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Mobile Communications Policies and National Broadband Strategies in Developed and Developing Countries: Lessons, Policy Issues and Challenges

Dr. Prabir Neogi[1]

Prof. Rekha Jain[2]

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[1] Visiting Fellow, Canada-India Centre for Excellence, Carleton University, Ottawa.
Corresponding author, Email: pkn.prabirneogi@gmail.com

[2] Professor, Indian Institute of Management, Ahmedabad (IIMA) and Executive Chair of the IIMA-IDEA Telecom Centre of Excellence (IITCOE). Email: rekha@iimahd.ernet.in ;

Abstract

Wireline and wireless broadband networks are seen by many countries as a basic infrastructure of the 21st century, which will help facilitate economic growth, participation in the Internet economy and increased competitiveness. Over the last fifteen years the use of the increasingly intelligent mobile phone has exploded and it has become the most widely used communications device in the world. The mobile phone has become the telecommunications access device of choice in the developing world, and is often the only available device for accessing the Internet and its associated services.

Given the benefits of ubiquitous broadband deployment and availability, many countries have launched major national initiatives to accelerate broadband deployment, or are formulating such strategies. These include most developed OECD countries like Australia, New Zealand, South Korea, Japan, Singapore, Sweden, the US, the UK, and the European Union as a whole. Developing countries in Latin America such as Brazil, Mexico and Chile, as well as Asian countries like India, China and Malaysia, also have national broadband strategies and plans.

In this paper we have examined, for a selected set of developing and developed countries, their national broadband strategies and their associated telecommunications and information policy issues, including goals, targets, funding models, the role of governments and implementation strategies, with a view to finding out what has worked, what did not, the problems encountered and lessons of general applicability which might be of interest to policymakers in developing countries like India. Policymakers need to define the appropriate roles of governments beyond the traditional regulatory and spectrum management role, recognizing the need to tailor these roles to particular national circumstances.

Keywords: Mobile communications, Broadband strategies, Internet, Spectrum

Introduction

"Every day we are moving closer to having almost as many mobile subscriptions as people on earth…The mobile revolution is m-powering people in developing countries by delivering ICT applications in education, health, government, banking, environment and business. Let us all celebrate this mobile miracle that I have no doubt will hasten our pace towards sustainable development".
Brahima Sanou, Director, ITU Telecommunications Bureau, *"The World in 2013: ICT Facts and Figures"*[3]

Today we have near-universal availability of the Internet, with users in some 200 countries worldwide. According to International Telecommunications Union (ITU) estimates for the end of 2015[4], some 3.2 billion people or 43% of the world's population of 7.4 billion (4 billion urban and 3.4 billion rural) were Internet users, and some 46% of the world's households had Internet access at home. Between 2000 and 2015 Internet penetration has increased almost seven-fold, from 6.5% to 43% of the global population; the percentage of households with Internet access at home has increased from 18% in 2005 to 46% in 2015. Two thirds of the world's Internet users were from developing countries where the number of users increased five fold in 10 years, from 408 million in 2005 to 2.1 billion in 2015. Internet user penetration stood at 43% globally, 82.2% in developed countries and 35.3% in developing countries. However, some 4 billion people from developing countries, representing two-thirds of their population, were not yet using the Internet.

In parallel, over the last fifteen years the use of the increasingly intelligent mobile phone has exploded and it has become the most widely used communications device in the world. The number of mobile-cellular subscriptions worldwide was estimated by the ITU at some 7.085 billion by the end of 2015; it is expected to exceed the global

[3] International Telecommunications Union (ITU) (2013), "*The World in 2013: ICT Facts and Figures".* Accessed on June 8, 2015 http://www.itu.int/en/ITU-D/Statistics/Documents/facts/ICTFactsFigures2013.pdf.

[4] International Telecommunications Union (ITU) (2015), "*The World in 2015: ICT Facts and Figures".* Accessed on June 8, 2015 http://www.itu.int/en/ITU-D/Statistics/Documents/facts//ICTFactsFigures2015.pdf.

population by 2016 or 2017. In 2015 mobile cellular penetration rates stood at 96.8% globally, 120.6% in developed countries and 91.8% in developing countries. India alone had some 944 million subscriptions in December 2014[5], and a wireless Tele-density of 75.4%; there are more than 30 mobile phone users for every wireline phone user in the country. The mobile phone has become the telecommunications access device of choice in the developing world, and is often the only available device for accessing the Internet and its associated services.

The global population covered by 2G networks has increased from some 58% in 2001 to 95.3% in 2015, but its growth has flattened over the last 2 years. This is largely because the deployment of 3G and more advanced (4G/ LTE) networks, which allow high-bandwidth broadband mobile communications, is increasing rapidly, although an urban-rural digital divide still exists. 3G overall population coverage increased from 45% in 2011 to 69% in 2015. However, while 89% of the 4 billion global urban population was covered, only 29% of the 3.4 billion global rural population had such coverage. The vast majority of mobile users in India currently access 2G networks to use voice and text communications services. However, mobile broadband communications networks (3G, 4G and LTE), which have become almost universal in developed countries, are now being widely deployed by major network service providers in developing countries like India. This expansion is likely to create billions of new mobile Internet users worldwide and the bulk of these users will be located in developing countries like India.

Mobile broadband is the most dynamic segment of the telecommunications market. Globally there are now more than four times as many mobile broadband subscriptions as fixed ones. Mobile broadband subscriptions have increased from some 268 million in 2007 to some 3,459 million in 2015, almost a 13 fold increase in 8 years corresponding to a compound annual growth rate of 37%. Some 68% of these mobile broadband subscriptions are now in developing countries. Globally, mobile broadband penetration per 100 inhabitants reached 47% by the end of 2015. The estimated 86.7% penetration rate in developed countries is more than twice the 39.1% penetration rate in developing countries. However, the rate of growth over the last 10 years has been much higher in developing countries and the potential for expansion is also much greater. From 2005 to 2015, mobile broadband subscriptions increased almost 5 fold from 225 million to 1,090 million in developed countries, but some 55 fold from 43 million (admittedly a very low base) to 2,368 million in developing countries.

Mobile broadband communications requires an integration of wireless and wireline networks. Spectrum is the lifeblood of mobile communications services. As broadband mobile Internet access becomes more readily available and affordable, intelligent mobile devices (e.g. smart phones, tablet computers, laptops) are being used widely for bandwidth-hungry applications, in business and financial transactions as well as for personal and social purposes, creating billions of potential new mobile Internet users. This means that the demand for additional spectrum bandwidth for mobile communications is likely to increase rapidly and outstrip the supply for the next few years. Issues and challenges related to spectrum allocation, re-allocation and management will become an important component of any national broadband strategy, and one that governments must address.

As mobile Internet access and use becomes the new norm policy makers in developing countries, in addition to dealing with the conventional issues related to facilitating the growth of mobile communications (e.g. spectrum availability and re-allocation, infrastructure sharing and interconnection, service pricing and availability, roaming costs), will need to formulate policies and regulations, where required, to address these new challenges related to the large scale migration of mobile users from 2G to 3G/4G broadband communications networks. Many governments have instituted a range of supply side policies to accelerate broadband deployment, increase availability and reduce costs. However, the most effective design of complementary demand side policies remains uncertain.

Problematique: From Availability and Access to Adoption and Use

"Broadband is the great infrastructure challenge of the 21st century. Like electricity a century ago, broadband is a foundation for economic growth, job creation, global competitiveness and a better way of life."

[5] Telecommunications Regulatory Authority of India (TRAI)(2014) Annual Report, December 2014. Accessed June 8, 2015, http://www.trai.gov.in

FCC "*Connecting America: The National Broadband Plan*", March 16, 2010[6].

Ubiquitous wireline and wireless broadband infrastructure deployment and use is *the* great infrastructure challenge of the early 21st century. Economic and social benefits flow from the uptake and use of mobile communications and the Internet, rather than the mere availability of these technologies and platforms. As the Internet increasingly becomes part of mainstream life in both developed and developing countries, those groups that are unable or unwilling to access and use online services stand to be severely disadvantaged relative to other groups.

This paper focuses on the impact of the widespread penetration and use of the mobile phone and other more intelligent mobile devices, particularly in developing countries. It examines and compares the role that wireless access and mobile broadband play in various national and regional broadband strategies, and how mobile communications is integrated with the wireline component of such strategies. It discusses and compares strategies being used in developed countries like the US, Australia and Korea, and developing countries like Brazil, India and Malaysia, among others. We wish to find out what has worked, what did not, the problems encountered and whether there are lessons to be learned that are of general applicability, as well as for particular developing countries such as India.

The paper will examine and discuss Broadband plans across selected developed and developing countries and analyze these plans to see how their formulation may have contributed to broadband outcomes in their respective countries. We shall also examine the role of public and private sector entities in the deployment of broadband infrastructures and services, and the sources of funding used to implement these plans.

This is a topic of continuing interest to both researchers and policymakers. A dialogue between the policymakers and researchers could help to identify current and future policy issues which will require further research work.

Categorization of National Wireline and Wireless Broadband Strategies

"A national broadband plan is as much a social contract as a plan of action to develop the industry base. It can be understood as bringing about a stronger foundation for effective governance, private investment and more active citizenship, leading to a desirable social and economic future". ITU News[7]

Ideally, a national broadband plan should become a permanent fixture of economic development and the embodiment of a shared vision. The plan should be resilient to the checks and balances brought about by politics. It needs to be endorsed by all policy-makers at the time of conception. The respective roles of public and private sector participation, and the potential for partnerships, are all important.

Generally, the private sector should assume primary responsibility for investing in the development of broadband. But this may not always be the best solution, particularly in developing countries like India, Brazil and Mexico, and a central role for the public sector may be needed, at least to get the broadband initiative off the ground. Addressing market failure and the need for intervention with universal service objectives will remain an important role for government.

As an aggregating anchor tenant, governments can contribute to demand through e-services for health, education, public administration, public safety, and the establishment of expertise centres to spread broadband expertise and knowledge. Demand aggregation through the offering of government services online and capacity building, or training through community centres, are particularly important for developing countries.

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[6] Federal Communications Commission (FCC) (2010) "*Connecting America: The National Broadband Plan*", report submitted to Congress on March 16, 2010; with many related studies and Working Papers developed or commissioned by the FCC's Omnibus Broadband Initiative. Accessed June 8, 2015 http://www.broadband.gov

[7] International Telecommunications Union (ITU) News (2011) *"What should be in a national broadband plan?"* ITU News, September 2011. Accessed July 21, 2015, http://www.itu.int/net/itunews/issues/2011/07/17.aspx

National broadband strategies can be categorized according to a number of parameters. These include:

- The *Scale and Scope of the Strategy*. Three types of strategies can be distinguished:
  - A broadband strategy that is a part of a larger, long-term phased national economic plan for the adoption and use of ICTs to improve competitiveness and productivity across the entire national economy (e.g. Singapore, Japan, South Korea);
  - A comprehensive national strategy, such as .the Australian National Broadband Network (NBN) initiative as originally announced in 2009, which was supported by all levels of government[8] (see Appendix 2);
  - Standalone or ad hoc programs at various levels of government, to improve broadband connectivity in rural and remote areas (e.g. the Canadian *Broadband Canada: Connecting Rural Canadians* program*).*

- The *Duration of the Strategy or Initiative.* Here one can distinguish between:
  - Short/medium term initiatives, such as 2-3 year sun-setting programs, e.g. the U.S. DOC/NTIA $4.2 billion Broadband Technology Opportunities Program/BTOP and USDA/RUS $2.5 billion Broadband Initiatives Program/BIP, funded under the *American Recovery and Reinvestment Act of 2009*[9]; and
  - Long term strategies extending over 5-10 years, such as the Australian National Broadband Network (NBN) initiative and the FCC's National Broadband Plan[10] (see Appendix 2 for details).

- *Degree of Integration* between the wireline/fixed and wireless/mobile strategies on the one hand, as well as between supply side initiatives and complementary demand side measures. The FCC's National Broadband Plan is an example of both kinds of integration.

- *Degree and Nature of Public Sector Funding Support*. Options include direct funding through capital grants, loan guarantees and targeted tax incentives. Governments often provide one-time, up-front capital grants to fund the deployment of the broadband infrastructure. It is more difficult to provide continuing subsidies for the ongoing operation of the network facilities.

- *Implementation Model.* Here the issues relate to the degree of government ownership and control of the infrastructure deployed with the help of public sector funds. The model of greatest interest is the Public-Private sector Partnership (PPP) model, with joint ownership of the deployed infrastructure (e.g. Singapore, Australia, New Zealand and Mexico).

Broadband Strategies of Selected Developed OECD Countries

"Within the next five years, we'll make it possible for businesses to deploy the next generation of high-speed wireless coverage to 98% of all Americans…It's about connecting every part of America to the digital age."
- President Barack Obama, State of the Union Address, January 25, 2011

Over the decade 2000 – 2010 many OECD countries have developed, or have been updating National Broadband Plans (NBPs) or strategies. This has involved the setting of a range of targets, the encouragement of investment by

[8] *New National Broadband Network*, News Release April 6, 2009, by the Australian Prime Minister, Finance Minister and the Minister for Broadband. Accessed on July 22, 2015 http://www.minister.dbcde.gov.au/media/media_releases/2009/022 .

[9] American Recovery and Reinvestment Act of 2009 (*Recovery Act*) (2009), NTIA *Broadband Technology Opportunities Program (BTOP)* and USDA/RUS *Broadband Initiatives Program (BIP).* Accessed on July 23, 2015 http://www.broadbandusa.gov , http://www2.ntia.doc.gov , and http://www.rurdev.usda.gov

[10] Federal Communications Commission (FCC) (2010) "*Connecting America: The National Broadband Plan*", report submitted to Congress on March 16, 2010. Accessed on June 8, 2015 http://www.broadband.gov

private network operators or direct government intervention, and the promotion of the wider adoption and use of broadband Internet access by consumers and businesses. These developments are well summarized in the 2011 OECD report "National Broadband Plans".[11]

OECD countries had already agreed on major reference points and broad policies to assist them in considering and developing their NBPs. In 2004, the OECD Council Recommendation on Broadband[12] called for:

- Effective competition and continued liberalisation;
- Encouragement of investment in new infrastructure, content and applications;
- Technologically neutral policy and regulations;
- Recognition of the primary role of the private sector;
- A culture of security to enhance trust in the use of ICTs;
- Both supply based and demand based approaches;
- Promotion of access on fair terms, irrespective of location;
- Assessment of market-driven availability and diffusion;
- Regulatory frameworks that balance the interests of suppliers and users; and
- Encouragement of research and development.

In 2008, at the Seoul OECD Ministerial Meeting on the Future of the Internet Economy[13], Ministers undertook to:

- Stimulate investment and competition in the development of high capacity information and communication infrastructures and the delivery of Internet-enabled services, within and across borders;
- Ensure that broadband networks and services are developed to attain the greatest practical national coverage and use;
- Encourage a more efficient use of the radio frequency spectrum to facilitate access to the Internet and the introduction of new and innovative services, while taking into account public interest objectives.

The Chairman's Report[14] from the Seoul Ministerial noted the importance of digital solidarity and that it should be a "political priority to avoid the creation of new digital divides". The Seoul Declaration for the Future of the Information Economy also highlighted the importance of making its benefits available throughout the world. The OECD and the World Bank (infoDev) followed up with a Workshop addressing policies and practices that could be adopted to improve access to ICTs in developing countries. The ITU/UNECSO Broadband Commission[15] also addressed the issue of the digital divide between developed and developing countries.

