

Consultation Paper No. 6/2003



TELECOM REGULATORY AUTHORITY OF INDIA

Consultation Paper

on

Accelerating Growth of Internet and Broadband Penetration

New Delhi

November 28, 2003

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Preface

India has seen rapid growth in the business process outsourcing (BPO) model and the country has been focusing on establishing itself as a knowledge-based society. Major opportunities will appear here as this is realized. Yet, internet and broadband penetration is low. For our knowledge-based society to grow quickly and various economic opportunities to become a reality, the spread of Internet and broadband needs should to be given top priority.

TRAI has taken several initial steps in the area of telephony, which have led to growth and wider availability of telecommunications services, reduction in tariffs from the competition among telephony service providers, and introduction of better technologies. This has been achieved through a process, which within a relatively short period has replaced cooptition or informal market sharing among service providers, with a market based on intense competition. The consequent decline in tariffs and dynamic focus on increasing subscriber base has led to mobile growth rates in the present year about twelve times that of the average annual growth rate of the previous seven years.

With greater convergence of technologies, internet and broadband can play a crucial role in rapidly improving the scope and coverage of our initiative to achieve wide reaching social and economics objectives. To complement and advance the policy initiatives in the area of telephony, the next initiative, perhaps even stronger than the previous ones, must come in the form of promoting penetration of internet and broadband. Additionally, as a new Unified Licensing Regime is constructed, the services that internet connections make possible, especially high speed connections, will need to be part of the consideration process.

One of the objectives of NTP99 is to create a modern and efficient telecommunications infrastructure which takes into account the convergence of data, media, telephony, and consumer electronics to propel India into becoming an IT superpower. Accordingly, NTP99 specified targets of providing high-speed data and multimedia capability using technologies including ISDN to all towns with population

greater than 200,000 by the year 2002. In reality, Internet and broadband have grown slowly. At present, internet based education and e-commerce are virtually nonexistent. The internet is available on fixed telephone lines using dialup access, but only at an average throughput of 10 kbps and a charge of approximately Rs.30 per hour. The recent release of the International Telecommunication Union's (ITU) Digital Access Index, which measures access to ICT services, ranks India at 119 among 178 countries – just four ranks away from the bottom of the category of classification under which India is placed.¹

Broadband and internet access are widely recognized as catalysts for economic development of a country in the long run. The development of broadband is also creating a paradigm shift in levels of available information, and therefore in accountability, particularly in government processes. Wider public access to government information underscores a commitment to democracy and good governance. Availability of broadband services at affordable price-levels will have a positive impact on gross domestic product (GDP) and the resulting economic structures are likely to attract new investment, create jobs, and increase productivity through infrastructure build-up and access to new and improved services.

I am quite hopeful that this paper would provide the necessary platform for discussing this important issue and would enable us to make significant progress in growing internet and broadband penetration. The consultation paper has already been placed on TRAI's website (www.trai.gov.in).

I request that written comments on this consultation paper please be furnished to Secretary TRAI by December 21st, 2003. For any further clarification on the matter, Secretary TRAI or Advisor (CN) may be contacted at traio7@bol.net.in (Ph No. (0)11-26167448) or traio9@bol.net.in (Ph No. (0)98-10323346) respectively.

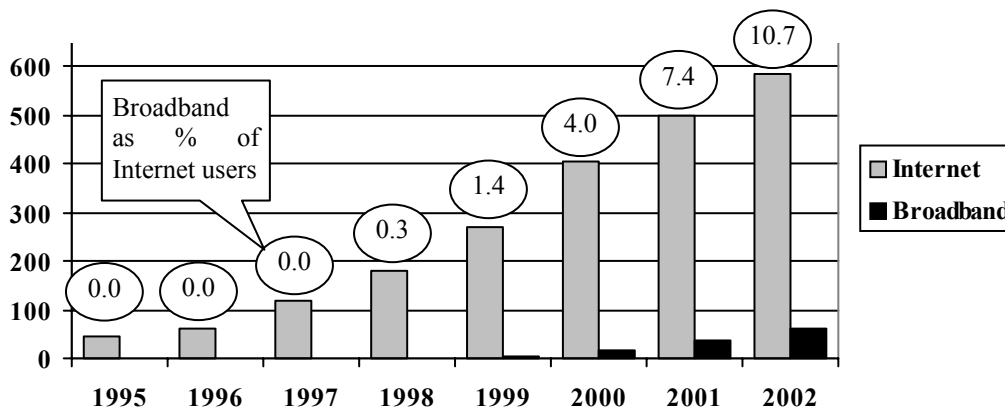
(Pradip Baijal)
Chairman, TRAI

¹ ITU Digital Access Index: World's First Global ICT Ranking , November 19, 2003

Chapter 1 Introduction

1.1 Introduction

1.1.1 The internet is growing at leaps and bounds around the world and broadband is rapidly becoming a large part of the growth (please refer to Figure 1-1²). As the effects of globalization are felt by all economies, including ours, the internet becomes a key medium in creating opportunities for growth and development. The growth of India's various information technology sectors, especially in business process outsourcing services, is evidence to the tremendous effect that inter-connectivity with nations around the world can have. Add to that the advantages that India has already leveraged and continues to do so, and it seems almost all the ingredients are in place for dramatic change in this country.



1.1.2 Not unlike the explosion recently witnessed in the telephony space, which was waiting for the right moment to occur, another explosion in internet pervasiveness is right around the corner. What triggered the events in telephony were efforts by government bodies, service providers, industry agencies, and consumer groups. Similarly, actions in internet and broadband must also be taken to cause another such surge.

² Source of figure: ITU World Telecommunications Indicators Database

1.1.3 The Authority is very much concerned about the dismal state of internet growth and broadband access in the country. There are many factors which are inhibiting the growth we desire, while there is also much that we can learn from the experiences of other developing countries.

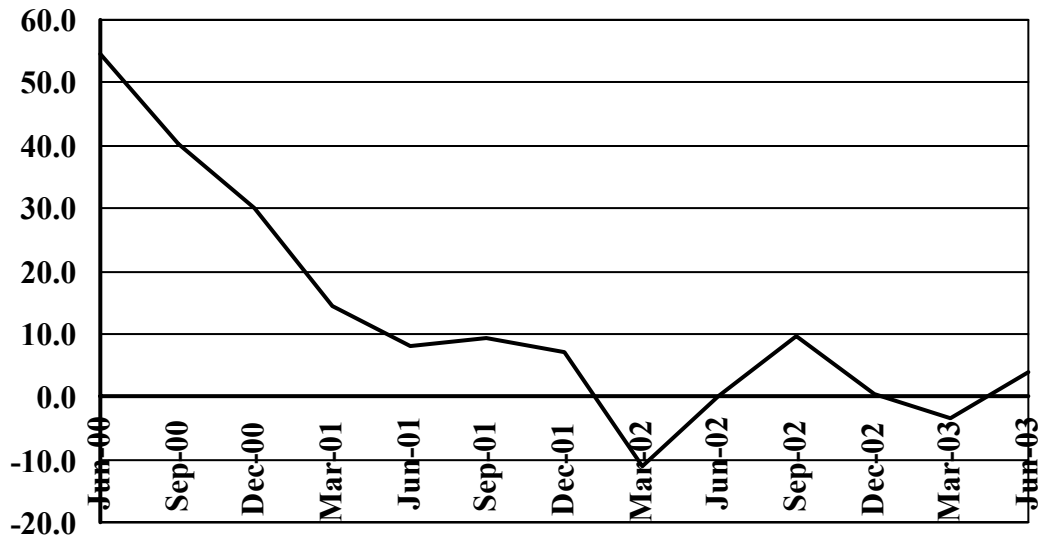
1.1.4 The objective of this consultation paper is to describe the current environment by taking a broad snapshot of where the country stands. Further, it appraises past work in this space and the recommendations from that effort. Next, the paper discusses the major policy, and fiscal and other incentives employed by a couple of other countries to successfully spur growth. Also examined are lessons from domestic successes. The paper also looks at various methods, including technologies, which are prevalent in today's market that India can take advantage of. Finally, it ends with issues for consideration and further discussion.

1.1.5 All stakeholders are requested to give their opinion on these issues through this consultation process.

1.2 Background

1.2.1 As is well-known, subscriber growth rates for internet access have already bottomed out. The government announced the ISP policy in November 1998 to facilitate and encourage entry of private sector operators and others as Internet Service Providers. Innovative packages and reduction in access charges coupled with some new ISP's offering free access helped the initial spread of internet in the country. An increase in PC penetration and tele-density during 2000-01 also helped growth in the initial phases. The subscriber base grew at rates near 200% during those years, but it has been almost stagnant since then. The subscriber base is in the range of 3.5 – 4.0 million, resulting in a penetration rate of only 0.4%. As can be seen in Figure 1-2 below, growth rates have gone from 55% to negative levels, even as recently as March of this year.³

³ Source of figure: The Indian Telecom Services Performance Indicators April – June 2003, Telecom Regulatory Authority of India, September 2003

Figure 1-2 – Growth Rate of Internet Subscribers in India

1.2.2 Broadband is even further behind and has very minimal penetration. One of the tasks of this consultation will be to define what qualifies as broadband. According to the Organization for Economic Cooperation and Development (OECD), broadband corresponds to transmission speeds greater than 256 kbps. The International Telecommunication Union (ITU) defines it even higher, at 1.5 Mbps, but both agree that it is faster than ISDN. An online survey conducted by TRAI has also shown that users consider broadband to be an always-on connection with download speeds faster than 128 kbps. Therefore, this report will also rule out ISDN as a broadband technology, even though certain service providers are marketing it as such. Additionally, broadband refers only to the last mile connection to the end user, even though many of the technologies can be used for backbone infrastructure.

1.2.3 Another pivotal task of this consultation paper will be to define what should be our annual goals for internet and broadband penetration over the next five years. The Chinese government, for example, has set a target of 200 million internet users by 2005, or a density of 15.6 users per 100 inhabitants. Additionally, their goal is that 30 to 40% should be via broadband access.⁴

⁴ China Broadband Overview, Point Topic, April 7, 2003

1.2.4 The importance of internet usage and broadband penetration has been recognized worldwide, as the ITU states, “For governments, broadband is a way of promoting economic development and certain social benefits. For telecommunication companies, broadband offers a route to offset the current slowdown in the industry and add additional diversified revenue streams. For consumers, broadband makes possible a much wider and richer range of applications, especially when higher speed services are available. For businesses, in particular small and medium sized enterprises, broadband brings the advantages of access to high speed communications, and the ability to reach a worldwide audience that was previously only available to larger companies.”⁵ While it is acknowledged that broadband will help address the global slowdown in the industry, in India it will take the country to new heights.

1.3 Structure for Growth

1.3.1 Generally speaking, internet usage is driven by three main factors. These criteria are the basis for a framework for evaluating how the many forces in this environment interact with each other. The factors are “Infrastructure for Access”, “Access Device”, and “Content”. Each of these considered independently drives the value of the other. Additionally, decisions of implementation made in one, are distinct from the other. A brief explanation of each follows.

1.3.2 Infrastructure for Access

This refers to the connectivity that the end-user, whether residential or corporate, gets in order to connect to the internet. It also refers to the complete connection to the final source of information that the end-user is seeking. This means that not only is this in reference to the last-mile infrastructure, but also to the ISP’s connectivity domestically and finally abroad. This infrastructure for access includes both downstream and upstream connectivity. Because of its general description, it can be a dedicated data connection, or simple dial-up over PSTN access. The connection can be wire-line or wireless. Finally, it should be noted that the choice of infrastructure does not limit or necessarily influence the choice of access device.

⁵ Birth of Broadband, ITU Internet Reports, September 2003

1.3.3 Access Device

This refers to the interface that the user has with the internet and its contents. It is the device that is used when establishing a connection over the available infrastructure, and is the means with which the user can access and interact with the content that she is searching for. The most common incarnation of this is the personal computer (PC), but is not limited to that. Though most users of the internet around the world today use a PC as their access device, large opportunities exist for alternatives to this.

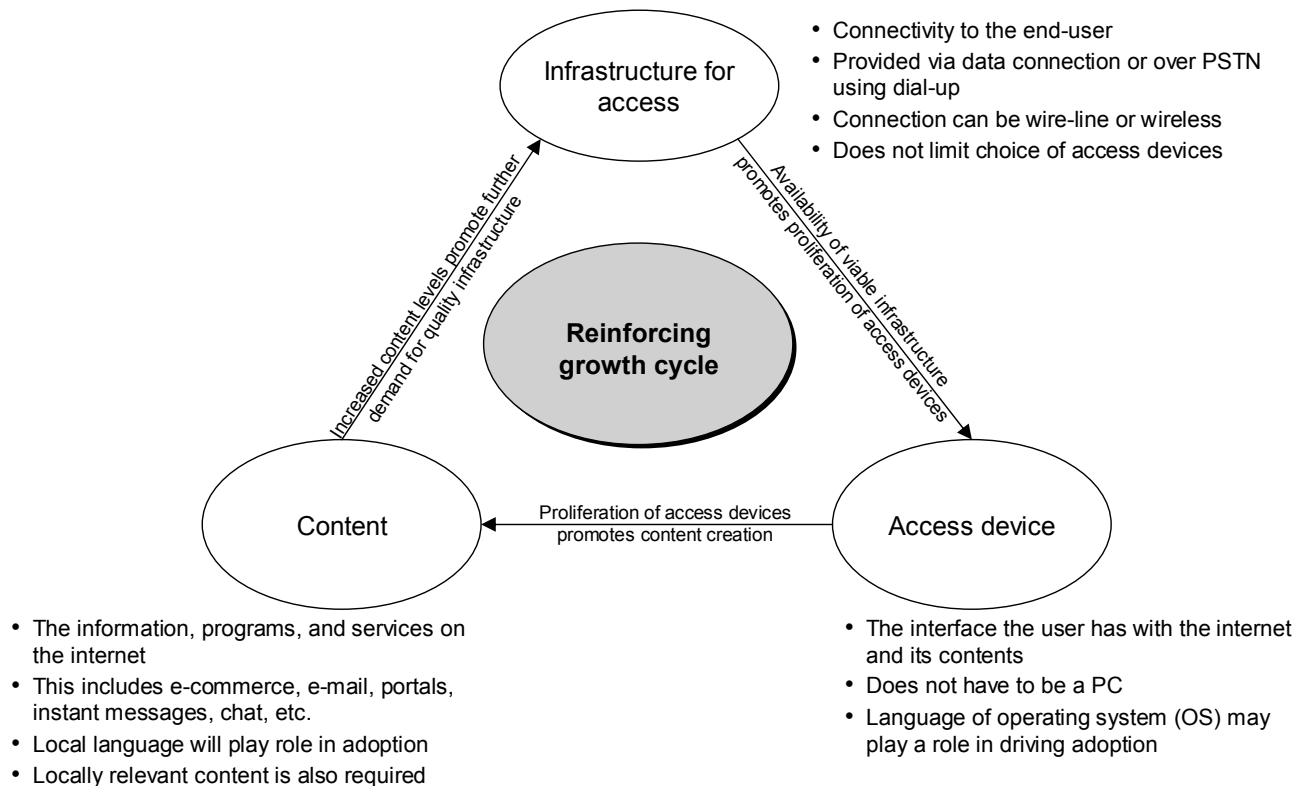
1.3.4 Content

This refers to the information, programs, and services accessed by users on the internet. Content includes portals, informational sites, e-mail, instant messaging, chat, e-commerce, as well as many other sub-categories. The content is not only that intended for use by consumers, but also includes business to business communications and commerce.

