

Promise of Connected Communities- The Indian Story

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ABSTRACT

Wi-Fi and WiMax networks are being looked upon as potential last mile connectivity solutions as well as cost-efficient deployments vis-à-vis traditional wired connectivity more so as most places in India especially in the rural sector lack the traditional telecom backbone infrastructure. This paper aims to cover the various initiatives of WiMax and Wi-Fi undertaken in India under the public-private partnership (PPP) models as an attempt to discuss the viability and overall sustainability of such projects. The research mainly covers the Indian states of Uttaranchal, Madhya Pradesh, Rajasthan and Maharashtra. The state of telecommunications in India is studied and is followed up with how wireless technologies can solve the issues and help bridge the digital divide. The key questions considered were- Creating a viable business case for the PPP wireless deployments, critical factors that will define the success of these projects in different situations; Opportunities and threats to incumbent fixed broadband operators and whether the projects really address the digital divide. The motivation and goals behind these projects, along with the perceived benefits of these technologies have been analysed. Several impending challenges of these projects have also been found out. This report shall also provide the key factors, which would be important for the success of these technologies in the aforementioned Indian states.

1. Introduction

“Just as one thinks that one has reached the full stop, something happens that renders an entire chapter out of date” - Ashok V. Desai on Indian telecommunications (May 2006).ⁱ

India represents one of the most active telecom markets world-wide, but the growth has been more or less lopsided, and as an attempt to bring the rural-urban divide, the governments are looking at wireless technologies as potential saviours.

Several Indian states¹ and cities have initiated wireless projects and this report will present findings from an investigation into the initiatives of Wi-Fi and WiMax in the states of Uttaranchal, Rajasthan, Madhya Pradesh and the city of Pune (Maharashtra) in India.

1.1 Research methodology

The primary data for the research is based on the interviews of various government officials, telecom operators, Internet service providers (ISPs), academic researchers and private vendors and people living in the states of Maharashtra, Uttarakhand, Rajasthan and Madhya Pradesh. Non-probability convenience sampling was used for the same and the sample size was 30 which included personnel from Intel, Motorola, MTNL², Pune Municipal Corporation³, Madhya Pradesh, Uttarakhand⁴ IT department, e-Governance wing government of India. The secondary data mainly constituted of press, publications, Internet data and academic review of existing literature. The discussion is based on the primary and secondary data and the consequent analysis upon the understanding of the project.

2. Indian wireless and Internet Market

2.1. Background of the Indian telecom sector

Telecommunication was introduced in India in 1851ⁱⁱ with the successful implementation of the first telegraph line. In 1854 the Indian Telegraph Act was passed and the line was opened for public use. The government controlled all aspects of the sector through the Ministry of Post and Telegraph (MPT) under the Indian Telegraph Act. However, there was only one member on the MPT board responsible for telecommunicationsⁱⁱⁱ and it was perceived that telephones were a luxury. Furthermore, the MPT had to compete with other government priorities for finance and resources. This resulted in little private participation, almost zero investment and a stagnant sector. For decades the industry⁵ was controlled entirely by the government but in 1997 an independent regulatory body, the Telecom Regulatory Authority of India (TRAI), was established. Its role was to advise the ministry on policy, resolve disputes and enforce rules^{iv}. In addition, the TRAI aimed

¹ States in this document refer to states of Uttarakhand, Madhya Pradesh and Rajasthan; City refers to Pune in Maharashtra

² MTNL- Mahanagar Telephone Nigam Limited- It is one of the telecom incumbents along with BSNL- Bharat Sanchar Nigam Limited

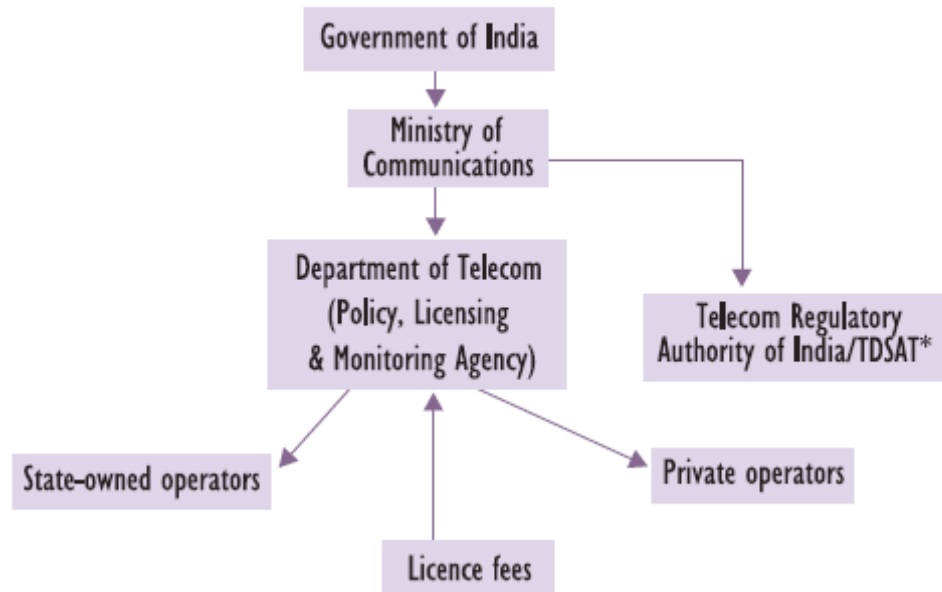
³ PMC in this document refers to Pune Municipal corporation the municipal corporation of Pune

⁴ Uttarakhand is the new name for Uttaranchal

⁵ Industry unless otherwise mentioned refers to the ICT industry

to protect consumer interests. It had control over tariffs and terms of interconnectivity but recommendations on licenses were not binding on the government. In 2000, the TRAI Act was restructured into a two-tiered body^v: TRAI 2000 and The Telecom Dispute Settlement and Appellate Tribunal (TDSAT) that was constituted for resolution of telecom disputes.^{vi}

Regulatory structure



Source: <http://www.indianembassy.at/content/india/documents/Telecomsr.pdf>

With the regulatory changes in the last decade, market liberalisation and increase in investments in the market, there has been a plethora of technologies which have hit the market⁶. Developments in technology are blurring the traditional boundaries between telecommunications, computing, and media. Technological advances are causing market definitions to shift and the overlap of wireline telecom, wireless telecom and cable television has become more pronounced.