A majority of OECD governments have made statements about their aspirations to achieving or sustaining "world class" broadband, or even "global leadership" in this area. The latter is usually expressed as very high levels of

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[11] Organization for Economic Cooperation and Development (OECD) (2011) *"National Broadband Plans",* OECD Digital Economy Papers No. 181, June 2011. OECD Publishing. Accessed on June 8, 2015 http://www.oecd-ilibrary.org/science-and-technology/national-broadband-plans_5kg9sr5fmqwd-en

[12] Organization for Economic Cooperation and Development (OECD) (2004), Recommendation of the OECD Council on broadband development adopted by the Council at its 1077th Session on 12 February 2004. Accessed on August 7, 2015 http://www.oecd.org/document/11/0,3343,en_2649_34223_34238436_1_1_1_1,00.html

[13] Organization for Economic Cooperation and Development (OECD) (2008), *Seoul Declaration for the Future of the Internet Economy.* Paris, Organization for Economic Cooperation and Development. Accessed on August 4, 2015 http://www.oecd.org/dataoecd/49/28/40839436.pdf

[14] Organization for Economic Cooperation and Development (OECD) (2008), *OECD Ministerial Meeting on the future of the Internet Economy: Summary of the Chair of the meeting.* Paris, Organization for Economic Cooperation and Development. Accessed on August 4, 2015 http://www.oecd.org/dataoecd/53/49/40989438.pdf

[15] International Telecommunications Union (ITU) (2010), *"World leaders agree: The future will be built on broadband".* Geneva, International Telecommunications Union, Accessed on July 22, 2015 http://www.itu.int/net/pressoffice/press_releases/2010/33.aspx

broadband availability with an increasing focus on adoption, combined with high transmission speeds and other technical characteristics (e.g. latency). Most governments have set targets for their NBPs, requiring certain levels of geographic coverage and minimum or average transmission speeds. Table 2 of the National Broadband Plans[16] report summarizes the targets for 32 OECD countries, as of 2010.

One important policy focus has been on making broadband more readily available in rural and remote areas, by deploying a combination of wireline and wireless technologies. For example, Estonia and Ireland have sought to cover areas without a fixed broadband service by using wireless technologies, in the first case with WIMAX and in the second with HSPA, plus some use of satellite services. The Australian National Broadband network also envisages the use of terrestrial and satellite wireless technologies to cover the les than 10% of the population that will not be served by the wireline network.

The national broadband plans for Australia, the US and South Korea are examined in greater detail in Appendix 2.

South Korea

Over the last five decades the **Republic of Korea** has made huge strides in the deployment, adoption and use of Information and Communication Technologies (ICTs)[17]. Korea is justifiably considered to be a global leader in broadband deployment, adoption and use. Its broadband strategy is a part of a much larger, long-term phased national economic plan for the adoption and use of ICTs to improve competitiveness and productivity across the entire national economy. Its progression in ICT "from rags to riches" may contain lessons for developing countries like Brazil and India, which are worth exploring and understanding. Its accomplishments and its way of getting there also offer a number of useful lessons to other nations.

Australia

The highlights of the Australian ***National Broadband Network*** **(NBN)[18]** initiative, announced on April 6, 2009, were as follows:

- Intended to bring 100 Mbps connectivity to 90% of all Australian premises, via a FTTP network;
- Up to 12 Mbps to all other premises via next generation wireless technologies (terrestrial and satellite);
- **An estimated total cost of A$43 billion over an 8 years rollout plan (2009-2017)** (later revised in a detailed implementation study by McKinsey & Co.).

The initiative was a comprehensive "whole of government" strategy that was announced by then Liberal Prime Minister Kevin Rudd and was supported by the other levels of government. A new autonomous entity called the National Broadband Network Company (NBN Co.)[19] was set up on April 9, 2009, as a wholly-owned Government Business Enterprise, to design, build and operate the planned national broadband network. Currently the Australian Government is the only investor in NBN Co. and will retain control at least until the network rollout has been completed and the goals of the strategy met. NBN Co. will remain a bandwidth wholesaler and provide non-discriminatory access to Internet and telecommunications service providers who provide retail services to end users.

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[16] Organization for Economic Cooperation and Development (OECD) (2011) *"National Broadband Plans",* OECD Digital Economy Papers No. 181, June 2011. OECD Publishing. Accessed on June 8, 2015 http://www.oecd-ilibrary.org/science-and-technology/national-broadband-plans_5kg9sr5fmqwd-en

[17] International Telecommunications Union (ITU) (2002), "*Broadband Korea: Internet Case Study"*, Report prepared by Tim Kelly, Vanessa Gray and Michael Minges, 2002. Accessed on July 29, 2015 http://www.itu.int/ITU-D/ict/cs

[18] Australian National Broadband Network (2009), *New National Broadband Network*, News Release April 6, 2009, by the Australian Prime Minister, Finance Minister and the Minister for Broadband Communications and the Digital Economy. Accessed on July 22, 2015 http://www.minister.dbcde.gov.au/media/media_releases/2009/022 .

[19] NBN Co. Ltd. (2010) Corporate Plan 2011-2013. Accessed on July 22, 2015 http://www.nbnco.com.au

However, with the change in the government of Australia as a result of the September 2013 election, the NBN initiative has been considerably modified and scaled down by the Conservative government. The Minister of Communication and the Minister of Finance, who are the Shareholder Ministers in NBN Co. Ltd., issued a new Statement of Expectations (SoE)[20] on April 8, 2014, which outlines the Government's commitment to the NBN in delivering *"very fast broadband as soon as possible, at affordable prices, and at least cost to taxpayers".* To achieve this objective, the NBN should be built in a cost-effective way, using the access technology most appropriate in each area of Australia. The SoE provides NBN Co ***"With flexibility and discretion in operational technology and network design decisions, within the constraints of a public equity capital limit of A$29.5 billion specified in its funding agreement with the Commonwealth, and the Government's broadband policy objectives".***

The SoE specifies the Government's decision to transition the NBN from a primarily Fibre-To-The-Premises (FTTP) model to the "Optimised Multi-Technology Mix (MTM)" model. The Government's policy will be delivered through the rollout of a "network of networks" interconnecting Fibre to the Premise (FTTP), Fibre to the Node (FTTN), Hybrid Fibre Coaxial (HFC), Fibre to the Distribution Point (FTTdp), Fibre to the Basement (FTTB), as well as Satellite and Fixed Wireless Networks, collectively described as the Multi-Technology Mix or MTM.

The USA

The National Broadband Plan[21], released by the US Federal Communications Commission (FCC) on March 17, 2010, sets out a roadmap for initiatives to stimulate economic growth, spur job creation and boost America's capabilities in education, health care, homeland security and more. The plan includes sections focusing on economic opportunity, education, health care, energy and the environment, government performance, civic engagement and public safety.

The Plan goals and recommendations include:

- 6 high level Goals for the year 2020, including speed targets;
- Some 200 recommendations, about half falling within the FCC's jurisdiction;
- To make 500 megahertz (MHz) of new spectrum available over the next 10 years, for wireless broadband enabled applications and services;
- To create a Connect America Fund (CAF) to support the universal provision of broadband at the national broadband availability target level, and shift up to $15.5 B from existing Universal Service Funds;
- A National Purposes component, to maximise the adoption and use of broadband enabled applications which will address National Priorities in areas like Healthcare, Education, Energy and the Environment, Public Safety and Government service delivery, to increase efficiencies and reduce costs.

The Obama administration has strongly supported the goal of finding 500 MHz of additional spectrum for new mobile broadband services, between 2010 and 2020, with the FCC and the NTIA jointly leading this initiative. However, under the U.S. system of governance certain proposals and recommendations with budgetary implications, such as incentive auctions to encourage the release of spectrum currently being used for other purposes, and the setting up of the Connect America Fund by shifting some $15.5 B from a number of existing Universal Service Funds, require Congressional approval. Here progress has been more problematic.

Certain judicial developments have taken place since the tabling of the National Broadband Plan which brought into question the FCC's authority to regulate broadband services by applying Common Carrier principles. However, the FCC has steadily moved ahead, via a variety of proceedings, to implement the key recommendations that fall under its jurisdiction. In a major recent development, the FCC has decided to regulate the Internet under Title II of the *Communications Act of 1934*, which allows the application of Common Carrier principles to the regulation of broadband and Internet services. The FCC's new Net Neutrality rules are based on this Title II authority.

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[20] Australian National Broadband Network (2014), Statement of Expectations by Shareholder Ministers, Letter dated April 8, 2014 Accessed on July 22, 2015 http://www.nbnco.com.au

[21] FCC (2010) *"Connecting America: The National Broadband Plan",* accessed on June 8, 2015, http://www.broadband.gov

Broadband Strategies of Selected Developing Countries

We examined in some detail the broadband plans of three countries: Brazil, India and Malaysia, in terms of the institutional structure of the telecom sector, telecom markets, the national broadband plan and its analysis.

Brazil

Institutional Structure

The Ministry of Communications was the policy making body. Anatel[22], the regulatory agency was established under the General Telecommunications Act, 1997. There were a number of operators, both public and private in different segments of services such as fixed line, mobile, satellite and broadband. Besides fixed line, broadband was provided over mobile and TV networks.

A Fund for Universalization of Telecommunications Services (FUST)[23] was set up in 2000 ("Brazil Company Laws", 2013, page no. 165). There are two other funds: Fund for Telecommunications Technological Development (FUNTTEL) for supporting technological developments and Fund for Telecommunications Inspection to cover the administrative cost of managing the telecom sector. The revenues for these funds came from the contributions of telecom operators providing public telecommunication services.

Telecom Market

Oi/Telemar was the largest fixed line operator and owned the main submarine cables that linked Brazil to Venezuela, Bermuda and the USA. It had a market share of 48%. Telesp had a market share of 27%. Embratel's network covered 26,000 km of optic fibre and had a market share of 18%. Telebras had combined the network infrastructure of electricity and fuel distribution companies and had a network of about 31,000 km. There were nearly 2500 other players[24] .

Key players in the cable subscription services/TV market were Net Servicos that was owned by Globo, whose majority shares were held by Embratel. Sky Brasil was owned by DirecTV, with Globo as a minority shareholder. Sky Brasil provided broadband services in partnership with GVT and would also provide mobile broadband services through its LTE network.

There were seven mobile operators with Vivo Participacoes, TIM Brasil and Claro occupying the top three positions respectively in terms of subscribers (Exhibit 1, Appendix 2). By August 2011, they had rolled out 3G services in 1,588 out of 5,565 municipal areas[25]. This showed an area coverage of 28% and covered 76% of the population. The 2014 World Cup and Olympics in 2016 were driving the government to push for 4G/LTE roll-out. Since Brazil has large areas that are remote, three satellite service operators provided services.

National Broadband Plan

A number of initiatives that would contribute to broadband deployment in Brazil included the General Update Plan of Brazilian Telecommunications focusing on goals for improving access to broadband. In August 2009, the

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[22] About Anatel. (2015, April 15). Retrieved from http://www.anatel.gov.br/grandeseventos/en/about-anatel , on August 8, 2015.

[23] Brazil Company Laws and Regulations Handbook, Strategic Information and Regulations. (2013, page no. 165). *International Business Publications*, USA.

[24] Jensen, M. (2011). *"Broadband in Brazil, A Multipronged Public Sector Approach to Digital Inclusion"*, Washington, D.C: infoDev / World Bank. Available at http://www.broadband-toolkit.org, accessed on August 8, 2015

[25] *ibid.*

Steering Committee for Digital Inclusion Programs (CGPID) developed the National Broadband Plan (PNBL)[26] that came into existence in May 2010. These covered universalization goals for network expansion and maintenance[27]..

In 2011, Ministry of Communications and Anatel gave the incumbent state owned operator Telebras[28] the responsibility of providing nationwide fibre optic connectivity. Provisions of further private investments in Telebras were allowed in 2011 subject to government having overall control. At that point the government held 89.88% of shares and 72.67% of the voting rights.

Telebras was envisaged as a wholesale operator for providing bandwidth to other broadband players, the government and social organizations such as schools, hospitals, NGOs etc. It was expected that Telebras would also manage the deployment of a fibre network in the unserved areas. To establish the fibre backbone, Telebras has leased capacity from existing electric and fuel companies. It was hoped that the involvement of a public entity would lower prices. This would also enable players in smaller towns/cities/rural areas, who would otherwise not have been served, to access broadband.

PNBL set the following objectives ("Broadband in Brazil", n.d.):

a) Broaden access to broadband-based Internet services
b) Accelerate economic and social development
c) Promote digital inclusion
d) Reduce social and regional inequalities
e) Promote job creation and income.

PNBL also aims to support the development of a Brazilian equipment and services industry. Towards this end, a consortium of telecom equipment suppliers was formed with the objective of supporting R&D. The primary target of the PNBL was set at providing access to broadband services to 40 mn households or 68% of the population by the year 2014 ("Broadband in Brazil", n.d.). PNBL set up a target price of R35 that would enable a large number of Brazilians to get connected.

Operators using the Telebras network were initially required to provide 20% of the target speed of 1 Mbps. This was later modified to 60% of the average contracted speed for those operators who had more than 50,000 customers. The targets were expected to increase to 70% and 80% successively over two years. The wholesale price offered by Telebras is about half of that of private operators ("Broadband in Brazil", n.d.).

Besides the network expansion, demand side policies covered included[29]:

a. Support for development of low cost devices through tax incentives.
b. Provision of public access facilities through Digital Inclusion programs implemented by a government company Serpro. Serpro's mandate was to modernize strategic areas of public administration. Its initiatives provided free access to computers and Internet in 98% of municipalities.
c. Joint Development of Serpro's Program with the Ministry of Agriculture Development. This would entail setting up and management of telecentres with access to database for supporting a variety of digital inclusion programs.
d. Broadband in Schools program: As a part of this nearly 84% of urban schools had free broadband access.

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[26]Brazil (2009), "*Um Plano Nacional para Banda Larga"* (National Broadband Plan). Ministerio das Communicacoes (Ministry of Communications). Accessed on July 24, 2015 http://www.mc.gov.br/plano-nacional-para-banda-larga.

[27] Rossini, C. (2014). *"Case Study Affordable Internet Access in Brazil, Alliance for Affordable Internet"*. Available at https://a4ai.org/wp-content/uploads/2014/08/A4AI-Case-Study-Brazil-FINAL_US.pdf , accessed on August 8, 2015.

[28] Telebras (2014). Overview of Telebras – Tech in Brazil article published October 24, 2014. Accessed on August 9, 2015 http://techinbrazil.com/overview-of-telebras

[29] Jensen, M. (2011). *"Broadband in Brazil, A Multipronged Public Sector Approach to Digital Inclusion"*, Washington, D.C: infoDev / World Bank. Available at http://www.broadband-toolkit.org, accessed on August 8, 2015

e. State and municipal level initiatives that included tax exemptions, free Internet access at public access points. Some of these, as in the state of Parana, were in collaboration with the state energy company. There were tax deferments in lieu of the state energy company sharing its bandwidth at mandated prices and reserving specific amounts for the extremely low and low paying customers.

To make the broadband market competitive, Anatel created a General Plan for Competition (PGMC) that mandated infrastructure sharing for large telecom and cable TV companies that had significant market power. This sharing was mandated at price levels lower than their retail prices. Further, broadband service providers were mandated to set up 51 IXPs. Operators were expected to provide mandated levels of backhaul capacity. Anatel also made it possible for smaller operators to enter the broadband market by lowering the license fee for operators with smaller geographic scope. The concept of net neutrality would be implemented to ensure that there was no slowing down of data from any source to the subscriber. The Ministry of Communications signed contracts with private operators to provide satellite services in remote areas. They were expected to provide more than 13,000 ground stations[30].

Status

Starting from 2010, PNBL envisaged a 4-year program. By the end of this period, against the target of 30 mn wired broadband connections only 23.2 mn connections had been achieved. On the mobile side, the achievements were much higher i.e. 127.2 mn against a target of 60 mn[31].

At the beginning of PNBL, Internet connections were present only in 30.7% of households at an average speed of 0.55 Mbps[32]. As per Ministry of Communications, Internet packages offered as part of its PNBL were available to over 90%[33] of the country's 5,570 municipalities. This figure included coverage achieved by PNBL concessionaires Oi, Telefonica, CTBC and Sercomtel in the third quarter of 2014. The Internet plans under PNBL cost R35, which offered a speed of around 1 Mbps. This amount was arrived at after it was found that close to 70 percent of the population was still offline ("Broadband in Brazil", n.d.). As an outcome of PNBL, over 612 Brazilian municipalities received service from the Telebras network, which amounted to around 40% of the population. The number of cities covered increased from 681 to 2,930 during this period and average Internet connection speed increased from 0.55 Mbps to 2.7 Mbps[34]. This indicated possibly high speeds in large cities and slower speeds in a large number of municipalities.

Future Plans ("Broadband in Brazil", n.d.)

