

Significant Policy Milestones in India's Digital Evolution (1851-2018)

Chavi Asrani & Abhay Pant

Information Communications Technology (ICT) facilitates in poverty reduction and promotes economic development. The telecommunication policy and regulatory framework in India has facilitated the growth of communications services in its current form today. India has the world's second largest pool of wireless subscribers. But there remains vast differences in access to ICT services across sectors and states in India. This study provides an abridgement of significant policy milestones since the introduction of telecommunication services in India in the year 1851 until the lately approved National Digital Communications Policy 2018.

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Introduction

Information and Communications Technology (ICT), has drastically improved connectivity, and amalgamated in most aspects of modern human life; it is now regarded as a general-purpose technology (Liao et al., 2016). ICT facilitates poverty reduction and advances economic growth (Qiang et al., 2009; Kim et al., 2021). India currently accounts for world's second largest pool of wireless subscribers. The National Digital Communications Policy (NDCP) 2018 discusses to accord communications infrastructure critical status at par with other connectivity infrastructure such as roadways, railways, waterways and airlines (DoT, 2018c). The policy and regulatory framework in India have facilitated growth of communications sector in its current form today, India's tele-density grew from about 2% in the year 2000 to presently about 87%, but there remain vast differences in ICT access across sectors and states (TRAI, 2022). This study provides an abridgement of significant policy milestones since the introduction of telecommuni-

cations in India in the year 1851 until the lately approved NDCP 2018.

Pre-independence: Telecommunication Legacy

India's telecommunications operations commenced in 1851 with the introduction of telegraph services (Sridhar, 2011). The first submarine telegraph cable from United Kingdom was installed in Bombay (now Mumbai) in 1870, thereby opening external communications in the sub-continent. The British Indian Government granted permission to Oriental Telephone Company Limited to establish telephone exchanges in India and exchanges were started in Calcutta, Madras, and Bombay in 1882 (BSNL, 2012). Later the colonial government passed a resolution outlining state's monopoly in telephone systems, following which telephone service was bundled with telegram service by 1884 (Mann, 2010). Next, the colonial government enforced the Indian Telegraph Act 1885, according state the power to establish telecommunications lines on private and public properties (DoT, n.d.a). This colonial Act, after various significant amendments is still upheld in India.

In 1927 high-frequency radiotelegraph was initiated in India, followed by the introduction of radiotelephony in 1933 (Mann, 2010). The Indian Wireless Telegraphy Act, instituting the license system to regulate the state monopoly was also enforced in 1933 (DoT, n.d.b). After the 12th amendment of this Act in 2003, it was stipulated that the Central Government may determine the license

fee after considering the recommendation of Telecom Regulatory Authority of India (TRAI) (Ministry of Law and Justice, 2004).

As the British ruling class considered telephones as a means for domestic communications, the telephone lines were deployed only for administrative and military control. An inquest of the British India telephone network spread, indicates that the requirements of the colonial government's control determined the communications system's progress (Mann, 2010). During the year 1943 the telephone system was nationalized, and telephone services initiated by the private companies taken over by the government (Mann, 2010).

Monopoly by the Government

After Independence, the Government of India (GoI) took control of the telephone network which connected 82,000 subscribers through 321 switching exchanges (Mann, 2010). India founded its first public sector unit, Indian Telephone Industries (ITI) Limited in 1948, as a manufacturer of telecommunications equipment (ITI Limited, 2018). Subsequently, commercial production of strowger switching equipment started in 1949 (Mani, 1989). In 1959, the government appointed the Telephone Switching Systems Committee, which recommended manufacturing of new superior switching equipment called crossbar. In 1964, ITI started manufacturing the crossbar switch of Penta-conta design, but as India's telephone density was low and usage high (due to sharing of tele-

phones), the Penta-conta design cross-bar switches were not suitable. Consequently, GoI formed India Crossbar Project Group in 1974, which redesigned local and trunk automatic exchanges, which were commissioned into service during 1978 and 1980 (Mani, 1989).

In 1978, the Ministry of Communications incorporated Telecommunications Consultants India Limited (TCIL) as a telecommunications consultancy and engineering company to provide telecom expertise in India and overseas (TCIL, 2018). Over the years TCIL has diversified into various areas including cyber parks and cities, intelligent buildings, and up-gradation of legacy networks (DoT, 2017a). To better India's telephone services, Sarin Committee on Telecommunications recommended switching over to digital electronic switching systems during 1981 (Mani, 1989). The sector witnessed pre-liberalization impetus in late 1980s with network expansion and structural reorganization. In 1984, GoI instituted Centre for Development of Telematics (C-DOT) to promote research and development in telecommunications sector, envisioning to develop capabilities coherent with the country's usage pattern (C-DoT, 2010). By the end of 1980s the switching system in India comprised our switches - manual, strowger, crossbar and electronic (Mani, 1989).

During the Seventh Five Year Plan (FYP), India's telecommunications sector advanced with the unbundling of the Department of Post and Telegraph in 1985 into Department of Posts and the Department of Telecommunications

(DoT) under Ministry of Communication. DoT administers planning, engineering, installation, maintenance and operations of entire telecommunications services in India. In 1986, Mahanagar Telephone Nigam Limited (MTNL) and Videsh Sanchar Nigam Limited (VSNL) were incorporated under DoT (NCAER et al., 2012). MTNL provided telecom services in Delhi and Mumbai; while VSNL took over from the 'Overseas Communications Services' to provide for India's international telecommunications, and DoT provisioned services in regions other than Delhi and Mumbai (TATA Communication, 2018).

In April 1986, DoT initiated 'Mission Better Communications,' which was later renamed as 'National Mission on Telecommunications' and brought within the ambit of 'Technology Missions' of the Eighth FYP. The mission under the headship of Sam Pitroda introduced modern digital technology and computerization of the telecom network aiming to improve accessibility and quality of service (QoS) (M.B., 1989). Private players started entering the industry during 1980s offering telecom equipment, subsequently franchises for Subscriber Trunk Dialing, International Subscriber Dialing and Public Call Office also grew.

During 1986, Education and Research Network (ERNET) project virtually brought Internet in to India. The dial-up network project was initiated by the Department of Electronics, with funding from the GoI and United Nations Development Program. This project created a network, to provide facility for Indian

research community and build-up India's competencies in networking (ERNET, 2018). In 1989, GoI instituted Telecom Commission with executive and financial powers to administer various aspects of the sector (DoT, 2017).

Until 1991, India's communications sector was monopolized by the government, and industry was a small-sized market, getting access to services was difficult and QoS poor. The sluggish growth of telecommunications was reflected in the growing waiting list for connections that stood at 1.31 million lines by the year end 1988, which was about 34% of the total working connections (Mann, 2010). One of the reasons for grim performance of the sector was low investment. The share of telecommunication investments in gross fixed capital formation was about 1.3% during 1971-1987, and the national plan outlay till the seventh FYP was just over 2% (Mani, 1989).

