A WHITE PAPER ON INDIAN BANDWIDTH INDUSTRY
A BUSINESS CASE ANALYSIS FOR THE HIGH INTERNET ACCESS PRICES IN INDIA

INDEX

Executive Brief

The present white paper aims to address the key issue of high bandwidth prices in India. The Indian bandwidth scenario along with the latest access prices has been presented in this paper. The focus of the argument is that Indian bandwidth prices are way too high vis-à-vis worldwide bandwidth prices.
To validate this higher prices premise, the Indian scenario has been compared with the International broadband experience for key countries like US, Korea, Japan, China and UK.

The key conclusions on the Indian bandwidth access prices are as follows:

a. Price Comparison:
The price comparison between India and worldwide bandwidth access prices clearly shows that there is a clear business case for drastically reducing the broadband access prices in the Indian context.

b. Threshold Subscribers:
There appears to be a threshold market size of between 2 to 3 million subscribers in any market. The rate of growth changes drastically once the market reaches this threshold size.

c. Impact of Absolute prices:
If monthly access prices falls below the $25 mark, the price elasticity goes up significantly and it makes business and economic sense for operators to go for maximising subscriber base by dropping the prices.

d. Impact of Prices relative to narrowband access:
An analysis of relative monthly access price of broadband (BB) vs. equivalent monthly spend on dial up narrowband (NB) for equivalent time usage clearly shows that the inflection point is around Broadband/Narrowband price ratio of 1.5.
It appears that across countries, the consumers are willing to play a premium for broadband but not more than 50% above their monthly spend on narrowband access.

e. Prime Demand Elasticity zone for India:
An unlimited download of 256 kbps ADSL broadband connection costs averages to about $22/mo currently in India. This price is already too high.
To achieve mass-market broadband penetration India must reduce this price further and shall bring it down to the range of $10 and $13 per month.
This is the prime demand elasticity zone in the Indian context.

Next, detailed business cases have been prepared to validate the higher prices premise in Indian context, in this white paper.
The business cases has been modeled on the basis of the following key parameters:
a. The Demand scenario in an average Indian city
b. Technology Options
c. Operating Expenditure
d. Investment Requirements
e. Impact of duties and taxes
f. Impact of revenue sharing arrangements

The impact of various parameters on the business case has been analyzed. The paper also describes in detail the Quality of service (QoS) parameter, which is also one of the most important issues facing the broadband industry today.

Definition of Broadband:

For the purpose of this white paper, Broadband has been defined as:
"An always-on network capable of providing interactive voice, data and video services on public networks".

In terms of speed, there should be at least two tiers of service- the 'true' broadband being capable of providing minimum asymmetric bandwidth of 1.5 Mbps and a 'lite' version capable of providing 256 kbps. Within these ranges and including the variations possible with service offering mix, it is expected that several tiers of broadband services will be made available to different segments to meet the market requirements. It should also be noted that by definition, broadband (triple play of voice, data and video on the same network) requires the convergence of services for enabling its adoption and usage.

In the Indian context always on high speed Internet access speed is below 256kbps and Broadband Internet access is at more than 256 kbps.

For the purpose of this white paper the word "broadband" has been used to mean "bandwidth" only. And the two words are to be used as one while reading the white paper.

2. India Bandwidth Scenario

Broadband connections have continued growth since beginning of 2006.
At the end of November 2006 total broadband connections in the country have reached 2 million. BSNL, Sify, MTNL, Airtel, Netcom, Reliance and Hathway are some of the major ISPs in India. TRAI has defined broadband as 256 kbps or higher. However, many ISPs advertise their service as broadband but don't offer the suggested speeds. Recently, Airtel and Hathway have begun offering unlimited downloads starting from 64 kbps. Broadband in India is very costly compared to Western Europe/UK and USA.

An unlimited download of 256 kbps ADSL broadband connection from Airtel and BSNL costs about $22/mo. The upload limit for 'BSNL UNLIMITED 256 kbps plan' is 64 kbps. BSNL offers 2Mbps down for Rs9000 or $225/mo with a download limit of 40GB,addition download costs around $2.2 per Mb

In last decade or so, many private ISPs have entered the market, many with their own local loop and gateway infrastructures. Right now the market is infinite and competition is fierce to lure prospective customers into buying their services. The telecom services market is regulated by TRAI. Although broadband law of 2004, changed the definition for broadband to 256 kbps always on, most ISPs found that they could provide broadband with a capping of data that can be downloaded.
ADSL providers include the following players:

- Tata Indicom (VSNL)
- MTNL/BSNL
- Bharti Telecom (Airtel, Bharti Televentures)
- Reliance Infocomm

According to estatsindia.com estimates, as of December 2006 the country had around 10 million Internet users, however at December end, the total number of broadband connections stood at around 2.00 million.

Although one would expect higher numbers to be achieved thanks to BSNL, the government owned telecom and Internet provider, which has declared 2007 as the year of broadband. BSNL is aggressively pursuing its strategy to increase the reach of its Dataone broadband service by reducing the tariffs and increasing the download speeds to 2 Mbps from the current 256 Kbps. BSNL because of its wide reach especially in the rural areas is in a good position to spread internet connectivity in remotest parts of the nation.

2.1. Internet Access in India

* As of December 2006 there were 10 million Internet subscribers (including broadband).

* About 20% of the total Internet subscribers are broadband subscribers (2 million), but this segment is growing at a faster rate.

* Annual growth rate of Internet subscribers seen for the last three years is about 25%.

* Internet subscribers are growing at a rate of about 9.44% million subscribers per quarter.

* The percentage of Internet subscribers using dialup connection for Internet access decreased from 84% in March-05 to 66% by March-06 and it is 60% at the end of June-06.

* 86% of the total Internet subscriber base (including broadband) is with five leading ISPs.

* As of Dec 06, 66% of the total Internet subscribers are with Public sector units as against 62% in June-06.

Although Dial-up connections are still the majority form by which users connect to the Internet, broadband connections have shown remarkable spike and are likely to grow at a higher rate with more competitive offerings in terms of speed and tariff by competing ISPs.

The following are the recent tariff rates charged by top broadband service providers. (Tariffs are subject to change).

For plans limited by download volume

Exhibit 1:Effective Charge per MB (Rs.) of download for Broadband Services

Service Provider	Monthly Charges	Monthly Free Data transfer (Download) in MB	Addl. data transfer charge - beyond monthly free download (Rs. Per MB)	Effective Charge per MB in Rs. (for 500 MB of data transfer)
MTNL	199	400	1	0.60
BSNL	250	409.6	1.4	0.75
Sify	300	500	NA (prepaid)	0.60
Bharti	250	400	1.4	0.78
VSNL	375	500	1.25	0.75

Source: TRAI

For unlimited download volume

Exhibit 2:Effective Charge per hour

Service Provider	Monthly Charges	Charge per day	Effective charge per hour
MTNL	1399	47	5.83
BSNL	900	30	3.75
Bharti	999	33	4.16
Sify	1000	33	4.17
VSNL	1200	40	5.00

Source: TRAI

3. INTERNATIONAL BROADBAND PRICES VIS-À-VIS INDIAN BROADBAND PRICES

Exhibit 3: Lowest broadband prices worldwide, per month, and change, (Mid 2005-early 2006)

Economy	Company	Speed kbit/s	Price per month US $	US $ per 100 kbp/s	Change 2005-2006
Japan	Yahoo BB	51'200	31.19	0.07	-12.5%
Rep. Of Korea	Hanaro	51'200	40.59	0.08	NA
Netherlands	Internet Access	20'480	27.97	0.14	-81.3%
Taiwan, China	Chunghwa	12'288	22.67	0.18	NA
Sweden	Bredbandsbolaget	24'576	56.08	0.23	-6.5%
Singapore	Starhub	30'720	73.17	0.24	-85%
Italy	Libero	12'288	37.23	0.30	-73.8%
Finland	Elisa	24'576	85.64	0.36	-51.4%
France	Free	10'240	37.29	0.36	-90.1%
United States	Comcast	4'096	20.00	0.49	NA
Germany	Freenet.de	6'016	30.95	0.52	NA
United Kingdom	Pipex	8'128	50.89	0.63	-53.6%
Hong Kong, China	Netvigator	6'144	51.17	0.83	NA
Portugal	Sapo	8'128	75.82	0.93	NA
Canada	Bell	4'096	41.26	1.01	-3.93%
Average		**18'287**	**44.33**	**0.42**	**-50.8%**
Best Practice (Top 20%)		**40'960**	**27.59**	**0.08**	**-73.3%**

Source: ITU

Broadband Access Price comparison vis-à-vis Indian context

<u>INDIAN SCENARIO:</u> For plans limited by download volume

Bandwidth Download Speed: 256 kbps upto 2 Mbps
Monthly Free Data transfer (Download) in Mb: 400Mb
Additional Usage Charges beyond Monthly free Usage: Re.1 per Mb
Monthly DSL Minimum Usage Charges: Rs.199/-
Price per month in US$: $4.42
US $ prices per 100 kbp/s: $2.22 (Indian context)

For unlimited download volume

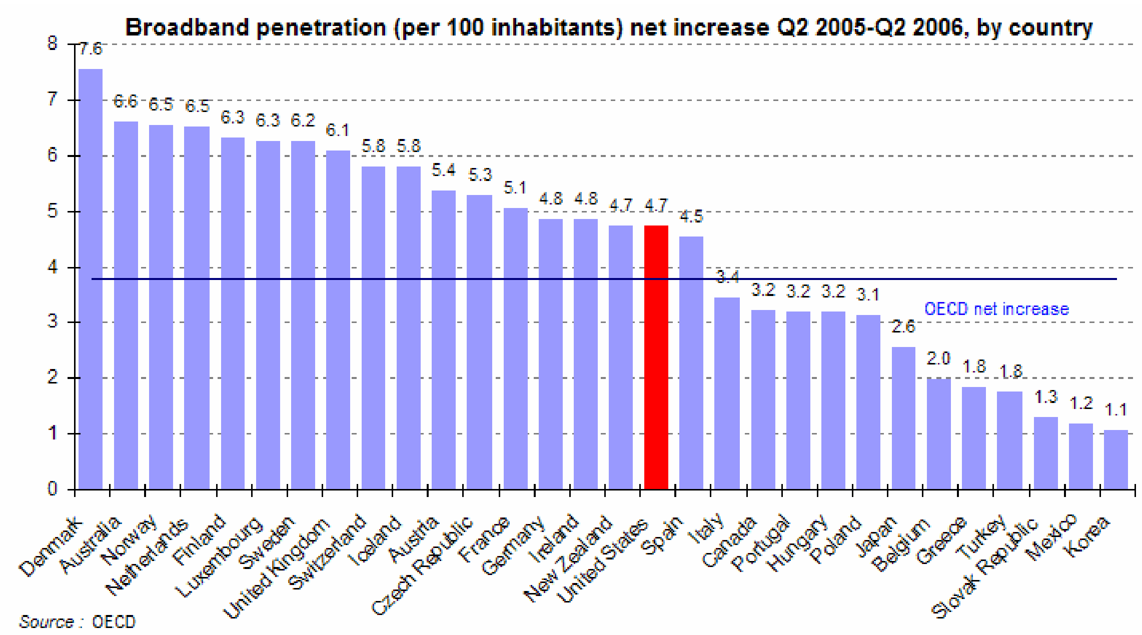
An unlimited download of 256 kbps ADSL broadband connection costs averages to about $22/mo. US $ prices per 100 kbp/s: $8.59 (Indian context)
Global average prices in USD per 100 kbp/s are around $0.42
(Refer to the exhibit 3 above)

The above price comparison clearly shows that there is a clear business case for drastically reducing the broadband access prices in the Indian context.