- Auctioning of additional frequencies for satellite communications was expected to provide further coverage.
- Anatel was considering provision of subsidy to mobile operators to cover underserved areas and to have third parties provide common infrastructure that could be shared by different operators.
- FUST was being revamped to cover broadband service provision with speeds of 2.5 Gbps to all municipalities with population of more than 30,000.
- Local government services to be available on the cloud to be provided by the federal government.
- To increase availability of spectrum, especially the 450 MHz, with better propagation characteristics suited to rural areas, 3G services in urban areas and the frequencies above 6 GHz to be used by Telebras for point to multi-point connectivity for municipalities.
- Provision of tax exemptions and fiscal incentives for broadband equipment and services, including tablets, computers, fibre optic networks etc. especially for deployments in the north and northeastern regions.
- Considering the local demand for broadband services.

[30] 2013 Investment Climate Statement – Brazil. (2013). Bureau of Economic and Business Affairs, February 2013. Available at http://www.state.gov/e/eb/rls/othr/ics/2013/204608.htm, accessed on August 8, 2015.
[31] http://techinbrazil.com/brazil-s-programa-nacional-de-banda-larga , accessed on August 8, 2015
[32] ibid.
[33] http://www.bnamericas.com/news/privatization/brazil-pnbl-broadband-coverage-hits-90, accessed on August 3, 2015
[34] http://techinbrazil.com/brazil-s-programa-nacional-de-banda-larga, accessed on August 8, 2015

- A new program, Banda Larga para Todos (Broadband for All), with the objective to provide fibre optic technology to 90% of the country's localities, double the broadband connections to 300mn from 150mn in four years and finally double the average data transfer rate[35].

Analysis

PNBL considered fixed line, mobile and satellite for deployment. This took into account the geography and demographics in Brazil. PNBL had a significant focus on end-user prices and these were kept fairly low.

PNBL selected the state run Telebras to be the main vehicle for implementation. Efficiencies of the private sector were not leveraged. It was envisaged that a public sector organization would lead to lower costs. However, capacity constraints within such organizations and the need to follow government procedures for procurement could lead to delays. Perceived lower costs in deployment may be more than offset by higher costs to the economy of non-deployment.

India[36]

Institutional Structure

The Ministry of Communications and Information Technology (MoCIT) was the policy making body for the sector. The Department of Telecom (DoT) was the government department responsible for the formulation of developmental policies, granting licenses for various telecom services, managing radio frequency in close coordination with the international bodies and enforcing wireless regulatory measures. Bharat Sanchar Nigam Ltd (BSNL) and Mahanagar Telecom Nigam Limited (MTNL) were wholly owned government incumbents. BSNL provided a variety of telecom services across the country except in Delhi and Mumbai, and MTNL provided these in Delhi and Mumbai. The Telecom Regulatory Authority of India (TRAI) Act (1997) established TRAI. The Telecom Dispute and Settlement Appellate Tribunal (TDSAT) was set up in 2000. To provide a dedicated source of funds for rural areas, the DoT set up the Universal Service Obligation Fund (USOF) in 2002 to provide support for infrastructure and services in rural areas. All telecom service companies contributed five per cent of their aggregate gross revenue to the USOF. While the USOF was administered by the DoT, the annual allocations were made by the Ministry of Finance. DoT identified the areas qualifying for USOF support based on non-availability of towers, socio-economic profiles, etc. (Jain, 2013).

By 2014, all services were competitively provided by private and public operators. Over time, driven by the boom in the mobile segment, the private sector had grown significantly, overtaking the public sector. There were four large private operators i.e. Bharti Airtel, Vodafone, Idea Cellular, and Reliance Communications with operations in multiple segments such as fixed line, VSATs, mobile, long distance, and international long distance. BSNL operated in the mobile, long distance and the fixed line segments. Exhibit 2 in Appendix 2 gives the relative size of these five operators along with their areas of operations.

Telecom Market

Like many other emerging economies, telecom growth had been driven by mobiles. The wireline infrastructure was sparse with 27 mn wireline telephones, for a population of slightly more than 1.2 bn. These were largely in urban areas. The mobile tele-density as of December 31, 2014[37] was 75.43%. Despite the significant spread of mobiles, the

[35] http://www.bnamericas.com/news/privatization/brazil-pnbl-broadband-coverage-hits-90, accessed on August 8, 2015

[36] Some parts of this section have been excerpted from *"Framework for Identifying appropriate roles for the public and private sector in National Broadband Deployments in Emerging Economies: The National Broadband Plan of India"* by Prof. Rekha Jain, presented at TPRC42, available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2418442, accessed on August 8, 2015

[37] TRAI (2014). *The Indian Telecom Services Performance Indicators*, October - December, 2014. Accessed on August 8, 2015 http://www.trai.gov.in/WriteReadData/PIRReport/Documents/Indicator_Reports%20-%20Dec-14=08052015.pdf,.

differences in urban and rural tele densities were high and growing. The urban tele-density as of December 31, 2014 was 148.06% while the rural tele-density was 46.09%. This contributed to the digital divide and bridging it was a critical agenda for the government.

Many operators had won spectrum for 4G during 2014 but there was no significant development on this front due to lack of devices and ecosystem and financial constraints on operators to roll out new services. While 3G services had been licensed out since 2010, these were mostly limited to urban areas. Large parts of the mobile network were 2G. Given the low level of penetration of wired infrastructure, broadband over mobile had a higher penetration than over fixed line. As of December 31, 2014[38], the number of users of wireless broadband was 70.42 mn, fixed broadband was 15.32 mn and mobile Internet was 248.06 mn. With falling prices for 3G, it was expected that rate of growth of broadband and Internet over mobile would increase rapidly. As per Huawei's India Broadband Report 2012, wireless broadband users were expected to be 450 mn by the year 2020[39].

Internet on mobiles has become the predominant method of accessing the Internet in India. Overall, as in the case of access via cable modems, because of low PC ownership and poor electricity availability, Internet and broadband through DSL and dial-up could not become widely adopted. This could deter ISPs from providing broadband over fixed lines, even if they had access to fibre.

Top wireless ISPs were Bharti Airtel, Vodafone India Ltd, Idea, BSNL and Reliance – all mobile operators – with market shares of nearly 26%, 22.%, 13% 12% and 11.81% respectively[40]. BSNL, Bharti Airtel and MTNL were the top fixed line ISPs as of December 31, 2014. BSNL, with a subscriber base of 13.17 mn Internet connections, held 70% of the total fixed line market share followed by Bharti Airtel with 7.95% and MTNL with 6% market share. There was fibre coverage in the national backhaul and various cities and smaller towns (middle mile), although it was very sparse in rural areas[41].

National Broadband Plan

At the policy level, India recognized the role of broadband in economic growth. In 2002, TRAI had recommended steps to the government on ways to increase Internet penetration in India. Subsequently, DoT had come out with policies for broadband in 2004. But few significant steps were taken.

As of 2014-15, balance in the USOF was US$ 6.1 bn[42]. Consequently, there was mounting pressure on the government to utilize the fund. It is in this context that the Indian National Broadband Plan (NBP), of which deployment of the National Optical Fibre Network (NOFN) was a core part, was conceived. The NOFN would connect the sub-districts to village administrative units (VAUs) with fibre (Exhibit 3, Appendix 2). Given the poor physical delivery of services in rural areas, the government felt that such a rural broadband network could improve its service delivery in areas such as banking, education and tele-health.

NOFN would connect sub-districts to 250,000 Gram Panchayats (GP) or village administrative units (VAUs) with high speed (100 Mbps) broadband network. The DoT created a high level committee (HLC) under the PM's Office to implement the NOFN. Since Rights of Way (ROW) was the most difficult resource to acquire for laying the network, HLC envisaged that there would be a tripartite Memorandum of Understanding (MoU) between the DoT, the concerned state and the executing agency to facilitate this. Subsequently, the DoT created a Special Purpose

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[38] *ibid.*
[39] http://www.tele.net.in/finance/item/10842 , accessed on July 25, 2015
[40] TRAI (2014). *The Indian Telecom Services Performance Indicators*, October - December, 2014. Accessed on August 8, 2015 http://www.trai.gov.in/WriteReadData/PIRReport/Documents/Indicator_Reports%20-%20Dec-14=08052015.pdf,.
[41] Jain, R. and Neogi, P. (2012). "*National Broadband Strategies: A Comparative Review and Possible Lessons for Developing Countries "*, paper presented at the International Telecommunications Society 2012 Asia-Pacific Regional Conference, New Delhi, India, February 22-24, 2012.
[42] http://www.usof.gov.in/usof-cms/usof_fundstatus.htm, accessed on August 8, 2015

Vehicle, Bharat Broadband Networks Limited (BBNL)[43] to establish and manage NOFN. BBNL would leverage the existing fibre optic resources of three government owned companies in the rail, power and telecom sectors: Railtel, Powergrid Corporation of India, and BSNL respectively. This was because public sector units such as Railtel and PGCIL not only had fiber optic resources for their own use but were also providing limited services using them to third parties. It was estimated that the NOFN could substantially benefit from BSNL's existing fiber optic resources. However, most of the fiber was largely up to the sub-district or block level. Therefore, NOFN was designed to lease capacity from these PSUs and build the incremental fiber where it was unavailable. The ownership of the fiber shared infrastructure would be that of the respective agencies.

On the demand side, it was envisaged that the focus would be on applications for skill development and education. With this in mind, Ministries of Rural Development, Panchayati Raj[44], Human Resource Development (HRD), Health and the National Council on Skill Development were considered as anchor clients.

Status

The initial target of reaching 250,000 village administrative units by December 2012 was first shifted to December 2013[45]. Until April 2013, pilot projects in three blocks covering nearly 60 VAUs had been rolled out. The NOFN completion date was further shifted to December 2016, with the first phase covering nearly 15 states by the end of December 2015 and the remaining states to be covered in the second phase. The delay was due to coordination issues and other problems cited by agencies involved. As of July 31, 2015, 2740 VAUs were active[46].

The implementation report[47], our field interviews with staff from BBNL, implementing agencies, end users, and site visits revealed that there was hardly any uptake of the provided bandwidth. The ISPs did not find a business case at there was insufficient demand making it commercially unviable at the bandwidth and rates quoted by BBNL. In those areas where some applications had been rolled out, they were hardly being used for a variety of reasons such as breakdown of hardware but no organizational mechanism in user organizations for maintenance, no particular benefit from a user's point of view, or the persons/organizations who had implemented the applications had moved away. Further, there were few programs/initiatives from the government that utilized broadband. There was demand for some e-government services such as issuance of birth, death and caste certificates, but these did not necessarily require a broadband connection. At the organizational level, BBNL saw itself as a project execution enterprise, with little focus on marketing and financial sustainability. Since BBNL connected the block to the VAU, many service providers, seeking connectivity from the district to the village, found BBNL's scope of offering limited. Further, BBNL divided the procurement process between BSNL and itself, causing coordination problems and delays.

Future Plans

NOFN was a critical part of the new PM's Digital India plan to create a digital infrastructure for service delivery in education and health, e-governance and to bring efficiency in the implementation of programs and functioning of the government. Concerned by the mounting delays in NOFN, the government constituted the Committee on NOFN to review the NBP. The Committee submitted its report on March 31, 2015. It examined the current organizational structure, inter-organizational issues, NOFN architecture to come up with recommendations. These were yet to be implemented.

The Committee suggested strengthening BBNL by having a person of national eminence, having experience in project management, preferably from the private sector as a non-executive Chairperson, expanding and professionalizing the board, giving autonomy to BBNL, and allowing recruitment from different arms of the government and the private sector.

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[43] Bharat Broadband Network Ltd. (BBNL), India (2015), Company Profile and NOFN project. Accessed on July 21, 2015 http://www.bbnl.nic.in.

[44] Gram Panchayats are village administrative units

[45] http://www.indianexpress.com/news/telecom-commission-approves-phased-rollout-of-rs-20k-cr-nofn-project/1170873/ , accessed on October 11, 2013

[46] http://www.bbnl.nic.in/content/active-gram-panchayats.php, accessed on July 24, 2015

[47] Source: an internal document received from BBNL

In order to overcome the fragmented nature of the existing NBP, i.e. limited to connectivity from the block to the VAU, the committee recommended considering new fibre connectivity from the district to the blocks and from the blocks to the Gram Panchayats on a ring architecture and the remaining one third on a linear basis (Exhibit 4, Appendix 2). This approach took into account the quality and actual availability of fibre with the three PSUs. The model for demand included both dark fibre and bandwidth. Some of the fibre pairs would be dedicated for government services. The remaining could be auctioned either for use by the concerned entity for its use such as mobile backhaul and for provision of retail broadband services. The unit of auction suggested was a district.

An important aspect that the Committee considered was the usability of existing BSNL fiber on which the earlier plan was predicated. Since BSNL had laid the fiber nearly 20 years ago and there could have been cuts and quality degradation due to splicing, jointing etc, the Committee recommended laying new fiber for the district to block and then from the block to VAU in a ring architecture. This increased the project cost nearly three times. For those VAUs that had a low household (HH) density or were difficult to reach, the Committee recommended the use of wireless spectrum licensed and unlicensed bands.

For implementation, the committee recommended three alternatives: private sector led, PSU led and state government led and identified the roles and responsibilities of respective agencies in each of the three models.

Analysis[48]

There were several possible reasons for the poor outcomes from the NOFN initiative. The following highlights some of them:

a) *Primacy of semi-formal mechanisms*: Although BBNL had signed MoUs with the three PSUs, there was no contractual oversight and hence very little that BBNL could do when there were delays. Further, as with many government organizations, there was poor accountability from the PSUs.
b) *Only involvement of state actors in deployment of NOFN:* This led to inability of government to leverage efficiencies that the private sector could bring in network deployment. Further, in service provision, private sector could also be more responsive to user demands, and this could lead to greater adoption.
c) *Few formal processes for inter-organizational coordination*: While organizations working in silos could remain highly focused in their specified domains, it could lead to slow adaptations to changing ground situations and lower levels of innovation.
d) *Poor involvement of stakeholders:* NOFN was conceived at the highest level in the Central government, state and district administrations had little say in the design and deployment of NOFN. This led to a "one size fits all" approach and inhibited the adoption of solutions that were closer to the ground. This was despite the fact that government based applications that were to ride on NOFN would largely be driven by the state or local administration.
e) *Community organizations and village administrative units* are important drivers of change, especially in the area of new technology deployment and adoption[49]. While these were considered as drivers of BB adoption, the NOFN did not have any explicit mechanism for incorporating the role of such organizations in its plan.
f) *Poor Inter-organization Coordination.* The HLC mechanism and involvement of three PSUs in infrastructure provision was chosen as a model possibly due to the need to leverage existing national resources. However, the organizational mechanisms that could facilitate coordination across these organizations were not thought through. The conception of a separate organizational structure for NOFN was possibly based on the experience of several countries such as Australia and UK.
g) *Limited Perspective on Technology Architecture:* The BB architecture conceived the network only as wired

[48] This section has been excerpted from *"Framework for Identifying appropriate roles for the public and private sector in National Broadband Deployments in Emerging Economies: The National Broadband Plan of India"* by Prof. Rekha Jain, presented at TPRC42, available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2418442, accessed on August 8, 2015

[49] Carmichael, L. R., Mcclure, C. R., Mandel, L. H., and Mardis, M. A. (2012). *"Practical Approaches and Proposed Strategies for Measuring Selected Aspects of Community-Based Broadband Deployment and Use",* International Journal of Communication, 6, 2445–2466, August 2012.

infrastructure. This perspective did not recognize the high and increasing adoption of mobile in rural areas. The NOFN had not delineated how wireless technology would be leveraged. BB plans in Australia considered last mile connectivity through fixed wireless and satellite based on their geography and existing wired infrastructure. Such contextualization was more important in India, as owing to the poor availability of electricity, PC would not be able to function. With alternative sources of energy that could be utilized for powering towers, access to Internet on mobiles could be provided, even when there is no electricity.

h) *Poor synergies with existing programs:* BBNL's blueprint envisaged laying incremental fibre along roads, as this was the easiest way to get ROW, especially since this entailed using public roads. However, it had not coordinated with the largest rural road programs that the central and state governments funded for new construction or upgradation. This would have drastically reduced the cost.

Malaysia

Institutional Structure

The Telecommunications Department of Malaysia, also known as Jabatan Telekom Malaysia (JTM) was formed after the merger of the Telecommunications Department of Malaya and the Telecommunications Department of Sabah and Sarawak in the year 1968. In 1987, JTM was corporatized to form Syarikat Telekom Malaysia Berhad (STMB). In November 1998, Malaysia adopted a convergence regulation model that encompasses both communications and multimedia industry to establish a new regulatory body, the Malaysian Communications and Multimedia Commission under the Malaysian Communications and Multimedia Commission Act (1998), the Communications and Multimedia Act (1998), and the Strategic Trade Act (2010). Its role was to implement Government's national policy objectives[50].