1.3.5 Overall, these three factors are related in the following way. Availability of viable infrastructure promotes proliferation of access devices. By providing the opportunity for these access devices to connect to each other, infrastructure adds increased value to access devices which otherwise may not be viewed as highly useful. Proliferation of access devices then further promotes development of content. Creators for content are encouraged to localize and specialize once they see that end-users of their content have the ability to access it. Finally, increased content creation itself further promotes demand for quality infrastructure. This demand not only comes from content seekers, but also from content providers looking for reliable hosting and provider services. This reinforcing growth cycle, or virtuous growth cycle, is what needs to be initiated before self-sustaining organic development is achieved. Please refer to Figure 1-3 below for a graphical representation.

Figure 1-3 – Factors to Growth of Internet and Broadband Penetration

INTERNET USAGE IS DRIVEN BY THREE DISTINCT FACTORS THAT DRIVE THE GROWTH OF THE OTHERS



1.4 Hurdles to Growth

1.4.1 Looking at today's environment in India, there are some clear hurdles to development in all three main factors. Combined, these hurdles have hindered growth and will need to be addressed systematically as attempts to trigger development are undertaken.

1.4.2 Infrastructure Hurdles

1.4.2.1 Considering first infrastructure, consumers are faced with problems centered on access, quality and cost. Some of the hurdles to basic internet usage through dial-up are:

- The high cost of installation of wire-line telephones, which then drives up rental and usage costs, is driving users to wireless technologies. These do not currently support dial-up access at sufficient speed and quality
- The cost of dial-up internet access, when accounting for both the charges paid to the basic service provider (BSO) and the ISP is high. This is especially true when considering that users in an urban setting are able to interact at only 10 kbps, even though they may connect at higher speeds
- When further considering that these connections display low levels of reliability because of frequent disconnections due to either the BSO or the ISP, customers ending up paying for more time than they are actually connected
- Finally, if low international bandwidth is taken-up by ISP's as compared to what is required given the volume of traffic going abroad, it deteriorates the overall usage experience. This may be due to the high costs charged to ISP's for international connectivity. The lack of a completed national internet exchange and sites hosted within the country are the main drivers for the high levels of international traffic

For the average user, the experience of simply sending an e-mail from a portal like Hotmail becomes a tedious process where each e-mail most likely costs her over Rs. 1.

1.4.2.2 The broadband market also has its own hurdles:

- Many challenges exist in the segment of last mile connectivity

- In India, cable TV infrastructure is not of sufficient quality in most places to allow for reliable bi-directional communication. Additionally, the management and ownership structure is very unorganized and controlled by too many parties
- The copper local loop is viable in most areas, but it is controlled primarily by the incumbent operators, BSNL and MTNL
- Competitive BSO's copper is not widespread enough because of the high cost of installation and alternative technologies like WLL being available
- Fiber is expensive to install in the last mile, especially in areas with spread out population, hence it is being used primarily to wire apartment buildings and commercial complexes
- The bulk of current wireless infrastructure in the country can not support reliable high speed data connectivity, though it is upgradeable to existing and emerging technologies to support broadband. Newer installations of CDMA in some instances already incorporate this, but it is not certain whether current network design and spectrum allocation would support high levels of usage
- Similar to dial-up, but further accentuated in broadband, users experience the limited upstream bandwidth and international connectivity problems. ISP's are burdened with the high costs they have to pay for both domestic and international private leased circuits (IPLC)
- The cost of customer premise equipment, such as VoIP devices, DSL/cable modems, set-top boxes, wireless LAN equipment (WiFi) and customer-end radio communication equipment, is high. This is driven by the relatively high customs duties on imported equipment

1.4.2.3 Though some users in metropolitan areas have signed up for broadband services, and certain BSO's and ISP's are experimenting with various offerings, these are all in their nascent stages of development with low levels of quality in several cases. Additionally, as the ITU points out, "It is also important to bear in mind that

broadband speeds are only as fast as the slowest portion of the network connecting them to the internet.”⁶

1.4.3 Access Device Hurdles

1.4.3.1 Other challenges exist in the access device part of the growth factors. Even today the cost of end-user devices is too high. Much of this is due to high rates of domestic and import duties on PC equipment. Other cost components are the high price for the Windows operating system, unreliable electricity creating the need for battery back-up or power generation, and lack of incentive for a wide-scale PC recycling program. Today many corporations, government organizations and institutes of higher learning are regularly discarding used equipment as they upgrade, and without significant tax incentives in place, have little motivation to make an extra effort to recycle these for the use of schools, community centers and lower income households. This lack of incentive has also prevented establishment of an industry segment specializing in this at any significant scale. In Canada, the government has implemented a policy of donating all of their PC’s that have been accounted for as fully depreciated to schools for refurbishing.⁷

1.4.3.2 Furthermore, current alternative access devices (e.g. Simputer) do not have significant cost savings for the level of features that they provide, and there is no widespread business model for bundling the access device (PC or alternate) with internet services at a monthly installment rate like some mobile service companies are doing (please refer to Chapter 3 – Domestic Successes and Appendix 2 – Case Studies for more detail). There is also no prevalent maintenance and replacement program for these devices on offer. Finally, the lack of availability of significant local language operating systems and applications further creates barrier to growth.

1.4.4 Content Hurdles

On the content front, the primary driver is a lack of incentive for content providers to invest in the space. Because of the limited number of users accessing the World Wide Web and the limited amount of time that even those users spend on it, business are

⁶ Birth of Broadband, ITU Internet Reports, September 2003

⁷ Industry Canada, www.ic.gc.ca, November 24, 2003

reluctant to spend money where they feel there is no return. This then limits the quantity of specialized, local and applicable content available to users in the country. Other elements of this framework are the early stage of financial and logistics infrastructure to support large scale business to consumer e-commerce transactions, and the levels of protection from piracy available.

1.5 TRAI's Task Force on Growth of Internet in the Country

1.5.1 Last year, TRAI had undertaken a project to address the issue of slow growth of the Internet services in the country. This task force consisted of experts from MOC&IT, IIT, IIM, C-DOT, TEC and ISPAI in addition to TRAI representatives. The main objective of the task force was to prepare an action plan to achieve faster growth of internet in the country and recommend an implementable methodology to facilitate the establishment of Internet Exchange Points (IXP) for peering within the country. The deliberations of the task force spread over six meetings during May – August 2002.⁸

1.5.2 The task force came up with a total of 13 recommendations:

- Infrastructure
 - Create internet exchange in India
 - Reduce tariff for international leased lines
 - Reduce dial-up access tariff by BSO's
 - De-license 2.4 Ghz band for last mile access
 - Permit receive only satellite by ISP's without requiring SACFA clearance
 - Permit co-location of ISP equipment at BSO exchange
 - Treat ISP in infrastructure category to allow concessions in taxes
 - Reduce duty on ISP and customer premise equipment
 - Diversify access technologies for last mile to include DSL, cable and W-LAN's
- Access devices

⁸ Report of Task Force on Growth of Internet in the Country, TRAI, August 2002

- Enable availability of low cost internet access devices and indigenous PC's
- Facilitate donation of used PC's by corporate entities, government and higher educational institutions via tax incentives
- Content
 - Implement e-governance and citizen services over internet
 - Foster local content development

Please refer to Table 1-1 in Appendix 1 – Background for an update on each recommendation.

Chapter 2 International Experience

2.1 Overview

2.1.1 India is a growing country in all regards. Even with its tremendous growth in the information technology sector, overall ICT usage and penetration in country still lags behind international averages. This section explores what we can learn from some countries that have had success in driving growth and usage of internet. Key comparative indicators show that India has plenty of scope to grow. Please refer to Table 2-1 below.

Table 2-1 – Key Internet and Broadband Indicators (Mid-2003)⁹

	Parameters	Korea	Malaysia	China	India
Access & Infrastructure	No. of PCs per 100	78.6	15	2.8	0.8
	No. of cable TVs per 100 persons	43	0	9	6
	No. of fixed telephone lines per 100 persons	49	18.5	16.7	4.5
	No. of mobile phones per 100 persons	68	39.6	16.1	2.4
	Cost of PC (USD)	[500]	1,100	-----	600
	Cost of cable/DSL modem (USD)	60	----	-----	100
	GDP (USD Per capita)	10,000	4,000	965	465
Internet Usage	No. of internet connections per 100 persons	58	11	2	0.4
	No. of users per 100 persons	59.4	33	5	1
	Average revenue per user from an Internet customer per month (20 hrs, USD)	N/A	10	-----	9
Broadband	No. of broadband connections per 100 persons	57.5	0.21	1	0.02
	Charges for broadband per month (USD)	30	29	16	20
	Charges per 100 kbps per month (USD)	0.25	7.61	3.07	15.63 ¹⁰
	Import duty on the customer premises equipment used for broadband	Local Made	----	Local Made	38 %

For more details regarding the below case studies, please refer to Appendix 2 – Case Studies.

⁹ Source of table: ABTO; China Internet Network Information Center; COAI; ITU; Korea Network Information Center; Malaysia Department of Statistics; World Bank; TRAI analysis. “[]” indicates that numbers are estimates

¹⁰ Based on present rate for 128 kbps, with limited data transfer allowed each month

2.2 Republic of Korea¹¹

2.2.1 The Republic of Korea (henceforth Korea) is the poster child for successful broadband roll-out and ubiquitous availability. For the vast majority of Koreans, using the internet and availing of the facilities that broadband has to offer has become part of their way of life. Additionally, though the internet for consumers in most places around the world has not made spectacular amounts of money for service providers, Korea has found ways to generate significant revenues. Last year, USD 148 billion, nearly 30% of GDP, was transacted on the internet.¹²

2.2.2 This growth has been a recent and accelerated phenomenon. In 1995, Korea had less than one internet user per 100 inhabitants, but surpassed the developed nation average of approximately 25 by 1999. By the end of 2002 they became the world's fifth largest internet market, with the third highest penetration (highest in Asia).

2.2.3 The government played a big role in coordinating the right steps from both public and private sector. The approach they took can be described in three parts: creating the right environment through pre-open market policies in telecommunications; intervention at the non-market end of supply by funding of internet backbone roll-out within cities and to more remote areas; and finally intervention at the non-market end of demand by providing IT training and moving the government to absorb ICT as part of their operations.

2.2.4 Infrastructure

2.2.4.1 The entry of competition forced Korea Telecom (KT) to abandon its investments in ISDN and move into the superior DSL technology before losing its customers. KT benefited significantly from this move as it leveraged its installed copper base to realize average revenue per user (ARPU) seven times higher than it had otherwise from basic telephony service. It also attained pay back for its investments in only a little over a year.

¹¹ Broadband Korea: Internet Case Study, ITU, March 2003; TRAI analysis

¹² Korea Network Information Center

2.2.4.2 Additionally, the Ministry of Information and Communication (MIC) has a very straightforward and simple licensing program. There are three license types: Network Service Provider (facilities builder and operators), Specific Service Provider (resellers of others' facilities) and Value-Added Service Provider (such as ISP's). The flexibility provided by such licenses with large service coverage played an important role in growth. The government also has a policy of keeping all revenues originating from telecommunications within the sector to fund government projects and incentive plans.

2.2.4.3 As the market began to grow, the government made it a priority to develop the ICT sector and bring Korea into a position of leadership. To help that process, it dedicated USD 2.4 billion to create a national backbone over fiber. Furthermore, emphasis was made on developing a domestic exchange. By offering low interest rate loans to facilities based service providers, and using providing further incentive for them to invest in less densely populated areas, the government was able to create economic payback that far outstripped the cost.

2.2.4.4 ISP's were also given the opportunity to offer whichever converged services they desired. This meant that they had higher incentives to invest since they had the ability to provide voice over IP, television and internet services, providing multiple revenue streams. The VoIP market in Korea is actually growing much faster than the PSTN market, and is expected to completely replace normal telephony in the near future. Finally, ISP's were also provided with a very liberal international gateway policy. Because of this, costs have been kept very competitive, and Korea has over 5.2 Gbps capacity to other countries.

2.2.4.5 To attract consumers, ISP's have favored flat rate pricing based on bandwidth required, and the tariff in Korea today is among the lowest in the world at \$30 per month for 10 Mbps downstream.

2.2.4.6 Korea also benefits from inter-modal competition with widespread penetration of mobile phones that support high speed data connectivity, cable, WLL, satellite-based access and many WiFi hotspots.

2.2.5 Access Device and Content

2.2.5.1 Local manufacturing has played a large part in controlling costs of PC's in Korea. Additionally, many local manufacturers also participate in the actual infrastructure part of market, providing customer premise and service provider equipment.

2.2.5.2 Gaming and multi-media messaging has also become part of the way of life, especially for youngsters. In terms of local content development, Korea has exploded with the traffic and usage patterns of Koreans make them the largest users of indigenous content. The top 10 web sites are all local ones in Korean, and the number of .KR sites ranks the nation fifth in the world.

2.2.5.3 The government provided training on PC and internet usage for low income and disabled households with children. They launched programs to also provide these families with heavily subsidized and sometimes free PC's. Demand for usage was driven within the government, too. Each employee was given her own e-mail address and was trained on how to leverage ICT as part of their daily tasks. Over 55% of all educational documents and government filings are electronic at this point.

Appendix 2 – Case Studies provides more detail on Korea's experience.

2.3 *Malaysia*¹³

2.3.1 Malaysia has fared very well in driving internet penetration across the country, even in its remotest of areas. Though broadband penetration has not yet reached significant levels, the number of users of the internet is impressive.

2.3.2 The primary driver behind overall telecommunications growth is that Malaysia opened its market much earlier than most other countries. There are four generic licenses within a framework of convergence that are not too different from what was discussed earlier for Korea's licensing regime which allowed provision of several services in the same license: network facilities provider (the owner and

¹³ Multimedia Malaysia: Internet Case Study, ITU March 2002; TRAI analysis

operator of infrastructure); network services provider (the supplier of basic connectivity and bandwidth to support application services); application services provider (the provider of specific functions like voice, data, e-commerce); and finally the content application services (a special subset of ASP which includes television and radio broadcast and internet content services).

2.3.3 Infrastructure

2.3.3.1 Though the incumbent, Telekom Malaysia Berhad (TMB), maintains control over most of the backbone as well as lines to individual homes, other players have used highway, railroad, satellite and other wireless infrastructure to develop their own domestic connectivity.

2.3.3.2 The primary growth driver for internet has been reliable and inexpensive dial-up access. The government has heavily regulated telephone rental rates and calls to ISP are heavily controlled. Malaysia has the second lowest dial-up rate in Southeast Asia of 0.7 US cents per minute.

2.3.3.3 Another factor driving costs down for consumers is that ISP's are allowed to establish international gateways as long as they have a network facilities license. The flexibility provided by regulation to allow VoIP without restriction has brought increasing competition into the market place for both telephony and internet.

2.3.4 Access Device and Content

2.3.4.1 As part of the government's overall objectives for ICT growth it has stated that universal access includes access to data at 128 kbps, as well as a telephone line. Additionally, village authorities were provided with a PC and internet connectivity in their administrative office and PC's with free internet access were set up in post offices. Since the purchase price of a computer with internet access can be 90 percent of a rural household's disposable income, the government launched many efforts to reduce costs. They have allowed families with children over 10 years old to withdraw money from their retirement funds to contribute to PC purchases, and have provided subsidized PC's at special events.

2.3.4.2 The Malaysian government has also taken it upon themselves to bring the government completely online and have ICT be an integral part of their system. They also launched the Multimedia Super Corridor (MSC) as a nurturing ground for local entrepreneurship and industry, as well as attracting foreign organizations to establish offices there.

