

Consultation Paper No. 06/2020



**Telecom Regulatory Authority
of India**



Consultation Paper on
**Roadmap to Promote Broadband Connectivity and
Enhanced Broadband Speed**

New Delhi, India

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Written comments on the Consultation Paper are invited from the stakeholders by 21/09/2020, and counter-comments by 05/10/2020. Comments and counter-comments will be posted on TRAI's website: www.trai.gov.in. The comments and counter-comments may be sent, preferably in electronic form on the email: jams@traigov.in and sksinghal@traigov.in. For any clarification/ information, Shri Sunil Kumar Singhal, Advisor, (Broadband & Policy Analysis) may be contacted at Tel. No. +91-11-23221509.

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CHAPTER 1

INTRODUCTION

- 1.1 As we are presently afflicted with the COVID-19 pandemic, the Government, private enterprises as well as the common public are relying more on the use of broadband connectivity for interaction in comparison to physical connectivity such as Rail, Road, or Air transport network. Post pandemic era will see a change in the ways we live, work, and interact. We would require living in a world which facilitates socializing and economic activities with minimized human contact. The widespread availability and use of broadband have both economic and social benefits. In the post pandemic era, like potable water and electricity, access to broadband would become a necessity. It would be difficult to imagine life without broadband connectivity. The use of telecom and internet connectivity will feature extensively in daily life, and in a sense, broadband would become a fundamental human right.
- 1.2 Even before the COVID-19 pandemic, during the last two decades, in an increasingly knowledge-driven globalised world, telecommunication has emerged as a key driver of economic and social development. Communications services such as voice, video, data, internet, and wideband multimedia are indispensable in modern society.
- 1.3 Demand for high speed and reliable broadband has been growing, and, in the post pandemic scenario, it will grow much faster. A corresponding increase in the supply of broadband services would require increasing investments in the telecom infrastructure, including fiberisation. The telecommunication infrastructure and connectivity are the bedrock for any developing country in the race of digital transformation of the society.

- 1.4 As India aims to strengthen its position in the digital economy, it becomes imperative for the country to use broadband as a lever for growth. This becomes even more important as we consider the various kinds of policy initiatives competing economies are taking, and amount of investment and resources they are committing towards high speed and reliable broadband proliferation. As we cannot afford to lose our strength in the world as a knowledge-based economy, making broadband growth even more important for us.
- 1.5 To facilitate the faster and cost-effective rollout of telecom networks, innovative approaches to infrastructure creation need to be devised. Optimal utilisation of the available telecom infrastructure would improve affordability of broadband services to common public and, in turn, create further demand in the market.
- 1.6 The Digital India programme of the Government, launched in 2015, brought the topic of digitization to the forefront of public discourse. Since then, several areas such as the construction of broadband highways, public internet access, e-governance, development of basic information technology skills, etc., have achieved considerable progress. With the increasing role of technology and use of cloud computing-based solutions, and the growing significance of Industry 4.0, India can only unlock its true potential once broadband connectivity, the basic building block for most technological solutions, reaches the last mile. Importance of broadband in India can be emphasised by the simple fact that, *“for developing countries in the low- and middle-income brackets, broadband is a key driver of economic growth and, according to a study by the World Bank, provides a boost of 1.38 additional percentage points to GDP growth for every 10-percentage-point increase in broadband penetration — higher than any other*

*telecommunication service*¹. The positive effect of increase in internet subscriptions on GDP is higher in developing countries than in the developed countries as it helps developing countries in leapfrogging the scarcity of physical infrastructure.

I. Types of broadband connectivity

1.7 Depending on the type of the last mile connectivity, a broadband connection can either be provided at the customer's premises, i.e., at a fixed location through a wireline or Fixed Wireless Access (FWA) modem or to a customer using a handheld terminal. Accordingly, a broadband connection can be categorized as fixed or mobile. Further, a fixed broadband connection can be further categorized as wireline or FWA.

A. Mobile broadband

1.8 Mobile broadband works by connecting a 3G, 4G, or 5G capable handheld device to a cellular wireless network. This device could be a smartphone, feature-phone, dongle, laptop, tablet, or any other device which is physically portable, and 3G, 4G, or 5G technology compliant. A user can take this device anywhere while travelling for telephonic communication and internet access. It is a hassle-free means of providing broadband in areas where wireline connectivity is a bit difficult to reach – especially in rural and remote areas. Further, it keeps an individual on move connected with the internet.

1.9 Worldwide, mobile broadband subscriptions are increasing relatively faster, mainly due to the falling retail prices and ease in the provisioning of services, particularly in developing countries. Mobile data continues to become more affordable across all regions. Average affordability of data services (1GB) is best in South Asia at

¹ Broadband: A Platform for progress, A report by the Broadband Commission for Digital Development

1.2% of monthly income.² While subscription of mobile broadband has become cheaper, affordability of internet-enabled handsets remains a challenge as the cost of internet-enabled devices has not fallen significantly; it remains a key barrier to mobile broadband adoption in low- and middle-income countries.

- 1.10 Mobile broadband has some constraints, also, due to which it is difficult to associate any guaranteed performance or quality of experience with it. Some of these constraints could be attributed to individual operators like insufficient number of sites, limited spectrum, congestion in the user plane of individual radio sites, limited backbone bandwidth, more number of subscribers accessing the data services than designed capacity of radio access network, and poor coverage inside the premises such as basements, high-rise buildings, tunnels, etc. Variations in consumers' experience could be due to certain external factors also such as location of a subscriber within a cell, subscriber's device type and quality, variations in performance due to topographical and environmental factors, performance of websites hosted outside the TSP's public data network, etc.

B. Fixed wireline broadband

- 1.11 Fixed wireline broadband is an always-on and high-speed data connection provided at the customer's premises. It can either be provided via Unshielded Twisted Pair (UTP) copper cable or OFC or Coaxial copper cable or hybrid wireline networks. The cable connects to a modem, which can then be connected to the customer's devices using WLAN or Wi-Fi technology or an Ethernet cable. Wireline broadband is more reliable, has much lower latency, and supports higher speed, making it most suitable for accessing

² Broadband commission-State of broadband Sept.2019

cloud-based enterprise applications, electronic communications, video streaming, online gaming, video conferencing, etc. However, provisioning of wireline broadband services is capital- and manpower-intensive, and a time-consuming activity, and its maintenance is also challenging.

C. Fixed Wireless Access (FWA) broadband

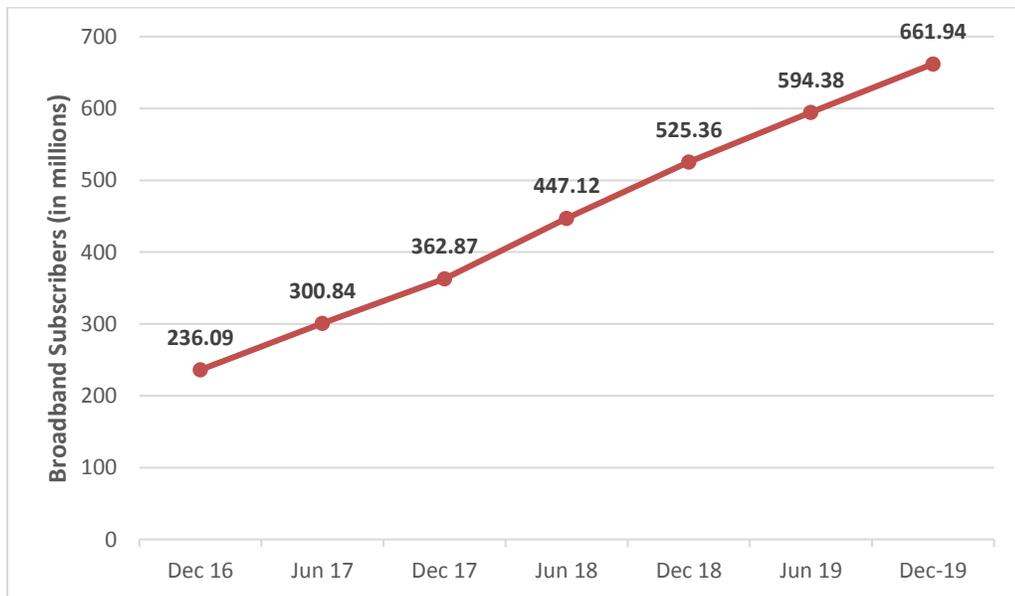
- 1.12 FWA broadband is an always-on and high-speed wireless data connection at the customer's premises. FWA refers to a wireless link that provides connectivity to objects that are stationary. The wireless link is used as a substitute for wireline connection in the last mile. It offers business opportunities to converged access service licensees (i.e., mobile and fixed operator) as they have most of the knowledge, processes and network components (such as BSS systems, network management, and core networks) needed to offer an FWA service. Subscribers install transceiver equipment, i.e., modem in their home or building to communicate with the fixed wireless transmission towers. Transceivers consist of a small dish or rectangular-shaped antenna with attached radio transmitters and receiver. For provisioning of FWA broadband, TSPs use transmission towers that communicate with the subscriber's modems.
- 1.13 Compared to mobile broadband, FWA typically face different constraints. The FWA service often requires line-of-sight access between the subscriber's location and the transmission tower. Obstructions from hills or trees prevent it from being installed in some locations. Rain or fog can sometimes adversely affect the quality of the service. Despite the rapid growth in mobile broadband services, there is a large underserved and unserved market for fixed broadband. This market can, to a very large extent, be served cost-efficiently with FWA, when it would be built on the huge installed

base of cellular systems and global reach of mobile technologies such as LTE and 5G New Radio (NR).

II. Current state of broadband penetration in India

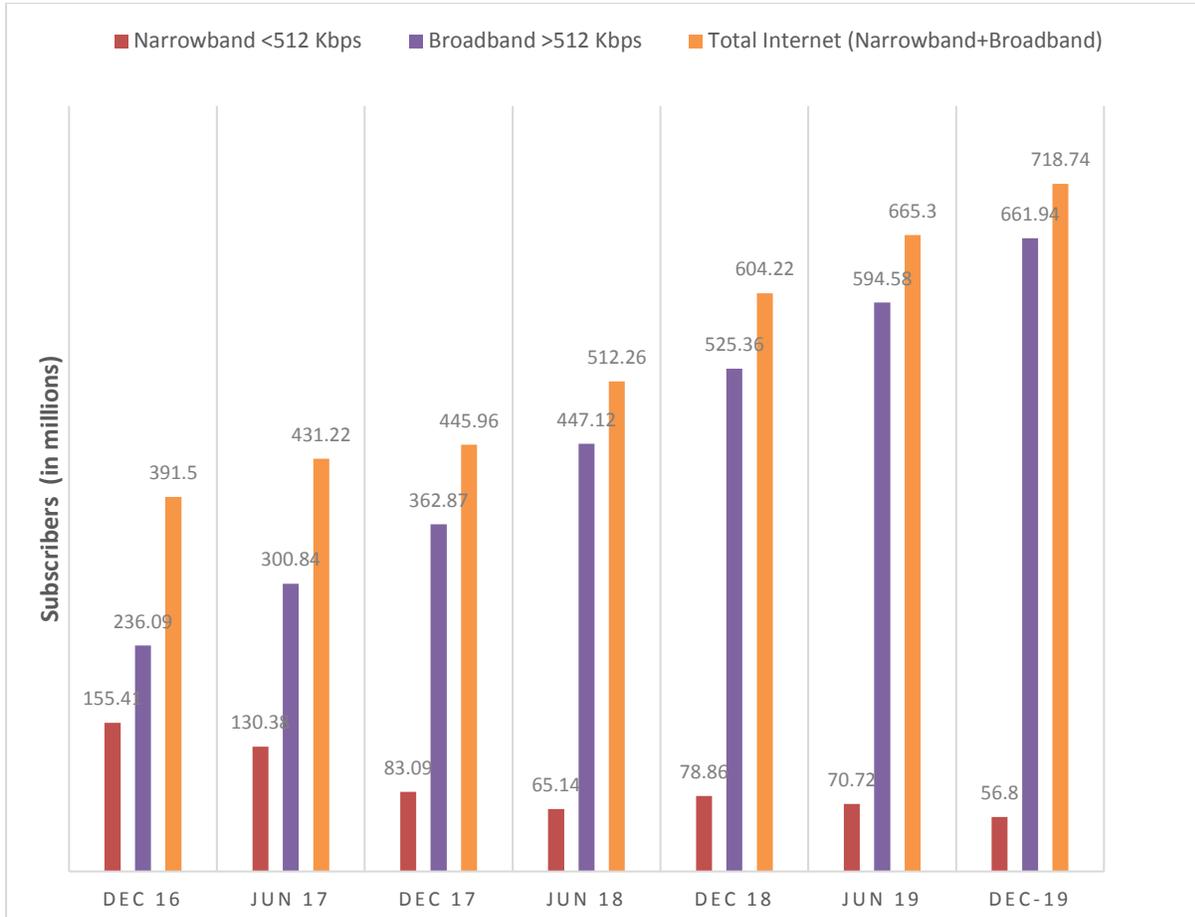
1.14 The broadband subscriber base in India has been growing at an accelerated pace over the last 3–4 years. There has been a subscription growth of over 40% Compounded Annual Growth Rate (CAGR) between 2016 and 2019. As of March 2020, there are approximately 687 million broadband subscribers in the country. Figure 1.1 depicts the growth of the broadband subscribers on a half-yearly basis³. Figure 1.2 gives a break-up of Narrowband and Broadband connectivity.

Figure 1.1: Broadband Growth in India (Half-Yearly Basis)



³ TRAI Performance Indicator Reports

Figure 1.2: Break-up of Narrowband and Broadband Subscribers



1.15 At the end of March 2020, there were 19.18 million wired broadband connections. In terms of penetration, it implies that only 7.6 per 100 households⁴ have access to fixed line broadband. As for wireless broadband, there were a total of 668.26 million connections as of the end of March 2020. The wireless broadband penetration is 50.35 per 100 inhabitants. Half yearly growth of wired and wireless broadband subscribers up to December 2019 has been depicted in Figure 1.3 and Figure 1.4, respectively. Table

⁴ Based on census 2011, India has 249.5 Million households

1.1 gives the internet subscriber base of the country as of March 2020.

Figure 1.3: Wired Broadband Subscribers (in Millions)

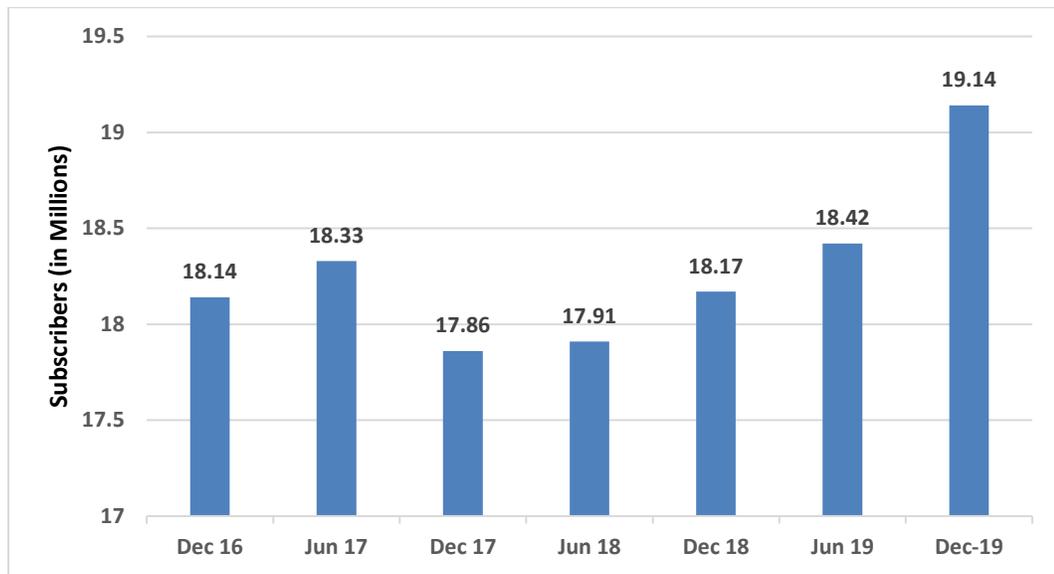


Figure 1.4: Wireless Broadband Subscribers (in Millions)

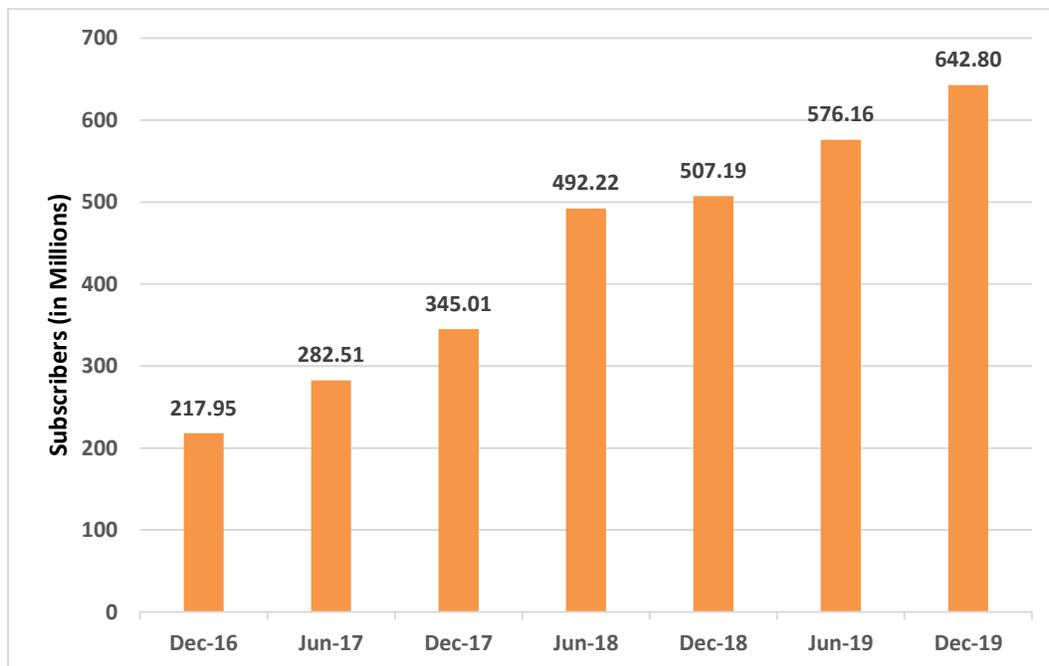


Table 1.1: Internet Subscribers as on 31st March 2020

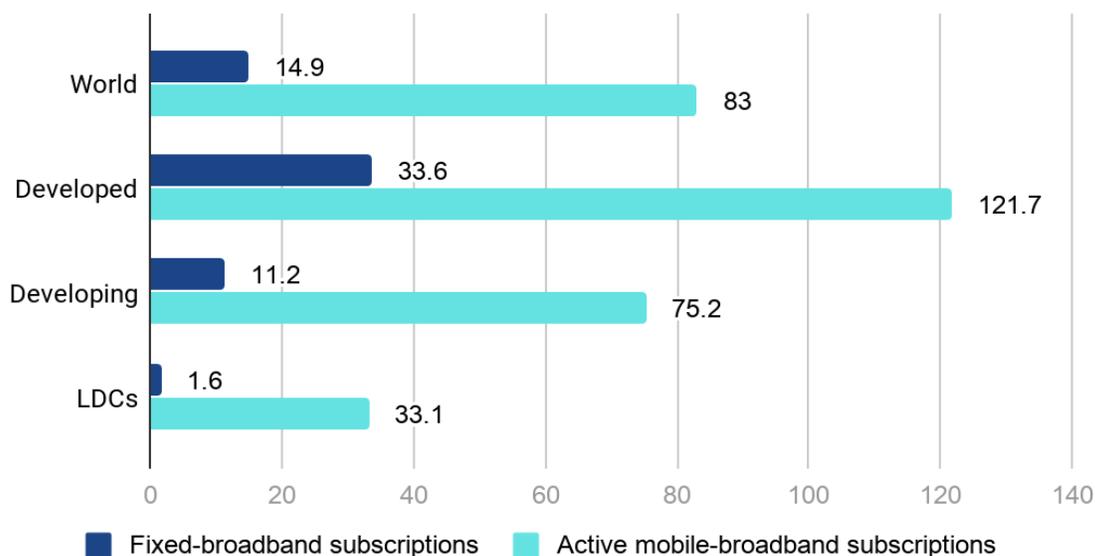
Segment	Mode of Access				Total Subscribers (in million)
	Wired Subscribers (in million)	Wireless Subscribers (in million)			
		Fixed Wireless (Wi-Fi, Wi-Max, Radio & VSAT)	Mobile Wireless (Phone + Dongle)	Total Wireless	
Broadband	19.18	0.60	667.66	668.26	687.44
Narrowband	3.24	0.01	52.51	52.51	55.75
Total	22.42	0.61	720.17	720.77	743.19

1.16 According to ‘The State of Broadband 2019’ report published by the Broadband Commission⁵, the year 2019 marks the first full year when more than half of the world (51.2%, or 3.9 billion people) has begun to participate in the global digital economy by logging onto the internet. At a household level, most households in the world now have access to internet at home (57.8% in 2018, up from 18.9% in 2005). As per another ITU report⁶, there were 33.6 active fixed line broadband subscriptions per 100 inhabitants in developed countries against 11.2 in developing countries. Active mobile broadband subscriptions per 100 habitants in developed countries are almost 1.6 times as compared to developing countries, which is four times as compared to the Least Developed Countries (LDCs) (see Figure 1.5).