Though there has been a consistent rise in wireless and mobile technologies, the tele-density is still not very high, mainly due to the existing tele-density gap between the rural and urban sectors. According to estimates, tele-density in rural areas is only 1.87% as compared to 40.65% in urban areas.^{vii}. In 2005 TRAI recommended that operators share infrastructure, subsidy be used to support infrastructure growth and wireless players be allowed to access the universal service obligation (USO) fund. It also wanted lower license and spectrum charges for rural areas and provision of power backup. Operators, considering the increasing saturation levels in cities, are looking to expand into rural areas. Even though there has been discussion surrounding infrastructure sharing there has been very little movement on the ground. The focus still is largely urban.^{viii}

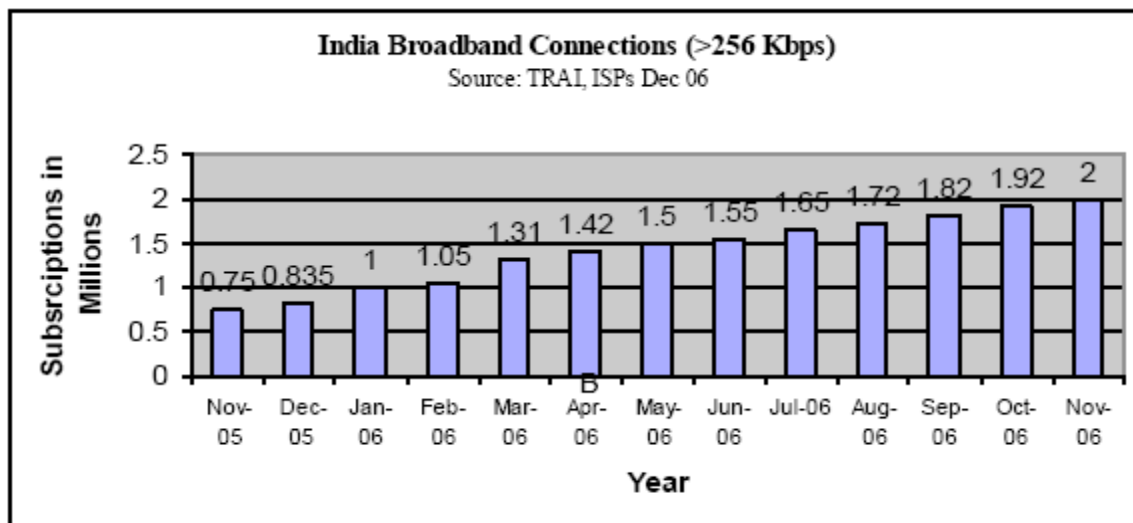
⁶ The market unless otherwise mentioned refers to the Indian ICT market

2.2 Indian Internet market

By early 2007, Internet subscribers in India totalled more than 8.5 million. This equated to an estimated 60 million Internet users throughout the country or a penetration of almost 6% (Paul Budde, June 2007⁷).

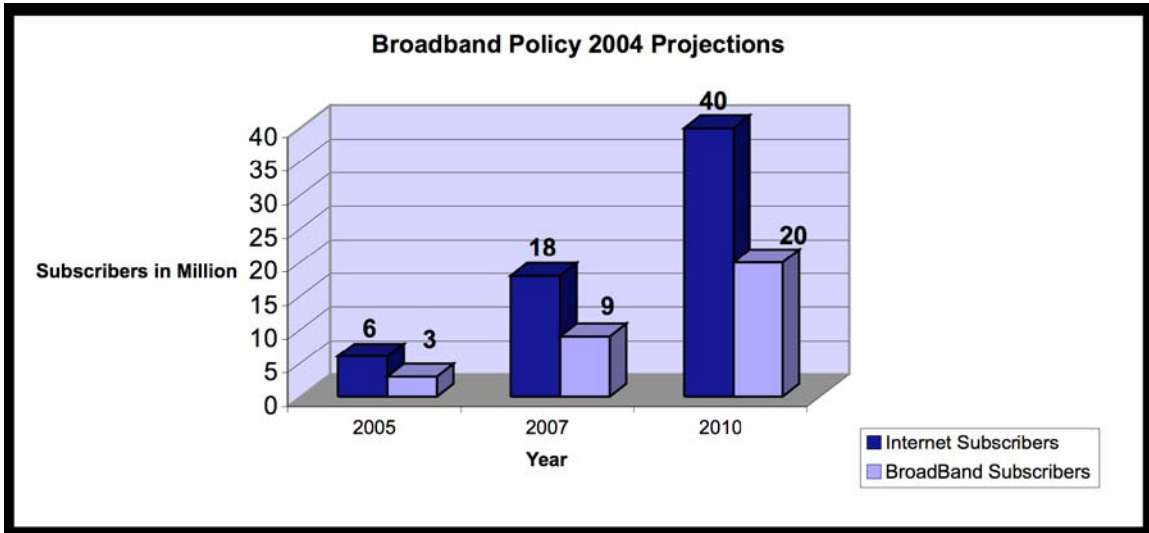
Despite the manner in which the country's Internet market has been booming, India's move into high-speed broadband Internet access has been distinctly sluggish. And, while there appears to be considerable enthusiasm amongst the population for the Internet itself, this has not been reflected in broadband subscription numbers. The dial-up Internet subscriber base has been increasing steadily since 1999, accelerating rapidly in 2005 when the number of subscribers increased by over 200% during that year. However 2006 that a substantial surge in broadband users with the total subscriber base in the country expanding by almost 200% to just over 2 million by year's end. Despite this surge, broadband penetration in India still remains around only 0.2%; broadband services were still only accounting for 25% of the total Internet subscriber base, still in itself comparatively low (Paul Budde, June 2007).

The online activity of people has been on the rise and other than emails, Indians are online for chatting, searching- Jobs etc. Matrimonial, travel and entertainment services like music downloads are also popular (IMAI, December 2005). Blogging has also caught on to the Indian masses with Rediff.com naming blogging as one of the top 100 important activities in India in 2006. Social networking is also finding a way into the young Indian crowd. These services however, are largely limited to tier 1 and tier 2 cities. For Internet access, dial up services are still popular in some parts. Broadband connections are typically ADSL and the incumbents BSNL and MTNL have 70% market share in the broadband market.^{ix}



⁷Paul Budde Communications Pvt Ltd, **Telecoms, Media and broadband in India**, June 2007