2.3.4.3 Finally, efforts were also made to ensure that each school had at minimum one computer lab with internet connectivity for student use. The Ministry of Education actually reserves a third of its budget towards connecting rural schools.

2.3.5 It is evident that India needs to replicate some of the steps taken by both the above nations to fuel the growth of internet and broadband in the country.

More detail on Malaysia's experience is provided in Appendix 2 – Case Studies.

Chapter 3 Domestic Successes

3.1 Overview

There are a number of lessons from domestic successes that can be applied to the effort of increasing internet penetration and broadband roll-out. Some of these lessons are from recent changes in the telephony industry, both fixed and mobile, while other show how local entrepreneurs can be leveraged for wide scale cost-efficient deployment.

For more details regarding the below case studies, please refer to Appendix 2 – Case Studies.

3.2 Television and Cable TV Spread¹⁴

3.2.1 Many cite the example of the successful penetration of cable TV services in the country as a good example of how internet usage can also spread. The usage of the local service provider (LSP) model has allowed tremendous cost containment in last mile access. This is driven by a high level of sharing of the cables laid in communities by many households, and all installation and maintenance being done by the LSP herself. In terms of access devices, the variety of televisions in the market place, whether locally manufactured, assembled or imported, is sufficient to cover the range of market segments.

3.2.2 On the downside, the cable TV network resulting from this arrangement is unreliable and unsuitable in most cases for bi-directional communication. The quality of the simple video transmission is at best acceptable, and there is limited scope for access to premium services such as pay-per-view or subscription channels. Additionally, this structure also allows for a significant grey market for services and revenue leakage.

¹⁴ Telecommunications Reform in India, Ashok Jhunjhunwala, Rafiq Dossani; TRAI analysis

3.2.3 Modifying the LSP to solve these issues by maintaining quality of infrastructure, quality of service and sufficient revenue monitoring principles creates an opportunity to have a significant impact on broadband roll-out. Additionally, the LSP model can be further extended to serve as a source of micro-level local content.

3.3 *Telephony Market*

3.3.1 The changes brought about by competition in all segments of the telephony market demonstrate what significant impact can be achieved by opening an industry with the appropriate parameters for healthy competition. The changes were broad-sweeping and not only decreased tariffs for usage, but also increased customer service focus and general awareness of the products and services.

3.3.2 In addition to attracting subscribers through cost-based value proposition, service providers also focused on network and customer service quality by introducing new services, investing in upgrading technology, and creating innovative schemes, all benefiting the consumer community. Outside of the mobile field, the introduction of competitive fixed service carriers, whether via wire-line or fixed wireless also forced the incumbent to wake up or risk losing their market share.

3.3.3 One thing to note, though, is that much of the initial growth in this space was driven by domestic innovation by C-DOT through R&D that accounted for the unique economic and physical environment that India was in at that time.

3.3.4 The advantages accrued by the consumers can be credited to the fierce competition that occurred. The lessons from this space demonstrate clear guidelines that can be carried over the internet and broadband space.

3.4 *Other Concepts from Successes in Domestic Market*

3.4.1 Recent developments of business models in the telecommunications industry demonstrate examples of how creative solutions to the unique problems faced in the Indian market can drive success. These examples stem from the techniques used by entrants into the mobility market, and many of the organizations pursuing rural build-

out as a profitable endeavor. For some case studies, please refer to Appendix 2 – Case Studies.

3.4.2 Mobile operators have shown that creative packaging of offers can drive tremendous levels of success in terms of number of subscribers. The keys to their success are primarily based on two areas: low cost of entry; and lifestyle marketing.

- Low cost of entry – WLL operators popularized the concept of leasing handsets. This was integral to growth as it brought CDMA handset makers to the Indian market, while also providing users with a choice of phones directly from the operator. More significantly, the overriding effect was that it made it significantly more affordable for consumers to own a mobile connection with minimal upfront fee
- Lifestyle marketing – mobile operators also effectively marketed their products by reaching beyond the upper class, and positioned mobile phones as one of life’s necessities. They also demonstrated how the service could be used by individuals of all backgrounds, allowing consumers to personally associate with it

3.4.3 Rural development projects have shown that information technology access in villages can radically change the way and quality of life of farmers and their families. Additionally, many of these projects are accomplishing this in a profitable way. The drivers for success here include: leveraging the LSP model to both operate a franchise and serve as an intermediary; providing locally relevant content in local language that demonstrates how ICT usage can have immediate positive economic and lifestyle impacts, thereby justifying personal spending; using low cost and indigenous technologies that provide sufficient coverage for the services being offered; and finally, innovative approaches to providing access to services.¹⁵

- LSP model – many of the projects in this space recognize the need for a local entrepreneur to be the primary operator and face of the services being offered through telecommunications kiosks. This provides the benefit of giving each

¹⁵ n-Logue Communications Pvt. Ltd.; Telecommunications and Computer Networks (TeNeT) Group, IIT Madras; ITC e-Choupal, ITC Limited, www.itcportal.com; Case Study: Project “Gyandoot”, India, Report of APT Study Question 1.5, Sanjay Dubey, Naveen Prakash, Gyandoot Samiti, August 2002; TRAI analysis

community a sense of ownership of the venture. It also allows for micro-marketing since the kiosk operator personally knows each family in the village and understands their needs. Finally, as an intermediary, the LSP is able to read, operate the computer and navigate the internet on behalf of villagers wanting to avail of the services being offered. By training this one individual, much of the divide in learning is overcome. This can also be extended to languages, where operators understanding other languages such as English can perform the translation function

- Locally relevant content – project leaders have learnt very quickly that general internet usage is not attractive to farming communities. What draws them to paying for ICT services is when the services being offered can directly impact the economic or lifestyle situation of a family. General web browsing has not typically had good penetration, but tele-medicine and agricultural consultations via video-conference, vocational e-learning related to applicable technical skills, video/voice mail, matrimonial, agricultural data and e-governance services have all been much more popular. Additionally, these services provided in local language are even more popular
- Low cost technologies – bringing data access to villages can be quite expensive and challenging, so the use of indigenous technologies like CorDECT and other wireless solutions, coupled with basic access device equipment have brought costs down to reasonable levels such that public access points can individually become profitable at reasonable revenue levels. Additionally, leveraging subsidies on interest rates for loans have further helped in achieving success
- Innovative approach to access – telephony access in villages has been extended through innovative approaches such as having a postman carrying a mobile CDMA telephone set with printed billing facilities as part of his beat, and NGO's offering financial and infrastructural help to small entrepreneurs in West Bengal to establish mobile PCO's using CDMA coverage of an existing operator

3.5 The lessons learnt from the above domestic success models in different fields can be applied to the internet and broadband area also to fuel accelerated and

sustained growth. These cases also demonstrate how a multitude of solutions are possible, and that no single one of them may be sufficient to service the entire possible market.

Chapter 4 Technical Options

4.1 Overview

The many examples of how other countries have grown coupled with those about how various spaces within the Indian market itself have flourished present us with a number of options to address. These options are grouped into specific areas, some applicable to policy and government action, while others are issues that service providers can decide under their own purview.

4.2 Government Action¹⁶

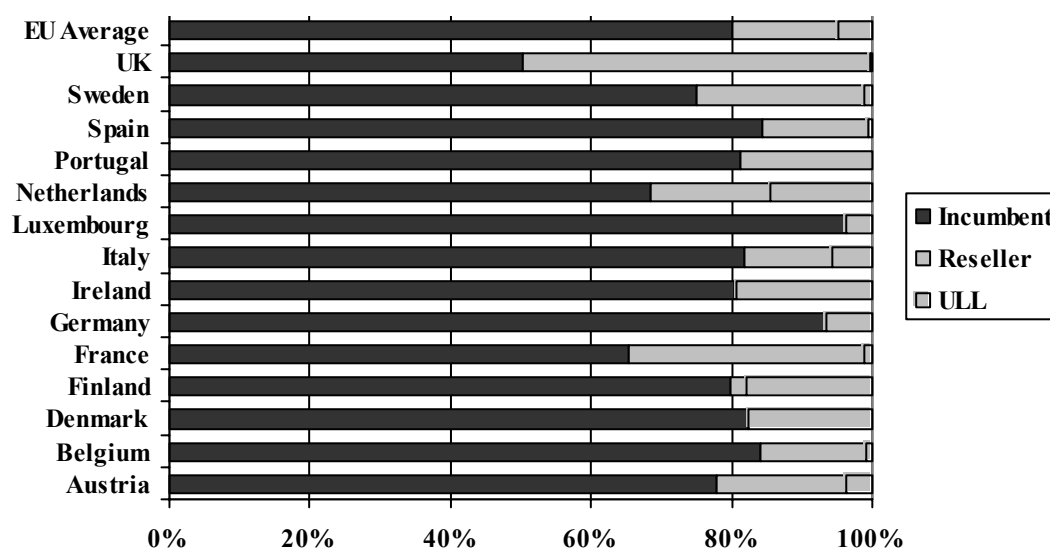
4.2.1 There are a few categorized ways in which the government and the regulator can act in this field. All of these are predicated upon active participation by the private sector as well. The two generic areas are funding/subsidies and liberalized regulation.

4.2.2 On the side of funding, several governments around the world have decided to support various efforts to drive internet growth in their countries. Typically the form of support is via either direct or indirect subsidies. Under the direct side, they are usually either for consumer usage or network construction investment. Governments hope that by creating the initial push, consumers and service providers will take over after that.

4.2.3 On the indirect side, the steps are usually to give tax credits and low interest loans for both infrastructure players and consumers. Another form of indirect subsidy is for the government to act as a primary consumer of the output of ICT development. By connecting and bringing online schools, hospitals, ministries and community centers the government can, in effect, become the largest client of the industry when it starts, giving some comfort to entrepreneurs of a minimum guaranteed market size, especially in less developed areas.

¹⁶ Birth of Broadband, ITU Internet Reports, September 2003

4.2.4 On the regulatory front, the government needs to prioritize the target of open competition, like it did in the telephony field. Market liberalization has been adopted by almost every market around the world where significant strides forward in this space have been taken. While it is true that in most markets, especially broadband, incumbent telecommunications operators dominate the market, the competition is what has driven them to develop their technology, product and services while reducing price. Please refer to Figure 4-1¹⁷ below.



4.2.5 The other areas of regulatory concern include

- Facilitating market entry – lowering and simplifying legal and regulatory barriers that have traditionally been present in telecommunications industries
 - Licensing and registration – streamlining regulatory process to accelerate entry, provide flexibility of operations and control cost
 - Rights of way – improve access for creating infrastructure by streamlining permission process and ensuring its fair and equal to all players. Additionally, ensuring that owners of right of way fulfill their obligations

¹⁷ Source for figure: European Competitive Telecommunications Association (ECTA) DSL scorecard, April 2003. Note: ULL = Unbundled local loop

- Ownership restrictions – while management and ownership control in the telecommunications sector is important, we need to assess whether regulatory changes may be required because of the high investments required for build-out
- Radio spectrum constraints – managing the growing need for radio spectrum by various new technologies and applications in an effective manner. This also includes coordination of application specific spectrum allocation with other countries to allow seamless migration of access devices and users
- Ensuring fair competition – this includes not just lowering the barrier's to entry, but at times forcing advantages away from the incumbent carriers to spur alternative providers, e.g. asymmetric regulation that may not favor the incumbent
 - Open access networks – since infrastructure competition requires a long time and significant amounts of funds to develop, mandating unbundling and facilities sharing is considered be an effective way for introducing a competitive stimulus in the market
 - Cross-ownership – a converged environment means that players may have significant holdings in multiple segments of the sector, for example a cable TV operator also owning other telecommunications infrastructure. In this situation, the operator may not have an incentive to roll-out competing technologies for fear of dropping prices and cannibalization, thus slowing market development and hurting consumer interest
 - Anti-competitive behavior – ensuring that market dominant players and incumbents, through cross-subsidies and bundling, are not forcing other players out of business by offering below cost tariffs
- Universal service – deciding whether internet and broadband services are to be included in universal service obligations along with which party will execute those responsibilities

4.3 Technologies for Broadband Infrastructure¹⁸

4.3.1 This section serves as a snapshot of the technologies currently available for implementation of broadband data connectivity. Most of the emphasis is in last mile, including last 100 meters technologies, as that is typically the toughest problem to solve. Since this list is meant to be as exhaustive as possible, if there are missing protocols and standards, please include them in replies to this consultation paper. A more detailed explanation of each option can be found in Appendix 3 – Technology Summary.

4.3.2 Fixed-line Infrastructure

4.3.2.1 For fixed-line connections, digital subscriber line (DSL) technologies are the most popular worldwide, followed closely by cable. DSL is more common than cable in Asia and Europe, while in the Americas cable dominates. While DSL and cable modem technologies have typically been built on existing networks, some new transmission technologies, such as fiber optic cables, have been gaining in popularity, especially as prices for installation drop.

4.3.2.2 DSL Technologies

A key advantage of DSL technologies is that they use existing copper twisted pair wiring and do not require new cabling. DSL utilizes different frequencies to split voice and data services over the same standard phone line since phone networks only use a small portion of the available bandwidth for voice traffic. DSL speeds are influenced by the distance between the subscriber and the local exchange, the gauge of the phone wire, and the type of DSL technology, while offering a dedicated amount of bandwidth that does not vary with the number of subscribers logged on in an area. Below is a list of the varieties, and more detail on each can be found in Appendix 3 – Technology Summary.

- Asymmetric DSL (ADSL, G.dmt, ITU-T.G.992.1)
- ADSL (G.lite, ITU-T.G.992.2)
- SHDSL (Single Pair High-Speed DSL, ITU-T G.991.2)
- Symmetrical DSL (SDSL)

¹⁸ Birth of Broadband, ITU Internet Reports, September 2003

- ADSL2, ADSL 2plus (ITU-T.G.992.3/G.992.4)
- VDSL (Very-High-Data-Rate DSL, ITU-TG.993.1)

4.3.2.3 Cable Modem Technologies

Cable networking has evolved and with new equipment has made it possible to send data in both directions via usage of different channels on separate block of 6 MHz frequencies, making internet access over cable a viable solution. One channel sends data from the internet to users (6 MHz of frequency corresponds to roughly 30 Mbps) while another channel receives. Cable subscribers in a small area share the same channels to send and receive data, therefore the bandwidth users receive is tied to how much bandwidth their neighbors are using. A new ITU-T Recommendation J.122 (DOCSIS2) was approved at the end of 2002 and offers improvements to the existing standard while maintaining backwards compatibility.

4.3.2.4 Fiber Optic Cable Technologies

Fiber optic cable uses lasers or light emitting diodes (LED's) to transmit pulses of light down extremely fine strands of silicon, and because light uses higher frequencies, they can carry thousands of times more data than either electric signals or radio waves. In telecommunications, the frequency used is roughly 100 MHz, 100 million times that of an AM radio signal and 100 billion times that of an electric telephone signal. Currently, most fiber optic cables transmit light only at one frequency, but, as technology improves, the bandwidth on fiber optic lines can be increased by simply adding more frequencies on the line, just as DSL uses several frequencies to split voice and data traffic over copper.

The costly aspect of fiber cables is the actual laying of the cable and the termination equipment, and as technologies have improved, the price of the equipment has dropped. Currently the cost of fiber rollout is approaching the cost of other wired networks. While most fiber optic cable is laid in the ground, Japanese companies such as NTT have started using aerial cables to connect homes. This decreases the costs of installation and makes use of existing power poles as anchors.

