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Broadband
The lifeline of Digital India

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"A 10% increase in broadband penetration increases the per capita GDP by 1.38% in the developing countries."

World Bank

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Foreword

Hemant Joshi

The focus of the Government to build Digital India through broadband highways connecting every household, village, panchayat, universities, and government departments will go a long way in providing solution to the never ending problems of rural India and to create smarter villages. As part of the digital agenda, the new Government wants to make every household and every individual digitally empowered. The emphasis in budget on e-Governance, computerization, e-Visas, FDI in e-Commerce, digital classrooms, etc. will need high speed broadband connectivity. Digital forces of social media, mobility, analytics, and cloud are shaping the new virtual world today. Undoubtedly, broadband is the lifeline of the Digital India project of the government.

Broadband can help in achieving many of the UN's Millennium Development Goals through useful applications for medical diagnosis and treatment, cleaner water, improved sanitation, energy production, the export of commodities and food security. Mobile broadband could be catalytic in integrating rural & urban India and help widen markets, create better information flows, lower transaction costs and lead to disintermediation of economy. Wireless broadband would make those things possible and affordable, which are currently not feasible to be delivered, in a vast country like India. Broadband could also help in reducing bigger problems of urbanization, greenhouse radiations and traffic congestion, to name a few.

There is no doubt that the demand for Internet and related services is exploding since consumers want connected devices everywhere they go. Connectivity is influencing purchasing decisions taken for goods and services. Wireless Internet connectivity is being built into an increasing number of consumer electronics. This leads to enormous opportunities for smart homes, smart cars, and even smart cities where everything is connected and could be controlled remotely. Digitization of data is also a strong enabler of broadband applications and services.

However, for broadband to gain acceptance among the general populace, service providers and others must deliver applications that bring tangible value to peoples' lives. Since broadband would cater to several industries such as healthcare, education, automotive, retail, banking, energy, agriculture, telecom networks will need to support these vertical-tailored applications as per business and regulatory requirements. Industries will have to re-invent themselves as much as the telecom industry must invent in the next decade. They will need to deliver the connected user experience through seamless cloud services, applications and content, entertainment, and productivity. Networks will need to be upgraded to handle the ever increasing data traffic that will arise from billions of connected devices. Such zeta-bytes of data traffic can be efficiently handled by optic fibre networks which can also provide speeds of several Gbps.

Operators and consumers alike are exposed to cyber-crime and host of other security risks. Network operators must adapt to a continuously changing risk landscape, and vendors must provide appropriate security in their products, solutions, and services. Regardless of these challenges, the enormous benefits and opportunities make broadband an untamed driver of innovation and economic growth. It's time to overcome these challenges and unleash its full potential.

Message from Aegis School of Business

Bhupesh Daheria
Trustee Aegis Knowledge Trust
Founder Aegis Graham Bell Awards

Access to internet and high speed network should be a basic human right as this notion is gaining the popularity worldwide. This year on Independence Day, our most celebrated Prime Minster Shri Narendra Modi, shared the blue print of Digital India dream.

Digital India - A program to transform India into digitally empowered society and knowledge economy. Under, Digital India, Govt. will spend ₹1.13 trillion in the next three-five years to provide Internet connections to all citizens. The plan is likely to create over 17 million direct and 85 million indirect jobs. The backbone of this grand project is the national broadband plan which aims to connect 250,000 village councils at a cost of ₹270 billion, to be completed by December 2016. If executed, every citizen will be able to easily access government services, which will be seamlessly integrated across departments and jurisdictions, and available in real time on mobile phones and online, in Indian languages.

It seems like a fairy tale or some kind of a wild dream, isn't it?

To me, it does look like a fairy tale but a dream which India needs to see and make it true. And my take on it is that yes it seems like fairy tale but that's what India needs and we need to make it come true.

In fact similar mixed sentiments aroused in 2001 when Shri Atal Bihari Bajpaiji, the then Prime Minister, launched Golden Quadrilateral a dream highway network connecting many of the major industrial, agricultural and cultural centres of India at a cost of 600 billion. And today if you travel from Mumbai to Bangalore via road one can see the results.

Today's India needs broadband highways/ expressways to ride on the era of digital economy.

Our knowledge workers now need broadband expressways not highways to fly. And it's good that we are shifting our gears from brick mortar to bytes. Broadband will add wings to innovation economy and its backbone of this Digital India dream.

As the nation is going forward to materialize this dream, Mr. Rajan Mathews, DG, COAI suggested the need to come up with a whitepaper on broadband to cover the various aspects of Broadband like use case in job creation; innovation; e-governance; challenges ahead; public private partnership and policy.

Hope this study will bring perspective to the initiative.

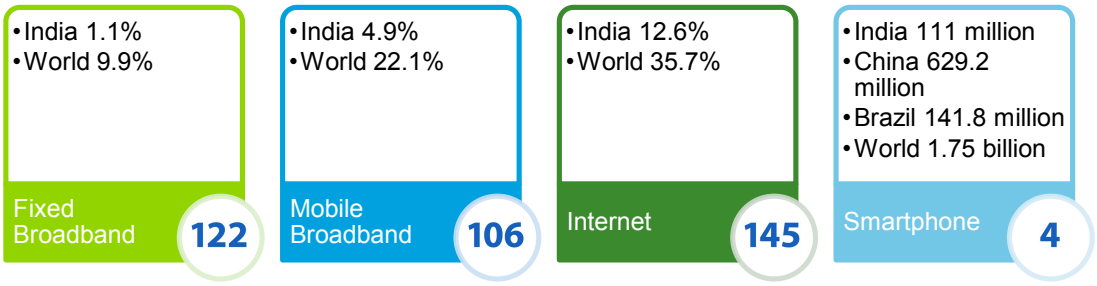
Broadband: The story so far

The world has moved a long way from the Stone Age to Digital Age and so has communication. Communication has become more effective, convenient and reliable. Broadband is helping in achieving many Millennium Development Goals of the United Nations through useful applications for medical diagnosis and treatment, clean water, improved sanitation, energy conservation, export of commodities and food security. India has its own set of challenges, such as poor infrastructure for education, healthcare, banking, rural-urban divide, corruption, inequality, lack of information and awareness, traffic congestion among others. Broadband diffusion across the length and breadth of the country could turn these challenges into opportunities for developing solutions to address the needs of the masses. These applications and services aim at improving the operational efficiency, productivity and collaboration. With the efficient means of communication and collaboration in almost all the sectors, broadband is consistently proving its value in the social and economic transformation of several nations.

Current situation of Internet in India

The telecom sector in India has witnessed impeccable growth in the last decade after the private participation. The tele-density which was 12.86[1] in March 2006 had reached 75.23[2] by March 2014. With 252 million Internet users in India, the penetration stands at about 20%. India ranks third in the worldwide internet users after the US and China. The fixed broadband penetration is 1.1% with India ranking 122nd in the world[3]. The mobile broadband penetration is 4.9% while the smartphone penetration is increasing every quarter with 111 million users in 2nd quarter of 2014.[4]

Figure 1: India's ranking in the world and penetration of services



Source: A report by the Broadband Commission 2013

Penetration: While the world is moving from narrowband to broadband, India has 191 million narrowband subscribers. Against a target of achieving 175 million broadband connections by 2017 (NTP 2012), only about 61 million have been achieved. Top five States (Maharashtra, Tamil Nadu, Delhi, Karnataka and Andhra Pradesh) have a total of 54.4% of overall connections. Metro and category A circles account for 61% of overall connections. Though, the presence of wireless Internet subscribers has increased significantly with almost 233 million subscribers, the adoption is considered relatively weak in a mobile phone dominated country. Overall low broadband penetration has resulted in the absence of an ecosystem (content, applications, service models and device categories), which can address the mass market requirement.

