Consultation Paper no. 12/2014

Telecom Regulatory Authority of India

Consultation Paper
on
Delivering Broadband Quickly: What do we need to do?

New Delhi

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Stakeholders are requested to furnish their comments to the Advisor (Networks, Spectrum & Licensing), TRAI by 14th October, 2014 and counter comments by 21st October, 2014. Stakeholders are advised not to request for extension of dates for submission of comments/counter comments. Comments and Counter Comments would be posted on TRAI's website www.trai.gov.in. The comments/counter comments in electronic form may be sent by e-mail to nsl.trai@gmail.com or kapilhanda5@gmail.com. For any clarification/ information, Shri Arvind Kumar, Advisor (NSL) may be contacted at Tel. No. +91-11-23220209 Fax: +91-11-23230056.

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CHAPTER-1

Introduction and Background

A. Introduction

1.1 Internet which began as a means of transmission of electronic information from a room sized computer to another room sized computer has transformed into an omnipresent global system of interconnected computer networks that link several billion devices worldwide. Every minute, hundreds of millions of people are creating and consuming an enormous amount of digital content. As digital connectivity reaches the far corners of the globe, netizens are using it to improve a wide range of inefficient markets, systems and behaviours. Broadband plays a critical role in an economy and contributes significantly to the development and social progress of a country. It not only increases competitiveness and productivity but also helps the economy to eliminate the social divide and achieve inclusive growth

B. Target as envisaged in NTP-2012:

1.2 A high-speed Internet access is generally called "Broadband". The DoT has revised the definition of Broadband through its notification dated 18th July 2013. The revised definition of Broadband 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."

1.3 NTP-2012 has the vision ***Broadband on Demand*** and envisages 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 provides the enabling framework for enhancing India's competitiveness in all spheres of the economy. Target and strategies as envisaged in NTP-2012 are as follows:

Target :

"3. 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.

5. 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."

Further, Point 1.5 of part IV strategies contained in the National Telecom Policy-2012 states that**:**

"To revise the existing broadband download speed of 256 Kbps to 512 Kbps and subsequently to 2 Mbps by 2015 and higher speeds of at least 100 Mbps thereafter."

C. Present Status of Broadband in India

1.4 The number of Narrowband and Broadband connections as on 31 March 2014 are given below in Table 1.1.

Table- 1.1

Internet Subscribers as on 31st March 2014 [in millions]

S.No.	Category	Narrowband	Broadband	Total Internet
1.	Wired	3.64	14.86	18.50
2.	Fixed Wireless	0.04	0.40	0.44
3.	Mobile Wireless	187.04	45.61	232.65
	Total	**190.72**	**60.87**	**251.59**

1.5 Against a target of achieving 175 million broadband connections by 2017, only 60.87 million have been achieved. The country is nowhere near meeting the target for a service which is considered almost a basic necessity in many developed countries. Broadband is helping to deliver a wide range of services, from services directly related to the Millennium Development Goals set by the United Nations, to services in support of broader citizen participation or services leveraged across different sectors to bring more people into the formal economy. Therefore there is an urgent need to review the present policies and its implementation initiated to build infrastructure required for penetration of broadband in the country.

D. Market share of various operators

1.6 Internet Service Providers (ISPs), Unified Access Service Licensees (UASLs) and Cellular Mobile Service Providers (CMSPs) are permitted to provide broadband access under the existing licensing framework. 60.87 million subscribers for March 2014 have been reported by 121 operators. However, the top ten service providers account for about 97% of subscriber base and the top 5 service providers alone hold 83% market share. State owned companies viz. BSNL and MTNL together have about 74.9% market share for wireline broadband and 30.5% for overall broadband subscriptions. This suggests that despite having a license for providing broadband services, the majority of the service providers are either unwilling or unable to penetrate into the market and the market is still dominated by a few players only.

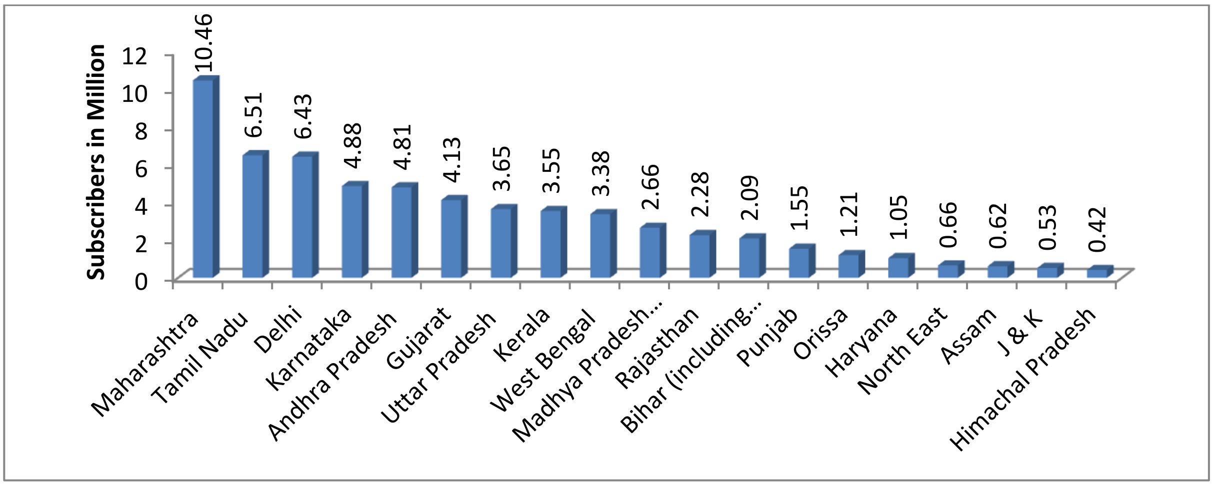
E. State-wise Broadband Connections:

1.7 State wise distribution of broadband subscribers may be seen in **Figure 1.1**. From the figure it can be seen that top five States have a total of 54.4% of overall connections. Metro and category A circles account for 61% of overall connections. Broadband outreach is very uneven. Many States have a little to no broadband connectivity.

F. Broadband Tariff Trends

1.8 Although broadband penetration is low in India, the entry level tariff for broadband services has come down drastically from Rs.1500 per month in 2004 to around Rs.500 a month in 2014. Most service providers charge a monthly rental between Rs.200 to Rs.1600 for a broadband connection and providing various packages for data transfer. Most service providers provide unlimited download packages. Unlimited broadband plans are on offer for Rs.549 per month.

Figure-1.1 : State-wise Broadband connections (31st March 2014)



G. Initiatives taken by TRAI so far:

1.9 The Authority has taken a number of initiatives in the past to promote the growth of broadband. Some of the recommendations[1] in chronological order in this regard are:-

- Accelerating growth of Internet and broadband penetration on 29 April 2004.
- Review of broadband policy on 03 November 2005.
- Improvement of NIXI on 20 April 2007.
- Review of Internet services on 10 May 2007.
- Growth of broadband on 02 January 2008.
- Improving effectiveness of NIXI on 22 April 2009.
- National Broadband Plan on 08 December 2010.
- Reference on National Broadband Plan on 04 May 2011.
- Application services on 14 May 2012.

[1] These recommendations are available on TRAI's website www.trai.gov.in.

H. Why is Broadband Important:

1.10 The proliferation of Broadband in a country is driven by a number of social, economical and technological factors. Access to Internet and its services/applications through a reliable broadband network will have a huge economic impact on the future. As per McKinsey Global Institute estimate, the potential economic impact of Internet based technology in terms of consumer surplus will range from $ 13 to $ 30 trillion by 2025. The share of developing countries in this economic impact is estimated approximately 43%[2]. Therefore, the need for inclusive growth has never been felt more than today. It is important to include the large rural population in the country in governance and decision making process to inculcate a sense of participation and self-determination. It is equally important to provide life enhancing urban-like amenities to the rural population in areas like health, education and entertainment. According to the World Bank's estimates, a 10% increase in broadband penetration accelerates economic growth by 1.38% in developing countries. It is, therefore, natural that countries around the world are concerned about creating a robust broadband infrastructure that would sustain high growth of broadband services. Convergence of communications, media and IT is driving a host of new broadband services and creating new revenue streams across sectors and industries. For a country like India, the Government can play a critical role in diffusion of modern ICT such as broadband. NTP-2012 recognised telecom, including broadband connectivity as a basic necessity like education and health and envisaged work towards 'Right to Broadband'.

I. The Broadband Supply Chain:

1.11 As policy makers consider plans and strategies for faster proliferation of broadband networks, it is important to recognize that such networks have many components. <u>All of these parts must work together for the network to function effectively and efficiently.</u> This

[2] McKinsey Global Institute 2012, Disruptive Technologies.

section categorizes these components into four hierarchical levels, which together constitute the broadband supply chain: the local access network, metropolitan or backhaul link, the national backbone network, and international connectivity (figure 1.2).

1.12 The broadband supply chain as depicted in **Figure 1.2** has four main components:

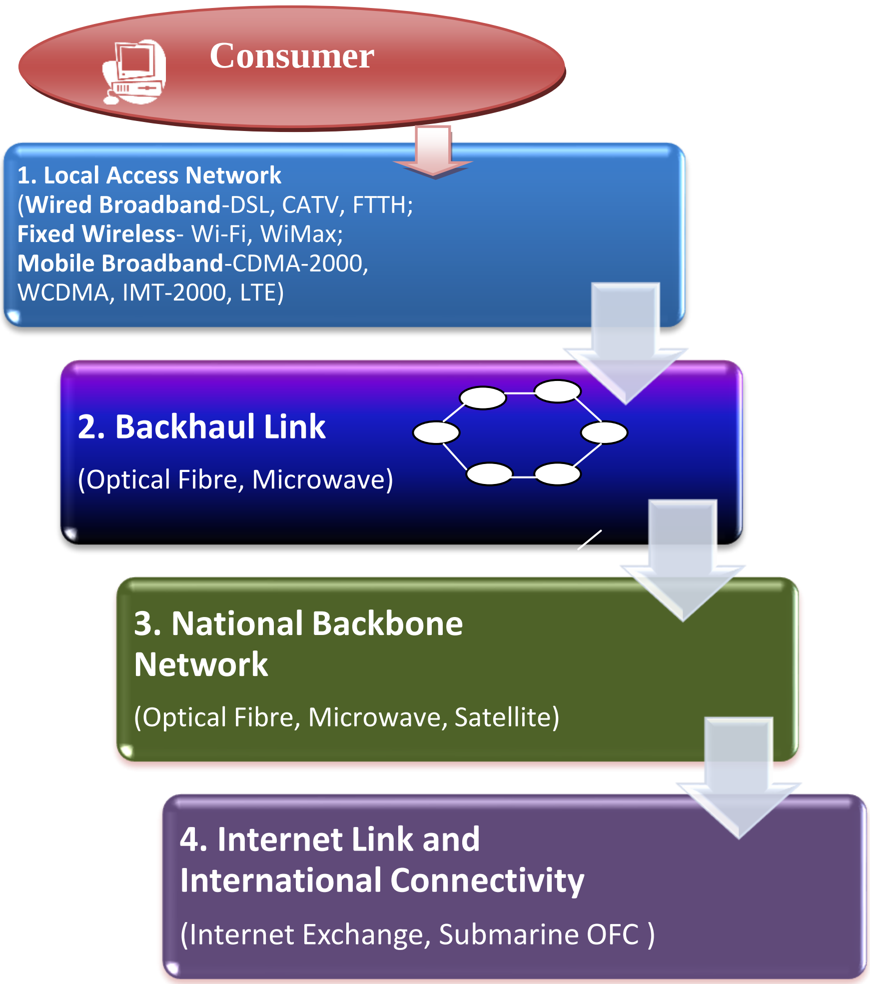
(i) **Local access networks:** provide the wireline and wireless infrastructure that end users utilize to connect to the broadband network.

(ii) **Metropolitan or backhaul links:** provide the connections between local areas and the national backbone network, usually via fibre optic cable (OFC) and microwave and, to a lesser extent, satellite. In a wireless network, these links are used to bring traffic from cell sites back to a switching centre (this is known as backhaul).

(iii) **National backbone network:** provides pathways for transmitting Internet data across a country, typically via microwave, satellite, and OFC links. This also includes traffic management, exchange, and routing as well as equipment related to enhancing efficiency and quality over IP networks such as Internet exchanges, metropolitan rings, and next-generation networks (NGNs).

(iv) **Internet Link and International connectivity:** ISPs also need to arrange for exchanging and routing their traffic to other networks around the world. Such arrangements ensure that Internet traffic can be delivered anywhere in the world, eliminating the need to have physical connections to every country. An ISP typically arranges to hand off its traffic at the points where its contracted physical connectivity terminates. International connectivity provides links to networks in other countries usually via satellite and OFC.

Figure 1.2: Broadband Supply Chain



1.13 Two additional points should be noted. First, the different levels of the overall broadband network should ideally be in sync. If insufficient backhaul capacity exists, then no matter what the speed of the access networks, high broadband speeds will simply not be achieved. High speeds in the local access network segment can only be realised if the speed and capacity in the national and international network segments are adequate to support them. Second, technology deployment is dependent on a country's existing level of infrastructure. Countries without significant wireline infrastructure in the local access network may find it financially impractical to deploy ubiquitous wired networks, but they may be able to upgrade existing wireless networks. Similarly, countries often find it more financially attractive to leverage existing networks through upgrade or evolution than to deploy the latest state-of-the-art technology by building completely new networks.

J. International Experience

1.14 Governments around the globe have used various models to give impetus to the growth of broadband in their countries. While many countries have left the construction of broadband networks to the private sector, Governments in some countries either guarantee bilateral or multilateral loans for the construction of backbone networks or are full or partial owners of wholesale or retail service providers. A summary of the initiatives taken by some countries for penetration of broadband may be seen as **Annexure**.

K. Structure of the Consultation Paper

1.15 The objective of this Consultation Paper (CP) is to discuss issues contributing to the poor broadband penetration in India and solicit stakeholders' views on actions required to be taken both by the Government and the service providers to accelerate the proliferation and use of broadband in the country.

1.16 This CP is divided into seven chapters. The first chapter discusses the background of internet and broadband services in India, the basics of broadband including its definition, and various initiatives taken by the Authority regarding development of broadband infrastructure in the country. The chapter also describes the broadband supply chain from a topological perspective, starting from local access deployment solutions and progressing to regional, national, Internet link and finally international connectivity. Each component of the broadband supply chain as discussed in Chapter 1 is covered in subsequent chapters with a view to examine related issues. The second chapter focuses on the various wireline and wireless broadband access technologies being used and discusses the present status of Internet and Broadband in the country as well as initiatives required to address the hurdles in the access segment. Chapter 3 dwells on the metropolitan or backhaul links. Chapter 4 discusses the internet Link, internet exchange point and international connectivity. Chapter 5 highlights some demand side issues associated with proliferation of broadband like lack of awareness and digital literacy, high cost of access devices, limited range of application and services. Chapter 6 focuses on the various implementation and policy issues. Chapter 7 lists the issues for consultation.

CHAPTER-2

Access Networks for providing Broadband

A. Introduction

2.1 In the broadband supply chain, local access networks directly connect the end users to broadband services, the so-called "last mile." Several wireline and wireless broadband technologies are used today to support local access networks. Having multiple broadband access options increases consumer choice, stimulates intermodal competition, enhances quality and is generally associated with lower retail prices. Different technology options have different advantages and limitations and are suited to different requirements. However, countries may not be able to use all possible technological choices because of historical, technical, regulatory, or financial reasons.