4. International Experience in broadband

Market Statistics

Exhibit 4: Broadband Penetration Net Growth for OECD Countries Q205 - Q206



Source: OECD

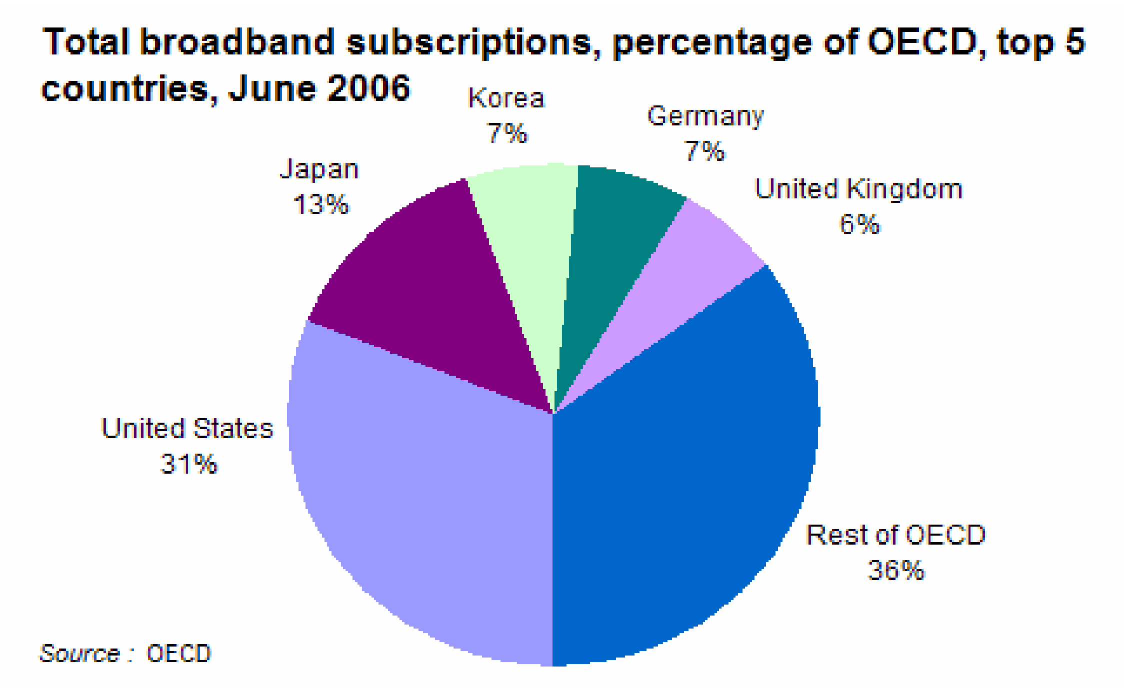
• A brief look at the share of various technologies in the top 10 broadband markets indicates (refer exhibit 5 below) that, DSL is the most commonly used technology to provide broadband services in the top 10 countries.

Overall DSL accounts for 60% of the market and cable subscribers account for another 35% share. The newer technologies such as Fiber, wireless, satellite, etc currently account for less than 5% of total market supply.

4.1. Total Broadband Subscribers Worldwide

Over the past year, the US has maintained its lead with 31% of total broadband subscribers worldwide. While they have added subscribers over the past year, Japan, Korea, and Germany have lost ground percentage-wise as broadband spreads to other countries, dropping from 15% to 13%, 9% to 7%, and 7% to 6% respectively The UK maintained its fourth place position over the past year with 6% of total broadband subscribers.

Exhibit 5: Total Broadband Subscriptions as a Percentage of OECD for Top 5 Countries June 2006



Source: OECD

4.2. The cheaper it is, the faster it grows

Exhibit 6: Total penetration (per 100 inhabitants), by type of access

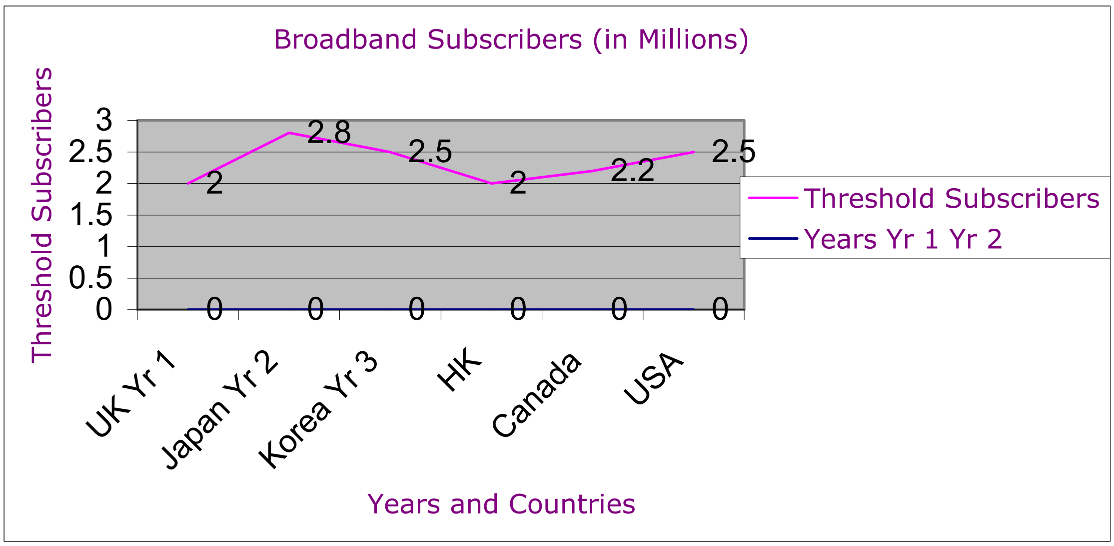
Technology	DSL	Cable	Other
Country			
United States	7	10	2
Japan	13	3	5
Israel	14	5	NA
Belgium	13	5	NA
Taiwan, China	18	4	NA
Sweden	13	4	5
Canada	12	10	NA
Norway	18	4	2
Finland	20	3	NA
Switzerland	15	8	1
Hong Kong, China	13	10	NA
Denmark	16	7	2
Netherlands	17	8	NA
Korea (Rep.)	13	10	2
Iceland	26	NA	1

Source: ITU

5. Broadband Threshold Subscribers Worldwide

Exhibit 7. Worldwide Broadband Subscribers Growth Rate

Name of the Country	Threshold Subscribers (In millions)	Years
UK	2	1
HK	2	2
Canada	2.2	2
Korea	2.5	2
USA	2.5	1.5
Japan	2.8	2



Source: ITU Telecommunication Indicators Database Promoting Broadband

Key Pointers

• As is evident from the above exhibit, in absolute terms, there appears to be a threshold market size of between 2 to 3 million subscribers in any market. The rate of growth changes drastically once the market reaches this threshold size.
The factors that could be contributing could be market visibility and resulting subscriber comfort level with the service, minimum scale of operations for operators and proof of concept for operators waiting to invest, interest of content and application service providers and availability of useful content and applications, etc.
The critical issue is that countries that achieve this threshold quickly are more likely to achieve mass penetration than those that are still below the threshold.
India has just managed to reach the threshold market size of between 2 to 3 million subscribers, as recently as the end of December 2006.

• In terms of penetration, there appears to be broadly three different groups of countries viz.,
a. Countries with very high /fast penetration such as Korea
b. Countries with mid level penetration HK, Canada and Japan
c. The slow penetration growth markets such as the case of US

These differences appear to be independent of macro-economic factors but seem to be caused by local market factors and government policies.
• Three local market factors that have significant impact on market penetration levels are:

a. Price (absolute prices) changed per month for entry-level access prices

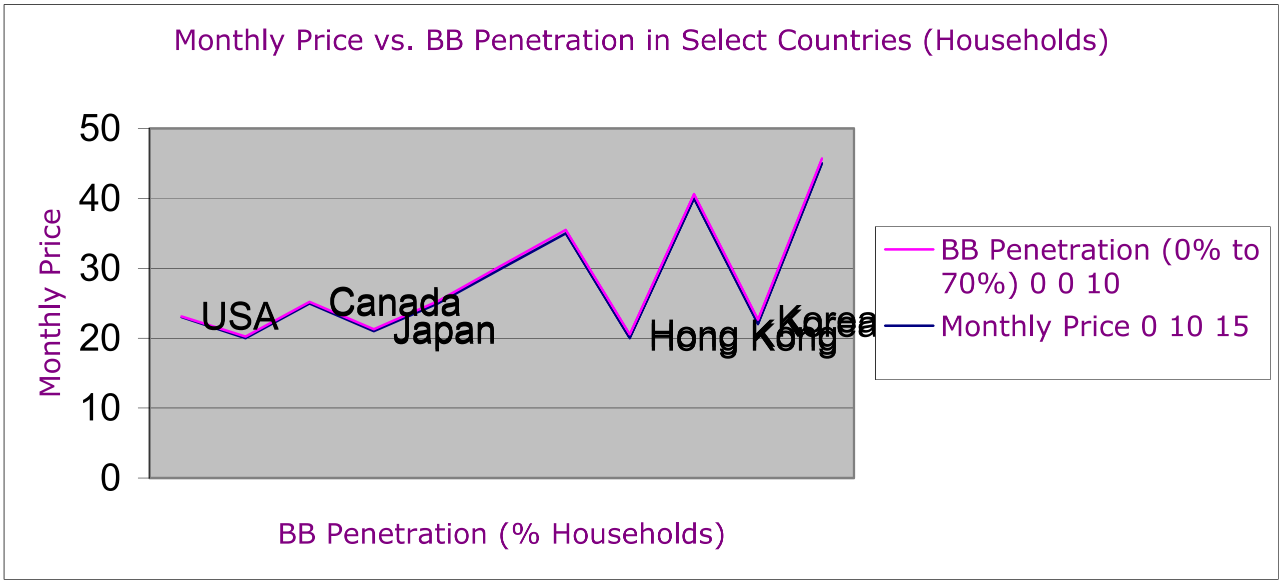
b. Relative price premium charged for broadband vis-à-vis the complementary product-Narrow band

c. Availability of differentiated/broadband content and services

6. Impact of Absolute Prices

As is evident from the exhibit below, price elasticity of demand across countries becomes significant only at prices below $25

Exhibit 8: Price vs. broadband penetration



Source: Wachovia Securities, Worldwide DSL Scorecard; ITU World Telecommunication Indicators; IBM Institute for Business Value Analysis, 2006

Key Pointers

- There are two critical issues that are evident from the graph above.