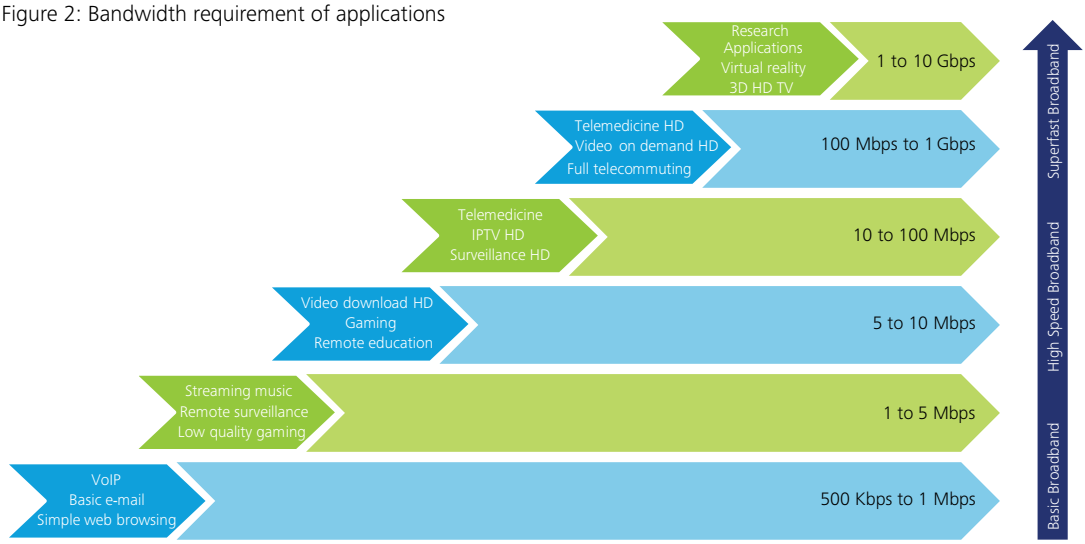
Size of market: The broadband market in Asia Pacific is expected to grow at 12% annually for the next 5 years where as Indian fixed broadband market is expected to reach $2.12 billion by 2017.[5] Out of 149 Broadband Service Providers, top 10 service providers share the 96% of total broadband subscriber (>=512 Kbps) base in India. State owned companies viz. BSNL and MTNL together have about 74.9% market share for wireline broadband and 30.5% for overall broadband subscriptions. Despite having the license to provide broadband service, the majority of service providers are unable to penetrate the market due to complex ecosystem and huge investment required to attain economies of scale.

Speed: In India, the recent upgrade from 256 to 512 Kbps speed is deemed sufficient as broadband whereas countries like US consider 4 Mbps as broadband. According to global internet content delivery company

Akamai's State of the Internet Report for Q4 2013, the average broadband connection speed in India at 1.5 Mbps was the lowest in the Asia-Pacific region. South Korea leads the pack at 21.9 Mbps followed by Japan at 12.8 Mbps. China is more than double of India at 3.4 Mbps.

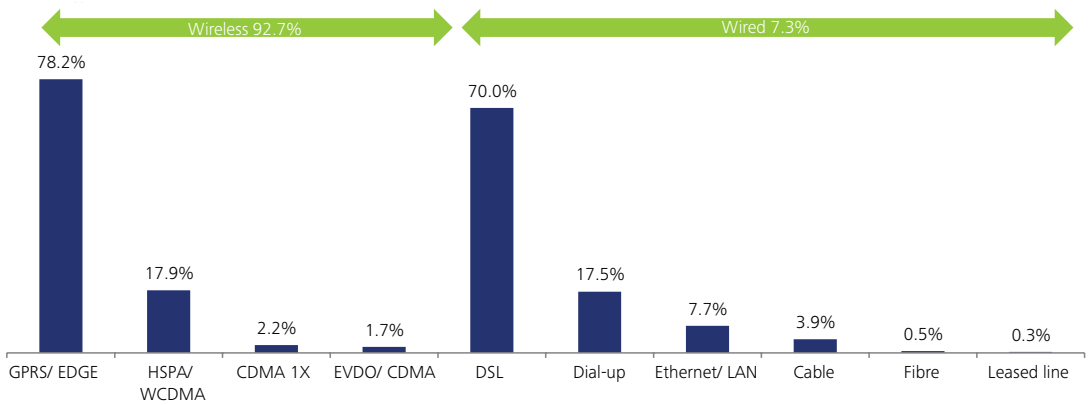
Only basic web browsing, email, social networking, music downloads can be done at this speed of 512 Kbps. For advanced browsing, gaming, video streaming, telemedicine, video on demand, etc. high speed broadband will be the fundamental need. Evolving technologies such as virtual reality, research applications, remote supercomputing, etc. would demand superfast broadband of 100 Mbps to 1 Gbps. Moreover, triple play and quad play services, which allow users to access Internet, TV, landline and mobile in a single wireless connection will require higher bandwidth. Google is launching Google Fiber, a fibre-to-the-premises (FTTP) service to provide broadband internet and television at 1 Gbps speed. This could be a game changer as Google has also tied up with several content providers to offer array of on-demand services.

Figure 2: Bandwidth requirement of applications



Technology: Below graph clearly depicts very heavy reliance of Indian subscribers on wireless networks. It is also increasingly clear that countries aspiring to be on the forefront of innovation, global trade and knowledge leadership must have next generation broadband roll-out on their agenda. Carriers should continue pushing mobile broadband as a substitute for fixed broadband in areas with scarce broadband access, and as a complement to home broadband for urban users until the National Optical Fibre Network (NOFN) project is implemented.

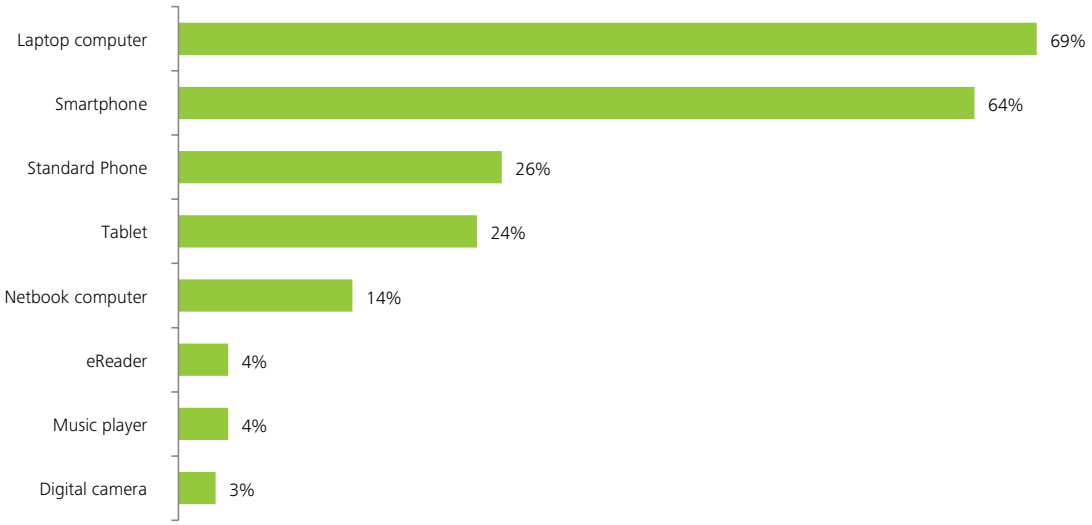
Figure 3: Technology trend for wired and wireless Internet access



Terminals: Today, there are many options of terminals in comparison to the past when PCs and Internet Cafes were used to access broadband. Smart Set Top Box, Smartphones, eReaders, Tablets are the new generation devices to access the Internet. Terminals take different forms depending on the use for reading, retail POS, banking portals, virtual classrooms, healthcare monitors, billboards, etc. Smartphones have seen the highest growth in the past years outselling the PC shipments.