4.3.3 Wireless Infrastructure

4.3.3.1 Fixed Wireless Technologies

Fixed wireless systems are constrained by their allotted radio spectrum. Typically, 1Hz of spectrum can yield 1-4 bps of throughput. Fixed wireless systems use frequencies between 900 MHz to 40 GHz, with higher frequencies able to carry far more data but not able to travel as far as lower frequencies and often requiring line of sight. Below is a list of the varieties, and more detail on each can be found in Appendix 3 – Technology Summary.

- Multipoint microwave distribution system (MMDS)
- Local multipoint distribution system (LMDS)
- 802.16 (WiMAX)
- CorDECT

4.3.3.2 Satellite Technologies

While satellite connections are typically more expensive than other methods of delivery, they provide a viable option to rural and remote areas that have no other real broadband options. Additionally, simplicity in network design, reliability, and rapid deployment are other advantages. Downsides, though, include latency, security weaknesses, less bandwidth, and poorer signal quality. However, for point-to-multipoint occasional use applications where bandwidth is required on a part-time basis, satellite consistently proves more cost effective. It is also the only technology that boasts 99% coverage of world landmass. Recently, consumer satellite technology has allowed for two-way communication, meaning that all Internet communication can take place through a bi-directional satellite dish at the customer premises.

4.3.3.3 Wireless LAN Technologies

A wireless local area network (WLAN) is a local area network with at least one segment using electromagnetic waves to transmit and receive data over short distances, in place of wired networks, by establishing an access point. Wireless LAN's are most commonly used as last 100 meters diffusers of a broadband connection, although they are being used increasingly as methods of providing broadband access over longer distances in rural areas by increasing power levels of

the equipment, using specialized antennae, and ensuring line-of-sight access. One disadvantage they have, though, is that they are less secure.

Several factors have contributed to the phenomenal growth of WLAN's: a steep drop in prices, the mobility benefits of wireless connectivity, off-the-shelf availability, and easy installation. Below is a list of the varieties, and more detail on each can be found in Appendix 3 – Technology Summary.

- 802.11b (Wi-Fi)
- 802.11a (Wi-Fi5)
- HiperLAN2 (High Performance Radio Local Area Network)
- 802.11g

4.3.3.4 IMT-2000 / Third Generation Mobile Technologies

Mobile telephone networks may one day be the preferred broadband conduits. IMT-2000 (3G systems) is sometimes called "broadband for mobile phones". In reality though, the available speeds of 144 kbps for all radio environments and 2 Mbps in low-mobility and indoor environments in current 3G implementations are technically too slow.

Despite concerted efforts at global standardization IMT-2000 has emerged with five possible radio interfaces based on three different access technologies (FDMA, TDMA and CDMA). The vast majority of industry attention has been directed towards wideband CDMA (W-CDMA), known in Europe as UMTS, and CDMA2000, including CDMA2000 1x, which is widely deployed in Korea and Japan. As the technology and speeds improve, one should expect to see the prices for 3G data access decrease.

4.3.3.5 Free Space Optic (FSO) Technologies

Free space optics (FSO) use the same laser technology used in fiber optics, but without wires, taking advantage of the speeds reachable by using infrared light waves. Though line-of-sight is required, speeds of up to 1.25 Gbps can be maintained, offering another method for solving the last mile problem. FSO technology has the benefit of not requiring spectrum like other wireless technologies, and is also

inexpensive to install and can be implemented very quickly. On the other hand, FSO is subject to several technical problems caused by changes in atmospheric conditions such as fog and heated air, movement of the receiver/transmitter caused by wind, or interruption of the signal by passing objects like birds.

4.3.3.6 Mesh network technologies

A new wave of technologies, mesh networks, will enable multipoint-to-multipoint networking. Mesh networks rely on each user also becoming a broadcaster in the network where each subscriber access point is also part of the routing infrastructure. As users are added to the network, the reach of the entire network expands. Other technologies can bring the backbone connectivity over long distances and at the local level, the mesh network can then be built out from one central point in the community. Another benefit of mesh networks is they do not require line of sight since working around obstacles is achieved through routing to bypass them.

4.3.4 Other Broadband Technologies

4.3.4.1 Power line communications

Since power lines form one of the most extensive networks in the world, sending data via power line communication (PLC) can result in an immediate teledensity jump. Like DSL, electrical signals act as a carrier for data transmission, piggybacking on the network and being filtered out at the end points. For example, power is sent over the line at 50-60 Hz while data is sent via the 1 MHz range, thus avoiding interference. These signals are sent over medium voltage wires, the lines running between substations, and local transformers. PLC has some problems, though, where the data signal can be disrupted due to noise interference and long distances, in addition to interfering with radio, television, telephone, and DSL signals at times.

4.3.4.2 HAPS/LAPS

This technology uses balloons and other low or high altitude platform stations (LAPS or HAPS) to provide fast, wireless Internet services over a large area. These systems are significantly less expensive than satellite systems and can be deployed quickly through a tethered balloon hovering from 3 km, or an untethered stationary object at 21 km above the ground. The tether includes fiber optic cables as the medium for

information transfer, while untethered versions use radio signals to transmit data to the backbone network.

With current use by the U.S. government and companies around the world working on developing the technology, LAPS and HAPS may offer an inexpensive alternative to satellite service in the near future, especially in underserved areas.

Chapter 5 Key Issues for Discussion

5.1 Summary

5.1.1 The earlier chapters of this consultation paper have covered many topics including issues facing internet and broadband penetration in India, in addition to discussing case studies we can learn from. Success in this endeavor is going to be driven by well coordinated actions from all stakeholders.

5.1.2 India is a country which is aiming to achieve global leadership in knowledge-based activities based on its reservoir of an educated and trained population. The increased use of internet and broadband would not only contribute towards such an objective, but would also further the goals of several social programs. This issue is one of creating opportunities in knowledge-based sectors as well as quick and transparent delivery of social policies. Failure in seizing these opportunities would be extremely costly for our society and economy.

5.1.3 In general, there are several factors that will drive the three part (infrastructure, access device, and content) reinforcing growth cycle. Once the point of inflection is achieved, like it has been recently in the telephony space, then expansion may be self-sustaining. In summary, the issues that have been identified and on which consultation is sought are:

- Definition of broadband and time bound targets
- Link with USO fund policies
- Fostering roll-out of internet and broadband via a multitude of access paths, using the appropriate technology at the right time
- Cost reduction in infrastructure by
 - Finding ways to reduce access cost burden on internet and broadband users
 - Finding ways to reduce tariffs in IPLC and domestic leased lines
 - Accelerating the deployment of the National Internet Exchange of India (NIXI) to minimize dependence on hosting websites abroad

- Reducing costs caused by duties / taxes
- Possibly allowing unrestricted internet telephony
- Promoting the availability of low cost internet access devices
- Fostering local development and manufacturing of equipment via government incentives and taxation policy
- Government becoming torchbearer in promoting ICT usage through much greater usage of these services in transactions
- Promoting access to and development of local content

5.1.4 The first step that needs to be taken is to force enabling growth and reliability in infrastructure at affordable cost to end-users. This is also the arena in which the goal of competition needs to be achieved first. Referring back to the three factor model introduced earlier in the paper, actions in this space will have the effect of setting the growth cycle in motion. This does not mean that no simultaneous efforts needs to be made on other fronts, as without swift and decisive action in all arenas any growth efforts will not have the needed impact.

5.1.5 As the policy maker and regulator do their part to facilitate action, the corporate sector will have to look to them as a thought partners. Many business models are possible in this area as the market is young and pent up demand exists, just waiting for the appropriate setting for an outlet. The discussion below is intermingled with questions about what the details of regulation and implementation in each area may entail.

5.2 Definition of Broadband and Goals

5.2.1 As discussed in the introduction, the stakeholders should establish first, a definition of what qualifies as broadband service in the Indian context, and second, what goals should be set for growth in internet and broadband services.

Questions

1. *Should the definition of broadband for the Indian market be “an always-on connection with minimum 256 kbps download speed”?*

2. *What is a reasonable target, considering today's levels of teledensity, cable TV penetration, and other telecoms indicators, for India to set as its goal for internet usage and broadband penetration in 2009, 5 years from today? What are the intermediate milestones that need to be identified along this path?*

5.3 Link with Existing and Ongoing Policies

5.3.1 It is important that the policies suggested to stimulate growth in internet usage and broadband must take account of the unified license and universal service obligation (USO) regimes.

5.3.2 Unified license is likely to provide greater flexibility to choose combinations of technology and service provided / value-added. Simplification and flexibility of the licensing / regulatory framework may also result in the provision of services for niche market segments, e.g. pure-play resellers or rural area service providers. As can be seen from the examples of Korea and Malaysia, who have already adopted regulations similar to the unified licensing regimes, this structure can help accelerate competition and growth.

5.3.3 The present universal service obligation policy aims to fund the upgrade of village public telephones (VPT) to public telecom and info centers (PTIC) with some also receiving high speed data connectivity (HPTIC) at 128 kbps.¹⁹

Questions

3. *Should there be a revision in the targets of the universal service obligation policies to speed up the penetration of internet and broadband in the country? If so, on what factors should new targets be based?*

5.4 Infrastructure

5.4.1 Preliminary thoughts in infrastructure focus on: first, provoking roll-out via opening multiple access paths (e.g. unbundling local loop, facilitating satellite

¹⁹ Guidelines for Implementation of Universal Support, Department of Telecom

access); second, reducing the cost for service providers and customers in this space; and finally, other issues to foster development. All of these will stimulate open competition.

5.4.2 Fostering Roll-Out via a Multitude of Access Paths

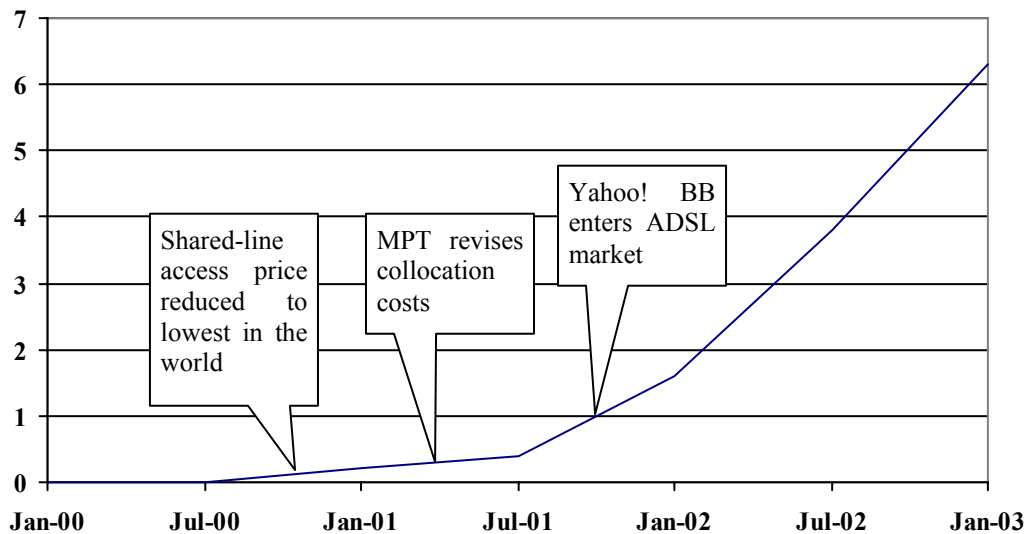
A major hurdle to growth in infrastructure is said to be restrictions on access in the last mile, the quality and reliability of the last mile access, and its cost.

- Contending with these issues may require even full or partial unbundling of the local loop (ULL).²⁰ For example, one option may be to allow local copper loop owned by all BSO's, especially incumbents to be used by competitive service providers for transmission purposes via the various varieties of DSL technologies. Many other countries, including Korea, Germany, US, UK and Japan have effectively used this strategy to stimulate broadband penetration. This initiative may need to be combined with a policy to keep price of access for shared infrastructure low. In Japan mandating the lowest access price in the world for shared line access, USD 1.43 per month, took DSL subscribers from 70,655 at the end of 2000 to 6,590,000 in January of 2003, just two years. Please refer to Figure 5-1 below.²¹ In contrast, the UK, which has a price four times that of Japan has some of the lowest DSL penetration amongst developed nations

²⁰ Birth of Broadband, ITU Internet Reports, September 2003

²¹ Source of figure: Promoting Broadband: The Case of Japan, ITU, April 2003

Figure 5-1 – Growth in number of DSL subscribers in Japan driven by decreases in infrastructure access costs (millions)



Questions

4. *Is it possible to have a large increase of DSL users in India in the near future, or are there various constraints in meeting such an objective?*
5. *What percent of Indian households with wire-line telephones meet the technical requirements for DSL service, including both distance and technical quality of local loop*
6. *Should we have local loop unbundling at this stage for encouraging growth in internet and broadband? If so, which variety is most applicable for the Indian market? Should there be differences depending on characteristics of switch and/or population density? At what cost and speed could each of these various options be rolled out? The three types of local loop unbundling are*
 - *Under full local loop unbundling (full access), competitive providers have access to both voice and data on the line*
 - *Under shared unbundling (line sharing), competitive providers have access to either the voice or data transmission portion of the line*
 - *Under bit stream access, the incumbent installs high-speed access links to its customers and allows competitive providers access to this link. In*

this arrangement, the incumbent maintains control of the technical and service provisions

7. *What should be the basis for deciding the charge for the shared portion of infrastructure? Should this be subsidized by the government? On what basis should this be reviewed over time?*
8. *What other examples from telecommunications markets abroad should be taken into account so that policies created in India avoid errors committed earlier, with respect to access and pricing of the resources for both users and suppliers of internet and broadband infrastructure and services?*
9. *Who will handle customer service maintenance calls in each of the possible scenarios? Will consumers have one number to call, or will they be expected to call each provider in case they are not obtaining all their services from the same company?*
10. *How will the service relationship between the infrastructure owner and sharer be structured? What obligations will each party have? How responsive does each party need to be to requests by the other, and how will this be measured and tracked? This should apply to all interactions and transactions including converting customers from one service provider to another, maintenance and troubleshooting requests, quality of service control, and establishing connectivity of a competitive provider with the incumbent at its facilities*
11. *What are the implications of collocation of ISP providers in BSO premises? Should collocation of ISP nodes in the BSO premises be a mandated part of unbundling the local loop? Are there other solutions that are more feasible, such as giving competitive service providers access via leased line into premises (which are owned and operated by the competitive service provider) that are adjacent to the exchange? If collocation is mandated, what should be the parameters under which it is executed? What are the hurdles besides limited space that need to be taken into account?*
12. *Since customer affordability is of the highest priority in roll-out, what other steps need to be taken to ensure that cost of access is affordable at various levels of the market?*

- Allow internet access via direct-to-home satellite communication
 - This opens another method for solving the last mile problem for broadband access by end-users
 - This is still one of the few widely available broadband solutions that allows both high quality digital video and data to be transmitted

Questions

13. *What hurdles prevent regulation in this area from being liberalized? This applies for both receive only and bi-directional communication since new satellite technology enables this*

- Another way to address last mile issues may be to promote upgrade and build-out of superior local loop infrastructure which can support both voice and data traffic
 - Several nations have provided both direct and indirect subsidies for developments in this network segment. These subsidies covered not only the copper based or wireless networks, but also revamping existing cable TV infrastructure
 - Further, governments have also addressed the issue of easing the process for ISP's to gain rights to laying own last mile infrastructure via wire-line or wireless channels
 - Another important issue relates to the development of indigenous technologies to bridge the last mile at reasonable cost and with consideration for the unique challenges of the Indian environment

Questions

14. *What is the biggest hurdle to investing in last mile infrastructure? Is it cost of capital including interest rate, foreign investment caps, or something else?*

15. *Should incentives for incumbents differ from those for competitive entrants?*

16. *What is the possibility of using cable TV, fixed telephone, GSM and CDMA infrastructure to provide premium quality, high speed, high capacity converged communications services? With regards to mobile technology, is the architecture of cell sites designed to handle always-on data*

communication, or is it primarily designed with spectral density of peak voice usage in mind? Are any policy initiatives required in this regard?