⁵ THE STATE OF BROADBAND 2019 - ITU/UNESCO Broadband Commission report

⁶ ITU Publications: Measuring digital development Facts and figures 2019

Figure 1.5: Broadband Subscribers per 100 Inhabitants Worldwide, 2019



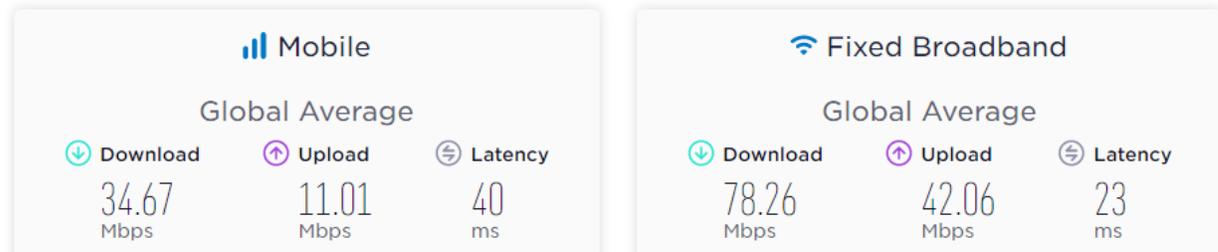
III. Current state of broadband speed in India

1.17 In addition to the availability, accessibility, and affordability of broadband, speed, and reliability of broadband are other crucial parameters of importance. Reliable and high-speed broadband connectivity is a pre-requisite for its commercial and economic use. As far as speed is concerned, as per Ookla speed test global index June 2020 report⁷, India is experiencing download speeds of 12.16 Mbps in case of mobile broadband and around 38.19 Mbps in case of fixed broadband. In this global index, India ranked 129th among 138 nations in terms of mobile broadband speed and 75th among 174 countries in fixed line broadband. Also, the highest mobile broadband speed, experienced in South Korea, is around 100Mbps. Whereas, for fixed line broadband highest speed reported is that of Singapore at 205 Mbps. Global average speed in case of mobile and fixed broadband is depicted in Figure 1.6.

⁷ <https://www.speedtest.net/global-index>

Figure 1.6: Global Average Broadband Speed

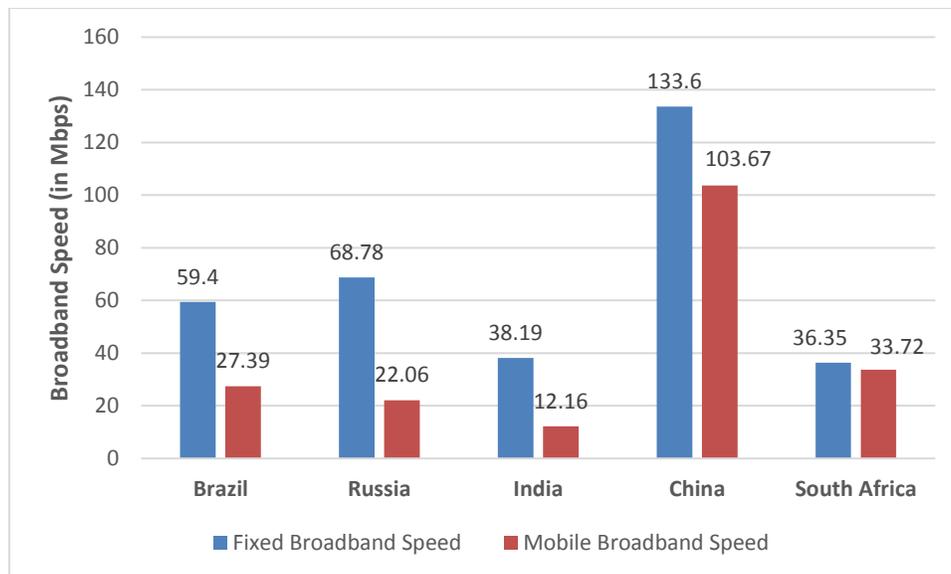
Global Speeds June 2020



Source: Speedtest.net global index

1.18 Another meaningful comparison of broadband speeds can be done among almost similarly placed BRICS nations, which is presented in Figure 1.7.

Figure 1.7: Comparison of Broadband Speeds Among BRICS Countries



Source: Speedtest.net global index

1.19 As per all the above comparisons, it becomes obvious that broadband speed in India is a cause of concern.

IV. Broadband policy evolution in India

1.20 Among Information and Communication Technologies (ICTs), access to broadband has demonstrated the greatest impact on

economic development in terms of growth of Gross Domestic Product (GDP). Use of broadband at individual level also has changed lives in a myriad of ways. Announcing national broadband policy is an important initiative for any Government to set the vision and strategy of how adoption of broadband should be increased in the country. By prioritizing broadband, setting targets such as adoption, speed, and reliability, and identifying the critical policy measures to be implemented, Governments create dynamic environment for orderly growth of broadband.

- 1.21 Recognizing the potential of ubiquitous broadband service in growth of GDP and enhancement in quality of life through societal applications including tele-education, tele-medicine, e-Governance, entertainment as well as employment generation by way of high speed access to information and web-based communication, the first broadband policy in India was formulated in 2004. The basic objective of this policy was to accelerate the growth of broadband services in the country.
- 1.22 The Broadband Policy 2004 visualized creation of infrastructure through various access technologies, which could contribute to the growth and mutually coexist. It defined broadband connectivity as an 'always-on' data connection that is able to support interactive services including internet access and has the capability of the minimum download speed of 256 kbps to an individual subscriber. The policy also estimated that, by 2010, internet subscription and broadband subscription would rise to 40 million and 20 million, respectively.
- 1.23 Through its recommendations dated 8th December 2010 on 'National Broadband Plan', the Authority, *inter alia*, recommended the following:

“Broadband connection may be defined as a data connection using

any technology that is able to support interactive services including Internet access and support a minimum download speed of 512 Kilobits per second (Kbps).

It is to be noted that the upload speed will at least be half the download speed. This definition of broadband (both Wireline and Wireless) given in para 6.21 above, will be effective from 1st January 2011. The stipulated download speed of 2 Mbps will be effective from 1st January 2015.” (Emphasis supplied)

(Para 6.21 and 6.22 of the recommendations)

1.24 With the vision of broadband on demand, National Telecom Policy-2012 (NTP-2012) envisaged leveraging telecom infrastructure to enable all citizens and businesses, both in rural and urban areas, to participate in the internet and web economy thereby ensuring equitable and inclusive development across the nation. It provided an enabling framework for enhancing India’s competitiveness in all spheres of the digital economy. NTP-2012 defined the following objectives for broadband services:

- i. Provide affordable and reliable broadband-on-demand by the year 2015, and to achieve 175 million broadband connections by the year 2017, and 600 million by the year 2020 at minimum 2 Mbps download speed and making available higher speeds of at least 100 Mbps on demand.
- ii. Provide high speed and high-quality broadband access to all village panchayats through a combination of technologies by the year 2014 and progressively to all villages and habitations by 2020.

1.25 The Department of Telecommunications (DoT) revised the definition of broadband through its notification dated July 18, 2013, which is as follows:

“Broadband is a data connection that is able to support interactive

services including Internet access and has the capability of the minimum download speed of 512 kbps to an individual subscriber from the point of presence (POP) of the service provider intending to provide Broadband service.”

1.26 The Authority vide its report on “Need for Reviewing Definition of Broadband” dated 24th May 2016 reiterated that *the current definition of broadband in the country be reviewed and minimum download speed be increased to 2 Mbps.* (emphasis supplied)

1.27 National Digital Communications Policy 2018 (NDCP-2018) seeks to unlock the transformative power of digital communications networks to achieve the goal of digital empowerment and improved well-being of the people of India; and towards this end, attempts to outline a set of goals, initiatives, strategies, and intended policy outcomes. Some of the strategic objectives of the NDCP-2018 are provisioning of broadband for all by 2022 and to propel India into the top 50 nations in the ICT Development Index of ITU from 134 in 2017. As part of the Connect India mission, it proposes to create robust digital communications infrastructure to promote ‘Broadband for All’ as a tool for socio-economic development while ensuring service quality and environmental sustainability. The following goals have been laid down in NDCP-2018 for 2022 under the Connect India mission:

- a. Provide universal broadband connectivity at 50 Mbps to every citizen
- b. Provide 1 Gbps connectivity to all Gram Panchayats of India by 2020 and 10 Gbps by 2022
- c. Enable 100 Mbps broadband on demand to all key development institutions, including all educational institutions

- d. Enable fixed line broadband access to 50% of households
- e. Achieve ‘unique mobile subscriber density’ of 55 by 2020 and 65 by 2022
- f. Enable deployment of public Wi-Fi Hotspots; to reach 5 million by 2020 and 10 million by 2022
- g. Ensure connectivity to all uncovered areas

V. References received from DoT

- 1.28 DoT, through its reference dated 26th April 2019 (**Annexure A**) requested the Authority to furnish its recommendations as per Section 11(1)(a) of the TRAI Act 1997, as amended, on the following points:
- (a) *“Different speeds for different categories, i.e., fixed vs Mobile with upload/download speeds defined;*
 - (b) *How different categories of broadband speeds such as basic broadband, high broadband & Ultra-High Broadband, etc. can be defined as in Europe; and*
 - (c) *The roadmap to enhance Broadband speed to achieve the NDCP-2018 objective of 50 Mbps.”*
- 1.29 DoT, through two other separate references dated 8th May 2019 and 6th June 2019 (**Annexure B and C**), sought the recommendations of the Authority for implementing NDCP-2018 strategies “*By encouraging innovative approaches to infrastructure creation and access including through resale and Virtual Network Operators (VNO)*” and “*Promoting broadband connectivity through innovative and alternative technologies*”, respectively. Both strategies are part of the mission “*Connect India: Creating a Robust Digital Communication Infrastructure*” and listed under the broader heading 1.1 “*Establishing a ‘National Broadband Mission –*

Rashtriya Broadband Abhiyan' to secure universal broadband access". In essence, it appears that DoT is seeking the Authority's recommendations on (i) defining fixed and mobile broadband, (ii) innovative approaches for infrastructure creation, (iii) promoting broadband connectivity, and (iv) measures to be taken for enhancing broadband speed.

VI. Need for the present consultation

1.30 As can be seen from the above, increasing reliable and high-speed broadband connectivity in the country has been in focus of the Government and the Authority since 2004. Number of policy and regulatory initiatives has been taken in the past to reach the present state. Constant developments happening in the field of ICTs are putting continuous pressure on the Government, the Authority, and the TSPs to further improve the penetration and performance of broadband networks.

1.31 Efforts are continuing to meet the ever-growing demand and expectations of consumers. During last five–six years, the Authority has issued several recommendations to the Government on related issues under consideration in this CP. Some of them are still under consideration of the Government. Many new strategies have been identified in the NDCP-2018. Such strategies need to be converted into actionable points. Accordingly, through the present Consultation Paper (CP), the Authority intends to seek the inputs of stakeholders on (i) defining fixed and mobile broadband, (ii) innovative approaches for infrastructure creation, (iii) promoting broadband connectivity, and (iv) measures to be taken for enhancing broadband speed.

Structure of the Consultation Paper

1.32 The CP has been structured in seven chapters. This chapter introduces the subject and sets the context for present consultation. Chapter 2 summarises the initiatives of the Government relating to broadband that are in the process of implementation and the Authority's recommendations on related issues, which are still under consideration of the Government. Chapters 3, 4, 5 and 6 discusses the additional issues relating to (i) defining fixed and mobile broadband, (ii) innovative approaches for infrastructure creation, (iii) promoting broadband connectivity using innovative and alternative technologies, and (iv) measures to be taken for enhancing broadband speed, respectively. Finally, Chapter 7 summarizes the various issues for consultation.

CHAPTER 2

POLICY AND REGULATORY INITIATIVES

2.1 Digital India is one of the flagship programs of the Government. It has a vision to transform India into a digitally empowered society and knowledge economy. It emphasises on the development of Broadband Highways, Universal Access to Mobile Connectivity, Public Internet Access Programme, and using digital technologies for serving the citizens. In this direction, the Government has launched many schemes using Universal Service Obligation Fund (USOF) for proliferation of the broadband and improving internet access to common people. It is important to recapitulate these schemes here so that these can also be considered while finalizing the roadmap.

2.2 Further, to promote the broadband connectivity and improve its performance, in recent years, in consultation with the stakeholders, the Authority has issued several recommendations to the Government. Many of them are still under consideration of the Government. Since some of these recommendations are relevant to the issues under consultation, instead of discussing the same in detail again, the summary of these recommendations could be included in the roadmap.

I. Government initiatives for increasing broadband coverage

2.3 For proliferation of broadband services across the country and achieving the policy objective of broadband @ 50 Mbps for all, significant amount of investment would be required in the network. The NDCP-2018's aim to attract USD 100 Billion investment over a period of 4–5 years from 2018 to 2022. Major part of this would come from the private sector. The Government must support the efforts of private sector by facilitating encouraging policy

environment and investing through USOF in such areas where private investment is commercially non-remunerative. In the recent past, schemes approved by the Government to extend the broadband access to commercially non-remunerative areas of the country, and the policy initiatives taken to address the Right-of-Way (RoW) challenges being faced by stakeholders have been discussed here. Issues relating to the private sector investment in telecom infrastructure and further policy initiatives required to be taken by the Government for orderly growth of the sector have been discussed in subsequent chapters. Synopsis of such initiatives is given in the following sections:

A. BharatNet project

- 2.4 Development of broadband highways is core of the Government's Digital India program. Towards achieving this goal, the Government is implementing the BharatNet project in a phased manner. The project, financed through the Universal Service Obligation Fund (USOF), would provide high-speed connectivity to 2.5 lakh Gram Panchayats (GPs) in the country. The project envisages an optimal mix of OFC, Radio, and Satellite media. The high-speed infrastructure created under the project would be available to all categories of services providers, which include TSPs, ISPs, and Cable TV service providers, on non-discriminatory basis. It would also be used to provide reliable and high-speed broadband connectivity to the panchayat and village-level Government institutions to provide universal internet access to public. Further, as part of this flagship project, 'Last Mile' connectivity, using Wi-Fi or any other suitable broadband technology, for internet access is to be provided at all GPs in the country. The status of implementation and utilization of the project is as under:

- a) As on 10th July 2020, a total of 1,53,810 GPs has been connected by laying 4,39,555 km OFC, and out of these in 1,41,563 GPs necessary equipment for delivering high-speed connectivity have also been installed, i.e., these GPs are service ready. In the remaining GPs, the project is under implementation.
- b) As on 12th July 2020, 57,162 public Wi-Fi hotspots have been installed in the GPs and out of these 25,573 public Wi-Fi hotspots have been made operational. Further, using BharatNet connectivity infrastructure, 1,15,648 broadband connections have been provided to the State Government institutions. At hundreds of places, the bandwidth has been provided to TSPs and ISPs for delivering broadband services.

B. Improving telecom services in Andaman & Nicobar Islands (ANI) and Lakshadweep

- 2.5 Both these group of islands are strategically important for the country. These islands are lagging in telecom infrastructure development as compared to other parts of the country, mainly due to their difficult geographic terrain. Presently, telecom connectivity to these islands is provided through satellite medium. On 22nd July 2014, the Authority sent its recommendations to the Government on 'Improving Telecom Services in Andaman & Nicobar Islands and Lakshadweep'.
- 2.6 On 10th August 2020, a direct communication link, through a dedicated submarine OFC, between mainland (Chennai) and Port Blair and five other islands viz. Little Andaman, Car Nicobar, Havelock, Kamorta, and Great Nicobar, have been commissioned. Further, the work of augmentation of available satellite bandwidth, and augmentation of intra-Island OFC has been awarded to BSNL. In ANI, existing bandwidth of 2 Gbps has been upgraded to 3.79

Gbps by installation of 25 VSAT terminals. Similarly, in Lakshadweep Islands, existing bandwidth of 318 Mbps has been upgraded to 1 Gbps by installation of 25 VSAT terminals.

C. Improving telecom connectivity in Ladakh region

2.7 The Government has decided to provide voice and data connectivity in 361 identified villages in Ladakh and Kargil region.

2.8 Hence, it can be seen that several initiatives have been taken by the Government to provide telecom connectivity in the unserved or underserved areas, which are commercially non-remunerative. Successful implementation of these plans of the Government would facilitate achieving the objective of “Broadband for All” by 2022 as envisaged in the NDCP-2018.

II. TRAI recommendations on improving broadband proliferation and performance

2.9 In the recent years, the Authority has issued several recommendations to the Government on wide-ranging issues such as broadband penetration, allocation of microwave RF carriers, implementation of BharatNet, in-building access, public Wi-Fi networks, etc., on which decisions are still awaited. Details of these recommendations are available on the Authority’s website: www.traigov.in. All these recommendations have a direct relation with the issues under consideration in this CP. The synopsis of these recommendations is given below:

A. Recommendations on “Allocation and pricing of Microwave Access (MWA) and Microwave Backbone (MWB) RF carriers” dated 29th August 2014

2.10 The Authority sent its recommendations dated 29th August 2014 to the Government on “Allocation and pricing of Microwave Access

(MWA) and Microwave Backbone (MWB) RF carriers”⁸; and further, replied to the back-reference received on this issue from DoT vide its response⁹ dated 17th November 2015. These recommendations emphasize on the usage of the high capacity E-band and V-band spectrum to increase broadband penetration and speed in India. The Authority recommended that these bands should be opened with ‘light-touch regulation’; and for backhaul purpose, allotment should be on a ‘link-to-link’ basis at a nominal fee. In line with other countries, through these recommendations, the Authority further recommended that V-band should be license-exempt band for indoor and outdoor access applications. The same were reiterated by the Authority in its recommendations on “Delivering Broadband Quickly: What do we need to do?” dated 17th April 2015.

B. Recommendations on “Delivering Broadband Quickly: What do we need to do?” dated 17th April 2015

- 2.11 The Authority issued its recommendations¹⁰ dated 17th April 2015 to the Government on “Delivering Broadband Quickly: What do we need to do?” to accelerate the proliferation of broadband in the country. In this recommendation, the Authority has put a lot of emphasis on fibre-based networks, which are capable of providing near-limitless capacity; offer the most future-proof approach in meeting broadband demand over the long term, not only for fixed services but also for mobile network services. One of the important observations made here was the laying cost being 3–4 times higher than the cost of fiber, which needs to be brought down and accordingly some of the recommendations issued in this direction were as follows:

⁸<https://tra.gov.in/sites/default/files/MW%20Reco%20Final29082014.pdf>

⁹https://tra.gov.in/sites/default/files/Response%20to%20back%20reference%20on%20Microwave_17.11.2015.pdf

¹⁰ <https://tra.gov.in/sites/default/files/Broadband%3D17.04.2015.pdf>

- i. All infrastructure sectors such as road construction authorities/agencies like NHAI/SH/PP Projects must include, in their construction design policy, a provision for a utility duct to enable laying of OFC for all new infrastructure and also adopt similar measures in existing projects in a “Dig Only Once” policy approach.*
 - ii. There is a need to change building by-laws which currently deem only electricity, water and fire safety as necessary infrastructure for the issue of a completion certificate. Making mandatory inclusion of either ducts/optical fibre with well-defined access mechanisms in all upcoming office complexes, commercial spaces and residential complexes would have a significant and measurable net positive impact on BB penetration.*
- 2.12 In the same recommendations dated 17th April 2015, the Authority has said that for the delivery of high-speed internet in the country, more and more fixed line broadband connections are required. As the cost of installation and maintenance of a fixed line is much higher than mobile telephony, there is a need to create incentives for TSPs to invest in the fixed line business. In a bid to promote investment in, and adoption of, wireline networks, the Authority recommended that:
- i. To promote fixed line BB, the license fee on the revenues earned on fixed line BB should be exempted for at least 5 years.*
 - ii. There is a need to mandate city developers and builders to have properly demarcated sections within buildings and on rooftops for housing BB infrastructure and antenna. These areas should have uninterrupted power supply for reliable, always-on services.*
- 2.13 Through the same recommendations dated 17th April 2015, the Authority has also emphasized the need of utilizing the cable TV last mile access to deliver broadband, as is being done in many developed countries. The Multi System Operators (MSOs) and the

Local Cable Operators (LCOs) play an important role here, and to encourage them the following recommendations were made by the Authority.

- i. *Cable operators should be allowed to function as resellers of ISP license holders to enable them to take advantage of their cable network to provide BB.*
- ii. *Viable business models need to be created by encouraging LCOs' entrepreneurship skills and guiding them to handle the new business. Financial support through banks/institutions and USO Fund has also been recommended.*
- iii. *Provision of bandwidth at a subsidized price to operators serving underserved areas to ensure affordable BB.*

2.14 Through the same recommendations dated 17th April 2015, the Authority has also emphasized that Last mile access planning is critical for realizing the policy objectives of inclusion and universal access and hence the present network planning for providing 100 Mbps bandwidth connectivity to all GPs irrespective of the GP population may not be correct. It has recommended that *“The bandwidth equipment for network planning needs to be re-assessed considering GP population and other relevant factors.”*

2.15 Increasing availability of access spectrum is significant for improving mobile broadband speed and its mass adoption. Action points on various dimensions including the previous recommendations¹¹ made by the Authority on spectrum are listed as under

- i. *Align spectrum bands with globally harmonized bands to achieve interference-free coexistence and economies of scale. The Authority has been recommending that more spectrum in the*

¹¹ <https://traf.gov.in/sites/default/files/Broadband%3D17.04.2015.pdf>

existing spectrum bands (viz. 900/1800/2100/2300/2500 MHz bands) should be assigned for commercial operation.