2.2 This chapter discusses the various access networks and related technologies for deploying broadband infrastructure and identifies some of the issues associated with implementing these technologies. The access networks described in this chapter are categorised in the following three categories:

- Wired Access Network: DSL, Cable TV, OFC in the Access Network, BPL.
- Fixed Wireless Access Networks: Wi-Fi, WiMax, Satellite,
- Mobile Wireless Access Networks: The new technologies that enable access while improving spectral efficiency

2.3 For all practical purposes the DSL, Cable Modem and Fibre to the Home account for nearly all broadband subscriptions in the country. Mobile Wireless Access Networks are the other main source of delivering broadband. However, due to the paucity of spectrum, they are not equipped to provide the desired bandwidth speeds. Wi-Fi, WiMax and Satellite have their own constraints. The WiMax technology has not gathered pace and without an eco-system it cannot be the foundation for any large broadband initiative.

Similarly, while Wi-Fi is certainly important from the perspective of reducing the load on access spectrum, its ability to reach out to millions of customers is severely constrained. The others, which represent potentially viable options for broadband delivery, are discussed in the succeeding paragraphs. The focus here is on the physical networks and associated protocols for routing traffic rather than end-user services and applications that are accessed over the networks (for the latter see Chapter-5).

B. Wired Access Networks

2.4 Digital Subscriber Line [DSL], CATV, and Fibre to the premises or Fibre to the Home (FTTH) are generally used in the wired access network for provision of broadband. Some of the other options like Ethernet-based Local Area Net-works (LANs) and Broadband over Power Line (BPL) are also used for providing wired broadband services.

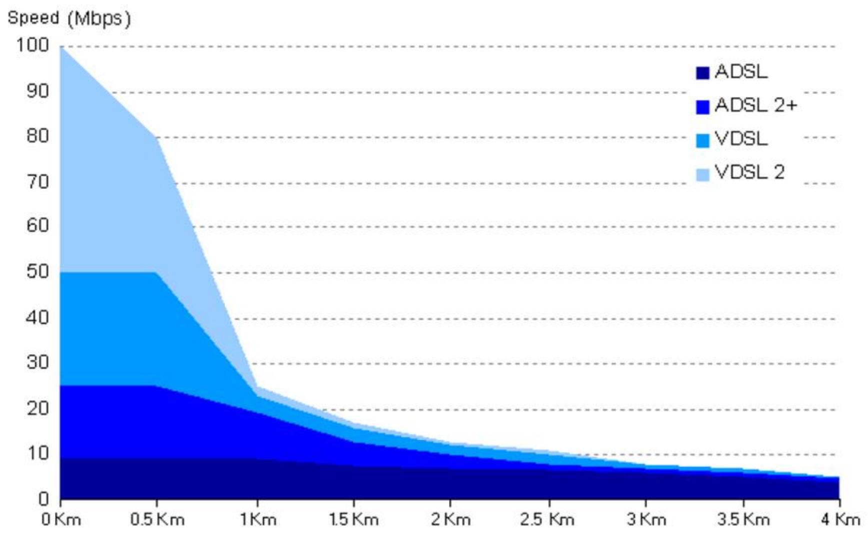
B.1 Digital Subscriber Line [DSL]

2.5 The public switched telephone network (PSTN) line running to the subscriber's premises has traditionally been copper wire. The narrow band channel offers an analog carrier originally configured to provide a single telephone call. Two "twisted-pair" copper wires are used to support duplex communications (that is, the ability to send and receive at the same time). The PSTN can also support narrowband Internet access, with subscribers using a modem for dial-up access to the internet.

2.6 DSL technologies use special conditioning techniques to enable broad-band Internet access over the same PSTN copper wire. Transmission speeds vary as a function of the subscriber's distance from the telephone company local exchange, the DSL version, the extent of OFC in the network, and other factors. DSL requires that the bandwidth over the copper line be separated between voice and data. Nonetheless, users can continue to make and receive PSTN telephone calls when using DSL data services.

2.7 DSL connection upload and download speed is also tabulated in Table 2.1 below.

Figure 2.1 Theoretical Performance of DSL Technologies



Source: IDATE

Table 2.1 DSL Connection Speeds, by Type of Line

Type of line	Downstream speed	Upstream speed	ITU-T
Asymmetric DSL (ADSL)	6 Mbit/s	640 kbit/s	G.992.1
ADSL2	8 Mbit/s	800 kbit/s	G.992.3
ADSL2+	16 Mbit/s	800 kbit/s	G.992.5
Very high-speed DSL (VDSL)	52 Mbit/s	52 Mbit/s	G.993.1
VDSL2	100 Mbit/s	100 Mbit/s	G.993.2

Source: Adapted from ITU 2008.
Note: The speeds shown are those specified in the standard, not necessarily those experienced by end users.

2.8 The inherent disadvantage of DSL technologies is the trade-off between speed and distance which can be seen in **Figure 2.1**. However, technologies like bonding, vectoring and phantom mode have since been developed to improve the performance of DSL technologies. These are known as DSL acceleration technologies.

2.9 The traditional PSTN copper wire networks in India, which are required for deployment of DSL, are mostly owned by the PSU operators. Due to the rapid growth of mobile networks, not much investment has been made by the TSPs in the copper network resulting in limited availability and poor quality. Functioning of DSL is highly sensitive to the quality of the copper loops. A large number of old pairs may need conditioning to qualify for use with DSL technology. Testing and conditioning each pair is a time consuming and expensive process. A majority of wired broadband connections, are presently working on copper using DSL technologies. Currently there are just around 6 million loops in rural areas and 23 million in urban areas. Wireline subscriber base is also showing a continuous declining trend as shown in **Table 2.2**. The further fall in their numbers, coupled with issues of quality of already available copper, are the major impediments in delivering broadband through this access technology. Also it would be prudent on the part of the service providers to lay OFC rather than copper considering the advantages of OFC. DSL, hence has a limited future in the country.

Table 2.2

As on	Wireline Subscriber Base (In Millions)						
	Urban		Rural		Total		
	BSNL/ MTNL	Pvt.	BSNL	Pvt.	BSNL/ MTNL	Pvt.	Total
31st March 2008	23.62	4.16	11.61	0.03	35.23	4.19	39.42
31st March 2009	22.37	5.01	10.55	0.04	32.92	5.04	37.96
31st March 2010	21.56	5.59	9.76	0.04	31.33	5.63	36.96
31st March 2011	20.05	5.99	8.64	0.05	28.69	6.04	34.73
31st March 2012	18.43	6.19	7.49	0.05	25.93	6.25	32.17
31st March 2013	17.25	6.25	6.65	0.06	23.91	6.31	30.21
31st March 2014	16.13	6.41	5.89	0.07	22.02	6.48	28.50

2.10 Universal Service Obligation Fund (USOF) had launched a Wire Line Broadband Scheme and signed an agreement with BSNL in January 2009 for provision of 8,88,832 wire line broadband from about 28,000 Digital Subscriber Line Access Multiplexers(DSLAMs) in rural areas spread across the country. Under this Scheme, subsidy support was being provided for broadband connectivity, Customer Premises Equipment (CPE) and Computers. As on 31 May 2014, a total of 6,05,113[3] broadband connections have been provided under this scheme.

[3] Information as provided by USO Fund Administrator.

B.2 Cable TV Network

2.11 Cable modems provide subscribers with access to broadband services over cable television (CATV) networks. Cable TV networks can be a cheaper and convenient source of providing broadband to households. Cable TV networks already have access to large number of households (over 97 million households now). These networks cater to much larger rural population compared with copper connectivity. CATV holds put great promise as a potential network through which broadband penetration can be achieved. According to industry, Multi System Operators (MSOs) have laid around 30,000 km of OFC to provide connectivity to cable operators besides large backbone OFC network for inter-city and intra-city connectivity. At many places they are using OFC networks of TSPs. International experience too suggests that provision of broadband services is an attractive business avenue for the cable TV sector.

2.12 Internet access via CATV networks using a modem, and broadband access is typically called cable modem service. Television content is separated from internet traffic at the head end. A cable modem termination system (CMTS) exchanges digital signals with cable modems and converts upstream traffic into digital packets that are routed to the Internet. The CMTS receives traffic from the Internet and routes it to the appropriate cable modem of the subscriber. Because CATV networks use a cascade of amplifiers to deliver video programming, cable modem service has fewer limitations than DSL with regard to the distance of the subscriber from the head end. **Figure 2.2** shows typical setup for provisioning of broadband through Cable TV network:

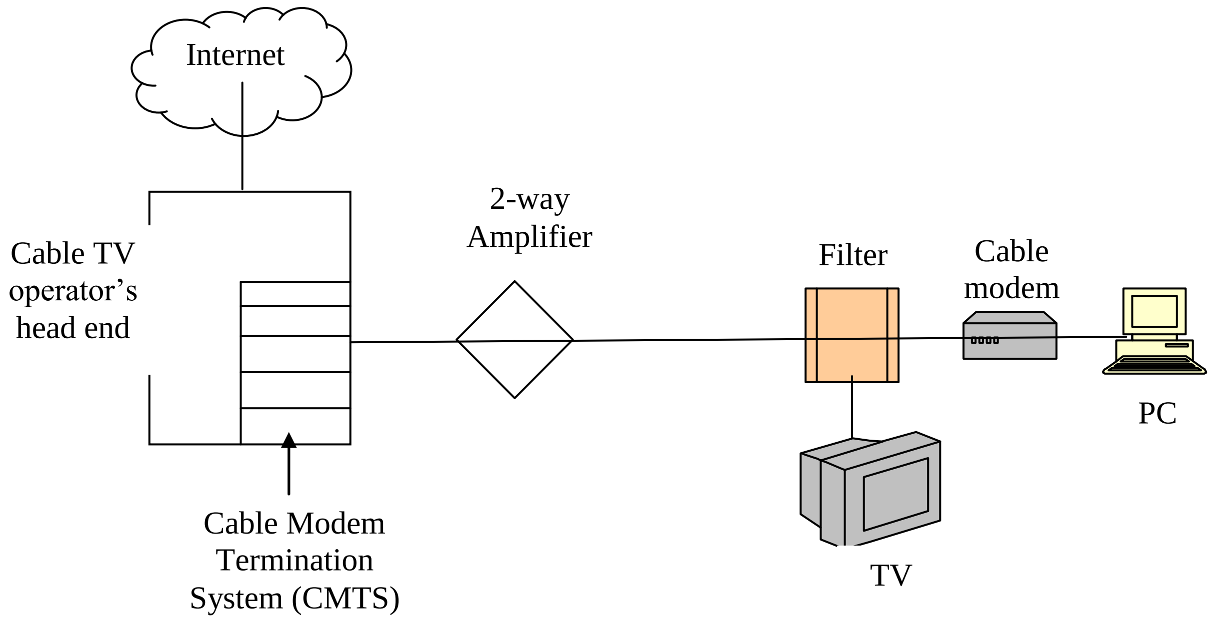


Figure 2.2: Broadband through Cable TV Network

2.13 CableLabs developed standards for cable modem technology in the late 1990s. The technical guidelines are called Data over Cable Service Interface Specification (DOCSIS). The DOCSIS guidelines have been progressively enhanced in terms of functionality (for example, support for IPv6) and speed. The latest version is 3.0, with a slightly different European implementation (EuroDOCSIS). DOCSIS has been approved by ITU. These technological developments in Cable TV networks have made it possible to send data in both directions via usage of different channels on separate blocks of 6 MHz frequencies, making Internet access over cable TV a viable solution. One channel sends data from the Internet to users (downlink) (6 MHz of frequency corresponds to roughly 30 Mbps) while another channel receives (uplink). Cable subscribers in a small area share the same channels to send and receive data; therefore, the bandwidth which a user receives is dependent on number of users utilising the service at any given point of time.

2.14 The current major broadband technologies deployed by the cable industry are DOCSIS and Ethernet over Cable (EoC) technology.

- DOCSIS provides bidirectional transfer of signal between a Cable Modem Termination System (CMTS) placed at the head-end and Cable Modem (CM) at customer location over the existing coaxial or Hybrid Fibre Cable (HFC) network. The Ethernet solution has an Ethernet network, based on OFC backbone and extended LAN technology using CAT5/6 cable as the last mile or EoC based on deeper fibre concept with last mile delivery on existing co-axial cable.

- An ethernet based network is easy to deploy to deliver high speed symmetric bandwidth through a highly scalable network catering to present and future demand of bandwidth. Also, a combination of DOCSIS in the backhaul and EoC in distribution network is used in certain cases.

2.15 In India, the present deployment uses DOCSIS version 1 which has a limit of 30 Mbps per RF channel and a subscriber gets a maximum speed of 3 Mbps speed. In the Ethernet option it can deliver up to 96 Mbps per cable section with the present version supporting up to 32 users.

2.16 Older CATV networks cannot sustain higher bandwidths without significant upgrades. CATV operators that have recently built their networks generally have a high-capacity bandwidth network from which they can partition a portion for broadband data service. However, unlike DSL, where subscribers are provided a dedicated connection between their home and the provider's switch, cable modem broadband capacity is shared among nearby users, which can cause a marked deterioration in service at peak times.

2.17 Although some countries have a significant number of CATV subscribers, cable broadband penetration on a worldwide basis remains relatively low, particularly in developing countries, because cable operators have not made the necessary investment in upgrading their networks.

2.18 Cable television (CATV) network is based on broadband coaxial cables i.e. traffic flows only in the downlink direction. By and large cable TV networks in India are analog and one way. These networks require upgradation for providing broadband. The digitization of Cable TV networks mandated in a phased manner in the country has opened up a new window of opportunity to increase broadband penetration. Of the 97 million cable TV connections, 24 million have already been digitized and digitization is scheduled to be completed by this year end. In other words, the cable industry can contribute ready-built access to a huge potential broadband market.

2.19 Upgradation of cable TV network per line requires significant cost and seems to be one of the reasons for slow upgradation of Cable TV networks to provide broadband. Some of the methods for upgradation of cable TV networks are:

- Using Bi-directional amplifiers in existing network
- Combination of OFC / cat 5/ cat 6 cables
- Passive Optical network (OF upto subscriber premises)

2.20 Discussions were held with various service providers regarding Capital and Operational expenditure required towards provision of broadband over Cable services (DOCSIS 2.0 & DOCSIS 3.0). Rough estimates of CAPEX and OPEX are as follows:

Table: 2.3

CAPEX per Cable Modem Subscriber

Details	DOCSIS 2.0 - Normal Broadband		DOCSIS 3.0 (50 Mbps)
	Normal Range	Higher Range	
Cost per Home Passed (HP)	600	750	900
Subscriber Penetration % in HP area	15%	15%	15%
HP cost conversion per Subscriber	4,000	5,000	6,000
Last Mile Installation / Drop Cabling	1,000	1,200	1,200
Cost of Modem	1,250	1,250	2,350
Backend Capex per Subscriber	1,000	1,000	2,500
Capex per Subscriber	7,250	8,450	12,050

Home Passed => trunk wire touching the top of the building, total residential units available in the building counted as HP.
Last Mile => from building terrace wire coming into customer's residence and connecting the Cable Modem

Table: 2.4

OPEX details as % of subscription revenue

Opex details

Particulars	as % of Subscription Revenue
Bandwidth & Leased line Charges	11.74%
LCO Commissions (incl DSA)	12.04%
Network Maintenance Expense	2.54%
License Fees	0.17%
Outsourced Call Centre Charges (variable)	2.11%
Total Variable Cost	**28.60%**
Gross Margin / Contribution	**71.40%**
Total Staff Cost	27.80%
Marketing & Business Promotion Exp	1.94%
Total Operational Expenses	9.75%
Total General & Admin Cost	4.33%
Total Fixed Costs	**43.81%**
Total Provision For Bad Debts & Adv	**5.93%**
EBITDA	**21.65%**

2.21 There are apprehensions by cable TV operators that providing only broadband services over cable TV network may not give them a commensurate rate of return on investments required for up gradation of the network. The above tables also suggest that the rate of return on broadband services on the CATV network may not be sufficient to justify the additional CAPEX and OPEX. However, the penetration percentage of 15% shown in Table 2.3, as submitted by service providers is on highly conservative side raising this percentage would bring down the CAPEX and the OPEX substantially.