17. *What are the benchmarks for cost per line in the various last mile technologies, including DSL, cable, CDMA, CorDECT, GSM, direct-to-home satellite, etc.*
18. *What reforms need to be made to spectrum management such that beneficial wireless network architecture for backbone, last mile, and last 100 meters can proliferate?*
19. *How should support or incentives be given to improve the quality of dial-up services to provide at least more reliable access to the internet than is available today?*
20. *What is the right balance of having many small players each with their own piece of last mile infrastructure versus having fewer larger integrated players? How can quality and inter-connectivity be governed?*
21. *Aside from funding, what other methods can be used to fostering local research and development in the fields of protocols and devices? If funding is a required avenue, what is the most efficient means for structuring this?*

5.4.3 Cost Reduction

Many of the hurdles to growth in infrastructure mentioned above are due to cost of operation and capital expenditure required to provide quality service in this market. What has been happening is that either cost to the consumer ends up being too high, or the quality of access is poor. In the case of dial-up access, it appears that both can be true. There are three areas to enable cost reduction for operators, thereby reducing cost that consumers have to pay and increasing their quality of service, in addition to one area for possible immediate reduction in cost to consumers directly.

- Reducing IPLC and domestic leased line tariffs via introduction of effective competition / regulation

Questions

22. *What policies should be formulated to encourage using the capacity available in the backbone networks of various entities such as the railways, power*

- companies, and other infrastructure providers to increase available bandwidth for domestic private leased lines?*
23. *What are the factors limiting ISP's and other service providers from establishing new satellite gateways / terrestrial links for national and international connectivity?*
24. *Should the government consider mandating certain policies to increase deployment of broadband networks, for example, requiring that all major physical infrastructure construction projects such as building or upgrading highways, inner-city metros, railways or sewer networks requires a simultaneous laying of duct space for fiber / telecommunications cables?*
25. *In view of the small number of operators having installed bottleneck facilities for international access, is there a need to specify cost-based tariffs for access to such facilities, or to use some type of benchmark pricing? If the latter, then what benchmarks should be held as the standard?*
- Accelerating deployment of national internet exchange (NIXI)
 - A very high speed backbone interconnecting ISP's and the various towns and cities in the country is greatly needed. Shifting a large portion of the 85% of traffic that currently travels abroad to stay within the country will reduce costs for ISP's, increase performance and increase the attractiveness of hosting/mirroring content within India. All of this would directly benefit end users
 - TRAI's Task Force gave its recommendations fourteen months ago for establishing the National Internet Exchange of India (NIXI), and the first nodes have come online recently. Not all ISP's in the region of those nodes have connected. Much faster progress needs to be made in this area for ISP's and users to start reaping its benefits

Questions

26. *What can be done to help the process of accelerating deployment, both from the perspective of NIXI, and from ISP's connecting with them? Should connection of ISP's to NIXI be made compulsory?*

27. *Are the parameters for connection with NIXI that are currently laid out such that they pose a burden on ISP's wanting to connect with NIXI?*
28. *Is there a need to improve the structure of NIXI management, and if so, how?*

- Reducing costs arising due to tax policy
 - Duties are relatively high (of the order of 39% in some cases) on certain customer premise equipment (CPE) such as VoIP devices, DSL/cable modems, set-top boxes, wireless LAN equipment (WiFi) and customer-end radio communication equipment. It is necessary to consider whether the costs arising from such duties are inhibiting the growth of internet and broadband. In this regard, it is important to recall the impact a reduction in duties on mobile telephone handsets had on promoting the use of these services

Questions

29. *What is the likely effect of a reduction in duties (customs, excise, etc.) on items used for internet and broadband access on increasing the volume of usage of such services?*
30. *What factors are inhibiting the development and/or manufacture of CPE equipment domestically?*
31. *What steps policies could be taken to reduce government policy-induced costs?*

- Reducing direct cost to consumer for internet access
 - The cost of internet access via dial-up services is relatively high for customers when combining the tariffs charged by the BSO and ISP. Though recent steps have been taken by the BSO's to introduce flat fee subscription plans for heavy users of dial-up services, there may be a need to further revise existing tariffs to immediately stimulate internet penetration and usage

Questions

32. *What would be the projected impact on usage volume if tariffs charged by BSO's for internet access were reduced?*
33. *Is there a scope for reduction of dial-up charges by BSO's? If so, what are the implications to BSO's of mandating this, and, if required, what are possible ways to compensate them?*

5.4.4 Other Infrastructure Issues

There are other areas of need for change which do not fit neatly into the above categories. The policy options include

- Allowing unrestricted internet telephony by ISP's
 - Any set of recommendations would have to take account of the requirements of flexibilities under the unified licensing regime
 - Revenues from unrestricted internet telephony services can provide ISP's a new revenue stream that helps to fund and justify their investments in network quality. This has been used in other countries like Malaysia and Korea as discussed in their case studies. One of the main drivers behind the growth of the Yahoo! BB subscriber base in Japan was the heavily discounted communication services offered through internet telephony with packages that allowed for unlimited "on-network national" calls. This attractiveness may hold true in markets like India where all calls are metered²²
 - This also brings increased competition into the overall telephony market, further driving down price and benefiting consumers. Even in rural areas, internet telephony could be a more cost effective option
 - The provision of internet telephony, including interconnectivity with PSTN networks, needs to be examined carefully under the unified licensing regime

Questions

34. *What are the implications of allowing unrestricted internet telephony on mainstream telephony services and the operators providing them?*

²² Birth of Broadband, ITU Internet Reports, September 2003

35. *If unrestricted internet telephony is permitted, how can a level playing field with other mainstream telephony providers be ensured? Should a license fee regime including USO contribution be introduced for ISP's offering such services?*
 36. *What should be the policies for interconnection of internet telephony to PSTN? What aspects should be kept in mind when determining such policies?*
 37. *What, if any, system for standards of quality of service should be created?*
- Streamline right of way permissions
 - Since government agencies, including local bodies, own most of the public land and regulate rules in each locality uniform guidelines may be required to facilitate faster permissions for right of way

Questions

38. *Has right of way been a major hurdle in either backbone, local loop or both arenas? What are the major issues of contention?*
 39. *What types of regulations can be issued that would help to ease the process for acquiring right of way permissions? Should backbone and local loop be handled differently? Or should the differentiator be based on population density such that one set of rules governs urban areas while another is for rural communities?*
 40. *Is there a need for a body that facilitates this process and can also serve as an appellate forum in case of undue delay?*
- Foster local manufacturing and/or assembly of network equipment

Questions

41. *What is preventing this from happening at a large scale today? What issues should be addressed in this effort?*
42. *If the barrier is economic incentive, what is the best structure to offer?*

5.5 *Access Device and Content*

5.5.1 Access devices and content are the other two inter-related pieces of the factors for growth of internet and broadband. Significant steps also need to be taken in these areas to ensure that developments made in infrastructure are matched with what is necessary for overall growth of internet and broadband penetration.

5.5.2 **Access Device**

The biggest factor in access devices are that the costs are too high for the level of benefit that the consumer sees, and may also be perceived as being unaffordable for the common man. While it is true that basic PC's can be purchased for approximately Rs. 20,000 today, even families that can afford them are not purchasing because of a lack of a clear value proposition at that price point. The importance of promoting lower cost solutions have been emphasized often. There is a need to

- Foster research into building access devices suited for the various segments of Indian consumers. An important solution may be a set top box that uses a TV as the monitor and has the flexibility to work with any type of internet connection (dial-up, DSL, cable modem, wireless)
- Support development of access device using alternative product providers to reduce cost dramatically (e.g. Linux, AMD instead of Windows, Intel). China has recently dedicated money to fund companies to develop local language applications and solutions for Linux²³
- Encourage large scale local manufacturing and/or assembly
- Devise a policy of incentives, e.g. preferential government taxation rates on PC's, both for those domestically manufactured and those that are imported

Questions

43. *What can we learn from past attempts at creating alternative access platforms like the Simputer so that future efforts do not make the same mistake? What organizations should be charged with this task? What is the best support that the government can give to foster this?*

²³ China to Invest in Linux-Based Software, CNN.com, November 5, 2003

44. *How much can the cost of a PC go down by using alternative product providers?*
 45. *What is preventing local manufacturing and assembly of PC's from growing larger and driving retail prices down?*
 46. *What incentives can be provided and what is the expected effect on volume of production in the country?*
- Provide PC's and low cost access devices to lower income communities and schools. This may require schemes which, for example
 - Facilitate donation of used PC's by corporates, government agencies and universities by providing significant tax benefit
 - Run government sponsored programs for lower interest rate loans and funds availability for PC and other access device purchases. Malaysia had great success in allowing withdrawal of funds against retirement savings for lower income families with children

Questions

47. *What incentives are required for promoting charitable donations of PC's? What other systems besides tax incentives should be created to further support and foster such efforts?*
48. *How can an effective program to allow support of purchases of access devices be implemented? What channels should be used to avail of this opportunity?*

5.5.3 Content

Locally applicable and local language content needs a boost; businesses are still resistant to investing large amounts of money in this activity. While this is the third part of the growth factors and may need to be supported as other parts increase, it is critical to take the country over the point of inflection where growth becomes truly exponential and self-propelling. This would involve

- Providing appropriate legal framework for businesses online (e.g. copyrights, patents, digital signatures, verification authorities, etc.).

Questions

49. *What frameworks already exist today to address these issues? What needs to be done and how urgent is action in this particular area, and is it preventing business from going online?*

- Bringing government tasks online
 - The government may be required to move its processing and tasks to electronic formats and become an online leader
 - This may require policies including mandating that ICT should be part of each agency's, city's and government organization's plan, and giving every employee a personal e-mail address
 - The benefits of such actions have been realized in many economies that have developed ICT infrastructure since this helps disseminate the usage patterns through the populous and it starts to become a part of their way of living. A number of steps in this direction have been taken as documented by the recent "India: E-Readiness Assessment Report". The case studies on specific successes show the tremendous impact that initiatives of e-governance can have.²⁴ In addition to those case studies, there are other examples from the government sector (e.g. online railway bookings) which show the increased and efficient use of internet services

Questions

50. *What facilitating steps can be taken to ensure that the government achieves a higher level of leveraging ICT as compared to today's status? What have been the past hurdles to success in this arena? How can those hurdles be overcome?*

51. *Is there a way to measure that the government's decisions and investments in IT have sufficient return?*

²⁴ India: E-Readiness Assessment, Report 2003, Department of Information Technology, Ministry of Communications and Information Technology, Information for Development Program (infoDev)

5.6 Partnering with Business

5.6.1 As has been stated previously, all the efforts that various government organizations make will only render results if coupled with partnership from the business community. Private organizations are the ones who at the end of the day need to drive the majority of the change.

5.6.2 Though the market penetration today is at only 1% in terms of internet users and 0.4% in terms of internet subscribers, there are already a number of distinct market segments. To increase those levels, each market segment will have to be catered to differently as their needs and willingness to spend on these services will initially be quite different. The classification may broadly be simplified as follows:

- Large corporations / upper and upper middle income groups – have internet access at their offices, but need faster more reliable access at home, especially for children, at intermediate cost levels
- Medium / small enterprises – most likely using internet for rudimentary purposes via dial-up. Need access to reasonably priced and reliable broadband access to have direct impact on business
- Other income groups using internet – have internet access at their offices, maybe at school, and a telephone line at home. But, most likely do not have a computer with internet access. Needs a lower cost access device with reliable and affordable access to the internet, but does not need speed yet
- Rural users (actual and potential) – not typically exposed to the internet, and do not have personal telephone access. Growth will be driven by public access points, but still need low cost access devices with reliable internet connectivity. Local language will play a significant role in driving penetration here

5.6.3 Each business will have to refine these definitions even further as they venture to serve the market. But what can be clearly seen from the examples of successes in other countries is the value of the bundle and flat fee internet access. Typically the bundle will include multiple telecommunications services like premium TV, telephony and internet, or maybe just two of the three. On the telephony side,

large discounts are typically offered as compared to the tariffs of the incumbent. In India, one additional item, the affordability of the access device, acquires major significance; the entry cost for the subscriber should not be a large portion of the income level. The case study of operators providing limited mobility with wireless local loop clearly shows that reducing the cost of entry and combining the device with the service can have tremendous results by making inroads into large portions of the population.

5.6.4 Finally, to measure the rate of change and evaluate efforts being taken by all parties, some system of monitoring progress may need to be established.

Questions

52. *What are common strategies / policies that can be followed to encourage general increases in internet and broadband usage? What specific policies are required for encouraging growth amongst each of the major categories of users?*
53. *Should the government mandate some form of usage fee / pricing structure for internet / broadband usage?*
54. *What metrics (e.g. subscriber numbers, number of hosts, domestic and international bandwidth) should be tracked to measure the progress of efforts in this space? Korea (Korea Network Information Center – KNIC) and China (China Internet Network Information Center – CNNIC) are great examples of successful implementation of this initiative*

Appendix 1 Background

Table 1-1 – Progress on Recommendations of the Task Force on Growth of Internet, August 2002

Recommendation	Action taken	Status
Create internet exchange in India	TRAI has recommended this to the Government which was accepted and DIT agreed to fund it	NIXI has been established in STPI premises. Nodes at Delhi (Noida) and Mumbai became operational. NIXI, Kolkatta will be operational by the end of December and NIXI, Chennai is likely to be operational by the end of this month. Around 20 ISPs already connected
Reduce tariff for international leased lines	TRAI is in the process of reviewing the charges	Charges are still considered to be on higher side and TRAI is in the process of fixing the same for IPLC's
Reduce dial-up access tariff by BSO's	TRAI mandated reduction of dial up charges during off peak hours. Mandating for reduction of day-time dialup charges was not agreed upon as it may cause congestion in the BSO's network	BSO's have reduced the night-time dial up charges and have also started offering flat rate packages for unlimited dial-up usage
De-license 2.4 Ghz band for last mile access	TRAI recommended the same to the government	WPC wing of DOT has delicensed ISM (2.4 GHz) band for indoor and in-campus usage, but have not agreed for delicensing for outdoor usage due to fear of interference to existing users
Permit receive only satellite by ISP's without requiring clearance	TRAI recommended it to government	Ministry of Communication (WPC) is looking into it and is likely to simplify the procedure shortly
Permit co-location of ISP equipment at BSO issue exchange	TRAI facilitated joint meeting of BSOs & ISPs on this issue	Co-location is not normally being provided by BSOs as it is difficult to extend the facilities to all ISPs non-discriminatively. Also the agreements for hired buildings by BSOs, does not permit sub-lease

Recommendation	Action taken	Status
Treat ISP in infrastructure category to allow concessions in taxes	Forwarded to DOT	There is no significant difference in the tax rates now between telecom operators & ISPs
Reduce duty on ISP and customer premise equipment	Forwarded to DOT	Under consideration of government
Diversify access technologies in local to include DSL, cable and W-LAN's	Pertaining to ISP's	ISPs have started using wireless media. The current cable TV network is not suitable for passage of bi-directional signals. Some ISPs are making use of new co-axial cables/ HFC for providing Internet services through Cable TV network. Some BSO's have started offering DSL services on their own lines
Enabling availability of low cost internet access devices and indigenous PC's	This is not directly under the purview of TRAI	With the Government funding Simputer was developed but it has not become popular because of too less features & too small size. Government (DIT) is exploring alternative avenues
Facilitate donation of used PC's by corporate entities, government and higher educational institutions via tax structures	Forwarded to DIT	There is no significant difference in the tax rates now between telecom operators & ISPs
Implement e-governance and citizen services	Not pertaining to TRAI	State governments have initiated e-governance programs but they are in their very early stages
Foster local content development	Not pertaining to TRAI	Local content developers are waiting for improvements in internet penetration and reluctant to invest large amounts until then

Appendix 2 Case Studies

International Examples

Republic of Korea (South)²⁵

Korea is the poster child for successful broadband roll-out and ubiquitous availability. For the vast majority of Koreans, using the internet and availing of the facilities that broadband has to offer has become part of their way of life. Additionally, though the internet for consumers in most places around the world has not made spectacular amounts of money, Korea has found ways to generate significant revenues. Last year, USD 148 billion, nearly 30% of GDP, was transacted on the internet.²⁶

This growth has been a recent and accelerated phenomenon. In 1995, they still had less than one internet user per 100 inhabitants, but surpassed the developed nation average of approximately 25 by 1999. By the end of 2002 they became the world's fifth largest internet market, with the third highest penetration (highest in Asia).