- ii. WPC should be mandated to urgently decide the short-term and long-term plan for all spectrum through public consultations and putting it in public domain to ensure transparent procedures for the allocation of all spectrum bands. This shall allow innovative solutions and market-driven models for efficient utilization of spectrum.*
- iii. It is very important that spectrum is reasonably priced and made available in significant quantities so that a balance can be maintained in the payments to the Government for spectrum and the investment required for network expansion and equipment.*

2.16 A key concern in the deployment of broadband services through satellite in India is the restrictions imposed on providing satellite bandwidth competitively. An effective exploitation of this resource will facilitate expeditious proliferation of broadband, especially in regions that are technically non feasible through other means. In addition, satellite communication technology is experiencing various changes such as the use of Ka band satellites, which can provide large capacity and higher speeds. To address these issues various action points as follows have been suggested in the Authority's recommendations dated 17th April 2015 on "Delivering Broadband Quickly: What do we need to do?"

- i. 'Open Sky' policy should be adopted for VSAT operators similar to what is available to ISPs and broadcasters. VSAT service providers should be allowed to work directly with any international satellite operators.*
- ii. Separation of Licensor, Regulator and Operator functions in the satellite space domain to conform to best international practices of free markets.*

- iii. *The issue of coordination of additional spectrum in the 2500–2690 MHz band with Department of Space (DoS) needs to be addressed urgently, so that this band can be optimally utilized for commercial as well as strategic purposes.*
- iv. *Time-bound award of licenses for operating satellite services and Regulating/Opening of Ka band.*

C. Recommendations on Implementation Strategy for BharatNet in February 2016

2.17 The Authority took cognizance of the requirement of faster building of ICT infrastructure and issued its recommendations¹² on Implementation Strategy for BharatNet in February 2016. It has inter alia recommended that:

- i. *Centre State Public private partnership (CSPPP) mode by involving State Governments and the private sector that aligns private incentives with long-term service delivery in the vein of the Build-Own-Operate Transfer/Build-Operate-Transfer models as the preferred choice for the national broadband network, BharatNet.*
- ii. *Award of EPC (turnkey) contracts by BBNL to private parties through international competitive bidding needs to be planned. Such contracts can be given region-wise with clear requirements for interconnection with other networks, as well as infrastructure sharing with other operators who would like to utilize this network. A commercial model around this will need to be suitably deployed.*

D. Recommendations on “In-Building Access by Telecom Service Providers” dated 20th January 2017

2.18 Installation of telecom infrastructure inside the building or premises by the TSPs is another major area of concern. To address

¹²<https://www.trai.gov.in/sites/default/files/Recommendations%20on%20BharatNet%2001.02.2016%20FINAL.pdf>

this, the Authority issued its recommendations¹³ dated 20th January 2017 to the Government on “In-Building Access by Telecom Service Providers”; and further, replied to the back-reference received from DoT on this issue vide its recommendations dated 9th March 2018. The objective of this recommendation was to promote the sharing of IBS as well as other in-building telecom infrastructure such as Copper cables, Optical Fibre Cables, LAN cables, etc., and telecom nodes (DSLAM, PABX, etc.). The salient points of this recommendation are:

- i. TSPs/IP-Is should be mandated to share the in-building infrastructure (IBS, OFC and other cables, ducts, etc.) with other TSPs, in large public places like Airports, hotels, multiplexes, etc., commercial complexes and residential complexes.*
- ii. The TSPs/IP-Is may be categorically disallowed to enter into any kind of agreement or contract, which results in exclusive access or lessening of competition. Indulgence into such a practice, through either formal or informal arrangement, may be treated as violation of the license agreement/registration.*
- iii. DoT should take up the matter with the Ministry of Urban Development to ensure that Suitable provision for the creation of Common Telecom Infrastructure (CTI) inside the newly constructed public places like Airports, commercial complexes and residential complexes, should form part of the Model Building Bye-Laws.*
- iv. Government should ensure that the essential requirement for telecom installations and the associated cabling is formed part of National Building Code of India (NBC), being amended by Bureau of Indian Standards (BIS).*

¹³ https://www.trai.gov.in/sites/default/files/Recommendation_20_01_2017.pdf

- v. *The telecom ducts to access the buildings from outside should invariably be part of the CTI, which could be used by TSPs/IP-Is for putting cables; which would ensure unhindered access to TSPs/IP-Is.*
- vi. *No building plan should be approved without having a plan for creation of CTI including the duct to reach to the telecom room inside the building. Completion certificate to a building to be granted only after ensuring that the CTI as per the prescribed standards is in place.*

E. Recommendations on "Proliferation of Broadband through Public Wi-Fi Networks" dated 9th March 2017

2.19 To facilitate proliferation of broadband at affordable prices using alternate technology, the Authority vide its recommendations¹⁴ dated 9th March 2017 to the Government on "Proliferation of Broadband through Public Wi-Fi Networks", and, further, replied to the back-reference received from DoT on this issue vide its recommendations¹⁵ dated 5th June 2020, recommended an 'unbundled and distributed model' that is completely different than the 'integrated model', which is presently used by traditional TSPs/ ISPs to deliver internet services. These recommendations of the Authority issued on *suo motu* basis were necessitated because despite significant progress in the space of mobile broadband, delivering reliable and affordable broadband services in the dense urban areas, inside the buildings, and rural and remote areas remains a challenge. Lack of ubiquitous high speed and reliable broadband connectivity not only adversely affects the Digital India program, a flagship program of the Government, but also reduces the productivity of individuals and enterprises.

¹⁴ https://traai.gov.in/sites/default/files/WiFi_Recommendation_09032017.pdf

¹⁵ https://traai.gov.in/sites/default/files/Recommendation_05062020.pdf

F. Recommendations on “Enhancement of Scope of Infrastructure Providers Category-I (IP-I) Registration” dated 13th March 2020

2.20 Infrastructure sharing enables economies of scale, improves affordability, and avoids duplication of networks where possible. It allows faster roll out of networks and services. Keeping all this in view, the Authority issued its recommendations¹⁶ dated 13th March 2020 to the Government on “Enhancement of Scope of Infrastructure Providers Category-I (IP-I) Registration”, vide which it has recommended that:

- i. *The scope of Infrastructure Providers Category – I (IP-I) Registration should be expanded to satisfy the present need for telegraph in the country.*
- ii. *The expanded scope of the IP-I registration should include to own, establish, maintain, and work all such infrastructure items, equipment, and systems which are required for establishing Wireline Access Network, Radio Access Network (RAN), and Transmission Links. However, it shall not include core network elements such as Switch, MSC, HLR, IN, etc. The scope of the IP-I Registration should include, but not limited to, Right of Way, Duct Space, Optical Fiber, Tower, Feeder cable, Antenna, Base Station, In-Building Solution (IBS), Distributed Antenna System (DAS), etc., within any part of India.*

¹⁶ https://traf.gov.in/sites/default/files/Recommendations_13032020.pdf

CHAPTER 3

BROADBAND DEFINITION

3.1 The term “broadband” has become commonplace for describing the future of digital communications. Broadband is an always-on high-speed data access facility. It transports multiple types of data traffic, i.e., voice, video, and data including internet access through different mediums like Digital Subscriber Line (DSL), Coaxial cable, Optical Fiber Cable (OFC), radio spectrum, etc. General public as well as Governments and enterprises are becoming more and more dependent on broadband for day-to-day activities like electronic communications, e-governance, infotainment, shopping, education, healthcare, skill development, and financial services. Such high degree of dependence on broadband necessitates that it is defined unambiguously. It will facilitate customers while deciding to subscribe broadband.

I. Broadband Definition in India

3.2 The prevailing definition of broadband in India as notified by DoT on 18th July 2013 is as follows:

“Broadband is a data connection that is able to support interactive services including Internet access and has the capability of the minimum download speed of 512 kbps to an individual subscriber from the point of presence (POP) of the service provider intending to provide Broadband service.”

II. NDCP-2018 objectives relating to definition of broadband

3.3 Two strategic objectives of the NDCP-2018 are provisioning of broadband for all by 2022, and to propel India to the top 50 nations in the ICT Development Index of ITU from 134 in 2017. As part of the Connect India mission, it proposes to create robust digital

communications infrastructure to promote 'Broadband for All' as a tool for socio-economic development, while ensuring service quality and environmental sustainability. Under Connect India mission, the following goals relating to broadband have been laid down for 2022:

- i. Provide Universal broadband connectivity at 50 Mbps to every citizen
- ii. Provide 1 Gbps connectivity to all Gram Panchayats of India by 2020 and 10 Gbps by 2022
- iii. Enable 100 Mbps broadband on demand to all key development institutions, including all educational institutions
- iv. Enable fixed line broadband access to 50% of households

III. Significance of broadband speed for digital economy

- 3.4 During the last decade, Indian economy has witnessed increasing use of ICT for delivery of services. The online services like web browsing, video streaming, digital meeting platforms, tele-health, tele-medicine, virtual learning, e-Commerce, e-Governance, online banking, and e-payment are growing at a fast pace.
- 3.5 Government of India is doing huge investments in e-governance through many mission-mode projects. Various citizen-centric services like eSign, Digital Locker, UPI protocol and BHIM payment app, eKYC, DBT, Authentication (Attendance, PDS, Aadhaar Pay, Jeevan Pramaan) have been launched by the Government.
- 3.6 With larger base of mobile broadband consumers and ease and speed of transactions that these channels offer, use of mobile for accessing these online services has picked up in India. Most of these applications or services, which act as an enabler for digital economy, require high speed and reliable internet access facility.

- 3.7 Success of all these digital economy initiatives largely depends on a robust, reliable, low latency, and high-speed broadband infrastructure in the country. High-speed broadband infrastructure creates an enabling environment; and builds a foundation upon which applications, services, businesses, and technologies could be developed. High-speed internet access has opened doors to new paradigms in all sectors of the economy whereby the common man at the bottom of the pyramid is served more efficiently and at a fraction of cost as compared to earlier days.
- 3.8 Other advances in science and technology such as big data, sensors networks, automation, Intelligent Transport Systems, IoT, machine learning, and artificial intelligence also depend extensively on cloud services and broadband connectivity. The convergence of networks, services, and devices is redefining the way in which content is hosted and delivered; and this is also fuelling the demand for broadband services. Therefore, just like physical forms of connectivity like Roadways, Railways, Airlines, and Waterways, high-speed broadband networks are also becoming essential infrastructure for economic development in the country.
- 3.9 In today's technological world, speed and coverage are some of the key differentiating factors for customers, while narrowing down to an ISP. Countries around the globe have set their broadband targets in terms of speed and coverage. Speed requirement varies depending upon the type of applications. Speed must be above a certain threshold to access a particular type of applications such as video conferencing or real-time gaming. Accordingly, speed is a major criterion for defining broadband. The threshold speed (uplink or downlink) for defining broadband varies from country to country.

IV. International Experience in Defining Broadband

3.10 While the term broadband is used to describe many different internet connection speeds, Recommendation I.113 of the ITU Standardization Sector (ITU-T) defines broadband as a transmission capacity that is faster than the primary rate ISDN, at 1.5 or 2.0 Mbit/s. However, this definition is not strictly followed by most of the countries. Many countries follow the OECD definition¹⁷ for broadband in terms of download speed — *‘Services enabling at least a 256 Kbps advertised downlink internet access is classified as broadband.’*

3.11 **Germany’s** FNA (the Telecom Regulator) has defined fixed and mobile broadband differently as:

- i. Fixed broadband as having a capacity equal to or higher than 144 Kbit/s download speed.
- ii. Mobile broadband refers to third-generation technologies (3G) and higher speed mobile technologies (i.e., HSPA or LTE), while excluding GSM/GPRS technologies.

There is no upload speed limit set for defining fixed or mobile broadband in Germany.

3.12 **Brazil’s** definition of broadband as considered by the regulator, the National Telecommunications Agency¹⁸ is as follows:

- i. Fixed broadband access is made through providers of fixed telecommunication services, allowing the capability of transmission, emission and reception of multimedia data, including internet connection, regardless of its speed.
- ii. Mobile broadband access is through mobile phones with 3G or 4G technology.

¹⁷ OECD: Indicators of Broadband Coverage 2009

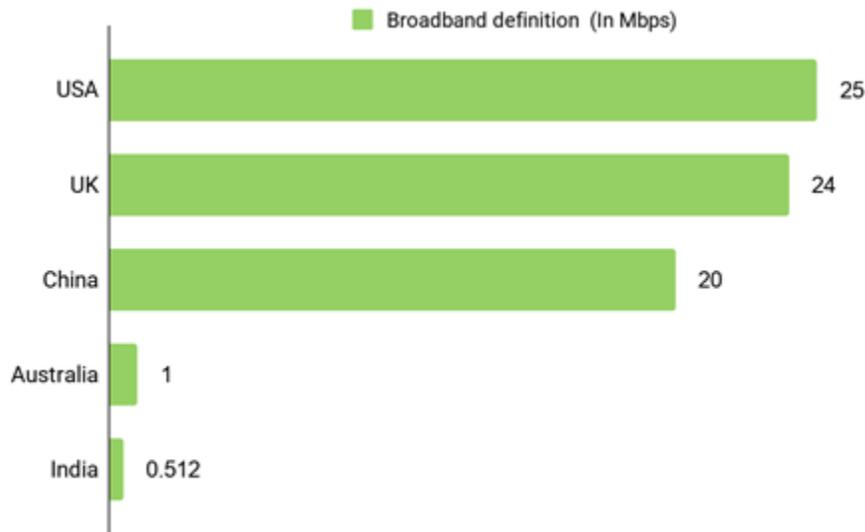
¹⁸ Broadband in Brazil: past, present and future – November 2016, page 55

- 3.13 According to the **Canadian** Radio-television and Telecommunications Commission's (CRTC) Communications Monitoring Report 2015, "broadband" is defined as a minimum Internet download speed of 1.5 megabits per second (Mbps).
- 3.14 In the **United States**, broadband is referred to as the "advanced telecommunications capability" by FCC since 1996. FCC revised the definition of broadband in 2015¹⁹ as advanced telecommunications capability that enables users to originate and receive high-quality voice, data, graphics, and video using any technology, with a minimum download speed of 25 Mbps and upload speeds of 3 Mbps. This definition is applicable to fixed as well as mobile broadband.
- 3.15 In **Europe**, the term 'broadband', in the context of internet access, does not have a specific technical meaning but is used to refer to any infrastructure for high-speed internet access that is always-on and faster than the traditional dial-up access.
- 3.16 As per the Office of Communications (OFCOM), **U.K.**, Broadband is a data service or connection generally defined as being always-on, and providing a bandwidth greater than narrowband connections.
- 3.17 **Bangladesh** Telecommunication Regulatory Commission revised the definition of Broadband in February 2016²⁰ as:
"Internet access that is always-on and faster than traditional Dial-up access is Broadband. In terms of bandwidth, internet service above 5 Mbps is defined as Broadband and the bandwidth below 5 Mbps is defined as Narrowband"
- 3.18 The threshold download speed of broadband across some of the major countries following a common definition for fixed line as well as mobile broadband is depicted in Figure 3.1.

¹⁹ 2015 Broadband Progress Report by FCC

²⁰ Bangladesh Definition of Broadband – April 2018

Figure 3.1: Threshold Download Speed of Broadband Across Major Countries



(Source: National Broadband Plans of Countries; Deloitte Research)

V. Analysis of various approaches for defining broadband and issues for deliberation

3.19 There is, as such, no universally adopted definition of broadband. As discussed above, different organisations and countries have followed different approaches for defining broadband. While subscribing or evaluating a broadband plan, generally, next to price, the speed is the decision-making parameter. Consequently, in many countries, including in India, broadband is defined in terms of speed.

3.20 Presently, broadband do not necessarily provide the same upload and download speeds. Generally, the download speed is much higher than the upload speed of broadband. Such asymmetric broadband services were designed keeping in view the requirements of web browsing and video streaming, the two most

popular early usage of broadband. Accordingly, in the definition of broadband also significance used to be given to download speed only. In recent years, uses of peer to-peer applications such as social media and video conferencing have increased. Such peer-to-peer applications are bringing significance to the upload speed also.

- 3.21 While the reliability and speed are the most significant parameters of consideration for many applications, two additional parameters, i.e., “latency or delay” and “jitter” are crucial for applications that depend on real-time delivery of information or interaction, such as conversational voice and video, and real-time gaming. However, generally, these parameters are still not included in the definition of broadband.
- 3.22 From the international experience, it appears that some of the countries still believe that the broadband definition should be independent of speed or technology. May be because, in the rapidly changing technological scenario, the threshold speed that is considered to be adequate for defining broadband at one point of time may become insufficient to meet the expectation of consumers after some time. Instead, the core concepts, such as always-on and high-speed connection, could be preferred alternatives for defining broadband as they would not be as constraining or subject to frequent revision. This can be an alternate for defining broadband in India also as by following this approach the broadband definition may not require frequent revisions. At the same time, we can continue setting broadband targets through the policy objectives like it has been done in NDCP-2018.
- 3.23 However, non-fixing of threshold speed for defining broadband may have concerns relating to non-transparent or insufficient communication to potential customers. Further, in absence of the

threshold speed for categorising a data connection as broadband, if TSPs/ISPs stop competing on speed parameter and do not upgrade their networks to deliver enough speed, which is comparable to speeds available in other parts of the world, even, increase in broadband penetration may not yield expected gains to GDP. This becomes more relevant due to the fact that most of the applications and services accessed through internet are designed keeping in view the global markets. Hence, the question for seeking inputs of the stakeholders arises is should we also define broadband based on core concepts only such as always-on, high-speed, etc., and delink the speed from definition of broadband or we should continue to define broadband in terms of download and upload speed?

- 3.24 As per “ITU – UNESCO Broadband commission state of broadband 2018 report”, many countries still follow the definition of broadband as recommended by Organisation for Economic Co-operation and Development (OECD), which considers the threshold download speed for broadband as 256 Kbps. Periodically, some of the member countries of OECD suggested for raising this threshold speed, but without consensus on a new baseline, OECD instead decided to introduce speed tiers for reporting broadband subscriptions like 256 Kbps to 1.5/2 Mbps, 1.5/2 Mbps to 10 Mbps, and so forth with increasing tiers of service up to above 1 Gbps. This can be another approach for defining broadband as per which rather linking the definition of broadband with speed we may introduce speed tiers for broadband in line with the objectives of National Broadband Policy in force, i.e., NDCP-2018 and reporting requirements to multilateral institutions like ITU and the World Bank.

- 3.25 One of the strategic objectives of NDCP-2018 is “*Propelling India to the Top 50 Nations in the ICT Development Index of ITU from 134 in 2017.*” In this context, following the speed tiers approach may have another advantage that it would enable proper reporting of broadband subscription data, which is an input for calculating the points in ICT Development Index, to ITU and in-turn reflect the correct position of India’s ICT development before the international community including investors and companies. ITU seeks the data relating to broadband from 256 kbps onwards.
- 3.26 As noted earlier, in India, the present definition of broadband is linked to download speed. This is defined in terms of the capability of the medium, and technology used to provide broadband connectivity, i.e., it should be able to deliver minimum download speed of 512 kbps to an individual subscriber from the point of presence (POP) of the service provider intending to provide broadband service. Further, the Authority recommended that, from 1st January 2015, the minimum download speed for broadband be revised to 2 Mbps. However, this recommendation of the Authority has not been implemented by the Government. It is also pertinent to note here that in India, presently, the minimum upload speed is not linked with the definition of broadband.
- 3.27 During the last decade, keeping in view the developments happening in the ICT sector, and growing importance of ICT in the economy; many countries have upwardly revised the minimum speed threshold for defining broadband. This put an indirect demand on TSPs/ ISPs to upgrade their systems and networks to fulfil the demand for higher speed broadband. However, any upward revision in the threshold speed for defining broadband may lead to non-counting and under reporting of such internet connections to ITU which would fall in between 256 kbps and

revised threshold speed. This in turn may adversely impact the India's position in ICT development Index. However, non-revision of threshold speed for broadband may not encourage ISPs and TSPs to upgrade their networks to deliver higher broadband speed, and that in-turn may adversely impact another objective of the NDCP-2018, i.e., to "*Provide Universal broadband connectivity at 50 Mbps to every citizen*". Therefore, it becomes necessary to consider all dimensions before revisiting the definition of broadband.

3.28 Recent COVID-19 pandemic has witnessed a considerable increase in the dependence of enterprises as well as individuals on applications, such as, video conferences, cloud services, social media, and Work From Home (WFH), etc. These latest changes in the broadband usage pattern bring forward the threshold upload speed as an important parameter as well for defining broadband. Hence, another issue of utmost consideration while reviewing the definition of broadband is that whether threshold downlink speed alone is sufficient or threshold upload speed also need to be prescribed.