However, there is still high growth potential in PC market with just 10% penetration in India. The global PC and laptop market is growing at 4.2% while smartphone market is growing rapidly at more than 40%. Internet-of-things is bringing a new range of devices such as smart TV, purifiers, glass, watch, routers, etc. to the ecosystem for connectivity. Multi-functional devices are driving exponential growth in data usage.

Figure 4: Which devices do you use to access the Internet?



Source: Deloitte Global Mobile Consumer Survey, 2013 - India Results

Tariffs: Data services contribute about 34% of the total revenue for CDMA and 13% for GSM players in India. The low tariff leads to a lower ARPU which is the primary reason for weak private participation in building the broadband backbone of the country. The ever increasing spectrum price and other regulatory charges like AGR, license fee, spectrum charges, and service tax have raised the price of wireless broadband. The average cost per MB in India is $0.03 which is higher than the global average of $0.02 per MB. 3G prices are ₹250 to 300 for 1GB while fixed broadband provides the same for ₹125 per month. However, the end user equipment costs for fixed broadband go up. Results of Deloitte Mobile Consumer Survey 2013 showed that quality of network for voice and data has become the key differentiator while choosing mobile operator and not price. Significant number of consumers would prefer an 'all-you-can-app' tariff allowing them unlimited use of over-the-top (OTT) services. Higher adoption could also minimize the average cost per MB.

Applications and Services: The broadband though in its infant state in India, is being used in many fruitful applications in different sectors for the socio-economic development of the country.

India still lacks a critical mass of high-demand applications that can generate new users in areas of healthcare, agriculture, education, and e-Governance. Although some content has started migrating to online platform, it lacks the regional or local relevance which is very essential to attract the Indian masses.

Broadband is changing the business model worldwide. Online retailing, banking, social media networking and cloud based storage applications are finding more mobile based users.

Table 1: Comparison of old and new models available in various sectors

Category	Traditional Model	New Model	Bandwidth
News and Information	Local / regional / national, News channels, Radio, Newspaper, Magazines	e-Papers, NewsHunt IBNLive	Low - Medium
Banking	Bank Branches, Post Offices	m-Pesa, Statebank FreedoM, ICICI iMobile	Medium
Ticketing	Ticket Counters, Agents, Manual Payment	MakeMyTrip, BookMyShow, Expedia, IRCTC, RedBus	Medium
Ad-Posting Classifieds	Newspaper, Weeklies, Paper Classifieds, Magazines	OLX, Quikr, Matrimony sites (Jeevansathi, BharatMatrimony), Real estate sites (MagicBricks, 99acres, CommonFloor)	Low-Medium
Files and folders	Print copies, storage cabinets and colour tabs	Dropbox, Google Drive, OneDrive	High
HealthCare	Primary Health Centers, Community Health Centers, Private Hospitals	Sehat Sathi, Electronic Health Records, Narayana Health using telemedicine	Medium-High
Education	Classrooms / Lectures / Libraries	Khan Academy, Educomp's SmartSchool, Massive Open Online Courses	High
Shopping/ Bill payments	Shops, Malls, Cash payments at utility provider	Flipkart, Amazon, PayTM, Freecharge, BillDesk, MobiKwik	Medium

The above solutions are being used in urban areas but the user experience is not worthwhile and the current presence is negligible in rural areas. A strong backhaul and high-speed yet affordable access may help in implementing these solutions nationwide.

Additionally, the Government's investment in the National e-Governance Plan (NeGP) to cover projects including automation of land records, tax, driving licenses, passports and common service centers; the Unique Identification (UID) will help drive demand for broadband and promote inclusive growth of rural and semi-urban India.

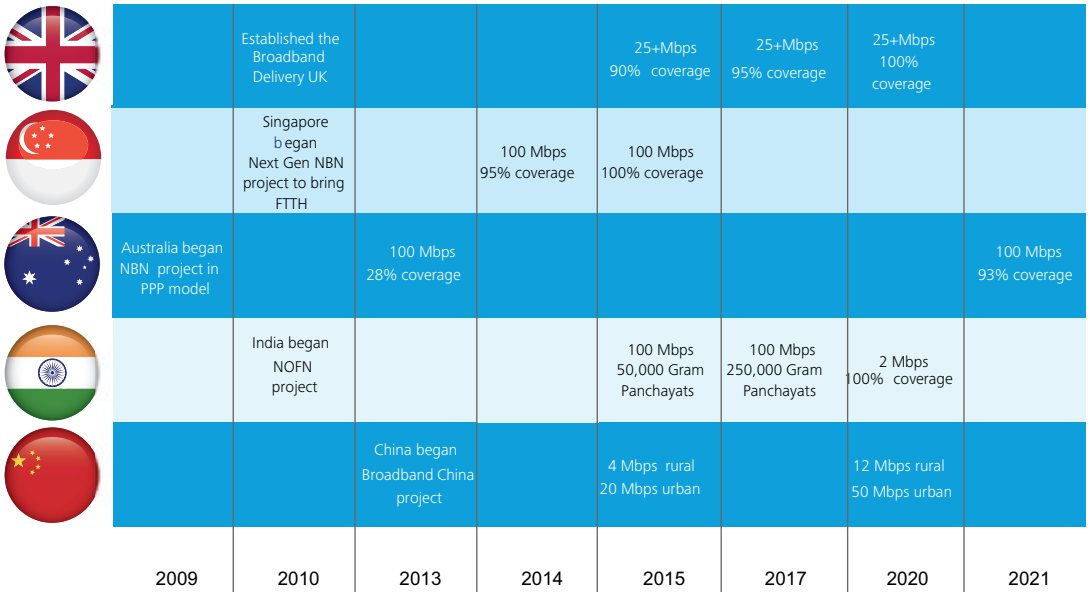
"E-governance is way to good governance... There was a time when it was said that Railway unites the country. I say, today IT has the power to unite the country and its people." Narendra Modi, Prime Minister of India

Government Initiatives: The National Broadband Policy of India started in 2004 as NTP-2004 to realize the potential of broadband services. It aimed at enhancing the quality of life by implementation of tele-education, tele-medicine, e-Governance, entertainment and also to generate employment through high speed access to information and web-based communication. The minimum download speed was 256 kbps and the last mile access was provided by wired line technologies like Digital Subscriber Line (DSL) or cable. The implementation of 3G technology in 2010 introduced wireless broadband in India by removing the wired line last-mile bottleneck. The NOFN was approved by the Government in 2011 to connect 250,000 gram panchayats (GPs) across India with high speed optic fibre.

The National Broadband Network has been a huge success in Australia in bridging the digital divide. Because of mobile broadband the economy has grown by an extra 0.28% every year since 2007. Australia's GDP was $33.8 billion larger by the end of 2013 than it would have been without mobile broadband – a 2.28% growth.[6]

The Singapore Government is putting in place a new nationwide Next Generation Broadband Network to

Figure 5: Broadband targets by country



Source: Country regulator websites, Industry News

increase its economic competitiveness in an increasingly digital world and to meet its future economic and social needs. Singapore now has over 95% household coverage of fibre-to-the-home (FTTH) with speed starting from 100 Mbps, which is transforming the way people work and interact.