2.22 The available data suggests that out of total 97 million subscribers, 24 million subscribers are digital access subscribers and may be seen as capable to provide broadband access. However, only about 0.71 million connections i.e. 1.16% of total 60.87 million broadband connections have been reported using cable modem by March 2014.

B.3 Optical Fibre in the Access Network

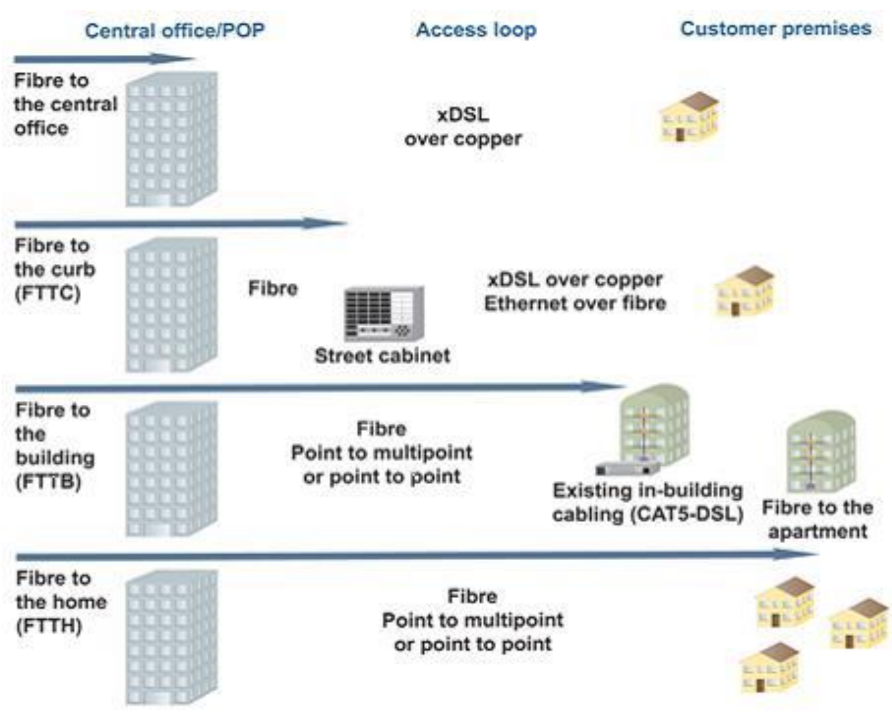
2.23 OFC in the access network is capable of providing high bandwidth throughput for services. This is because OFC has very high capacity and distance is not a limitation as optical signals can travel 70 to 80 kilometers before they need to be amplified. Amongst available access technologies, OFC is perhaps best suited to support futuristic broadband needs. But, it is expensive. So the objective invariably is to reduce costs. In the traditional broadband delivery system the link from the central office to the core network is usually OFC and twisted copper cables connect the central office to the customer premises. The intention is to bring the OFC as close to the end-user as possible to achieve higher speeds.

2.24 Fibre to the premises refers to a complete fibre path linking the operator's switching equipment to a subscriber's home i.e. Fibre to the Home (FTTH) or business (FTTB). On the other hand, fibre to the node (FTTN) and fibre to the curb (FTTC) use OFC only in portion of the way to a subscriber's premises. FTTN and FTTC are, therefore, <u>not</u> subscriber access technologies like FTTH, but are <u>used to extend capabilities of DSL and cable modem networks</u> by laying OFC deeper into the network. FTTH offers the highest speeds amongst commercialized broadband technology. <u>However, it is not widely available around the world, with the FTTH Council reporting that only 26 economies have at least 1 percent of their households</u>

connected. FTTH can be designed with various topologies: point-to-point, where the OFC link is dedicated to traffic from a single subscriber; point-to-multipoint, where OFC branch to more than one premise and thus share traffic; and a ring, where the OFC is designed in a closed loop that connects various premises. Different types of Fibre Access Networks are shown in **Figure 2.3**.

Figure 2.3

Different Types of Fibre Access Networks



2.25 With a view to assess capital and operational expenditure requirements, discussions were held with various FTTH providers. On the basis of the discussions, rough estimates of CAPEX and OPEX for FTTH access network using passive optical network, both for Single Family Unit (SFU) or Flat bed and multiple dwelling Unit (MDU) or High Rise Apartments using point to multipoint architecture are as follows:

Figure 2.4

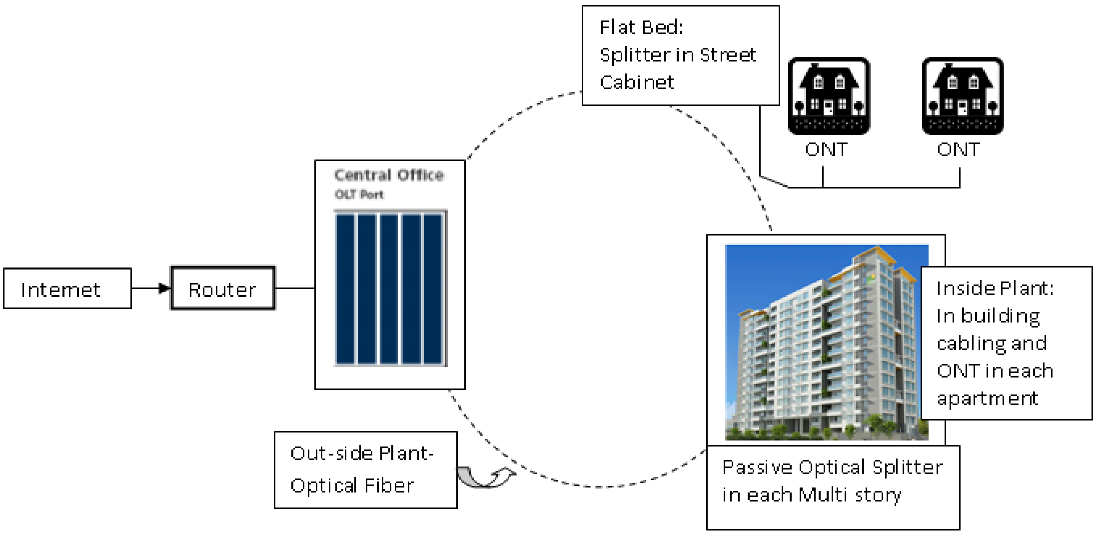


Table 2.5

End to end CAPEX for access network of FTTH

			Captive FTTH					
			Flat Bed or Single Family Unit (SFU)			High Rise or Multiple Dwelling Unit (MDU)		
Sr No.	Particulars		Per Home pass (Rs.)	Utilisation Factor	Per Connected Home (Rs.)	Per Home pass (Rs.)	Utilisation Factor	Per Connected Home (Rs.)
1	**Control Office**							
	Optical Line Terminal (GPON - OLT)		1,800	50%	3,600	1,800	50%	3,600
	Control Office and other equipments (Power Plant, EMS, Anti -Static Flooring, Generator,Access Control, Fire Fighting, Air Conditioning, Interior, Racks, UPS etc)		250	50%	500	250	50%	500
2	**Out Side Plant**							
	Per mtr cost (Including Right Of Way)	1200						
	Per Home Cost (Including ROW)= Per Mtr Cost* 1.5/5 Mtr per user (For High Rise@ 1.5 mtr per user and for Flat Bed @5mtr per user)		6,000	40%	15,000	1,800	30%	6,000
3	**In Side Plant (Material and Services) - OSP Manhole to Splitter** (Fibre , Duct , Splitter, Conduit, G I Pipe, Fibre Management Unit IP 65 Box , Splitter Box etc.)		1,500	100%	1,500	1,500	30%	5,000
	Sub Total-Total fixed network cost		**9,550**		**20,600**	**5,350**		**15,100**
4	**Customer Premises Box**							
	ONT		5,600	100%	5,600	5,600	100%	5,600
	Power Connection, CATV Cabling etc.		400	100%	400	400	100%	400
	Total Tangible Cost		15,550		26,600	11,350		21,100
5	Interest cost on fixed network upto the peak utilisation		1,146		2,472	642		1,812
6	Project Planning and Coordination (10% of tangible project Cost)		1,244		2,128	908		1,688
	Cost per Connected Home		**17,940**		**31,200**	**12,900**		**24,600**

Table 2.6

End to end OPEX for access network of FTTH

		Annual Opex per Home					
	Network Opex	**Flat Bed**			**High Rise or MDU**		
1	Duct and Fiber	1.5%	16,500	248	2.0%	11,000	220
2	Electronics and support Infra	8.0%	10,100	808	8.0%	10,100	808
3	Annual Maintenance Opex per Annum			**1,056**			**1,028**
4	Opex for Fault Repair and L1 Support			550			550
5	(3) + (4)			1,606			1,578
6	Annual cost of Overheads per Annum			400			400
7	Approximate cost per subscriber per Annum for Internet Leased Line			3000			3000
8	**Total Opex per Annum**			**5,006**			**4,978**
9	Opex per month			417			415

2.26 From the above it is seen that the cost per subscriber is dependent on the type of residence, whether it is SFU or an MDU.

2.27 It may be appreciated that deployment of a FTTH network involves huge investments by the service providers. The investment required can vary considerably depending on the geography being served. Sparsely populated rural areas are the most expensive to connect because of the long distances to homes. Urban environments are more densely populated, but they also pose construction challenges and expenditure in terms of high Right of Way (RoW) charges.

B.4 Other Wired Broadband Access Networks

2.28 Although DSL, cable modem, and FTTH account for nearly all subscriptions worldwide, other technologies like Ethernet-based Local Area Net-works (LANs) and broadband over powerline (BPL) are also used. Wireline LANs are used to connect many subscribers in a large building such as apartments or offices. Subscribers are typically connected directly to a fibre or Ethernet backbone and the access to broadband is distributed through the LAN.

2.29 Broadband over powerline (BPL) uses the electricity distribution network to provide high-speed Internet access. BPL operates by differentiating data traffic from the flow of electricity. This separation occurs by using a much higher frequency to carry data through the copper wires, coupled with encoding techniques that subdivide data traffic into many low-power signals spread over a wide bandwidth. The former encoding scheme is known as Orthogonal Frequency

Division Multiplexing (OFDM), and the latter is a type of spread spectrum technology. In both technologies, digital signal processing integrated circuits help to keep data traffic intact, identifiable and manageable.

2.30 India ranks 125th in the world for Fixed Broadband penetration with only 1.2 per 100 inhabitants having access to fixed broadband. With the world average being 9.4 per 100 inhabitants, the country comes in below average in terms of fixed broadband penetration according to the State of the Broadband report of September 2014.

2.31 In view of the foregoing the following issue needs deliberation:-

Q1. What immediate measures are required to promote wireline technologies in access networks? What is the cost per line for various wireline technologies and how can this cost be minimised? Please reply separately for each technology.

C. Wireless Broadband Access Networks

2.32 The immense success of cellular telephone service attests to the attractiveness of wireless technologies as a last mile solution. The reasons for its attractiveness include being generally easier and cheaper to deploy than wireline solutions and consumers' fondness for mobility. The next-generation wireless networks have the technological capability to offer bit rates at near parity with current wired options, though not yet at the same price points. However, the ability of carriers to offer such services will depend on whether sufficient radio spectrum can be allocated for mobile broadband services and whether innovations in spectrum conservation techniques can help operators to meet consumer demand.

2.33 The Wireless Broadband Access Networks can further be divided into two categories (1) Fixed Wireless Access Networks (2) Mobile Wireless Access Networks. Each of these categories, along with the respective technologies used are briefly described in the following paragraphs.

C.1 Fixed Wireless Access Networks

(a) Wi-Fi

2.34 Wi-Fi refers to Wireless Local Area Networks (WLAN) that use one of several standards in IEEE 802.11 family of standards specifying wireless local area networking over 2.4 and 5 GHz frequency bands. Wi-Fi is a cheaper technology and can provide good coverage in remote areas with few access points. This is a very effective technology for increasing broadband penetration. 2.4 GHz band has already been de-licensed and therefore can be used effectively for this purpose. However, presently only low power outdoor usage of Wi-Fi is permitted, resulting in limitation of distance.

2.35 Wi-Fi is not typically deployed as a commercial local access network; it is used most often to redistribute a broadband connection to a wider group of users in homes, offices, and “hotspots.” Wi-Fi technology has gone through several updates that provide varying speeds depending on the frequency and version used (table 2.7).

Table 2.7

Wi-Fi technology	Frequency band (GHz)	Maximum data rate (M bit/s)
802.11a	5	54
802.11b	2.4	11
802.11g	2.4	54
802.11n	2.4, 5	450

Source: Wi-Fi Alliance, “Discover and Learn,” http://www.wi-fi.org/discover_and_learn.php.

2.36 Due to its affordability, scalability and versatility, its popularity has spread to urban as well as rural areas. Wi-Fi can provide a good solution to offload mobile data traffic at indoor locations and ease congestion on cellular networks. With users demanding ubiquitous network access, the number of Wi-Fi hotspots in non-residential areas like airports, shopping malls are expected to grow rapidly over the next few years.

2.37 Security is one of the main concerns for wireless networks, since radio signals travel through the open atmosphere and can be intercepted by individuals. Wi-Fi users have to be educated regarding the measures for securing their Wi-Fi connections.

2.38 Interference can also be an issue while using the unlicensed band of 2.4 GHz for Wi-Fi devices as it is also used by many other devices like cordless phones, microwave ovens and wireless local loop (WLL) radio systems.

(b) WiMAX.

2.39 Worldwide Interoperability for Microwave Access (WiMAX) provides fixed, portable or mobile non-line-of sight service from a base station to a subscriber station. It can have service coverage of aerial 10 Kms from a WiMAX base station for point-to-multipoint, non-line-of-sight service. This technology has the capability to deliver approximately 40 Megabits per second (Mbps) for fixed and portable access applications. A WiMAX cell site offers enough bandwidth to support large number of businesses with speed of 1.544 Mbps and residential customers with the equivalent of DSL services from one base station. Although it provides better security, however, installation and operational costs being high are a big impediment to the use of the technology.

2.40 Mobile WiMAX takes the fixed wireless application a step further and enables cell phone-like applications on a much larger scale. It enables streaming video to be broadcast from a speeding police or other emergency vehicle at over 70 MPH. In addition to being the final leg in a quadruple play, it offers superior building penetration and improved security measures over fixed WiMAX. Mobile WiMAX will be very valuable for emerging services such as mobile TV and gaming.

(c) Satellite

2.41 Aside from its role in the international and backbone segments of the broadband supply chain, satellites are also used to provide direct subscriber access to broadband services, particularly in remote areas where wireline broadband is not available and there is no terrestrial high-speed wireless coverage. The subscriber uses a satellite antenna or dish that is connected to a satellite modem.

Speeds vary depending on the satellite technology, antenna, and the weather. Latency can be an issue for some applications (for example, gaming). Although they serve specific niches, satellites do not offer the same price to quantity ratio as other broadband solutions.

2.42 Keeping in view the size of antenna to be installed at subscriber premises, satellites operating only in the Ku frequency band (10-18 GHz) are useful. It is expected that next generation satellite will expand into the Ka frequency band (18-31GHz). Satellite transponder in Ku band typically has capacity of 72 MHz. Half transponder of 36 MHz can easily serve 10,000 to 20,000 subscribers for provision of broadband service.