3.29 It is a fact that while core network for fixed and mobile broadband may be the same or similar, the last mile characteristics of these two types of broadband connectivity are completely different. In case of fixed broadband, be it wireline or wireless, it is technologically feasible to ensure the delivery of minimum guaranteed speed in the 'Last Mile' connectivity as it is non-rivalrous in nature. In case of mobile broadband, due to shared access medium, ensuring the delivery of minimum guaranteed speed in the 'Last Mile' connectivity may not be feasible. Whether due to this differentiation the fixed and mobile broadband should be defined differently?

- 3.30 As discussed in previous section, some of the countries like Germany, Brazil, etc., follow separate definitions for fixed and mobile broadband. Germany follows a speed linked definition for fixed broadband and technology dependent definition for mobile broadband. Brazil has not linked its fixed broadband definition with speed, whereas for mobile broadband, it follows a technology dependent broadband definition.
- 3.31 Further in case of fixed broadband also, in some of the countries, ISPs offer different categories of broadband, on the basis of offered speed range. One such example is European Union countries. The European Commission has defined three categories of fixed broadband in terms of download speeds²¹:
- (a) 'Basic broadband' for speeds between 144 Kbps and 30 Mbps;
 - (b) 'Fast broadband' for speeds between 30 and 100 Mbps; and
 - (c) 'Ultra-fast broadband' for speeds higher than 100 Mbps.
- 3.32 Similarly, fixed broadband services in U.K., categorized based on speed²², are as follows:
- (a) Decent – offers download speed at least 10Mbit/s and upload at least 1Mbit/s
 - (b) Superfast – offers download speed of at least 30Mbit/s
 - (c) Ultrafast – offers download speed greater than 300Mbit/s
 - (d) Full fiber – offers download speeds of 1 Gbit/s.
- 3.33 Segmentation of fixed broadband based on speed may facilitate in meeting the different needs of different sections of customers. Further, it may also improve affordability as different plans can be priced at different price points. Therefore, in addition to improving transparency in communication to customers, this segmentation may also help in increasing the fixed broadband penetration.

²¹ European Court of Auditors special report: Broadband in the EU Member States 2018

²² U.K. report: Connected Nations 2018

However, in the Indian context, the feasibility of this approach needs to be ascertained as it may require institutionalisation of some speed measurement program.

- 3.34 While defining the broadband based on some threshold speed, the question arises is should this threshold speed or more be actually delivered to categorise a data connection as broadband, or it is the minimum capability of the underlying medium and technology to deliver that threshold speed, which is sufficient to categorise a data connection as broadband. Presently, the second approach is followed in India. In case of mobile broadband, ensuring the actual delivery of minimum threshold speed may not be practical because of technology limitations. Apart from the usual factors affecting speed in fixed broadband, i.e., core network congestion, link between web server and the telecom network, accessibility of web server, type of application, etc., the mobile broadband speed also depends on many other factors as well, such as:
- i. Number of concurrent active subscribers in a cell;
 - ii. Location of customer and distance from the base transceiver station (BTS)/eNodeB;
 - iii. Peak/off peak time
 - iv. Kind of device and customer-premises equipment being used.

- 3.35 In view of the above and keeping in view the objectives of NDCP-2018, the questions arise are:

Q.1: Should the existing definition of broadband be reviewed? If yes, then what should be the alternate approach to define broadband? Should the definition of broadband be:

- a. Common or separate for fixed and mobile broadband?**
- b. Dependent or independent of speed and/or technology?**

- c. Based on download as well as upload threshold speed, or threshold download speed alone is sufficient?**
- d. Based on actual speed delivered, or on capability of the underlying medium and technology to deliver the defined threshold speed, as is being done presently?**

Kindly suggest the complete text for revised definition of the broadband along with the threshold download and upload speeds, if required for defining broadband. Kindly provide the reasons and justifications for the same.

Q.2: If you believe that the existing definition of broadband should not be reviewed, then also justify your comments.

Q.3: Depending on the speed, is there a need to define different categories of broadband? If yes, then kindly suggest the categories along with the reasons and justifications for the same. If no, then also justify your comments.

VI. Measuring Broadband Speed

3.36 Measurement of broadband speed, as an important exercise, being undertaken by policymakers and regulators of different countries. For this purpose, fixed and mobile broadband speeds data is collected by the regulators through independent market research agencies. It helps in assessing the performance of broadband services being delivered by TSPs/ ISPs. At the same time, it also enables the assessment of national broadband goals. Leading countries like U.S., U.K., and Australia have launched speed measurement programs for monitoring broadband performance. These programs aim to increase transparency for subscribers, and encourage performance-based competition.

International experience

3.37 In the **United States of America (USA)**, FCC – the telecommunication regulator in the country, executes Measuring Broadband America program every year. This program is built on principles of openness and transparency. It is a performance study of broadband service in the U.S. It also improves availability of information to consumers. Under this program, speed measurements for fixed and mobile broadband are carried out separately.

(a) For measuring fixed broadband speed, a dedicated device is used, which is pre-configured with custom testing software for measuring internet performance. It is placed inside the consumer's home, directly connected to the customer end router via Ethernet cable. It, therefore, directly accesses fixed internet service being delivered to the home and periodically run tests to measure broadband performance. For more details the link may be referred: <https://www.fcc.gov/general/measuring-broadband-america>.

(b) Mobile broadband speed is measured using FCC Speed test app – a smartphone-based application to test broadband performance data from volunteers participating in the collaborative, crowdsourcing initiative. Data is collected to inform consumers, and help industry and policymakers with the goal of improving mobile broadband performance nationwide.

3.38 In **U.K.**, OFCOM's broadband speed measurement is applicable only to those ISPs who are signatories to the Voluntary Code²³ on Broadband Speeds, which requires that speed estimates are provided ahead of sale, and gives consumers the right to exit their

²³OFCOM Better Broadband Speed Information: Voluntary Code of Practice (Residential)

contract penalty-free if speeds are below a guaranteed minimum level. Its aim is to monitor the performance of fixed-line residential broadband connections. OFCOM with the help of an agency has recruited a panel of U.K. residential broadband users and supplied monitoring units to each panellist²⁴. The testing is carried out by these panellists through testing software pre-installed in the monitoring units. The performance data is collected and analysed by OFCOM.

3.39 In 2017, the **Australian Competition and Consumer Commission** (ACCC) launched its program called ‘Measuring Broadband Australia (MBA) to measure internet performance²⁵. Testing units were supplied to internet users to measure the quality of experience for fixed-line internet. The MBA program relies on households across Australia volunteering to receive a testing unit, which tests the speeds of their fixed-line broadband services. The MBA speeds are direct measures of what volunteers can achieve over their connections when downloading and uploading data. Hundreds of thousands of speed tests are run and the average speeds are achieved through calculations for different volunteer groups. Quarterly reports are prepared for publication by the ACCC. Reports show the performance across a range of broadband plans at the service provider level.

3.40 In **India**, TRAI launched the mobile app, known as TRAI MySpeed App, allowing users to measure the QoS parameters, such as speed and packet loss, of wireless data networks and report these back to the Authority. Tests results collected from the App are processed, and analyses of results are published on the portal <https://myspeed.trai.gov.in/>. The analyses provide a comparative

²⁴ U.K. Home Broadband Performance Report - May 2019

²⁵ ACCC Measuring Broadband Australia Report - November 2019

picture of the mobile broadband speeds achieved on various Telecom Service Providers (TSPs)' networks. In addition, consumers also use mobile apps of other agencies like Opensignal, etc., to measure the achieved broadband speed. However, as on date, for measuring fixed broadband speed, any mechanism based on dedicated hardware or software embedded in a device at the users' premises does not exist in the country.

VII. Broadband speed measurement challenges

- 3.41 Measurement of broadband speed can be done either through a dedicated testing unit directly connected to the customer end-network device or modem or through some embedded software running in the customer end-network device or through some native applications running on user's smartphone or tablet, etc. Each of these measurement methodologies suffer from various challenges as discussed below.
- 3.42 A typical broadband speed test sends traffic that traverses many network links, including the Wi-Fi link inside the user's home network, the link from the ISP's device in the home to the ISP network, and the many network level hops between the ISP's edge router and the speed test server, which is often hosted just outside the ISP network. The speed measurement that results from such a test, in fact, reflects the capacity of the most constrained link, sometimes referred to as the "bottleneck" link—the link along the end-to-end path that is the limiting factor in the end-to-end speed. If a user has a 1 Gbps connection to the internet, but its home Wi-Fi network is limited to 200 Mbps, then any speed test from a device on the Wi-Fi network to the Internet will not exceed 200 Mbps. Bottlenecks can exist in the ISP network, in the transit network between the client and the server, in the server or server data-center network, or other places. In many cases the bottleneck is

located somewhere along the end-to-end path that is not under the ISP's direct control.

- 3.43 Testing client type also has an important influence on the test results. Client types range from dedicated hardware to software embedded in a device on the user's network, to native software made for a particular user operating system, and web browsers. Embedded software refers to examples where the software is integrated into an existing network device such as cable modem, home gateway device, or Wi-Fi access point. A native application is software made specifically to run on a given operating system such as Android, iOS, Windows, and Mac OS. Finally, web-based tests simply run from a web browser. Speed measurements by native applications may be affected by limitations of end-user device memory, CPU, network interface card, etc. In general, dedicated hardware and embedded software approaches tend to be able to minimize the effect of user-related factors and are more accurate as a result.
- 3.44 Impairment in individual access network link can also affect the measured speed. To mitigate the potential for an individual impairment unduly influencing ISP-wide results, tests should be conducted with a large number of users. Sometimes, transit networks may also introduce speed bottlenecks. End-to-end paths often have devices such as load balancers and firewalls, which can also act as a constraint and affect the test result.
- 3.45 It may also happen that the test servers are of limited capacity. For example, if a server has a 1 Gbps Ethernet connection then the server cannot be expected to measure several simultaneous 1 or 2 Gbps tests. Many other infrastructure-related factors can affect a speed test, including server storage input and output limits, available memory, CPU and so on. Designing and operating a high

scale, reliable, high performance measurement platform is a difficult task, and as more consumers adopt 1 Gbps services this may become even more challenging.

- 3.46 A speed test estimates the available capacity of the network between the client and the server. Therefore, the throughput of the test will naturally depend on the distance between these endpoints as measured by a packet's round-trip time (RTT). Speed tests that are initiated by a user suffer from self-selection bias, i.e., many users initiate such tests only when they are experiencing a technical problem or are reconfiguring their network. Crowdsourced tests are more likely to suffer from self-selection bias. Similarly, if tests are too infrequent or are only taken at certain times of day, the resulting measurements may not accurately reflect the correct speed.

VIII. Relevance of broadband speed measurement program in India

- 3.47 Speed is the single most important metric of interest in characterizing the "quality" of broadband service. To promote openness and transparency in communications to consumers, it may be beneficial to measure actual speed and make available the test results statistics to users. It may encourage healthy competition amongst service providers on the basis of broadband performance. If speed tiers are introduced for categorizing fixed broadband, the measurement of speed may become more relevant. This may also help in reporting the category-wise broadband subscriptions correctly.

- 3.48 In view of the above, the question arises is:

Q.4: Is there a need to introduce the speed measurement program in the country? If yes, please elaborate the methodology to be implemented for measuring the speed of a customer's

broadband connection. Please reply with respect to fixed line and mobile broadband separately.

CHAPTER 4

INFRASTRUCTURE CREATION

- 4.1 Universal access to broadband, enhancement of broadband speed up to average 50 Mbps, and realisation of gains in GDP due to increase in broadband penetration are closely linked with creation of digital communication infrastructure in the country. As discussed earlier, universal access to broadband is critical for the success of the Digital India program, and therefore creation of supporting ICT infrastructure becomes a priority for the Government as well as the industry. Accordingly, the NDCP-2018 has the vision that *“To fulfil the information and communication needs of citizens and enterprises through the **establishment of a ubiquitous, resilient, secure, accessible and affordable Digital Communications Infrastructure and Services**; and in the process, support India’s transition to a digitally empowered economy and society.”* Further, one of the three missions stipulated in the NDCP-2018 emphasises on infrastructure creation, i.e., **“Connect India: Creating Robust Digital Communications Infrastructure”**.
- 4.2 NDCP-2018 also emphasises *“Digital infrastructure and services are increasingly emerging as key enablers and critical determinants of a country’s growth and well-being. **With significant capabilities in both telecommunications and software, India, more than most countries, stands poised to benefit from harnessing new digital technologies and platforms to unlock productivity, as well as to reach unserved and underserved markets; thus catalysing economic growth and development, generating new-age jobs and livelihoods, and ensuring access to next-generation services for its citizens.**”*; and *“The task before India’s policy makers is to ensure that the*

*advantages of the new technologies are accessible to all equitably and affordably; while securing them against existing and emerging threats. **India needs to particularly ensure that its communications' infrastructure supports the entire population, whose demographic profiles vary widely across various indices such as literacy, economic conditions, and urbanisation.** It is important for India to remain sensitive to these factors and promote policies that increase opportunities for their social and economic development. **Accordingly, this policy aims for Universal Coverage rather than revenue maximization.***”

4.3 Despite rapid growth of mobile broadband subscribers during the last 3–4 years, India continues to lag other similarly placed countries significantly, both in terms of average speed and broadband penetration. As the NDCP - 2018 envisages for providing universal broadband connectivity at 50 Mbps for every citizen, it would require substantial investment in digital communication infrastructure. Under the mission '**Propel India: Enabling Next-Generation Technologies and Services through Investments, Innovation, Indigenous Manufacturing, and IPR Generation**', the policy has a goal to attract investments of USD 100 Billion in the Digital Communications Sector.

4.4 Digital communication infrastructure goes much beyond the traditional telecommunication networks. It includes many other significant infrastructure elements, and systems such as Data Centres (DC) – used for hosting of content and cloud-based applications and services, Content Delivery Networks (CDN) – used for delivering the content up to the edge of the network, etc. Since the Authority has received a separate reference from DoT on “*Evolving enabling regulatory frameworks and incentives for promoting the establishment of International Data Centres, Content Delivery Networks and independent interconnect exchanges in*

- India*”, and the Authority proposes to have a separate consultation with stakeholders on this issue, the scope of this CP is being limited to for traditional telecommunication networks.
- 4.5 Being a capital-intensive sector, the telecom infrastructure creation would require significant amount of investment. Major part of the required investment has to come from private sector as the Indian telecom market is dominated by the private sector. The Government is required to support the efforts of private sector through facilitative policy environment; and by investing through USOF in such areas where private investment is commercially non-remunerative.
- 4.6 Traditional telecommunication networks’ infrastructure can be sub-classified into two categories, i.e., active and passive infrastructure. Presently, in India, while active as well as passive infrastructure can be established by licensees, only passive infrastructure can be established by Category-I Infrastructure Providers (IPs-I).
- 4.7 To fulfil the ever-increasing demand for telecom services at affordable prices, sharing of infrastructure is vital in the telecommunication industry. Sharing of infrastructure is vital for market agents because they always look to optimise costs, and it is vital for policy makers also who are trying to maximize social welfare. Sharing of infrastructure is associated with reduced capital expenditures (CapEx) and operational expenses (OpEx), lowering barriers to entry, and affordable prices as well as increased competition and internet use. Infrastructure deployment in low-population density or low-income level areas is a low-return investment for the service providers, hence, there is an added incentive for sharing of infrastructure as it would lead to a reduction in expenses of TSP’s. BEREC report on infrastructure

sharing²⁶ estimates that:

- a. Passive infrastructure sharing cost savings: [16%–35%] CapEx, [16%–35%] OpEx;
- b. Active infrastructure sharing (excl. spectrum) cost savings: [33%–35%] CapEx , [25%–33%] OpEx ;
- c. Active infrastructure sharing (incl. spectrum) cost savings: [33%–45%] CapEx , [30%–33%] OpEx ;

4.8 In India, sharing of the passive infrastructure such as Dark fibres, Right of Way, Duct Space, and Towers is permitted to TSPs as well as Category-I Infrastructure Providers (IPs-I). Based on the mutual agreements, the active infrastructure sharing has been permitted amongst TSPs. Presently, sharing of active infrastructure is limited only to the antenna, feeder cable, Node B, Radio Access Network (RAN), and transmission system.

4.9 The reference under consideration from DoT is seeking the Authority’s recommendations on implementing the NDCP-2018 strategy *“By encouraging innovative approaches to infrastructure creation and access including through resale and VNO”*. The NDCP-2018, in its strategy for establishing a ‘National Broadband Mission — Rashtriya Broadband Abhiyan’ to secure universal broadband access, also envisages enhancement in the scope of Infrastructure Providers (IPs). It pronounces that *“Encourage and facilitate sharing of active infrastructure by enhancing the scope of Infrastructure Providers (IP) and promoting and incentivizing deployment of common sharable, passive as well as active, infrastructure.”* As noted in Chapter 2, the Authority has already given its recommendations dated 13th March 2020 on *“Enhancement of Scope of Infrastructure Providers Category-I (IP-I) Registration”* to the

²⁶https://berec.europa.eu/eng/document_register/subject_matter/berec/reports/816-4-berec-report-on-infrastructure-sharing

Government. Through these recommendations, the Authority has already recommended to the Government to include establishment of certain active infrastructure elements and systems in the scope of IP-I Registration. Further, through these recommendations, the Authority has also recommended to the Government to permit resale or access of passive and active telecommunication infrastructure, created by IPs-I, to TSPs as well as Virtual Network Operators (VNOs). Therefore, the primary focus of deliberations in this chapter is to identify innovative approaches to infrastructure creation.

- 4.10 Creation of passive infrastructure such as Duct Space, OFC connectivity, and Towers is capital intensive and time-consuming activity. For establishment of a ubiquitous, resilient, secure, accessible, and affordable Digital Communications Infrastructure, prerequisite is to ensure easy availability of passive infrastructure. Once the passive infrastructure is available in time and on a reasonable price, the active infrastructure can be established as per the demand in a time-bound manner. Therefore, there is a need to identify innovative approaches for creation of passive infrastructure items like duct space, OFC connectivity and towers, and efficient use of the same.

Duct Space:

- 4.11 A duct is essentially a tube-like structure that is used for housing the Optical Fibre Cable (OFC). This provides protection to the OFC from damage and facilitates faster rollout of OFC networks. For underground OFC networks, suitably sized ducts are required to match the cable size. Further, for network growth and maintenance, additional ducts get laid.
- 4.12 When a common duct infrastructure is laid, it incentivizes the TSPs and ISPs to provide services as the cost gets divided among various

service providers. A service provider just needs to buy/lease the number of micro ducts as per requirements, blow the optical fibre cable, connect the electronics, and provide the services. The hassles of trenching, ducting, and RoW permissions can be avoided.

Optical Fiber Cables

- 4.13 Optical Fiber is a fundamental and structural part of both mobile and fixed broadband networks. Faster rollout of fibre is important for backhauling a large amount of data at high throughput, improving reliability, and reducing latency. To achieve the objective of universal broadband connectivity at 50 Mbps to every citizen, fiberisation of telecommunication networks is must. There are two main types of OFC network installations: underground and aerial. Aerial fibre installation is generally less costly and faster to deploy than underground fibre as aerial fibres can be easily deployed using the existing electric poles. However, the underground fiber provides more reliability and requires less maintenance efforts.
- 4.14 Advocating the need for giving OFC, the status of Public utility, the NDCP-2018 suggests promotion of collaborative models involving the State, Local Bodies and the private sector, as necessary, for provision of the shared duct infrastructure to deploy fibre in municipalities, rural areas and along national/state highways. It would provide impetus to high speed and reliable broadband availability.

Towers

- 4.15 As per the NDCP-2018, one of the strategies for establishing a 'National Broadband Mission – Rashtriya Broadband Abhiyan' to secure universal broadband access, is to facilitate the establishment of mobile tower infrastructure by extending incentives and exemptions for the construction of telecom towers,

and according and accelerating RoW permissions for telecom towers in Government premises.