Korea is actually not the most suited of its peer group, Hong Kong, Singapore and Taiwan, to have reached this high level of success in ICT. They actually have the lowest per capita GDP and overall population density of the four. Additionally, their language is distinct, and even has its own characters. But, Korea does have the advantage of the highest literacy rate (98%) and school enrollment rate. Additionally, the government played a big role in coordinating the right steps from both public and private sector. The approach they took can be described in three parts: creating the right environment, through pre-open market policies in telecommunications; intervention at the non-market end of supply, funding of internet backbone roll-out within cities and to more remote areas; and finally intervention at the non-market end of demand, by providing IT training and moving the government to absorb ICT as part of their operations.

²⁵ Broadband Korea: Internet Case Study, ITU, March 2003; TRAI analysis

²⁶ Korea Network Information Center

Infrastructure

The beginning of this growth was really spurred by the permission of local phone competition. In April 1999, Hanaro entered the market, and started offering DSL services to attract customers away from the incumbent, Korea Telecom (KT). Since the population lives mostly in apartments within a densely packed city, especially compared to the spread of population in India, building a competitive local loop can be economically justified. This entry forced KT to abandon its investments in ISDN and move into the superior DSL technology before losing its customers. KT benefited significantly from this move as it leveraged its installed copper base to realize average revenue per user (ARPU) seven times higher than it had otherwise from basic telephony service. It also attained pay back for its investments in only a little over a year.

Additionally, the Ministry of Information and Communication (MIC) has a very straightforward and simple licensing program. There are three license types: Network Service Provider (facilities builder and operators), Specific Service Provider (resellers of others' facilities) and Value-Added Service Provider (such as ISP's). It also has a policy of keeping all revenues originating from telecommunications within the sector to fund government projects and incentive plans.

As the market began to grow, the government made it a priority to develop the ICT sector and bring Korea into a position of leadership. To help that process, it dedicated USD 2.4 billion to create a national backbone over fiber. This backbone was used to connect ministries, agencies, public institutions and schools. Furthermore, emphasis was made on developing a domestic exchange. When the first one that was built became insufficient a significant overhaul was done and a new one established. Most ISP's connect to each other through this facility rather than attempting private arrangements. The government also supported the private sector through establishing a relationship of giving advice on planning and growth. By offering low interest rate loans to facilities based service providers, and using providing further incentive for them to invest in less densely populated areas, the government was able to create economic payback that far outstripped the cost.

ISP's were also given the opportunity to offer whichever converged services they desired. This meant that they had higher incentives to upgrade and build infrastructure either on their own or in partnership with FSP's. The ability to provide voice over IP, television and internet services provided for multiple revenue streams to subsidize the cost of their overall operations and reach economies of scale. The VoIP market in Korea is actually growing much faster than the PSTN market, and is expected to completely replace normal telephony in the near future. This has of course provided tremendous benefits for consumers, especially in the national and international long distance markets. Finally, ISP's were also provided with a very liberal international gateway policy. Because of this, costs have been kept very competitive, and Korea has over 5.2 Gbps capacity to other countries.

To attract consumers, ISP's have favored flat rate pricing based on bandwidth required. The user has the ability to select different levels and combinations of downstream and upstream bandwidth and is charged based on that, but in the vast majority of cases users are not capped to a specific amount of data transferable in a month. The tariff in Korea today is among the lowest in the world at \$30 per month for 10 Mbps downstream.

Overall, the market today has a variety of options for broadband access. A large portion of households are also passed by cable, giving them the option of access via cable. Additionally, companies providing LAN, wireless in local loop and satellite-based access also exist. The mobile telephony market also had significant impact on overall internet usage and broadband penetration. With Korea being a primarily CDMA market, data connectivity at high speeds, and therefore applications and gaming became increasingly popular. More recently, WiFi hot spots have sprung up almost ubiquitously, too. This inter-modal competition also keeps the pricing and customer service levels of the service providers in check.

Access Device and Content

Local manufacturing has played a large part in controlling costs of PC's in Korea. The large technology conglomerates almost all play in this space. Additionally, many

local manufacturers also play in the actual infrastructure part of market, providing customer premise and service provider equipment.

As mentioned above, a large part of the content provided by ISP's is through their ability to provide converged services. The reduced cost of telephony available via VoIP and the television access demonstrated significant value beyond just internet access to consumers. Further, though, gaming and multi-media messaging has also become part of the way of life, especially for youngsters. Especially good news for ISP's is that users of these services are willing to pay more for them. In terms of local content development, Korea has exploded. The traffic and usage patterns of Koreans make them the largest users of indigenous content. The top 10 web sites are all local ones in Korean, and the number of .KR sites ranks the nation fifth in the world.

The government also played a significant role in this realm. They provided training on PC and internet usage for low income and disabled households with children. They launched programs to also provide these families with heavily subsidized and sometimes free PC's. Demand for usage was driven within the government, too. Each employee was given her own e-mail address and was trained on how to leverage ICT as part of their daily tasks. Over 55% of all educational documents and government filings are electronic at this point. Teachers in schools have access to their own PC's with internet connections, and are required to leverage ICT as an integral part of their curriculum. This increases with higher levels of education. The central government has made it part of the core goals of all other governmental organizations to operate in this frame of thought where ICT becomes a key enabler of their activities. In this end, the government also remains one of the largest and best clients for the ICT sector.

Malaysia²⁷

Malaysia has fared very well in driving internet penetration across the country, even in its remotest of areas. Though broadband penetration has not yet reached significant levels, the number of users of the internet is impressive.

²⁷ Multimedia Malaysia: Internet Case Study, ITU March 2002; TRAI analysis

The primary driver behind overall telecommunications growth was that Malaysia opened its market much earlier than most other countries. The Communications and Multimedia Act of 1998 is the basis off which change was brought about in the industry. The main thrust of the act is to provide an environment of converged services. There are two bodies which control (Ministry of Energy, Communications and Multimedia) and regulate (Malaysian Communications and Multimedia Commission) all the services, and instead of the previous system of 31 service-specific licensees, there are four generic one. The four licenses are not too different from what was discussed earlier with Korea: network facilities provider, the owner and operator of infrastructure; network services provider, the supplier of basic connectivity and bandwidth to support application services; application services provider, the provider of specific functions like voice, data, e-commerce; and finally the content application services, a special subset of ASP which includes television and radio broadcast and internet content services.

The structure is completely technology independent and separates the actual activity being performed by the operator. So once a company providing voice services over their copper line wants to begin offering TV or data services, they can do so without the need for a new license.

Infrastructure

Since competition was allowed in both cellular and fixed markets in the mid-1990s, multiple operators are present with varying levels of infrastructure. Though the incumbent, Telekom Malaysia Berhard (TMB), maintains control over most of the backbone as well as lines to individual homes, other players have used highway, railroad, satellite and other wireless infrastructure to develop their own domestic connectivity.

The primary growth driver for internet has been reliable and inexpensive dial-up access. The government has heavily regulated telephone rental rates, providing residences in rural areas (based on number of lines in a switch) favorable rates – USD 3.42 per month vs. USD 9.21 for businesses in the cities on the Peninsula. Pricing of

telephone calls is similar to the Indian market where both long distance and local calls are billed on usage basis. The long distance billing uses four charging bands based on distance. Though there are five major players, all tend to have similar rates, though some differences can arise in packages. But, calls to ISP are heavily controlled. Malaysia has the second lowest dial-up rate in Southeast Asia of 0.7 US cents per minute, as compared to 1.1 US cents per minute in India. This includes both the dial-up phone tariff and the cost of the internet access.

Another factor driving costs down for consumers is that ISP's are allowed to establish international gateways as long as they have a network facilities license. Since this market is left open, each of the players has significant bandwidth to access data abroad, with the two leading players, TMB and Jaring having a total of over 500 Mbps.

The regulation to allow VoIP without restriction has brought increasing competition into the market place for both telephony and internet. This, like in Korea, has served to attract users with another service that they find useful, and helps the ISP's in providing an additional source of revenue to help justify infrastructure spending.

Broadband access has been delayed in coming for a few reasons. Cable TV access is not widespread as most households prefer to stay with channels available via terrestrial broadcast. Those who do pay for premium television service tend to get it from satellite broadcasts. Additionally, the government has not forced TMB to unbundled the local loop, which TMB itself has obviously been trying to avoid.

Access Device and Content

As part of the government's overall objectives for ICT growth it has stated that universal access includes access to data, as well as a telephone line. It has defined data access as a minimum speed of 128 kbps (ISDN speed), and at minimum collective access on demand. Any community in Malaysia asking for such access should be able to have granted to them a telephone line with this speed of access in a reasonable amount of time. And the government has not stopped there in just defining infrastructure as access, they have also included "Financial means to afford

and use ICT products and services; and basic skills or capabilities to use and the actual usage of ICT products and services.”²⁸ It has allocated 5% of its total budget towards ICT spend over five years.

The ramifications of this declaration are that the government has launched numerous programs to address the various problems implicit in this statement. Village authorities were provided with a PC and internet connectivity in their administrative office and PC’s with free internet access were setup in post offices, with special government portals created to provide local information and government services. Since the purchase price of a computer with internet access can be 90 percent of a rural household’s disposable income, the government launched many efforts to reduce costs. By allowing families with children over 10 years old to withdraw money from their retirement funds to contribute to PC purchases, and providing subsidized PC’s at special events, the government has worked to overcome the hurdle that expensive access devices cause.

The Malaysian government has also taken it upon themselves to bring the government completely online and have ICT be an integral part of their system. They commenced the building of a private broadband government network, extended by a virtual private network (VPN). They also launched the Multimedia Super Corridor (MSC) as a nurturing ground for local entrepreneurship and industry, as well as attracting foreign organizations to establish offices there. The benefits of the MSC on the overall economy have already been tremendous, and what sets this apart from efforts of other countries is the scale and level of planning with which this was executed through infrastructure build-out and incentives.

Efforts were also taken to ensure that each school had at minimum one computer lab with internet connectivity for student use. The ministry of education actually reserves a third of its budget towards connecting rural schools. Teachers are required to take training in ICT use that as part of their curriculum. Distance learning has also become

²⁸ National IT Council, Access and Equity, INFOSOC Malaysia 2000

a hot topic in Malaysia with only 168 student in 1998, scheduled to reach 54,000 in 2005.

Domestic Examples

Television and Cable TV Spread²⁹

Many cite the example of the successful penetration of cable TV services in the country as a great example of how internet usage can also spread. There are indeed many things we can learn from it, but because of the inherent nature of how this service and technology spread, it bring with it many disadvantages that today actually prevent the usage of the cable TV network for data, and especially broadband.

The local service provider (LSP) model has indeed worked wonders for the spread of affordable cable services. A local entrepreneur is able to get low cost upstream data access from a central content provider. This video feed from the parent company is then channeled into the local loop, or last mile, that is controlled by this LSP. The LSP then goes door to door marketing her services to individual home owners within her reach. This micro-marketing is effective in keeping costs low while managing to get a large number of households registered. It also protects, to some degree, the parent company from having to deal with billing and payment issues. Additionally, it perfectly aligns the incentives of the parent organization and the LSP, allowing the LSP to drive and experience what her own success can bring her.

The infrastructure for the last mile is also laid by the LSP herself. This also helps in keeping costs contained as the wires are strung across tree tops or electrical poles, using low, or no cost labor, and very low cost devices for splitting or boosting signals. This has even encouraged technically inclined youngsters to learn how the networks work and attempt to create or fixing their own devices to overcome certain technical challenges. This infrastructure cost is also shared amongst a large group of households since each connection does not need an individual line, but can be used for many other subscribers.

²⁹ Telecommunications Reform in India, Ashok Jhunjhunwala, Rafiq Dossani; TRAI analysis

In terms of access devices, the variety of televisions in the market place, whether locally manufactured, assembled or imported, is sufficient to cover the range of market segments. Each individual or family can decide how much money they want to invest in an access device, and can see the immediate cost/benefit of spending more or less.

On the downside, though, the path taken in this space also has its many drawbacks. The resulting cable network is completely unreliable in most cases, and can not be used for bi-directional communication. The quality of the simple video transmission is at best acceptable, and there is limited scope for access to premium services such as pay-per-view or subscription channels. This significantly limits the business model opportunities available to both the LSP and the parent company. Additionally, this structure also allows for a significant grey market for services and because of a lack of sufficient accounting controls, leaves room for revenue leakage.

If the LSP model can be modified to solve these issues by maintaining quality of infrastructure, quality of service and sufficient revenue tracking principles, it has the opportunity to have a significant impact on broadband roll-out. Additionally, if the LSP model can be further extended to serve as a source of micro-level local content, it can revolutionize the online content industry in the country.

Telephony Market

The changes brought about by competition in all segments of the telephony market demonstrate what significant impact can be achieved by opening an industry with the appropriate parameters for healthy competition. The changes were broad-sweeping and not only decreased tariffs for usage, but also increased customer service focus and general familiarity with the products and services. As is widely stated, the growth experienced in the past 7 – 8 months in telephony in India is equivalent to what we have experienced for the past 12 years.

Once spectrum was allocated and multiple players were allowed to operate in the mobile telephony market, the participant companies invested in infrastructure and found ways to drive overall growth. In addition to attracting subscribers through cost-

based value proposition, they also focused on network and customer service quality. Especially with the entrants of the basic service providers in the limited mobility market, mobile operators were forced to look for more innovative ways to attract and retain customer in a growing market. They introduced new services, invested in upgrading technology, and created innovative schemes, all benefiting the consumer community.

Outside of the mobile space, the introduction of competitive fixed carriers, whether via wire-line or fixed wireless also forced the incumbent to wake up or risk losing their market share. The drop in tariffs, the speed with which new installations are completed, and the improvement in overall customer service that even MTNL and BSNL have been able to display shows the importance of incentive from competition.

General knowledge and awareness of the facilities provided within telephony also increased. The terms of the industry and the understanding of the technology was directly impacted by firms competing for share of the user base. This has had positive effects on the population as a range of workers including plumbers, gardeners, etc. increasingly use the service as a business instrument and see immediate improvement in their businesses and quality of life.