2.43 Though satellite connections have traditionally been more expensive, they can still offer some cost effective options like point-to multipoint (broadcast or multicast) applications that do not require huge bandwidth. VSATs (the small fixed earth stations used to setup satellite based communications network) have been fairly successful in the Indian market. The major users have been banking sector, lottery, distance education, fast moving consumer goods industry and the Government. **Figure 2.5** shows typical setup for provisioning of broadband through satellite.

2.44 There is also a case for using Direct to Home (DTH) reception system, which is primarily used for receiving video broadcasts, for broadband. The uplink in this arrangement, which is normally required to be narrow band, can be from conventional terrestrial media (dialup, EDGE, GPRS etc.). **Figure 2.6** shows typical setup for provisioning of broadband through DTH:

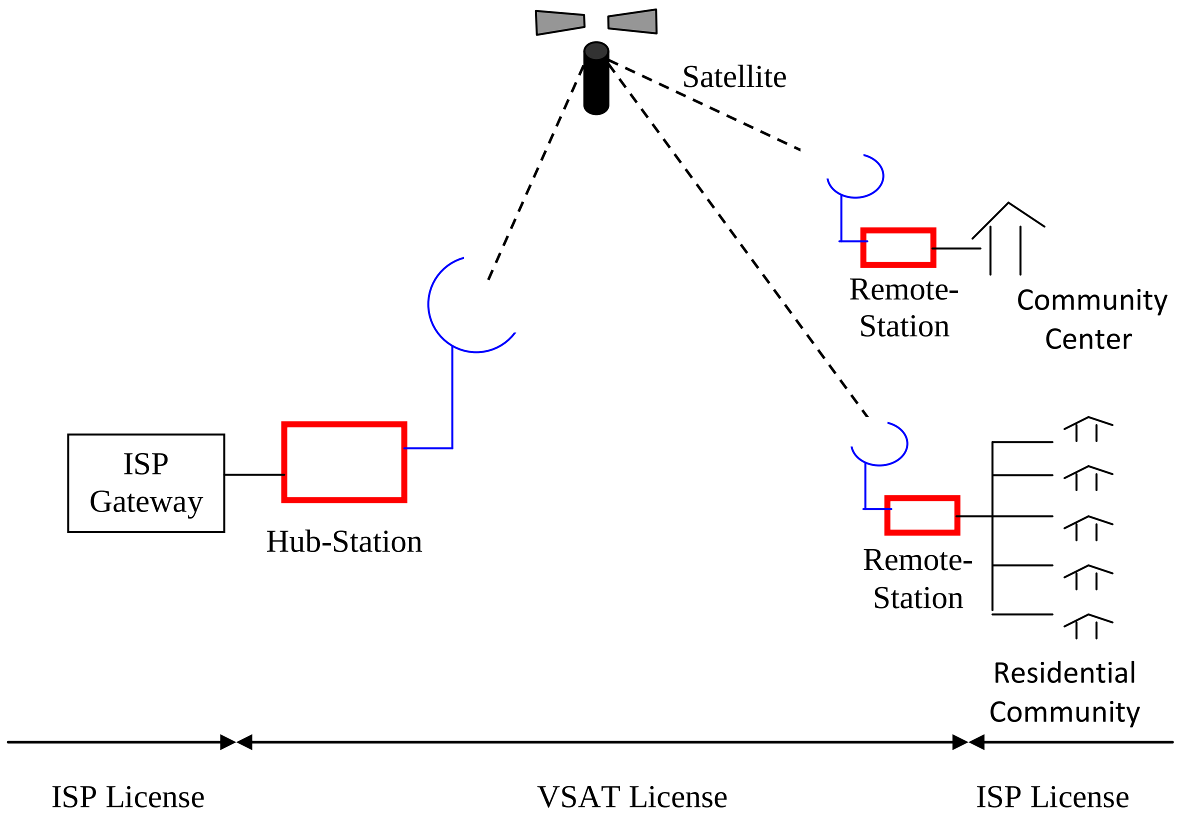


Figure 2.5 – Broadband through VSAT

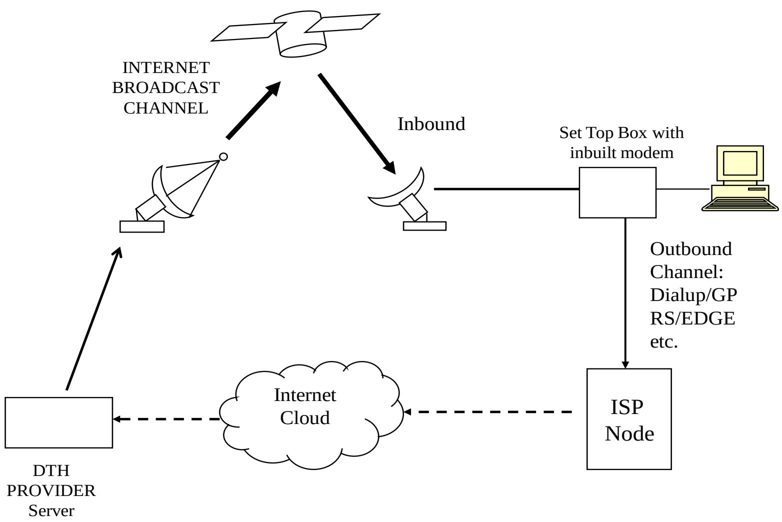


Figure 2.6: Broadband through DTH

2.45 Creating infrastructure to provide connectivity to remote and difficult terrain is difficult and requires substantial cost. Satellite is an effective media to provide broadband connectivity to such areas like Northeast, J&K, HP, Uttarakhand etc. However, the high cost of providing broadband over satellite indicates that it is not a viable business case and needs to be subsidised. Suitable incentive schemes need to be worked out so that broadband can be provided in rural, remote and far flung areas. USO fund may be utilised to provide subsidy for provisioning of broadband services through satellite in remote and hilly areas.

C.2 Mobile Wireless Access Networks

2.46 There are mainly two competing technologies in cellular service viz. Global System for Mobile Communications (GSM) and Code Division Multiple Access (CDMA). The major difference between the two technologies is how they turn voice and data into radio waves and how the carrier connects to the phone. Other differences include the coverage area, the data transfer speeds and the type of hardware used. They both have derivatives for use with 3G technology known as Universal Mobile Telecommunications System (UMTS) and CDMA 2000.

2.47 UMTS also referred to as Wideband CDMA (W-CDMA) is characterized by the use of Frequency Division Duplexing (FDD). W-CDMA is often marketed as an upgrade from GSM, although it requires new base stations and initially new frequency allocation. However, since W-CDMA handsets are generally dual-mode to support GSM, roaming between the two networks is typically seamless.

(a) CDMA 2000

2.48 CDMA 2000 refers to the CDMA2000 1x and CDMA2000 Evolution Data Optimized (EV-DO) technologies that are part of the IMT-2000 standards. CDMA2000 1x supports circuit-switched voice up to and beyond 35 simultaneous calls per sector and high-speed data of up to 153 kbit/s in both directions. There have been three revisions to the EV-DO standards.

(b) IMT-2000

2.49 The first two generations of mobile networks were characterized by analog and then digital technology. There were no global standards, and a variety of technologies evolved. In an effort to standardize third-generation (3G) mobile systems, the ITU developed the International Mobile Telecommunications (IMT) family of standards. Despite the goal of standardization, five significantly different radio interfaces for IMT-2000 were approved in ITU-R Recommendation M.1457 in 1999. These were CDMA direct spread, CDMA multi carrier, CDMA TDD, TDMA single carrier and FDMA/TDMA. WiMAX was added to M.1457 in 2007. Currently, there is just not enough IMT spectrum to support the projected growth of mobile data. The continuing growth of mobile broadband clearly relies on the identification of additional IMT spectrum.

2.50 High-Speed Packet Access (HSPA) refers to the various software upgrades to achieve higher speeds on W-CDMA networks. Initial speed improvements are listed below:

- High-Speed Downlink Packet Access (HSDPA) increases download data rates. Speeds achieved to **14.4 Mbit/s**, with most operators offering speeds up to 3.6 Mbit/s. Upload speeds are 384 kbit/s.

- High-Speed Uplink Packet Access (HSUPA) increases upload rates. Upload speeds are increased to a maximum of **5.7 Mbit/s**.

- HSPA+ (also known as HSPA Evolved) provides an evolution of HSPA and provides data rates up to 168 Mbps on the downlink and 22 Mbps on the uplink. Technically these speeds are achieved through the use of multiple antenna technique known as MIMO (Multiple Input Multiple Output) and higher auto modulation or combining multiple cells into one.

Table 2.8 W-CDMA and HSPA Theoretical Data Rates

Technology	Download speed	Upload speed
W-CDMA	384 kbit/s	384 kbit/s
HSDPA	14.4 Mbit/s	384 kbit/s
HSUPA	Specification for upload and not download	5.7 Mbit/s
HSPA	42.0 Mbit/s	11.0 Mbit/s

Source: GSMA, "About Mobile Broadband," http://www.gsmamobilebroadband.com/about/.

(c) IMT-Advanced

2.51 The ITU has been working on standards for the next generation of wireless systems for several years. One of the most significant requirements for International Mobile Telecommunications-Advanced (IMT-Advanced) networks, is peak data rates of 100 Mbit/s for high mobility and 1 Gbit/s for low mobility. In October 2010, the ITU announced that two technologies met the requirements for IMT-Advanced: LTE-Advanced and Wireless-MAN-Advanced (ITU 2010).

(d) LTE and LTE -Advanced.

2.52 Development of the LTE mobile network standard started in 2004. Targeted speeds were initially 100 Mbit/s for downloads and 50 Mbit/s for uploads. LTE is designed for frequency flexibility, with bandwidth requirements ranging from 1.25 to 20 MHz and support for both paired (FDD) and unpaired (TDD) bands.

2.53 LTE standards have been developed under the auspices of the 3G Partnership Project (3GPP). It has theoretical maximum download speeds of **300 Mbit/s** and upload speeds of 75 Mbit/s. In order to meet global requirements for fourth-generation (4G) mobile networks, 3GPP developed LTE Release 10 and Beyond (LTE-Advanced), which was submitted to the ITU in October 2009.

2.54 In the wireless broadband space too, the country's record is not very encouraging, being ranked 113th as per the State of The Broadband report of September 2014. The Internet and mobile were widely credited with the death of distance- in future wireless broadband may be credited with the death of location as our societies become as mobile as our devices and users. Considering the potential of wireless technologies the following issue needs deliberation:-

Q2. What are the impediments to the deployment of wireless technologies in the access network? How can these deployments be made faster? Please reply separately for each technology.

D. Identification of Spectrum Bands for providing Wireless Broadband[4]

2.55 It is expected that the demand for spectrum to support IMT and terrestrial mobile broadband applications will increase over a period of time. Significant and continuing advances in mobile broadband technologies have increased the spectrum efficiencies and thus, enhanced the capacity to carry data. These advancements are expected to continue. It is also expected that industry will more extensively deploy infrastructure in order to ease the demand on spectrum. Increasing data spectral efficiency, increase in number of cell sites, particularly by using small cells in large numbers and data off-loading are extremely important ways for increasing network capacity and will cater to the increase in user demand up to a certain extent, but surely these will not be enough to address the singular demand for mobile-broadband services. Therefore, more spectrum will be needed to meet increasing demand for mobile broadband applications. This demand will also need to take into account the spectrum requirements of emerging technologies and applications.

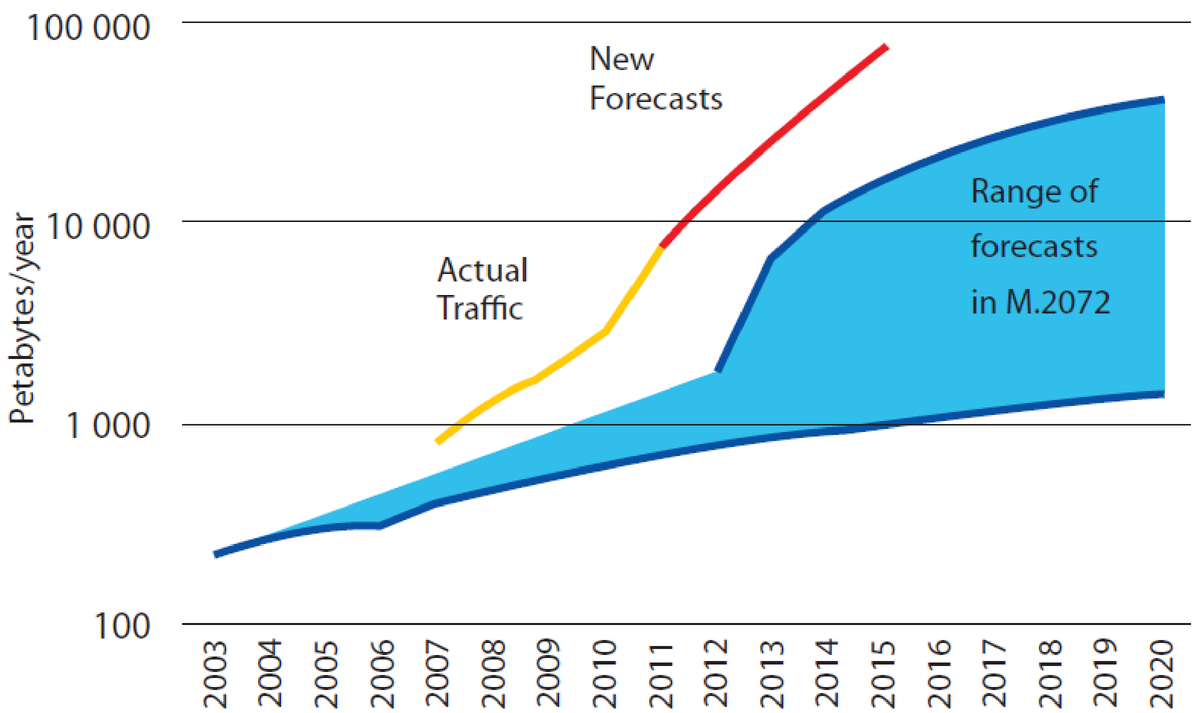
2.56 Following the recommendations from the World Radio communication Conferences viz. WARC-92 and WRC-2000, the ITU identified some globally harmonised spectrum bands for implementation of the terrestrial component of IMT-2000. Spectrum bands thus identified provide a total bandwidth of 150 MHz and 519 MHz respectively globally. Later on, WRC-07 identified 120 MHz of

[4] http://www.itu.int/net/newsroom/wrc/2012/features/imt.aspx

additional spectrum for use by International Mobile Telecommunications (IMT-2000 and IMT-Advanced) on global basis. It also identified 72 MHz for ITU-R Region 1 (Europe, the Middle East and Africa) & Region 3 (Asia Pacific), and 108 MHz in the ITU-R Region 2 (Americas and nine countries in Region 3, including India). In addition, 200 MHz country specific spectrum has also been identified.

2.57 Given the rapid evolution of mobile broadband traffic, the ITU conducted an assessment of the global mobile broadband deployments and forecasts for IMT, and published as ITU-R M.2243 Report, 2011. Similar exercised was carried out by ITU in the year 2005 and results were published in ITU Report ITU-R M.2072. Comparisons of both estimates indicate that the current projections significantly exceeds the previous estimates of the data projections in broadband mobile systems as shown in the chart below:

Figure 2.7



2.58 WRC-12, by its Resolution 807, decided to include the following as Agenda items 1.1 of WRC-15

> “*to consider additional spectrum allocations to the mobile service on a primary basis and identification of additional frequency bands for International Mobile Telecommunications (IMT) and related regulatory provisions, to facilitate the development of terrestrial mobile broadband applications, in accordance with Resolution* ***233 (WRC-12).”***

2.59 The above agenda item is expected to result in identification of additional spectrum bands for IMT services. Following Table indicates the different spectrum bands, which have been identified for IMT so far.