China has announced plans to allow private companies to invest in the country's broadband market to relieve financial pressures on three local players and to end their triopoly. Depending on the speed and extent of applications adoption, Internet could enable up to 22% of total GDP growth through 2025.[7]

The government has taken many important initiatives to increase the broadband presence in the country and is dedicated to building world class smart infrastructure with the help of technology and using it for solving various perennial problems of the country. With a vision of Digital India, the government has allocated ₹5 billion to build high speed broadband highways connecting all gram panchayats, government departments, universities, R&D institutes, etc. It is heavily investing in National Knowledge Network (NKN) to connect higher learning/ research institutions to a high-speed digital network. The National Optical Fibre Network (NOFN) project would be the backbone for the success of all these strategically important initiatives.

As a result of promotion of the ambitious Digital India project, the telecom commission has delayed levying of 8% fees on the internet service providers in the country. This is because levying the fees would have restricted the penetration and rate of growth of internet connectivity in the country.

"India is set for a "digital revolution" as it implements a $18 billion program to expand high-speed Internet access and offer government services online."
Ravi Shankar Prasad, Minister of Communications and IT

"It is imperative to create conducive operating environment for providing innovative and affordable mobile broadband services to the citizens for the overall development of the nation."
Rajan Mathews, Director General, COAI

The speed, infrastructure, service provision and service quality have always been the low points for Indian broadband users, both wireline and wireless. The current penetration of broadband in India is not encouraging; however, the steps taken towards an aggressive expansion of broadband could lead to better results.

Broadband: The backbone of Digital India

Globally, the telecom sector is transitioning from a voice oriented market to a data driven market. For a developing country like India which has a population of 1.23 billion, connectivity is a key driver for growth. Every day people and machines produce humongous amount of data, which needs to be transmitted in real time with high accuracy. New services such as HD media streaming, video conferencing, cloud computing and the convergence of data and telephony networks are demanding high speed broadband. Data traffic is growing exponentially with proliferation of a new and powerful generation of multimedia mobile devices with several competing operating systems. Various sectors such as healthcare, banking, education are rapidly driving the bandwidth demand to a level that was simply unthinkable only a couple of years back to reach the masses in rural areas through m-Health, m-Learning and m-Commerce. Key value driver for e-Commerce, e-Governance and video collaboration is convenience.Latest technologies like machine-to-machine and the upcoming smart cities, smart grids, smart homes and digital class-rooms need reliable high-speed internet connection to be operational. Explosion of online ventures for job search, shopping, classified, ticketing, etc. are testimonial to the new digital ecosystem available for venture capitalists and young entrepreneurs to reach new customers. The connectivity and data transfer are now key performance indicators for many businesses, small or large. These new services have diverse requirements, ranging from real-time interactive high availability to non-real time, from low to high bandwidth, and from mission-critical to noncritical services. All these technology innovations and consumer services are driving the demand for broadband.Several initiatives of the Government such as the National Broadband Network, National Optical Fibre Network, National Knowledge Network, Digital India, among others to promote demand for broadband access. Government is also motivated to provide low cost mobiles and tablets to end users in rural areas and increasingly bringing public services to online platform. All these drivers have resulted in broadband emerging as the most dominant technology platform going forward. Enterprises and SMBs have begun to realize the benefits of mobility and digitization; these benefits, will likely spur accelerated adoption of broadband.

Figure 6: Drivers of broadband services

Socio-economic	Commercial	Technological
• Digital classrooms • Telemedicine • Electronic Banking • Entertainment • e-Governance	• Video and web collaboration • Video on demand • Video surveillance • Smart - cities, cars, homes, grids • e-Commerce	• Cloud Computing • Smart devices • Optic Fibre Networks / 4G • M2M • Digitization of content • Social Networking

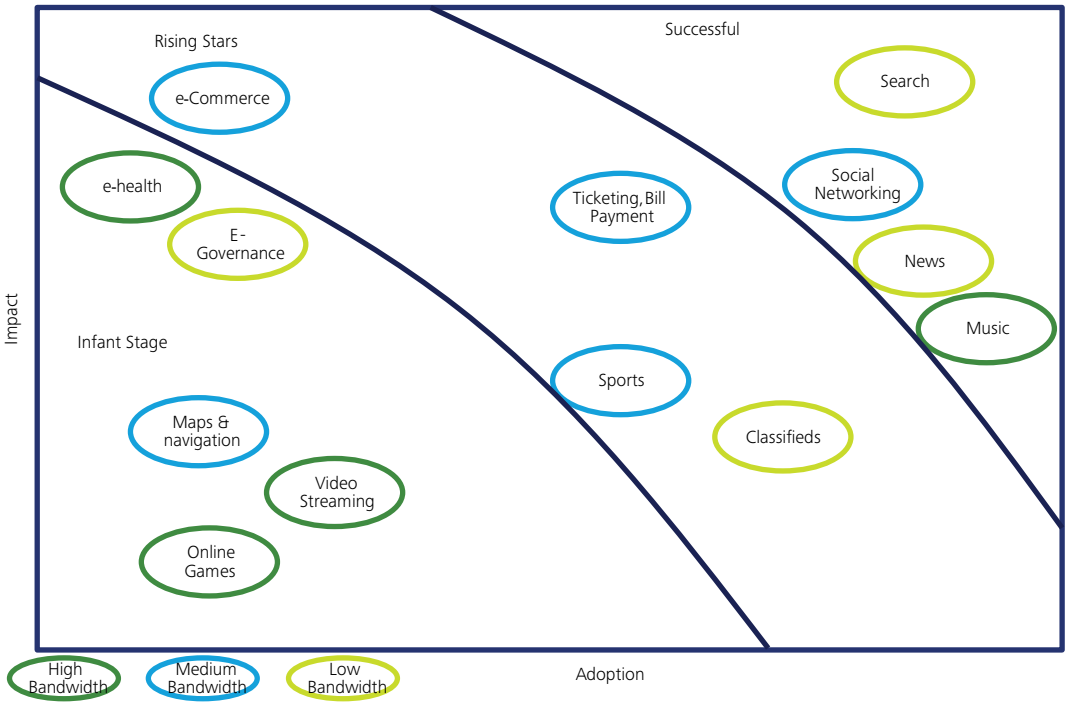
Broadband: The next basic utility

The contribution of Telecommunications as percentage of India's GDP has increased steadily over the last 10 years from ~1.2% in 2002 to ~6.9% in 2012-13, clearly indicating the growing importance of the telecom sector in the Indian economy.[8] One of the key factors behind this growth has been affordability of the mobile services driving widespread adoption across various segments of the population. The equivalent success of broadband penetration is yet to be unfurled in India.

The broadband in India has already generated 9 million direct and indirect jobs. A 1% addition to the broadband penetration can add $2.7 billion to the GDP of the country in the year 2015.[9]

Broadband has been transforming many economies of the world and rapidly becoming a utility. By nurturing a digital environment, broadband offers number of benefits like increased business productivity, improved healthcare, better education, interactive entertainment, and greater government efficiency. The economic growth can be achieved when more population have easy access to information, retail and service sectors. Broadband is critical for India's inclusive growth in financial, healthcare and education sector, among others.

Figure 7: Adoption of various platforms and their impact on the individuals



Uplift rural India

The contribution of rural India to the economic growth is enormous. There is almost 70% of population living in the rural part of India in around 638,365 villages.[10] According to the Economic Survey of India, in 2013-14, agriculture industry contributed 15.2% to the country's GDP. The agriculture sector grew by 4.7% in the year 2013-14 and it accounts for 54.6% of employment in the country. Almost 75% of new factories in India in the last decade were built in rural areas.[11]

The importance of broadband for increasing efficiency and productivity of both manufacturing and agriculture sector cannot be overstated. It can make the rural market more accessible to various players and can help in bridging the rural-urban digital divide. The services could be in local languages to reach the masses of India without any cultural, geographical or linguistic barrier.