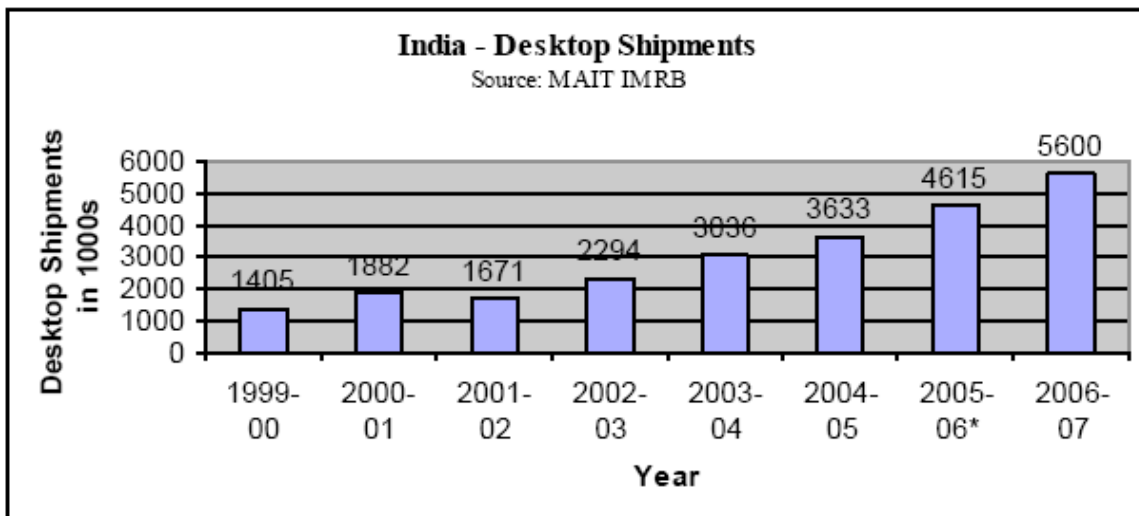
The Government in 2004 defined its ‘Broadband Policy’ and laid out a complete national mandate for broadband infrastructure. The policy targeted 3 million broadband connections in the country by end of 2005. By December 2005, the total broadband connections were only 835,000 and by November 2006 the number moved up to about 2 million, far lower than the expectations.



Source: Government of India broadband Policy projections

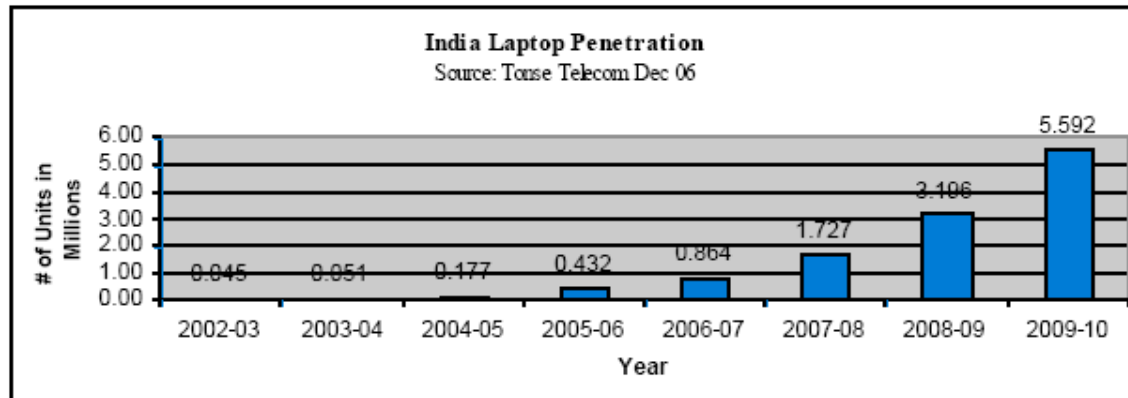
2.3 PC and laptop penetrations

While mobile connections and handsets have been growing in the tunes of millions a month, the PC market in India has only grown around 25% a year. The PC sales in the country were around 5 million in 2006, and are expected to be around 5.6 million in 2007 (IMRB, 2006). It is important to note that the prices of PCs have been consistently falling. While the linkage to Wi-Fi/ WiMax growth from PC penetration is not a strong one in itself, increase in PC and broadband penetration especially with the policy push from the government, could be a big boost to wireless deployments [ix].



Source: IMRB, Jan 2007

The laptop penetration in India is low right now, but has been rapidly increasing with falling prices. Laptops sales are expected to double this year (MAIT, 2006). Tons Telecom estimates that laptop market will continue to grow impressively for the next three years and exceed 5.5 million units annually by 2009-10 [ix].



Source: Tons telecom, Jan 2007 (ix)

As prices continue to drop, more consumers will be motivated to buy laptops, because of advantages of mobility, low space requirements, cost advantages, and this will drive demand for wireless networking.

2.4 Commercial deployment of wireless in India

The Wi-Fi hotspot market is in its infancy in India [ix]. But hotspot deployments are definitely on the rise and seem to be driven by the demands of a growing mobile community and workforce. Several operators have set up Wi-Fi hotspots. BSNL is in the process of setting up 300 hotspots in twenty-four cities. These hotspots will be located at hospitals, libraries, hotels, restaurants and other public places. Currently there are about 1000 Wi-Fi hotspots in India (Tons Telecom, Jan 2007). According to estimates the Wi-Fi market will grow to about \$275 Million by 2011-12 (Tons telecom, 2007). Research firms Maravedis and Tons Telecom have also predicted that India will have 13 million WiMax subscribers by 2012.

The residential user category is the fastest growing category for broadband which has stemmed from the need to stay connected. The PC has become an important educational tool. Increasing number of bank transactions, utility bill payments, travel planning is being done online in the cities. The wireless penetration in business has been growing especially in the growing IT and software sectors. IMRB has estimated that the overall consumption of notebooks in the business sector grew by 143% in 2005-6 from 2004-5 (June 2006).

Several service providers have already launched Wi-Fi hotspots in airports, hotels etc. However, the progress has been relatively slow, due to the lack of a reliable business model. While hotels and airports have preferred a flat rate system, Wi-Fi providers insist on a revenue sharing arrangement. Railtel Corporation under the Ministry of Indian

Railways is expected to launch its hotspot rollout for India's railway stations (ix). Railtel plans to introduce Wi-Fi enabled Internet kiosks at stations.

3. Government initiatives of Wi-Fi and WiMax in India

3.1 ICT⁸ Profiles

In most Indian states the state of ICT is underdeveloped especially in the rural sectors, having a considerably large populace that lags behind. The states of Uttaranchal (74.41%), Madhya Pradesh (77.33%) and Rajasthan (76.62%) have a high percentage of people residing in rural areas and traditionally have had poor ICT infrastructure.

Oft referred to as the 'The Queen of the Deccan', Pune (11.12% rural) on the other hand, has had a glorious past. It has grown into a premier educational and industrial centre.