Table 2.9

Sl. No.	Spectrum band (MHz)	Band Size (MHz)	Remark
1.	1885-2025	140	WARC-92, Globally
2.	2110-2200	90	WARC-92, Globally
3.	806-960	154	WRC-2000, Globally
4.	1710-1885	175	WRC-2000, Globally
5.	2500-2690	190	WRC-2000, Globally
6.	450-470	20	WRC-07, Globally
7.	2300-2400	100	WRC-07, Globally
8.	790-862	72	WRC-07, Region-1 and Region 3
	698-806	108	WRC-07, Region 2 plus nine countries in Regions 3 including India.
9.	3400-3600	200	WRC-07, No global allocations, but identified by over 80 administrators in Regions 1 plus 9 in Region 3 including India, China, Japan and Rep. of Korea).
Total Identified Spectrum for IMT:		Global- 869 MHz Region wise- 72/108 MHz Country specific- 200 MHz	

2.60 The Authority has been emphasising the need to allocate spectrum in the spectrum bands identified for IMT services since long. In its recommendations on 'Allocation and Pricing of Spectrum for 3G and Broadband Wireless Access Services' dated 27th September 2006, the Authority recommended that at least 200 MHz of spectrum should be made available for BWA to accommodate growth requirement until 2007 and an additional 100 MHz of spectrum should be coordinated by 2010.

2.61 The Authority in its recommendations on 'Spectrum Management and Licensing Framework' dated 11th May 2010 had estimated that there would be a total requirement of 500 MHz -660 MHz for voice and data services by the year 2014. One of the objectives of the National Telecom Policy- 2012 is to ensure adequate availability of spectrum and its allocation in a transparent manner through market related processes and to make available additional 300 MHz spectrum for IMT services by the year 2017 and another 200 MHz by 2020.

Present Usage of Spectrum Bands in India, identified for IMT systems:

2.62 Let us first identify the total bandwidth allocated in the country versus the required bandwidth already identified for IMT by ITU. In the following paras, the present usage status of bands identified for IMT is discussed.

450-470 MHz

2.63 As per NFAP-2011[5], 2x7 MHz has been allocated to IMT applications. However, none of the spectrum in this band is presently assigned for it. Spectrum in this band is assigned to State Police Organisations, Defence, Security Agencies, Public Sector undertakings and other organisations. In its recommendations on 'Allocation and pricing of spectrum for 3G and BWA services' dated 27th September, 2006, the

[5] IND 35: The requirement of IMT applications in the frequency band 450.5-457.5 MHz paired with 460.5-467.5 MHz may be considered for coordination on a case-by-case basis subject to its availability.

Authority examined and considered that there exists a possibility to allocate 2 x 5 MHz in the 450 MHz band for EV-DO services. In its recommendation on 'Spectrum Management and Licensing Framework' dated 11th May 2010, the Authority stated that in view of excellent propagation characteristics, and suitability for coverage in rural areas and to provide additional spectrum to the CDMA operators for EVDO, 2x7 MHz of spectrum in this band needs to be refarmed from the existing users.

698-806 MHz (700 MHz band)

2.64 NFAP-2011[6] has made allocation for IMT and Broadband Wireless Access in 698-806 MHz band. As per WPC, out of the 2x45 MHz (considering APT700, FDD band plan), 2x15 MHz has been assigned to Defence. Balance spectrum i.e.2x30 MHz has been planned to be assigned for IMT services. The Authority in its recommendations on 'Auction of Spectrum' dated 16th April 2012, has recommended that auction in this band may be carried out in the first half of 2014-15. Further in its recommendations on "IMT – Advanced Mobile Wireless Broadband Services" dated 19th March 2013, the Authority has recommended that "*APT700 band plan should be adopted for the 700 MHz spectrum band (698-806 MHz) with FDD based 2x45 MHz frequency arrangement*" .

2.65 Earlier also, the Authority had recommended for allocation of spectrum in this band for wireless communications. In its recommendations on 'Allocation and pricing of spectrum for 3G and BWA services' dated 27th September, 2006, the Authority had recommended that the DoT should coordinate some part of 700 MHz spectrum for making it available for rural wireless networks in near future. In its recommendation on 'Spectrum Management and Licensing Framework' dated 11th May 2010, the Authority had recommended that 698-806 MHz be earmarked <u>only for IMT applications</u>.

[6] IND38: The requirement for IMT and Broadband Wireless Access may be considered in the frequency band 698-806 MHz subject to coordination on a case-by-case basis.

824-844 MHz/ 869-889 MHz (800 MHz band)

2.66 In this band complete 2x20 MHz has been earmarked for the cellular telecommunication systems[7] in NFAP. However, in J&K LSA 2x2.5 MHz has been assigned to Defence. Depending upon the number of inter-operator guard bands, number of carriers in the 800 MHz band generally varies from 13 to 14, which translates to effective utilisation of 2x16.25 or 2x17.5 MHz of spectrum out of 2x20 MHz of spectrum. Total spectrum assigned in this band is between 2x5 MHz and 2x15 MHz in various Service Area, except in Delhi and Kerala, where there is assignment of 2x17.5 MHz and 2x16.26 MHz respectively.

2.67 As per the present licence conditions, existing operators have been mandated to use spectrum in 800 MHz band using CDMA technology. Also, a minimum of 2x5 MHz of spectrum is required for deploying UMTS technology. Therefore, if the spectrum in this band is liberalized, a few TSPs may utilize it for deploying latest technologies such as UMTS.

890-915 MHz/935-960 MHz (900 MHz Band)

2.68 In the 900 MHz band, 1.2 to 4.8 MHz is assigned to Defence and 2x1.6 MHz to Indian Railways. Therefore, only 2x18.6 to 2x22.2 MHz is available in different Service Areas in India out of total 2x25 MHz.

1710-1785/1805-1880 MHz (1800 MHz band)

2.69 Out of the total 2x75 MHz of spectrum available in this band, 2x20 MHz has been designated as Defence Band. Therefore, spectrum availability for cellular telecommunication systems in this band is limited to only 2x55 MHz of spectrum. Actual assignment for commercial purposes is not even 2x55 MHz currently. <u>Therefore, it is essential that at least 2x55 MHz spectrum may be made available for commercial use at the earliest.</u>

[7] IND46 of NFAP2011: Frequency band 824-844 MHz paired with 869-889 MHz has been earmarked for cellular telecommunication systems, including WLL

1785 -1805 MHz

2.70 As per WPC, entire 20 MHz has been assigned to Defence.

1880-1900 MHz

2.71 As per WPC, entire 20 MHz has been assigned to Defence.

1900-1910/1980-1990 MHz

2.72 In this band, Defence is having 2x2.5 MHz of spectrum. Remaining 2x7.5 MHz of spectrum can be utilised for IMT subject to interference analysis with the adjacent 3G band. However, this is likely to be swapped with 2100 MHz band as mentioned in subsequent para.

1920-1980/2110-2170 MHz (2100 MHz band)

2.73 This band is world over harmonized for the deployment of 3G services. In most of the countries, entire 2x60 MHz spectrum has been assigned to 3G services. However, in India only 2x20 MHz of spectrum in 17 Service areas and 2x25 MHz of spectrum in remaining 5 Service Areas have already been assigned to the service providers in 2010. Defence is likely to vacate 2x5 MHz of spectrum in 17 Service Areas and will retain remaining 35 MHz of spectrum. Thus, a maximum of 2x25 MHz spectrum shall only be available for 3G services in this band. Surely, more spectrum needs to be assigned in this band. <u>Defence is likely to vacate 2x15 MHz of spectrum in 17 service areas but no time frame has been announced by the Government till date.</u>

2010-2025 MHz

2.74 As per WPC entire 15 MHz has been assigned to other users like BSNL, Railways etc.

2300-2400 MHz (2300 MHz band)

2.75 ITU-R WRC-07 has identified 2300MHz band for IMT family of technologies in all three ITU-R regions. As per the NFAP, the requirements of IMT applications including Broadband Wireless Access (BWA) in 2300-2400 MHz spectrum band may be considered for coordination on case to case basis. Out of total 100 MHz of spectrum in this band, 20 MHz is assigned to Defence. 40 MHz of spectrum has already been assigned to the telecom service providers for Broadband Wireless Services (BWA) in TDD Mode. As per WPC additional 20 MHz is available in all Service Areas, except in Punjab, Rajasthan and UP (W). Balance 20 MHz of spectrum shall be used for inter-operator guard bands.

2500-2690 MHz (2600 MHz band)

2.76 This spectrum band was identified for IMT in WRC 2000. It is unique in the sense that it provides a substantial amount of spectrum (190 MHz) that has been allocated on a primary basis in all three ITU regions for terrestrial mobile communications. The efficient operation of the latest wireless technologies, such as LTE requires significantly larger spectrum channels than the preceding (3G) wireless systems. This band provides the scope of giving TSPs blocks of 2x20 contiguous spectrum. It is well-suited for providing the capacity necessary to meet demand for high-data rates of large numbers of users in urban areas and other congested locations. As per ITU-R Recommendation ITU-R M.1036-4, there are three recommended frequency arrangements in the band 2500-2690 MHz as given in the Table below.

Table 2.10

Frequency Arrangements	**Paired Arrangements**					**Un-paired arrangements (e.g. for TDD) (MHz)**
	Mobile station transmitter (MHz)	**Centre gap (MHz)**	**Base station transmitter (MHz)**	**Duplex separation (MHz)**	**Centre gap usage**	
C1	2500-2570	50	2620-2690	120	TDD	2570-2620 TDD
C2	2500-2570	50	2620-2690	120	FDD	2570-2620 FDD DL external
C3	Flexible FDD/TDD					

2.77 Most of the countries have followed an approach aligned with the ITU Option 1 band plan (C1). Presently, in India, out of the 190 MHz of spectrum in this band, 150 MHz is assigned to Department of Space (DoS) for Satellite Networks. Only 40 MHz has been coordinated with DoS in the frequency range 2535-2555 MHz and 2635-2655 MHz for terrestrial BWA application. The frequency sub-band 2635-2655 MHz has already been allotted to BSNL/MTNL for BWA application. However, these assignments are not as per the ITU band plan Option -1. It has resulted in the non-optimal use of the spectrum assigned to the PSUs. In fact MTNL has surrendered this spectrum both in Delhi and Mumbai while BSNL has also surrendered this spectrum in six LSAs.

2.78 The Authority in its recommendations on "Allocation and pricing of spectrum for 3G and broadband wireless access services" dated 27th September 2006 had recommended that an additional 40 to 80 MHz be coordinated with DoS. Allocation of the 2.6GHz band for mobile services is vital to ensure sufficient spectrum is available to meet growing demand for mobile broadband and it needs to be structured in line with international norms. Therefore, the spectrum in this band should be made available as per ITU band plan (Option-1). There may be requirement of spectrum in this band for strategic/defence purposes also. The decision on harmonisation of this band is pending since long. There is an urgent need to decide the issue so that this band can be optimally utilised for commercial as well as strategic purposes.

3300-3400 MHz

2.79 This band does not appear in the list of spectrum bands identified by ITU for IMT. However, NFAP-2011 has allocated it for Mobile[8], Fixed and Radiolocation services on co-primary basis. As per the information provided by WPC, entire 100 MHz range has been allotted to ISPs.

[8] IND65: Requirements of Broadband Wireless Access (BWA) applications may be considered in the frequency band 3.3 – 3.4 GHz on a case-by-case basis.

3400 – 3600 MHz

2.80 At present, entire 200 MHz spectrum in this band is with Department of Space (DoS). NFAP 2011[9] has made provisions to cater to the requirement of IMT including Broadband Wireless Access (BWA) on a case by case basis subject to availability of spectrum in this band and coordination and also with appropriate protection from out of band emission to the networks in the FSS in the frequency band 3600-4200 MHz. The Authority, in its recommendations dated 27th September 2006, has mentioned that "the DoS has informed the Authority that the lower extended C band from 3.4-3.7 GHz is being used for INSAT satellite for television reception. As per the DoS, use of these bands for terrestrial application has to be technically coordinated after detailed space terrestrial system interference analysis. They have undertaken a study of these aspects and findings are expected shortly." In these recommendations, the Authority had recommended that the DoT should get 100 MHz for broadband wireless applications in the 3.4–3.6 GHz band, coordinated with DoS urgently and make appropriate allocations.

2.81 In its recommendation on 'Allocation and Pricing of 2.3-2.4 GHz, 2.5-2.69GHz, 3.3-3.6 GHz' dated 11th July, 2008, the Authority decided not to make any recommendations for 3.4-3.6 GHz band unless DoT assess the compatibility of satellite based services with the terrestrial BWA services and a detailed analysis is done in a transparent and time bound manner to ascertain the feasibility of mitigation of the interference problems reported by some of the stakeholders including DoS, coexistence of both the services and also the feasibility of migration of satellite services to some other suitable band.

2.82 **The above discussion indicates that considerable chunks of spectrum in the spectrum bands, earmarked for IMT by ITU, are being used by other agencies.**

[9] IND66 of NFAP 2011.

E. Broadband Subscriptions in various categories

Table 2.11
Category wise break up of Broadband subscriptions

S.No.	Category	Subscriber Base (in Millions)
1	Wired	14.86
2	Fixed Wireless	0.40
3	Mobile Wireless	45.61
	Total	60.87

2.83 Mobile subscribers using various high speed data access technologies form the large chunk of the 60.87 million broadband subscribers under the revised definition of the services. Technology wise break-up of the broadband subscribers in each of the three categories of wired, mobile and fixed wireless are indicated in **Table 2.12**.

Table 2.12
Technology Wise break-up of Broadband Subscription

Category	Technology	Broadband Subscribers in Million	Top 3 Service Providers and their % Share in the Broadband subscription through that particular technology		
Wired	DSL	12.76	BSNL (78,10%)	Bharti (10.73%)	MTNL (8.80%)
	Ethernet /LAN	1.27	Beam Telecom (29.82%)	Asianet (9.69%)	Atoria Convergence (7.06%)
	Cable Modem	0.71	You Broadband (51.77%)	Hathway Cable (40.33%)	Ortal (6.75%)
	Fibre	0.07	BSNL (34.83%)	You (12.04%)	Tata (9.51%)
	Leased Line	0.05	Tata (26.72%)	Bharti (19.49%)	BSNL (12.72%)
Mobile Wireless	HSPA/WCDMA	39.32	Bharti (27.93%)	Idea (18.37%)	Vodafone (17.05%)
	CDMA based HSD/HSPA	5.06	Reliance (54.71%)	Tata (55.29%)	------
	EVDO	1.23	Sistema Shyam (100%)	------	-----
Fixed Wireless	Wi-Fi	0.35	Tikona Digital (72.11%)	D-Vois (7.36%)	Chandra Net (6.33%)
	WiMax	0.03	Reliance (40.82%)	Tata (33.18%)	Spacenet Internet Service (11.83%)
	Radio (P to P) and VSAT	0.02	Hathway Cable (23.20%)	Sify (16.99%)	Reliance (7.32%)
Total		**60.87**			

The two main sources of access are DSL in the wired segment and HSPA/WCDMA in the wireless sector which make up about 70% of overall connections.

CHAPTER-3

Backhaul Links and National Backbone Network

A. Introduction

3.1 Beyond local access networks, connectivity is needed to connect smaller towns and villages to the backbone and provide links in and around metropolitan areas. These links are sometimes called the “middle mile.” Such links can be provided by satellite, microwave, or OFC, with the latter becoming increasingly common due to its high capacity. Backbone networks are critical components in the broadband supply chain. They consist of very high-speed, very high-capacity links that connect the major nodes of the network—often the major cities of a country. These links need to have large capacities because their function is to aggregate traffic from different areas of the country and then carry it on to the next node or city.

