistent connectivity and greater coverage across cities, with a low tower deployment cost. The Heterogeneous Network (HetNet) that is expected to provide the required geographic coverage for 5G, will include a wide range of network elements such as pico, femto, micro, small, and even Wi-Fi. These elements serve a smaller area than traditional macro cells via spectrum reuse. Deployment of 5G, along with digitisation across 'key stroke' level processes within industries (such as manufacturing, healthcare, smart devices, and IoT), will create new opportunities for TSPs to diversify and extend their business solutions. 5G will also enable operators to optimise the cost per GB by a factor of 10.[63] The 5G technology is set to bring the next wave of disruption in the telecommunication sector, with an array of cross-industry applications that are poised to further boost telecommunication carriers' income.

Statistics

- By 2035, about 270 million 5G connections shall be present in India and 7.8 billion globally.[64]
- Total contribution of 5G to the annual global GDP will be nearly US$3 trillion.[64] 5G Technologies is estimated to make an overall contribution of US$450 billion to the Indian economy (0.6 percent of GDP by 2040).[68]

Use case

Revolutionary use of technologies (such as IoT) is limited by speed of internet due to latency issues. 5G promises to deliver significantly higher speed of transmission and latency as low as one millisecond. This will empower industries and technologies such as IoT and satcom, to innovate over the backbone of this 'glitch-less' network.

For instance, 5G will enable development of smart ports for the shipping industry, which is estimated to save labour costs by 70 percent.[65] This will help ports to have optimised supply chain capabilities and generate additional profits.

In the healthcare industry, doctors will be able to perform remote surgeries with higher precision and lower risk on account of 5G network capabilities.

Conclusion

In 1990, the introduction of browsers on the internet unlocked avenues for multiple internet bases businesses. This revolution is still ongoing to date where mobile banking applications have almost replaced traditional banking. Similarly, we can expect 5G equipped with Ultra Reliable Low Latency (URLLC) and Massive Machine Type Communications (MmTc) to make way for ideas and innovations that have been conceived only in science fiction. We could expect sectors such as education, healthcare, transportation, agriculture, Fast Moving Consumer Goods (FMCG), and e-commerce to tremendously grow and evolve online. 5G is expected to become a dominate technology by 2035. 5G is going to transform the way we communicate and shall lead to amalgamation of various industries with the telecommunication sector.

"India is one of the top five markets for 5G network infrastructure business. As India embarks on its 5G transformation journey, open-networking concepts, such as Open RAN will play a major role in helping to meet the goals of digitally connecting the population and enhancing productivity in the B2B segment. We are seeing this play out in other geographies. Europe is currently leading the world in adopting Open RAN. New business models are emerging including public-private partnerships to bridge the digital divide. NEC's collaboration with the UK government to accelerate rural broadband connectivity using Open RAN neutral host architecture provides a template that could be relevant to India's goal of connecting the billion Indians. The broadening 5G RAN vendor ecosystem is also helping to accelerate transformation in the B2B market, and the Indian corporate sector will benefit from 5G-enabled use cases being deployed across verticals such as manufacturing, smart cities, smart health, and hospitality."

Rahul Chandra, Head - Global 5G Business Development at NEC Corporation

Private networks

A private network is dedicated for private use by an organisation where access is restricted to authorised devices and users. It is a limited coverage network with a spectrum requirement of 50–100 MHz.[66] Private network s has no connection with external public network and commercial communication services.

The Industry 4.0 revolution and technological advancements such as IoT, automations, and robotics, have led to an upsurge in the adoption of private networks. With the increasing bandwidth, latency, and heightened security demands, corporates are opting to have their own networks. Establishment of private networks is not dependent on TSPs. In several European countries, regulators have started offering direct spectrum to enterprises which enables them to establish their private networks. Earlier, TSPs were responsible for construction, operation, and ownership of wireless network. In the current Indian telecommunication scenario, if TSPs can provide private 5G networks to enterprises, they can boost the enterprise revenue to more than 40 percent from the current 10 percent.[66] Another revenue source for TSP is network slicing over a public network, where enterprises can enjoy the advantages of a private network without the upfront cost and complexity involved in installing and operating an on-site wireless infrastructure.

Many companies in sectors such as retail, healthcare, education, utilities, manufacturing, and transportation are expected to deploy private 5G networks over the next 10 years. Several industry verticals focusing on process automation for Industry 4.0 and demanding 'real-time' connectivity will be looking to take advantage of the private network's potential.

Use case

The global market value of private 5G network is expected to increase from US$1,375 million in 2021 to US$14,284 million in 2028, growing at a CAGR of 39.7 percent.[67] Some of its use cases are listed below.

Manufacturing - Private 5G networks are gaining traction in manufacturing because many organisations want to build their own networks to advance the notion of industry 4.0. It will help companies to optimise data linkage across various connected machines and track assembly line products in real-time. It will also provide increased agility, shorter response time in the manufacturing process, and safety of price-sensitive information.

Smart facilities - To make smart facilities, private 5G networks can provide considerably improved network connection, which can be used to promote digital transformation. These networks are being considered for airports, stadiums, and office buildings. This will allow these venues to swiftly enhance transmission capabilities, especially inside where signals are weaker. Smart facilities will enable the deployment of a new suite of modern IT systems in a faster and secure manner.

Logistics - Warehouses, distribution centres, and ports have a continual inflow and outflow of products that must be tracked. Logistics are supported by a broad variety of linked devices, including parcels, shipping containers, connected cameras, and heavy machinery. The rise of e-commerce has increased efforts to automate numerous logistical activities with robots that demand strong connectivity. Thus, private 5G networks can help logistics facilities expedite their digital transformation goals.

Advantages - Private networks bring faster and safer operations, new capabilities, and efficiency in industrial processes in addition to seamless connectivity. Industry 4.0 shall have a new generation of cyber networks, which will be supported by a private network. Use of private network shall fulfil mission-critical applications' coverage, performance, and security requirements.