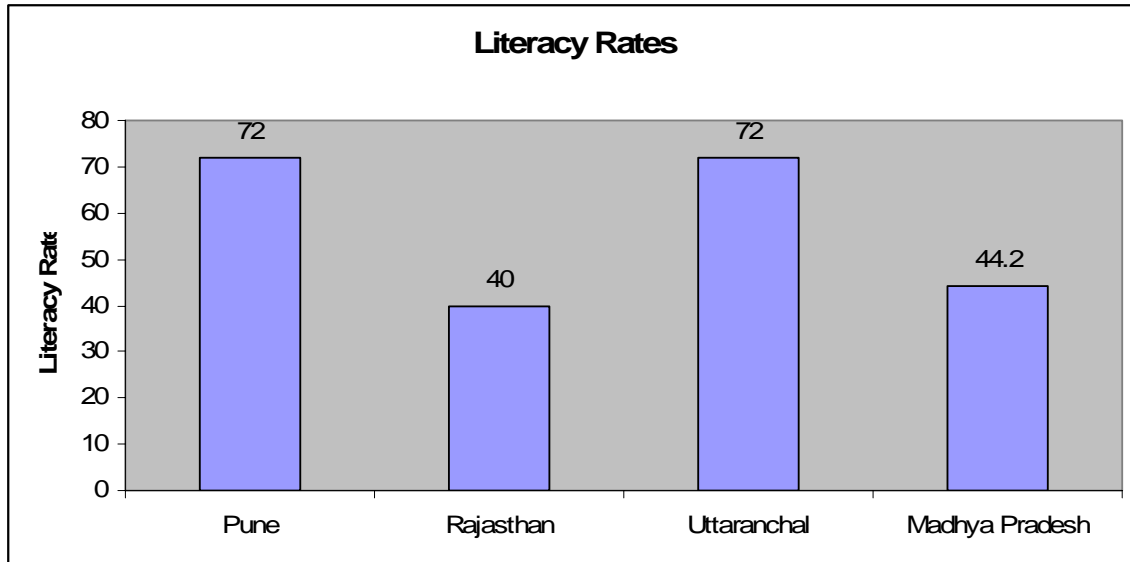
The following diagram shows the comparison between these places -



Source: CMYK, Drivers of IT Penetration in Indian States, Chapter 3, 2005

With its growth into a major IT hub and a student city with a high e-literacy rate, Pune also has the distinction of having the largest Internet user base in the country^x. The PC penetration of Pune is also the highest in the country.^{xi} On the other hand, Madhya Pradesh, Uttaranchal and Rajasthan lag behind with low tele-densities and a low Internet base. Madhya Pradesh with tele-densities of 0.6 (rural) and 10.2 (urban) and with only 32,186 (population 60 million) Internet connections comes in last.

⁸ Information and communication technology



Data Source: Census 2001

Internet connectivity in Pune was officially started in 1998 when it was put under category B service area and dial-up services were provided by the incumbent BSNL and private ISPs. Broadband services started in 2004^{xii}. However some parts of the city don't have the broadband facilities yet. Wireless technology for Internet usage and ubiquitous connectivity has been given a big impetus by several projects being implemented in Pune of late. On 12th December 2005 with the help of BSNL the Pune airport was made wireless, while the Sun-N-Sand hotel is also Wi-Fi enabled since January 2006 with an investment of 140 thousand INR with implementation done by Tata Indicom. The BSNL office at Baji Rao road in Pune is also Wi-Fi enabled. The University of Pune has been Wi-Fi enabled with the network being inaugurated on March 4th, 2005^{xiii}. The University made a 10 million INR⁹ investment towards this project^{xiv}. It has installed 5 antennas on the University campus of nearly 411 acres with a strength 4500 students and researchers^{xv}. There are 20 point-to-point links and 150 hotspots which can be altered to achieve flexibility^{xvi}. Pune Cantonment Board- PCB announced wireless access on MG Road between Amedkar Chowk and Sant Namdeo Chowk. A data rate of 2 Mbps is being provided with a free trial period of 3 months by HOL Infosolutions and Marvel, after which there would be charges levied on usage.

In Rajasthan, Data Infocomm was the first to deploy a Wi-Fi based network^{xvii}. A campus-wide networking project was undertaken at Sobhasariya engineering college at Sikar and also at the Department of agriculture, government of Rajasthan^{xviii}. Internet connectivity though is predominantly centred round the big cities and most connections are dial-ups.

Uttaranchal was classified as a category C service area^{xix} and dial-up connections are most common, and that too only in the bigger cities. About 20% of all Internet users are in Dehradun, the capital (xix). Recently in Uttaranchal ENRAP-IFAD did a pilot project

⁹ \$1US= INR 45.31 £1GBP= INR 83.54, 2006 (average annual rate) www.oadna.com

to provide Wi-Fi connectivity in district Chamoli. It was observed that with the given topography Wi-Fi technologies were ideal. With low interference over long distances, connectivity was possible. Wi-Fi was used for a maximum distance of 35km. Madhya Pradesh has the highest coverage of optical fibre in the country^{xx}. Several government and private organizations have initiated projects to provide basic connectivity to remote and rural areas, but as in the other states¹⁰ broadband has not gone much beyond the capital and big cities.

3.2 Public-private partnership Wireless projects

The Pune Municipal Corporation PMC has announced the “Unwire Pune” project, with Intel Technologies Ltd. as the chief technology and program management consultant. This project is aimed at making 400 sqKms of the city alongwith adjacent areas of Pimpri and Chinchwad wireless. Intel would be deploying the Wi-Fi and WiMax technologies for making the city wire-free. The main aim behind to project is to provide seamless connectivity to citizens, businesses and academic institutions.^{xxi}

Intel would be responsible for developing an extensible, high performance technical architecture and detailed design to suit the PMC requirements. Intel would also be responsible for informing and educating the PMC by various workshops and training programs. PMC has set apart an initial estimate of 70 million INR for the project. Apart from the push by the corporation, Pune has been selected over a lot of cities like Hyderabad and Bangalore, mainly because of its small size^{xxii}. PMC is planning to build 10 WiMax towers, 800 Wi-Fi hotspots in the city. After the technical survey was done (by Intel) tenders were opened for implementation of the plan. Initially free access to low end users and charges to high end users (with high bandwidth usage) had been planned.^{xxiii} The technology to be used for Wi-Fi would be IEEE 802.11g standard, which has backward compatibility with 802.11b-only clients also. It would mean a data rate of 54Mbps, according to specifications. There would be 99% uptime and the frequency band used would be 2.4 GHz. For WiMax IEEE 802.16 standards would be used.^{xxiv}

In April 2007, the project finally took off, much later than its expected date, and PMC joined hands with Microsense to commercially roll out the first phase of 802.16d Wi-Fi and WiMax network in the city. The first phase would provide connectivity in a 25 sq km expanse of the city, and would take about four months to completion. PMC has offered a service plan of INR 250 per month with the speed of 256 Kbps. The rest of the city would be covered in the next 12-16 months. Internet access would initially also be provided to 30 municipal schools in the city. The Pune project cost has been estimated at INR 100 crore over the next couple of years for setting up the infrastructure^{xxv}.