Post Liberalization

Appreciating the potential of telecommunications in contributing to economic development, the Eighth FYP made telecom access an essential element in planning (GoI, 1992). Private participation was encouraged and manufacturing of telecom equipment was decentralized. Telecom services were classified into basic telephony, radio paging, and cellular mobile. Specific value-added services such as radio paging, e-mail, voice mail, audio and video text services were initiated in 1992 (Medudula et al., 2016). Licensing process for cellular-mobile ser-

vices in the four metro cities (Delhi, Mumbai, Kolkata, and Chennai) was embarked in 1992 following a duopoly market approach and Global System for Mobile (GSM) was the mandated technology (Sridhar, 2011).

The announcement of National Telecom Policy (NTP) -1994, emphasized on providing telephone on demand, improving service quality, and extending services in rural sector. NTP-1994 visioned to establish India as a manufacturing hub and an exporter for telecom equipment, and endorsed for private participation in the sector (DoT, 2016). Increased private participation provided funds for network expansion, relinquishing the state monopoly that caused low supply, high prices for telecom services. However, during 1995 only two operators were allowed per License Service Area (LSA)

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The GoI held the first commercial communications spectrum auction in 1995, subsequently second-generation (2G) services were initiated, and industry grew exponentially (Prasad et al., 2008). India's tele-density grew from 0.69% in 1991-92 to 1.9% in 1997, but the wireline waitlist continued to rise during the late 1990's (NCAER et al., 2012). With increased private participation, sector needed a regulator, and

in February, 1997, TRAI was established to regulate telecom services, including fixation of tariff rates (DoT, 2018).

On August 15th, 1995 VSNL launched India's first public Internet service; but service quality was low, and subscriptions grew slowly (Sridhar, 2011). To improve Internet uptake, GoI issued Internet Service Provider (ISP) licenses to private enterprises in 1998 (TRAI, 2008). There was no ISP license fee required and ISPs could determine their own tariffs. The number of ISPs were also unrestricted. The liberal regulation ensured competition among ISPs for subscribers, resulting in low tariff rates, that facilitated Internet uptake.

After the implementation of NTP-1994, GoI realized that except augmentation of mobile density, progress was not made in provisioning basic telecom service. Thus, NTP-1999 re-emphasized on universal provisioning of quality telecom services (DoT, 2016a). Private operators were awarded license on a revenue sharing basis and a one-time entry fee. GoI recognized that the cost of providing telecommunications services was higher in remote areas, and these areas generate lower revenue due to low population density and low income, therefore it would not make a business case for operators to serve these areas adequately. To address this market inefficiency and achieve universal service obligation (USO) targets, GoI decided to raise funds through a universal access levy. Further, in October 1999, services portion of Department of Telecommunications (DoT) was detached from it and brought under

the newly founded Department of Telecommunications Services (DoT, 2016a).

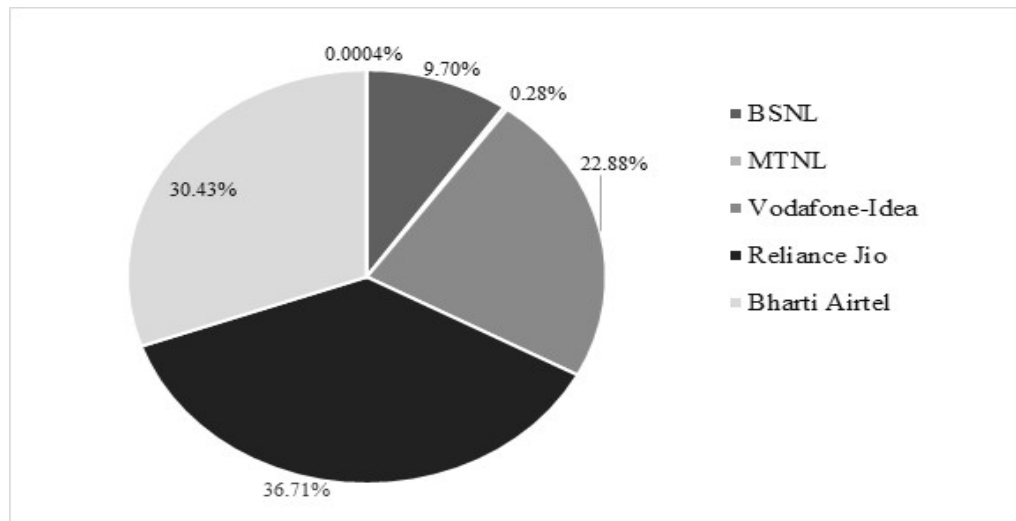
The Millennium Decade

During the year 2000, TRAI 1997 Act was amended to clarify its role. Under this amendment, the Telecom Disputes Settlement and Appellate Tribunal (TDSAT) was also incorporated to resolve industry disputes, to ensure sector's continued growth. (Ministry of Law & Justice, 2000). During 2000, TRAI also issued the first QoS regulation, defining parameters for service quality. In October 2000, the Department of Telecommunications Services was corporatized as Bharat Sanchar Nigam Limited (BSNL), for providing services in India except for Delhi and Mumbai, followed by the provisioning of Internet services (CAG, n.d.).

By 2001 India's tele-density grew to over 3%, but wireline waitlist stood at 1.649 million. To provide better services, public sector telecoms (BSNL & MTNL) were given the third wireless operator licenses, with 900MHz spectrum on a pro-bono basis, and the fourth wireless license was awarded to a private operator via auctions; the winning bidder was granted 1800MHz start-up spectrum (Prasad et al., 2008). By 2022, there were four operators per LSA; additionally, VSNL was also privatized with stake sale to Tata Group and later in 2008, it was acquired by the Tata Group (NCAER & TRAI, 2012). The sector now comprises three types of players: public sector companies, private Indian companies, and companies with foreign investments. Public sector companies