India's planning for private networks – Countries such as Germany and France are allocating private licenses to enterprises. It remains to be seen whether India will administratively allocate spectrum to enterprises for establishing private 5G networks or opt to auction the spectrum as it does for telecommunication operators. Private networks will be key to harness the potential of 5G in India. A comprehensive policy on partnership between TSPs and private network infrastructure companies, including spectrum distribution, is required before the auctions in 2022.

"Private networks are different from public networks, in context of cellular connectivity, refer to dedicated networks that are authorised for and used by designated user/devices. In India, given price/cost sensitivity the use cases for private will be hybrid networks wherein public networks (i.e., standard cellular- 4G/5G) will co-exist with private ones. The use cases for 'hybrid' will be for access controlled large spaces, such as airports, multi-use complexes, industrial/ warehouse automation, and Ultra-High Net Worth (UHNW) residence complexes. Most significant benefits for private networks are the ability to provide capacity and coverage on demand. These networks give the ability to provision personalised connectivity experience and value services such as e-concierges."

Ram Sellaratnam, Founder, CEO and Managing Director - iBus Networks and Infrastructure Pvt Ltd.

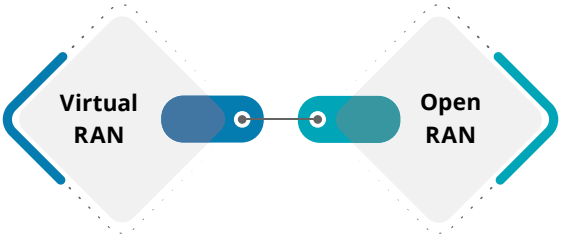
Next generation Radio Access Networks (RAN)

A RAN (Radio Access Network) is a form of mobile network architecture which encompasses radio base stations with massive antennas. It is a wireless access point that connects devices to the main network. The next generation RAN is a collection of significant architectural alterations to telecommunications access networks.

To offer cellular services, Mobile Network Operators (MNOs) use traditional RAN architecture that comprises custom hardware and proprietary software, which requires expensive, time-consuming, and labor-intensive operations and maintenance. Vendor choice for MNOs is also a constraint as equipment and interfaces connecting the hardware are bound by proprietary conditions of the original supplier. With the launch of 5G, MNOs must match the speed at which networks are deployed and expanded to satisfy the rising digital hunger of users. To facilitate this, MNOs are moving away from proprietary systems and going towards virtual platforms that are open, standards-based, and software-centric. This is where Open RAN kicks in.

Open RAN uses a software-driven functionality that is tightly integrated inside the hardware. It allows a telecommunication operator to update software instead of replacing network gear to reduce upgrade and innovation cycles and bring new features and capabilities to market more quickly. The two concepts of openness under Open RAN are mentioned below:

Replaces specialised custom-built hardware with a low-cost, general-purpose hardware that includes a programmable RAN infrastructure. These virtual architectures allow software-based services to be administered without changing the underlying hardware.



In addition to separating software from hardware, the open and standards-based interfaces of Open RAN replace the proprietary communication interfaces, thereby enabling operators to source equipment and software from different vendors.

Benefits

- Lower upfront capital deployment costs and operating expenses lead to low ownership cost. Software-based RAN infrastructure helps telecommunication operators roll out new features and functions at distributed RAN locations in a cost-effective manner.
- Using open RAN, MNOs can add new features and functionalities without needing to replace network equipment. This reduces the upgrade and innovation cycles significantly. Suppliers can also benefit from open RAN.
- Due to open RAN's interoperability, suppliers can design products and solutions for use by a wide range of operators rather than constructing custom solutions for each one.
- As the number of bandwidth-intensive apps increases, open RANs make it easier for third parties to create AI/ML solutions that assist operators.

Conclusion

With huge investment outlays needed for building and expanding communication networks, Open RAN can be a game changer. Indian telecommunication operators are considering open RAN as a viable option to cut expenses and customise their networks in preparation for the transition to 5G. It has also made it easier for Indian software, equipment, and system integrators to have a share in the global 5G market by building 'Make in India' solutions and equipments.

Technologies enabling digital transformation

Undoubtedly, technology and digital transformation go hand-in-hand to create a digital economy. Widespread availability of network has been a catalyst for innovation and has led to creation of remarkable technologies that can solve complex operational processes and make human lives easier in a matter of seconds. Some of the technologies listed in this report are a testament to the massive potential of digitalisation in India.

IoT

IoT is a network system of interconnected computing devices which enables transfer of data without requiring 'human-to-human' or 'human-to-computer' interaction. In some ways, it entails connecting every geographical location and 'things' in the world, to internet. For instance, consider your mobile phone before it became a smartphone and imagine the technological revolution since the launch of the first smartphone in 2007. Similarly, IoT also offered several opportunities for the entire telecommunication ecosystem.

Benefits

Using a highly versatile IoT cloud platform, companies can connect their physical assets to the cloud and remotely manage their operations, investigate malfunctions, and keep track of inventory. Leading telecommunication operators have launched IoT platforms that integrate data seamlessly and connect billions of devices. Such platforms are poised to fulfill IoT's requirements by offering high-speed internet.

Additionally, with IoT, enterprises can streamline the process of connecting, collecting, and analysing data through flexible Application Protocol Interfaces (APIs). IoT-enabled devices are communicating with each other in an efficient manner and enterprises are saving significant energy and cost. This also empowers management to make decisions to increase an organisation's overall efficiency.