3.2 In liberalized telecommunications markets, there may be more than one backbone network. Competing firms, for example, often lay OFC across a country to compete with each other. The economic impact of backbone networks lies in their ability to reduce costs by spreading them over higher volumes of traffic. However, this benefit is highly dependent on the market situation in a given country.

3.3 The choice of a national backbone strategy is highly dependent on a country’s size, topography, regulatory environment and broadband market size. In reviewing the different technologies, it is important to bear in mind that the selection of the appropriate backbone connectivity option often depends on the distance to be covered the forecasted capacity requirements and the carrying capability of existing networks. OFC is typically perceived as the optimum solution for national backbone connectivity given its high capacity and upgradeability.

B. Microwave Backhaul

3.4 Over a period of time, OFC has evolved as the more practical wired solution for backhaul as well as backbone network, because of extra-ordinary high capacity. However, OFC is not viable/ practically feasible solution for each and every site due to various issues like cost, difficult terrain, Right of Way (ROW), logistical challenges, time constraint or economical viability. The mobile backhaul is an integral part of the network which connect cell site BTSs with BSCs. From an implementation point of view, the backhaul architecture can be further divided into two parts i.e. last mile which provides connectivity to BTS from the aggregation points also called pre-aggregation segment and aggregation part which aggregates traffic from different access parts and backhauls into BSC/RNC. Though microwave does not have the matching capacity of OFC, it is capable to cater to requirements in the pre-aggregation segments. It is a cost-efficient technology for flexible and rapid backhaul deployment to almost any location. It is also scalable and highly reliable. Use of microwave links as a cost-effective alternative to traditional fixed line has been increasing.

3.5 At present, for MW backhaul links, mostly 15 GHz and 18 GHz frequency bands are used. Some links also use 23 GHz band. The channel/ RF carrier bandwidth up to 28 MHz is used. With the deployment of 4G technology for broadband services, there will be huge demand of backhaul capacity and the existing backhaul links may not be sufficient to cater to large data originated from 4G networks.

3.6 Considering the importance of Microwave in backhaul, the Authority has issued its recommendations on 'Allocation and Pricing of Microwave Access (MWA) and Microwave Backbone (MWB) RF carriers'. As per the recommendations a ceiling on the number of MWA carriers that can be assigned to a TSP (based on the quantum of access spectrum held by the TSP) has been stipulated. Also, it has been recommended that in order to increase broadband penetration in India, the usage of high capacity backhaul E-band (71-76 / 81-86 GHz) and V-band (57-64MHz) may be explored for allocation to the telecom service providers. Both E-band and V-band should be opened with 'light touch regulation' and allotment should be on a 'link to link basis'.

C. Domestic Leased Circuits

3.7 Backhaul links are also provided through Domestic Leased Circuits (DLCs). Internet Service Providers (ISPs) require DLCs for connecting their customers to their Point of Presence (POP) for provision of leased line Internet access. Availability of DLCs is therefore a critical requirement for new businesses and service providers.

3.8 Small ISPs are generally dependent on the transmission infrastructure in the form of leased circuits from existing/incumbent telecom operators. The internet services provided by the ISPs to their end users largely depend on the quality and timely availability of such leased circuits. Competition in supply of all segments of end-to-end connectivity is vital to deliver retail products at a reasonable price to users. New entrants generally find it difficult to compete in some of the segments of domestic leased line market, specially the "last mile".

3.9 The last mile is one of the most critical components in the domestic leased circuit. The last mile has traditionally been provided over the access network consisting of a pair of copper wire connecting the Customer Premises Equipment (CPE). Now-a-days OFC /wireless based media are also deployed as local lead for the higher capacity links. The deployment of Access Network based on copper/ OFC requires long rollout period and large initial investments, making the 'local lead' the most capital intensive element of the telecom infrastructure.

3.10 As the cost of installing 'local lead' infrastructure for a new operator can be substantial, it is in the national interest and economic efficiency that the existing infrastructure is fully utilized. Additionally, in the absence of uniform, clear and enforceable guidelines for various processes such as right of way (RoW), civic clearances etc., different State Governments adopt different rules, criteria, costs and time frames causing significant amount of effort and delays to operators in getting the necessary clearances. Also, 'last mile' connectivity to sparsely distributed households is costlier than in densely populated areas. The new entrants find it difficult as well as uneconomical and hence are reluctant to build their own 'local lead' infrastructure.

3.11 The issue of availability of last mile is further exacerbated in rural areas where households are sparsely distributed and generally only one or two operators are present. The sharing of existing infrastructure in rural areas by the rural operator may minimise the cost of ISPs to provide broadband in rural areas.

3.12 In addition to the high cost for setting up of the access network, its operation and maintenance cost is also high. Due to distributed geographical area, the average utilization of the resources for 'local lead' is very poor. Additionally the leased line seekers generally require Service Level Agreement (SLA) to ensure guaranteed QoS to their end users. This further requires higher maintenance costs and additional resources on part of 'local lead' providers to meet the SLA requirements. In view of this, the combined long distance leased line tariff along with 'local lead' charges may make a business case and not the provision of 'local lead' alone.

3.13 The Tariffs for Domestic Leased Circuits are being regulated by the Authority and ceiling tariffs were recently reviewed and prescribed in "The Telecommunication Tariff (Fifty Seventh Amendment) Order, 2014" (4 of 2014) dated 14.07.2014. A summary of the ceiling tariffs is given in **Table 3.1**.

Table 3.1

Summary of Ceiling Tariff of DLCs prescribed through TTO (57th & 58th Amendment)

Capacity	Ceiling Tariff for 5 Km* (In Rs.)	Ceiling Tariff for >500 Km (In Rs.)
E1 (2 Mbps)	12,086	341,000
DS-3 (45 Mbps)	613,000	2,654,000
STM-1 (155 Mbps)	1,610,000	6,965,000
STM-4(622 Mbps)	4,188,000	18,108,000

*for DS-3, STM-1& STM-4 capacities, the minimum distance band is 50 Km

3.14 Considering the above mentioned issues, comments of the stakeholders are requested on the following :

Q3. The recommendations of the Authority on Microwave backhaul have been recently released. Are there any other issues which need to be addressed to ensure availability of sufficient Microwave backhaul capacity for the growth of broadband in the country?

Q4. The pricing of Domestic Leased Circuits (DLC) have been reviewed in July 2014. Apart from pricing, are there any other issues which can improve availability of DLC?

CHAPTER- 4

Internet Traffic Exchange Points

A. Introduction

4.1 Internet offers access to content by the users anywhere in the world. Therefore, Internet Service providers (ISPs) need to arrange for exchanging and routing their traffic to various parts of the world. For this, the ISPs have to secure network connections to all potential senders and recipients of content. Reciprocal interconnection makes it possible for an ISP to access the entire global Internet "cloud" for its subscribers. Such arrangements ensure that Internet traffic can be delivered anywhere in the world, eliminating the need to have physical connections to every country. An ISP will typically arrange to hand off its traffic at the points where its contracted physical connectivity terminates. In order to provide the physical connections between widely separated broadband resources and consumers, countries must establish international links (gateways) to connect to the Internet and telephone networks in other parts of the world. The technologies providing long-haul transmission, such as OFC and satellites, typically have very high investment costs. However, while initial "sunk" costs are high, they have very low incremental costs to accommodate additional users. These technologies also enable carriers to activate additional capacity on an incremental, graduated basis as demand grows. Exchange of traffic generally happens in following manner :

- A *peering* arrangement is where two ISPs freely exchange Internet traffic. However for having a peering arrangement between each other, the two ISPs need to have sufficiently high traffic for each other. The peering requirements of large ISPs often exceed the capability of smaller ISPs. For example, in order for an ISP operating in the Asia-Pacific region to peer with Sweden's TeliaSonera, it would have to provide traffic equaling at least 500 Mbit/s and the ratio of inbound and outbound traffic exchanged between the ISP and TeliaSonera should not exceed 3:1.

- A *transit* arrangement is where a small ISP pays a large ISP to take their traffic to its destination. The fee is generally a function of the traffic or physical connection. Smaller ISPs generally make transit agreements with global IP carriers that can guarantee that their Internet traffic will get routed anywhere in the world. Global IP carriers with worldwide IP networks are often referred to as "Tier 1" carriers, with the distinguishing characteristic that they do not generally pay any transit fees and have the capability to reach all networks connected to the Internet.
- An Internet exchange point (IXP): IXPs offer traffic switching and routing flexibility. By using an IXP, ISPs can individually and collectively reduce their bandwidth and line transmission costs, provide more reliable service with lower latency, and operate more efficiently. This arrangement improves quality of service by reducing the transmission time, number of routers and distance the traffic must travel. It provides a neutral, universally supported "clearing house" for the exchange of traffic, making it possible to keep local traffic local.

4.2 While large global carriers from developed countries operate most of the Tier 1 networks, carriers from developing countries are starting to emerge as significant players. India's Tata Communications Ltd. (TCL), for example, operates a global network that makes it the world's largest, farthest-reaching, whole-sale Internet transit provider. It provides Internet connectivity to over 150 countries across six continents, with speeds up to 10 Gbit/s.

4.3 In India a National Internet Exchange of India (NIXI) was established in 2002. NIXI is managed by a limited liability company registered as a Section 25 company under the Companies Act of India. It is managed by a Board of Directors drawn from the

Department of Electronics and Information Technology (DeitY), eminent academicians, ISPAI, and from among the peering ISPs.

4.4 At the end of December 2013, there were 141 operational ISPs, out of which 62 were category ‘A’, 49 were category ‘B’ and 30 were category ‘C’. However, only 39 ISPs are connected to 7 nodes of NIXI. Out of 39 ISPs connected to NIXI, 29 are category ‘A’, 9 are category ‘B’ and one is category ‘C’. Category ‘A’ ISPs are connected to multiple nodes (**refer Table 4.1**).

Table 4.1
Number of ISPs connected at NIXI nodes

Sl no.	**NIXI NODE**	**Number of ISPs Connected**			**Total Connections**
		A	**B**	**C**	
1	NOIDA(Delhi)	20	4	1	25
2	MUMBAI	25	4	-	29
3	CHENNAI	17	-	-	17
4	KOLKATA	10	-	-	10
5	BENGALURU	7	-	-	7
6	HYDERABAD	5	2	-	7
7	AHMEDABAD	1	-	-	1

4.5 There has been resistance from the service providers to join NIXI which caused serious hurdles in establishing NIXI as an effective IXP providing body. Adding to this is the fact that NIXI is still not a licensed service provider under the Telegraph Act and therefore cannot be regulated in terms of QoS, tariffs and infrastructure by TRAI/DoT.

4.6 The need for an effective IXP is evident from the fact that IP traffic has increased manifold since 2003 when NIXI came into existence. With a robust subscriber base and the ongoing increase of data, the IP traffic is expected to increase manifold in our country in the coming years. To tap the exponential increase in broadband customers in near future as well as increasing content digitization, formulation of an effective and proactive policy keeping in view an effective IXP is therefore required to create an IP backbone.

B. International Connectivity for connecting to Internet cloud

4.7 Indian ISPs require International Leased Line to connect to the internet cloud. Most data that is delivered to Indian consumers are coming through servers located outside the country. Therefore, availability of sufficient capacity at affordable price is a prerequisite for faster growth of broadband in the country.

4.8 During the discussion with Service Providers, it emerged that present rate of Internet Leased Line (ILL) has lost significance as (a) present charges are much below the ceiling prescribed by the Authority in the year 1999 and (b) now ISPs are looking for higher bandwidth i.e, STM 1, STM 4 etc. The service providers further informed that the rough estimates for dedicated ILL are around Rs. 25 Lakhs per annum for STM-1 Link and around Rs 75 lakhs per annum for STM-4 link in unprotected mode. In protected mode, the charge is about 1.5 times of the charge applicable for the link without protection. Some large ISPs also take IP Ports directly outside the country and they only take IPLC from ILDOs in India. The rough estimates of IP Port charges applicable outside the country mentioned by service providers are 1-2 USD/Mbits in USA, 8-10 USD/Mbits in Europe, and 15-20 USD/Mbits in Singapore for APEC countries traffic. As most of the content is hosted outside the country, Indian ISPs have to interconnect at various parts of the world. Interconnectivity cost may be reduced by hosting more and more content in the country.

4.9 In view of the ongoing discussion, the stakeholders are requested to comment upon:

Q5. What are the specific reasons that ISPs are proactively not connecting with NIXI? What measures are required so that all ISPs are connected to the NIXI?

Q6. Would the hosting of content within the country help in reduction of the cost of broadband to a subscriber? If yes, what measures are required to encourage content service providers to host content in the data centre situated within India?

CHAPTER-5

Demand side issues in adoption of Broadband

A. Introduction

5.1 India has the intrinsic strengths for an Internet transformation, but concerted efforts are required to address key gaps in the Internet ecosystem. Consumers, entrepreneurs, enterprises and the Government can play a pivotal role in building a strong Internet ecosystem driven by the country's young Internet-savvy population and strong local consumption, entrepreneurship and innovation, and a large pool of technically trained human capital. Identification of the impediments to expansion of this ecosystem and addressing these impediments to create an environment to encourage broadband growth is the need of the hour. The Digital India project aims to offer a one-stop shop for Government services which would use the mobile phone as the backbone for its delivery mechanism. The Rs.1,13,000 crore initiative seeks to transform India into a connected knowledge economy offering world class services at the click of a mouse. Plans to digitally connect the country will be supported by modules on digital literacy in regional languages which the Government plans to run in the next few years.

5.2 All the issues pertaining to major components of broadband supply chain have already been discussed in the previous chapters. This chapter discusses some key demand side issues which are restraining the proliferation of Internet in India.

B. Demand side issues hindering the proliferation of Broadband in India:

5.3 The various demand side issues that hinder the proliferation of broadband and the corresponding initiatives taken are discussed in the following paragraphs:

B.1 Consumer awareness and general education:

5.4 One of the constraints in awareness and adoption of web technologies is lack of primary education and the relatively high rate of illiteracy, because of which large sections of the population are not familiar with the use of PCs and web-based devices. The Internet ecosystem in India still has a long way to go to in providing local language and text-to-speech support for its content, devices and applications. The list of top ten languages on the Internet does not include even one Indian language, despite the large population of people who speak the country's major languages. Most of the content available on the websites is in English and the English literacy rate in India is quite low (around 7%).

5.5 A Virtual Learning Environment (VLE) which is an e-learning education system based on the web can become a major source for making the people aware about the benefits of broadband and e-governance applications. Some of the VLEs across the various States are already instrumental in spreading awareness among rural masses in their locality regarding the benefits of Internet and services available at Common Service Centres (CSCs). VLEs should be given formal training by the DeitY for this purpose.

5.6 VLEs can also organise awareness workshops in the villages covered by their respective CSCs, which will help in boosting the PC and Internet literacy among the rural masses. For this purpose they may be provided certain amount of funds through National e-Governance Plan (NeGP) awareness campaign program.

B.2 Digital literacy rate:

5.7 Digital literacy refers to the knowledge and skills in using computers in ways that are appropriate to a person's needs. As the world is gradually moving to digital communication through mobile phones, computers, emails, internet, radio, television, tablets, touch screens, text messages, voice calls and so on, India can have a good percentage of digitally literate people if more and more people have access to the Internet. According to some estimates, computer literacy in India is just 6.5%.

5.8 One of the examples of initiative towards enhancement of digital literacy is “National Computer Literacy Drive (NCLD)”, commonly known as NCLD. This project was organized by Institute of Technical Education & Career (ITEC), inspired from National Skill Development Mission Program, Govt. of India to provide Technical Education Service in West Bengal as well as in rest of India. NCLD was established with the endeavour of imparting higher knowledge in Technical Education as well as Conventional Education to aspiring boys and girls so that they can become competent managers, engineers and technologists of repute.