The new technologies are not far from the rural India. Technologies like machine-to-machine (M2M) are being used in many agricultural VAS applications like Nano Ganesh.[12] John Deere has used M2M in their tractors to keep track of the performance and fuel consumption.[13]

"Connecting more than a billion people with Internet is not only going to improve lives of people in India but helping innovation and imagination of Indian people will help turn around the world and we are very excited in opportunities in India."
Mark Zuckerberg, CEO, Facebook

IKSL's Experts Farmers' Helpline that provides information to farmers on weather forecast, real time market prices, farming tips, etc. There are many successful examples of mobile banking services provided in rural areas such as m-Pesa, m-Kesho. Confederation of NGOs of Rural India (CNRI) launched a scheme to introduce Internet libraries in rural households.

Broadband can be an enabler of e-Commerce, tele-medicine, e-Learning and other services mentioned above and remove the supply-demand gap in the rural areas that lack basic infrastructure.

Job creation

As per the demographics of India, almost 53% of the population is below the age of 25 years.[14] By 2025, a majority of young population will enter the workforce. To empower them to contribute meaningfully to the economy, it is imperative for the government to ensure that the most basic criterion of providing education is met.

There are just 7% of computer literates in India.[15] In the budget 2014, the government provided ₹1 billion[16] for digital classrooms which could equip students with skills and knowledge for better employment. Broadband can enable e-Learning platforms such as Massive Open Online Course (MOOCs) which can help in basic as well as higher education and ultimately raise the employability levels.

The government has tied-up with some big e-Commerce players to provide handicrafts online.[17] The tie-up along with the connected gram panchayats will provide a good platform for rural people to showcase their products in a global market and entrepreneurial skills could be boosted.

The budget for smart cities and funds allocated for IT and software start-ups may generate more employment options in India. Position of India as a global IT and ITeS hub is helping in generating higher employment opportunities in India. The Indian IT-ITeS sector employs about 3 million people.[18]

Participatory governance

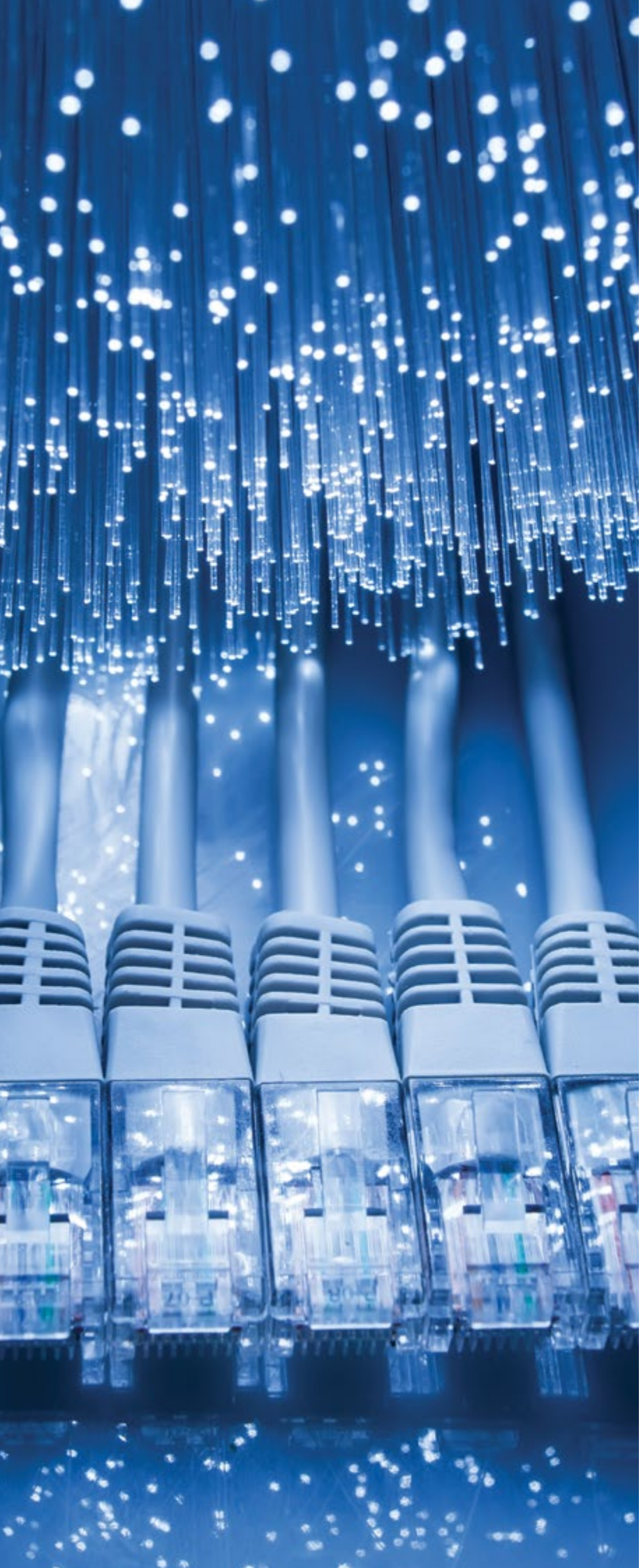
To interact with a very populous country is a challenge for any government. The continuous interaction between people and government helps in better governance through crowdsourcing. The growth in the Indian telecom sector and high penetration of mobile devices are helpful in improving the connectivity between the government and citizens but in a digital world, data connectivity plays a major role. Broadband access can facilitate more open and participatory governance.

Reduce urbanization

Expanding broadband networks to the towns and villages can increase economic efficiency and productivity, thus supporting new non-agricultural income and increased income from agricultural activities. Greater exposure to broadband can help in reducing urban desire and improve skills and education of rural communities.[19]

Future of workplaces

The way of communication and working has changed significantly. The postal letters are replaced by e-mails and meeting rooms with virtual environment. 5 billion users could be online by 2020 – that's equivalent to the entire global population in 1987[20]. These points of global connectivity, together with open source platforms



"Smart-grid is the future of energy conservation." RN Nayak, Chairman, Power Grid Corporation of India

and crowd sourcing methods, will radically redefine who can be part of future workforce. Workplaces will move from offices to homes, cafes, etc. due to technological advances and changes to work and workers itself. Companies will be operating in fundamentally different ways and workplaces that will be more digital, integrated and, fundamentally build around workforce to meet their evolving flexibility needs.[21] Broadband can help in moving to decentralized workplaces thus reducing energy demands, noise pollution, vehicle emissions, and other forms of pollution.

Greening the nation

As per Smart 2020 report, Information and Communication Technologies (ICT) based solutions can contribute towards the reduction of global greenhouse gas (GHG) emissions by 15% by 2020 and in the process also deliver energy savings to the tune of over €600 billion to global business. Hence operators will be motivated to move towards zero emission technologies reducing the carbon footprint and mitigate high energy costs.

According to the World Wide Fund, electronic conferencing can eliminate 20% of business travel which reduces greenhouse gas emissions by 1.08 million tonnes a year. Video-conferencing would also help in reducing not only road traffic congestion but also air traffic, as it is often considered as a substitute to transport.

Challenges: The roadblocks on Broadband Highway

India faces several challenges in the deployment of broadband across the nation which requires supply and demand side analysis. The suppliers consist of the Internet Service Providers (ISPs), the network provider, equipment manufacturers, content providers and government while the demand is from the individuals, enterprises, government offices, small and medium businesses (SMBs) and other stakeholders like schools, post offices and gram panchayats. The challenges and the requirements of broadband access in India are radically different from the developed world. Delivering a broadband connection to rural users, that is viable and profitable at the current low levels of ARPU is a mammoth task. It is equally important to focus on encouraging broadband demand among communities while working on the supply side issues.