Statistics

- IoT units in India are estimated to reach 100 billion by 2035[64], producing immense data volume, generating revenues in trillion, and boosting employment opportunities.
- The Indian IoT market is expected to expand at a CAGR of 13.2 percent from 2020 to 2025.[69] The IoT market in Asia-Pacific is expected to grow at a CAGR of 25.8 percent between 2019 and 2026. It shall reach US$436.77 billion by the end of 2026.[70]
- Global System for Mobile communications Association (GSMA) expects the global IoT market to triple in the next five years and reach US$906 billion in revenues.[71]

Use case

Utility companies no longer require technicians to read or update meters. IoT-enabled smart meters can collect the consumed data for gas, water, and energy, and periodically send alerts to a central server for processing. IoT has enabled utility companies to save up to US$200 per meter per maintenance trip in US.[72]

Industrial IoT can connect machines, tools, and sensors, to give much more visibility into production. Organisations can automatically track parts using sensors that can help identify bottlenecks, find the root cause of problems, and improve quicker by having a real-time view.

In pharmaceutical operations, temperature of the manufacturing, storage, and logistical infrastructure can be critical to quality. Use of IoT-connected temperature and humidity sensors can empower the pharmaceutical industry to monitor those variables and automatically initiate corrective measures if vital parameters go beyond the expected limits.

Conclusion

Customers' desire for greater connectivity between the outside world and their personal life is expected to drive the growth of IoT. 5G-ready network of telecommunication operators will empower the end-to end IoT platform, allowing higher speed and greater connectivity. This shall enable a wide range of new IoT services and devices to meet the increasing technological needs of customers.

A leading telecommunication operator has designed new digital innovations, such as 'Learning-on-the-Go' (LeGo) and 'N-Rich', which train employees to elevate their technical knowledge on topics such as IoT. Furthermore, the Digital University of Kerala (DUK), collaborated with Centre for Materials for Electronics (C-MET), to set up Intelligent Internet of Things sensors in Kochi. The Telecommunication Sector Skill Council (TSSC) has associated with Broadband India Forum (BIF) to train and skill BIF members on IoT and other emerging technologies. With demand for IoT on the rise, such initiatives by educational institutions, organisations, and government bodies shall enable rapid economic growth in the Indian market. IoT is also very well positioned to generate new job opportunities across the telecommunication ecosystem.

Cloud computing

Cloud technology helps store data, access files, software, and servers through internet-connected devices. Unlike traditional hardware and software, cloud computing helps businesses stay at the forefront of technology without making significant investments in purchasing, maintaining, and servicing equipment themselves. This technology delivers network analytics, artificial intelligence, and software applications over internet. This helps companies become agile in planning their resources without purchasing any physical asset.

Various large-scale cloud service providers are helping the global organisation with its requirements. The cloud-enabled world is unlocking opportunities for large IT service providers and provides a variety of new revenue streams for telecommunication operators. Operators may repackage existing hosting and networking capabilities. They can deliver cloud infrastructure and storage services by combining cloud and telecommunication transformation into a powerful amalgamation.

Benefits

Using cloud computing, organisations can host software and hardware at a much lower cost. Organisations experiencing rapid growth but lacking capital to invest in hardware, may seek cloud services with the Infrastructure as a service (IAAS) model. In the telecommunication industry, cloud computing enables efficient allocation of computing resources, thereby reducing the cost of hardware. Similarly, if organisations want ready-to-use software that is available via a third party over internet, they can use the SaaS model. Furthermore, implementing cloud improves the total cost of ownership and de-risks the upfront capital expense (CapEx) and operational expense (OpEx). Deploying cloud also enables highly scalable and flexible infrastructure. A massively scalable cloud allows building highly scalable services for operators to meet demand for peak loads and seasonal variations. The cloud that allows scaling of the mobile network to meet the challenges of erratic traffic and thereby, eliminates the risk of low-data speed and slow page loads. With cloud computing in foray, telecommunication businesses shall improve on customer engagement through seamless and secure communication. A leading telecommunication operator in India has also built a comprehensive set of innovative cloud solutions. These solutions are benefiting customers to adopt new services across analytics, data warehousing, IoT, and migrate to the cloud from legacy infrastructure. Cloud computing ensures adequate security and high-performance network services with end-to-end quality assurance for end-users.

Cloud computing also brings in various benefits for telecommunication operators. Heralding a change in how Information Communication and Technology (ICT) resources are provided, cloud computing for telecommunication opens new opportunities to create and deliver business value as well as increase profitability. Through its utmost convenience and flexible pricing models, cloud enables telecoms to become more agile and competitive in the new environment.

Statistics

- The global cloud computing market is projected to grow from US$250.04 billion in 2021 to US$791.48 billion in 2028 at a CAGR of 17.9 percent.[73]
- Per an IDC report, the Indian public cloud services market revenue reached US$3.6 billion in 2020. It is set to reach US$9.5 billion by 2025, growing at a CAGR of 21.5 percent.[74]

Use case

Cloud computing permits auto-scaling features to services, such as virtual machines. Applications can automatically grow their infrastructure resources in response to a rise in traffic. Users can access modern machines designed for heavy parallel processing tasks. These machines enable continuous integration, delivery and help increase application velocity by reducing the time to market.

In the entertainment industry, cloud computing provides a way for platform owners to store their content digitally and stream the content to consumers. It also allows consumers to share their comments and reviews online. In the healthcare industry, cloud computing provides a way for patients to store their medical records digitally and allows medical practitioners to access them from anywhere at any time. This will reduce the effort and paperwork burden on medical practitioners and help improve the healthcare industry. In manufacturing, companies find it difficult to manage diverse locations and supply chains requiring large, intricate database applications. Cloud allows these companies to connect remotely, and provides real- time updates along with the necessary infrastructure, to empower each location while maintaining affordability and reliability.

Telecommunication industrials are creating a cloud-based, omni-channel communications platform that enables voice, SMS, and IVR to ensure customers have a superior experience.

Global telecommunication operators have started launching a commercial 5G mobile network. They use cloud services to support their 5G network rollout to maximise decision-making velocity and take an advantage of large-scale compute capabilities of the cloud. This ensure faster and agile rollout of network.