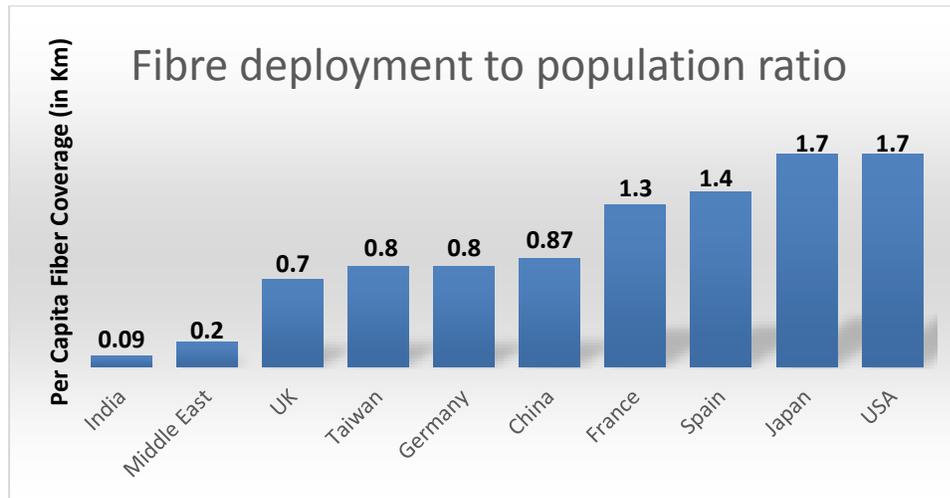
I. Demand factors for telecommunication infrastructure

- 4.16 With the increase in smartphone penetration and reduction in data tariffs, internet consumption is on the rise in the country. To sustain this rising consumption of data and for meeting the demand for enhanced broadband speed, substantial investment in telecom infrastructure is required.
- 4.17 Fiberisation of mobile telecom towers in India, which is only about 30%, is far behind the global accomplishments, which is around 70–80 percent²⁷. Fiberisation of telecom network is a must to support high-speed applications and services. The NDCP’s “Fiber First Initiative” aims to facilitate a “Fibre-to-the-tower” programme to enable fiberisation of at least 60% of mobile telecom towers.
- 4.18 Further, in terms of FTTH penetration, India has only 2.93 million FTTH connections in comparison to over 350 million in China. Without increasing the FTTH penetration, the Strategic Objectives of NDCP-2018 cannot be achieved.
- 4.19 In terms of per capita fiber coverage also, India is far behind its global counterparts. According to a recent report by ICRA Limited, India’s per capita fibre coverage is around 0.09 km, way below its global counterparts. China’s per capita fibre coverage is 0.87 km, while that of the U.S. and Japan is approximately 1.7 km. Details of per capita fibre coverage in few countries is given in figure 4.1

²⁷ Deloitte report 2016: Broadband Infrastructure for Transforming India

below:

Figure 4.1: Per Capita Fiber Coverage



Source: tele.net

- 4.20 Through the Digital India program, the Government is working for digital empowerment and digital transformation. Digital innovations are transforming businesses at a rapid pace. Technology is being used by growing Start-ups to solve complex problems and deliver value to stakeholders. At the current pace of digitization and digitalization, it is expected that India's digital economy has the potential to reach one trillion USD by 2025²⁸. This growing digital economy of India is creating demand for telecommunication infrastructure and services.
- 4.21 Further, a total of 100 cities have been selected under the Smart City initiative of the Government to transform existing cities to Smart Cities. Estimated cost of this project is Rs. 2,03,172 crores. The success of this initiative of the Government largely depends on timely availability of required telecom infrastructure.
- 4.22 Huge demand for passive telecom infrastructure would also come from the rollout of 5G networks. While some countries such as

²⁸ India's trillion-dollar digital opportunity: Digital India MeitY Report - https://meity.gov.in/writereaddata/files/india_trillion-dollar_digital_opportunity.pdf

South Korea and the U.S. have begun rolling out commercial 5G networks, India is about to start the trials for 5G use cases, and the Government is in the process of finalising the auctioneer for auction of 5G spectrum. To cater to the growing demand of data and deliver high-speed broadband, 5G networks would be denser than the previous generation cellular networks. One illustrative example, a cell using 20 GHz spectrum is expected to have only a third of the radius of the coverage compared to a cell using 3.5 GHz²⁹. This indicates that roughly 9 cells of 20 GHz will be needed to replace a cell of 3.5 GHz if same coverage is to be provided. As per the report of the 5G High-Level forum, constituted by DoT:

"5G will require massive addition of both above and below the ground infrastructure, both in passive and active categories. These include backhaul radios, antennas, towers, street furniture, and ducts, etc. In long term, 5G infrastructure densification can exceed 1,000 Base Stations per Sq. Km."

- 4.23 Enabling Next-Generation technologies and services through investments, innovation, indigenous manufacturing and IPR generation is contemplated under **"Propel India mission"** of the NDCP-2018. One of the goals of this mission is to accelerate the transition to Industry 4.0 by developing the market for IoT/ M2M connectivity services in sectors like agriculture, Smart Cities, Intelligent Transport Networks, Multimodal Logistics, Smart Electricity Meter, Consumer Durables, etc. This would require readily available broadband connectivity.
- 4.24 In view of the above, for implementing all these programs and achieving the NDCP-2018 objectives, constant demand for ubiquitous, resilient, secure, accessible, and affordable Digital Communications Infrastructure would be there in the foreseeable

²⁹ GSMA report - <https://www.gsma.com/futurenetworks/wiki/infrastructure-sharing-an-overview/>

future. This would require creation of passive infrastructure at rapid pace.

II. Right of Way (RoW)

- 4.25 For the speedy rollout of passive infrastructure, it is necessary that Right-of-Way (RoW) permissions, to be granted by the appropriate authorities are granted expeditiously at reasonable prices, and in a non-discriminatory manner to the TSPs and IPs-I.
- 4.26 In this regard, Section 10 of the Indian telegraph Act, 1885,³⁰ (the Act) grant 'Power for telegraph authority to place and maintain telegraph lines and posts', and Section 15 of the Act provides the mechanism for resolution of 'Disputes between telegraph authority and local authority'.
- 4.27 Accordingly, to address the issues relating to RoW, the Government has notified the Indian Telegraph Right of Way (RoW) Rules³¹ 2016 (the Rules), with the aim of streamlining the process of RoW permissions. Its salient points include:
- a) A single-window clearance mechanism for RoW permissions by all state Governments
 - b) One-time fee capped for telecom infrastructure installation
 - c) Time-bound clearances with deemed approvals
- 4.28 As per the said Rules, any dispute arising between a licensee (the telegraph authority) and the appropriate authority (as defined in the Rules) in consequence of the Rules shall be referred to the officer designated by the Central Government. Further, the Rules also provided that the Central Government shall, within a period of 60 days from the date of coming into force of the Rules, designate, by notification, officers with such jurisdiction as may be mentioned

³⁰https://www.indiacode.nic.in/handle/123456789/2307?view_type=browse&sam_handle=123456789/1362

³¹ https://dot.gov.in/sites/default/files/ROW_2016.pdf?download=1

in the notification, for the purpose to referring disputes. Accordingly, through notification dated 19th June 2017³², the Central Government designated the officers for dispute resolution. As per the Act, an appeal from the determination of such officer shall lie to the Central Government; and the order of the Central Government shall be final.

4.29 Now, after more than 3 years from the date of notification of the Indian Telegraph Right of Way (RoW) Rules 2016, the question arises is whether the Rules have effectively addressed the issues relating to grant of RoW permissions in time at reasonable prices in non-discriminatory manner or still there are concerns? Whether the appropriate authorities, as defined under the Rules, have reviewed their own procedures and align them with the Rules? Whether the RoW disputes under the Rules are objectively and in time getting resolved? If not, then what further changes are required in the Rules to make them more effective?

4.30 In view of the above, the questions arise is:

Q.5: Whether the Indian Telegraph Right of Way (RoW) Rules 2016 have enabled grant of RoW permissions in time at reasonable prices in a non-discriminatory manner? If not, then please suggest further changes required in the Rules to make them more effective.

Q.6: Is there any alternate way to address the issues relating to RoW? If yes, kindly elucidate.

Q.7: Whether all the appropriate authorities, as defined under the Rules, have reviewed their own procedures and align them with the Rules? If no, then kindly provide the details of such appropriate authorities.

³² <https://dot.gov.in/sites/default/files/19June2017.pdf?download=1>

Q.8: Whether the RoW disputes under the Rules are getting resolved objectively and in a time-bound manner? If not, then kindly suggest further changes required in the Rules to make them more effective.

- 4.31 In addition to the above, another strategy to address this complex issue could be through better coordination amongst appropriate authorities. It is pertinent to note here that the creation of the passive infrastructure such as Dark fibres, Right of Way, Duct Space, and Towers is the national priority and grant of RoW permissions is a multi-stakeholder issue. There are multiple authorities like Local Bodies, Railways, Roadways and Highways, Forest departments, electricity distribution, and transmission agencies, etc., which grant RoW permissions for laying OFC/ erection of telecom infrastructure. Many times, to execute a telecom project like laying of OFC along a road, RoW permissions from multiple agencies or authorities may be required simultaneously. Effective coordination among these appropriate authorities may help in timely permissions from all concerned and speedy execution of the project. Given the high degree of dependence of the national economy on high speed and reliable broadband services, the central, state, and local authorities after such coordinated efforts may start to appreciate the importance of timely RoW permissions.
- 4.32 Further, with the latest developments happening in the field of ICT, the availability of telecom infrastructure is becoming crucial for successful functioning of these authorities also. One such example is Smart City program. Without appropriate telecommunication infrastructure and services, the projects under Smart City program, being executed by Local Bodies, cannot be executed efficiently; and without permissions of the Local Bodies, telecommunication infrastructure cannot be created in the cities. Therefore, it is a case of mutual need also. However, presently, at

- the State level, there is no institutional or coordination mechanism to appreciate the requirements and concerns of each other and address them amicably. This becomes even more important as the telecom service has practically attained the importance of public utility.
- 4.33 While it is a fact that the communication is a central subject, increasingly, with the advent of ICTs, the State-level social and economic activities are becoming dependent on adequate availability of telecommunication infrastructure and services. Accordingly, many States have declared their policies to connect every household with broadband. They have also started participating in the development of telecommunication infrastructure in the State through their Public Sector Undertakings (PSUs). In this endeavour, some State Governments have waived off the RoW charges for the State PSU led projects.
- 4.34 The NDCP-2018, under the mission Connect India, for establishment of a National Digital Grid, emphasises on '*Creating a collaborative institutional mechanism between Centre, States, and Local Bodies for Common Rights of Way, standardisation of costs and timelines; and removal of barriers to approvals*'. Given the importance of digital communication infrastructure in growth of the economy and development of the country, there is a need to establish such collaborative institutional mechanism urgently. Keeping in view the practical aspects of the problem to be resolved, the contours of such collaborative institutional mechanism may be suggested by stakeholders.
- 4.35 One such institutional mechanism, to address the common issues relating to RoW permissions, could be a standing coordination-committee constituted at each Licensed Service Area (LSA) level. This committee could include the State-level representative from each appropriate authority and the telegraph authority. This

committee may coordinate the common issues in grant of RoW permissions and try to resolve the same. The convenor of this committee could be an LSA level senior officer of DoT as the responsibility of orderly growth of the telecommunication services is vested in the Central Government.

4.36 As per the license conditions, while the individual licensee shall continue to apply and seek RoW permissions from the respective appropriate authority, this coordination committee may consider only such issues which are common in nature and require some procedural intervention. This committee could also look for ways of increasing the telecom infrastructure in the State, and reducing the cost of building and maintaining passive telecom infrastructure. This would improve affordability of telecom services in that State. Senior officers of the DoT in each LSA, who would be the convenor of such committees, may meet periodically to share the best practices followed by different State-level coordination committees to solve the common issues relating to grant of RoW permissions in time at reasonable prices. This mechanism may ultimately give space to inter-sector collaborative regulations, which are need of the hour, keeping in view the imminent developments, like Industry 4.0, Smart City, Smart Power Grid, Intelligent Transport Systems, etc., happening in the field of ICT.

4.37 In view of the above, the questions arise are:

Q.9: What could be the most appropriate collaborative institutional mechanism between Centre, States, and Local Bodies for common Rights of Way, standardisation of costs and timelines, and removal of barriers to approvals? Justify your comments with reasoning.

Q.10: Should this be a standing coordination-committee at Licensed Service Area (LSA) level to address the common issues relating to RoW permissions? If yes, then what should be the

composition and terms of reference of this committee? Justify your comments with reasons.

III. Common duct space

- 4.38 Another approach for speedy rollout of OFC networks, in towns and cities as well as along the State and National highways and Railways, could be developing the common duct infrastructure for laying OFC. Given that Optical Fibre is now considered as public utility in the NDCP-2018, the time has come for development of common ducts. For implementing a 'Fibre First Initiative', the NDCP-2018 emphasises on *'Promoting collaboration models involving state, local bodies and private sector as necessary for provision of shared duct infrastructure in municipalities, rural areas and national highways'*.
- 4.39 When the conduit would already be in place at the time of laying fibre, the time and cost needed to deploy the fibre will be minimal. This could facilitate entry of new service providers in the market, reduce cost of rolling out fiber networks, enable fiberisation of the wireless networks, accelerate growth of fixed broadband, and provide protection against the much-eared fibre cuts. Due to increased competition in the market and cost optimisation, it could make services more affordable.
- 4.40 In a way, the availability of common ducts along the roads and streets would result into implementation of the 'Dig Once'³³ policy. The digging, restoration, and re-digging of the roads would be avoided as chambers/manholes would be provided at suitable intervals to lay the fibre. Once a common duct gets developed, it is no longer necessary to excavate the road or street every time when

³³ As per IEEE, the world's largest technical professional organization dedicated to advancing technology for the benefit of humanity, 'Dig Once' can be defined generally as policies and/or practices that minimize the number and scale of excavations when installing telecommunications infrastructure in public rights-of-way (e.g., highways).

- new fiber cable is required to be laid, and it can greatly simplify the task of maintenance. A service provider will just have to take on lease or purchase the micro duct for his cable. In this way, hassles of arranging RoW permissions would also be avoided.
- 4.41 Availability of common duct would increase public safety. Additionally, decreased road re-construction will reduce traffic congestion as well as increase the infrastructure life spans, which are often diminished by frequent digging. When development of common ducts is coordinated with construction of new roads or other utility projects, there is substantial time and cost savings.
- 4.42 Initially, considerable amount of investment and one-time RoW permission from land owning agencies would be required for developing the common ducts consisting of multiple micro-ducts. These micro ducts at a later date could be leased/sold to service providers. Generally, the developer of the common duct infrastructure maintains and manages the same.
- 4.43 Such common ducts could be developed by the land-owning agencies; and they can lease/sell them on commercial terms to the service providers. An example of this model could be National Highways Authority of India (NHAI), which can develop common ducts for OFC along the highways along with the construction of the highway itself. This would optimise the cost of construction for common duct, and it could be another source of revenue for NHAI.
- 4.44 Alternatively, the land-owning agency can grant one-time, long-term RoW to a utility company, and the utility company can develop and maintain the common ducts infrastructure. In lieu of the RoW permission, the land-owning agency can either charge one-time fee from the utility company intending to develop common ducts infrastructure or enter into a public-private partnership arrangement with the developer of common ducts infrastructure.
- 4.45 In the first case, where the land-owning agency intend to charge

- one-time fee, it can make public its intent to grant one-time, long-term RoW for developing common ducts infrastructure and utilities can participate in the bidding process for development of this infrastructure. The ownership of infrastructure would lie with the utility.
- 4.46 In the second case, where the land-owning agency intends to enter into a public-private partnership arrangement with the developer of common ducts infrastructure, it may bring in a private sector partner in PPP mode, through transparent process. In this model, the land-owning agency may provide the RoW for developing common ducts infrastructure while the PPP partner may invest in the development of the infrastructure. RoW charges may be waived off in lieu of ownership of part of the common ducts' infrastructure proposed to be developed by the implementing agency. One such example is:
- 4.47 The Rajarhat New Town, Kolkata, a greenfield city, formed a Joint Venture company called New Town Telecom Infrastructure Development Company Ltd. (NTTIDCO) between West Bengal Housing and Infrastructure Development Corporation (HIDCO), a Government company, and WEBFIL, a private sector telecom infrastructure company. NTTIDCO invested in creating common ducts in a planned utility corridor across the city. This infrastructure is being offered to service providers on a long-term lease for them to lay their optical fibre cables through these ducts.
- 4.48 One issue, which is pertinent to discuss from public policy perspective here is, whether development of common ducts infrastructure could give rise to monopoly? In fact, it would depend upon the model followed for development of common ducts infrastructure. If the common ducts infrastructure gets developed under exclusive arrangement, the risk of monopoly would always be there. In a diverse country like India, it is possible that different

States and Local Bodies may adopt different models. Accordingly, there would be a need to put in place an institutional mechanism to address such concerns relating to monopoly. One way of addressing such concerns could be intervention of TRAI as telecommunication regulator in such monopoly cases.

4.49 In view of the above, the questions arise are:

Q.11: Is there a need to develop common ducts along the roads and streets for laying OFC? If yes, then justify your comments.

Q.12: How the development of common ducts infrastructure by private sector entities for laying OFC can be encouraged? Justify your comments with reasoning.

Q.13: Is there a need to specify particular model for development of common ducts infrastructure or it should be left to the land-owning agencies? Should exclusive rights for the construction of common ducts be considered? Justify your comments with reasoning.

Q.14: How to ensure that while compensating the land-owning agencies optimally for RoW permissions, the duct implementing agency does not take advantage of the exclusivity? Justify your comments with reasoning.

IV. Cross-Sector Infrastructure Development – Dig Once Policy

4.50 Another innovative idea for infrastructure creation is cross-sector collaboration. Such collaboration could either be in the beginning of the infrastructure development itself or at later stage by leveraging the existing assets of other sectors. The NDCP-2018, for implementing a 'Fibre First Initiative', emphasises on '*Leveraging existing assets of the broadcasting and power sector to improve connectivity, affordability, and sustainability*'. In the broadcasting sector, the RoW permissions available with cable operators for establishing coaxial cable network could be used for laying aerial fiber network. Similarly,

- the transmission and distribution networks of power sector could be effectively utilised to roll-out wireless broadband networks.
- 4.51 For collaboration in the beginning of the infrastructure development itself, voluntary joint trenching or coordinated trenching looks feasible options. This is also referred to as 'Dig Once' policy.
- 4.52 Voluntary joint trenching requires that two public utility companies like electricity and telecom or water and telecom licensees formulate joint construction plans and receive approval to excavate in public rights of way simultaneously. One example of such voluntary joint trenching is Telangana's 'Mission Bhagiratha' project. Under this project, the establishment of Optical Fiber Network is integrated with 'Mission Bhagiratha', which is a project for safe drinking water for all village and city households in the state. The plan is to install ducts for optical fibre along with the extensive water pipeline network being laid under Mission Bhagiratha. This will save the state huge funds that would have been required to install a separate OFC network³⁴. Other examples of voluntary joint projects are optical fiber networks of GAILTEL and POWERGRID. Such voluntary agreements could happen between two unrelated entities also.
- 4.53 Coordinated trenching requires informing interested excavators, such as broadband providers, in advance when underground work or road construction is going to happen so that they can be prepared to install equipment in conjunction with scheduled excavations. In coordinated trenching, use of ICT can play an extremely important role. As per the Indian Telegraph Right of Way Rules, 2016, the appropriate authority shall develop an electronic application process (through online portal) for submission of applications for RoW permissions. These Rules also provide that the State Government may at its discretion establish a single electronic application process for all appropriate authorities

³⁴ Mission bhagiratha website - <http://missionbhagiratha.telangana.gov.in/>

under its control. The same online portal can be used by all other public utilities also to apply for RoW permissions. In such case, it (online portal) can be used to inform interested excavators, such as broadband providers, in advance when any other utility applies for permission to do underground work or road construction.

- 4.54 'Dig Once' policy minimize disruption in public rights of way. Public utilities like water and electricity have somewhat similar network architecture as traditional telecommunications network. Therefore, whenever anyone of such public utility agencies seeks RoW permission for laying underground pipes or cables, the TSPs and IPs-I can be informed through online portal automatically, so that, if required, the ducts for laying OFC can also be buried simultaneously.
- 4.55 The 'Dig Once' policy is used to minimize the number and scale of excavations when installing the telecom infrastructure. This policy has several advantages:
- a) Cost Savings – the cost savings in limiting the number of times a road must be opened to deploy broadband is the greatest advantage of implementing dig once practices and policies. When fibre installation is coordinated along with a road or utility project, it becomes much cheaper than adding the broadband infrastructure after the channel is built, and there are nearly 20% cost savings.³⁵
 - b) Economic Benefits – Increase in penetration of broadband would foster growth in existing businesses in the area and would result in boosting the local economy.
 - c) Decrease in time needed to deploy fiber – When the common duct is already in place at the time of fibre installation, the time and cost needed to deploy the fibre will be significantly lesser compared to in the absence of a common duct.

³⁵ Dig Once America statistics - <https://staticshare.america.gov/uploads/2016/04/6.-GCI-Dig-Once.pdf>

- 4.56 The Committee on Public Undertakings, in its 2018–2019 report, urged the NHAI to conduct a study on the financial and technical viability of the idea of laying underground utility ducts to facilitate the installation of gas pipelines, power, and phone lines, and optical fibre cables, etc., to reduce frequent digging of the roads. If found feasible, NHAI may plan for making the laying common underground utility ducts mandatory for their road construction projects³⁶.
- 4.57 Some new road construction projects in states like Chhattisgarh have included ducts installation at the time of road construction and are now available to TSPs on rent³⁷. Various states of India are increasingly adopting new PPP models and associated policies that are increasingly encouraging the co-deployment of OFCs at the time of road construction itself.
- 4.58 Indian Metro Rail Networks are one of the fastest growing in the world. Of the 67 metro projects across 27 cities in India, almost 54 projects are in various stages of development. Metro networks require both over ground and underground infrastructure development for operating metro rail, both of which can be harnessed for OFC deployment. The over ground metro pillars and underground metro tunnels can be easily used to install fibre optic cables. Typically, the fibres can be installed on the pylons and hangers on metro pillars and on the walls of the tunnel alongside power and other cabling. This can not only save the cost of infrastructure development for telecom companies but can also be an additional source of revenue for the metro rail networks. In addition, there will be huge savings in terms of deployment time as the infrastructure is readily available for use. Thus, deployment costs and time may be reduced by deploying cables using the metro pillars and tunnels. Moreover, the OFC deployed

³⁶ NHAI 25th report December 2018:

http://164.100.47.193/lssccommittee/Public%20Undertakings/16_Public_Undertakings_25.pdf

³⁷ UN ESCAP Report October 2018:

<https://www.unescap.org/sites/default/files/Codeploy%20and%20Resilience%20India-BD-edit.pdf>

through metro infrastructure can also be used for providing the broadband access inside the metro rail stations, thus generating an additional revenue stream for both broadband service providers and metro rail corporations.