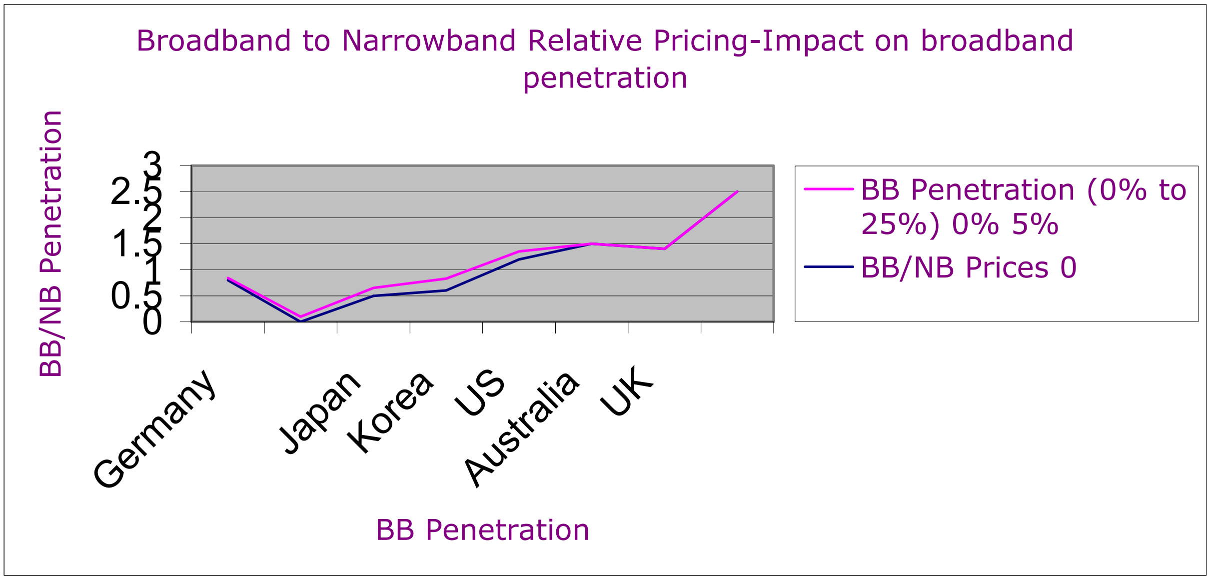
First, if monthly access prices were to for any reason fall below the $25 mark, the price elasticity goes up significantly and it makes business and economic sense for operators to go for maximising subscriber base by dropping the prices.

Second, where markets have prices above $25, players would find it better to maximize prices and unit subscriber profitability. Among the developed countries, the price range of $18 and $22 appear to be prime demand elasticity zone. Although even this price has been constantly coming down owing to various other factors as detailed in the business case. **(refer page)**

7. Impact of Prices relative to narrowband access

• Given the variations in purchasing power parity and the difference across countries with respect to presence of complementary products, an analysis of relative monthly access price of broadband (BB) vs. equivalent monthly spend on dial up narrowband (NB) for equivalent time usage was expected to provide additional inputs.

Exhibit 9: Prices relative to narrowband access



Source: Wachovia Securities, Worldwide DSL Scorecard; ITU World Telecommunication Indicators; IBM Institute for Business Value Analysis, 2006

Key Pointers

• The inflection point in the above curve is around Broadband/Narrowband price ratio of 1.5. It appears that across countries, the consumers are willing to play a premium for broadband but not more than 50% above their monthly spend on narrowband access.

• In countries, which provide unlimited access, the improved services and experience from Broadband are understood to have increased time spent on-line significantly. This effectively reduces the per hour broadband access price (since prices are fixed monthly rates) leading to *perceived hourly rates* for broadband in 'high usage' countries being lower than narrow band prices.

• If the 1.5X limit for broadband pricing were applied to the Indian market, the effective maximum acceptable price for mass-market adoption for broadband would lie between Rs.450 to Rs.600 per month, i.e. $10 to $13 (average narrowband monthly spends range from Rs.300 to Rs.400 per month). This range is more likely to be acceptable to the Indian market than the $18 to $22 per month arrived at from the analysis of absolute price elasticity of penetration among the developed economies.

- An unlimited download of 256 kbps ADSL broadband connection costs averages to about $22/mo currently in India. This price is already too high.
To achieve mass-market broadband penetration India must reduce this price further and shall bring it down to the range of $10 and $13 per month.
This is the prime demand elasticity zone in the Indian context.

8. Key Lessons For India

In conclusion, the key lessons for India based on the review and analysis of experience of multiple countries around the world in promoting broadband is summarized as follows:

- The accepted meaning of broadband across countries varies widely, with various ranges starting from 128 kbps to 1.5 mbps being set as the minimum limits for broadband speeds. Given that the nature of service offerings is bandwidth dependent, there is a need to define broadband service standards in India to ensure that appropriate content such as education, e-commerce, teleworking, e-health, etc. can be effectively provided on the network to the public.

- While per capita income of countries is a determinant of broadband penetration, in the year 2003 for example there were wide variations in actual broadband penetration between different countries with similar per capita income (of the order of 1:12). Conversely, there are also wide variations in per capita incomes of countries with similarly high broadband penetrations (of the order of 1:7).
This gives confidence that even a low-income country such as India with the right mix of policies, could aim for a reasonable penetration and ensure that India is an integral part of the global knowledge economy.

- The key determinant of mass-market penetration by broadband is the ratio of narrowband and broadband prices. Broadband prices in India should be set such that they do not exceed the 1.5X multiplier on the average monthly costs of the average narrowband user. This would imply that the access prices for broadband in India should be in the range of $10-$13 for mass-market penetration.

- Various market indicators support the view that for real mass-market penetration, in addition to price, availability of appropriate content and services (e-education, e-commerce, e-governance, entertainment, etc.) are necessary. The offtake of specific services however depends on availability of appropriate content/services, prices at which they are available, access network capability to deliver content and services (Baseline capability and the QoS of the network) etc.

- The key underlying determinant for mass-market penetration, pricing and availability of appropriate content is the presence of a holistic national policy and the effectiveness of its implementation. The critical objectives necessary to be covered in the government policy include:

  - Consumption promotion/consumer protection

  - Competition promotion

  - Investment promotion/investment protection

• To meet each objective, the government policies need to cover several key aspects/issues simultaneously. These aspects include:

a. Consumer protection/consumption promotion through:

i. Pricing controls

ii. Mandating and regulating quality standards in broadband services

iii. Interconnect adaptability

iv. Bridging the digital divide/provide access points

v. E-governance initiatives (as anchor tenant and as an incentive to usage)

vi. ICT user training for the non-IT literate

vii. Promotion of relevant appropriate services and content especially for public good (e.g. education, health, agriculture, local language, culture support, etc.)
Promoting competition

b. Promoting competition through:

i. Inter modal competition through promoting convergence of services/licenses

ii. Intra modal competition through breaking monopoly of indifferent dominant incumbent or promoting and supporting competition

• Investment promotion through:

◦ Convergence of services, licenses and regulatory authorities

◦ Easing access to key resources for rollout of broadband

◦ Open up the investments in the broadband space to overseas investors as well.

In content and applications, there are three critical issues that need to be addressed:

• There is a need for the industry to come together and set up centers like for example, “Experience centers” to conduct live research on the Indian customer behavior.

• Establish a conditional access and copyright/IPR regime for the digital world that shifts from a “reactive-penalty for breach” approach to a “pro-active-prevention of breach” approach.

• There are a number of public good areas such as e-education, e-health and E-governance, where the government will need to create an appropriate environment for promotion of investments as well as direct funding/sponsorships for various initiatives. Further, broadband business models are by nature highly capital intensive and risky. Businesses need to look to strategies, which manage the risks and improve the viability through measures in capex, opex reduction and through multi-stream revenue models.

⇒ Capex Reduction through:

° Strategy for scale

° Alliance and partnerships both within a value chain and across value chains

° Sharing of existing resources, leasing rather than investing in competing resources

° Maximise asset utilisation by “pocket” focus strategies

⇒ Opex reduction through:

° Specialising in core areas and alliances/outsourcing for non-core revenues

° Focused approach to management of marketing, channel and customer related costs while maintaining high degree of customer satisfaction

⇒ Build multi-stream and robust revenue models

° Tie-up/alliance with multiple content and service providers as early as possible with revenue share arrangements for paid services/content

° Develop broadband specific content and services, which leverage the differentiated capability of broadband rather than provide the older “web world”/ “broadcast world” products. The content should be appropriate/relevant priced.

° Promote e-commerce and permission based advertising revenues

• The government policies regulatory framework for broadband needs to be supportive of industry structures and business models. Two primary aspects are original implementation of convergence and competition management.

8.1. Key objectives for India model

• Vision led mass-market penetration

• Viable and de-risked business model for the service provider through:

a. A low access entry price to drive mass market

b. Multi-segmented offerings to capture maximum value

c. Value added content for customers from Day1 or easy revenue sharing arrangements

• De-risk capex by:

a. Leveraging existing infrastructure at a reasonable cost sharing/revenue sharing arrangements and sharing infrastructure

b. Large volume purchases (pooled purchasing) further reduce capital expenditure

ANNEXURE

I. INTERNATIONAL BROADBAND MARKET SCENARIO

US broadband market: US Broadband Market By Access Technologies

Broadband Market Size 2006
(By share of major players)

xDSL: 34%
Break-Ups for major players are as follows:
SBC: 35%
Verizon: 29%
Bell South: 16%
Others: 11%
Qwest: 9%

Cable: 66%
Break-Ups are as follows:
Comcast: 32%
AOL: 23%
Cablevision: 7%
Mediacom: 2%
Cox: 13%
Charter: 11% and Others: 12%

Others: 0.5%: Cable and DSL are the broadband access technologies in US and cable has gained a larger share of broadband market
Source: Broadband Battle, April 2006, CSFB, Broadband Handbook Feb 2006, Merrill Lynch, And World Broadband Statistics Q3, 2006

Exhibit 10: US broadband market-access, players, products and prices

Player	Technology	Mkt. Share within Technology (2003)	Bandwidth Range	Price Range (Per month)
AT&T	DSL	54%	1.5- 3Mbps	$29.99- $34.99
Verizon	DSL	26%	768kbps (128kbps)-1.5Mbps(768kbps)	$14.95-$29.95
Qwest	DSL	7%	256-640kbps	$15-$27 (ISP charges additional)
Comcast	Cable	39%	1.5Mbps	$40-$58
Time Warner	Cable	22%	2 Mbps	$45-$60
Cox	Cable	11%	3 Mbps	$40-$50
Charter	Cable	8%	256kbps-1.5 Mbps	$30-$50
Other DSL	DSL	13%	NA	NA
Other Cable	Cable	5%	NA	NA

Source: Broadband Battle, April 2006, CSFB, Broadband Handbook Feb 2006, Merrill Lynch, and Leichtman Research G Press Release Q3, 2006