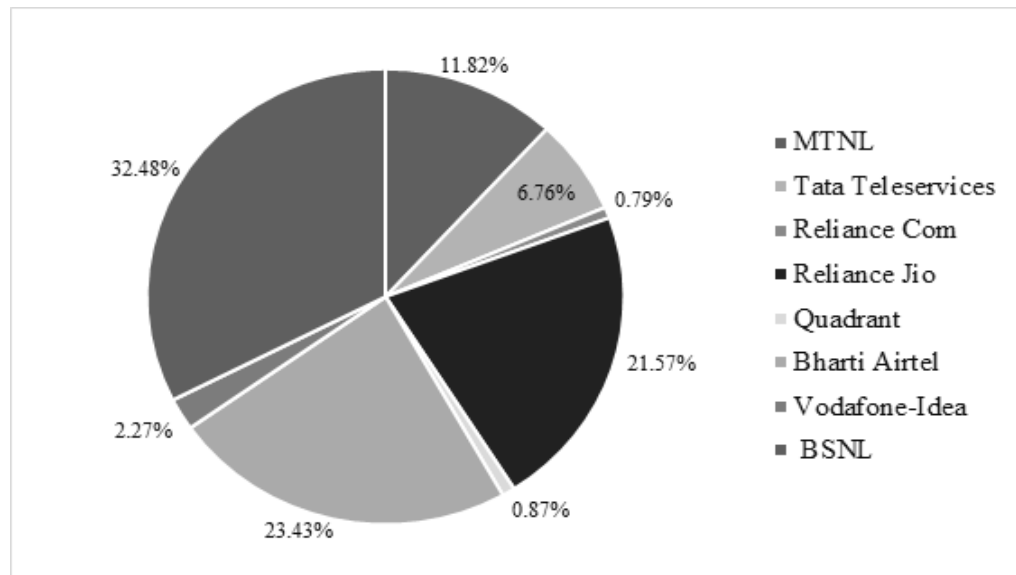
account for about 10% market share in wireless market, and about 40% market share in the wireline market (Figs. 1 & 2) (TRAI, 2022).

Fig. 1 Wireless Service-provider Market Share in Terms of Subscribers as on 30th November, 2021



Source: TRAI (2022)

Fig. 2 Wireline Service-provider Market Share in Terms of Subscribers as on 30th November, 2021



Source: TRAI (2022)

Meanwhile, to deal with airwave scarcity subscriber linked spectrum allotment system was embraced (Prasad et al., 2008). The USO policy that came into effect in April 2002, assisted in building the rural telecommunications infrastructure (NCAER & TRAI, 2012). Additionally, ISPs were permitted to offer Internet Protocol (IP) telephony in 2002, and online applications such as gaming music and video download started receiving traction (TRAI, 2008). But these applications required extra bandwidth, which was not possible with the dial-up access, thus service providers began offering always-on high-speed Internet access (more than 64Kbps) using technologies like digital subscriber lines, cable TV network, and Ethernet Local Area Network, which improved the Internet uptake. To provide last mile connectivity, in 2003 TRAI recommended that ISPs may use any media including fiber, radio and copper cable to provide connectivity (TRAI, 2008).

The announcement of calling party pay (CPP) regime in January 2003 reduced the price of telecommunication service (Sridhar, 2011). Further, the introduction of interconnection usage charges (IUC) in May 2003 ensured the just revenue sharing terms among operators, facilitating a fair play among telecom service providers (TSPs). The CPP and IUC regime advanced competition in the sector and stimulated subscriber growth. For encouraging Internet adoption, Department of Information Technology established National Internet Exchange of India (NIXI) in June 2003, to ensure that Internet traffic originating in and destined

for India, is routed domestically by ISP peering, this facilitated in improving service quality by reducing latency (NIXI, 2018).

In 2002, the Code Division Multiple Access (CDMA) technology was introduced in India, by Reliance to provide basic telephone services using wireless local loop technology. This resulted in disagreements among CDMA and GSM operators (Medudula et al., 2016). TRAI acknowledged that the licensing routine should not constrain technological advancements and unregulated the licensing matters from technological categorizations. With the amendment of NTP-1999 in 2003 the licensee could now offer services using any technology in the specific LSA after conversion of the license to a universal access service license, this triggered unlimited competition in the sector (DoT, 2016b). The universal access service license delinked spectrum allocation from licensing, the firms are now given licenses after fee payment, but spectrum is awarded only when available.

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TRAI review report on spectrum allocation in 2005, submitted that TSPs in India held spectrum below international average, and recommended that before allocating airwaves to new operators, the incumbents should be provided sufficient spectrum to ensure provisioning of qual-

ity services (Prasad et al., 2008). During 2005, TRAI also subjected National Long Distance and International Long Distance tariffs to a ceiling to ensure lower tariffs.

Appreciating the potential of Internet in providing development service such as health care, online-education, e-governance and providing employment opportunities, GoI announced Broadband Policy in October 2004 (TRAI, 2005). The policy re-defined broadband as always-on Internet connection with minimum download speed of 256Kbps up from the earlier 128Kbps. To provide institutional support for Internet proliferation, Broadband policy emphasized on infrastructure requirement in the form of different access technologies and budgetary incentives for domestic manufacturing of Internet equipment (DoT, 2016c).

In July 2005, some ISPs informed TRAI, that achieving Broadband Policy-2004 Internet uptake targets will remain unmet unless local loop is unbundled. Thus, local loop was unbundled to enable full network utilization. Price controls for leased line providers were imposed to promote competition and lower tariffs for international connectivity and broadband services. The increase in Internet subscription, caused added consumption of IP addresses, raising concerns of IP addresses shortage; thus in 2006 TRAI recommended allocation of permanent IP addresses for broadband and migration from IP version4 protocols to IP version6 (TRAI, 2006).

In 2005, Foreign Direct Investment limit in the sector was increased from

49% to 74% which eased funds in the industry and promoted competition (NCAER & TRAI., 2012). The regulatory measures also reduced the local call tariff of mobile service from INR 16.80 per minute in 1997 to INR 1.00 per minute by 2007. To make services more affordable TRAI also ordered a reduction in tariff for national roaming services in 2007 (TRAI, 2007).

In 2007, competition was furthered, with the newly awarded licenses on a fixed fee basis, and the 'crossover spectrum policy' allowing TSPs to use any technology with the same license (Sridhar, 2011). In 2007 there were about seven to eight operators in most LSAs, which doubled in 2008 as additional seven to eight operators were given license in each circle, thus triggering fierce competition (Sridhar, 2011).

Despite NIXI being operational since 2003, the number of ISPs peering on exchange remained limited, as nodes were available at just four locations, while ISPs were spread across India (TRAI, 2007a). This resulted in high cost of leased line to connect with NIXI nodes. To better utilize NIXI nodes, in 2007, TRAI recommended ISPs to either domestically link with all the nodes or with the international bandwidth providers via peering. ISPs were suggested to state and accept all their routes at NIXI nodes, with this ISPs were now not required to obtain an autonomous system number to indirectly link with NIXI nodes. This aided domestic traffic to be treated differently by international bandwidth providers and assisted in providing flexibility to the ISPs

for connecting, and was thus cost saving (TRAI, 2007a).

The IUC regulation was amended in 2009, reducing domestic IUC to 20 paise per minute, which lowered tariffs. Operators were also permitted to sell long distance prepaid calling cards which improved service affordability (TRAI, 2009a). To confirm QoS, TRAI specified service quality norms in 2009 (TRAI, 2009). Better QoS and low tariffs improved the uptake of telecommunications. By December 2009, India had the second largest telecom network in world with 562.15 million subscriptions (Planning Commission, 2011). But, the success of telecommunications was skewed in favor of urban areas. Another area of concern during 2000-10 was the slow broadband adoption.