- 4.59 As noted earlier, the cross-sector collaboration could happen at later stage also by leveraging or sharing the existing assets of other sectors. One such example is 22,500 km long optical fibre network being implemented in Andhra Pradesh over existing electric poles. The project cost came down to 333 crores from the initial estimate of 4,700 crores because the Government opted for an aerial fibre network, wherein optical fibre lines were laid over existing infrastructure such as electric poles to save costs in the State³⁸. Other examples of cross-sector infrastructure sharing are LCOs using electric poles for laying aerial OFC and Coaxial cables to deliver cable TV. The same broadcasting infrastructure could be used to deliver broadband services also.
- 4.60 As noted above, huge demand for passive telecom infrastructure would also come from the rollout of 5G networks. 5G will use much higher radio frequencies than today's cellular networks. While these higher frequencies carry larger amounts of data, they also have very short ranges. For 5G to work well, many additional small radios or "cells" must be installed close together — as close as 200 feet apart. For hosting such small cells infrastructure, sharing electric poles looks to be one possibility. This can facilitate faster rollout of 5G networks in India. To explore the feasibility of such options, the Authority has already started engaging with the Central and State level electricity regulators in the country.

³⁸ Livemint news 2016 - <http://www.apedb.gov.in/gallery/2016/august/020816/cisco-to-lay-22500-km-long-internet-fiber-network-in-andhra-pradesh-print-view-livemint.pdf>

- 4.61 Empirical evidence suggests that cross-sector infrastructure sharing lower deployment costs, and increase market entry, thereby, making markets more competitive.

United States experience

- 4.62 Deploying fibre optic communications' cables is a costly, complex and time-consuming process. Data from the U.S. Department of Transportation 'Intelligent Transportation Systems Joint Program Office' indicates the average cost of deploying fibre-optic cable is about \$27,000 per mile. And according to the Federal Highway Administration, "90 percent of the cost of deploying broadband is when the work requires significant excavation of the roadway." The high cost of construction creates a barrier to entry for potential broadband communications providers. As a result, state, and local Governments have turned to cost-saving measures to incentivize the broadband deployment.
- 4.63 The 'Dig Once Policy' aimed at cost-cutting is adopted by Arizona, Minnesota, and Utah, as well as several municipalities. The objective of this policy is to install an underground fibre link when building or renovating roads, railways, pipelines, utility infrastructure, or energy distribution channels. The policy strongly suggests laying fibre rather than empty conduit to reduce the cost and time for adding fibre. It also provides internet companies access to state- and city-owned rights of way.
- 4.64 Boston's Dig Once Policy is a "joint build" policy that requires all telecoms to install their cable in shared underground conduits on a shared-cost basis. This policy also designates a "lead company" that is tasked with coordinating efforts between all telecoms involved in the installation process, planning, and implementing the installation.
- 4.65 A new study by Broadband Now in USA states that passing 'Dig Once' legislation could have saved the USD 126 billion in broadband

deployment costs. Dig Once also helps in saving the environment from the pollution created by repeated digging of roads and trenches. This also saves from lot of supplementary problems associated with digging like traffic jams, public safety, spilling of construction materials over roads, repeated obstruction, snapping and fracturing of gas and water pipelines, and associated public inconvenience & costs of fixing them.

4.66 In view of the above, the questions arise are:

Q.15: What could be the cross-sector infrastructure development and sharing possibilities in India? Justify your comments with examples.

Q.16: Whether voluntary joint trenching or coordinated trenching is feasible in India? If yes, is any policy or regulatory support required for reaping the benefits of voluntary joint trenching and coordinated trenching? Please provide the complete details.

Q.17: Is it advisable to lay ducts for OFC networks from coordination, commercial agreement, and maintenance point of view along with any other utility networks being constructed?

Q.18: What kind of policy or regulatory support is required to facilitate cross-sector infrastructure sharing? If yes, kindly provide the necessary details.

Q.19: In what other ways the existing assets of the broadcasting and power sector could be leveraged to improve connectivity, affordability, and sustainability.

V. Infrastructure sharing, trading, and leasing

4.67 As per the available information, as on date, more than 900 IPs-I, and 1600 TSPs and ISPs are operating in India. Further, approximately 60,000 LCOs are also laying OFC for cable TV and broadband services. This number is increasing with time as the demand for passive infrastructure and fixed broadband is increasing. The passive

infrastructure such as Dark fibres, Right of Way, Duct Space, and Towers established by IPs-I can be leased or sold by them to TSPs/ ISPs for delivering telecommunication/broadband services. However, for facilitating such commercial transactions, no single platform is available where the details of demand and supply for passive infrastructure are available. This may be leading to inefficient market operations.

4.68 For attracting investment in the passive infrastructure development and its sustainable growth, it is necessary that the passive infrastructure market operates efficiently. This could be achieved through an e-marketplace for passive telecom infrastructure. This e-market place could register the details of demand and supply for passive infrastructure, and the same could also be used for leasing/trading of passive infrastructure. It could be supported by the Geographic Information System (GIS) platform, where the details of available ducts, OFC, and towers can be mapped.

4.69 Later on, the same GIS platform could be used for mapping of the other utilities also, so that the coordination and synergy effects could be brought into the horizon for trenching and ducting works between the existing TSPs and IPs-I as well as between TSPs/IPs-I and other utilities like Road, Rail, Gas, Water, and Power Distribution, etc. This common GIS platform could also help in reducing the interruptions, and cost of maintenance as the same can be used for auto-notifications to respective utility companies before undertaking any digging, trenching, etc. This platform could also facilitate cross-sector collaboration for co-deployment of passive infrastructure.

4.70 GIS has the unique ability to:

- a) Integrate data from multiple sources, update, and maintain the database from all the utilities
- b) Present them visually using geography as a common element of these various data sources

c) Help understand patterns and relationships between these data elements³⁹.

4.71 Another issue for discussion here is, if such e-marketplace improves market efficiency and helps in attracting investment in the passive infrastructure sector, who should establish, maintain, and operate the same. Should it be managed by any of the Government agency or it can be managed by an industry body? What could be the business model for making it sustainable?

4.72 In view of the above, the question arises is:

Q.20: For efficient market operations, is there a need of e-marketplace supported by GIS platform for sharing, leasing, and trading of Duct space, Dark Fibre, and Mobile Towers? If yes, then who should establish, operate, and maintain the same? Also, provide the details of suitable business model for establishment, operations, and maintenance of the same. If no, then provide the alternate solution for making passive infrastructure market efficient.

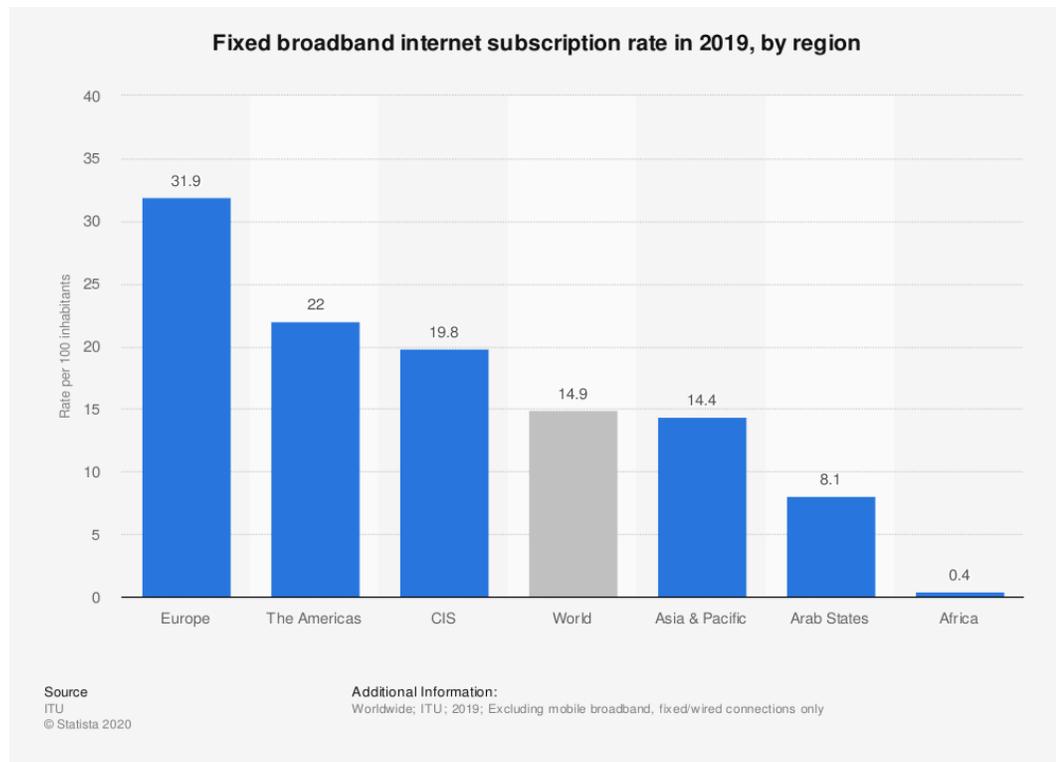
³⁹ ESRI India 2015:GIS for Smart Cities

CHAPTER 5

PROMOTING BROADBAND CONNECTIVITY

5.1 Currently, India has the second highest number of online consumers in the world, accounting for about 10% of the world's internet population. However, when we compare the same with India's share in the world population which is approximately 16%–17%, even this achievement looks below par. This becomes more alarming when we compare the fixed broadband penetration. As per www.statista.com, in 2019, it is estimated that, at global level, wired broadband subscriptions reached 14.9 active subscriptions per 100 inhabitants of the global population. In comparison, in India, we have approximately 1.5 active subscriptions per 100 inhabitants only. The region-wise details of fixed broadband internet subscription rate in 2019 are given in Figure 5.1.

Figure 5.1: Region-wise Fixed Broadband Subscription Rate 2019



Source: www.statista.com

5.2 The Government has notified the policy objectives through NDCP-2018, one of those is to provide universal broadband connectivity @ 50 Mbps. To meet this NDCP-2018 objective, there are two important aspects that need a careful deliberation. One is to achieve universal broadband connectivity or 'broadband for all' objective; another is speed enhancement from 11–12 Mbps presently to average 50 Mbps.

I. Mobile Broadband

5.3 Mobile internet has better availability and generally proves to be more affordable for low to medium usage than fixed-line broadband. As per the available details, at macro level, except in some left out areas where the Government is executing certain schemes through USOF to fill the gaps in mobile broadband coverage, the wireless broadband coverage is available across the country.

5.4 Further, Wi-Fi technologies can play a significant role in the penetration of mobile broadband due to ease of deployment and faster rollout. In rural and remote locations where spread of houses is limited to a smaller area, wireless coverage using Wi-Fi technology may be cost effective and easy to maintain. In this manner, cellular and Wi-Fi technologies could complement each other in delivering the mobile broadband services.

5.5 In general, TSPs/ISPs may incur substantially lesser costs in setting up Wi-Fi access infrastructure compared to mobile broadband networks like 3G/4G, especially in rural and remote areas. This is on account of the fact that Wi-Fi technology utilises unlicensed spectrum, the equipment is both cheaper and more readily available, and maintenance and operational costs are significantly lower. The lower cost of Wi-Fi delivery should easily translate into lower prices per GB for the end users, making it a more affordable service. Added to this is the fact that Wi-Fi networks can often offer faster speeds

- compared to mobile broadband, allowing users to access more bandwidth-intensive applications and content.
- 5.6 Despite significant progress in the space of mobile broadband, delivering reliable and affordable broadband services in the dense urban areas, inside the buildings, and rural and remote areas remains a challenge. World over, 'Wi-Fi hotspots' are used to fill this gap in cellular coverage. Moreover, in cellular covered areas, Wi-Fi may allow TSPs to offload their cellular data. While doing so, operators can offer a better user experience and higher access speeds to subscribers in Wi-Fi zone, hence facilitating subscriber satisfaction and retention.
- 5.7 Accordingly, the Authority issued its recommendations dated 9th March 2017 to the Government on "Proliferation of Broadband through Public Wi-Fi Networks" to promote use of Wi-Fi technology, which uses the unlicensed spectrum.
- 5.8 At present, as compared to monthly subscription charges of fixed broadband, the monthly charges of mobile broadband are less than one third. As per the report⁴⁰ 'ICT Price Trends 2019', published by ITU, in India, mobile broadband services cost less than 1 percent of per capita Gross National Income (GNI). As Wi-Fi technology use unlicensed spectrum, which is free, broadband services delivered using Wi-Fi technology would be even more affordable.
- 5.9 Accessibility of mobile broadband is also improving day by day as new as well as pre-owned mobile devices like Smartphones and Tablets are becoming affordable for masses. Further, the significant increase in uptake of video consumption in native languages and availability of multilingual keypads of mobile devices in Indian languages has reduced the language barrier and improved accessibility. Behind the

⁴⁰https://www.itu.int/en/ITU-D/Statistics/Documents/publications/prices2019/ITU_ICTpriceTrends_2019.pdf

regularly increasing subscriptions of mobile broadband services, better availability, affordability, and accessibility may be the important factors.

5.10 As the NDCP-2018 aims to provide universal broadband connectivity by 2022, still approximately 40% of total mobile subscribers are not accessing data services. Achieving 'broadband for all' objective of the NDCP-2018 may be possible using wireless technologies only.

5.11 In view of the above, the question arises is:

Q.21: Even though mobile broadband services are easily available and accessible, what could be the probable reasons that approximately 40% of total mobile subscribers do not access data services? Kindly suggest the policy and regulatory measures, which could facilitate increase in mobile broadband penetration.

II. Fixed Broadband

5.12 In promoting fixed broadband connectivity also, these three factors, i.e., availability, affordability, and accessibility, could be of considerable importance. It is pertinent to note here that, now a days, generally, the converged devices such as Smartphones and Tablets are commonly used for accessing mobile as well as fixed broadband. Therefore, to a large extent, the issue of accessibility may not be the limiting factor in growth of fixed broadband.

5.13 Fixed broadband service stands out when it comes to reliability, speed, and cost per GB of data consumption, while mobile broadband takes a lead due to its basic characteristic, viz., mobility. With fixed broadband, one can get up to Gigabit per second with symmetrical download and upload speeds and very low latency when compared to mobile broadband. Some of the performance metrics of fixed and mobile broadband are compared in the Table 5.1:

Table 5.1: Performance Metrics of Fixed and Mobile Broadband

Performance metrics	Fixed Broadband	Mobile Broadband
Latency	Low	Relatively higher
Reliability	Highly reliable	Less reliable
Mobility	Mobility restricted within the premises	Full mobility
Minimum Speed Assurance	Possible	Not possible
Maximum Speed	Up to one Gbps	Up to 100 Mbps
Affordability	More affordable for heavy users	More affordable for light users

5.14 In view of the above, generally, the broadband policies aimed at economic development focus more on improving fixed broadband penetration. For this, we need to roll out more and more optical fiber infrastructure in the access network, both in urban and rural India.

5.15 In European countries, primary internet access at home is provided mainly by fixed technologies. By the end of 2019, fixed broadband was available to 97% households⁴¹. Among fixed technologies, xDSL has the largest footprint (91%) followed by DOCSIS 3.0 cable (46%) and FTTP (34%).

5.16 In view of the above, the question arises is:

Q.22: Even though fixed broadband services are more reliable and capable of delivering higher speeds, why its subscription rate is so poor in India?

⁴¹ DESI connectivity report, 2020

III. Availability and Affordability of Fixed Broadband

- 5.17 Demand for broadband services plays an important role in growth of the broadband connectivity. It depends on customer expectations. Generally, customers expect reliable and high-speed broadband services at affordable prices as they access videos and other bandwidth hungry applications. Meeting customer expectations largely depends on the technologies adopted by service providers.
- 5.18 A variety of broadband technologies like xDSL, FTTH, Cable TV broadband, Wi-Fi, mobile technologies like 3G, 4G, FWA, etc., are available in the market for delivering broadband services. The performance, availability, and affordability of broadband service delivered using different technologies vary.
- 5.19 In India, as already noted, mobile broadband has better availability and affordability for cost-conscious subscribers. Though affordable, but the availability of public Wi-Fi hotspots to access broadband services is quite poor. The availability of wireline, i.e., xDSL, FTTH, and Cable TV, broadband networks is also limited to few cities and, the monthly subscription rates of fixed wireline broadband are generally higher than mobile broadband. The availability of FWA networks is miniscule.
- 5.20 It shows that, presently, other than cellular mobile technologies, availability of networks of other technologies is quite limited. There is a need for exploiting blend of wireline and wireless broadband technologies to promote broadband connectivity.
- 5.21 As noted earlier, fixed line broadband services are delivered using various technologies such as xDSL, G.Fast, Data over Cable Service Interface Specification (DOCSIS), Ethernet, and GPON, etc. Further it uses multiple mediums like traditional copper telephone lines, Coaxial cable, OFC, and combination of these mediums.

- 5.22 Broadband connections using xDSL technologies are provided over traditional copper telephone lines already installed to subscriber premises. DSL-based broadband transmission speeds ranges from several hundred Kbps to few megabits per second (Mbps). The availability and speed of an xDSL service depends on the length of cable used and deteriorates with distance. It requires relatively low investment in passive infrastructure if the cost of already laid copper cable is ignored.
- 5.23 The G.Fast specification is developed by the ITU-T and combines the best aspects of optical fiber networks and DSL technology to support access speeds of up to 1 Gbps via existing copper twisted pair for loops shorter than 250 meters. The access speed reduces as the distance increases further. ISPs can use G.Fast to increase broadband speed without having to extend fiber all the way to the home⁴². As G.Fast enables the use of existing assets, it may reduce the cost of providing broadband services and therefore improve affordability. G.Fast technology is deployed in many countries including U.K.⁴³, Israel, and Australia⁴⁴, etc.
- 5.24 More than 50 % of the existing fixed subscribers are working on DSL technology. DSL broadband subscribers constitute about 60%–70% of the of total wireline telephony subscribers working on copper cable. Accordingly, in India, there is limited scope for growth of the fixed broadband using DSL technology.
- 5.25 CATV broadband is usually offered to customers via the existing CATV network. Since the bandwidth is shared among several users connected through a last mile cable, many times, the broadband speed reduces during peak traffic periods of the day.

⁴² Nokia: G.fast- Break down barriers to fiber deployment

⁴³ Giganet U.K. G.Fast news

⁴⁴[nbn-co-plugs-in-first-gfast-units-across-Australia](#)

- 5.26 In most of the cases, to deliver high speed broadband services, Cable TV operators deploy Hybrid Fibre-Coaxial (HFC) networks. The implementation of DOCSIS 3.1 standard allows for higher bandwidths to end users of up to 10 Gbps. DOCSIS (Data over Cable Service Interface Specification) is an international telecommunications standard which enables the addition of high-bandwidth data transfer to the existing HFC network being used for delivery of cable TV services.
- 5.27 Optical fibre is the globally preferred technology to provide high-speed broadband to end users. Generally, it uses the Gigabit Passive Optical Networks (GPON) technology for provisioning of broadband services through FTTH connectivity. This is considered as future-proof solution but requires higher initial investment in the last mile connectivity.
- 5.28 Ease in deployment of OFC networks at reasonable costs plays a significant role in the availability of FTTH networks. In India, multiple challenges relating to delayed and costly permissions for RoW, prohibitive costs for laying new OFC, non-optimal utilisation of available wireline infrastructure in the country, non-availability of efficient marketplace for sharing, leasing, and trading of fibre, etc., could be few of the factors which may be impeding the growth of fixed line broadband. The issues relating to non-optimal utilisation of available wireline infrastructure in the country is being deliberated here. Remaining issues have already been deliberated in Chapter 4.
- 5.29 In India, underdevelopment of fixed broadband market could be because of the dominance of the mobile telephony and lack of availability of wireline telephony infrastructure before advent of mobile telephony. It is a fact that before launch of mobile telephony in the country, the fixed line tele density was less than three percent only. As mobile became more affordable, the penetration of fixed line

- reduced further. This is evident from the fact that at the end of December 2019, when mobile tele density was approximately 87%, fixed line tele density was 1.6% only. Although time and again TSPs have revealed their intent through public announcements to invest in fixed line broadband network, not much has happened.
- 5.30 It is a fact that, in India, maximum numbers of houses have been wired using HFC networks for cable TV services. As per an estimate, the availability of HFC networks crosses more than 100 million households. Most of these networks have been established, and are being operated and maintained by local entrepreneurs, i.e., Local Cable Operators (LCOs). The procedure for registration of cable operator, under the Cable TV Act 1995, is extremely simple, and the Authority for registration has been delegated to local area head Post Offices. Requirement of regulatory compliances is also minimal. These could be some of the reasons that more than 60,000 local-level entrepreneurs opted for providing cable TV services. In approximately, a decade time they wired more than 100 million households.
- 5.31 World over, since the advent of the broadband, cable TV networks are being used to deliver fixed broadband. In India, share of the cable TV broadband in fixed broadband subscribers is minuscule.
- 5.32 As noted earlier, operations and maintenance of fixed line broadband is manpower intensive. By now, LCOs and their employees have more than two decades of experience in operations and maintenance of fixed line networks. In one of the world's largest and fastest program, these operators upgraded the existing analog cable TV networks to digital cable TV networks in less than five years. It indicates their determination and capability of adapting technology and marching with time. By doing an incremental investment, it may be possible to upgrade the existing HFC networks to deliver reliable and high-speed broadband, and re-skill available technical manpower in latest

technologies. It would increase the availability of fixed broadband networks across India. Since it would enable exploitation of existing networks for delivery of additional services, this may be able to bridge the affordability gap also to a large extent.