Telecom Market

The fixed line sector was dominated by the incumbent operator Telekom Malaysia (TM). It also had a considerable presence in mobile communications after its acquisition of Celcom. The main players in the mobile market were Celcom, Maxis and DiGi having a total market share of nearly 33%, 38% and 30% respectively[51]. Total number of subscribers in Malaysia as of December 31, 2014 was 42.9 mn[52]. Exhibit 5, Appendix 2 gives the details of leading mobile operators in Malaysia and subscribers as of December 31, 2014.

TM was the dominant player in fixed broadband market having an 89.1% market share[53]. TIME dotcom (TDC) was the other player that largely served enterprises. With the advent of mobile broadband, players such as Maxis and Celcom acquired significant market share.

The USP Fund has 6% of revenue contributions from all telecom operators whose income is more than MYR 2 mn in a given calendar year. The USP allows for 50% claw-back for contributing players towards implementation of broadband projects as approved by the MCMC.

Mobile phone use has been witnessing an upward growth with penetration rates of around 75 per cent of the population. About 67% of national households have access to broadband as of 2014[54].

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[50] Malaysia Ministry of Human Resources. (2012). Occupational Analysis Telecommunications Industry. Department of Skills Development, Ministry of Human Resources, Malaysia. Available at file:///C:/Users/vaio/Downloads/oa%20telecommunications%202012.pdf, accessed on August 8, 2015.

[51] http://www.digitalnewsasia.com/mobile-telco/a-deeper-look-into-malaysias-big3-mobile-telcos-in-1h2014, accessed on August 4, 2015

[52] http://www.forest-interactive.com/wp-content/uploads/2014/06/SEA-Statistics-2014-02.png, accessed on July 24, 2015

[53] https://www.tm.com.my/AboutTM/NewsRelease/Pages/TMAWARDEDFIXEDBROADBANDSERVICEPROVIDEROFTHEYEAR2013.aspx, accessed on August 4, 2015

[54] http://www.budde.com.au/Research/Malaysia-Broadband-Market-and-Forecasts.html, accessed on August 8, 2015

National Broadband Plan

The National Broadband Initiative (NBI) was seen as an enabler of economic growth for Malaysia to go from middle to a high income country. It encompassed both supply and demand side initiatives. The NBI was partly reliant on the existing Universal Service Provision Fund for funding.

The Government of Malaysia (GoM) felt that a supply driven speedy ubiquitous deployment of broadband services would facilitate its policy goals of increasing its GDP and national competitiveness, and leverage the knowledge economy.

On the supply side, the NBI examined two dimensions[55]:

a. ***Broadband for General Population (BBGP)***: This was designed as a two phase program. In the first phase, the average speed of access was envisaged as 2 Mbps, which would go to 20 Mbps. The activities included upgradation of 400 exchanges, and provision of 420,000 ports. The backhaul for this phase included speeds of up to 1 Gbps and coverage of suburban and rural areas in peninsular Malaysia. This had a budget allocation of MYR 9 mn (bn?) with support from USP. There were incentives and facility based competition for major technologies such as xDSL, WiMax and 3G/HSDPA. USP roll out facilitated both collective and individual access. Service provision was through competitive bidding.

b. ***High Speed Broadband (HSBB):*** This would cover both infrastructure roll-out and provision of open access to other service providers using FTTH in point to multipoint GPON architecture. This program was envisaged for provision of 100 Mbps speeds using fiber. It focused on capitals, industrial corridors and development regions. It would provide end to end connectivity, including both domestic and international, to 1.3 mn premises by 2012. A budget allocation of MYR 11.3 bn in two phases over 2008-2018 was made. It included upgradation of 95 exchanges to all IP exchanges, rehabilitation of copper infrastructure for higher speed and quality ADSL and the laying of submarine cable from peninsular Malaysia to Sabah and Sarawak. PPP was used as the model for HSBB.

On the demand side it focused on three dimensions:

a. ***Awareness***: This included programs for awareness creation, both in the public and private sector through mass media, holding roadshows etc.
b. ***Attractiveness***: This included promotion of e-government, e-education and e-commerce initiatives, leveraging on development of traditional information resources and improvement and alignment of online content strategies and activities.
c. ***Affordability***: this included initiatives to reduce PC costs, broadband subscriptions, enhancing scope of community access, distribution of Netbooks and subsidy for youth (aged 21-30 years) for buying a smartphone. There was support through grants to small and medium enterprises, especially for women to get online.

GoM chose Telecom Malaysia (TM) as the implementing agency for HSBB as it had the largest fibre network of 200,000 km, far more than the other private operators. MCMC had considered the option of creating a separate agency for the implementation, as had happened in many countries. It did not pursue this option as it thought that creation of a new agency would take time. Further, additional time would be required for the proposed new agency to acquire the requisite capabilities.

GoM signed a PPP with TM, with the GoM contributing MYR 2.4 bn (USD 740 mn) out of a total estimated cost of MYR 11.3 bn (USD 3.5 bn)[56]. The payments would be on reimbursements of costs incurred by TM. These amounts

[55] HSBB (2009) HSBB Malaysia's Drive for High Speed Broadband. MyConvergence, Malaysian Communications and Multimedia Commission, 3(1), January 2009. Accessed on August 8, 2015 http://www.oecd.org/dataoecd/49/28/40839436.pdf.

[56] Gunaratne, R. L. (2014). High Speed Broadband Network in Malaysia, LIRNEasia, March 2014. Available at http://broadbandasia.info/wp-content/uploads/2014/04/Malaysia-HSBB_Expert-Forum2014.pdf . Accessed on August 8, 2015

were arrived at by TM after working out its project profitability. The GoM contribution was aimed at covering what was considered as unprofitable areas, namely, new housing estates and so far uncovered industrial estates. GoM selected TM, despite a proposal from an infrastructure provider to lay the fibre at a lower cost (MYR 5.37 bn ?) and without government support[57].

GoM did not specify prices for open access, despite the public funding made available to TM. As a part of its social obligations towards the GoM funding, TM is expected to provide connectivity to government offices, build cyber centres in rural areas, promote broadband and offer training programs at cyber centres. As a part of the financial structuring of the project, during 2014-17, TM had to pay the GoM USD 15.5 mn towards revenue sharing. From 2018-2025, the revenue sharing would be based on a formula that takes into account the difference between projected and actual sales. This allowed the GoM to take into account the possible low revenue figures that TM may have projected to get higher GoM funding. If TM was unable to utilize the total funding of USD 3.5 bn, it was required to return 20% of it[58]. The phase 2 conditions were under negotiations in point to multipoint architecture using GPON, providing FTTH.

Status

Broadband witnessed growth across mobile, fixed line and wireless platforms driven by mobiles. A total of 6.4 mn subscriptions for broadband were recorded in the year 2013[59], with mobiles contributing to 3.29 mn. Malaysia recorded household penetration of 64.7% in 2013 compared to 31.7% in 2009 and higher than the Broadband Commission's target of 40%[60].

Some 84% of the populated areas in the country are covered under broadband services and GoM has now set a target to achieve 75 percent household broadband penetration during the present year i.e. 2015.

TM provides retail and wholesale services over HSBB, covering both end user consumers and other service providers. The offtake of BB was not only higher than TM's own targets, but by 2010 it had reached its target of 55.6% of households (HH), in comparison to 11% in 2006.

Integrated programs for BB delivery brought about by TM (Unifi) had surpassed the target numbers by 2012. The target was 1.2 mn, whereas TM had reached 1.43 mn. International fibre cable was also put in place. Uptake of wholesale services has been significant with Maxis, Celcom, Packet1 and REDtone having signed up for HSBB access[61]. Most customers had registered for packages with 1-2 Mbps.

Although designed as an open access network, specific prices were not announced a priori. Individual operators had to negotiate the rates.

Analysis

GoM had recognized the challenges in implementation of broadband deployment across the country. Subsequently, it introduced measures that went beyond infrastructure to make broadband services more affordable for the people. This was indicated in Malaysia gaining the first position in broadband affordability among 46 developing nations[62].

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[57] *ibid.*
[58] *ibid.*
[59] MCMC. (2013). Annual Report, Malaysian Communications and Multimedia Commission. Available at http://www.skmm.gov.my/skmmgovmy/media/General/pdf/MCMC-AR_ENG_2013.pdf, accessed on August 8, 2015.
[60] Broadband Commission. (2014). *State of Broadband 2014: Broadband for All*. Available at http://www.broadbandcommission.org/documents/reports/bb-annualreport2014.pdf, accessed on August 8, 2015.
[61] Gunaratne, R. L. (2014). High Speed Broadband Network in Malaysia, LIRNEasia, March 2014. Available at http://broadbandasia.info/wp-content/uploads/2014/04/Malaysia-HSBB_Expert-Forum2014.pdf . Accessed on August 8, 2015.
[62] MCMC. (2013). Annual Report, Malaysian Communications and Multimedia Commission. Available at http://www.skmm.gov.my/skmmgovmy/media/General/pdf/MCMC-AR_ENG_2013.pdf, accessed on August 8, 2015.

HSBB was a stand-alone program and was not integrated with other infrastructure programs such as roads. Such an integrated approach would have reduced the cost significantly.

While fiber is the most effective way for backhaul, for access newer wireless technologies such as LTE could be feasible. However, the HSBB did not examine these.

The project was assigned to TM without an open competitive process. GoM tried to balance this by seeking commitments from TM for coverage of underserved areas. However, TM's estimates had already included such costs. It was not clear whether all the upgraded exchanges would be solely restricted to the HSBB or would also be available to TM for use to serve its own customers. This would then give TM an advantage in a competitive scenario.

The availability of funds as a grant, without an open competitive process raises concerns whether HSBB could have been done at a lower cost. This was in a context where one operator (HSBT) had proposed rolling out HSBB without government support. Since MCMC has not regulated prices for open access, this issue becomes even more pertinent.

Quarterly payments linked to milestones ensured timely completion.

On another dimension, possibly a mix of technologies, wireless in the access part and fibre in the backhaul, would have reduced the overall cost of the project. This is especially relevant given that the penetration of smartphones has increased and reached 63% in the year 2013[63] and access to mobile broadband had become the dominant mode.

If customers were happy with 1 to 2 Mbps, then the issue was whether it was necessary to design a network with higher speeds.

Overall Analysis

As an outcome of the three NBPs, the fixed line government incumbent got to play a significant role in broadband deployment. The selection of the incumbent had been done with the objective of lowering costs. The subsequent delays in roll-outs as in the case of India and Brazil should lead the governments in these countries to rethink their focus on costs alone. The economic value of timely deployments should override such considerations.

User adoption continues to be a challenge. This is more true of the target socio-economic categories. In this segment, support for relevant content development and usage may have to be supported by the government as was done in Brazil. The low demand for high bandwidth packages as in Malaysia highlights the challenges. Integration with a variety of service delivery departments in the government for citizen relevant content could mitigate this.

Brazil had focused on fixed, mobile and satellite. In the Indian plan, such a focus had emerged only very lately based on the deliberations of the Committee set up to recommend the way forward. In Malaysia, the focus was more on the fixed line. Wireless technologies that have driven telecom growth in these three countries did not have significant focus in early formulations. This may be due to insufficient recognition of mobile as a broadband access device. But a focus on making the costs of mobile deployments lower by making more spectrum available, facilitating infrastructure sharing, and making costs of smartphones lower for target segments could drive mobile broadband adoption.

Despite the government taking proactive steps to focus on broadband, both Brazil and India did not meet their targets. India was lagging far behind. This could be either because of ambitious targets or inadequate thought on architecture, delayed funding and inappropriate organizational mechanisms.

Among the three countries, only India had set up a separate organizational mechanism in terms of BBNL to design, and deploy its NBP. Brazil and Malaysia had implemented NBP's through the fixed line incumbents.

[63] http://www.thestar.com.my/Tech/Tech-News/2013/09/12/Smartphone-and-tablet-penetration-hits-63-percent/, accessed on August 4, 2015

We further analyze the broadband strategies along the dimensions identified earlier:

a) ***The Scale and Scope of the Strategy***: The Brazilian, Indian and Malaysian NBPs were comprehensive national strategies. These were not a part of larger economic policies to enhance adoption of ICTs, as in Korea. Although the Brazilian and the Malaysian policies talked about national competitiveness through broadband, there were no specific measures to address this aspect. In India, the NBP, was made an integral part of the national program: 'Digital India' which sought to integrate ICT into service delivery, education health, and governance. The Brazilian and the Malaysian plans also attempted to integrate different ministries and departments. But since in all the cases, the NBPs were conceptualized as broadband infrastructure programs, the integration of service delivery with infrastructure has been difficult.

b) ***The Duration of the Strategy*:** In all three cases, the NBP duration was envisaged as the planned time for infrastructure provision. No time was specifically allocated for service development or delivery. The initial duration of the Brazilian, Indian and Malaysian program was four, two and five years respectively. Subsequently, these were extended. In Brazil, this was extended to cover more population and areas than originally envisaged. In India, the period was extended by three years, due to significant gaps in meeting targets in the original NBP. The Malaysian NBP was extended by seven years with significant additional scope.

   While the NBPs were seen as medium term projects, in reality these were longer term projects, both in terms of the scope, funding and time. Possibly, it is politically easier to push for shorter term projects and extend them. It also turns out to be a better strategy for areas such as telecommunications, where technologies change very fast. Shorter term perspective may enable governments to make mid-way corrections and incorporate new technologies.

c) ***Degree of Integration across Technologies***: Although all three NBPs were primarily focused on fixed lines, there were some aspects that focused on wireless. For example, making more spectrum available was an integral part of PNBL. Support for wireless technologies (including satellite for India and Brazil) had come in the subsequent reviews. In the Malaysian NBP, despite the need for wireless being not as strong as in Brazil and India, given their geographic scope, the NBP supported development of 1,000 towers.

   Further, degree of integration may be examined between supply and demand policies. While the three NBPS stated that they would address demand side aspects, the implementation on the demand side was limited. In the PNBL, there was support for low cost access devices. In Malaysia, netbook distribution was integral to the GBPP. In India, there was no support for access devices. Although relevant content development and e-governance were considered as drivers for the NBPs, due to lack of integration across different departments, this aspect was poorly implemented. The Brazilian and Malaysian NBPs showed higher degree of demand side aspects through integration with government programs. Despite this, overall, the supply side got far more primacy than demand side.

d. ***Degree and Nature of Public Sector Funding***: In all three cases, the funding was primarily done through the Universal Service Fund. In Malaysia, there was an additional support through the government budget. While TM received funds from the government, it also invested its own capital. The GoM would get a revenue share from the HSBB if it exceeded its targets.

e. ***Implementation Model***: While India had set up a separate organization BBNL for deploying broadband, Brazil and Malaysia implemented broadband through the incumbent operator. While BBNL was a separate organization, it was practically a department under the DoT. This approach gave the government control over the policies and implementation.

Major Findings and Lessons

As pointed out in the Introduction, over the last fifteen years the use of the increasingly intelligent mobile phone has exploded. It has become the most widely used communications device in the world, the telecommunications access device of choice in the developing world, and it is often the only available device for accessing the Internet and its associated services. Mobile broadband is the most dynamic segment of the telecommunications market. By the end of 2015 there were more than four times as many mobile broadband subscriptions as fixed broadband ones and two-thirds of them are now in the developing world. Starting from a very low base, the rate of growth of broadband subscriptions over the last 10 years has been much faster in the developing countries than in developed ones, largely because the deployment of 3G and more advanced (4G/ LTE) networks is increasing rapidly in the developing world. However, some 4 billion people in the developing world are still not using the Internet. Therefore the potential for mobile broadband deployment is much greater in these countries.

The most important lesson of general applicability is "***One size does not fit all***". There is a need to recognize that proposed broadband strategies and the role of governments must be tailored to fit particular national market and institutional structures, taking geography and demographics into account. For example, a large number of national strategies in developed countries (e.g. Singapore, South Korea, Japan, Australia) focus predominantly on the deployment of ubiquitous, fibre-optic broadband wireline networks, such as Fibre-to-the-Premise/Home (FTTP/FTTH) or Fibre-to-the-Node (FTTN). However, in a country like India, where there are more than 30 times as many cell phone users as wireline phone ones, wireless technologies, both fixed and mobile, will play a crucially important role in universal broadband deployment and last mile access.