The Uttaranchal government has reportedly had an alliance with Intel and a WiMax pilot project, as a backhaul connectivity model for the state is being worked upon^{xxvi}. One WiMax tower with four antennas in each direction covering a range of 20kms each, with each antenna providing for 128kbps Internet connection (reportedly free) to atleast 15 people is planned in the first phase which would cover Dehradun and Champawat. The CPE of WiMax was reported as INR 20,000. Tehri and Chamoli would be covered in the second phase^{xxvii}. The government is not pushing towards Wi-Fi hotspots and is leaving

¹⁰ States in this document refer to states of Uttarakhand, Madhya Pradesh and Rajasthan

that to private organizations, though these hotspots would connect to the main WiMax backhaul network. Though, surprisingly the project manager for the SWAN¹¹ programme for the Uttaranchal state government denied such reports. He did say that Uttaranchal was working with Intel, but no MoU has been signed. The Uttaranchal government is keenly following the progress of Wi-Fi and WiMax deployments in Pune, and they intend to arrive at a decision in some time. The government is not very keen on working on propriety technologies. The state government does however want to set up a wireless backbone network within two years time (xxvii).

In contrast the *Rajasthan* has gone ahead and signed a MoU with Motorola in February 2006 making it the first statewide deployment of wireless broadband infrastructure^{xxviii}. The MOTOWi4 canopy network will provide for a wireless backbone grid system. The state IT department refused to reveal any information on this project, saying that only after substantial work is done the details will be made public. Motorola has said that Canopy users will be able to enjoy WiMax benefits in the unlicensed frequency band above 5 gigahertz (5.8 Ghz) once the system becomes available^{xxix}.

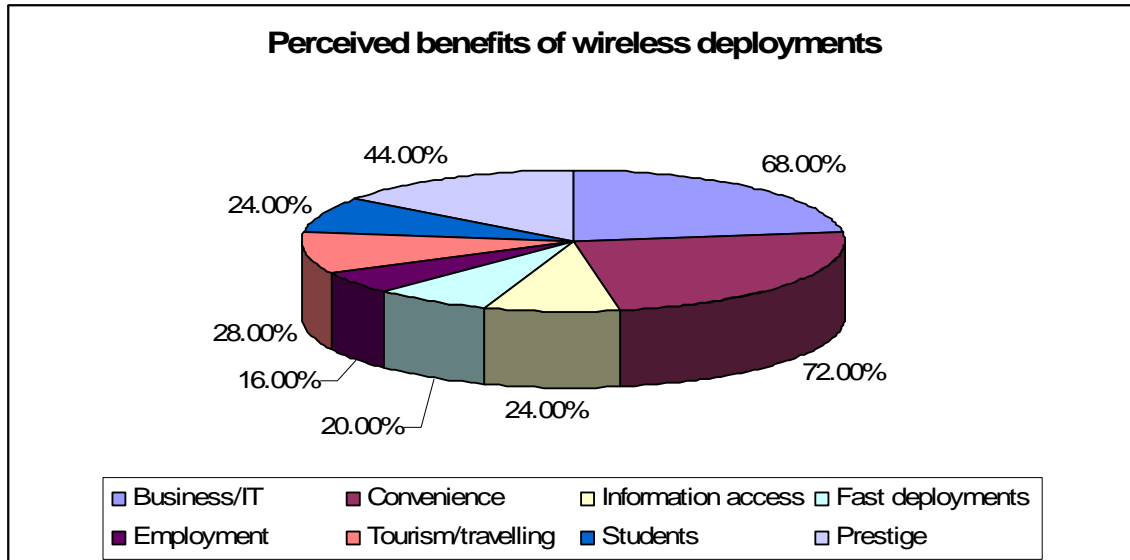
The *Madhya Pradesh state government* has signed the MoU in November 2006 with Motorola and Teledata Informatics as private partners for a wireless network. This project will provide broadband connectivity to rural areas. The villages will be connected to district headquarters and Bhopal. The revenue from the contract is expected to fetch INR 600million annually. The initial contract is set for a period of five years. Teledata Informatics has proposed to set up a continuum of telecom infrastructure, IT applications and a distributive system for providing an effective solution and improve socio-economic conditions in rural areas of the state. A sum of INR 1.5 billion will be invested by Teledata Informatics for the same. In the first phase (for six months) a specific project venture will be established with an operating hub at Bhopal. Connectivity will be provided at specific points in Bhopal and 200 points in rural areas. IT applications, services and logistics will be provided for.^{xxx}

3.3 Motivation and perceived benefits of projects

According to the Wireless advocacy group, the main reasons for the interest shown in city wide wireless projects is that, it is believed that with such connectivity, economic development would be high. It would enhance visitor experiences, attract more people to the city, and retain young professionals.^{xxxi}

Though, there are several such ‘talked-about’ goals and benefits, which the governments have set before themselves for the impending projects in all the states mentioned, in this research the residents of various states were interviewed individually and were asked their opinions which were aggregated together for getting an insight into the benefits and goals of Wireless deployments by state governments in their states and cities. Responses showed that according to people convenience (72%) was the biggest benefit of state-wide wireless deployments and the business/software sector (68%) would be benefited the most. The following chart shows the details of the responses:

¹¹ State Wide Area Network



Source: Interviews; sample size- 30; Please note total is more than 100% as respondents were allowed to give multiple answers

With a lot of software companies and other businesses in Pune, the adoption of ICT has been very rapid. The large presence of software professionals and students has an increased the need of faster and better means of communication. Wireless connectivity to the city would mean convenience for everyone.

Talking about wireless deployments, a MTNL official said that connectivity everywhere would be like wearing ones wrist watch or carrying a cell phone, everything aspect of life would be affected, positively. Several respondents also related to their experiences abroad saying that, they had seen the power of wireless Internet abroad and for cities in India, which were increasingly becoming software-driven; a state-wide deployment would only be an additional investment in the right direction. Respondents also mentioned that some areas around their cities did not have a broadband footprint yet and did not have fibre links, and especially for those areas, wireless Internet, which the ease of deployments would pave the way for universal access. One respondent referred to these projects as another step towards positive policy making with these deployments only being like any infrastructure facility, which the citizens were entitled to have. Respondents also mentioned that with the recent developments of multi storey buildings and malls, wireless Internet would be faster and a much needed facility for the residents. These views were reiterated by the Pune municipal commissioner Nitin Kareer who stated that- “As much as providing basic facilities such as sanitation, sewage, roads, street lights, health, etc, PMC would like to provide basic IT infrastructure such as stable Internet connectivity to its citizens to enhance their overall outlook by exploiting the vast information pool and advantages of Internet. This will surely be a huge differentiator for Pune city and will enhance the status of moving Pune towards becoming the IT capital of the country.”^{xxxii}

3.3.1. Connecting the last mile

The biggest challenges in India with connectivity have been the last mile connectivity and lack of legacy infrastructure. A BSNL employee mentioned that even in big cities, some areas had poor optical networks. Wireless networks overcome both of these problems. As a result, a lot of governments are stepping forward to adopt these networks.