Supply side

In many Indian states, socio-economics and supply side challenges limit the adoption curve for broadband services.

Lack of desired infrastructure: The broadband subscriber base in India is only 60.87 million out of 251.59 million of internet base.[22] Lack of nationwide optic fibre backhaul is the primary barrier in adoption of high speed broadband in the country. The estimates in early 2010 showed the need of approximately 1.8 to 2 million route km of optical fibre cable (OFC) to reach broadband in all the panchayats in the country. The total length of optic fibre networks in India is close to 1.15 million route km and most of it belongs to the urban part connecting cities. Digital Subscriber Line (DSL) can work on BSNL's existing copper network. But the country has 40 million copper loops (16 million in rural areas, 24 million in urban areas) and of these, 50% are deemed fit for broadband connectivity.[23] With increasing copper prices, ubiquitous broadband coverage is not possible through copper. Moreover, copper offers limited bandwidth as compared to optic fibre.

Right of Way (RoW): Obtaining RoW permission for optic fibre network is a costly and time-consuming process. Network providers spend almost 50% of the overall CapEx on RoW fees. The RoW charges in some states are as high as 12.7 million ₹ per kilometer.[24]

Complex regulatory environment: Although 100% FDI is allowed in telecom, complex regulatory environment and lack of transparency results in lack of investor confidence. Several scams and retrospective tax issues are shying away the global and Indian investors.

Low last mile connectivity: The NOFN will connect 250,000 gram panchayats and all cities. But the real challenge will be the last mile connection. BSNL can use its copper cables across India to provide the last mile connectivity through DSL or cable technology and other players could use the wireless technology. However, the speed provided by these technologies is much less compared to the optic fibre and might not support future requirement of very high speed.

Unavailability of affordable devices: Availability of compatible and affordable devices is a big concern for the successful broadband connection. Smartphone prices are coming down and the penetration is increasing continuously. Still, India is 71% feature phone market which cannot access high-speed internet.[25] Similarly, in case of fixed broadband, the user need to purchase End User Equipment like modems and splitters which cost more than an average Indian can afford. The Personal Computer penetration in India is just 10%.

Lack of content: Most people, especially who live in rural area, prefer local or regional language content. As per the vernacular report 2013 by IAMAI, 45 million users access content in their local language which is 36.8% of the active internet users.[26] But with diverse cultural and linguistic landscape in India, it is very

"Improving accessibility to government websites and scaling the local language web can open up a whole new opportunity for local entrepreneurs and make the internet more meaningful to non-English speaking users."
Rajan Anandan, MD, Google India

"Digital India is all about bringing the power of internet, bringing the power of death of distance, bringing the power of death of time zones to the betterment of every Indian."
Narayana Murthy, Co-founder, Infosys

difficult to provide relevant content in local languages. India's broadband network needs to offer affordable content that is relevant to the country's diverse population characterized by multiple languages, varying levels of literacy, inequitable physical infrastructure and low levels of income.

Lack of public access points: There is lack of rural PC kiosks or tele-centers, which can deliver governance and other services like e-Choupal to the farmers to help them with farming related information.

Unavailability of useful applications: Relevant, useful and innovative advancements in services, applications, and content are absent 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. There is a huge challenge to provide user friendly and cost-effective tools and applications.

Demand side

Some of the demand-side barriers that have hindered broadband adoption are:

Limited digital literacy and awareness: Despite India being an IT hub of the world, the computer literacy rate is only 6.5%.[27] Most of the government offices still do most of the work manually. Education level, age and income level also impact digital literacy to a great extent. Most of the available content is in English but the English literacy rate is just 7% in India.[28]

Limited affordability: 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 ₹0.5 million annual family income.[29] The investment for deploying and maintaining OFCs and 4G along with the increasing spectrum charges are responsible for high broadband tariffs. The FTTH connection will incur more cost to the network providers and ISPs which in turn will end up in high tariffs. With a cost sensitive market in mind it is very difficult to raise the usage charges.

Broadband deployment: A long term view

Network and technology

Broadband network can be divided into 3 parts i.e. core network (backbone), backhaul and the access network. To provide high-speed broadband network all the 3 links should be in synchronization with each other. If there is an insufficient backhaul link then high speed cannot be reached irrespective of any access network. High bandwidth, reliability, robust, sustainability and scalability are some of the parameters which are equally important as economic viability of deploying any technology.

Most of the incumbent service providers have built strong IP backbone networks. Those who do not have backbone can get leased lines from incumbents and connect their access networks. Backhaul is a constraint in both urban and rural areas. Today the wireless backhaul network is mainly dependent on microwave in urban areas while total absence of aggregation network in rural areas. Most of the backhaul is done on copper networks of BSNL from rural areas. Hence, there is inevitable need to develop optic fibre backhaul to support the high speed multimedia demand arising in the future.

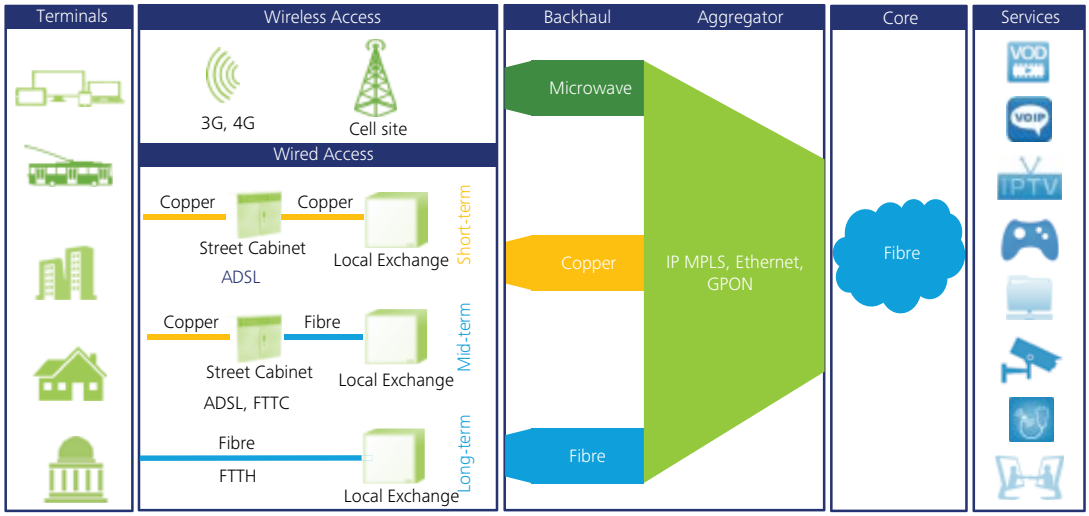
Access network in India is mainly based on copper loops, coaxial cables and microwave so far. Today 70% of the broadband connections are on DSL technology using copper lines and 3.9% on cable modem. xDSL technology is limited to line speeds of up to 24 Mbps and a channel on the cable can have a bit rate of 30 Mbps or more. These networks also need substantial investments to upgrade them to provide high speed broadband as legacy copper networks would need conditioning to make them fit for DSL access and most of the cable TV networks in India are one way. Nevertheless, they could, in principle be used in combination to deliver the most cost effective solution in the short term, avoiding the prohibitive costs associated with universal FTTH access.