Korea Broadband Market By Access Technologies

Broadband Market Size 2006
(By share of major players)

xDSL: 60%
Break-Ups for major players are as follows:
KT: 77%
Hanaro telecom: 21%
Dreamline:1%
Others: 1%

Cable: 40% Break-Ups for major players are as follows:
Hanaro telecom: 38%
Thrunet: 36%
Onse Telecom: 12%
Dreamline: 2%
Dacom: 2%
Others: 10%

LAN: 11%, Internet via Satellite: 0.06%
Source: 2006 White Paper Internet Korea ITU report Korea Broadband case study, World Broadband Statistics Q3, 2006

Exhibit 11: Korea broadband-access, players, products and prices

Player	Technology	Mkt. Share	Bandwidth Range	Price Range (Per month)
KT	ADSL, Ethernet, Fiber	52%	1.5-100 Mbps	$12-$30
Hanaro	ADSL/VDSL, HFC, LMDS, Wireless LAN	35%	1.5-10 Mbps	$12-$20
Others	HFC, LAN	13%	1-2 Mbps	NA

Source: Company websites, ITU Country Case Studies, SEC Filings of the companies

Japan Broadband market by access technology

Broadband Market Size 2006
(By share of major players)

xDSL: 76%
Break-Ups for major players are as follows:
- Yahoo BB
- DION (KDDI)
- OCN (NTT)
- ODN (Japan Telecom)
- Nifty (Fujitsu)
- So-net (Sony)
- BIGLOBE (NEC)

Cable: 24%
Break-Ups for major players are as follows:
- Jupiter Telecom
- Titus Communications
- Tokyu Cable

Others: 3%:

Source: Japan Broadband Case Study, April 2006, ITU; World Broadband Statistics Q2 and Q3 2006, Point Topic

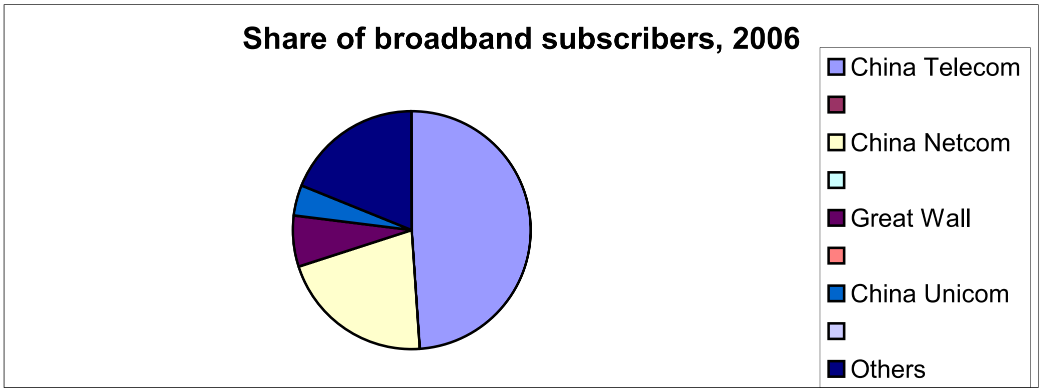
Exhibit 12: Japan Broadband-access, players, products and prices

Player	Technology	Bandwidth Range	Price Range (Per month)
Yahoo! BB	DSL	8-12 Mbps	$19-$21
DION (KDD)	DSL	12 Mbps	$24
NTT	DSL, FTTH	12-100 Mbps	$25-$30
OCN (Japan Telecom)	DSL	12 Mbps	$25
TTNET	FTTH	100Mbps	$82-$144
K-Opticom	FTTH	100Mbps	$50
Usen	FTTH	100Mbps	$40-$43
Jupiter Telecom	Cable	NA	NA
Titus Communications	Cable	NA	NA
Tokyu Cable	Cable	NA	NA

Source: Japan Broadband Case Study, April 2006, ITU

China broadband market-service providers

Exhibit 13: Share of China broadband subscribers



Source: CCID, July 2006

China Telecom, the biggest fixed network carrier, has a natural performance, holding large quantities of twisted pair cable.

Although China Telecom offers broadband largely by ADSL technology, it is also the largest provider of Metro Ethernet and WLAN broadband services. China Telecom provides VNET service to broadband customers, which is in a cooperative mode and open system.

China Telecom cooperates with software providers and system-integration providers to build a broadband value chain, which can obtain more revenue from the broadband network.

China broadband market-by access technology:

ADSL: 57%

The incumbent China Telecom currently dominates the ADSL services. China Telecom also dominates last mile networks across the country.
China Telecom was initially reluctant to push the service for fear of cannibalizing its leased line access particularly its proprietary DDN (digital data network) services, but began doing so from 2001

CATV: 19%

CATV Broadband service is still being offered on a "trial" basis, in order to avoid the attention of the MII. As a "trial" service, it is generally still the cheapest form of broadband access in China

LAN: 24%

China Telecom is the major player in the metro Ethernet service market. Metro Ethernet services are currently cheaper than ADSL services and comparable with cable modem
Source: IDC, 2006

Exhibit 14: China broadband market- Pricing

	Monthly Pricing***		
	Residential ($)	Corporate ($)	Installation Charges
ADSL	16	170	Varies from zero upwards depending on service provider and region
Cable Modem	10	115	
Fixed Wireless Access	Not available	LMDS 235	
Metro Ethernet	11	135	

*Source: Source: IDC, 2006 ***Pricing as of Jan 2006*

Service bundling has not yet taken off in China. Other key points in regard to Chinese market are as follows:

- Some provincial service providers are marketing their own bundled packages, such as VPN with broadband, or even videoconferencing with VPN.

- Demand is definitely picking up for VPN in China. VoIP is likely to continue to be sold as a separate service in the near future, and not be bundled with broadband.

- Carriers are trying to offer voice together with data communications, but billing systems are not yet mature enough to offer sophisticated bundling of services.

UK broadband market

UK broadband market by access technologies

Broadband Market Size 2006
(By share of major players)

Cable: 54%
Break-Ups for major players are as follows:
NTL: 61%
Telewest: 39%

xDSL: 46%
Break-Ups for major players are as follows:
BT: 61%
Pipex: 17%
Kingston: 3%
Others: 19%
Note: Pipex and Kingston are ISPs reselling BTs wholesale DSL offerings

Others: 0.5%
Source: Second Annual Report & Strategic Recommendations, Nov 2006 BSG; World Broadband Statistics Q2 & Q3 2006, Point Topic

Exhibit 15: UK broadband- access, players, products and prices

Player	Technology	Mkt. Share	Bandwidth Range	Price Range (Per month)
BT	DSL	52.1%	500kbps-2 Mbps	$22-$71 (Wholesale prices) $50-$292 (Retail prices)
NTL	Cable	32.8%	150kbps-1Mbps	$30-$58
Telewest	Cable	14%	500kbps-2 Mbps	$42-$83
Others	FWA, Satellite, DSL	1%	NA	NA

Source: Oftel's Internet & Broadband Brief, September 2006, company websites

BT wholesales DSL connectivity to other service providers (ISPs) who then sell it to retail customer. There are over 100 ISPs offering DSL products

II. Quality of Service (QoS)

An important element that needs to be addressed, both from the perspective of the consumers and the service providers, is the Quality of Service (QoS) for broadband services. This has to address issues related to network services, customer related services and the enforcement framework for enforcing the QoS.

• On the network side, QoS can be defined as a measure of network performance that reflects the quality and reliability of a connection. QoS can also indicate a data traffic policy that guarantees certain amounts of bandwidth at any given time, or can involve traffic shaping that assigns varying bandwidth to different applications.

The key dimensions that need to be considered for QoS for broadband are:

i. Bandwidth requirement-this defines the peak traffic rate as well as traffic pattern (sustained, bursty or interactive)

ii. Network Latency-Delay in transmission of data across a network

iii. Jitter- Variation of delays experienced by data packets

iv. Packet Loss Rate-Percentage of packet loss due to network congestion

• The key issue is the need to define a standardized service level in context of the minimum throughput that is being guaranteed for various services to a subscriber who takes up a connection with a certain specified nominal (or advertised) connection speed.

For instance, while an ADSL connection with nominal connection speed of 1.5 Mbps would support 1.5 Mbps (and therefore video streaming) in the last mile between the subscriber and the gateway router, the minimum guaranteed access speed to an international internet exchange could be set at 12.8 kbps (a one is to ten contention assuming a peak internet access speed of 128 kbps for a residential subscriber). This standard service level would therefore need to take into account the nominal connection speed that is advertised, actual wire speed between the subscriber and ISPs gateway router and the contention ratios (i.e. ratio of aggregate nominal customer speeds to bandwidth available to domestic and international internet exchanges).

Similarly for video related applications, video quality metrics would need to be adopted in line with those specified by ITU/ANSI/ETSI standards.

• Another important issue that impacts QoS is that while service levels can be specified in a single service provider domain, it has not been possible to provide these levels in a public network as many of the standards that support the internet are wide open to standardization and do not have adequate built-in QoS mechanisms.

With the increasing use of IP services and a greater demand for QoS on networks, a number of protocols (such as MPLS, Diffserv, RSVP, IPv6 and SIP) have begun to be adopted make the Internet more than a best efforts network. Perhaps the most ambitious protocol that is emerging is IPv6, which not only addresses the potential address shortage of the currently prevalent IPv4 protocol, but also brings in improved QoS, more efficient processing of data packets and improved security.

• In the broadband context, it would be imperative that India also considers the upgradation of the networks to support contemporary protocols. This needs to be examined in detail and a roadmap needs to be created for ensuring that all carriers in the public network invest simultaneously in such upgrades to be able to offer the required QoS for broadband services in public networks.

• The broadband service providers would also need to have legally enforceable SLAs (Service Level Agreements) from the infrastructure and/or access providers as well as with NLDOs/ILDOs, etc. to be able to support the requisite QoS norms.

• In order to achieve all of the above, a QoS regulation would need to be put in place that should include the following:

i. Determination of the specific service levels for various aspects of broadband services jointly by the industry and the regulator and agree to a roadmap for upgrading networks.

ii. Regular monitoring of networks and access level performance of service providers and publishing of periodic performance ratings.

iii. Defining a code of practice for broadband service providers (as in Singapore) including mandating service providers communicate service levels in a precise and transparent manner to the consumers.

iv. Setting financial penalties for operators not meeting the defined standards of service.

III. Key recommendations for the Industry

The following exhibits provide the summary of the key recommendations and action points for the industry.