In the state of Uttaranchal which has a rugged terrain with lots of hilly areas extreme climatic conditions, landslides etc., often result in loss of connectivity between various places. The current communication infrastructure is not sufficient for sharing information across places. A lot of places being located at different altitudes also cannot have line of sight communication. The state is said to have a 'money-order economy', with people move over to bigger cities, as the economic growth in small places is very low, mainly attributed to lack of connectivity options. Rajasthan also has arid climatic conditions with similar problems. Wi-Fi is being looked upon as requisite for remote connectivity and disaster management^{xxxiii}. According to Ms. S Kala of ENRAP¹², people in Gauchar district on attending a workshop on Wi-Fi in their area said that Wi-Fi usage would result in creating a better quality of life for them by providing critical information about food, mortality information, tele-medicine, emergency control etc.^{xxxiv}. VoIP with biometric smart cards could be used for monitoring income levels. Uttaranchal is looking to market niche products like herbal medicines, exotic fruits, flowers by using Wi-Fi connectivity. E-tourism is also an option that would be explored.

3.3.2 Addressing the Digital Divide

Rural communications presents a great opportunity. In addition to catching up with all the advantages that urban users of modern communications have discovered, rural users need a lot more: there simply are not enough teachers and doctors to cater to the needs of vast, dispersed populations, so distance learning and telemedicine are their only hope. These states are looking upon Wi-Fi for providing ICT to all, especially in the rural and remote areas, while also cashing in the benefits of these technologies for socio-economic development, as they create new job opportunities and sustainable alternate means of livelihood.

The state of Madhya Pradesh apart from the above benefits is looking at wireless networks after the initial success of projects like E-chaupal and Gyandoot, which showcased the use of ICT for development for people in remote areas.

Respondents from smaller towns mentioned that wireless Internet would enable them to get information online, without having to move to big cities, and hinted that this could create jobs/ access in those areas, and migration into cities could reduce. They also said that with the Internet they would be able to use online marketplaces, find current prices for agricultural goods, climatic conditions and their children could access educational resources without having to go to the nearest towns.

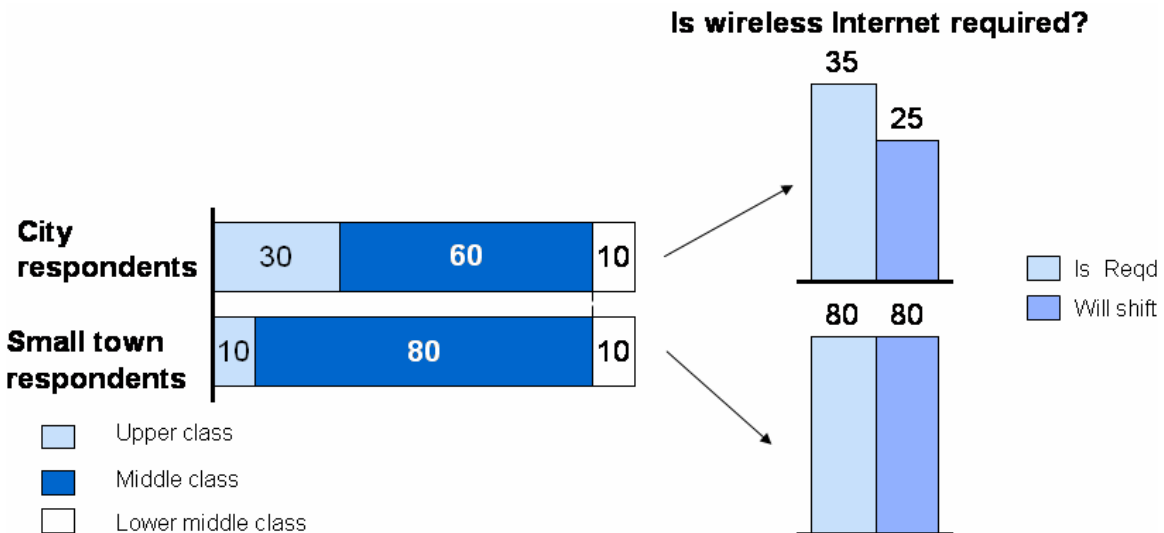
An interesting finding in this process was that, respondents from smaller cities were more excited with the prospects of wireless Internet. On the other hand, people in bigger cities

¹² Knowledge Networking for Rural Development in Asia/Pacific Region

felt that wireless Internet could be successful only if it was cost competitive, and they seemed skeptical with whether they would shift over to wireless or not. Some of them also mentioned that they would also like to have free trials periods before deciding whether to shift or not. One respondent mentioned that wireless Internet is by no means a necessity in the city, but may well be a ‘cool’ thing to do. However, it was also said that wireless broadband would provide people with an additional service and they would not be dependent on traditional service providers only.

Noteworthy however is that all the deployments mentioned are first being rolled out in bigger cities and then shifting over to the interiors. Respondents mentioned that it could make more sense to start these projects in smaller towns which did not have any other broadband services, where people really needed these. However, most respondents also mentioned that to take wireless into small towns, it was important to make people aware of the technology and its possible benefits.

The following chart shows the economic classification of the city and small town respondents who were interviewed. It was observed that only 35% of city respondents thought wireless broadband was required as against 80% small town respondents who said it was essential and that they would adopt it also, if given the facility. Respondents mentioned that the educated middle class even in small towns would adopt wireless purely because of the fascination of the technology, if not anything else. Respondents also concluded that new technology adoptions show the level of development in a place, and that could be the motivation behind such projects. Some people felt that the shift of people from dial-ups to broadband had displayed their openness to new technologies and the same would be seen in case of wireless broadband also.



Source: Interviews; Sample size 30 (City- 20 + small town 10)

Even though a large percentage of rural and semi urban correspondents were in favour of wireless deployments, they also did mention that, since the societies were traditional, the

trust factor was only established in the favour of the incumbent and to make wireless acceptable, several factors like availability of access devices, mouth to mouth publicity would be critical factors. One respondent also mentioned that in male dominated communities, acceptability of wireless would have to come from the males in the community first which would then seep down to all people. All respondents agreed upon the necessity of introducing massive awareness programmes in local languages to help people get used to the new technological products and to make them aware of its benefits.