Conclusion

Cloud computing is expected to deliver advanced computing resources on-demand with regular updates without buying and maintaining on-premise infrastructure. With cloud computing, teams become more effective and rapidly acquire services without the considerable effort. Telecommunication operators are aiming to collaborate with cloud providers and explore using the cloud servicing area, to unlock a variety of new opportunities such as end-to-end platform service backed by cloud infrastructure.

Augmented Reality (AR)/ Virtual Reality (VR)

VR creates a digital environment that replaces a user's real-world environment. It is primarily used in gaming and entertainment applications. Augmented Reality (AR) overlays digital content and information onto a digitised physical world as if they exist in the actual world. For instance, imagine a store shelf with a product. At present, it may have labels identifying the name and quantity of a product. With VR, the user will be able to see sales and inventory data, and other analytical information at the shelf while taking a walk around the store. VR and AR are reshaping marketing in domains ranging from real estate and automotive, to consumer goods and retail. Increasing demand for VR equipment amongst smartphone users, launch of entry-level VR headsets in the market, and a marketing push by smartphone manufacturers, have boosted the VR market across the globe.

Benefits

AR/VR provides object visualisation thus, enabling a unique user experience. With its ability to showcase larger than life experience, there are high chances of AR getting enhanced by word of mouth and social sharing. This generates the opportunity to rapidly acquire new customers.

The problem of scheduling routine inspections of telecommunication equipment can be resolved by applying AR. The equipment can be viewed remotely with the appropriate instructions given to any person, thus, reducing the overall duration of repair. In addition, costs are much lower as the inspector does not need to travel to the equipment location physically. In the telecommunication industry, AR/VR helps repair and maintain service lines and undersea cables with real-time video instruction that improves response time and enhances customer service.

AR also helps in content quality improvement. It captures user reactions and experiences, providing a tool to improve content by analysing users' behavioural patterns. It creates a room for enhancing the content based on explicit real-life experience that customers' practice. The highly exciting content also motivates users to frequently interact with their mobile application. This interactivity with AR/VR shall also enhance customer retention.

Launch of 5G and high-speed data communications have become key drivers for adoption of VR/AR. Telecommunication operators can collaborate with AR/VR service providers and set up a VR-enabled environment, where they can provide end-to-end solution (including seamless connectivity through 5G rollout).

Statistics

- The AR and VR markets globally were worth US$12 billion in 2020 with a massive annual growth rate of 54 percent, resulting in a projected valuation of US$72.8 billion by 2024.[75]
- AR and VR in the Indian market stood at US$1.83 billion in FY2020 and is forecasted to grow at a CAGR of 38.29 percent until 2027.[76]

Use case

Implementing AR/VR in telecommunication will revolutionise traditional business models to improve productivity and efficiency. Soon, telecommunication companies will be able to deliver top-notch services at an inexpensive rate by cutting costs with the help of AR/VR. Inventory management is one of the most important dimensions in the entire telecommunication value chain, right from equipment manufacturing to its final delivery. An AR-enabled worker, having end-to-end visibility of the inventory, including what is on the shelf, what is in stock, what is in transit, and what is on the counter, will be more responsive to customers and can help avoid overstocking or understocking.

Businesses can solve a variety of maintenance issues by deploying AR in telecommunication. AR/VR has the potential to simplify and accelerate the entire inspection process. In telecommunication, AR can be a valuable tool for field technicians, assisting them in identifying defects and estimating the repair time. Field service technicians can also identify various components of machines using AR. Industries can use technicians to scan components for reaping AR/VR benefits.

Conclusion

Digital reality is likely to have multiple applications for both consumers and enterprise in the longer term. No matter which business industry you belong to, AR and VR can help your business grow exponentially with their features and exciting user experience offerings. Investments in the VR and AR segments are increasing as consumers are showing interest, and industry leaders recognise these areas as a potential opportunity for growth. Across domains, AR/VR is changing how products and services are developed and delivered. This is translating into increased productivity and operational efficiencies. With its rapid growth, AR is looking towards converting Earth into VR. In this way, users would be able to experience the never-traveled areas of the Earth through a virtual experience. AR supported apps and videos have already launched and are improving every day. The technology has the potential to become the foundation of next-gen computing. As a telecommunication giant started adopting AR/VR, odds will be stacked against small and medium businesses. Hence, business leaders should tap the benefits of VR and AR in telecommunication.

Blockchain

Blockchain is a decentralised, unchangeable ledger used to record transactions and track assets in a corporate network. This ledger gives a complete trail of transaction and can be accessed only by authorised members, thereby providing transparency across the businesses.
With a blockchain network, it is possible to keep track of all key information from inventory to production and procurement to payment (amongst others).

Traditionally, telecommunication operators control the whole value chain, including network infrastructure, basic voice and data connections, and associated consumer services, for both consumers and enterprises. However, with increased competition from infrastructure-light OTT companies, declining voice revenues, and rising expenses due to high bandwidth demands, cost optimisation and development of new income streams is inevitable.

Blockchain is likely to have the biggest effect on operators' core management systems and adjacent services, allowing cost savings via process improvements and revenue growth through new value offerings.

Benefits

- Use of blockchain can enable instant settlements, quick dispute resolution to telecom players and real-time usage updates to end customers.
- Reduction of subscriber or other ID based fraud by facilitating easier and faster device identification while users are on the move.
- The use of blockchain technology aims to reduce the role of intermediaries in the telecom ecosystem, enabling better control over operations and reducing related costs. For example, electronic SIM (eSIM) removes the necessity of partnerships with numerous SIM card manufacturers, thereby eliminating manufacturing and distribution costs.
- Blockchain improves coordination amongst various operators and allows for a shared view of the transactions. Thus, making the transaction safe and cost efficient by eliminating the third party.
- Blockchain facilitates data across various systems into a single view that allows for reliable audits (due to the history of every transaction being available in the ledger).
- Blockchain allows a decentralised storage solution for KYC documents to be shared with individuals. This will help reduce instances of forgery and curb the submission of fraudulent documents.