Going Digital

India's Eleventh Five-Year Plan target of 600 million telephone subscriptions was met in 2010 ahead of 2012 (Planning Commission, 2011). However, then and as it remains, there is much scope for better ICT penetration, especially in rural areas.

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To improve service affordability, in 2010 TRAI directed TSPs to sign agreements amongst themselves, allowing subscribers of one operator to utilize the long-distance calling card of another op-

erator, depending on an appropriate offer. In April 2010 third-generation (3G) and Broadband Wireless Access (BWA) (4G) spectrum was auctioned and mobile broadband at speed up to 2Mbps was also introduced, subsequently, the uptake of 3G services commenced in 2011-12 (Mani et al., 2015).

By September 2010 there were 10.30 million broadband subscriptions with four metro cities leading in subscriptions, and the 2004 policy target remained far-fetched. To facilitate broadband growth, National Broadband Plan was announced in December 2010, envisioning establishing an open-access broadband network on optic fiber, to connect all regions with population over 500 (TRAI, 2010).

The introduction of Mobile Number Portability (MNP) in 2010 further induced competition in the sector encouraging TSPs to provide better QoS at better tariff rates to attract subscribers from other TSPs, while retaining their own.

In October 2011, the National Optic Fiber Network project was approved with an outlay of INR 201 billion with funding from USO fund. The project envisages provisioning of broadband services till the level of all 250,000 *Gram Panchayats* (GPs) with optic fiber network. In 2015 the National Optic Fiber Network project was revamped and renamed as *BharatNet* to provide high-speed broadband connectivity to all GPs by 2019. Until December 2021 the service has only been made available to about 1,32,700 GPs (BBNL, 2021)

In February 2012, Supreme Court of India, ordered cancellation of 122, 2G licenses issued in 2008, stating that appropriate eligibility criteria were not adopted during the allocations process (Medudula et al., 2016). In April 2012, India's first 4G services were initiated by Airtel through dongles and modems using Time Division-Long Term Evolution (LTE) technology in Kolkata. In subsequent years, 4G services were rolled by various TSPs in India.

After 2G license cancellations, the NTP-2012 approval, brought a positive vision in the sector. NTP-2012 re-emphasizing provision of affordable quality services, and service provisioning in remote areas. NTP-2012 visioned to empower citizens through the use of ICT by facilitating their partaking in e-governance, accessing education, health and financial services digitally; and obtaining employment. It incorporated a framework to aggregate spectrum availability for TSPs including triple play services (voice, video, and data) for which broadband is the key driver. The framework included rationalization of taxes, duties, and levies in the sector towards a stable fiscal regime to stimulate investments and generate employment in various segments of the industry (MeitY, n.d.). NTP-2012 encouraged to create 'One Nation' by allowing one license across services and LSAs. Before 2012 DoT charged a license fee at a rate of 10%, 8% and 6% for various LSA and services; it was during June-August 2012 that a uniform license fee at a rate of 8% was adopted (Medudula et al., 2016).

In November 2012, auction of 800 MHz and 1800 MHz spectrum began. Overall, 127.50 MHz of paired spectrum in 1800 MHz band was allotted to TSPs raising INR 94.07 billion for GoI (PIB, 2015). After the 2G licenses cancellation, there were no bidders for spectrum in 800 MHz band. Spectrum in 1800 MHz band was mostly bought by TSPs whose licenses were cancelled, as these TSPs required spectrum to continue operations (Medudula et al., 2016). The cold market response for auction was due to high reserve price, thus subsequent spectrum auction in March 2013 was conducted after reductions in the reserve price. But in 2013 auction, there were no takers for spectrum in the 900 MHz and 1800 MHz bands, and only one TSP bid for 800 MHz in 8 circles (PIB, 2013).

In September 2013, TRAI recommended that spectrum user charge (SUC) should be fixed at a rate of 3% of adjusted gross revenue (AGR) for all auctioned and BWA spectrum, and the highest SUC should be brought down to 5% for any spectrum from April 1st, 2014 onwards (TRAI, 2013). In October 2013, TRAI suggested to keep SUC at 1% of AGR across the spectrum bands, but DoT decided to stick to a higher charge of 5%, above the 3–4% spectrum fee charge for administratively allocated airwaves in the 800/900/1800 MHz bands. (TRAI, 2013). Next, in December 2013, an Empowered Group of Ministers ratified the Telecom Commission's recommendation, allowing TSPs to merge, till their post-deal market share did not exceed 50% (previously 35%) of the total subscriptions and subsequently the industry witnessed consoli-

dation (IBEF, 2015). During 2013, foreign investment in equity of a telecom licensee was also revised up from previous 74% to 100% (TRAI, 2017c).

After two consecutive spectrum auction fiascos in 2012 and 2013, TRAI recommended reduction in spectrum reserve prices in 1800 MHz band. Subsequently, spectrum auction of 1800 MHz and 900 MHz bands in 2014 was successful, garnering INR 611.62 billion for GoI, and stimulating 4G services uptake (PIB, 2015). The 2014 auction witnessed bids exceeding the reserve prices, as licenses of certain operators granted in 1994 were terminating, and these TSPs required spectrum to continue operations. Additionally, new entrants ambitioning to add 5 MHz of contiguous spectrum for provisioning of LTE services also contested for spectrum.

Next 3G service intra-circle roaming was permitted in June 2014 allowing TSPs to enter into intra-circle roaming agreements, to provide 3G services even in LSAs where they do not have license (Medudula et al., 2016). This supported in efficient spectrum utilization, and better QoS. In August 2014, the International Calling Card Service (access charges) regulation was specified, which listed access charges payable by ILD operators to service providers at 40 paise per minute for wireless services and INR1.20 per minute for wireline services (TRAI, 2014). This initiated competition in calling card segment by increasing customer's choice of long-distance operators and also lowered the tariffs rates. To ensure fair play, TRAI suggested a uniform license fee of

8% on AGR of ISPs. Further, considering TSPs request, with the third amendment of QoS regulations, TRAI rationalized the QoS norms in 2014, to ease compliance (TRAI, 2014a).

In February 2015, MNP was announced across all Indian states, this enhanced competition in the sector and encouraged operators to expand their network and deliver better services (TRAI, 2015). Further, to ensure adequate spectrum availability, GoI auctioned airwaves in 800/900/1800/2100 MHz bands, which successfully concluded in March, 2015 (Medudula et al., 2016). But, behest for 2100 MHz spectrum band was cold although much of it was sold baring in three circles. The spectrum was available in 900/1800 MHz bands from elapsing licenses and the unsold airwaves from the previous actions; interest in these spectrum band was high as the incumbent operators wished to continue operations. The 800 MHz band spectrum witnessed high bids in LSAs where continuous 5 MHz spectrum was available for providing LTE services (Jain et al., 2017).