Considering the need for connectivity, several rural initiatives and pilots have been launched across the country, and some noteworthy examples are:

- **Baramati** became the first town to get WiMax services in the country in November 2006^{xxxv} with a pilot project deployed by Intel along with Aircel and the Maharashtra government on the 3.3 GHz frequency over 20 km and 6 km. It will be available in Baramati and four neighbouring towns and will allow bandwidth speeds of up to 512 kbps. Connectivity has been made available to Baramati district hospital and smaller villages around it, to provide for connectivity and tele-medicine facilities to the rural population.
- **Gurudutt Sugars**, a sugar factory in rural Karnataka setup an outdoor wireless network for their enterprise applications in 2005 (ix). The wireless network is roughly 10 square km in radius and is a point-to-multipoint network. Branches are connected to the head office using point-to-multipoint links. This is a line of sight (LOS) network built using equipment from Brovis Wireless, a Chennai-based equipment maker and innovator. This is an 802.11g data network, and a billing application is being used at the sugar factories over this network. The solutions being deployed for extended range rural wireless typically involve increased output power and specialized antenna elements.
- **Monkey-proof Wi-Fi**^{xxxvi}: India's first wireless mesh network in the rural areas, Air Jaldi, set up about 7000 above the sea level in the Himalayan region of Dharamshala, India, is partnering with Technology and Infrastructure for Emerging Regions (TIER) research group, a University of Berkeley's Wi-Fi research initiative, to offer high-speed Wi-Fi connectivity solutions over long distance. WiLD developed by TIER, is a custom long distance, high-bandwidth, point to point Wi-Fi network, which is a fixed point to point wireless technology, like microwave links, that enables organizations to develop their own wireless network in remote areas. The technology allows anyone with about \$800 for a pair of small computers with directional antennas to network with another location within 50 miles and in line of sight. With the help of this, the local school has been connected to the Internet, and for the first time people are accessing high speed connectivity in these remote areas. This has opened up several new avenues for the local people.
- **Theni eye hospitals**: Thousands of residents of rural villages in India are receiving quality eye care thanks to a collaborative effort between an Indian hospital network and the researchers at the University of California, Berkeley, and at Intel Corporation who have connected the main hospital to small villages through Wi-Fi networks, allowing eye specialists at Aravind Eye Hospital at Theni (Tamil Nadu) to examine patients in five remote clinics via a high-quality

video conference. This project will be expanded in the state to include five hospitals that will be linked to 50 clinics that are expected to serve half a million patients each year^{xxxvii}.

3.3.3 Other industries and sectors

The city of Pune is looking at investment in wireless as a necessary investment which would make the city more attractive to the outside world. More businesses (along with software companies) would be interested in the city which has already invested in creating a comfortable ICT infrastructure. This would mean more jobs in various sectors. According to the PMC also the main motivation for undertaking a wireless project in Pune is primarily to strengthen the ICT infrastructure of the city and to make Pune the ICT hub of the country.

Interestingly, the city of Pune would be holding the Commonwealth youth games in 2008, and infrastructure development is a priority to the PMC, this being the biggest sporting event being organized by the city which will be a major push towards the tourism, hospitality and allied industries, and to be able to rake in the benefits, the city will have to be prepared for it. Wi-Fi is being looked upon as an investment into the infrastructure in this direction too, and its successful implementation would go towards realizing the benefits of the games in the city^{xxxviii}.

This would also give the city an impression of being futuristic in its adoption of new technologies. Applications like voice over Wi-Fi, video mails, distance learning would become possible. Health services and social workers would be able to take a virtual hospital or clinic out to their patients instantly. This is true about all other states also.

E-chaupal in Madhya Pradesh was a project that turned economically viable by bringing in profits to the promoters (ITC¹³) as well as the users. It created an e-marketplace, reducing the delivery chain, thus streamlining the processes. The state has thus become a believer in ICT and has encouraged its usage within the government departments as well as in rural areas. Broadband connectivity through Wi-Fi/ WiMax is looked upon as an absolute must to realize the true potential of ICT for development. The state looks at itself merely as an enabling facilitator, looking at the private sector for enterprise and energy. The state has an aim of contributing 5- 10% to the total ICT output of the country^{xxxix}, creating 600,000 more jobs in the sector by 2008. Wi-Fi would improve industry interaction, transparency, convenience and lower down transaction costs.

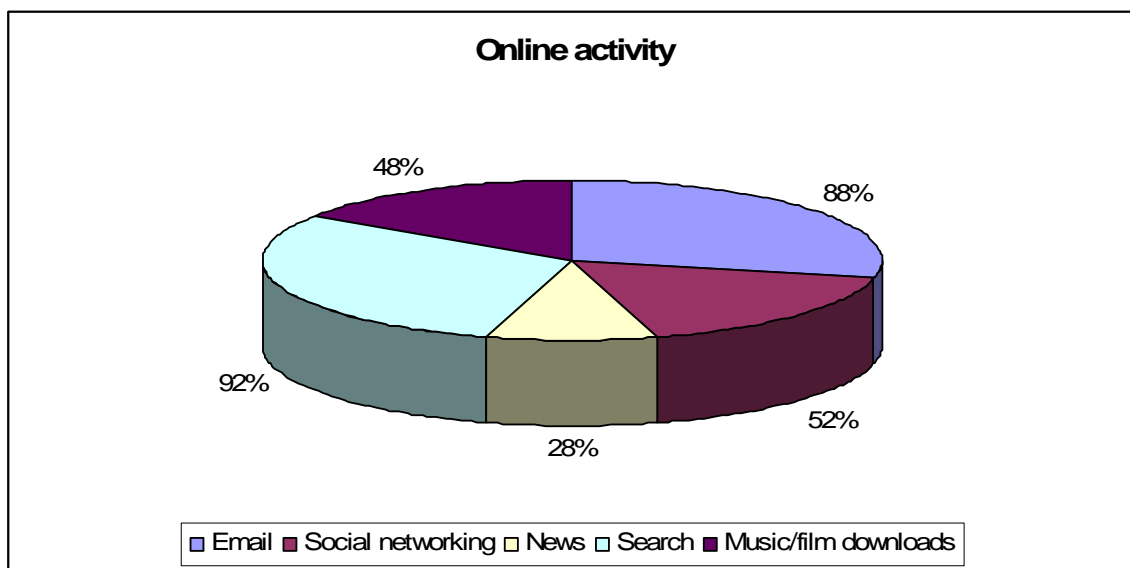
The emergence of the recent retail revolution in India is likely to be a major driver of Wi-Fi solutions in India. The Wi-Fi solutions would cover basic short distance data access applications and also drive automated inventory management, order processing automation, shelf-replacement, security solutions and vendor management. The hotel industry is only beginning to wake up to the Wi-Fi opportunity. Tons Telecom found that in some deluxe five-star hotels, Internet facility via Wi-Fi varies from INR 200 – INR 500 per hour (\$4.4 to \$11.1) and many of them agree that roughly about 60% of the guests use Internet access. Convention centres will also be offering wireless services and

¹³ <http://www.itcportal.com/>

it is estimated that in the next two years at least 50% of conferences and events in the country will provide Wi-Fi access (ix). The mobile phone industry may also become a driver for wireless by the introduction of Wi-Fi enabled mobile handsets. ISPs could look for revenue models at hotspots for mobile Wi-Fi users as opposed only to laptop users. Specialized ISPs and operators can offer broadband services to such mobile travelers at hotspots and Wi-Fi enabled homes.