Statistics

- In the global telecommunication market, the blockchain is expected to reach US$993.8 million by 2023, growing at a CAGR of 84.4 percent during the forecast period.[77]

Use case

1. Connections between IoT devices and systems using blockchain, makes it possible to link numerous IoT devices securely and cost-effectively through a self-managed network. The blockchain will allow manufacturing plant machines to interact and authenticate themselves to guide production operations.
2. 5G Enablement -- To reap the benefits of 5G's universal coverage, usage of blockchain technology can assist in determining which node provides the fastest access speed for each individual user or computer.
3. Smart Contracts - Smart contracts on blockchain can reduce the role of intermediaries by automating Service Level Agreements (SLA). Implementing smart contracts in roaming and other cases has improved revenue assurance and reduced fraud related instances.

Blockchain enables secure, error-free tand cost efficient connectivity for thousands of IoT devices. For instance, machines within a manufacturing plant will be able to communicate and authenticate themselves via blockchain to steer production processes.

Conclusion

Blockchain offers a plethora of benefits in the telecommunication industry's core operations. Operators should take a long- term view on the potential of blockchain technology to expand businesses. Telcommunication companies should look for digitisation across organisations and ecosystems. Blockchain can be a viable solution for specific scenarios and bring in simplified process, efficiency, and transparency. Beyond the typical function of a telecommunication operator, the technology will enable the creation of new business models and the exploration of new revenue streams.

Edge computing

Data is the foundation of modern existence. The quantity of data we generate, analyse, and transfer throughout the course of a typical day is staggering. Whether it is in smart factories where machines operate with little human intervention or amongst consumers who have a plethora of smart and connected gadgets at their disposal.

Earlier, data was stored and secured locally on the equipment managed by the data owners. Now, with the advancements in cloud computing technologies, both individuals and companies can use virtual space offered by cloud providers and manage their data. However, data transmission between endpoints and the provider's cloud uses a significant amount of energy and is hindered by latency. This is where edge computing comes into picture.

Edge computing introduces processing power in the network's local nodes, which results in improved performance, lower latency, and reduced costs. Taking an example of smart speakers, currently, queries are sent from the device to the server of smart speaker provider for processing the request. Edge computing will enable smart speakers to receive and process a user's request entirely on the device itself. Telecommunication is an important partner for many edge computing installations, with major telecommunications companies increasingly marketing their own edge computing and IoT solutions.

In 2021, TSPs will accelerate their expansion efforts by installing edge computing solutions for 5G networks. Due to a rise in the number of devices moving on and off networks, and an increase in a variety of bandwidth requirements, telecommunication operators are turning to edge computing technologies. Edge computing will transform and strengthen their (operator) own infrastructure such as expanding central offices to become next-generation data centres and edge hubs. This enables a high level of density and dynamic connectivity for 5G. As a result of these actions, they will be able to better serve subscribers and sell networks to businesses.

Benefits

- Edge computing helps combat issues such as bandwidth limitations, excess latency, and network congestion.
- Moving a huge amount of data across boundaries brings along risks of data security, privacy, and legal noncompliance. Edge computing keeps the data close to its source and within the bounds of prevailing laws. By implementing computing at the edge, any data traversing the network back to the cloud or data centre can be secured through encryption. The edge deployment itself can be strengthened against hackers and other malicious activities.

Statistics

The global market for edge computing is growing rapidly. It is expected to reach US$250.6 billion globally by 2024.[78] Certain businesses, such as manufacturing and telecommunications, have already scheduled the deployment of edge computing solutions.

It is estimated that by 2025, 75% of global enterprise generated data will be processed outside the traditional data centre or cloud owing to faster data processing and low latency.[79]

Conclusion

The ever-growing IoT lays emphasis on the need for localised network infrastructure and processing capacity. Endpoints are generating more data, burdening the existing network topology. 5G of cellular network technology enables significantly higher bandwidth and speeds up the expansion of IoT while enabling edge computing. AI-optimised edge processors give more processing capability, allowing edge systems to be used more widely. Collaboration amongst ecosystem stakeholders such as telecommunication operators, content delivery networks, technology providers, web scalers and start-ups, would be crucial to the success of service-oriented consumption and delivery models for corporate and retail consumers using edge computing.

Smart cities

Megacities have emerged across India due to rapid urbanisation, affordable housing, and population migration towards urban areas. Geographical expansion of cities in India has put massive strain on infrastructure development, public service delivery, and environmental sustainability. Economic, social, and ethnic stratification, along with health, safety, and security requirements, makes the issue more complex. To overcome these challenges, the Indian government and the telecommunication sector have collaborated to establish the Smart Cities Mission. This initiative aims to develop and achieve roadmaps on sustainable growth and energy efficiency, by providing the Indian diaspora with a cost-effective, reliable, and smart infrastructure.

GOI launched Smart Cities Mission (SCM) on 25 June 2015, with a vision of developing 100 smart cities across India. The monumental SCM has now completed six years, heralding a full shift of cities' aspirations to flourish and establish inclusive, efficient, and technologically linked ecosystems. Through these years, the selection of 100 smart cities has shown massive progress. As on 9 July 2021, these cities have tendered out 6,017 projects and marked successful completion of 2,781 projects worth over US$6.40 billion.[80] The past three years, there has been more than 260 percent growth in projects tendered and more than 380 percent rise in projects grounded or completed.[80]

Telecommunications industry has acted as a backbone of Information and Communications Technology (ICT) by providing a robust network coverage. The ecosystem of ICT infrastructure is a prerequisite for a smart city. ICT components consist of a plethora of devices, connected through technologies such as IoT, big data applications, and Machine to Machine (M2M) communications. This ecosystem of interconnected ICT infrastructure across public, private, and PPP services requires high speed, low latency, and a reliable telecommunication network to operate efficiently, thereby achieving the objective of a smart city. Smart cities depend on telecommunication backbone to:

- Enhance business prospects and strengthen the appeal of the city
- Efficiently and proactively connect with its residents
- Reduce operational costs, and optimally use and track resources
- Provide benefit to people with adequate availability of public resources (examples are cited in this section)

Embedded telecommunication infrastructure throughout the smart city, functions as a web by which the data flows efficiently. It allows execution of complex tasks, such as routing water to areas in need of water or managing an emergency in the quickest and most efficient manner. For instance, if a power line is short-circuited, an embedded chip will send information to the power hub, allowing engineers to respond quickly to the problem. Similarly, if water supply is disrupted due to a leak, smart sensors can detect and repair it quickly. Such problems are resolved with the support of an established telecommunication infrastructure throughout smart cities.