Wireless broadband has been mostly accessed on mobiles and dongles so far contributing to more than 92% broadband connections. 2G technologies - GPRS and EDGE have the maximum coverage and adoption while 3G technologies – HSPA, WCDMA, CDMA 1x, EVDO had limited adoption. Despite the availability of data plans providing Internet access to mobile users, a significant portion of traffic from mobile devices has moved to Wi-Fi connections to save on data plan fees or need for higher and faster data transmission capacities. The licensed service providers are rolling out 3G across the country to provide high speed data services. However, India has been lagging behind in deploying next generation technologies like 4G and FTTH, which can provide high capacity broadband access required by the data hungry multi-media smart applications. These advanced technologies also require substantial investments simply to make them available in the more accessible, densely populated urban regions. Also the spectrum allocated in India for 4G and 3G services is not enough to cater to the growing demand for data services by the urban areas and the expected future demand of the rural communities.

It is becoming more and more apparent that it is not financially viable to implement fibre-to-the-home (FTTH) solutions across the country immediately. A combination of technologies could be used in the short to medium term moving steadily to fibre only deployments across the country in the long term.
Following broadband network architecture is proposed for India. In the short term (1-3 years), copper local loop and microwave platforms could be used to provide broadband services across the country. In the medium term (3-5 years), optic fibre deployment should be done aggressively across the country to reach atleast till the street cabinets, thus serving the last mile on copper loops. In the long term, undoubtedly, FTTH will be the

"The Digital India program targets to connect all micro entities by Internet and we believe it has the potential to be one of the most revolutionary initiatives India has seen in recent times."
Chella Namasivayam, CIO, iGATE

Figure 8: Broadband Network Architecture



only way to cater to the burgeoning demands of data services. Capabilities should be built simultaneously for in-building solutions required at each stage to provide seamless experience while on the go and in the innermost corners.

Security and Business Continuity Planning

Terrorists will increasingly target information infrastructure, including the internet, telecommunications networks and computer systems.[30] The continued availability of the high bandwidth services would be very critical, as the data passing through the network, will also have high commercial value over and above the personal need of the users. Robust backup plans for the connectivity ingredients e.g. availability of the technical material, manpower and financial bandwidth to restore the services in real-time will be vital. This is even more essential when the broadband services are being used by high availability users such as corporates, hospitals, government, banks and similar establishments.

With enhanced connectivity and use of internet for multiple personal / business transactions, the incidences of electronic security breaches are also increasing. In order to protect the data integrity and confidentiality, appropriate deployment of the security systems at each layer of the broadband services is a must.

The business continuity and security aspects would be one of the key agenda for every stakeholder associated with the broadband services mainly the technology providers and the service providers. Stakeholders shall consider the international best practices around security and business continuity planning before they implement their products / services.

"Domination of cyber space will become increasingly important. When we speak of Digital India, we would also like to see a Digital Armed Force."
Narendra Modi, Prime Minister of India at Combined Commanders' Conference 2014

Public Private Participation: The success mantra

Internet access in urban areas could be predominantly financed by the private sector, but there are considerably greater challenges in extending coverage to less populated and price sensitive rural areas. Deployment of all-IP networks such 4G and optic fibre demand substantial investments in more accessible and densely populated urban regions. The rural areas also need a significant amount of investment against a comparatively low return. However, the socio-economic benefits provided by broadband are attracting countries to invest heavily in building high bandwidth and data capacity nationwide broadband backbone. It is increasingly unlikely that Government will be able to meet any gaps in provision of networks on their own. Public-private partnerships (PPPs) provide potentially effective solutions to this dilemma. PPPs have been successfully applied to meet a range of infrastructure requirements for schools, hospitals, bridges, sports facilities to airports.

PPPs should not be simply seen only as a method of financing. PPPs make it possible to implement projects with the appropriate scope and accelerated time scales, ensuring public funds will be used in the most effective and efficient manner while encouraging as much private sector involvement and especially risk sharing as possible.

Different kinds of PPP models have been used by countries for faster implementation of broadband network.

- Private Design Build and Operate (DBO) model: Private sector organization receives public funding (often a grant) to assist it in deploying a network and in offering open wholesale access. The public sector has no role in the ownership or running of the network.
- Public outsourcing model: The whole process is outsourced to a private sector organization to build and maintain. The public sector retains the ownership and usage.
- Joint venture (partnering) model: Both the public and private sectors share the ownership. Deployment and operation of the network are undertaken by a private sector organization.
- Public DBO model: Everything is done by the public sector from financing, building and maintenance. A network company is formed by the authority, and offers wholesale and (sometimes retail) services.

The National Broadband Network of Australia is using PPP to provide 1 Gbps connection to 93% of Australians.[31] New Zealand Government is spending $1.5 billion on public-private partnerships with Chorus to rollout FTTH connections of at least 100 Mbps to all towns and cities and awarded $300 million contract to Vodafone and Chorus to bring broadband of at least 5 Mbps to 86% of rural customers by 2016. In the examples described below, the project varies in the level of risk transfer and financial contribution from the private sector depending on the funding model.

"The idea is to provide cost-effective connectivity. I believe TV WhiteSpace technology can be the affordable answer to last-mile connectivity challenges in India, especially for remote areas that lack electricity and other infrastructure."
Bhaskar Pramanik, Chairman, Microsoft India

Table 2: PPP success cases from around the world

Company	Investments	Stakeholders	PPP model
Metroweb, Italy	€400 million	Municipal utility	Joint venture
Metropolitan Access Network (MAN), Ireland	€170 million	e-net (private) for 15 years to build and maintain	Public outsourcing
		Local and regional authorities 10%, European Regional Development Fund (ERDF) 45% and 45% Irish Government	
Auvergne, France	€38.5 million	France Telecom for 10 years to operate and extend	Public Outsourcing
Superfast Cornwall, UK	£132 million	BT Group 60%, ERDF 40%	Private DBO
Asturcon, Spain	€55 million	Government owned company GIT	Public DBO

India

NTP-2012 aims to provide affordable and reliable broadband-on-demand by the year 2015, 600 million by the year 2020 at minimum 2 Mbps download speed and making available higher speeds of at least 100 Mbps on demand.

The National Optical Fibre Network (NOFN) project, funded by the Universal Service Obligation Fund, targets to provide 100 Mbps broadband access to each of the 250,000 gram panchayats by 2017. This ₹200 billion project involves laying 600,000 km of fibre across the country. It is handled by a special purpose vehicle Bharat Broadband Nigam Limited (BBNL). BSNL (telecom operator), RAILTEL (telecom arm of the Indian Railways), and PowerGrid Corporation are the three public sector units (PSUs) who jointly hold 60% stake and government holds the rest.

Out of 250,000 gram panchayats across India, work for only 6410 gram panchayats has started in phase-I. MoU for Right of Way (RoW) has been signed with most of the States and Union Territories.[32] To meet the targets, the required speed of implementation is 30,000 km laying of fibre per month while the current speed is 500 km per month.[33] 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. It has solicited comments and suggestions from interested vendors who would be willing to take up the job of Project Management Consultants and Project Implementation and Maintenance Agency.The RoW, low ARPU and policy issues like stringent rollout obligations, high penalties on radiations, etc. are causing the suppliers to shy away from participating in NOFN project. Investment is recovered over a long time period, creating a mismatch between timing of outgoing (cost) cash flows and incoming (revenue) cash flows.

Given the costs involved in implementing optic fibre based broadband in a vast country like India, innovative financing and contractual models will be a necessity if the ambitious NOFN targets are to be realised. The participation of private players is very important for faster rollout of optic fibre network across the length and breadth of vast country like India. The private participation will not only bring efficiency into the processes but also help in fair and competitive pricing of high speed digital services. Moreover, the innovation in marketing, operations and business process proven by private players can help in faster and greater adoption of high bandwidth services in the remote and rural areas.