In September 2015, DoT approved for complete sale of airwaves between TSPs, but not leasing (PIB, 2015a). This facilitated inefficient spectrum use and assisted operators to provide better QoS. Additionally, spectrum allotment in 800/900/1800MHz band for 2G services which was bound by technology of the licensee- CDMA or GSM until 2008 was liberalized, similar to the auctioned spectrum, which is technology neutral; facilitating, smooth migration from 2G to 3G and 4G.

Aiming to transform India into a connected knowledge economy, in mid-2015, the GoI launched two massive programs centered around ICT: (i) the INR 980 billion 'Smart Cities Mission' envisioning to develop 100 smart cities using ICT, and (ii) the INR 1,130 billion 'Digital India' program striving to bridge the urban-rural digital divide in July 2015 (PIB 2014; Ministry of Urban Development, 2015). 'Digital India' program visioned to provide broadband connectivity to all GPs, promote e-governance, and deliver services like education, financial and health electronically. The targets of Digital India program still remain unmet (BBNL, 2021).

QoS remains an area of concern specifically in the provisioning of VoLTE services.

A significant area of concern during 2015 was call drops. TRAI identified that the financial disincentive for TSPs was not sufficient to ensure compliance of QoS norms, thus in October 2015 with the fourth amendment of QoS regulations, the financial disincentive for the non-compliance to QoS benchmarks was revised (TRAI, 2015a). Further, under the ninth amendment of the 'Telecom Consumer Protection' regulations, TRAI directed telecoms to recompense subscribers for call drops; but no coercive action was taken against operators if they did not comply (TRAI, 2015b). With the fifth amendment of QoS regulations, TRAI announced stricter financial disincentive for falling short of QoS norms with effect from October 2017 (TRAI, 2017a).

QoS remains an area of concern specifically in the provisioning of VoLTE services (TRAI, 2018).

During 2015 and 2016, net neutrality debate germinated in India, when Airtel suggested 'Airtel Zero,' a platform allowing its subscribers to access select applications for free, while data fee was to be incurred by the application providers, and Facebook proposed the Free basics plan suggesting to offer free Internet access for restricted content. These plans were regarded unjust as firms without deep pockets would not be able to pay for the operator's data charges, thus leading to anti-competitive concerns between big companies and operators. Appropriately, TRAI, announced 'Prohibition of Discriminatory Tariffs for Data Services,' regulation in February 2016, forbidding operators from charging discriminatory tariffs based on the content or applications accessed by the users (TRAI, 2016).

The amendment of Unified Licensed (Access Service) Agreement in February 2016 allowed for infrastructure sharing, which facilitated in provisioning of quality services and eased the infrastructure cost incurred by TSPs (DoT, 2016d). In April 2016, spectrum sharing was also permitted allowing TSPs to pool their spectrum holdings, thus enabling efficient utilization of the complete spectrum block (DoT, 2017). During 2016, spectrum in 800 MHz and 1800 MHz bands were harmonized and about 197 MHz of additional spectrum was recovered from its previous use as separation bands, which was successfully auctioned (DoT, 2017).

Spectrum harmonization assisted in improving QoS by making fragmented frequency spots contiguous thus making more airwaves available. In 2016, GoI also issued Virtual Network Operators (VNO) guidelines and subsequently issued VNO licenses (DoT, 2017). VNO enables operators to better utilize network and spectrum, by infrastructure sharing.

In November 2016, DoT notified the Indian Telegraph Right of Way Rules, 2016 for regulating underground (optical fiber) and overground (mobile towers) infrastructure (DoT, 2017). These rules aimed to streamline the right of way permissions for easing establishment of telecom infrastructure, but the lack of clarity on implementation of the right of way rules continued to challenge the infrastructure deployment. To alleviate the concerns around spectrum availability, in October 2016 DoT held a mega spectrum auction selling 965 MHz of spectrum in multi-bands earning the government about INR 660 billion (DoT, 2017). Of the total airwaves available for sale in 2016 about 60% were unsold (TRAI, 2017).

With the advent of data services in 2010, telecommunications and digital sector amalgamated moving past the traditional services. To safeguard the mis-uses of citizen's personal data, Ministry of Electronics and Information Technology (MeitY) constituted the Data Protection Experts Committee in July 2017. The committee's recommendations include jurisdiction of personal data processing, and suggested establishing an independent regulatory body for enforcing data

protection law and penalties for violating the law (MeitY, 2018). Next, in 2017 TRAI reduced IUC from earlier 14 paise to 6 paise from per minute raising revenue concerns among the industry incumbents (TRAI, 2017b). Reduction in IUC decreased the revenue earnings of the incumbent operators and benefited new entrants.

To tap the domestic mobile phone market and encourage mobile manufacturing in India, GoI increased import duty on mobile handsets, base stations and other specified telecom equipment's the duty to 15% in December 2017 (PIB, 2017). In Budget 2018 the customs duty on mobile phones was increased to 20%, and on some of the mobile parts and accessories revised to 15% (PIB, 2018).

In July 2018, TRAI's 2017 net neutrality recommendations backed by the doctrines of a free, open and non-discriminatory Internet were approved. But TRAI endorsed for fast lanes for specified services charted by the DoT and permitted operators to follow traffic management practices to warrant QoS. Also, content delivery networks and certain serious Internet of things services such as healthcare systems and autonomous vehicle systems that are massively dependent on seamless connectivity have been kept outside the ambit of net neutrality (DoT, 2018b).

National Digital Communications Policy

To facilitate India's digital transformation, in September 2018 GoI approved

the NTP-2018 aptly named the NDCP. Three critical aspects of the policy are: (i) connect India; create sturdy digital communications infrastructure and encourage broadband for all; (ii) propel India; facilitate the adoption of emerging technologies such as 5G, Artificial Intelligence, Internet of things, cloud; and (iii) secure India; to ensure data ownership, privacy and security (DoT, 2018c). NDCP visions to create additional 4 million jobs in the digital sector and augment sector's contribution in India's GDP. The policy also suggests regulatory reforms intended to attract investments in the sector (DoT, 2018c).