One thing to note, though, is that much of the initial growth in this space was driven by local innovation. The initial focus on providing access to as broad a user base as possible was made possible by the telephone switch created by C-DOT. This innovation accounted for the unique economic and physical environment that India was in at that time. And though much improvement has been made since then, the requirements of some imported equipment creates high installation and maintenance costs. More than 50% of existing incumbent switches are designed by C-DOT.

The developments in the telephony space also carry with them some disadvantages. The lack of mandated infrastructure sharing has caused roll-out to be slow at times and costly. Since the infrastructure investments are high, operators pay high interest rates on their loans, and also can only afford to make limited upgrades or installations at any given time. Additionally, less densely populated areas get almost completely

ignored as the most economically justifiable investments are in the urban areas. This situation has also led to higher levels of occupancy of scarce spectrum resources as operators try to reserve and own as much of it as possible for fear of its disappearing in the future.

The other area that has caused some concern is the severe litigation, which has introduced inefficiency and unproductive costs within the system, ultimately hurting consumers.

The advantages accrued by the consumers can be credited to the fierce competition that occurred. Though many operators are claiming that they are sustaining losses and are not able to recover their investments, it has brought about growth in the market and has forced innovative ideas to appear. The lessons from this space demonstrate clear guidelines that can be carried over the internet and broadband space.

n-Logue Communications³⁰

n-Logue has demonstrated very effectively that connecting rural India and using indigenous technologies to control costs can be done profitably and provides tremendous benefits. They have taken the LSP model and attacked all three factors of the internet and broadband growth model that was discussed earlier.

As discussed in the situation of cable television growth, the LSP model has many benefits of local marketing and management. It also provides real incentive for each operator to drive her own business to as large as it can be since the structure provides her with personal benefits. n-Logue works in coordination with a middle agency that assists in the process of identifying potential entrepreneurs in villages across primarily southern India. These entrepreneurs are asked to invest minimal amounts of money, but are given rigorous training on how to use a PC and leverage the advantages of the internet. The LSP is then provided with a PC, printer, internet camera, microphone, power back-up and CorDECT, an indigenous technology, based connection for phone

³⁰ n-Logue Communications Pvt. Ltd.; Telecommunications and Computer Networks (TeNeT) Group, IIT Madras

and data access. The LSP sets up a kiosk with these facilities, and also has a loan with a grace period of three months.

The choice of CorDECT as the last mile infrastructure stems around its characteristics of cost effectiveness via wireless in the local loop, and its ability to offer both a voice and data channel. Though the speeds are somewhat limited currently to only 70 kbps when voice is not in use and half of that when it is, CorDECT provides sufficient service for these purposes.

n-Logue supports the kiosk operator with marketing techniques and training on how to attract customers to use and pay for services. They also help in creating and providing specific local content in local language. This content is not just web sites, but also, via customized video conferencing software, consultations with doctors, agricultural specialists and others across India. Villagers also have access to other services like matrimonial, video mail, e-learning, e-governance, and of course general websites if the customer so desires.

This set of services has created significant changes in the lives of individuals who interact with it. At first most villagers are reluctant to pay, but once they see the magic that it can create in their lifestyles, and how it can save entire crops or even someone's life, they become increasingly repeat users. The medium of the operator and local translator, guide and advisor helps bring ICT to the daily lives of those in the community. The sustained speeds and reliable connection also have huge impact in the willingness of reuse.

This setup has been established in over 500 locations, and is quickly growing. Because of the infrastructure, equipment and technology used, each kiosk needs to generate only Rs. 3,000 per month to be profitable. At this level each kiosk is self-sustaining, and paying off the loans incurred by infrastructure and equipment expenses.

Though there are limitations on the bandwidth, distance and features CorDECT in its current form may offer, it's a step in the right direction. n-Logue has combined this

with an effective deployment of the LSP model to create a small information revolution of its own. This type of business model can definitely be carried forward and used to create explosive growth in less privileged areas, whether rural or urban.

Gyandoot³¹

Gyandoot is a unique Public Private Partnership program. There are three entities involved in this endeavor: Gyandoot Samiti; the district government; and, the kiosk manager. Gyandoot Samiti is a non-profit organization, while the kiosk manager is a private individual, typically a local entrepreneur. The District Magistrate is the president of the Samiti and the Samiti has the Chief Executive Officer of the district council as its Secretary. Additionally, the Samiti has appointed a program manager who draws his salary directly from them. One unique feature of the project is the complete financial independence of the Gyandoot Samiti from the State government, where the government plays the role of a facilitator and ensures timely delivery of e-governance services.

The kiosks are linked to a central server located at the district council's office through optical fiber & copper cables using dial-up connections. All of these kiosks are situated at central locations like weekly markets or village council offices. Thirty-five different e-governance, e-commerce and e-learning services are presently offered by Gyandoot. These services are chosen through a process participated in by the community, government officials and the Gyandoot team. Each service carries nominal charges set on the principle of opportunity cost but keeping in view the affordability of the region.

Over a period of 2 years, the achievements of the Gyandoot project have been remarkable. It has doubled the number of private kiosks from 9 to 18 while the population coverage has increased from 5 million to 10 million. The income levels of kiosks have increased significantly, in addition to computer literacy and IT awareness in each district. Tribal farmers are now able to get better returns for their agricultural produce by utilizing the services offered, while the project itself has employed more

³¹ Case Study: Project "Gyandoot", India, Report of APT Study Question 1.5, Sanjay Dubey, Naveen Prakash, Gyandoot Samiti, August 2002

than 40 persons directly. In the relevant districts, computer literacy amongst government employees has grown from a mere 2% to 60%.

ITC e-Choupal³²

ITC's International Business Division, one of India's largest exporters of agricultural commodities, conceived e-Choupal as a means to establish a more efficient agricultural supply chain aimed at delivering sustainable value to its customers around the world. The model was specifically designed to tackle the challenges posed by fragmented farms, weak infrastructure and the involvement of numerous intermediaries, among others, as seen in this industry in India.

e-Choupal releases the potential of Indian farmer who often faces the vicious cycle of low risk taking ability leading to low investment, which lead to low productivity and then weak market orientation. This situation caused low value addition and therefore low margins, which then led back to low risk taking ability. This has made the domestic agribusiness sector inefficient, despite rich and abundant natural resources. e-Choupal leverages IT to virtually cluster all the value chain participants, delivering the same benefits as vertical integration does in other markets. While intermediaries provide transaction supporting services (aggregation, logistics, counter-party risk and bridge financing), e-Choupal has removed them for the flow of information and market signals, providing that directly to farmers.

Village internet kiosks are managed by farmers themselves and enable direct access to information in their local language on the weather and market prices, disseminate knowledge on scientific farm practices and risk management, and also facilitate the sale of farm inputs and the purchase of farm produce from the farmers' doorsteps. This brings information-based decision making to each farmer. Real-time information and customized knowledge provided by e-Choupal enhances the ability of farmers to take decisions and align their farm output with market demand while securing quality and productivity. The aggregation of the demand for farm inputs from individual farmers gives them access to high quality inputs from established

³² ITC e-Choupal, ITC Limited, www.itcportal.com

manufacturers at fair prices. As a direct marketing channel, virtually linked to the “mandi” system for price discovery, e-Choupal eliminates wasteful intermediation and multiple handling. Overall, this process greatly reduces transaction costs. While the farmers benefit through enhanced farm productivity and higher revenues, ITC benefits from the lower net cost of procurement, even despite offering better prices to the farmer, by eliminating unproductive costs in the supply chain.

Launched in June 2000, e-Choupal reaches more than a million farmers in over 13,000 villages through 2,600 kiosks across five states. The problems encountered while setting up and managing these kiosks are due primarily to lack of infrastructure, including reliable power supply, and telecom connectivity and bandwidth. Additionally, the challenge of imparting skills to first-time internet users in remote and inaccessible areas of India presents another challenge. But, the enthusiastic response from communities has encouraged ITC to plan for the extension of the e-Choupal initiative to 11 other states across India over the next few years.

Bharat Sanchar Nigam Ltd. (BSNL)

BSNL, India largest telecommunications services provider, introduced GSM-based cellular mobile services in late October 2002. Within 6 months of this launch, they achieved a subscriber base of over 2.5 million. The success of BSNL was due to pursuing a strategy which was quite apart from the other cellular operators.

The thrust of BSNL’s strategy was to simultaneously cover 1,000 towns across India, while not concentrating on the metros. They also covered major railway and highway routes along with tourist destinations. By concentrating on meeting pent-up demand in under-served markets, BSNL was able to grow rapidly while other operators competed against each other in markets with multiple players.

This lesson is also applicable to the internet and broadband space as it shows that while much growth may come from cities, the largely under-served areas outside metros also hold significant value. Additionally, it shows the value of identifying offers that serve existing demand with creative solutions to hurdles preventing growth.

Reliance India Mobile (RIM)

Reliance India Mobile has shown that some creative entrepreneurship can make a big difference in the success of a business model. The growth they have achieved has outstripped other company's and has launched them into among the largest private service providers in the country. The factors contributing to this include providing low cost of entry and life-style marketing. These can be applied to the internet and broadband space as well.

RIM popularized the concept of leasing handsets to the mobile telephony market. This was much needed as it brought CDMA handset makers to the Indian market, and also provided users with a choice of phone directly from the service provider. The actual overriding effect, though, was that it made it significantly more affordable for consumers to own a mobile connection. The small upfront fee, especially when compared to the cost of similar phone in the GSM market, meant that the middle class did not have to pay out about one month's salary to own a handset. Coupling that base choice with a number of higher level entry points, Reliance was effectively able to segment the market and allow end-users to choose how much they wanted to spend to enter this service. This is similar to why television density is so high. Additionally, because of wholesale purchasing, Reliance actually pays much less for each handset than an actual consumer would, thereby benefiting both parties. Reliance also effectively marketed their product to consumers by reaching beyond the upper class. They positioned mobile phones as one of the necessities in life, and demonstrated how it can be used by individuals of all backgrounds, allowing consumers to easily associate with it.

Finally, RIM also entered a market where there was significant pent-up demand waiting to be released once the right environment and offers prevailed. Consumers were already seeking the product and there was already fairly significant growth. Reliance was able to expand the market with their actions.

The concern raised by the model that Reliance followed in this space is that it required huge cash flow and investment. Additionally, some of their actions have

raised regulatory concerns for some time. Otherwise, the lessons here are clear and easily ported to the internet and broadband space.

Appendix 3 Technology Summary³³

Fixed-line Infrastructure

For fixed-line connections, digital subscriber line (DSL) technologies are the most popular worldwide, followed closely by cable. DSL is more common than cable in Asia and Europe while in the Americas cable dominates. While DSL and cable modem technologies have typically been built on existing networks, some new transmission technologies, such as fiber optic cables, have been gaining in popularity as well, especially as prices for installation drop.

DSL Technologies

A key advantage of DSL technologies is that they use existing copper twisted pair wiring and do not require new cabling as would say, fiber optics. DSL utilizes different frequencies to split voice and data services over the same standard phone line since phone networks only use a small portion of the available bandwidth for voice traffic. DSL speeds are influenced by the distance between the subscriber and the local exchange, the gauge of the phone wire, and the type of DSL technology.

Another main benefit of DSL technologies is that they offer a dedicated amount of bandwidth that does not vary with the number of subscribers logged on in an area. This is because each line is a complete circuit to the central office of the operator. Cable and wireless technologies can suffer from congestion when an increased number of users simultaneously use the allotted bandwidth within a loop or access point.

- Asymmetric DSL (ADSL, G.dmt, ITU-T.G.992.1) – ADSL is a form of DSL where more bandwidth is allocated to download than to upload. This makes it ideal for web browsing and typical Internet usage, where downloading of large files is more important than uploading, since it enables maximum speeds of 8-10 Mbps downstream and a maximum of 1 Mbps upstream. ADSL is available at a maximum distance of 3 km from the local exchange. It is well

³³ Birth of Broadband, ITU Internet Reports, September 2003

suiting to residential use because it shares a single twisted copper pair with voice, allowing users to use the telephone and surf the Internet simultaneously on the same line. The transceivers falling in this category are described in the ITU-T Recommendations of the G.99x-series

- ADSL (G.lite, ITU-T.G.992.2) – Originally, ADSL installations required a physical splitter to separate out voice and data traffic forcing these installations to be performed by technicians. G.lite allows for a splitter-free connection that simply requires the modem to be plugged in, thus drastically reducing the expense and difficulty of rolling out ADSL service. G.lite also extends the reach of ADSL by sacrificing speed – it can reach 5.4 km but its maximum download speed is limited to 1.5 Mbps while upload is limited to 512 kbps
- SHDSL (Single Pair High-Speed DSL, ITU-T G.991.2) – Single pair high-speed DSL (SHDSL) is released in a recent ITU recommendation. SHDSL connections are best suited for servers (web, FTP, file) and other business uses. SHDSL uses a copper pair to send and receive data through two bands, allowing for speeds up to 2.3 Mbps in each direction. By including a second copper pair, SHDSL speeds can reach 4.6 Mbps in each direction. These speeds are possible over a 3-km range, decreasing for longer distances. SHDSL send data over the low frequencies to extend the reach of the loop, making it impossible for SHDSL to carry a voice channel like ADSL
- Symmetrical DSL (SDSL) – SDSL is a proprietary standard mainly used in North America. SDSL offers equivalent traffic flow in each direction and like SHDSL, cannot share the line with analogue signals. The capacity of SDSL is adjusted according to signal quality, and speed and distance combinations ranging from 160 kbps over 7 km to 1.5 Mbps over 3 km. Higher speeds are possible by combining multiple twisted pair wires
- ADSL2, ADSL 2plus (ITU-T.G.992.3/G.992.4) - ADSL2 is the sequel to the original ADSL recommendation, enabling improved speed, reach, power consumption and other technical elements over the original version. ADSL2 can deliver 8-12 Mbps while extending the reach of the original ADSL by 300 meters. The speed and reach increases in ADSL2 are largely owed to improved performance on long lines in the presence of interference. Other

improvements include addressing several technical issues that appeared with original ADSL standards. The new recommendations also allow for the use of filters, rather than splitters, at both ends of the connection. Further, the voice channels are realigned and offer providers the ability to combine multiple ADSL2 lines for faster bandwidth to certain customers. In addition, ADSL2 systems can enter an "all-digital" mode where voice channels are reassigned to data, similar to SHDSL. ADSL 2plus (ADSL2+) builds further on ADSL2 by increasing the bandwidth through extending the usable frequencies on the line. The download channel is extended from a maximum of 1.1 MHz with ADSL2 to 2.2 MHz with ADSL 2plus. This increases download bandwidth from 8 Mbps with ADSL2 to 16 Mbps with ADSL 2plus. These speeds are possible over 1.5 km.

- VDSL (Very-High-Data-Rate DSL, ITU-TG.993.1) – This is the latest form of DSL and offers the fastest DSL speeds to date, though over short distances – 52 Mbps over a standard twisted pair cable. This makes VDSL the optimal choice for branching out short distances from fiber connections, for example inside an apartment building or commercial complex.

Cable Modem Technologies

Cable networking has evolved and with new equipment has made it possible to send data in both directions, making internet access over cable a viable solution. The physical cable network sends different "channels" on separate blocks of 6 MHz frequencies along the same cable. One channel sends data from the internet to users (6 MHz of frequency corresponds to roughly 30 Mbps) and another channel is used to send data back on the Internet from households. All cable subscribers in a small area share the same channels to send and receive data, and the amount of bandwidth users receive is directly tied to how much bandwidth their neighbors are using.