B.3 Computer penetration:

5.9 According to MAIT- KPMG Report of September 2013, titled ‘Indian Market Place- IT the unrealized potential’, the PC penetration in India is limited to ~9 million rural households whereas ~14 million can afford computers as they are above the estimated affordability level of INR 5 lakh annual family income. Low rural literacy, poor infrastructure and lack of local language product customization are some of the key impediments to rural PC penetration. Increase in broadband penetration is not possible without computer penetration that enables access to broadband.

5.10 The lowest configuration PC costs about Rs 10,000 which makes it difficult for rural households with low annual income to access computers. Additional taxes and levies, take the access devices farther out of reach of the common man. There is a need to bring down the levies on computers and related hardware to match that of mobile phones and accessories and thereby encourage speedy proliferation of broadband. In addition, the cost of the minimum required gadgets like PC Modem, power stabilizer and printer along with the license costs of the software (OS, Database and Applications as applicable) do not justify their use for most of the households for accessing only the Government related information services.

5.11 Over the years, the cost of computers has come down but for most users the cost of an access device remains a barrier. However, with the introduction of affordable smart phones a significant change in the scenario is likely to take place.

B.4 Public access points:

5.12 Rural PC kiosks are one manifestation of various attempts to apply information and communication technology for socio-economic development. Kiosks (sometimes referred to as tele-centres) can be thought of as Internet cafes for rural villages, with one or more connected PCs available for shared use by village residents. They differ greatly from urban Internet cafes, however, in that the operational challenges and user needs of remote rural villages are appreciably different from that of cities. Rural kiosks typically offer a broad range of services and applications specialized for rural areas, whereas urban cafes tend to focus purely on Internet access and standard computer applications. Therefore, setting up of rural PC kiosks can be encouraged to increase the demand for broadband in rural areas.

5.13 e-Choupal is an initiative of ITC Limited, a conglomerate in India, to link directly with rural farmers via the Internet for procurement of agricultural and aquaculture products like soybeans, wheat, coffee, and prawns. e-Choupal tackles the challenges posed by Indian agriculture, characterized by fragmented farms, weak infrastructure and the involvement of intermediaries. The programme sets up computer kiosks with Internet access in rural areas of India to offer farmers up-to-date marketing and agricultural information.

B.5 Availability of vernacular content:

5.14 Due to the many different socio cultural profiles in India, there is a need for relevant content in local languages. Websites that currently exist in local languages are insufficient to cater to the large vernacular speaking population. According to the Vernacular Report 2012 released by the Internet and Mobile Association of India (IMAI) in January, 2012, there are 45 million users in India, who access content in local languages. A total of about 64 percent population (24.3 million users out of the total 38 million) of the rural internet users prefer internet in their vernacular language. In case of 84 million urban users, a total of 25 percent users' access or browse net in local languages and it constitutes of about 20.9 million people. The report also clears that the users of vernacular medium mostly used emails, search engines, news content, matrimonial services, online bank services and text chat. There is, therefore, huge potential and headroom for growth of local language content and therefore, going regional can help companies revolutionize the Internet market in the country.

5.15 The DeitY initiated an ambitious programme of TDIL (Technology Development for Indian Languages) (tdil.mit.gov.in) in 2005 with the aim to develop Information Processing Tools and Techniques to facilitate human-machine interaction without language barrier; creating and accessing multilingual knowledge resources and integrating them to develop innovative user products and services. The primary objectives included developing and promoting Software Tools and Applications for all 22 officially recognized Indian Languages. Though some progress has been made through release of language CDs containing various software tools like Bharteeya Open Office, Open type fonts, keyboard drivers, Firefox web browser, e-mailing client for free for public use for all 22 recognised Indian languages, however, the results have not been very encouraging.

B.6 Applications encouraging adoption and use of broadband:

5.16 For the demand side of the ecosystem, relevant, useful and innovative advancements in services, applications, and content are important for encouraging adoption and use of broadband. There is need to extend the benefits of the Internet into sectors of the economy, which are important in the Indian perspective. For example, applications for agriculture, such as farm extension services and supply chain solutions for farm produce, could promote Internet usage by large numbers in the rural economy. Applications for utilities, such as logistics management at ports, octroi and toll collection on roads, and for the energy sector, such as smart grids and power monitoring, would raise the productivity of infrastructure assets. Telemedicine and digitization of patient records would enable high quality health care services to reach millions; likewise, better educational outcomes can be achieved for a large part of the population through Internet based teaching aids and school performance management. The wide availability of public sector information could accelerate this process.

5.17 There is a huge challenge to provide user friendly and cost-effective tools, applications and content that enable access to ICT infrastructure in various Indian languages. Entertainment services, such as local language music and videos are immensely popular among the new users and could be used as a means to impart education and awareness about usage of the Internet. If promoted vigorously, digital literacy may precede traditional literacy and could become the primary source of literacy for millions. There is also a need for simpler and more intuitive mobile applications and services with simple graphical interfaces, and strong local language support, such as an India specific mobile operating system, or an agricultural application for farmers with an image based user interface.

B.7 Topographical barriers and demography:

5.18 Because of relatively low population density, topographical barriers, and greater geographical distances, broadband service may be more difficult to obtain in some rural areas. In attempting to address these challenges, some rural communities have found it helpful to develop a strategic plan for broadband deployment that includes creating a comprehensive business proposal to broadband providers. Mass adoption of broadband will require development of suitable software and ensuring that these services are accessible in all regions at all times.

B.8 Capacity building:

5.19 A large number of people at various levels have to be trained on the changed environment with ICT applications to meet the citizen expectations. It is important to identify and prepare project champions. Functionaries attempting to design e-Government applications must have adequate training and experience to design, implement and manage ICT applications. They must be able to adequately reengineer the existing processes and introduce the desired changes in the system. They must also be able to coordinate with number of agencies dealing with technology and citizen services. This skill upgradation will require special training programmes which provide formal inputs on the planning and implementation of ICT systems.

B.9 Rural entrepreneurship:

5.20 In the absence of a good business model, operators are not sure about minimum number of subscribers and financial returns per month. A study needs to be carried out on various possible business models viable for urban and rural areas. One of the business models could be to use franchisee model by the telecom service providers, wherein they can appoint local entrepreneurs from rural areas as franchisees for providing broadband services. For this purpose Village Level Entrepreneurs, who established and managed Common Service Centre (CSCs), may be considered. These VLEs are usually chosen from the local village community and are already computer and Internet literate.

5.21 It is essential to pay attention to the demand side. An examination of end-user strategies to promote universal access is critical if objectives are to be achieved.

CHAPTER-6

Implementation and Policy Issues

A. Introduction

6.1 To be successful, a broadband policy needs to reflect the requirements of different communities across the country. This means taking a holistic approach and leveraging the opportunities provided by wireline and wireless technology in each part of the network i.e. backbone, backhaul and local access. The implementation of broadband plans and strategies needs to be monitored. Monitoring should be an integral part of broadband plans and strategies – providing an information base for the initial development of plans and strategies as well as for checking the progress of particular policies and programs, and for the evaluation and reassessment of priorities and strategies. Performance monitoring helps to ensure that targets, costs, benefits and outcomes of projects are measured and programmes are well managed. This chapter therefore seeks to scrutinize various policy related issues which are an impediment to broadband penetration as also emphasize the importance of implementation monitoring.

6.2 Some of the elements of the proposed broadband ecosystem could be:

- Enabling regulatory framework.
- Well defined policy of infrastructure sharing.
- Simplified, transparent and fair processes for permissions from civil authorities.
- National Broadband plan with well defined milestones.
- Goal oriented implementation.
- Periodic monitoring of outcomes and timely course correction.
- Simplified licencing regime.
- Adequate availability of spectrum.
- Development of locally relevant contents and applications.

B. National Optical Fibre Network (NOFN) approved by the Government:

6.3 Government has approved the setting up of the National Optical Fibre Network (NOFN) to provide connectivity to all 2,50,000 Gram Panchayats (GPs) in the country. The main objective of NOFN is to extend the existing Optical Fibre Network to Panchayats by utilizing Universal Service Obligation Funds (USOF) and creating an institutional mechanism for management and operation of NOFN. All TSPs/Other Service Providers (OSPs) would be permitted to avail of NOFN infrastructure.

6.4 Bharat Broadband Network Limited (BBNL) is a Special Purpose Vehicle (SPV), set up by the Government of India in 2011, for the establishment, management and operation of NOFN. BBNL is a wholesale bandwidth provider and has been granted National Long Distance Operating (NLDO) license by DoT w.e.f. 01.04.2013. The NOFN project is estimated to cost about Rs. 20,000 Cr. The project is funded by the Universal Service Obligation Fund (USOF) and was planned to be completed in 2 years' time i.e. by end 2014.

6.5 As per the BBNL website *'At present OFC connectivity is available in all State Capitals, Districts, HQs and upto the Block Level*[10]*. There is a plan to connect all the 2,50,000 Gram Panchayats in the country by utilizing existing fibres of PSUs (BSNL, Railtel and Power Grid) and laying incremental fibre to connect to Gram Panchayats wherever necessary. Dark fibre network thus created will be lit by appropriate technology thus creating sufficient bandwidth at the Gram Panchayats. Thus connectivity gap between Gram Panchayats and Blocks will be filled'.*

6.6 Non-discriminatory access to the NOFN will be provided to all Service Providers. These service providers like Telecom Service Providers (TSPs), ISPs, Cable TV operators and Content providers can launch various services in rural areas. Various categories of applications like

[10] While OFC connectivity is available up to district headquarters, the claim regarding connectivity up to the Block level may not be true for many States.

e-health, e-education and e-governance etc. can be provided by these operators.

6.7 The NOFN Roadmap was:

- Bridge the gap in Aggregation Layer by extending the existing networks.
- 2.5 lakh Gram Panchayats to be connected on OFC.
- Approx 100 MB bandwidth at each Gram Panchayat.
- Non-discriminatory (open) Access to all SPs.
- CUG connectivity to be provided at Gram Panchayats for G2C services.
- Approx 5 lakh km new incremental OFC required.
- Approx 4 to 5 lakh km of dark fibre from existing OFCs of BSNL/Railtel/Powergrid required on long term lease basis.

B.1 Present status of NOFN Project:

6.8 As per the information available on the BBNL website, out of 2,50,000 Gram Panchayats across India, work for only 6,410 Gram Panchayats has been started in Phase-I. Number of districts/ blocks/ GPs by BSNL/Railtel/PGCIL planned to be covered under NOFN Phase I project is as follows:

Table 6.1

Sl.No.	*Service Provider*	*Districts*	*Blocks*	*GPs*
1.	*BSNL*	*408*	*2093*	*81224*
2.	*RailTel*	*45*	*255*	*8106*
3.	*PGCIL*	*37*	*670*	*14284*
	Total	***490***	***3018***	***103614***

6.9 On the website it is also mentioned that survey has been completed for more than 90% of the Gram Panchayats, MOU for Right of Way also has been signed with most of the States and Union Territories. The website also has information that BBNL is intending to outsource the work of laying OFC to interested parties who would take up the task of initially connecting approximately 50000 Gram Panchayats. BBNL has solicited comments and suggestions from interested vendors who would be willing to take up the job of Project Management Consultants (PMC) and Project Implementation and Maintenance Agency (PIMA).

6.10 As per media reports all State Governments and Union Territories have signed the MOU with BBNL granting Right of Way except Tamil Nadu and Lakshadweep. BBNL has already issued purchase order for procuring 1.8 lakh Kms. of OFC, out of that only 15000 Kms. cable has been delivered. Advance Purchase Order (APO) for the supply of GPON for 1 lakh numbers of ONT (Optical Network Terminal) and 4000 number of OLT (Optical Line Termination) has been issued. Supply for this is likely to begin shortly. Out of 6 lakh Kms., only 2000 Kms. duct has been laid and only 256 Kms. of OFC has been pulled through this duct.

6.11 The Government has set a revised deadline of March 2016 for completion of the NOFN project. However, as per a media report quoting DoT survey, the ongoing speed of laying cable is 500 Km. per month whereas the required speed to achieve the target is 30,000 Km. a month viz. 60 times what is being realized today!

6.12 In a number of countries, Governments are financing the deployment of backbone infrastructure to meet policy objectives or are considering this financing. Where Government is considering investment, the key issue is that under what circumstances can this investment be considered appropriate? In most countries it is a norm that Government investment in backbone or access network infrastructure is not required in those areas where there is already effective competition between telecom service providers. It is also reasonably assumed that Government investment is appropriate in those areas where, but for that investment there would not be effective competition between TSPs. In Europe the question of appropriateness of public investment is dealt with under State Aid

Rules. The European Commission State and guidelines issued in September, 2009[11], address this issue. <u>The concern is to ensure that Government funding does not crowd out private investment.</u> Under these guidelines, the European Commission suggested that Government investment in broadband networks could be analysed, on a geographic basis, in three categories. These three categories (with the necessary changes) also apply to Government investment in next generation access networks.

White Areas	Grey Areas	Black Areas
No broadband infrastructure exists, and none is likely to be rolled out in the near future (often rural or low income areas)	One broadband infrastructure provider and no more are likely to be rolled out in the near future.	Two or more broadband infrastructure providers.
Government investment in network roll-out is highly likely to be appropriate.	Government investment in network roll-out is appropriate in some instances if current services are unaffordable or do not meet user needs and other, less distortionary, measures (e.g. ex ante regulation) are not available.	Government investment in network roll-out is not appropriate without clear evidence of market failure, although facilitative measures (e.g. RoWs) and end-user financial support still permissible.

6.13 The guidelines provide that, where Government investment is appropriate, it should be on terms equivalent to what a market investor could have undertaken. The guidelines also describe some of the requirements in those cases where Government investment is appropriate, including open access requirements. In India, The Government may like to revisit the implementation methodology and

[11] European Commission, "Community Guidelines for the Application of State Aid Rules in Relation to Rapid Development of Broadband Networks" Official Journal of the European Union (2009).

entrust more work to the private TSPs. This would enable in building the network infrastructure in a more cost effective and efficient way.

6.14 The slow pace of implementation of the NOFN project raises a number of questions:

- Given the track record of BSNL, RailTel and Power Grid in implementing USOF projects in the Northeast, (please see TRAI's recommendations on 'Improving Telecom Services in the North Eastern States: An Investment Plan') are they really the ideal choice as institutions to be reposed with responsibility for this vitally important national project?
- It is common knowledge that decision-making processes in Public Sector Undertakings (PSUs) are cumbersome, time-consuming and often end in scrapping of a tender. That, in turn, further delays project execution. Would it then not be more sensible to recognize these institutional limitations and consider the award of EPC turnkey contracts by BBNL to private sector parties through International Competitive Bidding (ICB)? BSNL, Power Grid and RailTel could then devote their resources and attention to coordination, over sight and third-party inspection of the executed project.
- Are there any ways in which infrastructure development costs can be reduced? Even if the backbone has to be entirely built by the public sector to ensure open access, is it not possible to piggyback existing private sector access networks so as to minimize costs in reaching remote rural locations, i.e. if the private sector is willing to lay OFC or already has laid OFC up to a point, then could they not be induced to participate in the national project by making investments in extending the OFC closer to rural locations to enable high speed broadband delivery?

6.15 Stakeholders are requested to forward their comments on following issues:

Q7. Are PSUs ideal choices for implementing the National Optical Fibre Network (NOFN) project?

Q8. Should awarding of EPC turnkey contracts to private sector parties through International Competitive Bidding (ICB) be considered for the NOFN project?

Q9. Are there any ways in which infrastructure development costs can be reduced? Is it possible to piggyback on the existing private sector access networks so as to minimize costs in reaching remote rural locations?

Q10. What can the private sector do to reduce delivery costs? Please provide specific examples.