Other lessons of general applicability include the following:

- Major, long term broadband infrastructure deployment initiatives which require significant public sector funding and commitment also require long term political support for their successful implementation. Such initiatives cover a longer time frame (usually 5 years or more) than electoral cycles. Changes in governments may lead to major changes or curtailment of the initiative as originally proposed, unless the political support is sufficiently broad based and the commitment is shared across political parties (lessons from the Australian NBN initiative, and earlier major infrastructure projects such as the building of the U.S. Interstate Highway system, collectively the single largest civil engineering project in history);
- Widespread consensus, at least in developed countries, that demand for spectrum, which is the lifeblood of both fixed and mobile wireless services, will continue to outstrip supply for the foreseeable future. Much additional spectrum will need to be allocated, or re-allocated from other existing uses and users, to enable advanced new mobile and fixed wireless broadband services to be deployed.

In general, it is appropriate for developing countries to consider mobile and wireless broadband as a way of addressing the digital divide. There appears to be a continuous increase in wireless broadband services in developing countries with the deployment of 3G networks and 3G, 4G/LTE enabled handsets and devices.

Appropriate Roles for Governments

There is a broad consensus about the need for governments to carry on certain roles in support of a Digital Economy Strategy or a comprehensive National Broadband Strategy, but disagreement about other roles. The areas of agreement include:

- Broad consensus that the traditional role of governments in setting the market framework rules needs to continue, with:
  - regulatory oversight, where required;
  - ensuring a competitive marketplace;
  - consumer protection.
- Also broad consensus that efficient spectrum management and allocation/reallocation of spectrum frequencies is a key government task.

However, the consensus breaks down when it comes to the degree of direct support that governments should provide in areas like infrastructure deployment, or the promotion of the adoption and effective use of ICTs by businesses and individuals. Here one can consider options, as set out below:

Support for infrastructure deployment – options include:

- targeted tax incentives for private sector network suppliers;

- "pave the dirt roads", i.e. fund the deployment of broadband infrastructures in high cost rural/remote areas;
- "help build a digital Interstate Highway system" e.g. Australian National Broadband Network initiative, particularly as originally conceived.

Support Programs, particularly targeted demand side measures for the promotion of adoption and effective use of ICTs by current non-adopters, especially by:

- small businesses, to fully reap productivity and competitiveness gains;
- disadvantaged groups, to improve social inclusion.

Models for financing broadband infrastructure

The different models of financing the implementation of broadband infrastructure are influenced by legacy infrastructure and this determines the extent of direct government involvement. Ideally the primary funding for broadband infrastructure deployment should be privately based, but many markets are not sufficiently developed to offer sound financial investment opportunities.

Two routes are available to government — direct entry as a service provider and later privatization, or stimulation of the market and taking a share of the risk through partnership arrangements.

Where competition exists between vertically-integrated operators that manage their own network infrastructure and have sufficient stand-alone capacity for investment and innovation, such as the Telcos and Cablecos in the US and Canada, the role of government and the regulator is limited to facilitation of fair market competition and behaviour, and the timely and prudent access to public resources such as spectrum and property rights of way. Regulators have a responsibility to encourage infrastructure sharing among competitors (for example, backbone networks and mobile network towers). This alleviates cost pressures, especially where a mix of broadband infrastructure is not sustainable.

Where private investment is reluctant to enter the market, the government can step in as risk taker and enter into public-private partnerships. These can be contracts with an incumbent or with new entrants, and in effect operate as a temporary wholesale monopoly - though based upon open access principles which differ from the traditional public switched telephone network (PSTN) monopoly - until competition is better established.

An inventive partnership contract devised in New Zealand[64] grants the government an initial 100 per cent stake, which is then progressively bought out by the commercial partner as uptake occurs. Capital is returned to the government through this process, and this can then be reinvested in ultra-fast broadband networks. This arrangement essentially operates as a rotating line of credit.

Many developing countries now impose a universal service levy, and this accumulated resource might be applied in the future to bring broadband to underserved and unserved areas under contractual partnership with government.

The need for cross-sectoral considerations

In promoting broadband adoption, demand-side policies might involve tax incentives, governments as anchor tenants, the development of various e-government services such as benefit payments and transactional services, an enabling environment for small and medium-sized enterprises, export incentives, and the development of human capacity and resources.

This calls for an overarching strategy involving the consideration of cross-sectoral measures, and education of the broad base of society and industry in order to enjoy fully the benefits which broadband offers.

[64] New Zealand (2010). Ultra-Fast Broadband (UFB) Initiative. Accessed July 23, 2015 http://beehive.govt.nz/release/ultra-fast-broadband-deal-puts-nz-ahead-pack

Conclusions

Broadband Strategy, like other good strategies, needs to incorporate elements from successful strategies in different countries. For example, from the Korean and Japanese strategies it is clear that a focus on demand can drive broadband deployment, rather than the other way around. The involvement of a number of user agencies in a national broadband strategy can also help drive demand.

Broadband deployment, unlike other telecom networks, requires coordination across a variety of ecosystem partners such as device manufacturers, broadcasters, Telcos, cable operators, content and applications developers. Effective broadband deployment requires the design of institutions with adequate scope and a fine balancing across the roles of existing agencies. Government funding is often necessary to kick start broadband deployment, as it requires huge capital investment and short term returns are uncertain due to demand risks. The business case for broadband deployment in rural areas is even more risky. The lack of such infrastructure, on the other hand, makes the economy move into a negative vicious cycle, as has been the case in many developing nations. Therefore it is imperative that governments of developing countries take up this issue on a priority basis, similar to that of electrification.

Based on the above discussion, an obvious conclusion is that governments need to take a broader perspective than focus on infrastructure deployment alone, but also simultaneously on the creation and nurturing of various elements in the Internet ecosystem.

Suggestions for Further Work

Policymakers in both developed and developing countries need to identify the socio-economic impacts of large broadband deployment initiatives where major public funding is involved, especially impacts that result from the new and innovative uses of the infrastructure. This is very difficult to do with conventional economic analysis. While it is possible to estimate the costs of a particular initiative, it is very difficult to quantify the long term benefits, especially the indirect ones. As an analogy and case in point, could any economist have estimated the benefits of the U.S. Interstate Highway System to the U.S. economy, when the project was started in 1956?

Policymakers also need to define the appropriate roles of governments, beyond the traditional regulatory and spectrum management roles, recognizing the need to tailor these roles to particular national circumstances. Further, there is a need to identify the optimal institutional mechanisms that can be used in a particular national context to deliver broadband infrastructure and services.

The areas of policy work outlined above could form the initial elements of a medium term Policy Research Agenda. A dialogue between policymakers and researchers may help to develop more fully the outline of such a Research Agenda, covering a list of identified current and future issues which will require further work. The authors hope that this paper will contribute towards the process of starting this necessary dialogue, both in India and perhaps more widely in the international research community.

Bibliography

2013 Investment Climate Statement – Brazil. (2013). Bureau of Economic and Business Affairs, February 2013. Available at http://www.state.gov/e/eb/rls/othr/ics/2013/204608.htm, accessed on August 8, 2015.

About Anatel. (2015, April 15). Retrieved from http://www.anatel.gov.br/grandeseventos/en/about-anatel , on August 8, 2015.

American Recovery and Reinvestment Act of 2009 (*Recovery Act*) (2009), NTIA *Broadband Technology Opportunities Program (BTOP)* and USDA/RUS *Broadband Initiatives Program (BIP).* Accessed on July 23, 2015: http://www.broadbandusa.gov , http://www2.ntia.doc.gov , and http://www.rurdev.usda.gov.

Australian National Broadband Network (2009), *New National Broadband Network*, News Release April 6, 2009, by the Australian Prime Minister, Finance Minister and the Minister for Broadband. Accessed on July 22, 2015 http://www.minister.dbcde.gov.au/media/media_releases/2009/022.

Australian National Broadband Network (2010), *21st Century Broadband – Policy Brochure*, and related documents. Accessed on July 22, 2015 http://www.nbnco.com.au.

Australian National Broadband Network (2014), Statement of Expectations by Shareholder Ministers, Letter dated April 8, 2014. See also NBN Corporate Plan covering 2014-2017, released November 2014. Accessed on July 22, 2015 http://www.nbnco.com.au.

Bharat Broadband Network Ltd. (BBNL), India (2015), Company Profile and NOFN project. Accessed on July 21, 2015 http://www.bbnl.nic.in.

Booz & Company (2009), *"Digital Highways: The Role of Government in 21st Century Infrastructure"*, Available at: http://www.booz.com .

Brazil (2009), "*Um Plano Nacional para Banda Larga"* (National Broadband Plan). Ministerio das Communicacoes (Ministry of Communications). Accessed on July 24, 2015 http://www.mc.gov.br/plano-nacional-para-banda-larga.

Brazil Company Laws and Regulations Handbook, Strategic Information and Regulations. (2013, pg no. 165). *International Business Publications*, USA.

Broadband Commission. (2014). *State of Broadband 2014: Broadband for All*. Available at http://www.broadbandcommission.org/documents/reports/bb-annualreport2014.pdf, accessed on August 8, 2015.

Carmichael, L. R., Mcclure, C. R., Mandel, L. H., and Mardis, M. A. (2012). *"Practical Approaches and Proposed Strategies for Measuring Selected Aspects of Community-Based Broadband Deployment and Use"*, International Journal of Communication, 6, 2445–2466, August 2012.

European Commission (EC) (2010), "*Digital Agenda for Europe"*, Released May 19, 2010. Available at: http://ec.europa.eu/information_society/digital-agenda/.

Federal Communications Commission (FCC) (2010) "*Connecting America: The National Broadband Plan*", report submitted to Congress on March 16, 2010; with many related studies and Working Papers developed or commissioned by the FCC's Omnibus Broadband Initiative. Accessed on June 8, 2015 http://www.broadband.gov.

Gunaratne, R. L. (2014). High Speed Broadband Network in Malaysia, LIRNEasia, March 2014. Available at http://broadbandasia.info/wp-content/uploads/2014/04/Malaysia-HSBB_Expert-Forum2014.pdf . Accessed on August 8, 2015.

HSBB (2009) HSBB Malaysia's Drive for High Speed Broadband. MyConvergence, Malaysian Communications and Multimedia Commission, 3(1), January 2009. Accessed on August 8, 2015 http://www.oecd.org/dataoecd/49/28/40839436.pdf.

infoDev (2014) *"Broadband in Brazil: A Multipronged Public Sector Approach to Digital Inclusion"*, infoDev Case Study. Accessed on August 9, 2015 http://www.infodev.org/articles/broadband-brazil-multipronged-public-sector-approach-digital-inclusion

International Telecommunications Union (ITU) (2015), "*The World in 2015: ICT Facts and Figures".* Accessed on June 8, 2015 http://www.itu.int/en/ITU-D/Statistics/Documents/facts//ICTFactsFigures2015.pdf.

International Telecommunications Union (ITU) (2014), "*The World in 2014: ICT Facts and Figures".* Accessed on June 8, 2015 http://www.itu.int/en/ITU-D/Statistics/Documents/facts//ICTFactsFigures2014.pdf.

International Telecommunications Union (ITU) (2013), "*The World in 2013: ICT Facts and Figures".* Accessed on June 8, 2015 http://www.itu.int/en/ITU-D/Statistics/Documents/facts/ICTFactsFigures2013.pdf.

International Telecommunications Union (ITU) News (2011) *"What should be in a national broadband plan?"* ITU News, September 2011. Accessed on July 21, 2015, http://www.itu.int/net/itunews/issues/2011/07/17.aspx.

International Telecommunications Union (ITU) (2010), *"World leaders agree: The future will be built on broadband".* Geneva, International Telecommunications Union, Accessed on July 21, 2015 http://www.itu.int/net/pressoffice/press_releases/2010/33.aspx.

International Telecommunications Union (ITU) (2010), "*Broadband: A Platform for Progress"*, Broadband Commission for Digital Development, ITU & UNESCO, 2010. Available at: Http://www.broadbandcommission.org.

International Telecommunications Union (ITU) (2002), "*Broadband Korea: Internet Case Study",* Report prepared by Tim Kelly, Vanessa Gray and Michael Minges, 2002. Accessed on July 29, 2015 http://www.itu.int/ITU-D/ict/cs.

Internet and Mobile Association of India (IAMAI) *"Mobile Internet Report 2014"* Dec. 26, 2014, and "Internet in India 2014" Nov. 1, 2014. Accessed June 8, 2015, http://www.iamai.in.

Jain, R. (2014). *"Framework for Identifying Appropriate Roles for the Public and Private Sector in National Broadband Deployments in Emerging Economies: The National Broadband Plan of India",* presented at TPRC42, available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2418442 , accessed on August 8, 2015.

Jain, R. and Neogi, P. (2012). "*National Broadband Strategies: A Comparative Review and Possible Lessons for Developing Countries "*, paper presented at the International Telecommunications Society 2012 Asia-Pacific Regional Conference, New Delhi, India, February 22-24, 2012.

Jain, R. and Dass, R. (2011) *"Research and Action Agenda for a National Broadband Initiative in India"*, paper given at the International Telecommunications Society Regional Conference in Taiwan, 2011.

Japan (2007), *U-Japan Policy.*

Japan (2011), *Telecommunications Action Plan 2011.*

Jensen, M. (2011). *"Broadband in Brazil, A Multipronged Public Sector Approach to Digital Inclusion"*, Washington, D.C: infoDev / World Bank. Available at http://www.broadband-toolkit.org, accessed on August 8, 2015.

Kelly, Tim, Malas., V., Raja, S., Qiang, Christie Zhen-Wei and Williams, M. (2010) *"What role should governments play in broadband development?"*, The World Bank, 2010.

Kim, Youngsoo, Kelly, T. and Raja, S. (2010) *"Building Broadband – Strategies and Policies for the Developing World"*, The World Bank, 2010.

Korea (2013*)*, National Information Society Agency *2013 National Informatization White Paper*, Nov. 13, 2014. Accessed on July 27, 2015 http://eng.nia.or.kr.

Korea (2010), National Information Society Agency *Korea Informatized : progress and status overview,* 2010. Accessed on July 27, 2015 http://eng.nia.or.kr/.

Korea (2010), National Information Society Agency *2010 National Informatization White Paper,* Oct. 18, 2010, . Accessed on July 27, 2015 http://eng.nia.or.kr.

Korea (2007), National Information Society Agency *Korea Informatized : progress and status overview,* 2007. Accessed on July 27, 2015 http://eng.nia.or.kr/english/BBS/

Korea (2007), "u-Korea Master Plan: To Achieve the World's First Ubiquitous Society". Ministry of Information and Communication, Republic of Korea. Available at: http://www.ipc.go.kr/servlet/download?pt=/ipceng/public&fn=u-KOREA+Master+Plan+.pdf.

Malaysia Ministry of Human Resources. (2012). Occupational Analysis Telecommunications Industry. Department of Skills Development, Ministry of Human Resources, Malaysia. Available at file:///C:/Users/vaio/Downloads/oa%20telecommunications%202012.pdf, accessed on August 8, 2015.

MCMC. (2013). Annual Report, Malaysian Communications and Multimedia Commission. Available at http://www.skmm.gov.my/skmmgovmy/media/General/pdf/MCMC-AR_ENG_2013.pdf, accessed on August 8, 2015.

New Zealand (2010), Ultra-Fast Broadband (UFB) Initiative. Accessed on July 23, 2015 http://beehive.govt.nz/release/ultra-fast-broadband-deal-puts-nz-ahead-pack.

Ofcom and DTI. (2007), "*Public Broadband Schemes: A Best Practice Guide",* February 2007. Available at: http://www.ofcom.org.uk/media/mofaq/telecoms/pbs/dti_pbs.pdf .

Organization for Economic Cooperation and Development (OECD) (2011) *"National Broadband Plans",* OECD Digital Economy Papers No. 181, June 2011. OECD Publishing. Accessed on June 8, 2015 http://www.oecd-ilibrary.org/science-and-technology/national-broadband-plans_5kg9sr5fmqwd-en.