Key Recommendations for the Industry

Demand Stimulation

• Keep access prices between Rs. 450 to Rs.600 ($10-$13) for ensuring mass market penetration and subscriber offtake/usage
• Provide range of services/content including entertainment, education, health, community participation, tele working, etc. and differentiated and tiered bouquets to maximize revenues
• Provide Value-added content and services as early as possible

Strengthen revenue models

• Multi-segment focus and multi-tiered solutions for different price ranges to maximize value capture from the market
• Adopt/promote Kiosk/community solutions for rural, urban lower classes and small town populations
• Rural solutions have to be linked to participation in village economy/agri-commodity trade and commerce starting at the farmer's gate

Manage costs effectively

• Keep capital costs low through scaling either individually or through procurement pooling and other alliances among industry members to gain economies of scale
• Lower operating costs through outsourcing and sharing of resources with alliance partners

Key Recommendations for the Industry

Access side

• Support convergence of services at the earliest regardless of physical layer or prior classification of industry
• Support and assist early implementation of an effective Managed Access policy that allows for rapid capital formation and rollout of services to the market
• Move towards alliances/ partnerships that leverage existing capabilities and assets while bridging gaps in own capabilities using alliance partner's capabilities/ resources.
• Incumbents should consider innovative structuring options to achieve quick rollout without necessarily losing control
• Invest in human capital creation/ skills development in existing areas of gaps (CCDN, billing, payment, content aggregation, OSS/BSS) for broadband space
• Cable industry should initiate a range of programs to create a consolidated, technology savvy, customer oriented industry that is broadband capable
• Work out specific spectrum requirements with the government and work out a way for sharing of spectrum among players

Key Recommendations for the Industry

Content side

• Industry should jointly set up 'Experience Centers' to study broadband usage behavior and test market content/ applications; results can be made available to participating members
• Participate through investments in developmental content creation such as education, health etc.
• Re-purposing of existing content to meet broadband needs must ensure conversion of existing content to high digital quality levels
• By medium term, significant investment and effort to create broadband oriented and broadband specific content
• Create an industry association to track and adopt global trends in content standards to ensure alignment

Consumer Protection/Support systems

• Industry members across the value chain need to come together and develop a set of QoS based agreements that ensure quality of experience for the user
• Access/ CDN industry and the financing industry need to come together to put together viable financing schemes to enable availability of rental/EMI options for CPEs to the retail subscriber

Key Recommendations for the Industry

Backhaul/NLD/ILD/IP transport

• Promote local hosting of Internet content-first for locally owned Internet sites and also for high traffic international site's local replica
• Invest in creation of international bandwidth to support the expected growth of usage of international content with rollout of broadband
• Promote/develop IDCs, ASPs and other online service facilities to enable users to benefit from the rapid access to the Internet

Role of the Government/ Regulator

• Progressive reduction upto 75% of prevailing prices of international/domestic bandwidth prices by 2006
• Mandate interconnection for all broadband services (on any media/technology platform) with the national backbone
• Enable regulation for managed open access on incumbent copper network
• Release of unlicensed and licensed spectrum in the 2.5 GHz, 3.5 GHz and 5 GHz range at low costs
• Promote state level agreements for free Right Of Way in exchange for free bandwidth for government requirements
• Mandate standards for cable networks to make them broadband capable
• Mandate and enforce QoS standards for broadband service providers for each tier/type of broadband service; Regulator to conduct periodic audits, publish results and penalize violators
• Extend cyber laws on privacy and fraud to cover all media for broadband services

Industry structuring measures

- Determine timing for full convergence of services, i.e. allowing triple play regardless of technology/underlying media.
- Allow for sharing, leasing, trading, sale and transfer of licenses, spectrum, bandwidth and other assets/resources among all industry players
- Ensure adoption of global standards in technology/services so as to ensure interoperability and standardization
- Extend FDI limits to all parts of the broadband industry value chain to attract overseas investments
- Explore options for establishment of national level repositories to kick-start the content aggregation
- Establish mechanisms for secure micro payments

Role of the Government/ Regulator

Fiscal Measures

All broadband infrastructure/ service providers, regardless of underlying technology or media, to be provided with a 10 year income tax waiver (as provided for the IT companies)
Exempt CO equipment and CPEs (including STBs and PCs) from all customs and excise duties including countervailing duties, special duties and Sales Tax
Exempt broadband services for the next 10 years from payment of Service Tax
Tax exempt broadband allowance for users, the same being tax deductible for paying organizations
Treat investments in Broadband Experience Centers as R & D expenses-i.e. Tax-free status
Digital content (education, health, governance, local language, web content, interactive entertainment) to be accorded soft infrastructure status with enabling incentives and interventions
Provide Educated Unemployed youth who wish to set up BB Kiosks with easy financing options/support from the various self-employment/entrepreneurship development funds available

IV. 1. Business Case

In order to understand the cost economics involved in deployment of various broadband technologies in the Indian context, 10-year business cases have been developed for a typical Indian city for the following technologies:

- ADSL on incumbent copper network
- HFC networks-upgrade existing cable networks
- Fiber-based Ethernet rollout-new network creation

- Business case for wireless technologies especially Wi-Fi and WiMax has not been developed, since these technologies are not expected to have a city wide deployment in the near future and are likely to be suited for addressing niche local areas or remote locations where wired access is not available.

- These business cases are indicative in nature and provide a broad assessment of the relative economics and prima facie viability of the various technologies. These are important inputs in identifying the key factors that need to be addressed for ensuring a rapid broadband deployment such as investments required, possible risk sharing mechanisms and fiscal incentives that may be required to support the rollout. The business cases have been developed based on inputs on architecture/ costs provided by industry players (vendors as well as service providers) and market side estimates (ARPU/subscriber nos.) based on various secondary sources.

Assumptions

This section outlines the key assumptions that have been made to develop the business cases.
For developing the business cases, the top 33 Indian cities have been looked at with population over 1 million (excluding Delhi and Mumbai) and defined an "average" city whose profile in terms of key indicators has been outlined in the exhibit below:

Exhibit 16: "Average" city for business case analysis

	ALL INDIA URBAN	TOP 35 CITIES
Population	300 million	100 million
Total Households	59.0 million	23.2 million
DSL Households	13 million	6.5 million
C & S Households	32.5 million	19.4 million
SEC A&B Households	18.5 million	8.6 million
PC Households	2.4 million	1.8 million
SOHO DELs	6.0 million	2.7 million
Corporate DELs	6.0 million	3.5 million
SME DELs	3.5 million	1.5 million

Source: IBM BCS Analysis

• To get an idea of the profile of this average city, and therefore understand the demand for broadband in that context, the key indicators (such as DELS, C&S households, PC owning households, etc.) and future growth therein has been summarized in the exhibit below.

Exhibit 17: Growth of demand indicators in "average city"

Growth of Demand Indicators in the Average city

	2003 (est.)	2010	CAGR% p.a.	Comments
Total Households	465,000	544,000	2.25%	Urban population growth rate
DEL Households	127,000	146,000	2%	Gradual growth in line with population growth
C & S Households	348,000	460,000	4%	Annual growth estimated
SEC A & B Households	144,000	202,000	5%	Growth in line with per capita income
PC Households	39,500	193,000	12%	High initial growth-dropping in later years
Corporate DELs	75,000	89,000	2.3%	Gradual growth
SOHO DELs	54,000	64,000	2.3%	Gradual growth
SME DELs	30,000	45,000	6%	Growth at GDP rate

Source: IBM BCS Analysis

• The broadband subscriber base considered for analysis of the average city is derived from the demand estimation for the various segments that is based on the results of a market research study conducted by IMRB.
Source: Experience of consumer products and services in India-IMRB

• The business case for a given technology assumes that 50% of the potential broadband subscribers (in the residential as well as commercial segments) would be subscribers for this particular technology.

The table below presents the subscriber base for the business case, for the average city.

Exhibit 18: Broadband subscriber base for the business case

	Yr1	Yr2	Yr3	Yr4	Yr5	Yr6	Yr7	Yr8	Yr9	Yr10
Residential Subs	4,884	9,530	16,479	20,104	27,519	32,141	32,262	44,966	55,455	66,793
Commercial Subs	719	1,680	2,725	4,010	5,575	7,465	9,730	11,513	13,378	15,371
Total Subs	5,603	11,210	19,205	24,115	33,094	39,606	44,993	56,479	68,833	82,164

Source: Experience of consumer products and services in India-IMRB

2. Pricing for the Business Case:

The pricing for the business case has been assumed in line with the findings of the secondary research and the findings are as follows:

- For the residential segment, the charges include one time installation charge of Rs 5000 (including the upfront payment towards part of the cost of CPE) and recurring charges of Rs 800 per month that will include high speed internet access, BBTV, content in later years as well as the rental for CPE.

- For the analysis of the business cases, while the CPE rental and BBTV prices have been assumed constant at Rs 100 each across the business case period, access prices are expected to reduce from Rs 600 in the initial years to Rs 400 in the later years. The reduction in access prices is assumed to be compensated by the increase in revenues for content services from nil in the first two years to Rs 200 in the later years.

- The base business case assumes that these prices are the final cost to consumer and does not include any applicable taxes or levies (such as service tax, entertainment tax etc.). A sensitivity analysis on the impact of taxes on the pricing and business case viability has been carried out to understand how this could impact the cost to consumer and therefore the penetration levels that are possible.

- For the commercial segment, there is no installation charge and recurring charges of Rs 3500 per month have been assumed that would cover the basic access, the various value added services as well as the cost of CPE.

- Since DSL can be used to leverage the existing infrastructure, the DSL business case assumes rollout of broadband services on the existing copper network of the incumbent and therefore incremental costs required for broadband enabling the network have been considered. These costs provide for upgradation of city main rings/collector rings with optical equipment (DWDM/GE equipment), DSLAM, ISP infrastructure, CDN servers at the city/local levels, and CPEs (DSL modems and Set top boxes). No fresh layout of copper has been assumed in the business case.

- Given that majority of the current cable networks in the country are not capable of supporting broadband, the business case for cable-based broadband service is based on upgradation of the existing cable network to a HFC based bi-directional cable network that can support broadband services. The capital costs that have been considered cover the creation of the fiber network and related optical equipment, upgradation of coaxial cable, transceivers nodes, CDN servers at city/local level and CPEs (Cable modems and STBs).

- The fiber business case assumes a new network rollout and the architecture that has been assumed is Fiber-to-the-curb (FTTC) design with Ethernet in the last mile. Therefore the capital costs for this business case cover laying of fiber network, optical equipment/routers at various nodes, Ethernet switches, last mile cabling (CAT 5 or aerial fiber), network management center, CDN at city/local level and CPEs (network interface cards and STBs).

- In line with the trends witnessed in the technology market, a 15% year-on-year decline in equipment prices have been assumed for the initial 4-5 years after which they have been assumed constant.

- Upgradation/ replacement costs have been accounted for certain equipment such as optical equipment, CDN, DSLAMs etc. assuming a replacement rate of 50% after five years of installation.

- No investments have been assumed to have been made in terms of acquisition /creation of content and the business case assumes that content would be available from content providers/ content aggregators on a revenue sharing basis.

3. Key elements of operating expenditure that have been considered are:

- International/national bandwidth costs

- Revenue share for content (assumed at 30% of content revenues)

- Revenue share to telco or cablecos (This is being paid for services provided by the telco/cablecos to the broadband service provider which would include services like co-location, last mile access copper/coax, marketing/advertising support, billing/customer care support etc.)