C. Clearances for infrastructure deployment from local Authorities and Right of Way (RoW)

6.16 The issue of clearances for infrastructure deployment from local authorities and Right of Way (RoW) has been a major constraint in proliferation of OFC network in the country. In the absence of uniform, clear and enforceable guidelines for various processes such as right of way (RoW), civic clearances etc., different State Governments have adopted different rules, criteria, costs and time-frames causing huge effort and delays to the operators in getting the requisite clearances. The Authority in its recommendations of December, 2010, has discussed this issue and recommended that "the Government may fix and notify the charges for Right of Way in consultation with the State Governments on priority basis and ensure time bound availability of RoW to telecom service providers after due intimation to the agency concerned."

6.17 In view of the importance of this issue, the Authority, in its recommendations on 'Telecommunication Infrastructure Policy' dated 12th April 2011 has revisited the issue of 'Clearances for infrastructure deployment from local Authorities'.

6.18 In order to streamline the provisions of Right of Way (RoW) for telecom services, a committee of Secretaries was set up by Group on Telecom and IT Convergence (GOT-IT) in 2008. The committee studied the RoW policies of various State Governments and submitted its report containing model guidelines for streamlining the RoW provisioning. This report was circulated to all State Governments on 24th August, 2008. DoT has again circulated this report to all the States. However, implementation of these guidelines has met with limited success. There is an urgent need to engage with the State Governments for resolving the RoW issues or to modify the legal framework such that a uniform policy gets applicable and implemented across the entire country.

Issues for Consultation:

Q11. What are the major issues in obtaining right of way for laying optical fibre? What are the applicable charges/ constraints imposed by various bodies who grant permission of right of way? In your opinion what is the feasible solution?

Q12. Should the Government consider framing guidelines to mandate compulsory deployment of duct space for fibre/ telecommunications cables and space for telecommunication towers in all major physical infrastructure construction projects such as building or upgrading highways, inner-city metros, railways or sewer networks?

D. CATV

6.19 The reluctance of CATV operators to transition into becoming broadband suppliers derives from the following concerns:

- The rate of return on broadband services on the CATV network may not be sufficient to justify the additional capex and opex.
- If CATV Operators need to bundle different services, they have no option but to acquire a Unified License (UL). And, there is a financial barrier to obtaining an UL.

- MSOs are concerned about providing broadband services through the existing digital network as the conditions of the UL would require payment of a license fee. At present, no such fee is paid by cable operators. The provision in the UL clearly discourages CATV Operators from providing broadband services.

- CATV Networks have not been included in the infrastructure category and, therefore, are not able to access funding/financial support from banks and other institutions for upgrading their network.

Issue for Consultation:

Q13. What are the impediments to the provision of Broadband by Cable operators? Please suggest measures (including policy changes) to be taken for promoting broadband through the cable network.

E. FTTH

6.20 Some policy measures required to be taken for further growth of FTTH are listed below:

- Clear policy framework and licensing conditions will help in sharing last mile infrastructure for e.g. permitting sharing of infrastructure among various TSPs created by IP-I, mandating of infrastructure sharing in locations of heritage, security and environmental importance.
- With the huge requirement for infrastructure creation, there could be active involvement of Infrastructure Providers (IP-I) in meeting infrastructure needs of TSPs. IP-I and TSPs should be able to share infrastructure with all licenced TSPs.
- The ducts laid for the purpose may be shared by the TSPs as per rules laid down. To incentivize the sharing, lower rates of "Right of Way" may be prescribed if the ducts are shared amongst service providers.

6.21 In view of the above, stakeholders are request to comment upon:

Q14. What measures are required to reduce the cost and create a proper eco system for deployment of FTTH in the access network?

F. Wi-Fi

6.22 Some of the important steps that can be taken for proliferation of broadband through Wi-Fi hotspots:

- Unlicensed bands need to be allocated in bigger chunks in various slots as is the prevailing trend in various international markets.
- There should be more unlicensed spectrum in the 2.4 GHz range for the expansion of wireless communication networks.
- The 1880-1890 MHz band, which is earmarked for the operations of low power cordless communication in India, may be unlicensed in line with international practices. Many bands for this use have already been unlicensed in Europe and the United States.
- Experimentation/trials for new technologies and applications in the above candidate bands should be permitted on licence-exempt basis in order to facilitate innovation and application development.

6.23 Following issues therefore need deliberations:

Q15. Are there any regulatory issues in providing internet facility through Wi-Fi Hotspots? What are the reasons that installation of Wi-Fi hotspots has not picked up in the country? What type of business model needs to be adopted to create more Wi-Fi hotspots?

Q16. What are other spectrum bands which can be unlicensed for usage of Wi-Fi technology or any other technology for provision of broadband?

G. Availability of Spectrum

6.24 Wireless Technologies usually provide a competitive broadband access solution in areas with no communications infrastructure, or where the existing infrastructure cannot be easily and economically upgraded. The expanse and challenging terrain of the country means that for the local access network, wireless network will be less costly to build than fixed line by many magnitudes, and also quick to deploy.

6.25 The average spectrum holding of telecom service providers in India in 900 MHz and 1800 MHz band ranges from 4.4 MHz to 10 MHz which is far below most of their counter-parts in other countries. The gain in spectral efficiency increases non-linearly with the quantum of spectrum. As an example, with 5 MHz of paired spectrum (for GSM technology), it is possible to carry 33.03 Erlang traffic, whereas 10 MHz of paired spectrum can carry 138.6 Erlang traffic. The strong growth in mobile data traffic is generating growing demand for spectrum resources which are in finite and fixed supply. Wireless broadband will obviously be the major contributor to broadband growth. However, spectrum policy is fundamental to the successful rollout of wireless broadband. There is an urgent need to release new spectrum as soon as possible. The following issues therefore need consultation:-

Q17. How much spectrum will be required in the immediate future and in the long term to meet the target of broadband penetration? What initiatives are required to make available the required spectrum?

Q18. Are there any other spectrum bands apart from the ones mentioned in Chapter-2 to be identified for provision of wireless broadband services?

Q19. What are the measures required to encourage Government agencies to surrender spectrum occupied by them in IMT bands?

Q20. What should be the time frame for auctioning the spectrum in 700 MHz band?

H. Software and Application Development

6.26 Infrastructure is only an instrument to realise the larger objective of delivering meaningful content to end-users. While broadband will provide internet access and information, there remain issues pertaining to delivery of e-Governance to rural locations. Specifically, e-Health and e-Education have been cited as potential applications of wider usage. The private sector has raced ahead in the development of applications and when open access infrastructure is available, it is more than likely that they would use these applications to create new streams of revenue. However, little seems to have been done to flesh out the prime components of e-Health and e-Education. This work surely needs to begin on top priority. For example, should e-Education components target school-going children in primary, middle and/or secondary school level? Could we envisage delivery of vocational or even university education remotely? Who would design the programmes and check the content for quality control etc? Similarly, on e-Health, is it the intention to merely provide information on preventive measures for public health or to deliver remote access medical advice from a doctor using tele-medicine? For other services the Government wishes to deliver, be they land records or birth and death rates, or payments of bills, what progress has been made in developing applications? These are matters that cannot brook any further delay: without software and application development, the infrastructure will simply lie idle.

Issue for consultation

Q21. Do you agree with the demand side issues discussed in Chapter 5 and Chapter 6? How these issues can be addressed? Please also indicate any other demand side issues which are not covered in the CP.

CHAPTER- 7

Issues for Consultation

Q1. What immediate measures are required to promote wireline technologies in access networks? What is the cost per line for various wireline technologies and how can this cost be minimised? Please reply separately for each technology.

Q2. What are the impediments to the deployment of wireless technologies in the access network? How can these deployments be made faster? Please reply separately for each technology.

Q3. The recommendations of the Authority on Microwave backhaul have been recently released. Are there any other issues which need to be addressed to ensure availability of sufficient Microwave backhaul capacity for the growth of broadband in the country?

Q4. The pricing of Domestic Leased Circuits (DLC) have been reviewed in July 2014. Apart from pricing, are there any other issues which can improve availability of DLC?

Q5. What are the specific reasons that ISPs are proactively not connecting with NIXI? What measures are required so that all ISPs are connected to the NIXI?

Q6. Would the hosting of content within the country help in reduction of the cost of broadband to a subscriber? If yes, what measures are required to encourage content service providers to host content in the data centre situated within India?

Q7. Are PSUs ideal choices for implementing the National Optical Fibre Network (NOFN) project?

Q8. Should awarding of EPC turnkey contracts to private sector parties through International Competitive Bidding (ICB) be considered for the NOFN project?

Q9. Are there any ways in which infrastructure development costs can be reduced? Is it possible to piggyback on the existing private sector access networks so as to minimize costs in reaching remote rural locations?

Q10. What can the private sector do to reduce delivery costs? Please provide specific examples.

Q11. What are the major issues in obtaining right of way for laying optical fibre? What are the applicable charges/ constraints imposed by various bodies who grant permission of right of way? In your opinion what is the feasible solution?

Q12. Should the Government consider framing guidelines to mandate compulsory deployment of duct space for fibre/ telecommunications cables and space for telecommunication towers in all major physical infrastructure construction projects such as building or upgrading highways, inner-city metros, railways or sewer networks?

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Q14. What measures are required to reduce the cost and create a proper eco system for deployment of FTTH in the access network?

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Q16. What are other spectrum bands which can be unlicensed for usage of Wi-Fi technology or any other technology for provision of broadband?

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Q19. What are the measures required to encourage Government agencies to surrender spectrum occupied by them in IMT bands?

Q20. What should be the time frame for auctioning the spectrum in 700 MHz band?

Q21. Do you agree with the demand side issues discussed in Chapter 5 and Chapter 6? How these issues can be addressed? Please also indicate any other demand side issues which are not covered in the CP.

Q22. Please give your comments on any related matter, not covered above.

Annexure

Broadband Initiatives in Other Countries

1. NATIONAL BROADBAND NETWORK (NBN) - AUSTRALIA

The National Broadband Network (NBN) is an Australia wide project to upgrade the existing fixed line phone and internet network infrastructure. It is essential for Australia's transition to a digital future. Fast broadband has the potential to fuel growth and drive improvements to local economies, businesses and homes, bringing new opportunities to the whole country. NBN aims to enable access to fast, reliable and affordable phone and internet services, from a range of providers. The NBN is designed to enable lifestyle enhancements including health, education, well-being, sustainability and wealth.

With the roll-out the US$36 billion National Broadband Network (NBN), private and public entities will be taking advantage of the high-speed OFC network, and build out more private and public cloud service solutions.

As of 3 November 2013, construction of the FTTP network had passed 354,793 premises and there were 109,862 active customer services. In areas where the Fibre-to-the-Premises network is being rolled out, FTTP will gradually replace the copper network which is owned by Telstra and currently used for most telephony and data services. The Wholesale Broadband Agreement (WBA) is the contractual vehicle that NBN Co will be using to supply products and services to its wholesale customers for the next two years. As part of an agreement with NBN Co, Telstra will move its customers to the NBN, and lease access to its exchange space and extensive network ducting to assist in the rollout.

2. NEXT GENERATION NATIONAL BROADBAND NETWORK - SINGAPORE

SingTel sold its passive telecom infrastructure assets into a separate business trust under CityNet Infrastructure Management Pvt Ltd (CityNet) to support the ongoing operation of Singapore's Next Generation National Broadband Network (NGNBN).

Consolidation of OpenNet, CityNet, the NetLink Trust and SingTel has been completed. OpenNet is responsible for the design, build and operation of the passive infrastructure, which includes the optical dark fibre network (i.e. the Layer 1 assets). CityNet and the NetLink Trust were set up as the neutral party for SingTel to transfer the relevant passive infrastructure assets (comprising relevant ducts, manholes and exchange buildings) (i.e. the Layer 0 assets) that will be used by OpenNet for its deployment of fibre for the Next Gen NBN.

The IDA concluded that the proposed Consolidation is not likely to substantially lessen competition in any Singapore telecommunication market and there are no public interest concerns to deny the Consolidation Application. The IDA also noted the potential efficiencies and service improvements that the Proposed Consolidation may bring (being the consolidation of the Layer 0 and Layer 1 NGNBN companies in Singapore). Both phases of the Consolidation were approved by the IDA on 21 November 2013.

3. ULTRA FAST BROADBAND AND RURAL BROADBAND INITIATIVE-NEW ZEALAND

The Ultra-Fast Broadband Initiative is a government programme to expand and develop New Zealand's broadband services. Ultra-fast broadband will bring fibre optic technology to homes, schools, hospitals and businesses.

By 2020, 75 percent of New Zealanders will be connected to ultra-fast broadband. Schools, hospitals and 90 percent of businesses will be connected by 2015. Homes and the remaining 10 percent of businesses will be connected by 2019. The Ultra-Fast Broadband will enable downlink speeds of at least 100 Mbps (megabits per second), and uplink speeds of at least 50 Mbps.

The Government is contributing $1.35 billion to the initiative with significant amounts of private co-investment also being contributed by the government's Ultra-fast Broadband partners.

The Rural Broadband Initiative will deliver broadband to 252,000 rural households at prices and levels of service comparable with urban areas. It will deliver broadband peak speeds of at least 5Mbps (megabits per second) to 86 percent of rural homes and businesses. Before this initiative started, only about one-fifth of rural homes and businesses had broadband of 5Mbps. Over half of rural homes will be able to choose between copper and fixed wireless broadband. All public hospitals and schools, as well as a large number of rural public libraries, will receive a fibre connection.

There will also be extended cellphone coverage. Coverage will extend another 6,200 square km around New Zealand to make a total of 125,700 square km. Chorus and Vodafone were awarded the tender to provide broadband to rural New Zealand homes and businesses. As part of its agreement, Chorus will identify opportunities to collaborate with third parties and find ways to reduce the network set up cost. Any savings that can be linked to a specific community will be reinvested back into that community. Under the agreement, 154 new cellphone towers will be built, 387 cellphone towers will be upgraded and Chorus' existing OFC network will be extended by about 3,100 km. Chorus and Network Tasman will deploy fibre to provincial schools, rural hospitals, health centres and public libraries. Network Tasman will focus on roll out in Wakefield, Mapua, Motueka, and Picton. 57 remote schools and their surrounding communities will be connected by Inspire.net, Gisborne.net, Chorus, and Araneo.

4. HSSB NETWORK – MALAYSIA

In 2008 a Private Public Partnership (PPP) agreement was signed between the Malaysian Government and Telekom Malaysia (TM) to build a High Speed Broadband (HSBB) Network. It was estimated to cost MYR 11.3 billion (USD 3.5 billion) with the Government funding MYR 2.4 billion (USD 740 million). During Phase 1, 1.3 million premises were to be passed by FTTH (Fiber To The Home) while residential high rise buildings in the industrial areas around Kuala Lumpur were to be connected with VDSL2 (Very high bit rate digital subscriber line).
Phase 1 of the Malaysian HSBB network implementation was launched in 2010 in a record 18 month period and 1.4 million premises were passed by 2012. The take up of HSBB was also impressive with over 600,000 subscriptions (i.e. 43% take up of houses / premises passed) by June 2013. Four major operators had signed up for HSBB access services where HSBB is repackaged and sold to their own customers, and 19 had signed up for HSBB transmission services used to enhance their own backhaul network.

5. NATIONAL BROADBAND PLAN – BRAZIL

Plano Nacional de Banda Larga or **PNBL** is an initiative from the Brazilian government to provide broadband Internet access throughout the country to individuals, governmental institutions, businesses and civil societies that do not have access to this service yet.

The government aims to reduce both social and economical inequalities besides generating more jobs and get a competitive advantage in the international business by setting up the necessary infrastructure that allows data communication in non-metropolitan areas of the country.