To bridge India's digital gap NDCP visions to accomplish 'unique mobile subscriber density' of 65% by 2022, and ambitions universal provisioning of broadband access at 50 Mbps to every citizen. It visions fiber deployment for at least 60% tower sites, and recommended to establish National Fiber Authority to launch common service ducts and utility corridors in all new city and highway road projects, and incentivize fiber connectivity for new developmental construction. NDCP re-emphasizes on infrastructure sharing, to facilitate cost savings opportunities (DoT, 2018c). The policy addresses industry concerns by rationalizing existing license fee, USO fund levy and SUC. To ensure a conducive business environment for adoption of emerging technologies NDCP emphasis on the development of robust backhaul capacity and appropriate availability of harmonized and contiguous spectrum. It also aims to develop a security framework and discusses to allo-

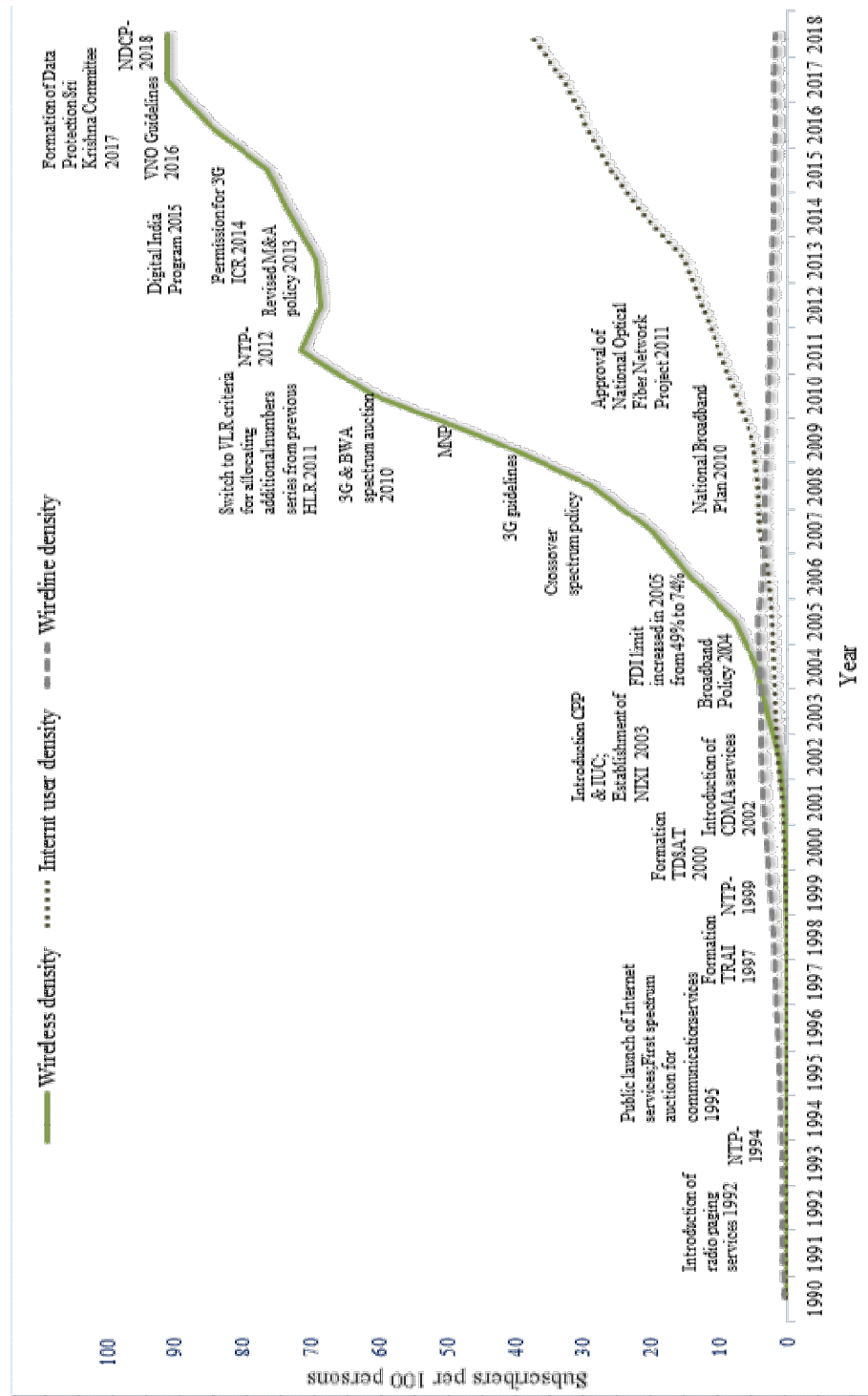
cate a 13-digit number for all M2M mobile connections. NDCP aims to create an enabling framework for cloud systems, content delivery networks, international data centers and over-the-top service providers (DoT, 2018c).

Regarding the data protection, privacy and safety, NDCP attends to craft robust and a flexible data protection regime to uphold citizen's privacy. NDCP recommends to frame exit norms for licensees and aligning them with the bankruptcy code to enhance efficiencies and consumer interests. It advises to simplify the processes for research and development procurement, and design a framework for the testing, and certification of innovative products/services, initiating a fund to promote research and development in emerging technologies, and supporting an intellectual property rights routine to encourage innovation (DoT, 2018c).