- Marketing/customer acquisition costs

- Billing related and IT costs

- Others- Personal and general and administration costs

- Provisioning of International bandwidth has been assumed at 12.8 kbps for each residential subscriber and 32 kbps for each commercial subscriber. Further the unit costs of national/international bandwidth has been considered at more reasonable levels of 50% of today's prevailing bandwidth costs for the initial years and reducing further to about 25% of the today's prevailing rates in the later years.

- While it is understood that certain reduction (to the extent of 25% of today's rates) in bandwidth costs is already being proposed, further reduction may be required in order to deliver the proposed broadband services with the adequate QoS, especially for addressing the retail segment.

- A critical element of the cost structure for the business cases is duties and taxes that would be applicable for the broadband business in the current scenario. In order to understand the impact of these on the supply side costs and therefore the viability of the business given that pricing is a market driven factor, a sensitivity analysis of the pricing to the duties and taxes has been carried and no duties and corporate taxes have been assumed for the base business case.

- The business cases that have been developed have been thereafter used to analyze the cost structures in terms of capex per subscriber and the viability of the technologies in terms of IRR, cash breakeven and cash payback period in the Indian context.

4. Business Case Analysis

The following section outlines the business case analysis and the findings thereof:

The key results of the business case analysis for the 'average' city are outlined in the exhibits below.

Exhibit 19: Business Case for 'Average' city-Analysis of Cost structure

Capex per Sub in USD*	Year 1	Year 3	Year 5
DSL over incumbent copper	681	323	256
HFC network-upgrade cable network	743	389	337
Fiber+Ethernet	1755	735	568

*Without duties

Exhibit 20: Business Case for 'Average' city-Viability Analysis

	IRR (10 Yrs)*	Cash Break Even (Years)*	Cash Pay Back Period (Years)*
DSL over incumbent copper	21.1%	Year 4	Year 7
HFC network-upgrade cable network	20.9%	Year 4	Year 7
Fiber+Ethernet	18.8%	Year 4	Year 7

*Without duties and taxes

5. Key results of the business case analysis:

5.1 Viability Analysis

- From the above analysis, it can be seen all the three technologies seem to have fairly viable business case in spite of the differences in capex costs per subscriber. While the high cost of fiber-based model can be explained on account of the creation of entirely new infrastructure, the higher operating margins (as there is no revenue sharing with an infrastructure provider which could be as much as 15-20% of total revenues in the other technologies) helps in improving the overall business economics for a fiber based model.

- On the cable business case, the higher capex figures are required for creating the HFC network, most of which is either not in place or needs significant upgrades. However the lower operating costs for a cable network, primarily on account of marginally lower revenue share (15%) with the cableco as compared to the DSL service provider helps in ensuring adequate returns. It should be noted that the DSL case has assumed that there are no upgrades that are required to the basic copper network. In case the copper needs significant replacement, the costs of the DSL rollout could go up.

- A significant point that needs to be taken into account is that while fiber-based rollout prima facie compares well with the DSL case in terms of overall viability, the higher investments and roll-out of a fresh network would result in longer time scales for deployment and therefore would increase the inherent risk for the fiber option.

5.2. Investments requirements

• Based on these business cases, an estimate can be made of the level of investment that is required in creating a broadband network infrastructure across the various cities in the country to achieve the projected demand numbers for the country. An estimation of these investment needs for the period 2004-2010 have been made in the exhibit below, assuming that 2004 is the first year for broadband services in India.

Exhibit 21: Investment Required for Broadband Network

	2004	**2007**	**2010**
Estimated demand for broadband (mn subs)	0.89	5.09	9.44
Estimated range of investment required* (USD bn)	0.6-1.55	1.5-3.3	2.0-4.3

Source: Experience of consumer products and services in India-IMRB
** Cumulative investment required for creation of broadband network infrastructure*

• Thus an estimated investment of around USD 2 to 4 bn (depending on the access technology option) is required for creating the required network for broadband in the country. Given the huge requirements of investment already envisaged in the Indian telecom sector (estimated at Rs 50,000 cr. over next few years), there is a need to attract foreign capital into the broadband sector to fund the broadband investment requirements. The government should therefore consider liberal foreign direct investment policy for the broadband industry.

5.3 Impact of duties and taxes

• The above investment requirement analysis has been worked based on the assumption that no duties or taxes are applicable on broadband infrastructure creation or service provisioning. However, the impact on the business cases with duties and corporate taxes as currently applicable indicate significant adverse impact on the viability of the business cases.

Impact of Duties and Taxes on IRR

Exhibit 22: Impact of Duties and Taxes on IRR

Technology	With No Taxes and Duties	With Duties	With Taxes	With Duties & Taxes
DSL over incumbent copper	21.1%	15.5%	15.4%	10.4%
HFC network-upgrade cable network	20.9%	17.2%	14.7%	11.6%
Fiber+Ethernet	18.8%	15.2%	13.7%	10.7%

This analysis clearly highlights the sensitivity of the business cases to the duty structure and corporate taxes. Further these duties would also increase the total investments required by about 15-25%.

• In case the service providers pass on the costs of the duties and taxes to the customer, the effective price to the customer could increase by about 5-10%. In addition, the cost of service tax and entertainment tax (as high as 30% in some states) could increase the cost to customer by another 8%-40%. This would result in premium pricing for broadband service and that would be counter-productive to the national goal of achieving high broadband penetration.

• In addition the significantly lower demand at higher price points would also have an adverse impact on the business cases of the service providers and the viability of the industry can be affected. Therefore in order to ensure that broadband is widely available to the masses, the government should consider exemption of broadband infrastructure/services from various duties and taxes. These concessions need to be in addition to duty reductions that have been already been extended by the government to the telecom and IT industry through the tariff cut announcements in early January 2004.

5.4. Impact of revenue sharing arrangements

• Another critical factor that impacts business viability is the revenue sharing arrangements between the broadband service providers and the content provider/ telco/ cableco. While the revenue share for content is based on the content revenues (assumed at 30% of the content revenues in the business case) and amounts to about 5% of total revenues for the service provider, the revenue share to telco/cableco is in the range of 20%/15% of total revenues and therefore has a very significant impact on the returns for the broadband service provider.

• Given that broadband is a relatively complex business and therefore a risky investment, the returns that investors would demand are likely to be in the range of 30% IRR. Therefore the revenue sharing and investment sharing arrangements between the broadband service provider and telco/cableco would need to be reviewed to attract investors.

An illustration of the possible investment sharing and revenue sharing arrangements between a DSL service provider and telco for the average city, assuming an IRR of 30% is provided in the exhibit below.
The network elements that have been considered for the investment sharing include the city level/collector/local fiber rings (with associated equipment) and CDN related equipment (both at city level and local level).

Exhibit 23: Investment sharing and revenue sharing arrangements between a DSL service provider and telco for the average city

Options	Metro Ring Upgrade	Collector Ring Upgrade	City CDN Central	CDN Edge Servers	Rev. Share # for 30% IRR for BSP
Option 1	BSP	BSP	BSP	BSP	11.5%
Option 2	Telco	Telco	BSP	BSP	16.2%
Option 3	Telco	BSP	Telco	BSP	22.5%
Option 4	Telco	Telco	Telco	BSP	23.4%
Option 5	Telco	Telco	Telco	Telco	24.8%

Source: IBM Institute for Business Value Analysis, 2006
BSP- Broadband Service Provider
 # Percentage of total revenues of BSP

• In this context, various innovative models that are based on partnerships, alliances, franchise arrangements etc. need to be worked out between the broadband service providers and the telco/cableco who own the existing networks.

• A key issue that needs to be addressed here is the mechanism for access to the incumbent copper network. This an important consideration from a point of view of ensuring adequate competition in the sector as well as ensuring there are enough investors to meet the huge investments required for achieving the mass-market penetration. While lot of countries have gone for unbundling of the local loop, the results of such experience have been mixed and have not always achieved the end objective. The regulator can play an important role in determining the nature of such arrangements as well as ensuring that workable mechanisms need to be put into place to ensure competition, investment and market penetration.

5.5. Impact of Bandwidth Requirements on Business Case

• An important issue in providing broadband in India is the provisioning of international bandwidth and the national bandwidth to support high speed Internet access as well as the inter city movement of data and multimedia content.
An analysis of the operating costs of the business case clearly shows that bandwidth costs for national and international bandwidth are a big component of the operating costs, amounting to 50-60% of the revenues in the initial years and declining to 30% of revenues in the later years.

• The business case has assumed that the international/national bandwidth prices for broadband access would be significantly lower (Rs 600 p.a. per clean kbps for international bandwidth in initial years) than the prevailing rates (Rs 1000 p.a. per clean kbps) in the Indian market and that the prices would continue to decline in the future (assumed to decline to less than Rs 300 p.a. per kbps in later years).
If the Indian prices of bandwidth are higher than those assumed, there will be an adverse impact on the viability of the business cases and this would require a premium pricing of the broadband service to ensure costs are recovered by the service provider.

• It is therefore evident that prices for international/national bandwidth need to be reduced in line with the market affordability. This would be a very important step in promoting the penetration of Internet and broadband in India. While historically the pricing has remained high on account of lack of availability of adequate international bandwidth, it is understood that there now exists sufficient fiber capacity for international connectivity with players like i2i, FLAG and Se-Me-We-2 and therefore the regulator needs to ensure that there is a cost based pricing of bandwidth.

• While there is a case for reduction in prices of bandwidth, a key point that should also be considered is how the demand for international bandwidth can be reduced. The current supply of international bandwidth requirement for India is estimated at 1.2 Gbps while according to estimates by Nasscom, the peak voice traffic will increase from 11 Gbps (in 2000-01) to 21 Gbps in 2004-05. The bandwidth requirement of corporates and ISPs is estimated to increase from 2.5 Gbps to 10 Gbps over the same period.

• In order to estimate the bandwidth requirements for broadband access, an estimate for bandwidth demand has been made. This estimate is based on bandwidth demand estimates for typical cities in population categories of over 10 mn (Delhi and Mumbai), 1mn-10 mn (33 cities) and 1 lac-1mn (350 towns) and aggregating the same.

While the subscriber base for the typical city in each category is based on the demand estimation, some of the other assumptions are as follows:

• International bandwidth has been provisioned at 12.8 kbps for each residential subscriber and 32 kbps for commercial subscribers (assuming a contention ratio of 1:10 and 1:4 respectively, at an average 128 kbps connectivity).

• Regional teleports have been assumed that will connect to all major cities and provide them uploads of relevant content required for their programming.
Each city is assumed to support the content storage requirement for itself as well as support the needs of nearby smaller cities and towns. It has been estimated that certain proportion of the content in a city would be drawn from the national teleport and therefore would require certain national bandwidth terminating into the city.