The cable modem technology, called DOCSIS, is a product of ITU-T Study Group 9. The first generations of cable modems were built on ITU-T Recommendation J.112, however a new ITU-T Recommendation J.122 (DOCSIS2) was approved at the end of 2002 and offers improvements to the existing standard while maintaining backwards compatibility. The new DOCSIS2 standard improves the way the cable modem

broadcasts data back to the central office, allowing for more economical use of existing bandwidth.

Fiber Optic Cable Technologies

Fiber optic cable uses lasers or light emitting diodes (LED's) to transmit pulses of light down extremely fine strands of silicon. Fiber optic cable can carry thousands of times more data than either electric signals or radio waves because light uses higher frequencies. The infrared laser light that is typically used in telecommunications has a frequency of roughly 100 MHz, 100 million times higher than an AM radio signal and 100 billion times higher than an electric telephone signal. Currently, most fiber optic cables transmit light only at one frequency, but, as technology improves, the bandwidth on fiber optic lines can be increased by simply adding more frequencies on the line, just as DSL uses several frequencies to split voice and data traffic over copper.

This has made fiber the technology of choice for backbone connections and other heavy bandwidth areas. Strands of fiber optic cables also comprise the majority of trans-oceanic lines. Since the costly aspect of fiber cables is the actual laying of the cable and the termination equipment, it is typically installed in large bundled strands to accommodate future bandwidth needs. As technologies have improved, the price of the equipment has dropped and currently the cost of fiber rollout is approaching the cost of other wired networks. Fiber is also less attractive owing to its lack of flexibility since it can only withstand a limited amount of curves and bends, making installations in apartment buildings very difficult due to the additional attenuation loss.

While most fiber optic cable is laid in the ground, Japanese companies such as NTT have started using aerial cables to connect homes. This decreases the costs of installation and makes use of existing power poles as anchors.

Wireless Infrastructure

Fixed Wireless Technologies

Fixed wireless systems are constrained by their allotted radio spectrum, a finite resource. Typically, 1Hz of spectrum can yield 1-4 bps of throughput, depending on

various factors (such as modulation technique and environmental factors). Fixed wireless systems use frequencies between 900 MHz to 40 GHz, with higher frequencies able to carry far more data but not able to travel as far as lower frequencies and often requiring line of sight. Higher frequencies also require more complex equipment that can be more expensive.

- Multipoint microwave distribution system (MMDS) – MMDS was traditionally used to provide one-way, analogue wireless cable TV broadcast service and was widely known as "wireless cable". MMDS frequencies (2.1 GHz to 2.7 GHz) are now being used for providing broadband services. This frequency range does not require line of sight. With MMDS, a transmitting tower must be placed at a high elevation and can provide high-speed data rates of up to 10 Mbps over a 48-56 km radius.
- Local multipoint distribution system (LMDS) – LMDS was originally designed for wireless digital television transmission. It occupies a large amount of spectrum above 20 GHz and can provide two-way broadband service including video, telephony and high-speed Internet access. The higher frequencies of LMDS require line of sight
- 802.16 (WiMAX) – The IEEE recently standardized 802.16 as a new fixed-wireless standard using point-to-multipoint architecture. The initial version (802.16) was developed to meet the requirements for broadband wireless access systems operating between 10 and 66 GHz, while a recent amendment (802.16a) does the same for systems operating between 2 and 11 GHz. WiMAX equipment should be able to transmit 32 - 56 km with maximum data rates close to 70 Mbps. The higher frequencies in the range require line of sight. Unlike wireless LAN technologies in the 802.11 series, WiMAX is meant to be a high-speed wireless backbone, or middle-mile technology. Other technologies can then disseminate the connections over the last leg of the network to users
- CorDECT³⁴ – CorDECT is a WLL solution developed by the TeNeT group at IIT Chennai. It consists of customer premise equipment, which includes a wallset with internet port (WS-IP) and an antenna that must be installed. The

³⁴ Telecommunications Reform in India, Ashok Jhunjhunwala, Rafiq Dossani

wallset has a U.S. standard RJ-11 connection for a phone, and connects to a computer via a standard serial port (RJ-232) without using a modem. A group of WS-IP's connects via wireless to a base station (CBS), which is then connected to an access point. The access point consists of a digital enhanced cordless telecommunications (DECT) interface unit (DIU) and an iKon remote access switch (RAS). The system provides internet access at 70 kbps, which drops to 35 kbps when a simultaneous phone conversation is in progress. The AU separates the voice traffic and transfers it to the circuit-switched telecommunications network using an E1 interface. The bursty internet traffic from multiple subscribers is statistically multiplexed and connected to a router using one or more E1 interfaces. A typical AU can serve 200 to 1,000 subscribers. The maximum distance that can be achieved in rural areas is 35 km, using an area relay base station (ARBS) which is 25 km away from a CBS and has a 10 km coverage radius of its own. In urban settings, the radius is likely to be 1 – 2 km in order to reuse spectrum. Finally, a multi-wallset (MWS) has been designed and can serve four independent subscribers in the same building, cutting cost per line in half.

Satellite Technologies

While satellite connections are more expensive than other methods of delivery, they provide a viable option to rural and remote areas that have no other real broadband options. However, while they offer worldwide coverage, they also suffer from latency (delay between a signal being sent and received) problems. Advantages of satellite technologies include ubiquitous coverage, simplicity in network design, reliability and rapid deployment. The downside includes security weaknesses, less bandwidth, higher latency and poorer signal quality. However, for point-to-multipoint occasional use applications where bandwidth is required on a part-time basis satellite consistently proves more cost effective. It is also the only technology that boasts 99% coverage of world landmass.

Satellite broadband connections were initially constrained to satellite communication for downloads and a dial-in connection for the upstream. However, new technology

has allowed for two-way communication, meaning that all Internet communication can take place through a bi-directional satellite dish at the customer premises.

Wireless LAN Technologies

A wireless local area network (WLAN) is a local area network with at least one segment using electromagnetic waves to transmit and receive data over short distances in place of wired network access. Mobile devices access the "wired" network by connecting, to an access point on the network. Wireless LAN's are most commonly used as last 100 meters diffusers of a broadband connection, although they are being used increasingly as methods of providing broadband access over longer distances in rural areas by increasing power levels of the equipment, using specialized antennae, and ensuring line-of-sight access.

Several factors have contributed to the phenomenal growth of WLAN's: a steep drop in prices, the mobility benefits of wireless connectivity, off-the-shelf availability, and easy installation. Nevertheless, while wireless LANs can be extremely useful, by dint of their very nature, they are less secure than their wired network counterparts.

- 802.11b (Wi-Fi) – Wi-Fi uses the 2.4 GHz frequency band to deliver 11 Mbps of data over a range of 100 meters, although obstacles such as trees or walls between the wireless adapter and the access point cause the speeds and range to drop. Please refer to X for an outline of typical ranges. Directional antennae and amplifiers (provided the total power radiated does not exceed what is allowed by nationally applicable regulations) can be used to extend the range of 802.11b products. 802.11b is a half duplex protocol - whereby transmissions can be sent or received, but not simultaneously. It shares the 2.4 GHz range with many cordless phones, microwave ovens and some wireless local loop (WLL) radio systems, so interference is possible

Table 3-1 – Range of WiFi in Different Environments³⁵

Environment	Range	
	Maximum	at 11Mbps
Outdoors / open space with standard antenna	225 - 300 m	45 – 100 m
Office / light industrial setting	75 - 100 m	30 - 45 m
Residential setting	40 - 60 m	20 - 25 m

- 802.11a (Wi-Fi5) – 802.11a was conceived earlier than 802.11b, but took longer to develop and was later to market than its more popular relative, 802.11b. 802.11a uses the less-crowded 5 MHz band and enables speeds of up to 54 Mbps, almost five times faster than Wi-Fi. Wi-Fi products are currently less expensive and much more prevalent than 802.11a ones, and the arrival of newer technologies such as 802.11g are making 802.11a even less likely to gain a large following. 802.11a has the advantage of operating at fast speeds in an open area of spectrum and the recent decision by the ITU World Radio Conference in July 2003 to release additional spectrum for WLAN use in that range may also add to its popularity
- HiperLAN2 – HiperLAN2 stands for "High Performance Radio Local Area Network" and is a European WLAN standard developed by the European Telecommunications Standards Institute (ETSI). It operates in the same 5 GHz frequency band as 802.11a, using orthogonal frequency division multiplexing (OFDM) and offering data rates of up to 54 Mbps, but their modulation schemes are different. HiperLAN has some advantages by making more efficient use of the spectrum and can transfer more data at any given time. In addition, HiperLAN offers quality of service support that is not possible with 802.11a, making HiperLAN a better choice for time-sensitive transmissions such as video, audio, and voice. HiperLAN has not been very successful and as the 802.11h Task Group works on revisions to 802.11 to make it more suitable for deployment in Europe, HiperLAN2 is facing tough competition

³⁵ The Wi-Fi Alliance, www.wi-fi.net

- 802.11g – This is the latest WLAN standard, and has recently become available off the shelf. 802.11g is backwards compatible with Wi-Fi because both run in the same frequency band of 2.4 GHz. But, by using the same Orthogonal Frequency Division Multiplexing (OFDM) modulating technique, it enables speeds of up to 54 Mbps. With equipment being closely priced to 802.11b devices, while providing five times the speed and backwards compatibility, 802.11g is likely to become the dominant WLAN technology
- CorDECT³⁶ – CorDECT is a WLL solution developed by the TeNeT group at IIT Chennai. It consists of customer premise equipment, which includes a wallset with internet port (WS-IP) and an antenna that must be installed. The wallset has a U.S. standard RJ-11 connection for a phone, and connects to a computer via a standard serial port (RJ-232) without using a modem. A group of WS-IP's connects via wireless to a base station (CBS), which is then connected to an access point. The access point consists of a digital enhanced cordless telecommunications (DECT) interface unit (DIU) and an iKon remote access switch (RAS). The system provides internet access at 70 kbps, which drops to 35 kbps when a simultaneous phone conversation is in progress. The AU separates the voice traffic and transfers it to the circuit-switched telecommunications network using an E1 interface. The bursty internet traffic from multiple subscribers is statistically multiplexed and connected to a router using one or more E1 interfaces. A typical AU can serve 200 to 1,000 subscribers. The maximum distance that can be achieved in rural areas is 35 km, using an area relay base station (ARBS) which is 25 km away from a CBS and has a 10 km coverage radius of its own. In urban settings, the radius is likely to be 1 – 2 km in order to reuse spectrum. Finally, a multi-wallset (MWS) has been designed and can serve four independent subscribers in the same building, cutting cost per line in half

IMT-2000 / Third Generation Mobile Technologies

Though today's broadband solutions are largely on fixed networks, mobile telephone networks may one day be the preferred broadband conduits. IMT-2000 (equally referred to as third-generation or 3G systems) is sometimes equated as "broadband for

³⁶ Telecommunications Reform in India, Ashok Jhunjhunwala, Rafiq Dossani

mobile phones". In reality though, current 3G speeds are technically too slow and the technologies are only available in some countries. Work began on the standard in the mid-1980s, and the 1992 ITU World Radio Conference (WRC-92) identified the 2 GHz band for the global deployment of IMT-2000. Eight years later, WRC-2000 allocated additional spectrum for 3G services in three frequency bands: one below 1 GHz, another at 1.7 GHz (where many second-generation systems currently operational and a third band in the 2.5 GHz range.

Despite concerted efforts at global standardization IMT-2000 has emerged with five possible radio interfaces based on three different access technologies (FDMA, TDMA and CDMA). Thus far, the vast majority of industry attention has been directed towards the CDMA technology and in particular wideband CDMA (W-CDMA), which is known in Europe as UMTS and CDMA2000, including CDMA2000 1x, which is widely deployed in Korea and Japan. Typically, 3G systems provide data rates at a minimum of 144 kbps for all radio environments and 2 Mbps in low-mobility and indoor environments, however, as the technology and speeds improve, we should expect to see the prices for 3G data access decrease.

Free Space Optic (FSO) Technologies

Free space optics (FSO) make use of the same laser technology used in fiber optics, but without wires, thereby taking advantage of the speeds reachable by using infrared light waves, rather than radio or electrical waves. FSO technologies send laser transmissions back and forth to communicate data over line-of-sight distances. The laser technology allows very fast transmission speeds of up to 1.25 Gbps, and therefore can offer another method for solving the last mile problem in cases where there is line-of-sight connectivity. FSO technology has the benefit of not requiring spectrum like other wireless technologies, and is also inexpensive to install and can be implemented very quickly.

On the other hand, FSO may be subject to several technical problems. First, as the lasers send data through the atmosphere, they are easily affected by atmospheric disturbances, in particular humidity and especially fog, whose tiny water particles can distort transmission. Second, the lasers must be kept entirely static to ensure

reception on the lens at the other end. Tall buildings that sway in the wind are therefore problematic. Other disturbances can include temporary interruption due to moving objects, such as birds flying through the beam. Finally, another problem is scintillation caused by heated air, which can cause disruption to the signal.

Mesh network technologies

A new wave of technologies, called "mesh networks", is emerging that will enable multipoint-to-multipoint networking. Mesh networks rely on each user also becoming a broadcaster in the network where each subscriber access point is also part of the routing infrastructure. As users are added to the network, the reach of the entire network expands. The true benefits of mesh networking become apparent in remote or hard-to-reach areas. Technologies such as WiMAX can bring the backbone connectivity over long distances and at the local level, the mesh network can then be built out from one central point in the community. As more distant users connect, they simultaneously increase outer areas of network reception. Another benefit of mesh networks is they do not require line of sight since mesh networks can work around obstacles by essentially routing to bypass them.

Other Broadband Technologies

Power line communications

Since power lines form one of the most extensive networks in the world, surpassing the phone network in size and coverage, sending data via power line communication (PLC) can save the cost of building out a telecommunication infrastructure from scratch. Much like DSL, electrical signals act as a carrier for data transmission to and from end-users, piggybacking on the network and being filtered out at the end points. For example, power is sent over the line at 50-60 Hz while data is sent via the 1 MHz range, thus avoiding interference. These signals are sent over medium voltage wires, the lines running between substations, and local transformers. One of the problems with PLC is that it can be difficult to avoid data being lost as it passes through the transformers and cable bridges had to be built to bypass them. Recently though, new technology has been developed that allows signals to make it directly through the transformer and is making PLC a viable option in many parts of the world. PLC still has other problems, though. First, due to noise interference and attenuation over long

distances there can be data signal disruption. Second, PLC can interfere with radio, television, telephone, and DSL signals.

HAPS/LAPS

This technology uses balloons and other low or high altitude platform stations (LAPS or HAPS) to provide fast, wireless Internet services over a large area. These systems are significantly less expensive than satellite systems and can be deployed quickly. Typically they either involve having a tethered balloon (similar to a weather balloon) hovering from 3 km, or an untethered stationary object at 21 km above the ground. The tether includes fiber optic cables as the medium for information transfer, while untethered versions use radio signals to transmit data to the backbone network.

The U.S. government has already been using balloons for some time for collecting data along its borders, while several companies are working on furthering developing these technologies. Skyline has proposed deploying 18 tethered balloons across the U.K., each hovering 1.5 km above ground and supplying access within an 80 km footprint and supplying ubiquitous coverage. Other companies around the world, such as SkyStation, plan to use untethered balloons at very high altitudes to provide a much wider coverage area, but with lower power. A third company, SkyTower, has developed a pilot-less, solar-powered airplane to hover over an area and provide broadband access from high altitudes, which happened to crash in a June 2003 test flight. LAPS and HAPS may offer an inexpensive alternative to satellite service, especially in underserved areas, but the technology is still new and faces stiff competition in developed broadband markets.