As rightly coined by TRAI, a smart city is an ecosystem of ecosystems, involving various sectors, infrastructure, and organisations to be efficiently integrated into one platform. When integrated, new communications capabilities from sensors on buildings, roads, and other city elements, and data sharing amongst service delivery channels, will allow the city to improve services, monitor and control resource usage, and respond to real-time information.

Smart cities function on the foundation of IoT and high connectivity of devices. The telecommunication sector can monetise this opportunity by acting as a connectivity provider. Additionally, telecommunication operators can take a step further and become smart city co-creators. Global operators across the world are partnering with their local governments to provide connectivity and manage the smart city portfolio. For instance, one of the largest mobile operators in Japan has formed a contract with the government of Yonaguni Island to administer IoT services of the island in various fields, such as educational, healthcare, agricultural, environmental and economic monitoring. Indian operators can also play a key role in operation and maintenance of smart cities by entering annual maintenance contracts with the government.

Smart Cities market revenue in India is expected to grow at a CAGR of 18.5 percent between 2017 and 2023 to touch an aggregate of US$47.70 billion[81] by 2023.

Telecommunication services are expected to be the single largest catalyst for achieving the smart city transformation.

Government initiatives to boost the telecommunication sector

The recently announced telecommunication reforms are a clear indication of the government's commitment towards sustainable growth of the telecommunication industry.

Current reforms[82]

On 15 September 2021 India's Union Cabinet approved the below mentioned, nine structural and five procedural reforms, along with moratorium relief in the telecommunication sector:

Structural reforms

- **Definition of AGR rationalised, interest rates reduced, and penalties removed:** Non-telecommunication revenues are excluded on a prospective basis from the definition of AGR, providing major relief to TSPs. This paves the way for a larger ecosystem. A proposed reduction of two percent interest rate in the deferred license fees will result in savings of US$ 2.6 billion to telecommunication companies over a period of four years.
- **Bank Guarantee (BG) requirements reduced:** Due to telecoms' perilous financial situation, this step is likely to significantly decrease operators' exposure to banks that have been reluctant to provide additional BGs.
- **Foreign Direct Investment (FDI):** 100 percent FDI allowed under the automatic route will ease the inflow of foreign investments in the telecommunication sector.
- **Spectrum-related reforms:** Scrapping spectrum usage charges for future auctions, scrapping of spectrum sharing charges, allowing spectrum surrendering, and increasing tenure of spectrum auctions will help bring flexibility to business models.

Procedural reforms[82]

- **Auction calendar established:** A timetable for future auctions will help operators plan and manage liquidity accordingly, thereby minimising uncertainty in the market.
- **Removal of licenses under old customs notification:** License requirements to import wireless equipment have been replaced with self-declaration to promote the ease of doing business.
- **Know Your Customer (KYC) reforms:** In order to digitise KYC processes and make subscriber acquisition easier, e-KYC based on Aadhaar will lower warehousing costs and help in a more accurate mapping of subscribers.
- **Standing Advisory Committee for Frequency Allocation (SACFA) clearance for telecommunication towers simplified:** To enable faster clearance and help telecommunication operators accelerate network deployment, the SACFA approval will now be provided through a single interlinked Department of Telecommunications (DoT) portal on a self-declaration basis. This will in-turn enable a faster roll-out of network in the country.
- **Four-years moratorium and other relief measures announced:** Moratorium or deferment of up to four years in regulatory payments (AGR judgement) and past spectrum purchases, along with an option of paying the interest amount by way of equity, will provide a breathing room for debt-laden operators. This will help telecommunication operators consolidate debt by reducing their immediate cash crunch. Four years is a fair period, and this clearly paves the way for a good 5G auction.

PPP model of BharatNet[83]

- The Indian government embarked on the BharatNet mission with an aim to connect 2.5 lakh gram panchayats with internet encompassing over six lakh[87] villages. At present, 1.56 lakh gram panchayats have been successfully connected.
- Union Cabinet approved a proposal for PPP in BharatNet to expedite efforts towards achieving the programme's goals. Private operators will oversee the design, upgrade, operation, and maintenance across BharatNet initiatives.
- With this model being planned to be implemented in 3.61 lakh[88] villages across 16 states, BharatNet is estimated to cost US$3.92 billion[84] under the PPP model, with the government contributing US$ 2.54 billion[83] through Viability Gap Finance (VGF).

Production-linked Incentive (PLI) scheme[85]

- The Union Cabinet approved the PLI scheme valued at US$1.62 billion for telecommunication and networking products in February 2021, to provide financial incentives to encourage local telecommunication network equipment manufacturing.
- Over the next five years, full utilisation of the scheme funds is likely to result in incremental production of US$31.93 billion[86] and exports of US$26.61 billion.[86] The scheme is also estimated to bring in more than US$0.40 billion[86] in investments and generate numerous employment opportunities. The PLI scheme is in line with the government's larger strategic goal of 'AatmaNirbhar Bharat' (Make in India), which encourages local telecommunication equipment production and reduces reliance on imports.