Based on these assumptions, the demand for bandwidth for 3 different classes of cities is indicated in the exhibit below:

Exhibit 24: Estimated Bandwidth Requirements in 2010

	10 mn + pop cities (Delhi/ Mumbai)	Other 1 mn + pop cities	1 lac to 1 mn pop cities
Subscriber #			
No. of cities	2	33	350
Average Population Assumed for city	16 Million	2 Million	0.4 mn
Average city subscriber numbers considered	1,728,481	89,985	8,623
Bandwidth (Mbps)			
Collector Ring (per ring basis)	7,833	3,059	808
Metro Ring (per ring basis)	112,346	16,692	2,347
City termination national bandwidth (per city basis)	112,271	10,005	2,272
Total International gateway bandwidth required	56,767	50,340	49,279
Total International bandwidth required for India		**156,386**	

Source: IBM BCS analysis

• It is estimated that the international bandwidth demand in India for broadband access alone would be to the tune of 156 Gbps. It should be note that this projection is based on the current status wherein there is hardly any local availability of content and even the connectivity between the Indian ISPs is through international gateways on account of absence of domestic internet exchange till very recently.
It is therefore imperative for India to look at reducing the huge demand for international bandwidth through a series of measures. A detailing of these measures would need to be done at an industry wide level to arrive at an actionable roadmap.

• Creation of domestic Internet exchanges in India so that domestic Internet traffic is exchanged within the country and not through international gateways.
This development will not only result in cost savings for ISPs, but also enhance the surfing experience through reduction in latency and delays, as multiple international hops become redundant. However, for its successful functioning, the critical issues that need to be addressed are the neutrality of the Internet exchange and support from all ISPs that is necessary for peering to be successful.

- While the first step in this direction has already been taken with the establishment of NIXI, the lack of participation from all ISPs can defeat the purpose of such an initiative. The government should therefore mandate that all Indian ISPs be connected directly or indirectly to each other through the domestic Internet exchange.

- The reduction in the high costs of leased lines, especially from far-off locations of NIXI, can also help in the promotion and growth of the domestic Internet exchange.

- Current estimates of Internet traffic from India show that 85% of the traffic from India is directed to international sites. In order to reduce this, frequently accessed international sites should be hosted/mirrored out of India. Creation of local content and local hosting of content as well all enterprise web applications can also help reduce the requirements for international bandwidth. This would require the creation of reliable and adequate infrastructure in India in terms of data centers, disaster recovery sites, etc. This could help in reducing the international traffic to about 25-30% of the total Indian Internet traffic in coming years.

- The international and national bandwidth requirements for broadband would still be significantly large number, even if all the measures above are successfully implemented and there is a need to augment the capacities to meet the increasing bandwidth requirements at the local, national and international levels.

- It is understood that sufficient fiber capacity for international connectivity exists with players like i2i, FLAG, Se-Me-We-2 etc. and this can be made available through additional investments in enabling required capacities as per requirements.

- At the national connectivity level, India already has over 500,000 cable KMs of optic fiber crisscrossing the country, connecting over 6000 towns and 25,000 villages (each block, and also select points beyond that). Several players like BSNL, Bharti, Reliance and Tata have significant capacities with STM-4/STM-16/DWDM equipment for the top 10 cities and optic fiber enabled with STM-4/STM-16 systems for the remaining cities/towns. These can be augmented by adding relevant electronics based on bandwidth requirements.

- At the city level, while fiber with STM-1/STM-4/STM-16 systems is already available in the metro sings and there are plans afoot to upgrade these to CWDM/DWDM technologies, collector rings at the RLU level are equipped with STM-1/STM-4 systems and additional requirements can be met by augmenting capacity on existing fiber.

5.6. Impact of Spectrum related issues

• A business case evaluation for wireless technologies especially WiMax has not been done as these technologies are still in the maturing phase and large-scale commercial deployments have not yet materialized.
However given the promising potential of this technology, especially WiMAX/Wi-Fi, for a wide range of situations including hot spot solutions in urban areas (public locations, corporate/commercial center solutions, small pockets and multi-dwelling units) as well as city/town level backbone/last mile access solutions for semi-urban and rural markets in the Indian context, there is a need to address the key issues related to availability and pricing of spectrum.

Internationally the spectrum that is being used for such wireless solutions are as follows:

• 2.4 GHz (802.11b and 802.11g) and 5 GHz (802.11a) for IEEE 802.11 family of solutions. Wi-Fi (802.11b), the most popular standard wireless LAN networking technology, is operating in unlicensed spectrum band of 2.4 Hz., both for indoor communication as well as outdoor commercial use.

• 2-6 GHz for IEEE 802.16/WiMAX type of solutions

• India has already delicensed the use of 802.11b and Blue-tooth in the 2.4 GHz spectrum band for indoors use. The government is also considering delicensing of spectrum for 802.11g and 802.11a standards for outdoor commercial use, and therefore offer more spectrum as there is a need for higher bandwidth and capacity for these technologies.

• Further, in order to encourage the growth of wireless broadband access, spectrum should be priced such that it is just sufficient to cover the administrative, monitoring and regulatory costs.

6. Business Cases Conclusions

• Bandwidth cost is a very important driver of business economics in the Indian context and it is imperative that Indian bandwidth costs are significantly reduced for ensuring broadband offtake in the country. At the same time, initiatives as suggested in this white paper, need to be taken to reduce the demand for international bandwidth.

• Given the adverse impact of duties and taxes on the business case as well as the pricing of broadband services, the government needs to ensure the following for mass-market broadband services in India:

◦ Exemption of broadband equipment from customs duties and associated levies.

◦ Recognize broadband industry as an infrastructure industry and grant tax exemptions/holidays similar to those for the telecom sector.

◦ Ensure that broadband services are exempt from levies like service tax and entertainment tax that could adversely impact the pricing and therefore the offtake of broadband.

◦ Attract investments in the industry by allowing for liberal foreign direct investment limits.

• While prima facie there is a viable business case (assuming tax and duty concessions) for all these technologies based on an assumed architecture for a typical city, the actual rollout could be different than the one envisaged here and would be dependent on the actual topology/layout/demographics of the city and the state and spread of the existing network and therefore different technologies could be better placed to address certain markets.
Scale for a certain technology is another important factor that could determine whether players can leverage benefits or synergies and therefore achieve lower costs structures and better returns.

• Another critical factor is the speed at which networks are upgraded and technologies are deployed in a city. While a 50% share of the estimated market potential has been assumed for the business case for each technology, the technology that is deployed effectively within a city would be better placed to capture the market and therefore the business case for the other technologies may be adversely impacted.

• The revenue share arrangement of the broadband service provider with the telco or cablecos for leveraging existing networks would be a critical driver of the business case returns and therefore mutually beneficial options for the same need to be considered.

• There is a need to specify service levels and mandate QoS through regulation.

• Increase in PC penetration would be critical for adoption of broadband, especially in the short term and therefore various measures should be taken to promote penetration of PCs in the country.

- At the same time, to address the large TV base in the country, options for a low cost solution with STBs that can use the TV as a monitor for display of Internet text and graphics on TV need to be explored.

- In order to get scale and therefore effectively ensure low price of CPE to the customer, Indian service providers will need to adopt global standards for CDN and CPE as well as provide innovative financing arrangements for funding the CPE cost for the customer.

V. Technology Options Analysis

The results of evaluation of the five categories of broadband technologies for the urban market, viz. xDSL (on copper), HFC (on upgraded cable), Fiber (+Ethernet), Wireless and Satellite, are presented in the exhibit below.

Exhibit 25: Evaluation of Technology Options for Urban market

Parameters	Technology Options				
	XDSL on Copper	HFC-Cable	Fiber-Ethernet	Wireless	Satellite
Bandwidth possible-downstream	From 1.5 Mbps to 12 Mbps	In principle same as DSL. QoS in cable architecture may be an issue	Practically no limits-Japan and Korea plan upto 40 Mbps to home on fiber systems	Wide range possible based on technology option WiFi used for typically 200+kbps connectivity With WiMAX/MMDS, upto 10 Mbps connectivity is possible	High bandwidth possible for downstream
Bandwidth possible-upstream	From 256 kbps (on ADSL) to 12 Mbps (on SHDSL)	Cable typically asymmetrical, since cable system is basically a downstream design and symmetric high bandwidth could be costly	No limits	Wide range based on technology option	Very limited use of two-way transmission in satellite systems
Leverage on existing infrastructure	Leverages existing twisted pair reducing incremental costs	Leveraging existing Digital TV class HFC systems reducing incremental costs	Fresh access networks will be required in most places. However over time, as prices decline and existing copper/cable will need to be replaced, fiber may automatically be used to replace them	While it is possible that wireless solutions can draw on existing hard infrastructure used in mobile phone, the technology infrastructure, spectrum requirements and even OSS/BSS would be totally new	Reusable satellite systems and communication spectrum for satellites. New CPE would be required
Maturity of Solution	Fairly stable-over 60% of global broadband services are on DSL	35% of global broadband subscriber based on cable-fairly stable and mature solution	Prima facie mature and established. However compared to DSL/Cable, has a low installed base	Some technologies are mature but no standards exist (LMDS/MMDS) Standards evolving (WiFi, WiMAX), likely to mature in near future	2-way satellite is not yet mature

Parameters	**Technology Options**				
	XDSL on Copper	**HFC-Cable**	**Fiber-Ethernet**	**Wireless**	**Satellite**
Long Term Prospects	May not have long term prospects as replacement of copper in long term by fiber is imminent	Again likely to be replaced at some stage by FTTH as fiber costs go down over time	Fully optical systems/Fiber-Ethernet solutions will remain the key "wired" networks of the future	Depends primarily on spectrum availability and costs. Also standards in wireless may still keep evolving. Specific standard may die out but wireless will have a place especially for mobile usage	Less likely given the costs involved. May be useful for specific applications such as very remote area or very high bandwidth requirements
Global Standards	Exists	Exists	Exists	Refer section on Maturity of solution	Since it is not yet mature, not clear
Equipment costs	Relatively low and getting lower due to scale of global demand	Cable costs among the lowest in absolute terms. A lot depends on the quality of existing cable in place, extent of fiber usage in the cable network and the architecture of the HFC within the city	Previously costlier than copper, fiber costs are coming down. With increase in scale of demand and offtake, the router/switch costs are also coming down. Possible to be competitive in the long term	Right now the standards based solutions-Wifi and WiMAX are fairly costly compared to DSL/Cable/Fiber solutions. But these could change over time based on offtake and scale of demand	Costs are likely to remain higher than wireline or wireless options
Capability of Players likely to take up this technology	Major players will be strong. LLUB players are a question mark	Fragmented industry, not savvy on technology, processes and not professional	Likely to be only players who are strong, have significant investment capability and are serious about the business	Most players likely to be strong-likely to be wireless voice telephony players, ISPs	Solution providers players likely to be the key players
Overall Medium Term Rating	**Strong**	**Strong On Technology; Weak On Industry Structure**	**Strong**	**Likely Deployments In Niche/Remote Areas and Mobile Applications**	**Likely Deployments For Remote Locations**

Source: estatsindia.com BCS analysis

• Based on the above analysis, it appears that wireless broadband connectivity services are likely to be used in rural networks where density of usage would be much lower or for hotspots kind of niche locations. And possibility of true broadband connectivity to home on wireless on a citywide basis in a major way will take few more years in India.

• Satellite solutions may be used in remote/niche locations where other options are not capable of providing connectivity solutions.