The revenue from the voice services is decreasing and the spectrum charges are increasing. The dependence of operators on data services can no longer be overstated. Fibre based broadband could help in solving the social, economic, infrastructure and sustainability problems faced today and the evolving challenges arising from the digital economy. Hence, the Government needs to encourage private players appropriately for their participation in the implementation of NOFN project and provide liberal policies and funding support for optimal utilization of existing and new fibre network in the future. Additionally to boost the demand, it is important to highlight the opportunities enabled by the NOFN network and increased business productivity through initiatives such as collaboration tools.

Recommendations: The accelerators for Broadband Highways

It is very important to have a holistic view of both supply and demand sides to ensure the success of broadband services in a country. Currently the Indian market is not mature for both the sides and it involve large costs and risks. Strategies to address rollout risks and facilitate broadband deployment are discussed below:

Supply-side strategies

All the players in the broadband value chain needs to focus on supply side strategies to provide high speed broadband connection to all individuals and enterprises with optimum user experience.

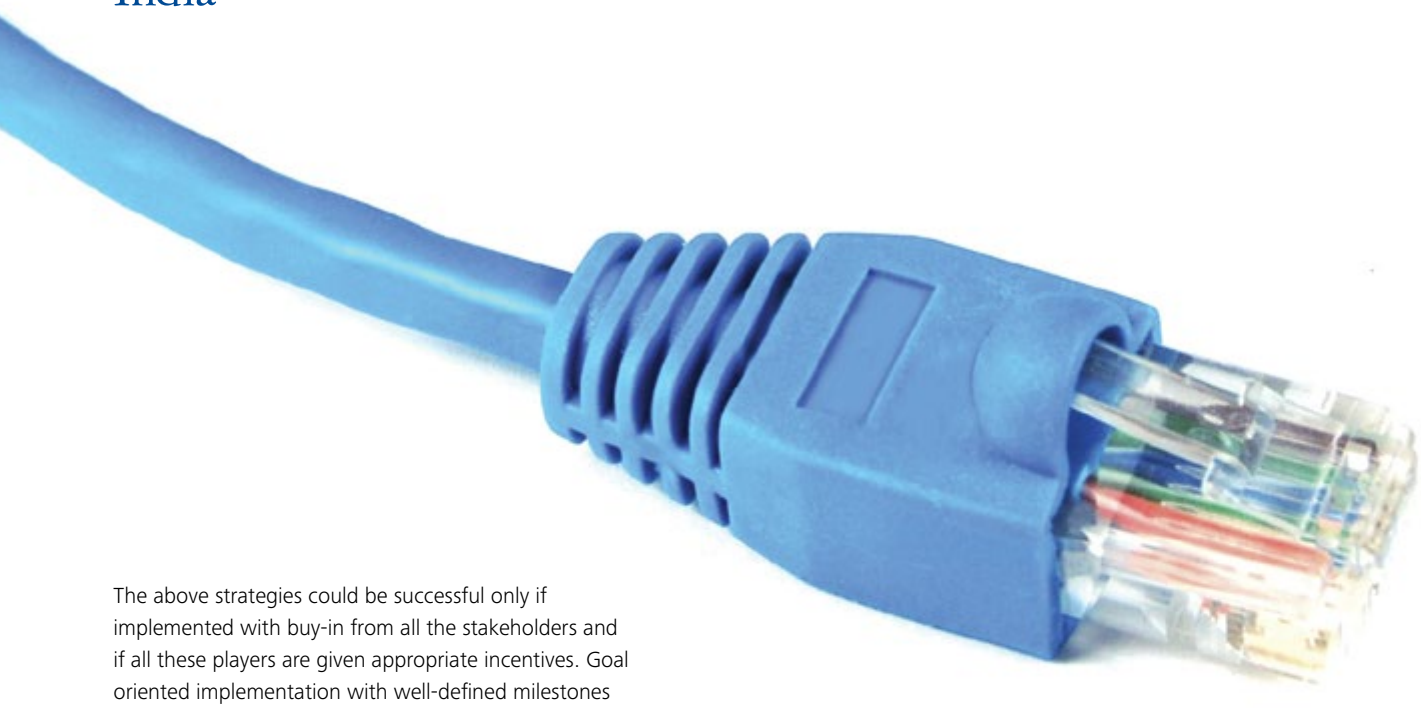
- Encourage public- private partnership model to attract higher private investments in infrastructure construction and business operations and efficiency
- Increase funding and institutional support
  - Provide subsidies, including tax concessions, tax holidays
  - Make available long term subsidized loans
  - Optimum use of Universal Service Obligation fund and other special funds keeping effective balance between the levies on operators and the expected benefits
  - Government equity or debt funding
- Create a good environment, promoting fair competition and efficient use of resources
- Continue to expand 3G coverage and depth, and promote large-scale commercial LTE
- Facilitate application service innovation combine to deepen broadband in various industries
- Focus on deepening broadband network on education, health, employment, emergency, and other livelihood areas of application
- Enhance formation of robust network and information security systems and strictly adhere to international cyber-crime laws and regulations
- Explore new model of cooperation for broadband infrastructure sharing accompanied by well-defined policy around it
- Promote efficient utilization of spectrum resources through spectrum sharing, trading and pooling
- Provide clear roadmap of national radio frequency spectrum allocation including the digital dividend and make available adequate amount of spectrum
- Encourage use of cloud computing model and green technologies to improve energy efficiency and to provide governance and services on demand to the citizens

Demand stimulation strategies

Currently the consumers do not see the benefits of broadband services and smart devices in their personal and professional life and hence they are reluctant to subscribe for such solutions. The demand side stimulation strategies are increasingly important for developing countries to increase awareness, education among the population and making the broadband attractive and affordable for the masses. Several initiatives have been already taken by the Government to improve the adoption of internet in rural and semi-urban markets such as launch of Aakash tablet, e-Mamta (tracking the health of mother and child), e-Dhara (computerization of land records in Gujarat), e-filing tax returns, to name a few.

- Promote consumption of information, develop new services, new markets
  - Encourage primary and secondary schools to include computer and internet related subjects and also to educate elderly people
- Make the broadband connection affordable for the common man depending on the speed requirement
- Accelerate public-sector procurement of services through online platform e.g. online access to RTO services, passport, property and income tax payments, birth/death/marriage certificates, pension funds, etc.
- Encourage SMEs and large enterprises to conduct business using broadband and business model innovation
- Accelerate the development and industrialization of affordable smart devices - mobile terminals, Internet TV, tablet computers and other forms of Internet end-products that are relevant for rural and urban communities
- Promote the development of local and regional digital content and innovative feature-rich applications to deepen broadband in various industries and fields
- Open broadband network facilities and provide ease of access at government agencies and public institutions such as municipal building, roads, railways, airports, subways
- Strengthen the skill development efforts for training and nurturing technical professionals and other talent
- Improve formation of patents and Intellectual Property Rights (IPRs) in India

"The 'Digital India' programme is a welcome step to the vision of creating a new, vibrant India that will catalyze employment generation and empower citizens. However, the fundamental issue to every technology deployment is a strong backbone of end-to-end security especially relevant with mounting incidents and the constant threat of cyber-attacks, malware and data theft."
Manoj Khilnani, Country Marketing Head, BlackBerry India



The above strategies could be successful only if implemented with buy-in from all the stakeholders and if all these players are given appropriate incentives. Goal oriented implementation with well-defined milestones would go long way in ensuring faster and desired results. The progress needs to be monitored periodically and steps need to be taken based on the changing market conditions and realities.

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