Organization for Economic Cooperation and Development (OECD) (2008), *Seoul Declaration for the Future of the internet Economy*. Paris, Organization for Economic Cooperation and Development. Accessed on August 4, 2015. http://www.oecd.org/dataoecd/49/28/40839436.pdf

Organization for Economic Cooperation and Development (OECD) (2008), *OECD Ministerial Meeting on the future of the Internet economy: Summary of the Chair of the meeting.* Paris, Organization for Economic Cooperation and Development. Accessed on August 4, 2015 http://www.oecd.org/dataoecd/53/49/40989438.pdf.

Organization for Economic Cooperation and Development (OECD) (2004), Recommendation of the OECD Council on broadband development adopted by the Council at its 1077th Session on 12 February 2004. Accessed on August xx, 2015 http://www.oecd.org/document/11/0,3343,en_2649_34223_34238436_1_1_1_1,00.html.

Picot, A. and Wernick, C. (2007), "*The Role of Government in Broadband Access*," *Telecommunications Policy*, Vol 31, No 10-11, pp. 660-674.

Qiang, C. Z. (2009), "*Broadband infrastructure investment in stimulus packages: Relevance for developing countries"*. Published May 2009, as a part of the ICT Regulation Toolkit produced by InfoDev and the ITU. Working Paper 49097, Vol 1. Available at: http://www.ictregulationtoolkit.org/en/Publication.3897.html.

Rossini, C. (2014). *"Case Study Affordable Internet Access in Brazil, Alliance for Affordable Internet"*. Available at https://a4ai.org/wp-content/uploads/2014/08/A4AI-Case-Study-Brazil-FINAL_US.pdf, accessed on August 8, 2015.

Sweden (2009), "*Broadband strategy for Sweden",* Report published by the Government of Sweden, Ministry of Enterprise, Energy and Communications, November 2009. Available at: http://www.sweden.gov.se/sb/d/2025/a/134980.

Tajiri, N., Jitsuzumi, T. and Okazaki, T. (2006), *"Policies for Broadband Diffusion in Developing Countries: The Case of Thailand,"* Journal of Information and Communication Research, Vol 24, No 1, pp. 49-61.

Telecomunicoes Brasileiras S.A. (Telebras) (2014). Overview of Telebras – Tech in Brazil article published October 24, 2014. Accessed on August 9, 2015 http://techinbrazil.com/overview-of-telebras

Telecommunications Policy Research Conference (TPRC) (2013) *"Intelligent Mobile Devices and their Impact: Perspectives, Lessons, Issues and Challenges"*, Panel held at the 41st Annual Telecommunications Policy Research Conference (TPRC41), September 28-30, Arlington, Va. Available through www.tprc.org archives and the SSRN.

Telecommunications Regulatory Authority of India (TRAI) (2014) Annual Report, December 2014. Accessed June 8, 2015 , http://www.trai.gov.in.

Telecommunications Regulatory Authority of India (TRAI) (2014). *The Indian Telecom Services Performance Indicators*, October - December, 2014. Accessed on August 8, 2015 http://www.trai.gov.in/WriteReadData/PIRReport/Documents/Indicator_Reports%20-%20Dec-14=08052015.pdf,.

Telecommunications Regulatory Authority of India (2010), *"Recommendations on National Broadband Plan",* 8 December 2010. Available at: http://www.trai.gov.in/WriteReadData/trai/upload/Recommendations/124/Broadbandrecommendation08_12_10final.pdf .

Thailand (2010), "Broadband Thailand 2015", Report of the Meaningful Broadband Working Group, Digital Divide Institute, Bangkok, Thailand, 2010. Available at: http://www.digitaldivide.org.

United Kingdom (2011), "*Broadband Delivery Programme: Delivery Model*", Broadband Delivery UK, Department of Culture, Media and Sport. Available at: http://discuss.bis.gov.uk/bduk/ and http://www.culture.gov.uk/what_we_do/telecommunications_and_online/7781.aspx .

Appendix 1: Selected Telecommunications and Wireless Statistics and Forecasts

A. International Telecommunications Union (ITU) Statistics

The **ITU's "*The World in 2013: ICT Facts and Figures*"** report estimated that by the end of 2013:

- There would be some 6.8 billion mobile service subscriptions worldwide, a 96% overall penetration for a population of 7.1 billion;
- Mobile-cellular penetration was estimated at 128% in developed countries and 89% in developing countries. Growth rates have begun to fall as penetration approaches 100% and market saturation is reached
- **Mobile broadband subscriptions grew at an average annual growth rate of 40% between 2007 and 2013, from 268M to 2.1B;**
- **There were now almost three times as many mobile broadband subscriptions (2.1B) as fixed ones (700M).**

The **ITU's "*The World in 2014: ICT Facts and Figures*"** report estimated that by the end of 2014:

- There would be some 7 billion mobile service subscriptions worldwide, a 96% overall penetration;
- Mobile-cellular penetration is estimated at 121% in developed countries and 90% in developing countries. Growth rates have begun to fall as penetration approaches 100% and market saturation is reached ;
- **The developing countries share of cellular-mobile subscriptions has increased from some 35% in 2000 to 78% in 2014;**
- **Mobile broadband subscriptions grew to some 2.3 billion, with 55% of them in developing countries;**
- **Globally, mobile broadband penetration per 100 inhabitants will reach 32% by the end of 2014. The estimated 84% penetration rate in developed countries will be four times higher than the 21% in developing countries.**

The **ITU's "*The World in 2015: ICT Facts and Figures*"** report estimated that by the end of 2015:

- **There would be more than 7 billion mobile service subscriptions worldwide, a 97% overall penetration rate for an estimated population of 7.4 billion (4 billion urban, 3.4 billion rural), and almost a 10 fold increase from 738 million in 2000;**
- The developing countries share of cellular-mobile subscriptions has increased from some 35% in 2000 to [78%] in 2015;
- The proportion of the population covered by a 2G network grew from 58% in 2001 to 95% in 2015;
- **Mobile broadband is the most dynamic market segment. 3G mobile broadband population coverage expanded from 45% in 2011 to 69% in 2015;**
- **Mobile broadband subscriptions grew to some 3.5 billion, with [55%] of them in developing countries. Globally, mobile broadband penetration per 100 inhabitants will reach 47% by the end of 2015, a value that has increased some 12fold since 2007;**
- **Globally, the urban-rural mobile broadband gap persists between the urban population of 4 billion and the rural population of 3.4 billion. 3G population coverage is 89% for the urban population, but only 29% for the rural population;**
- Globally, some 3.2 billion people are using the Internet, of which some 2 billion are from developing countries. Between 2000 and 2015 global Internet penetration grew 7 fold, from 6.5% to 43%.

B. Private Sector Projections and Forecasts (*update?*)

*A 2012 **Ericsson** report predicted that:

- Total global mobile subscriptions would stand at 6.6 billion by end of 2012, and **could hit some 9.3 billion by 2018;**
- **LTE subscriber numbers will hit 1.6 billion by end of 2018;**
- **Mobile data traffic will grow at a CAGR of 50% between 2012 and 2018.**

Note that new, higher end smartphones, like Samsung's flagship Galaxy S5 and Apple's iPhone 5and newer models, are LTE enabled devices. Some new automobiles have LTE and GPS capabilities built in.

***Cisco forecasts that Mobile Data Traffic per month will increase from 0.9 Exa-bytes in 2012 to 11.2 Exa-bytes by 2017 – a 66% CAGR for 2012 – 2017** (2013 VNI Mobile Forecast - *update*).

*A 2012 **Wireless Intelligence** report forecast 8.5 billion connections by 2017, **with 50% coming from the new generation of mobile networks.** The growth is expected to break down as follows:

- 3G: 40% (HSPA, EV-DO networks)
- 4G: 10% (LTE, TD-LTE and WiMAX networks)

*According to a Gartner report, by the year 2020 the number of people using the Internet will reach 5 billion but the number of devices connected to the Internet will exceed 100 billion.

C. Statistics for the Indian Telecommunications Sector *(need to re-check and update?)*

- **As of December 2014 (TRAI Report*)**
  - Telephone subscriber base – 971 m
  - Wireline telephone subscriber base – 27 m (overwhelmingly urban)
  - **Mobile subscriber base – 944 m (833 m active)**
  - **Wireless Tele-density – 75.43% ,** Overall Tele-density – 77.58%
  - **Urban subscribers – 572.3 m (58.94% of Total); Tele-density - 148.1%**
  - **Rural subscribers – 398.7 m (41.06% of Total); Tele-density - 46.1%**
  - Fixed Broadband Subscribers – 15.32 m
  - **Mobile Broadband Subscribers – 248.06 m**
  -
- **As of December 2014 (IAMAI - Mobile Internet in India Report 2014 & TRAI Report*)**
  - Claimed Internet subscribers – 302 m*
  - Mobile Internet subscribers – 248.06 m]
  -
- **As of Jan. 2015 (TAM Media Research Report)**
  - Cable TV households in India – 161 m
  - DTH households in India – 84 m
  -
- Sector contributed 7.2% of the total FDI inflows amounting to US$ 16.5 billion during April 2000 to August 2014

Appendix 2: Broadband Strategies and Plans of Selected Countries

Some governments, such as the U.S. and UK, began with a market led approach with respect to the deployment of broadband infrastructure, as opposed to their more active role in the building of earlier networks like canals, railways, highways and the electricity generation and distribution system. Subsequently, there has been a move to adopt more formal mechanisms. There have been two broad institutional approaches to broadband deployment: working with existing institutions through specific well-designed programs or setting up new institutional mechanisms.

Where existing institutions have been used for broadband deployment, as in Korea, a key aspect has been program design, which builds close synergies between the ministries/departments of telecommunications, IT, and broadcasting; phase-wise implementation of long-term strategies; reviews and performance based outcomes. When new institutions have been set up, these have emerged from ministries/departments whose mandate is broader than the management of the telecom infrastructure. The U.S., UK and Australia are examples where broad scoped institutions already existed or new institutions have been set up for broadband deployment.

Broadband initiatives have been funded by governments through a variety of instruments such as tax credits, regional subsidies and specially created funds. Details of selected national broadband strategies and the institutions set up for their implementation are outlined below.

Australia

The highlights of the Australian ***National Broadband Network*** **(NBN)**[65] initiative, announced on April 6, 2009 by the Australian Prime Minister, Finance Minister and the Minister for Broadband Communications and the Digital Economy, were as follows:

- Intended to bring 100 Mbps connectivity to 90% of all Australian premises, via a FTTP network;
- Up to 12 Mbps to all other premises via next generation wireless technologies (terrestrial and satellite);
- An estimated total cost of A$43 billion over an 8 years rollout plan (2009-2017) (later revised in a detailed implementation study by McKinsey & Co.);

The initiative was a "whole of government" strategy that was announced by then Prime Minister Kevin Rudd and was supported by the other levels of government. The Australian Department of Broadband Communications and the Digital Economy (DBCDE) was designated as the lead Department and its then Minister, Senator Stephen Conroy, became the committed champion of the national broadband strategy.

A new autonomous entity called the National Broadband Network Company (NBN Co.) was set up on April 9, 2009, as a wholly-owned Commonwealth company (a Government Business Enterprise) to design, build and operate the planned national broadband network. Currently the Australian Government is the only investor in NBN Co. and will retain control at least until the network rollout has been completed and the goals of the strategy met. NBN Co. will remain a bandwidth wholesaler and provide non-discriminatory access to Internet and telecommunications service providers who provide retail services to end users. Much further information, including a network rollout timeline, is available at the NBN web site http://www,nbnco.com.au

The December 2010 Update outlining NBN's first Corporate Plan for 2011-2013[66] had the following revised targets and highlights:

- 93% fibre, 4% fixed wireless and 3% satellite access;
- Fibre to all communities with more than 1,000 premises;
- More than 12 million households in fibre footprint by 2021 completion;

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[65] Australian National Broadband Network (2009), *New National Broadband Network*, News Release April 6, 2009, by the Australian Prime Minister, Finance Minister and the Minister for Broadband Communications and the Digital Economy. Accessed on July 22, 2015 http://www.minister.dbcde.gov.au/media/media_releases/2009/022 .

[66] NBN Co. Ltd. (2010) Corporate Plan 2011-2013. Accessed on July 22, 2015 http://www.nbnco.com.au

- A$27.5 B from Australian government in equity funding;
- Wholesale only open access, with uniform pricing.

[NBN Co. signed an arrangement with Telstra, the dominant Australian national telecommunications carrier, whereby Telstra's core network infrastructure was to be turned over to the NBN Co. for a total consideration of some $11 billion, with Telstra becoming the largest user of the NBN, in its service provision role.]

However, with the change in the government of Australia as a result of the September 2013 election, the NBN initiative has been considerably modified and scaled down. The Minister of Communication and the Minister of Finance are the Shareholder Ministers in NBN Co. Ltd. In a letter dated April 8, 2014 to the NBN management, the Ministers issued a new Statement of Expectations (SoE)[67], and in response on Nov. 11, 2014 NBN released a new Corporate Plan for 2014-2017[68].

The April 8, 2014 SoE outlines the Government's commitment to the NBN in delivering *"very fast broadband as soon as possible, at affordable prices, and at least cost to taxpayers".* To achieve this objective, the NBN should be built in a cost-effective way, using the access technology most appropriate in each area of Australia". The SoE provides NBN Co *"With flexibility and discretion in operational technology and network design decisions, within the constraints of a public equity capital limit of A$29.5 billion specified in its funding agreement with the Commonwealth, and the Government's broadband policy objectives".*

The April 8, 2014 SoE specifies the Government's decision to transition the NBN from a primarily Fibre-To-The-Premises (FTTP) model to the "Optimised Multi-Technology Mix (MTM)" model outlined in the December 2013 Strategic Review[69], having due regard to the following policy and commercial issues:

- The design of a multi-technology mix NBN will be guided by the Government's policy objectives of providing download data rates (and proportionate upload rates) of at least 25 Mbps to all Premises, and at least 50 Mbps to 90% of Fixed Line Premises (FL), as soon as possible;
- NBN Co will determine which technologies are utilized on an area-by-area basis, so as to minimize peak funding, optimise economic returns and enhance the Company's viability;
- NBN Co will ensure that upgrade paths are available as required;
- NBN Co will prioritise areas identified as poorly served by the "Broadband Availability and Quality Report" published by the Department of Communications in February 2014 (including any subsequent refinements arising from additional data), to the extent commercially and operationally feasible;
- As proposed by the (December 2013) Strategic Review, NBN Co will integrate existing HFC (Hybrid Fibre Coax) into the rollout where this is feasible and economically beneficial, and provide for wholesale-only, open access operation of these;
- NBN Co will trial Fibre-To-The-x (FTTx) architectures (i.e. FTTP, FTTN, FTTdp and FTTB for multi-storey dwelling units) to inform the Company's planning and decisions.

The Corporate Plan details the approach that NBN Co. intends to take to implement a Multi-Technology Mix (MTM) NBN, to fulfil the requirements of the April 8, 2014 SoE. This provides the NBN Co with the flexibility and discretion to make network design decisions, with an overall aim to constrain costs and accelerate the rollout. This is also in line with the Strategic Review, which recommended delivering the Government's policy through the rollout of a "network of networks" interconnecting Fibre to the Premise (FTTP), Fibre to the Node (FTTN), Hybrid Fibre Coaxial (HFC), Fibre to the Distribution Point (FTTdp), Fibre to the Basement (FTTB), as well as Satellite and Fixed Wireless Networks, collectively described as the Multi-Technology Mix or MTM.

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[67] Australian National Broadband Network (2014), Statement of Expectations by Shareholder Ministers, Letter dated April 8, 2014 Accessed on July 22, 2015 http://www.nbnco.com.au

[68] Australian National Broadband Network (2014), NBN Corporate Plan covering 2014-2017, released November 11 2014. Accessed on July 22, 2015 http://www.nbnco.com.au

[69] Strategic Review – December 2013. Accessed on July 27, 2015 http://www.nbnco.com.au/contant/dam/nbnco/documents/NBN-Co-Strategic-Review-Report.pdf

The United States of America

"Broadband is the great infrastructure challenge of the 21st century. Like electricity a century ago, broadband is a foundation for economic growth, job creation, global competitiveness and a better way of life."
FCC "*Connecting America: The National Broadband Plan*", report submitted to Congress on March 16, 2010.

The National Broadband Plan[70], released by the Federal Communications Commission (FCC) on March 17, 2010, sets out a roadmap for initiatives to stimulate economic growth, spur job creation and boost America's capabilities in education, health care, homeland security and more. The plan includes sections focusing on economic opportunity, education, health care, energy and the environment, government performance, civic engagement and public safety.