• Cable/HFC based broadband technologies are fairly mature and stable and could be easily used in case of cable homes. From a cost and financial viability perspective as well (refer exhibit below) cable displays a low cost and viable model similar to the DSL over existing copper model.
However without consolidation, professionalism and improvement in technological/process management and customer care capability in the business, the cable industry is unlikely to become truly broadband capable in the short term and the industry may take 3 to 4 years to achieve the same.

Exhibit 26: Viability Assessment of Technology Options

Technology Options	Capex per Subscriber in USD		IRR (10 year basis)	Cash Breakeven (Years)	Cash payback period (Years)
	2006	2010			
DSL over fresh copper	700	597	12%	Year 5	Year 9
DSL over existing copper	323	220	21%	Year 4	Year 7
HFC network-upgrade over existing cable network	389	322	21%	Year 4	Year 7
Fiber+Ethernet	735	455	19%	Year 4	Year 7

Source: estatsindia.com BCS analysis

• While DSL over fresh copper is clearly not a viable business model, DSL over existing copper, HFC over upgraded cable and Fiber based options considered in the analysis prove to be very close to each other in terms of business viability as can be seen from the comparison of IRR, cash breakeven and cash payback period.

However the assumptions relating to revenue share (between the ILEC and the broadband service provider) have a significant impact on the financials for DSL over existing copper and HFC over upgraded cable. If for instance, the revenue share (currently assumed at 15% for the analysis) is reduced to 10% for the last mile copper owner, the business viability for the broadband service provider could improve significantly. In the case of DSL over existing copper, it should be noted that if the service were provided by the incumbent telco itself, the viability of the model would improve significantly since the 15% revenue share would accrue to the incumbent in any case.

• In case of Fiber+ethenet model, although it appears to be very similar in terms of basic viability vis-à-vis DSL model, this business model is inherently riskier than the DSL model, for the following reasons:

• Higher capex per subscriber and higher initial fixed cost components in the capex

• Significantly higher capex per subscriber also means that initial investments for this model would be over twice the investments required for DSL

• A full nationwide rollout of fiber to the curb/home in all 250 to 300 cities and towns may require significant time given the need to physically connect up all the targeted homes/commercial users, whereas the owners of existing wireline telephony subscribers are capable of moving to DSL right away.

VI. Infrastructure Investments Required

To achieve the targeted goals of cities covered and subscriber base an investment of USD 1.4 bn is required by 2006 and USD 2.8 bn by 2010 (based on the DSL on existing copper model).
As can be seen in the exhibit below, the fiber-based model requires twice the investment of the DSL over existing copper model.

Exhibit 27: Investments required for Urban Broadband Infrastructure

Particulars#	**Investments Required (USD mn)**	
	By 2006	**By 2010**
DSL over existing copper		
Last mile access	595	1260
City backhaul	175	400
City level CDN	320	420
National network & International Bandwidth	160	505
National CDN	100	250
TOTAL in USD mn	***1,350***	***2,835***
TOTAL IN Indian Rs. mn	***62,000***	***130,000***
Fiber + Ethernet		
TOTAL in USD mn	***2,750***	***5,055***
TOTAL in Indian Rs. mn	***126,500***	***233,000***

Source: estatsindia.com BCS analysis
 # Additional investments will be required for Broadband Content creation and digitisation

Options for Short-term rollout-DSL

In the case of DSL, roughly 95% of the existing copper is owned by the incumbent telcos (BSNL/MTNL), who have the following three options for rolling out broadband services on this copper:

• Go alone by themselves: Given their dominance of existing copper and the advantages of their business models, there are issues regarding whether they would be focused in achieving the national broadband coverage and penetration targets discussed in this white paper.

• A mandated Open Access regime with Local Loop Unbundling (LLUB) could be imposed on the incumbents, that will throw open the existing copper to any new player. If the scheme succeeds, this would lead to entry of a large number of players for city/town level markets. Such a large influx of entrepreneurs at a micro-market level will adversely affect their ability to generate adequate scale their operations at the city/town level, thereby affecting the business viability of most of such entrants. This option has not met much success internationally.

• Lastly, the two national telcos could opt for (on their own) or be mandated to provide 'Managed Access', that will allow the incumbents to share the existing copper with a limited number of new service providers and also share the revenue generated, in a pre-determined manner.

Out of the three options above the last option of "Managed Access" appears to be the more practical option in the long run.

VII. Access Technologies: Comparison of the key technologies for quick reference:
Exhibit 28: Summary of broadband technologies

Family	Standard	Speeds*	Range	Spectrum	Remarks
DSL	ADSL (G.dmt)	8-10 Mbps	3 km	-	Guaranteed bandwidth, uses splitter
	ADSL (G. lite)	1.5 Mbps	5.4 km	-	Longer distances, doesn't require splitter
	ADSL2	8 Mbps	1.5 km	-	No split, improved ADSL
	SHDSL	4.6 Mbps	3 km	-	Symmetric, fast
	VDSL	52 Mbps	300m	-	High speed, short distances
Cable modem technologies		32 Mbps#	Long	-	Shares capacity among users
Ethernet based technologies		100 Mbps	100m^	-	Possible in fiber based models like FTTC
Wireless	802.11b Wi-Fi	11 Mbps	100m	2.4 GHz	Most popular and widespread
	802.11g	54 Mbps	100m	2.4 GHz	Fast backwards compatible with Wi-Fi
	802.16a WiMax	70 Mbps	50 km	2-11 GHz	Provides QoS, very long distance, Metronet
	MMDS	10 Mbps	48-56 km	2.1-2.7 GHz	Does not require line of sight
	LMDS	Upto 155 Mbps	Long distances	> 20 GHz	Requires line of sight
IMT-2000	UMTS (W-CDMA)	Upto 2 Mbps	-	1-2.5 GHz	-
	CDMA 1X EV-DO	2.4 Mbps	-	1-2.5 GHz	-
Satellite	-	512 kbps-2Mbps	-	-	Well suited for bursty bandwidth requirements and remote areas

Source: estatsindia.com BCS analysis
** Downloads speeds, #per channel, ^ for Ethernet in the last mile*

• DSL, in its various forms is the most popular broadband technology in the world. A key advantage of DSL technologies is that they use existing copper twisted pair wiring and do not require new cabling like fiber optics. DSL utilizes different frequencies to split voice and data services over the same standard phone line.

• Cable modem technologies are also not far behind in terms if their usage. Cable networks, originally designed for one-way video transmission, have evolved and it is possible to send data in both directions on a cable network, (i.e. downloading and uploading from the household), thus making Internet access over cable a viable solution.

• Fiber based Ethernet models
While DSL and cable technologies are based on copper wire, a newer technology, fiber optic cable, is drastically increasing bandwidth and steadily replacing copper networks, especially in the intercity as well intra-city backbone networks. Fiber optic cable can carry thousands of times more data than either electric signals or radio waves, because light uses higher frequencies. Fiber optics can therefore theoretically provide nearly unlimited bandwidth potential, and maximum bandwidth is actually limited by current technology. Currently, fiber optic technology can provide transmission rates of 10 Gbps per wavelength on a strand using DWDM (Dense Wave Division Multiplexing), with even higher rates in development.

• Wireless Solutions
Wireless technologies are becoming an attractive option for rural areas and developing economies that have limited existing infrastructure. Even in the developed world, wireless broadband technologies have been successful because of their low-cost installations and wide reach. Wireless solutions can be broadly classified into following categories:

◦ Fixed wireless technologies (also known as fixed wireless access or broadband wireless access)
◦ Wireless LAN technologies
◦ Satellite technologies
◦ Third generation (3G) mobile technologies

VIII. List of acronyms and abbreviations

ADSL: Asymmetric Digital Subscriber Line
ARPU: Average Revenue Per User
ASI: Asynchronous Serial Interface
B2B: Business to Business
B2C: Business to Consumer
BBTV: Broadband Television
BFSI: Banking, Financial, Securities, Insurance
BPO: Business Process Outsourcing
BSG: Broadband Stakeholders Group
BSNL: Bharat Sanchar Nigam Limited
BSO: Basic Service Operator
BSG: Broadband Stakeholders Group
BSNL: Bharat Sanchar Nigam Limited
BSO: Basic Service Operator
BSP: Broadband Service Provider
BSS: Business Support Systems
C&S: Cable and Satellite
CAS: Conditional Access System
CAT 5: Category 5
CATV: Cable Television
CDMA: Code Division Multiple Access
CDN: Content Delivery Network
CIC: Community Information Center
CPE: Consumer Premise Equipment
CTV: Color Television
DEL: Direct Exchange Line
Diffserv: Differentiated Services
DOCSIS: Data Over Cable Service Interface Specification
DSL: Digital Subscriber Line
DSLAM: Digital Subscriber Line Access Multiplexer
DTV: Digital Television
DVD: Digital Video Disc
DWDM: Dense Wave Division Multiplexing
EVDO: Evolution-Data Optimised
FCC: Federal Communications Commission
FDMA: Frequency Division Multiple Access
FSO: Free Space Optics
FTCC: Fiber-to-the-Curb
FTTH: Fiber-to-the-Home
Gbps: Giga bits per second
GDP: Gross Domestic Product
HDTV: High Definition Television
HFC: Hybrid Fiber Coaxial
HH: Households
IDC: Internet Data Centre
ILDO: International Long Distance Operator
IMT: International Mobile Telecommunications
IP: Internet Protocol
IPTV: Internet Protocol Television
IRR: Internal Rate of Return
ISDN: Integrated Services Digital Network

ISP: Internet Service Provider
ITU: International Telecom Union
ITV: Interactive Television
Kbps: Kilo bits per second
LAN: Local Area Network
LLUB: Local Loop Unbundling
LMDS: Local Multi Point Distribution System
LSP: Local Service Provider
Mbps: Mega bits per second
MDU: Multiple Dwelling Unit
MMDS: Multipoint Microwave Distribution System
MMORPG: Massively Multiplayer Online Role Playing Games
MPLS: Multi-Protocol Label Switching
MSO: Multi Service Operator
MTNL: Mahanagar Telephone Nigam Limited
NIXI: National Internet Exchange of India
NLDO: National Long Distance Operator
OECD: Organization for Economic Co-operation and Development
Ofcom: Office of Communications, UK
Oftel: Office for Telecommunications, UK
PV: Present Value
QoS: Quality of Service
RoW: Right of Way
SEC: Socio-Economic Classification
SLA: Service Level Agreement
STB: Set-Top Box
STM: Synchronous Transfer Mode
TDMA: Time Division Multiple Access
UMTS: Universal Mobile Telecommunications Systems
USO: Universal Service Obligation
VAS: Value Added Services
VDSL: Very High Data Rate DSL
VoD: Video on Demand
VoIP: Voice over Internet Protocol
VSAT: Very Small Aperture Terminal
WAN: Wide Area Network
Wi-Fi: Wireless Fidelity
WiMAX: Worldwide Interoperability for Microwave Access
WLAN: Wireless Local Area Network
WLL: Wireless in Local Loop