Changes in the telecommunication sector were highly awaited. These reforms mark the beginning of a new age. It shows the government's resolve to bolster the industry's sound growth and tackle the long-standing challenges faced by the telecommunication sector. These reforms also empower TSPs to make up for their liquidity woes and reduce their cash flow pressure. These initiatives and reforms are essential steps in the telecommunication industry's development and will encourage much-needed investment in the sector. It will give life to a billion people's digital ambitions and help India move forward to become a digitally driven economy.

Prospects for revenue streams in the telecommunication industry

With the current changing landscape in the technology and digital platforms, telecommunication companies are busy strategising the next step in finding possible business prospects to produce new revenue streams. In the past few years, TSPs have immensely benefitted from massive data traffic but witnessed a sharp decline in revenue from voice and SMS services. Telecommunication services are now shifting to digital services and traditional cable network providers are replaced by internet content providers. 'Beyond connectivity' is a phrase used by the TM forum to highlight the telecommunication industry's efforts towards diversified revenue streams as digitisation progresses and rollout of 5G begins.

The emergence of triple-play and quad-play services has been one of the largest trends in consumer telecommunication markets over the past decade. Below are some of the prospects for revenue streams in the telecommunication industry:

One-stop OTT app for consumers and enterprise – a new era of value-added services and beyond: TSPs can evolve their existing OTT customer support app, by analysing the current customer segmentation. This can be further digitised to offer a new set of services using technologies such as AR, VR, blockchain, OTT messaging/video/music, and IoT. This shall be empowered by 5G and edge computing that will provide high speed and high resolution content. As telco beholds the power of the largest consumer base (unlike any other industry), this 'one-stop OTT app' shall be accessible to masses, and will enable consumers to use services beyond customer support.

Using the one-stop OTT app, TSPs can offer various services to consumer and enterprise customers. A hybrid model of subscription may be commercialised for consumers using on-demand services and pay per use charges. Similarly, for enterprises, it shall become a revenue-sharing or upselling/cross-selling/re-selling platform as follows:

- Virtual classrooms for learning and education
- At home medical consultations and assessing patient symptoms remotely
- Driver assistance services providing automatic collision avoidance, traffic alerts, and brake status for nearby vehicles
- Experience live events such as concerts and sports tournament from home without missing any split-second action.
- Common app for access to latest movies and soundtracks
- Self-launch platform for artists to upload their songs

The one-stop OTT app shall become a marketplace for different sectors and end-consumers. This shall enable cost-effective and optimised interactions through reduced dependency on staff and facilities. Furthermore, it will allow other sectors to target the huge customer base available at a single platform for potential opportunities and strengthening sales and revenue streams. Below is an excerpt of a few industries for potential collaboration:

- **Healthcare:** Customers requiring medical assistance, such as virtual consultations, medical prescriptions, and in-patient check-ins at the registered hospitals and clinics can be facilitated through one-stop OTT app.

  Further, use cases in this area are mentioned below:
  - The technology landscape that telecommunication operators bring with themselves shall allow virtual and personalised experience through remote patient monitoring, enabling hospitals to manage patients' historical records and authorised claims, as well as reduce the cost of re-admissions.
  - Blockchain shall be used to authorise user identity, enabling a trusted relationship.
  - The one stop OTT app is visioned to allow permission-based view of the 'one to many' interactions between patient-to-hospital and vice-a-versa. It can also manage patients' medical history records and service credibility.
  - Using one-stop OTT app, AR/VR based virtual interaction can take place amongst the users and medical service providers.
- **Travel and tourism:** Customers should not be limited to purchasing travelling tickets or hotel accommodations. The one-stop OTT app can offer AR/VR based inside view of hotels, travel seating, etc. Airlines and other modes of travelling can then provide customers a personalised view for better selection of travel facilities.

  While user authentication can become a concern for travel and tourism partners, the telecom sector can facilitate the blockchain-based identity management that will be unique to each user providing assurance to the allied partners. Also, the one-stop OTT app shall enable seamless check-in experience for customers, by transferring the relevant real-time user data via secure channels.
- **Entertainment:** The one-stop OTT app can provide a platform for artists to showcase their talent and upload their portfolios (protected with copyrights). The app can also enable them to interact with entertainment industry giants or production companies partnered by TSPs. Parallelly, talent management companies shall get access to the pool of talented artists and their market presence.
- **Electronic:** Remote monitoring and repair is the need of the hour for the electronic industry. The one-stop OTT app can provide a platform to allow electronic enterprises to facilitate the repair and maintenance of the equipment installed at customer premises using AR/VR. While field engineers perform their jobs remotely, they can be provided with useful information on the spot, suggesting potential fixes and pointing out potential problem areas.
- **In-app advertisements for every sector:** TSPs can amalgamate B2B and B2C business models by offering services to companies for advertising their products/services on the one-stop OTT app. In return, users who opt and buy products through these digital ads, can get add-on data packages or any other discounts.

Explore the opportunity of becoming a market leader in the entertainment industry by leveraging the perpetual demand for content: An active OTT video and media market provides collaboration opportunities for TSPs. Indian telecommunication companies can focus on the following strategies to expand their reach in the OTT market and strengthen their user bases:

- **Acquisitions of established Pay-TV businesses –** Telecommunication giants globally have acquired cable TV businesses and satellite broadband connectivity providers. Indian TSPs can leverage the same strategy.
- **A production house instead of just being a content facilitator:** Indian telecommunication players can further focus on acquiring the rights to various sports broadcasts and other forms of entertainment by collaborating with content owners and various production houses globally. The telecommunication sector can further focus on creating its own production companies and Pay-TV services. It allows TSPs to invest strategically; reduce the dependency on third-party platforms for content; and generate revenue from selling subscriptions and reselling broadcasting rights of the content developed under their production houses.

Data monetisation: Following the advancements in big data technology, telecommunication operators can focus on offering a more customised online experience solution to end users of other sectors. With the presence across the country, telecommunication operators can segment consumers based on their needs, demography, and behaviour. Using this data, telecommunication operators can then collaborate with online retailers of other industries to provide information on users (such as location-based data and network usage). Complying with the rules and regulations set by regulatory authorities, telecommunication operators can monetise such information, and provide such statistics and data analysis services to other businesses. These businesses include retail, financial services, and advertising agencies, which can use these insights to build customer-centric personalised marketing campaigns.