Conclusion

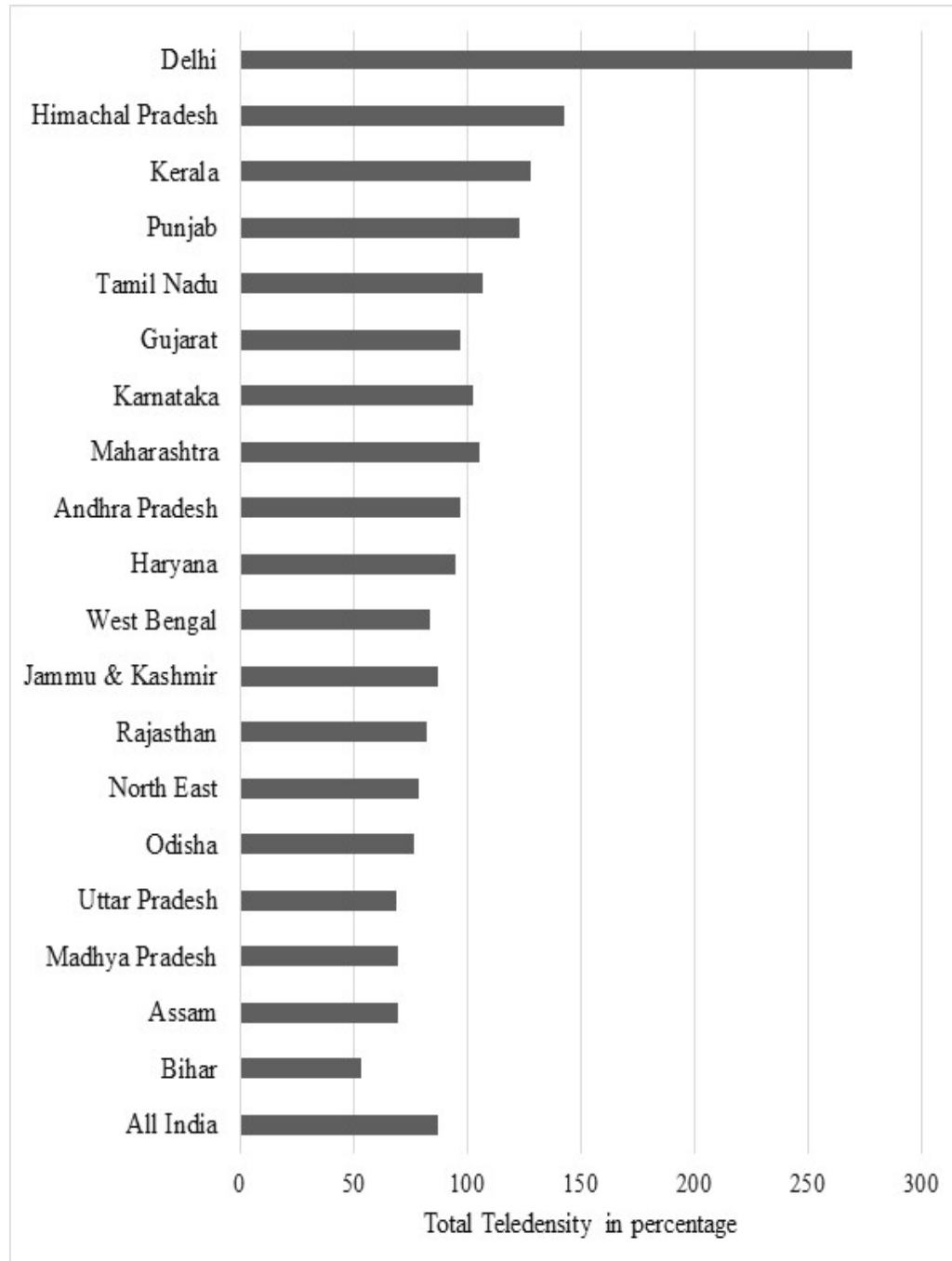
The proactive regulatory measures have facilitated growth of India's digital sector by promoting competition, and providing affordable services (Fig. 3). The decline in urban-rural digital divide over the years has largely been due to reduction in tariffs. The urban-rural gap in telecommunication from being four times in 2000 is now about three times, with urban tele-density now around 140% and rural at about 59%. Proliferation of digital communications services in rural sector remains a significant concern despite being regularly highlighted in various NTPs. Further, there are sizeable differ-

Fig.3 Digital Evolution of India, 1990-2018



Source: Compiled by the authors from DoT and TRAI reports

Fig. 4 Overall Tele-density (Circle/State Wise) – As on 30th November, 2021



Source: TRAI (2022)

Proliferation of digital communications services in rural sector remains a significant concern despite being regularly highlighted in various NTPs.

ence in adoption of telecommunications across different LSAs (Fig. 4). Despite the liberal Internet regulation adoption of broadband services has been slow. Broadband remains an urban phenomenon with 82.1% urban broadband penetration; and 19.48% rural broadband penetration where about 70% of Indian population resides (Census, 2011; TRAI 2018a).

As adoption of digital services reaches saturation in urban India, semi-urban and rural sectors will be the next drivers for the sector's growth, which are more price sensitive (Asrani et al., 2022). Developing infrastructure in underserved areas and maintaining QoS might be a challenging task for service providers. Provisioning of communications services in specified geographies, is conditioned on the interest of service providers to provision of services. GoI must ensure that service providers have a fitting business incentive to provision of services in underserved regions. In the past few years' behest for spectrum auction has not been very assuring although much of the spectrum put up for sale was sold; the cold market response to spectrum auction is attributed to the high reserve price of spectrum auction (Jain et al., 2017). To encourage the uptake of ICTs in India, GoI should not look at spectrum

as a revenue resource, as high spectrum prices feed in the tariffs of ICT services thus creating barriers to ICT adoption. To bridge India's digital divide, GoI must boost the digital device industry, rather than only fixating on ICT network and service providers alone (Panda et al., 2018). Digital devices manufacturers must innovate to ensure quality devices are supplied at best prices. The service providers must strategize and come up with innovative tariff plans and technological solutions to cater to the price sensitive massive Indian market, especially in the underserved geographies.

References

- Asrani, Chavi & Kar, Arpan K. (2022), "Diffusion and Adoption of Digital Communications Services in India", *Information Technology for Development* DOI: 10.1080 /02681102.2022.2046536.
- BBNL (2021), *BharatNet Usage Status as on 10-12-2021*, URL: <https://bbnl.nic.in/>, accessed on January 12, 2022.
- Bharat Sanchar Nigam Limited - Calcutta Telecom District (2012), *History & Growth of Calcutta Telephones*, URL: https://www.calcuttatelephones.com/mainfooter/MainFooter_Company.html, accessed on August 10, 2018.
- C-DoT (2010), *Brief History-Centre for Development of Telematics*, URL: http://www.cdor.in/about_us/berif_history.htm, accessed on February 2, 2015.
- Census (2011), *Population, Size and Decadal Change*. Census Vital Data, Chapter 1.
- Comptroller & Auditor General of India, (n.d), *Post & Telecommunications*, Chapter 9.
- DoT (2016), *National Telecom Policy*, Government of India.

- DoT (2016 a), New Telecom Policy-1999, Government of India.
- DoT (2016b), Introduction to Unified Access Services/Cellular Mobile Services, Government of India.
- DoT (2016c), Broadband Policy, 2004, Government of India.
- DoT (2016d), Amendment in Unified Licensed (Access Service) Agreement, NO.20-443/2014-AS-I-Pt, Government of India
- DoT (n.d.a.), Indian Telegraph Act 1885, URL: <http://www.dot.gov.in/act-rules-content/2442>, accessed on August 7, 2018
- DoT (n.d.b.), India Wireless Act, 1933, URL: <http://www.dot.gov.in/act-rules-content/2419>, accessed on August 7, 2018.
- DoT (2017), Profile-Telecom Commission, URL: <http://www.dot.gov.in/profile>, accessed on February 10, 2018.
- DoT (2017a), Indian Telecom Sector: An Overview, Annual Report 2016-17, Government of India.
- DoT (2018), Telecom Regulatory Authority of India Act, 1997, Government of India
- DoT (2018a), BharatNet (previously NOFN), Government of India
- DoT (2018b), Regulatory Framework on Net Neutrality, No 12-30/NT/2015/OTT (Pt), Government of India Government of India Government of India
- DoT (2018c), National Digital Communications Policy 2018 Draft for Consultation, Government of India.
- Government of India (1992), 8th Five Year Plan Communication, Information and Broadcasting.
- ERNET (2018), About us-How it began, URL: <http://www.ernet.in/about/abouternet.html>, accessed on August 10, 2018.
- ITI Limited (2018), Company Profile, URL: <http://www.itilttd-india.com/about>, accessed on August 16, 2018.
- India Brand Equity Foundation (IBEF) (2015), Telecommunication.
- Jain, Rekha & Dara, Rishabh (2017), "Framework for Evolving Spectrum Management Regimes: Lessons from India", *Telecommunications Policy*, 41:473-85.
- Kim, J., Nakano, S. & Nishimura, K. (2021), "The Role of ICT Productivity in Korea-Japan Multifactor CES Productions and Trades", *Applied Economics*, 53(14): 1613-27.
- Liao, H., Wang, B., Li, B. & Weyman-Jones T. (2016), "ICT as a General-purpose Technology: The Productivity of ICT in the United States Revisited", *Information Economics and Policy*, 36:10-25.
- Mani, Sunil (1989), "Technology Acquisition and Development: Case of Telecom Switching Equipment", *Economic and Political Weekly*, 24 (47): M181-M191.
- Mann, Michael (2010), "The Deep Digital Divide: The Telephone in British India 1883-1933", *Historic Government of India al Social Research*, 35 (131): 188-208.
- M., B. (1989), Battle for Self-Reliance in Telecommunications, *Economic and Political Weekly*, 24, (34):1941-43
- Ministry of Law and Justice, Government of India (2004), Indian Telegraph (Amendment) Act, 2003.
- Mani, Sunil & Sridhar, V., (2015), "Diffusion of Broadband Internet in India Trends, Determinants and Challenges", *Economic and Political Weekly*, 51: 54-62.
- Medudula, M. Krishna, Mahim Sagar & Ravi P. Gandhi (2016), Telecom Management in Emerging Economies- Evolutionary and Contemporary Perspectives, India: Springer.
- MeitY (n.d), National Telecom Policy - 2012, Government of India.
- MeitY (2018), Data Protection Framework, Government of India