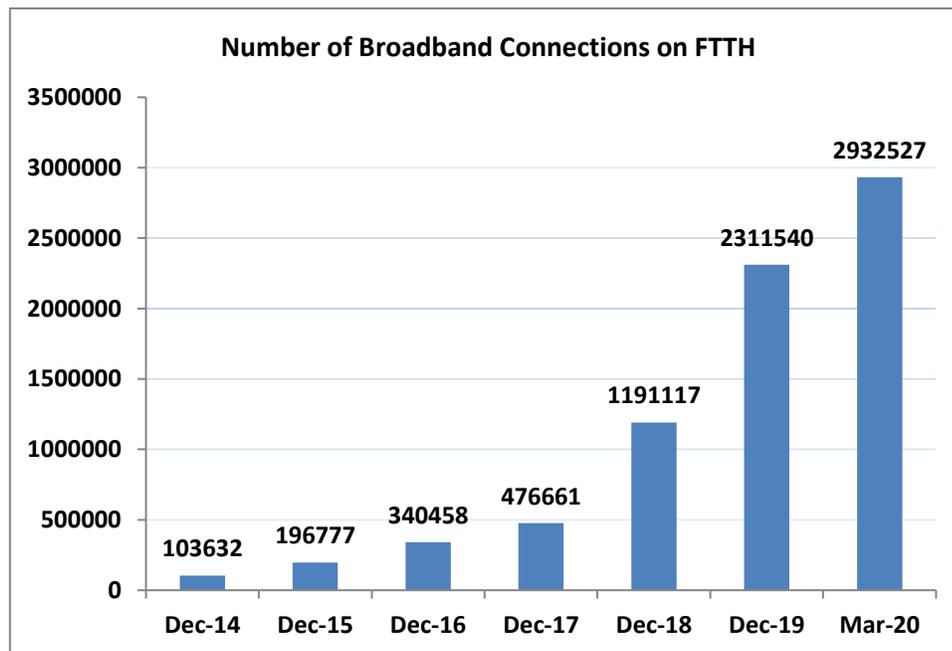
- 5.33 At present, monthly Average Revenue Per User (ARPU) of fixed broadband is significantly higher than cable TV monthly ARPU. Existing licensing framework for internet services enables use of these networks for delivery of broadband services. As per the licensing framework for Internet Services, two options are available to LCOs, i.e., either they themselves can obtain ISP license, or they can enter into commercial arrangement with existing TSPs/ISPs to provide last mile connectivity. The licensing framework for internet services provide flexibility of area of operations through three categories of licenses, i.e., category A, B, and C, at National, LSA, and District level, respectively. The question arises is what is holding back these entrepreneurs from providing broadband services?
- 5.34 One known issue, relating to payment of the license fee on adjusted gross revenue, which includes the revenue accrued from cable TV services, have been addressed by the Authority in its recommendations⁴⁵ to the Government on “*Definition of Revenue Base (AGR) for the Reckoning of Licence Fee and Spectrum Usage Charges*” dated 6th January 2015. The decision of the Government on these recommendations is awaited. In addition to this, is there any other issue that is holding back LCOs from providing broadband services in big way? Is it a demand or supply side issue? Whether the existing centralised procedure for granting ISP licenses is suitable for local level entrepreneurs or it requires decentralisation at the LSA level? Is it the significant difference in licensing and regulatory compliances of

⁴⁵ https://tra.gov.in/sites/default/files/Reco-AGR-Final-06.01.2015_0.pdf

internet and cable TV services? Should district level ISP licenses, with limited scope, have simpler license conditions to attract additional service providers for providing internet services? What further policy and regulatory support is required to address such issues?

5.35 Less than 15% of total wireline broadband connections in the country are working on FTTH technology. This could be because of limited availability of FTTH networks, which is considered as future-proof solution. This is reflected in the non-satisfactory progress in growth of FTTH broadband connections during the last 5 years, as presented in Figure 5.2.

Figure 5.2: FTTH Broadband Connections Growth in Last 5 Years



5.36 For increasing the availability and affordability of FTTH networks, issues relating to passive infrastructure creation at reasonable prices have been deliberated in Chapter 4. Is there any other supply side issue, which requires policy intervention to address the same?

5.37 The other issue could be from demand side. Customers may not be finding enough value for money in subscribing to fixed broadband. This may be because of the customer's perception that there may not

be much difference in performance between mobile broadband delivered using LTE technology and fixed broadband using DSL technology, which are the most prevalent broadband technologies in Indian market. What can be done to address this perceptual issue? Should the performance parameters of FTTH subscribers be reported separately to encourage other customers for subscribing to fixed broadband on FTTH technology? Other probable reason for lower demand for fixed broadband could be relating to day-to-day maintenance issues. In comparison to cell level maintenance requirements of mobile broadband, fixed broadband requires maintenance of individual connections.

- 5.38 As noted earlier, FTTH is capital intensive and takes more time for rollout. FWA can also provide an easier/cheaper solution to offer broadband connectivity to regions where wireline infrastructure is not present, or only copper wireline infrastructure is in place. Wireline networks using copper or fiber have traditionally been the preferred choice for delivering fixed broadband services due to their high capacity and reliability, but the need for universal connectivity means that alternatives to the wired network are more in demand than ever. Fixed wireless broadband networks using mainstream LTE-Advanced (LTE-A) technology are proving capable of delivering fast, high-quality, highly managed connectivity.
- 5.39 The surge in demand for high-speed broadband, along with the need to extend connectivity and improve the overall experience for broadband users, has opened new opportunities for fixed wireless access. As per Ovum consultancy⁴⁶, *“Fixed wireless networks are increasingly contributing to home broadband connection in developing markets where levels of HBB penetration are particularly low. Today*

⁴⁶<https://www.ondia.com/~media/informa-shop-window/tmt/whitepapers-and-pr/fixed-wireless-access.pdf>

FWA represents more than 90% of total broadband connections in Nigeria and DRC, and over 50% in a number of other countries including Ghana, Uganda, and Bangladesh.” As per GSMA, globally, over half of all LTE operators have launched an FWA service.

5.40 As the LTE networks are already existing, extending FWA over LTE can increase availability of fixed broadband. Use of common core and Fixed Mobile Convergence (FMC) may improve affordability.

5.41 In view of the above, the questions arise are:

Q.23: What could be the factors attributable to the slower growth of FTTH subscribers in India? What policy measures should be taken to improve availability and affordability of fixed broadband services? Justify your comments.

Q.24: What is holding back Local Cable Operators (LCOs) from providing broadband services? Please suggest the policy and regulatory measures that could facilitate use of existing HFC networks for delivery of fixed broadband services.

Q.25: When many developing countries are using FWA technology for provisioning of fixed broadband, why this technology has not become popular in India? Please suggest the policy and regulatory measures that could facilitate the use of FWA technology for delivery of fixed broadband services in India.

CHAPTER 6

BROADBAND SPEED ENHANCEMENT

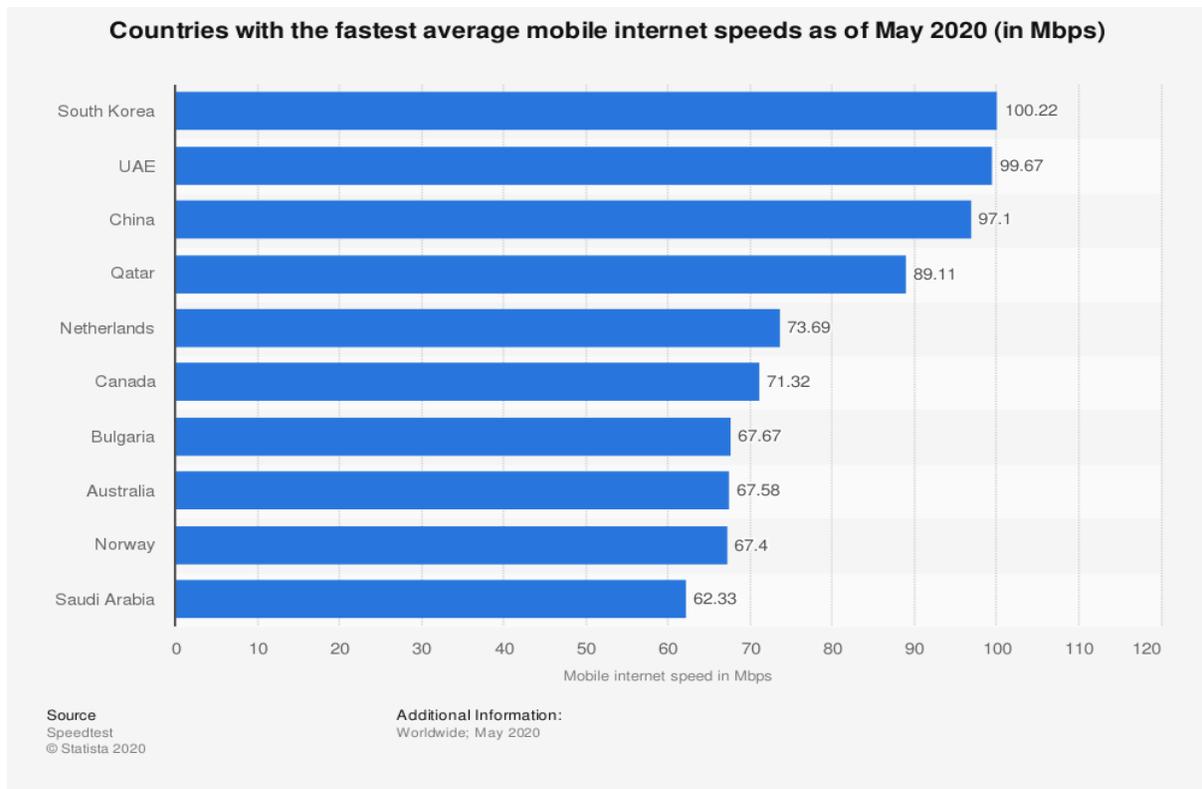
- 6.1 India is experiencing average download speeds of 12.16 Mbps in case of mobile broadband and around 38 Mbps in case of fixed broadband.⁴⁷ Despite the significant improvement in broadband speeds during the last 4–5 years, these are way below the global averages of 34.67 Mbps and 78.26 Mbps for mobile and fixed broadband, respectively. To meet the NDCP-2018 objectives of universal broadband connectivity @ 50 Mbps, lots is required to be done to enhance the broadband speed.
- 6.2 The NDCP-2018 emphasises that *“The objective of a national policy on digital communications is to prepare the country and its citizens for the future. Achieving these goals would require that the key stakeholders – namely the Centre, the States, local Governments and agencies, Telecom Service Providers, Internet Service Providers, Infrastructure Providers, handset and equipment manufacturers, the academic community, the innovators and start-ups come together to forge a coalition to deliver this national policy and its missions.”* Accordingly, the licensor, regulator and licensees, i.e., Telecom Service Providers and the Internet Service Providers should work in tandem to achieve the average broadband speed @50 Mbps goal.
- 6.3 In India, broadband subscriptions are dominated by mobile broadband. According to the performance indicator reports published by the Authority out of 687.44 Million total broadband subscribers, there were 667.66 million mobile broadband subscribers by the end of March 2020. Therefore, to achieve the NDCP-2018 objective of average speed @50Mbps, performance of the mobile broadband need to be significantly improved. Since, in India, the average fixed

⁴⁷ Speedtest Global Index

broadband speed is also much lower than the global average, performance of the core networks, which are generally common for fixed and mobile broadband, also need to be improved.

6.4 In many countries, the average mobile internet speeds are much higher. The details of such top 10 countries⁴⁸ is given in Figure 6.1.

Figure 6.1: Fastest Average Mobile Internet Speed in the World



Source: Statista

6.5 A number of factors determine broadband speed; some are influenced by operators (e.g., network design and capacity), some by consumers (e.g., mobile devices and CPEs), and some by external factors such as content hosting and the link between internet access network and server. For mobile broadband download speed, an additional driver is the amount of access spectrum, especially in the capacity bands above 1 GHz.

⁴⁸ <https://www.statista.com/statistics/896768/countries-fastest-average-mobile-internet-speeds/>

6.6 In achieving average 50 Mbps speed objective of the NDCP-2018, in India, there could be many bottlenecks in the internet space. We need to identify and address such bottlenecks. Some of those could be relating to capacity and congestion in the access and core networks, quality of devices being used to access internet, availability, and efficient utilisation of available spectrum for delivering broadband services, unavailability, or restricted availability of locally hosted content, and switching of internet traffic.

I. Core Networks:

6.7 Internet uses packets for transfer of information, which is bursty in nature. The technology permits use of a link (Bandwidth) by several users simultaneously. The number of users who can share the given bandwidth without impacting the quality of service depends on the applications, frequency of use, and many other parameters. This leverage allows ISPs to accommodate more subscribers using given bandwidth, and will also reduce cost of the access. This ratio of number of subscribers per unit of bandwidth is commonly known as ‘contention ratio’, and it may vary depending on and composition of traffic, and the quality of service the ISP is planning to offer. Speed of broadband is largely dependent upon three factors, i.e., bandwidth utilization, latency, and contention ratio.

6.8 The bandwidth hungry applications like Social Media, Video on demand (VoD), real-time gaming, video conferences, and Rich Communication Services send and receive continuous stream of packets and thereby require more bandwidth over simple text and information. As per the Ericsson Mobility Report June 2020, *“Video traffic in mobile networks is forecast to grow by around 30 percent annually up to 2025. It will account for nearly three-quarters of mobile data traffic, which is up from just over 60 percent in 2019. Mobile video traffic growth is driven by the increase of embedded video in many*

online applications, growth of video-on-demand (VoD) streaming services in terms of both subscribers and viewing time per subscriber, and the evolution towards higher screen resolutions on smart devices. All of these factors are influenced by the increasing penetration of video-capable smart devices. Social network traffic is also expected to rise by around 20 percent annually over the next 6 years. However, its relative share of traffic will decline from 10 percent in 2019 to around 8 percent in 2025, because of the stronger growth of video.”

6.9 Accordingly, the designs and capacity of internet networks may require to be constantly reviewed to accommodate such changes happening in the consumption basket. This may necessitate lower contention ratio. With higher contention ratio, service provider may accommodate a greater number of subscribers, which may eventually bring down the quality and speed of the broadband and may result in network congestion.

6.10 Bandwidth utilization and latency are two other important factors that affect the end-user broadband speed. Bandwidth refers to the maximum capacity of an internet backbone. The term latency refers to any of several kinds of delays typically incurred in processing of network data, the most obvious delay being the time it takes for a packet of data to go from a user’s computer to the website server they’re visiting and back (round-trip-time or RTT). Each hop a packet takes from router to router adds to the latency. Therefore, it also becomes important that in maximum how many hops, a network is able to reach destination server on which the content is hosted. This describes the importance of the data centres, CDNs, and IXPs in improving the broadband speed. For matching the global average broadband speed, delivery of maximum content to users from the edge of the network becomes a necessity.

6.11 As far as core networks are concerned, its design as well as capacity is fully in the hands of TSPs and ISPs. It does not require any natural resource like spectrum. The availability of sufficient OFC in the backbone networks is also there. The utilisation of available international bandwidth is also within limits. Then what could be the probable reasons for slower fixed broadband speeds, which largely depend upon the core networks only? It is pertinent to mention here that the performance of core networks affects the performance of the fixed and mobile broadband together. Is there a need of any policy or regulatory intervention by way of mandating certain checks relating to contention ratio, latency, and bandwidth utilisation in the core network?

6.12 In view of the above, the questions arise are:

Q.26: What could be the probable reasons for slower fixed broadband speeds, which largely depend upon the core networks only? Is it due to the core network design and capacity? Please provide the complete details.

Q.27: Is there a need of any policy or regulatory intervention by way of mandating certain checks relating to contention ratio, latency, and bandwidth utilisation in the core network? If yes, please suggest the details. If no, then specify the reasons and other ways to increase the performance of the core networks.

Q.28: Should it be mandated for TSPs and ISPs to declare actual contention ratio, latency, and bandwidth utilisation achieved in their core networks during the previous month to their customers while communicating with them or offering tariff plans? If no, state the reasons.

II. Radio Access Networks (RAN) Design and Capacity:

6.13 The performance of mobile broadband depends on the combined performance of the Core Network (CN) and Radio Access Network

(RAN). The issues relating to core network have been deliberated in the previous section. The mobile broadband speed, besides underlying technology, largely depends on RAN capacity and RAN user plane congestion.

6.14 Most of the mobile broadband subscribers use 4G devices and use LTE networks to access broadband. In India, more than 95% of total data consumption over mobile networks has been happening through 4G LTE networks. World over also, most of the data consumption is over mobile networks is happening through 4G LTE networks. Therefore, technology does not appear to be the limiting factor.

6.15 RAN capacity primarily depends upon the availability of passive infrastructure such as towers and OFC for backhaul connectivity, quantum of access and backhaul spectrum, and active infrastructure such as Baseband and Radio equipment. Issues relating to passive infrastructure have already been dealt in Chapter 4. The choice of active infrastructure such as Baseband and Radio equipment rests with licensees only. As the number of active infrastructure vendors is limited world over, similar equipment is being used to establish RAN. Some other challenges relating to mobile networks are discussed below.

A. Backhaul

6.16 Backhaul networks connect the RAN to the core network. OFC is often considered the most suitable type of medium for backhaul connectivity due to its longevity, reliability and ability to support very high capacity traffic. However, as per the details provided by TSPs, only about 31% of Base Transceiver Station (BTS) sites are connected on fibre network in the country. This is much less than the global trends, where more than 70%–80% sites have OFC connectivity. Therefore, in India, majority of the traffic from macro cells are still backhauled to core network through Microwave only.

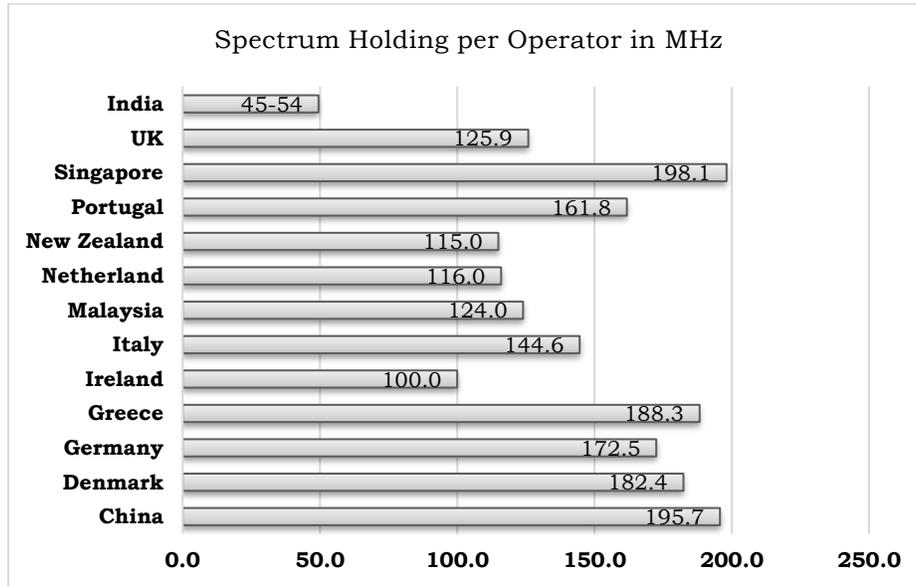
- 6.17 In this context, there are two frequency ranges viz E-Band (71–76 GHz paired with 81–86 GHz) and V-band (57–64 GHz) that are of great significance. These frequency ranges are commonly referred to as “millimeter waves”. The channel sizes in these bands are sufficiently higher than conventional microwave spectrum for fixed links which creates the capability of providing Ultra-high capacity (1 Gbps and above) fixed links, and may act as a suitable substitute in the interim for OFC in smaller distances (typically < 1 Km), particularly, in dense urban areas where laying optical fiber cable is difficult. The high spectral reuse in dense urban areas makes these bands suitable for last mile deployments in urban areas.
- 6.18 The authority has already given its recommendations to the Government on use of E- and V-band spectrum for backhaul connectivity. The decision of the Government is awaited. The opening of E- and V-bands could help to decongest the network over very short distances, while 15/18/21 GHz and other bands will continue to be used over relatively longer distances.