The Plan recommends that the U.S. set the following 6 goals for 2020, to serve as a compass over the next decade:

Goal No. 1: At least 100 million U.S. homes should have affordable access to actual download speeds of at least 100 megabits per second (Mbps) and actual upload speeds of at least 50 megabits per second.
Goal No. 2: The U.S. should lead the world in mobile innovation, with the fastest and most extensive wireless networks of any nation.
Goal No. 3: Every American should have affordable access to robust broadband service, and the means and skills to subscribe if they so choose.
Goal No. 4: Every American community should have affordable access to at least 1 gigabit per second broadband service to anchor institutions such as schools, hospitals and government buildings.
Goal No. 5: To ensure the safety of the American people, every first responder should have access to a nationwide, wireless, interoperable broadband public safety network.
Goal No. 6: To ensure that America leads in the clean energy economy, every American should be able to use broadband to track and manage their real-time energy consumption.

The proposed speed targets for 2020 include:

- affordable access for at least 100 million homes to at least 100 Mbps actual download speeds and 50 Mbps upload speeds;
- universal access, defined as a national broadband availability target of at least 4 Mbps actual download speed and 1 Mbps upload speed.

To summarize, Plan goals and recommendations include:

- 6 high level Goals for the year 2020, including speed targets;
- Some 200 recommendations, about half falling within the FCC's jurisdiction;
- To make 500 megahertz (MHz) of new spectrum available over the next 10 years, for wireless broadband enabled applications and services;
- To create a Connect America Fund to support the universal provision of broadband at the national broadband availability target level, and shift up to $15.5 B from existing Universal Service Funds;
- A National Purposes component, to maximise the adoption and use of broadband enabled applications which will address National Priorities in areas like Healthcare, Education, Energy and the Environment, Public Safety and Government service delivery, to increase efficiencies and reduce costs.

In the U.S. there already was a Universal Service Administrative Company (USAC) that had been designated by the FCC as the administrator for the existing Universal Service funds (e.g. E-Rate). It not only manages network roll out to high cost areas and low income categories, but is also responsible for the telecom and Internet services to rural health care providers and schools and libraries. Thus, besides network deployment, it has a sectoral focus. For its National Broadband Plan, the FCC suggested that the Executive Branch should establish a "Broadband Strategy

[70] FCC (2010) *"Connecting America: The National Broadband Plan",* accessed on July 22, 2015, http://www.broadband.gov

Council" to coordinate implementation of the Plan[71]. However, this recommendation has not been fully implemented.

It should be noted that Goals No. 2 and 5 specifically relate to broadband mobile communications. The specific recommendations on spectrum policy include:

- Make 500 Mhz of spectrum newly available for broadband within 10 years, of which 300 Mhz should be made available for mobile use within 5 years;
- Enable incentives and mechanisms to repurpose spectrum to more flexible uses. Mechanisms include incentive auctions, which allow auction proceeds to be shared in an equitable manner with current licensees, as market demands change. For example, this would allow the FCC to share auction proceeds with broadcasters who voluntarily agree to use technology to continue traditional broadcast services with less spectrum;
- Ensure greater transparency of spectrum allocation, assignment and use through an FCC-created spectrum dashboard to foster an efficient secondary market;
- Expand opportunities for innovative spectrum access models, by creating new avenues for opportunistic and unlicensed use of spectrum and increasing research into new spectrum technologies.

The Obama administration has strongly supported the goal of finding 500 MHz of additional spectrum for new mobile broadband services, between now and 2020, with the FCC and the NTIA jointly leading this initiative.

Under the U.S. system of governance certain proposals with budgetary implications, such as incentive auctions to encourage the release of spectrum currently used for other purposes, and the setting up of the Connect America Fund by shifting some $15.5 B from a number of existing Universal Service Funds, require Congressional approval.

Certain judicial developments have taken place since the tabling of the National Broadband Plan which brought into question the FCC's authority to regulate broadband services by applying Common Carrier principles. However, the FCC has steadily moved ahead, via a variety of proceedings, to implement the key recommendations that fall under its jurisdiction. In a major recent development, the FCC has decided to regulate the Internet under Title II of the *Communications Act of 1934*, which allows the application of Common Carrier principles to the regulation of broadband and Internet services. The FCC's new Net Neutrality rules are based on this Title II authority.

South Korea

Internet and Broadband Access

Over the last five decades the Republic of Korea has made huge strides in the deployment, adoption and use of Information and Communication Technology (ICT)[72]. Its progression in ICT "from rags to riches" may contain lessons for developing countries like Brazil and India, which are worth exploring and understanding. Its accomplishments and its way of getting there also offer a number of useful lessons to other nations.

In 1960 Korea had a telephone penetration of 0.36 per 100 inhabitants, barely one tenth of the then world average. By 1981 Korea had caught up with the world average and by the end of 2002 its Tele-density was 48.8%, or almost 3 times the world average. By 2002 some 92% of Korean households had a fixed wireline telephone and 79% had a mobile one. Internet penetration increased from less than 1% in 1995 to 55% in 2002, ranking top in Asia and 3rd in the world. Korea also led the world in broadband Internet access penetration. In December 2002, Korea's penetration of Digital Subscriber Line (DSL) and Cable Modem Internet access was first in the world.

Korea is the leading example of a country rising from a low level of ICT access and adoption to one of the highest in the world. These are astounding achievements given that fact that in 2002 Korea was not among the world's most developed nations, on the basis of GDP per capita. It is classified as an upper-middle-income economy; a group that

[71] www.broadband.gov

[72] International Telecommunications Union (ITU) (2002), "*Broadband Korea: Internet Case Study",* Report prepared by Tim Kelly, Vanessa Gray and Michael Minges, 2002. Accessed on July 29, 2015 http://www.itu.int/ITU-D/ict/cs

included nations such as Argentina, Brazil, Turkey, South Africa and Venezuela. In addition, Korea has its own language and character set and few Koreans speak English well. These factors would tend to work against a high level of Internet access.

Instead, there are other factors besides *wealth* that have contributed to its success. These include:

Government support-The government has assisted the growth of Internet access as well fostered broadband Internet access, on a long term basis[73]. There were a variety of programs to encourage Internet access, such as wiring all primary and secondary schools with free Internet connections and providing training to ten million people, including housewives, soldiers and rural dwellers. The government also offered low-interest loans to companies providing broadband access. A significant point is that the Ministry of Information and Communications (MIC) was allowed to keep all income accruing from its regulatory activities (e.g., license fees, etc.) for funding government programs in the sector.

Urban geography-Though 20 percent of the Korean population resides in rural areas, the 80% who are city dwellers tend to live closely clustered in apartment complexes rather than individual, single family homes, which simplifies the task of providing wireline broadband connections.

Competition-Korea's broadband growth coincided with the introduction of competition in the local loop in April 1999. Hanaro, the new entrant, focused on providing DSL access in an effort to distinguish itself from the incumbent Korea Telecom Corporation (KT), which had focussed on providing ISDN services. In addition, the availability of cable television offered another outlet for providing broadband access. The competition among operators and technologies has resulted in broadband access prices which are among the lowest in the world.

Games-Electronic games are very popular with young Koreans and the development of online games, played initially in Internet cafes ("PC Bangs"), have helped stimulate market demand for broadband access.

Informatization

In Korea, the broadband strategy is part of a much larger, long term, multi-phased national plan for the adoption and use of ICTs to improve productivity and competitiveness across the national economy. The four broad phases, starting in 1978 and continuing up to 2015, include: Implementation of Government Administration Computerization, Diffusion and Expansion of National Backbone Network, Promotion of National Informatization and Establishing Knowledge Information Society[74], the world's first Ubiquitous Society. The policy motto driving this overall strategy may be paraphrased as "late in Industrialization, but leading in Informatization".

This long term strategy has turned Korea into a world leader in the deployment of very high speed broadband networks[75], both wireline and wireless, and in the adoption and use of broadband network based applications and services. In 2005 the OECD ranked Korea as the 1st in broadband penetration per 100 persons, and it has remained in the top 5 ever since. In 2012, with a population of 50 million, it had some 18.1 million wired broadband Internet subscriptions and 52.3 million mobile cellular telephone subscriptions (almost all smart phones).

The promotion of National Informatization has included the following initiatives:

- 1996-2000: 1st Phase Master Plan for Informatization Promotion;
- 1999-2002: Cyber Korea 21
- 2002-2006: e-Korea Vision 2006;

[73] Korea (2010), National Information Society Agency *Korea Informatized : progress and status overview*, 2010. Accessed on July 27, 2015 http://eng.nia.or.kr/

[74] *ibid* .

[75] International Telecommunications Union (ITU) (2015), "*The World in 2015: ICT Facts and Figures".* Accessed on June 8, 2015 http://www.itu.int/en/ITU-D/Statistics/Documents/facts//ICTFactsFigures2015.pdf.

- 2003-2007: Broadband IT Korea Vision 2007;
- 2006: u-Korea Master Plan;
- 2008: National Informatization Master Plan;
- 2009: National Informatization Action Plan;
- 2006-2010:1st Phase u-Korea Master Plan;
- 2011-2015: 2nd Phase u-Korea Master Plan.

The U-Korea Master Plan's vision is to make Korea the first ubiquitous society, based on the world's best u-infrastructure. The elements of the Plan include:

- **Friendly Government**: Streamlining government processes with real-time production and on-site orientated job processing (mobile environment), open government with participation channels for the public and organic growth of government operations (to decentralize towards the regions);
- **Intelligent Land**: focus on intelligent transportation and logistics, ubiquitous use of Radio Frequency Identification (RFID), public utilities;
- **Regenerative Economy**: simplified financial transactions (u-Banking), ubiquitous informatization, facilitating use of IT by SME's and increased cooperation on a sectoral basis;
- **Secure and Safe Social Environment**: provide real-time response systems, automation of dangerous jobs, security at borders;
- **Tailored u-life Service**: invest in school system, social networks, intelligent homes (savings on public utilities).

The Plan is in two phases: **Establishment Phase 2006-2010** and **Stabilization Phase 2011-2015.** This includes the deployment of an Ultra Broadband Convergence Network (UBCN), which will focus on the seamless integration of the wireline and wireless telecommunications infrastructure. The "Government as a Model User" component for the informatization of government services includes a variety of ICT based applications, including the deployment of a nationwide electronic government procurement system (KONEPS).

"Smartization"

However, in 2013 there was a turning point in Korea's very successful national Informatization strategy. The strategy, which had been focussed on ICT infrastructure, ICT industry and ICT use, is now about to make a shift towards a strategy focusing on smart infrastructure, smart industry, and smart use with added mobile features[76]. The new imperative will be to upgrade the positioning of Korea, in terms of an ICT powerhouse, to that of smart technologies. The paradigm shift will be from Industrialization to Informatization to "Smartization".

The changes in the new environment include innovation based on new technologies such as mobile communications, big data, cloud technologies, increased convergence, emergence of the hyper-connectivity environment where all things connect and interact with one another, and evolution to ICT-based services that are intelligent and human-oriented. Hyper-connectivity means an environment where all things and human users are always connected to each other via smart networks. This is usually referred to as the Internet of Things and Machine-to-Machine (M2M) communications will predominate in this environment. According to a Gartner report, by the year 2020 the number of people using the Internet will reach 5 billion but the number of devices connected to the Internet will exceed 100 billion. Cisco has made similar large forecasts for M2M connections and transactions.

[76] Korea (2013*),* National Information Society Agency *2013 National Informatization White Paper,* Nov. 13, 2014. Accessed on July 27, 2015 http://eng.nia.or.kr

Brazil

Exhibit 1: Details of Leading Brazilian Telecom Operators

Rank	Operator	Subscribers *(in mn)*	Ownership Pattern
1	Vivo Participacoes	79.35	Portugal Telecom and Spain's Telefonica
2	TIM Brasil	74.20	Subsidiary of Telecom Italia Mobile
3	Claro	68.77	America Movil
4	Oi (formerly Telemar)	51.08	CorpCo, a JV with Portugal Telecom

Source: http://techinbrazil.com/brazilian-mobile-operators-in-a-nutshell

India

To review the Indian Broadband strategy, we must examine the context in which it must operate. India, a federal country with 29 States and Union Territories, has a population of some 1.25 billion (2014 estimate). Some two-thirds of the population still lives in 620,000 villages, although the urban population is growing rapidly due to a migration from rural areas to the cities and towns which are thought to offer greater economic opportunities. There is a major urban-rural infrastructure divide, which includes transportation, electricity and communications.

As of December 2014 there were only 27 million wireline telephones in India, which were overwhelmingly concentrated in the urban centres, but some 944 million cell phones subscribers (almost 35 times the number of wireline telephones)[77] (see Appendix 1). Over 10 million cell phone subscribers were being added each month and the wireless Tele-density was 75.4%. Although the vast majority of these cell phones used 2G services (voice calling and text messaging), operators were also simultaneously deploying 3G services. The number of wireless broadband users, estimated at 248.06 million, far exceeded the number of wireline broadband users, estimated at 15.32 m.

As of December 2014 there were some 302 million claimed Internet subscribers, and 248 million mobile broadband subscribers. The long haul core or the backbone connecting the major cities was largely fibre based. There was also a significant amount of fibre in the Middle Mile networks to the smaller cities and towns. **The real gap was in the last mile network infrastructure, both in the urban and especially the rural areas.**

TRAI's Broadband Recommendations

The Telecom Regulatory Authority of India (TRAI) came out with its Recommendations on National Broadband Plan in December 2010. The plan had three major components:

1) Access networks to have predominantly wireless connectivity and for rural areas, which would be supplemented by a fibre backhaul. LTE, mobile WiMax and other technologies were envisaged for the wireless connectivity. The DSL or cable connectivity option, so popular in many developed countries, was not a feasible option due to the low number of existing fixed line connections (33 million – 8 and 25 million respectively in rural and urban areas), nearly 50% of which were estimated to be of adequate quality to get DSL enabled. Given that there were nearly 153 rural and 78 million urban households in 2011, DSL connectivity was not an option for proliferation of broadband in the access network.

Even when DSL connectivity was technically feasible from the network operators' perspective, the cost of the modem and PC were deterrents to the adoption of broadband. Given the limitations on availability of DSL, TRAI

[77] Telecommunications Regulatory Authority of India (TRAI) (2014) Annual Report, December 2014. Accessed June 8, 2015, http://www.trai.gov.in

had considered the wireless option and spectrum requirements for the access network in cities of different sizes and villages.

2) The TRAI Broadband Plan considered the option of FTTX for urban areas as well as for connecting to the villages in a phased manner. The plan was based on using the existing fibre based connectivity of all cities as backhaul.

TRAI proposed setting up of a National Optical Fibre Agency (NOFA) and State Owned Fibre Optic Agencies (SOFA) in each of the states. NOFA was envisaged as a wholly owned holding company responsible for overseeing the overall architecture, planning, procurement, deployment and maintenance of the shared fibre infrastructure. NOFA would have the necessary scope to be able to raise finances and take equity stakes in the SOFAs. The shared infrastructure of NOFA and SOFA would be made available on a commercial basis on TRAI regulated charges to any service provider.

3) Deployment of digital, addressable cable networks in a phased manner was an important aspect of broadband plan. Subsequently, the Parliament had passed the *"The Cable Television Networks (Regulation) Amendment Bill, 2011"* mandating the same on December 19, 2011. The process of digitalization was envisaged to be completed by December 31, 2014.

The National Telecom Policy - 2012

The Government of India approved the National Telecom Policy 2012[78] (NTP-2012) on May 31, 2012. The primary objective of NTP-2012 is maximizing public good by making available affordable, reliable and secure telecommunication and broadband services across the entire country. The thrust of the Policy is on the multiplier effect and transformational impact of such services on the overall economy. It recognizes the role of such services in furthering the national development agenda, while enhancing equity and inclusiveness. The Vision, Objectives and Strategies of NTP – 2012 are summarized below.