- Ministry of Law and Justice, Government of India (2000), The Telecom Regulatory Authority of India (Amendment) Act.
- Ministry of Urban Development, Government of India (2015), Smart City Mission Transform Nation: Mission Statement and Guidelines.
- NCAER & TRAI (2012), Telecom Sector in India: A Decadal Profile.
- National Internet Exchange of India (2018), NIXI About us, URL: <http://www.nixi.in/en/about-us>, accessed on August 18, 2019.
- Panda, Sitakanta & Asrani, Chavi, (2018), To Bridge the Digital Divide, Fix the Phone Industry First, *Financial Express*, August 25, 2018, URL: <https://www.financialexpress.com/opinion/to-bridge-the-digital-divide-fix-the-phone-industry-first/1291504/>, accessed on September 10, 2018.
- Press Information Bureau (PIB) (2013), DOT: Auction of 800 Mhz Spectrum to Commence on 11.03.2013.
- PIB (2014), Digital India – A Program to Transform India into Digital Empowered Society and Knowledge Economy.
- PIB (2015), Spectrum Auction Concludes with over 88% of Spectrum Offered Provisionally Committed.
- PIB (2015a), Spectrum Trading: Another Game-changing Reform in Telecom Sector.
- PIB (2017), After GST Regime, Telecom Companies Would Be Required to Re-work Their Costing and Credits Availability and Re-jig Their Prices and Ensure That the Increased Availability of Credit Is Passed on to the Customers by Lowering Their Costs.
- PIB (2018), Summary of Budget 2018-19.
- Planning Commission (2011), Telecommunications, Mid-Term Appraisal of Eleventh Five Year Plan, Oxford University Press, Chapter 17.
- Prasad, Rohit & Sridhar, Varadharajan (2008), A Critique of Spectrum Management in India, *Economic and Political Weekly*, 43(38): 13-17.
- Qiang, C.Z., Rossotto, C. M. & Kimura K. (2009), Economic Impacts of Broadband, Information and Telecommunications for Development, Chapter 3, World Bank.
- Sridhar, Varadharajan (2011), The Telecom Revolution in India: Technology, Regulation, and Policy, India, Oxford University Press.
- TATA Communication (2018), About us-FAQ-What Is the Corporate History of Tata Communications Limited?
- TCIL (2018), Profile, URL: <https://www.tcil-india.com/profile.php>, accessed on June 23, 2018.
- TDSAT (n.d), Telecom Disputes Settlement and Appellate Tribunal: A Brief Introduction.
- TRAI (2005), Broadband Policy 2004 - Targets and Achievement, F.No.2-2/2004-CN.
- TRAI, (200, Recommendations On Issues Relating to Transition from IPv4 To IPv6 in India.
- TRAI (2007), A Journey Towards Excellence in Telecommunication.
- TRAI (2007a), Recommendations on Improvement in the Effectiveness of National Internet Exchange of India.
- TRAI (2008), Background, in Recommendations on Growth of Broadband.
- TRAI (2009), Information Note to the Press, Press Release No 11/2009.
- TRAI (2009a), Overview of Telecom Sector, Annual Report, 2008-09.
- TRAI (2010), TRAI Issues Recommendations on National Broadband Plan, Press Release No. 64.
- TRAI (2013), Recommendations on Valuation and Reserve Price of Spectrum.

- TRAI (2014), The International Calling Card Service (Access Charges) Regulation, 2014, Notification No. 11 of 2014.
- TRAI (2014a), The Standards of Quality of Service of Basic Telephone Service (Wireline) and Cellular Mobile Telephone Service (Third Amendment) Regulations, 2014, Notification No. 12 of 2014.
- TRAI (2015), Telecommunication Mobile Number Portability (Sixth Amendment) Regulation, 2015, Notification No. 3 of 2015.
- TRAI (2015a), The Standards of Quality of Service of Basic Telephone Service (Wireline) and Cellular Mobile Telephone Service (Fourth Amendment) Regulations, 2015, Notification No. 8 of 2015.
- TRAI (2015b), Telecom Consumers Protection (Ninth Amendment) Regulation, 2015, Notification No. 9 of 2015.
- TRAI (2016), Prohibition of Discriminatory Tariffs for Data Services Regulation 2016, Notification No.2 of 2016.
- TRAI (2017), Consultation Paper on Auction of Spectrum in 700 MHz, 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2300 MHz, 2500 MHz, 3300-3400 MHz and 3400-3600 MHz bands, Consultation Paper No. 10/2017.
- TRAI (2017a), The Standard of Quality of Service of Basic Telephone Service (Wireline) and Cellular Mobile Telephone Service (Fifth Amendment) Regulation, 2017.
- TRAI (2017b), TRAI Issues Regulations on Domestic Termination Charges, Press Release No. 77/2017.
- TRAI (2017c), A Twenty-Year Odyssey 1997-2017.
- TRAI (2018), The Standard of Quality of Service of Basic Telephone Service (Wireline) and Cellular Mobile Telephone Service (Sixth Amendment) Regulation, 2018.
- TRAI (2022), Highlights of Telecom Subscription Data as on 30th November, 2021, Press release No. 4/2022.