5G leading the way: As we witness the rollout of 5G, it possesses tremendous potential for B2B services in India. With the launch of Industry 4.0 and other revolutionary changes, telecommunication operators should now focus on monetising the new technology. 5G can be used to empower the experience of consumers with varied use cases across different sectors. According to TM Forum, TSPs will have to develop new ordering, fulfilment, assurance, and billing capabilities from scratch to create products and services using 5G in a variety of verticals. Telecommunication can monetise its infrastructure of 5G technology, along with the capabilities of network slicing, SDN, and network function virtualisation. TSPs can offer the following services, while strengthening and extending the enterprise customer base:

- Assisting government in realising the modern concept of smart cities
- Empowering the automotive sectors with the capability of autonomous vehicles
- Sustaining and retaining the user base for sporting organisations by enabling an AR-based view of the live sporting event
- Enabling advanced remote surveillance system using drones. In this context, telecommunication operators can collaborate with drone manufacturing companies and offer an end-to-end remote surveillance system to various industries.

Collaborating telecommunication with cloud storage: As the digitalisation evolves, user demands for data and subsequent, data storage will increase at a drastic pace. At present, Indian telecommunication giants are offering cloud storage to their enterprise users. The storage comes with various security features, such as antivirus, Distributed Denial of Service (DDoS) protection, content filtering, and data loss prevention. As regular users witness a heavy surge in data, they experience a space crunch on their hard disks. Hence, demand efficient cloud storage system with cloud-deployed security solutions can be the next big revenue stream for operators, given their huge customer base. Indian telecommunication players can generate a strong revenue stream by offering such services to varied customer segments.

With government regulations' intent on breaking monopolies and levelling the playing field, telecommunication operators must use digital transformation optimally to get the maximum benefits. Global telecommunication industry giants have already welcomed the digital revolution with open arms. By identifying key areas for digital transformation, telecommunication operators are looking for future-proof revenue streams. Digital transformation has turned out to be an effective source of generating new revenue streams, provided that the right investments are made at the right time.

Conclusion

Proliferation of network usage is a key milestone for digital transformation in India. The telecommunication industry has undergone a tremendous metamorphosis and responded to the high demand for data across sectors and fields.

The launch of 'digital reset' in the manufacturing sector will change the way products and production systems are designed, manufactured, operated, and serviced using technological enablers such as IoT, private networks, cloud and edge computing. These enablers will transform the traditional communication channels into a real-time supply chain, supported by digital production lines. Similarly, the quality and penetration of education and healthcare in India will radically increase with the emergence of latest automation technologies and networks. After the expansion of network coverage even to the remotest of regions of the country, unnecessary travel costs for students and patients will plummet as healthcare and education will be easily accessible through unified connected devices. A collaboration between the sectors will further strengthen their reach to offer services such as teleconsultations, online workshops on digital literacy, and financial inclusion to both the rural and urban areas.

Furthermore, current KPIs that are being tracked by the telecommunication regulatory bodies are mainly focused on new subscriber additions, Average Revenue Per User (ARPU), tele-density, etc. In order to improve digital adoption, government statistical bodies should start tracking KPIs that will help industries to make relevant business decisions. For instance, internet adoption rate based on demography can be tracked. This would allow new industries to take adequate decisions in terms of their business avenues, ultimately improving the country's overall economic dynamics.

As we move forward and welcome the revolutionary onset of 5G in India, the questions on its affordability need to be addressed. 4G and VoLTE model is an exemplary way to achieve this. Its rollout ensured a rapid rise in digital adoption amongst Indian consumers at affordable costs. To repeat this growth story, the government should ensure economical distribution of 5G spectrum amongst telecommunication operators. This will ensure judicious pricing of 5G for consumers, eventually maintaining the current growth in terms of digitisation.

The government may also introspect creation of a separate cabinet portfolio on 'Digital Transformation' that will work cohesively with other government bodies and drive digital adoption in India.

5G is also poised to enhance the digital financial sector (fintech). Despite consumers' increased dependency on digital services, there remains a lacuna of trust that needs to be addressed. Consumers feel an underlying threat of data breach and financial fraud while using the fintech services. Such challenges can be successfully addressed with the telecommunication sector and government's intervention by creating a secured and cost-efficient ecosystem for users. A strong lead in adoption of AI will be of immense relevance in filling the trust gap of users and bolstering digital transactions in the country. Banks and fintech organisations are incorporating AI/ML applications to assist online banking engagements and use AI to flag unusual spending patterns. AI in financial services allows an application to learn from interactions without the need to re-engineer or rewrite algorithms. This will allow institutions to be one-step ahead of fraudsters by providing deep API traffic visibility. Regulatory authorities should mandate the use of AI and Blockchain in tracking fraudulent financial transactions. This shall ensure transparency in the system and encourage more people to adopt digital services.

At present, networking is not merely reduced to connectivity. It has formed a grander picture comprising upliftment of users by becoming a primary source of livelihood. Our emphasis on defining the telecommunication industry as a 'service enabler' encapsulates how it binds together every industry and application to build a strong foundation of 'Digital India'. India's digitisation is undeniably meant to grow by heaps and bounds as both the government and operators aim to form a robust partnership marked with unparalleled growth and evolution of telecommunication sector in India.

About CII

The Confederation of Indian Industry (CII) works to create and sustain an environment conducive to the development of India, partnering industry, government, and civil society, through advisory and consultative processes.

CII is a non-government, not-for-profit, industry-led, and industry-managed organisation, with over 9,000 members from the private and public sectors, including SMEs and MNCs, and an indirect membership of over 300,000 enterprises from 294 national and regional sectoral industry bodies.

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