B. Access Spectrum

- 6.19 It is important to recognise that each new technology generation uses wider channel bandwidths and improved spectrum efficiency to drive faster connection speeds. This means they use increasing amounts of spectrum, making the need for new mobile frequency bands essential. The most recent types of 3G and 4G-LTE networks are capable of providing faster speeds by combining several channels together, making them even more reliant on large amounts of spectrum.
- 6.20 As per GSMA “state of mobile internet connectivity report-2019”, countries with the fastest networks have assigned the greatest amount of spectrum to operators in the band above 1 GHz. Average access spectrum holding per operator in India is 45 to 54 MHz, which is much lower as compared to many other countries in the world.

Quantum of access spectrum in < 3GHz frequency range in some countries is given in the Figure 6.2.

Figure 6.2: Spectrum Holding per Operator in Various Countries⁴⁹



6.21 This indicates as to how important it is to put-to-use available access spectrum for increasing mobile broadband speeds. This position may improve after successful auction of the access spectrum in next round. In the upcoming spectrum auction, the following quantity of access spectrum, in 22 LSAs put together, is likely to be put for auction.

Table 6.1: Spectrum Likely to be Put to Auctions in 2020

Sl. No.	Band (MHz)	Availability (MHz)
1.	700	770 (paired)
2.	800	236.25 (paired)
3.	900	81.4 (paired)
4.	1800	323.6 (paired)
5.	2100	275 (paired)
6.	2300	560 (unpaired)
7.	2500	230 (unpaired)
8.	3300-3600	6050 (unpaired)

⁴⁹<https://www.desktopsdr.com/worldwide-frequency-allocation-tables> & other websites

6.22 To increase the capacity and improve performance of RAN, several radio technologies (e.g., 2G, 3G, 4G-LTE, and increasingly also Wi-Fi) could be used simultaneously. As range of technologies is used to establish such radio access networks, these are commonly referred to as heterogeneous networks or HetNets. Most notably, this involves using large numbers of small cells such as Pico and Femto cells. These are very low power base stations, and bring the full data capacity of a conventional base station to a much smaller area. While a base station would traditionally spread its radio capacity over a kilometer or more, a small cell could serve a single home or business, containing only a few people, resulting in faster and more responsive mobile services. Similar to 4G-LTE, by squeezing more data into a single frequency band — small cells allow a single frequency band to be re-used more often, allowing it to carry more data.

C. RAN design

6.23 While planning a RAN, a TSP needs to assume certain design parameters which include a given quality of service parameters, which that TSP intends to offer to its customers. Such parameters could include average throughput, Maximum Bit Rate (MBR), Aggregated Maximum Bit Rate (AMBR), PRB utilization, etc. The mobile broadband speed directly depends upon these design objectives. It may be possible that design parameters assumed by Indian TSPs are more conservative than their counterparts in other countries and thereby the mobile broadband speed is much lesser in India.

III. RAN User Plane Congestion:

6.24 Since the average mobile broadband speed in India is much lesser than the world average, and in most of the leading countries maximum data consumption is happening over LTE networks only,

one reason for slower mobile broadband speed could be RAN congestion. RAN user plane congestion includes user plane congestion that occurs over the air interface (e.g., LTE Uu), in the radio node (e.g., eNB) and/or over the backhaul interface between RAN and CN (e.g., S1-u). RAN congestion may be the outcome of increase in the data consumption by existing users, changes happening in the traffic mix over a period of time, or addition of new subscribers without undertaking necessary capacity expansions.

6.25 If that is the case, then is there a need of any policy or regulatory intervention by way of mandating certain checks relating to RAN user plane congestion? Should it be mandated to TSPs to declare actual congestion, average across the LSA, recorded during the previous month over the air interface (e.g., LTE Uu), in the radio nodes (e.g., eNB) and/or over the backhaul interfaces between RAN and CN (e.g., S1-u), while reaching out to or enrolling a new customer? In such case, we need to identify some simple parameters which a common person can easily understand.

6.26 In view of the above, the questions arise are:

Q.29: What could be the probable reasons for slower mobile broadband speeds in India, especially when the underlying technology and equipment being used for mobile networks are similar across the world? Is it due to the RAN design and capacity? Please provide the complete details.

Q.30: Is there a need of any policy or regulatory intervention by way of mandating certain checks relating to RAN user plane congestion? What should be such checks? If yes, then suggest the details, including the parameters and their values. If no, then specify the reasons and other ways to increase performance of RANs.

Q.31: Should it be mandated to TSPs to declare actual congestion, average across the LSA, recorded during the previous month over the air interface (e.g., LTE Uu), in the radio nodes (e.g., eNB) and/or over the backhaul interfaces between RAN and CN (e.g., S1-u), while reaching out to or enrolling a new customer? If so, then suggest some parameters which can objectively determine such congestions. If no, then specify the reasons and other ways to increase performance of the RAN.

IV. Consumer Devices:

6.27 The broadband speed, to some extent, may also depend on consumer devices. In case of fixed broadband, it is the CPE, which in most cases in India is supplied by TSPs. In case of mobile broadband, it is mobile handsets, which in India in most cases are purchased by customers from open market. In case of 3G and 4G technologies, even the network performance to some extent may get affected because of the quality of mobile devices attached with the network. This may be the reason that in many countries TSPs bundle the mobile devices with their tariff offerings. This way such TSPs may be able to keep better control on their network performance, and optimise the resource utilisation. In India, TSPs do not bundle devices with their tariff offerings. This may be due to the applicable license fee definition and corresponding extra burden on TSPs when they bundle devices. This may be making their offerings non-competitive.

6.28 As per Opensignal, the handset network technologies which can affect the network experience include:

- a. The ability to connect to more frequency bands.
- b. The ability to connect to more than one radio band at once – called carrier aggregation.

- c. Technologies that improve the performance on any given radio frequency such as the modulation type (e.g., 64 or 256 QAM), and the use of multiple simultaneous antennae (e.g., 2x2 or 4x4 MIMO).
- 6.29 If that is the case, is there a need of any policy or regulatory intervention by way of mandating certain checks relating to consumer devices? To improve the consumer experience, should minimum standards for consumer devices available in the open market be specified? Will any such policy or regulatory intervention have potential of affecting affordability or accessibility or both for consumers?
- 6.30 In view of the above, the questions arise are:
- Q.32: Is there a need of any policy or regulatory intervention by way of mandating certain checks relating to consumer devices? If yes, then please suggest such checks. If no, then please state the reasons.**
- Q.33: To improve the consumer experience, should minimum standards for consumer devices available in the open market be specified? Will any such policy or regulatory intervention have potential of affecting affordability or accessibility or both for consumers? Please justify your comments.**

CHAPTER 7

ISSUES FOR CONSULTATION

- Q.1: Should the existing definition of broadband be reviewed? If yes, then what should be the alternate approach to define broadband? Should the definition of broadband be:**
- a. Common or separate for fixed and mobile broadband?**
 - b. Dependent or independent of speed and/or technology?**
 - c. Based on download as well as upload threshold speed, or threshold download speed alone is sufficient?**
 - d. Based on actual speed delivered, or on capability of the underlying medium and technology to deliver the defined threshold speed, as is being done presently?**

Please suggest the complete text for revised definition of the broadband along with the threshold download and upload speeds, if required for defining broadband. Kindly provide the reasons and justifications for the same.

- Q.2: If you believe that the existing definition of broadband should not be reviewed, then also justify your comments.**
- Q.3: Depending on the speed, is there a need to define different categories of broadband? If yes, then kindly suggest the categories along with the reasons and justifications for the same. If no, then also justify your comments.**
- Q.4: Is there a need to introduce the speed measurement program in the country? If yes, please elaborate the methodology to be implemented for measuring the speed of a customer's broadband connection. Please reply with respect to fixed line and mobile broadband separately.**
- Q.5: Whether the Indian Telegraph Right of Way (RoW) Rules 2016 have enabled grant of RoW permissions in time at reasonable**

- prices in a non-discriminatory manner? If not, then please suggest further changes required in the Rules to make them more effective.
- Q.6:** Is there any alternate way to address the issues relating to RoW? If yes, kindly elucidate.
- Q.7:** Whether all the appropriate authorities, as defined under the Rules, have reviewed their own procedures and align them with the Rules? If no, then kindly provide the details of such appropriate authorities.
- Q.8:** Whether the RoW disputes under the Rules are getting resolved objectively and in a time-bound manner? If not, then kindly suggest further changes required in the Rules to make them more effective.
- Q.9:** What could be the most appropriate collaborative institutional mechanism between Centre, States, and Local Bodies for common Rights of Way, standardisation of costs and timelines, and removal of barriers to approvals? Justify your comments with reasoning.
- Q.10:** Should this be a standing coordination-committee at Licensed Service Area (LSA) level to address the common issues relating to RoW permissions? If yes, then what should be the composition and terms of reference of this committee? Justify your comments with reasons.
- Q.11:** Is there a need to develop common ducts along the roads and streets for laying OFC? If yes, then justify your comments.
- Q.12:** How the development of common ducts infrastructure by private sector entities for laying OFC can be encouraged? Justify your comments with reasoning.
- Q.13:** Is there a need to specify particular model for development of common ducts infrastructure or it should be left to the land-owning agencies? Should exclusive rights for the construction

- of common ducts be considered? Justify your comments with reasoning.
- Q.14:** How to ensure that while compensating the land-owning agencies optimally for RoW permissions, the duct implementing agency does not take advantage of the exclusivity? Justify your comments with reasoning.
- Q.15:** What could be the cross-sector infrastructure development and sharing possibilities in India? Justify your comments with examples.
- Q.16:** Whether voluntary joint trenching or coordinated trenching is feasible in India? If yes, is any policy or regulatory support required for reaping the benefits of voluntary joint trenching and coordinated trenching? Please provide the complete details.
- Q.17:** Is it advisable to lay ducts for OFC networks from coordination, commercial agreement, and maintenance point of view along with any other utility networks being constructed?
- Q.18:** What kind of policy or regulatory support is required to facilitate cross-sector infrastructure sharing? If yes, kindly provide the necessary details.
- Q.19:** In what other ways the existing assets of the broadcasting and power sector could be leveraged to improve connectivity, affordability, and sustainability.
- Q.20:** For efficient market operations, is there a need of e-marketplace supported by GIS platform for sharing, leasing, and trading of Duct space, Dark Fibre, and Mobile Towers? If yes, then who should establish, operate, and maintain the same? Also, provide the details of suitable business model for establishment, operations, and maintenance of the same. If no, then provide the alternate solution for making passive infrastructure market efficient.

- Q.21: Even though mobile broadband services are easily available and accessible, what could be the probable reasons that approximately 40% of total mobile subscribers do not access data services? Kindly suggest the policy and regulatory measures, which could facilitate increase in mobile broadband penetration.**
- Q.22: Even though fixed broadband services are more reliable and capable of delivering higher speeds, why its subscription rate is so poor in India?**
- Q.23: What could be the factors attributable to the slower growth of FTTH subscribers in India? What policy measures should be taken to improve availability and affordability of fixed broadband services? Justify your comments.**
- Q.24: What is holding back Local Cable Operators (LCOs) from providing broadband services? Please suggest the policy and regulatory measures that could facilitate use of existing HFC networks for delivery of fixed broadband services.**
- Q.25: When many developing countries are using FWA technology for provisioning of fixed broadband, why this technology has not become popular in India? Please suggest the policy and regulatory measures that could facilitate the use of FWA technology for delivery of fixed broadband services in India.**
- Q.26: What could be the probable reasons for slower fixed broadband speeds, which largely depend upon the core networks only? Is it due to the core network design and capacity? Please provide the complete details.**
- Q.27: Is there a need of any policy or regulatory intervention by way of mandating certain checks relating to contention ratio, latency, and bandwidth utilisation in the core network? If yes, please suggest the details. If no, then specify the reasons and other ways to increase the performance of the core networks.**

- Q.28:** Should it be mandated for TSPs and ISPs to declare, actual contention ratio, latency, and bandwidth utilisation achieved in their core networks during the previous month, while to their customers while communicating with them or offering tariff plans? If no, state the reasons.
- Q.29:** What could be the probable reasons for slower mobile broadband speeds in India, especially when the underlying technology and equipment being used for mobile networks are similar across the world? Is it due to the RAN design and capacity? Please provide the complete details.
- Q.30:** Is there a need of any policy or regulatory intervention by way of mandating certain checks relating to RAN user plane congestion? What should be such checks? If yes, then suggest the details, including the parameters and their values. If no, then specify the reasons and other ways to increase performance of RANs.
- Q.31:** Should it be mandated to TSPs to declare actual congestion, average across the LSA, recorded during the previous month over the air interface (e.g., LTE Uu), in the radio nodes (e.g., eNB) and/or over the backhaul interfaces between RAN and CN (e.g., S1-u), while reaching out to or enrolling a new customer? If so, then suggest some parameters which can objectively determine such congestions. If no, then specify the reasons and other ways to increase performance of the RAN.
- Q.32:** Is there a need of any policy or regulatory intervention by way of mandating certain checks relating to consumer devices? If yes, then please suggest such checks. If no, then please state the reasons.
- Q.33:** To improve the consumer experience, should minimum standards for consumer devices available in the open market be specified? Will any such policy or regulatory intervention

have potential of affecting affordability or accessibility or both for consumers? Please justify your comments.

Annexure A (Chapter 1/Para no. 1.28)

DoT Reference I

No.4-1/2018-Policy-1
Government of India
Ministry of Communications
Department of Telecommunications

New Delhi-1, the 26th April, 2019

To

The Secretary
Telecom Regulatory Authority of India (TRAI)
Mahanagar Doorsanchar Bhawan
Jawahar Lal Nehru Marg (Old Minto Road)
New Delhi- 110002

Subject : Revision of definition of Broadband

Sir,

In continuation of this Section's letter of even number dated 02.04.2019 and TRAI's letter No. 4-3/2019/BB&PA dated 11.04.2019 on the subject mentioned above and to say that the recommendations may please be furnished under Section 11(1) (a) of the TRAI Act, 1997 on the following points:

- i). Different speeds for different categories i.e. fixed vs Mobile with upload/download speeds defined;
- ii). How different categories of Broadband speeds such as basic Broadband, High Broadband & Ultra-High Broadband etc. can be defined as in Europe; and
- iii) The roadmap to enhance Broadband speed to achieve NDCP objective of 50 Mbps

 26/4/2019
(Sandeep Bhardwaj)
Director (VBB)
Ph. 23036544

Annexure B (Chapter 1/Para no. 1.29)

DoT Reference II

Government of India
Ministry of Communications
Department of Telecommunications
Access Services Wing
Sanchar Bhavan, 20, Ashoka Road, New Delhi-110001

No: 20-281/2010-AS-I Vol. XII (pt.)

Date:08.05.2019

To,
The Secretary,
Telecom Regulatory Authority of India,
Mahanagar Doorsanchar Bhawan,
Jawaharlal Nehru Marg, Old Minto Road,
New Delhi-110002

Subject: Seeking recommendations of TRAI on strategies of National Digital Communications Policy, 2018 - reg.

The National Digital Communications Policy, 2018 (hereinafter, referred to as, the NDCP, 2018) of the Government of India envisages, *inter-alia*, the following strategies under its 'Connect India' and 'Propel India' missions:

"

1. Connect India: Creating a Robust Digital Communications Infrastructure

...

Strategies:

1.1 Establishing a 'National Broadband Mission – Rashtriya Broadband Abhiyan' to secure universal broadband access

...

- (j) *By Encouraging innovative approaches to infrastructure creation and access including through resale and Virtual Network Operators (VNO)*

2. Propel India: Enabling Next Generation Technologies and Services through Investments, Innovation, Indigenous Manufacturing and IPR Generation

Strategies:

2.1 Catalysing Investments for Digital Communications sector:

(b) *Reforming the licensing and regulatory regime to catalyse Investments and Innovation, and promote Ease of Doing Business by:*

v. *Enabling unbundling of different layers (e.g. infrastructure, network, services and application layer) through differential licensing*

(c) *Simplifying and facilitating Compliance Obligations by:*

v. *Reforming the Guidelines for Mergers & Acquisitions, 2014 to enable simplification and fast tracking of approvals*

viii. *Creating a regime for fixed number portability to facilitate one nation – one number including portability of toll free number, Universal Access Numbers and DID numbers*

2.2 Ensuring a holistic and harmonized approach for harnessing Emerging Technologies

(e) *Ensuring adequate numbering resources, by:*

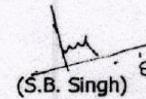
ii. *Developing a unified numbering plan for fixed line and mobile services*

2. Telecom Regulatory Authority of India is, hereby, requested to furnish recommendations, under the terms of the clause (a) of sub-section (1) of Section 11 of the Telecom Regulatory Authority of India Act, 1997 (as amended), in respect of the afore-mentioned items of the NDCP, 2018.

3. For sake of convenience, the strategies/ items under strategies of the NDCP, 2018, on which recommendation of TRAI are being sought, are summarized below:

- (a) Strategy 1.1 (j) of 'Connect India' mission,
- (b) Item (v) under Strategy 2.1 (b) of 'Propel India' mission,
- (c) Items (v) & (viii) under Strategy 2.1 (c) of 'Propel India' mission, and,
- (d) Item (ii) under Strategy 2.2 (e) of 'Propel India' mission.

4. This issues with the approval of the Secretary, Department of Telecommunications, Government of India.


(S.B. Singh) 8/5/19

Deputy Director General (AS)

Tel: 011-23036918

Annexure C (Chapter 1/Para no. 1.29)

DoT Reference III

F. No.4-27/NDCP2018-NT
Government of India
Ministry of Communications
Department of Telecommunications
(Networks and Technology Wing)

Dated: ^H6 June, 2019

To
The Secretary,
Telecom Regulatory Authority of India,
New Delhi.

Subject: Seeking recommendations of TRAI on NDCP-2018 provision related to Promoting broadband connectivity through innovative and alternative technologies – reg.

The National Digital Communications Policy, 2018 seeks to unlock the transformative power of digital communications networks-to achieve the goal of digital empowerment and improved well-being of the people of India; and towards this end, attempts to outline a set of goals, initiatives, strategies and intended policy outcomes.

2. In this regard, under Connect India Mission of NDCP-2018, various strategies have been laid out to accomplish the objectives. The strategy no 1.1 relates for Establishment a 'National Broadband Mission-Rashtriya Broadband Abhiyan' to secure universal broadband access.
3. **NDCP-2018 strategy provision no 1.1(k) envisages "Promoting broadband connectivity through innovative and alternative technologies."**
4. Accordingly, TRAI is requested to provide its recommendations under section 11 (1)(a) of TRAI Act, 1997 (as amended), in respect of the afore- mentioned provision no 1.1(k) of NDCP-2018.

This is issued with the approval of Secretary(T).


(Rajiv Sinha)
06/06/19
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List of Acronyms

S.No.	Acronym	Description
1	ACCC	Australian Competition and Consumer Commission
2	ANI	Andaman & Nicobar Islands
3	BB	Broadband
4	BBNL	Bharat Broadband Network Limited (BharatNet)
5	BTS	Base Transceiver Station
6	CAPEX	Capital Expenditure
7	CAGR	Compounded Annual Growth Rate
8	CATV	Cable Television
9	CPE	Customer Premises Equipment
10	DAS	Distributed Antenna System
11	DOCSIS	Data Over Cable Service Interface Specification
12	DoT	Department of Telecommunications
13	DSL	Digital subscriber line
14	EPC	Engineering, Procurement and Construction
15	EU	European Union
16	FCC	Federal Communications Commission
17	FNA	Federal Network Agency
18	FTTH	Fiber to the home
19	GDP	Gross Domestic Products
20	GIS	Geographic Information Systems
21	GPON	Gigabit Passive Optical Networks
22	GPRS	General Packet Radio Service
23	GPs	Gram Panchayats
24	GSM	Global System for Mobile communication
25	HFC	Hybrid fibre-coaxial network
26	HSPA	High Speed Packet Access
27	IBS	In-Building Access Solution
28	ICT	Information and Communications Technology
29	IoT	Internet of Things

S.No.	Acronym	Description
30	ISDN	Integrated Services Digital Network
31	ISP	Internet service provider
32	ITU	International Telecommunication Union
33	LCO	Local Cable Operator
34	LTE	Long-Term Evolution
35	LSA	Licensed Service Area
36	MBA	Measuring Broadband Australia
37	MWA	Microwave Access
38	NDCP	National Digital Communications Policy
39	NHAI	National Highways Authority of India
40	NTP	National Telecom Policy
41	OECD	Organisation for Economic Co-operation and Development
42	OFC	Optical Fibre Cable
43	OFCOM	Office of Communications, United Kingdom
44	OPEX	Operational expenditure
45	PPP	Public-private partnership
46	QoS	Quality of service
47	RAN	Radio Access Network
48	RoW	Rights of Way
49	SSA	Secondary Switching Area
50	TRAI	Telecom Regulatory Authority of India
51	TSP	Telecom Service Providers
52	USD	United States Dollar
53	USOF	Universal Service Obligation Fund
54	VDSL	Very high-speed digital subscriber line
55	VNO	Virtual Network Operator
56	VSAT	Very Small Aperture Terminal satellite
57	Wi-Fi	Wireless Fidelity
58	Wi-MAX	Worldwide Interoperability for Microwave Access
59	WLAN	Wireless Local Area Network