The **Vision** is **to provide secure, reliable, affordable and high quality converged telecommunications services anytime, anywhere for an accelerated, inclusive socio-economic development.**

There are 36 separate **Objectives**. For this paper some of the most relevant objectives are:

- Provide secure, affordable and high quality telecommunication services to all citizens;
- **Increase rural tele-density from the current level of around 39% to 70% by 2015 and 100% by 2020;**
- Provide affordable and reliable broadband-on-demand by 2015 and **to achieve 197 million broadband connections by 2017, and 600 million by 2020, at a minimum 2Mbps download speed, and making available higher speeds of at least 100 Mbps on demand;**
- **Provide high speed and high quality broadband access to all village panchayats, through a combination of technologies by 2014, and progressively to all villages and habitations by 2020;**
- Strive to create ***One Nation – One License*** across services and service areas;
- Achieve ***One Nation – Full Mobile Number Portability*** and work towards ***One Nation – Free Roaming***;
- ***Reposition the mobile phone from a mere communications device to an instrument of empowerment that combines communication with proof of identity, fully secure financial and other transaction capability, multi-lingual service and a whole range of other capabilities that ride on them and transcend the literacy barrier;***
- Ensure adequate availability of spectrum and its allocation in a transparent manner through market related processes. ***Make available additional 300 MHz spectrum for IMT services by 2017 and another 200 MHz by 2020.***
- Promote efficient use of spectrum with provision of regular **audit of spectrum usage**;
- De-licensing additional frequency bands for public use;
- Address the Right of Way (RoW) issues in setting up of telecom infrastructure;
- Mandate an ecosystem to ensure setting up of a ***common platform for interconnection*** of various networks, for providing non-exclusive and non-discriminatory access;

[78] Government of India (2012) National Telecom Policy 2012. Approved on 31.05.2012. Ministry of Communications & IT, Department of Telecommunications (Policy – I Section).

- **Recognize telecom as an Infrastructure Sector**, to realize the true potential of ICT for development;
- Evolve a **policy framework for financing the sector**, consistent with long term sustainability.

The National Telecom Policy - 2012 does not specifically mention any institutional mechanism for broadband deployment, despite emphasizing the role of broadband in the future. A variety of Strategies are proposed in various areas including Broadband, Rural Telephony and Universal Service Obligation Fund (USOF); R&D, Manufacturing and Standardization of Telecommunication Equipment; Licensing, Convergence and Value Added Services; Spectrum Management; and Telecom Infrastructure / ROW issues, Green Telecom, etc.; Security; Skill Development; Public Sector; Cloud Services; Financing of Telecom Sector; Role of Regulator and Changes in Legislation; and Operationalization of the Policy.

Important proposed Broadband strategies include:

- To recognize telecom, including broadband connectivity as a basic necessity like education and health and work towards a "**Right to Broadband**";
- To lay special emphasis on **providing reliable and affordable broadband access to rural and remote areas** by appropriate combination of optical fibre, wireless, VSAT and other technologies. **Optical fibre network will be initially laid up to the village panchayat level, by funding from the Universal Service Obligation Fund (USOF);**
- To revise the existing broadband download speed from 256 Kbps to 512 Kbps and subsequently to 2 Mbps by 2015, and higher speeds of at least 100 Mbps thereafter;
- To establish appropriate institutional framework to coordinate with different government departments/ agencies for laying and upkeep of telecom cables including Optical Fibre Cables, for rapid expansion of broadband in the country;
- To promote synergies between rollout of broadband and various Government programs like viz. e-governance, e-panchayat, MNREGA, NKN, AADHAR, etc.;
- To **ensure availability of adequate spectrum** to meet current and future demand for for microwave access/ backhaul, in appropriate frequency bands;
- To ***leverage the mobile device and SIM Card with enhanced features*** for enabling secure transactional services including online authentication of identity and financial services.

The relevant spectrum management strategies are as follows:

- To move at the earliest towards liberalization of spectrum to enable use of spectrum in any band to provide any service in any technology, as well as to permit spectrum pooling, sharing and later, trading, to enable optimal utilization of spectrum through appropriate regulatory framework;
- To undertake periodic audit of spectrum utilization, to ensure its efficient use;
- To refarm spectrum and allot alternative frequency bands or media to service providers from time to time, to make spectrum available for introduction of new technologies for telecom applications;
- ***To prepare a roadmap for availability of additional spectrum every 5 years;***
- **To make available adequate globally harmonized IMT spectrum in 450 MHZ, 700 MHz, 1800 MHz, 1910 MHz, 2.1 GHz, 2.3 GHz, 2.5 GHz, 3.5 GHz bands, and other bands to be identified by ITU for commercial mobile services;**
- To identify additional frequency bands periodically, for **exempting them from licensing requirements** for operation of low devices for public use;
- To **review the existing geographical unit of allocation of spectrum**, with a view to identifying scope for optimization;
- To promote use of white spaces with low power devices, without causing harmful interference to the licensed application in specific frequency bands by deployment of Software Defined Radios (SDRs), Cognitive Radios (CRs), etc.

The following Strategies proposed for the Financing of Telecom Sector:

- To create a Telecom Finance Corporation as a vehicle to mobilize and channelize financing for telecom projects, in order to facilitate investment in the telecom sector;
- To endeavor to include telecom sector projects within the ambit of financing from exiating entities;
- To rationalize taxes, duties and levies affecting the sector and work towards providing a stable fiscal regime to stimulate investments and making services more affordable.

NTP – 2012 also recognizes the predominant role of the private sector in telecommunications and the consequent policy imperative of ensuring the continued viability of service providers in a competitive environment. Pursuant to NTP – 2012, these principles and objectives would guide decisions needed to strike a balance between the interests of users/consumers, service providers, and government revenues.

Exhibit 2 - Top Five Telecom Operators with Revenue and Area of Operation

Sr No	Service Providers	Revenue *(Rs bn)*									Category
		05-06	06-07	07-08	08-09	09-10	10-11	11-12	12-13	13-14*	
1	Bharti Airtel	113	179	264	370	418	595	714	803	857	Mobile, Broadband & Internet, Digital T Wireless Internet, Email on the go, Callir Conferencing
2	Vodafone	68	106	155	204	236	273	354	356	376	Mobile, Wireless broadband
3	Idea Cellular	30	44	67	101	124	155	195	221	265	Mobile, Wireless broadband
4	BSNL	402	401	353	352	321	288	284	264	265	Bfone Telephone, EPABX, ISDN, Taran Broadband, Leased Line, Telex Telegrap Intelligent Network, I-Net, HV-Net, RAI Transponder, CellOne Mobile Service
5	Rel. Comm.	108	145	186	229	221	231	204	218	223	Wireless, Broadband, Rural Communicat Data Center (IDC)
Total of Top Five		721	875	1025	1256	1320	1542	1751	1862	1986	

Source: Voice&Data, from various editions, available at http://voicendata.ciol.com/, accessed on July 24, 2015
*Revenue for year 2003-04 till 2012-13 is the actual while for the year 2013-14 is estimates

National Optical Fibre Network (NOFN) and Bharat Broadband Network Ltd. (BBNL)

National Optical Fibre Network (NOFN) will connect 250,000 village administrative units (VAUs) with high speed (100 Mbps) broadband network. Such a network would "transform governance, service delivery and unleash local innovation capacity through rural broadband"[79]. For appropriate applications and skill development to happen, a number of ministries such as the Ministries of Rural Development, Panchayati Raj[80], Human Resource Development (HRD), Health and the National Council on Skill Development would work together.

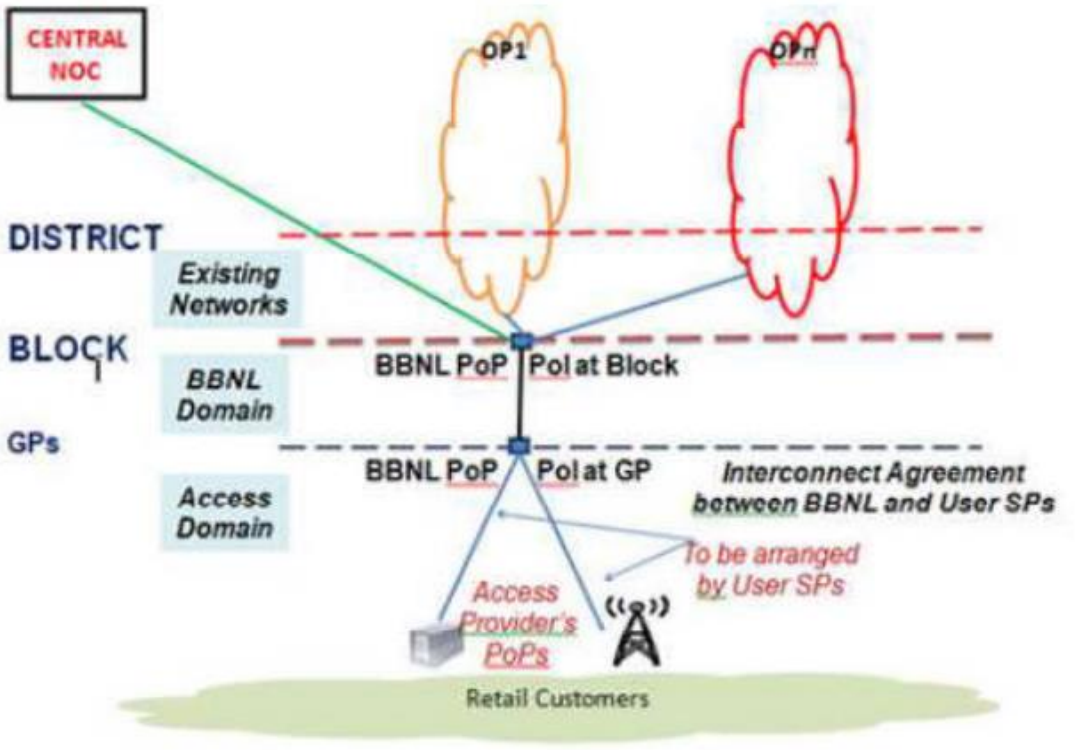
The Department of Telecommunications (DoT) created a high level committee (HLC) under the PM's Office headed by Mr Sam Pitroda and Mr Nandan Nilekani, Chairman, Unique Identification Authority of India (UIDAI) on April 26, 2011 to implement the NOFN. The HLC was responsible for developing a framework for implementation including the technological architecture, budgets and other issues related to NOFN. The NOFN had an estimated cost of Rs 200 bn, which would be provided for by the Universal Service Obligation Fund (USOF). This was justified as NOFN provided rural connectivity.

A new, wholly owned Special Purpose Vehicle (SPV) – Bharat Broadband Network Limited (BBNL) - was created to establish and manage the NOFN. It would leverage the existing fibre optic resources of three government owned companies (Public Sector Units or PSUs):
i) Bharat Sanchar Nigam Ltd. (BSNL), the public sector wireline telecommunications carrier;
ii) RailTel Corporation of India Limited (RailTel), a wholly owned subsidiary under the Ministry of Railways;
iii) Power Grid Corporation of India Limited (PGCIL), the central electricity transmission utility under the Ministry of Power.

[79] National Knowledge Commission, http://knowledgecommission.gov.in/ , accessed on October 11, 2013
[80] Gram Panchayats are village administrative units. India has some 620,000 villages.

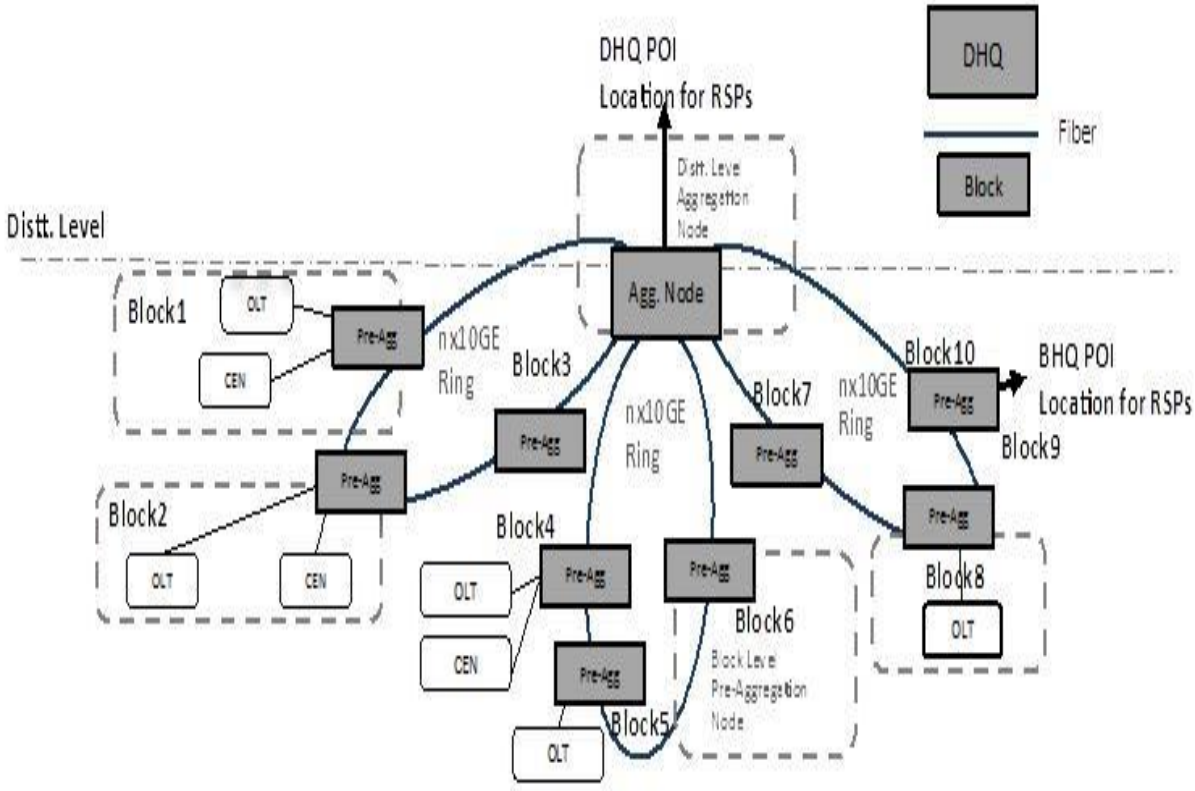
Both RailTel and PGCIL already had the mandate of creating broadband infrastructure for their own operations and to also utilize the remaining capacity for telecom services. These fiber optic resources were largely limited in their extent to the sub-district or block level (a block consists of a number of villages and functions as an economic development unit). NOFN was designed to lease capacity from these PSUs and build the incremental fibre infrastructure where it was unavailable. NOFN would thus provide connectivity from the blocks to the VAUs. The ownership of the fibre optic shared infrastructure would be that of the respective agencies.

Exhibit 3: Conceptual Diagram of NOFN



Source: http://bbnl.nic.in/upload/uploadfiles/files/6_%20NOFN%20Pilot%20Report%20-%20Feb%202014.pdf, accessed on August 6, 2015.

Exhibit 4: Middle Mile (DHQ-BHQ) Service Orchestration Layer



Source: Report of the Committee on National Optical Fibre Network (NOFN)

Malaysia

Exhibit 5: Details of Leading Malaysian Telecom Operators

Rank	Operator	Subscribers *(mn)*	Ownership Pattern
1	Celcom	13.4	Axiata Group Berhad
2	Maxis	12.4	Ananda Krishnan Saudi Telecom Company
3	DiGi	10.9	Telenor (49%) & Employees Provident Fund (Malaysia)
4	U-Mobile	4.0	U TV & STT Communications (33%) & MPHB Capital Bhd. (7.72%)
5	Tune Talk	1.5	Axiata Group Berhad & Tune Group

Source: http://www.forest-interactive.com/wp-content/uploads/2014/06/SEA-Statistics-2014-02.png, accessed on July 24, 2015

Table 2: Subscription of Wireless Broadband 2013

Technologies	**Subscription of Wireless Broadband** *('000)*	**%**
Mobile Broadband	3287.7	86.9
WiMAX	283	7.5
Subscription at KTW	197.2	5.2
LTE	8.8	0.2
EV-DO	6.4	0.2
Total	3783.10	100

Source: Source: Malaysian Communications and Multimedia Commission Annual Report 2013

Table 3: Household Broadband Penetration 2009-2013

Year	**Household Broadband Penetration** *(%)*
2009	31.7
2010	55.6
2011	62.3
2012	66.0
2013	67.1

Source: Malaysian Communications and Multimedia Commission Annual Report 2013

Table 4: Fixed Line Broadband Subscriptions by Technology, 2013

Technology	**Fixed Line Broadband Subscriptions** *('000)*
xDSL	1,599
FTTx	700
Others	6

Source: Malaysian Communications and Multimedia Commission Annual Report 2013