It does appear that India may actually be turning out to be a major destination for health related travel (ix). There has been a steady rise in the inflow of medical tourists into India. These tourists are driving demand for good quality hotel rooms/lodges that are Wi-Fi equipped and hospitals are gearing up to provide the best in connectivity for both data and voice services for their in-patient guests.

The media and entertainment industry is also growing at about 18% annually (Tonse telecom, 2007). Young Indians are online more often and are accessing content via mobile phones/ laptops and PCs. The following chart shows the online activity of the respondents interviewed.



Source: Interviews; sample size- 30; Please note total is more than 100% as respondents were allowed to give multiple answers

The average time spent online by the respondents in a day was about 3.72 hours. About 92% of the respondents interviewed searched online, and a further 88% spent their time emailing. In the younger age group social networking sites like orkut etc were also very popular.

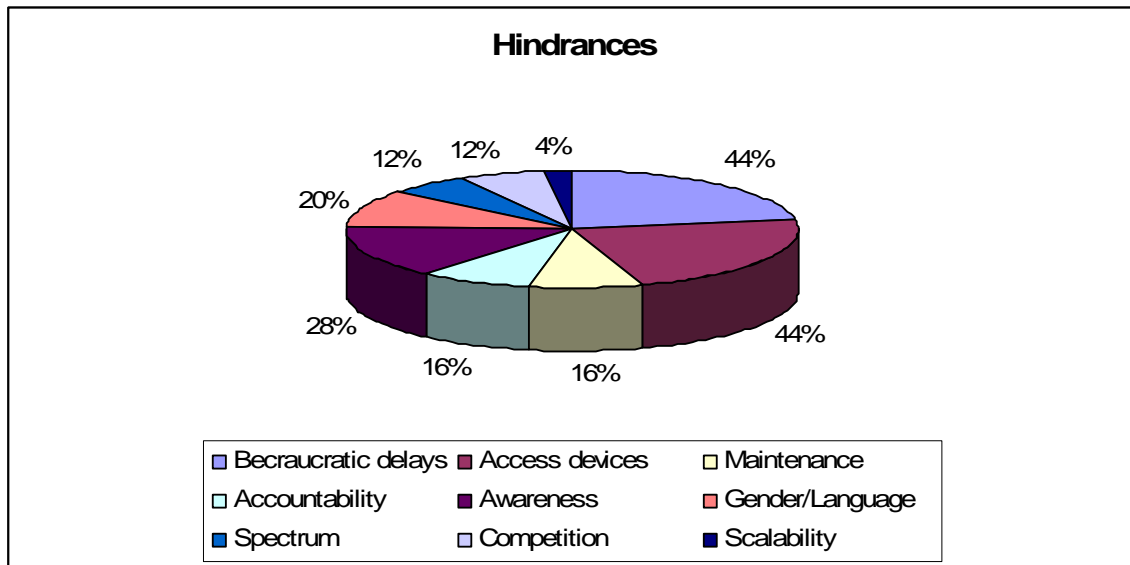
Bollywood music and films have come up as bring drivers for online and mobile content. About 1 million ringtones are downloaded a day. Once the broadband infrastructure falls in place and Wi-Fi devices proliferate it is likely that broadband content will continue to get downloaded via these new devices (ix). Wi-Fi technology has already started penetrating flat screen/LCD televisions, audio/media MP3 players, cameras, and mobile

handsets. A number of products ranging from Wi-Fi flat screen televisions to Wi-Fi-only Skype phones are being launched in India in late 2006 and during 2007(Tonse telecom, 2007).

With all its possible advantages to allied industries, the projects are still utopian concepts. It remains to be seen whether they will be a successful and if at all the benefits would be realizable (xxxviii).

3 Challenges

Interviews revealed several challenges which the projects could be faced with. The top three hindrances according to respondents were- lack of handheld devices, bureaucratic delays, lack of awareness of new technologies and their benefits amongst the common masses. The following chart shows the perceived hindrances from the respondents' end:



Source: Interviews; sample size- 30; Please note total is more than 100% as respondents were allowed to give multiple answers

3.1 Digital Divide:

The Internet is certainly a major phenomenon in India today.^{x1} It is well understood that the growth of Internet would help the country become a part of the global E-commerce industry as well as will enable the citizens to avail various benefits of the technology. Though the government and the industry alike have supported the Internet, the implementation of policies has been plagued by lots of delays, which have inhibited the reach of the technology to the masses. Technologies like the Internet have been viewed as a luxury, which has further hindered the growth. Economically, the technology started off with the basic requirement of PCs, which to begin with were expensive. This meant that some sections of the society have always lacked behind with respect to adoption of the Internet. Internet thus grew slowly compared to initial estimates. This low growth made sure that Internet did not become a full fledged part of the lives of most Indians. The shop round the corner has not yet been replaced by the E-shop, people being still skeptical (xxxviii). All that most state governments and the central government have done is to

have websites, and online databases, e-governance is still in its infancy. For the common man, life without the Internet is still very much possible and even though they accept the fact that life would be easier with the Internet, most people are complacent about it, and unless driven by some factors like very low costs, they are highly unlikely to change this attitude. Hence a new technology like Wi-Fi also, given its benefits will have this barrier in any part of India. In keeping with this one respondent said that while the Internet infrastructure was being built, the applications of real use to the local communities were not being looked into.

The PMC expects every citizen of Pune to use the Wi-Fi network. Visitors to the city would be able to access Internet with a temporary account provided to them. This plan is optimistic and ambitious (xxxviii). Even though in comparison to the rest of the country, the city of Pune economically is placed very high, having the highest per capita income^{xli}, but amidst all the positive figures another one that also catches attention is that, 40% of the city population is in slums. The recent spate of floods has left these people in a bad state, and they have been seeking proper housing and relocation assistance (especially in case of the Kamgar Putla slum area^{xlii}). Under these circumstances, a logical implication of this would mean that with people lacking basic facilities, it is highly unlikely that they would be interested in wireless and more so, they would not be economically sound enough to buy laptops (xxxviii).

In all the other states, the issue is worse with a large number of people below the poverty line. In that case then, either the states would have to provide the people with facilities, in the form of kiosks or the like, wherein people can access Wi-Fi at affordable rates or the Wi-Fi would not cater to this section of the population. Madhya Pradesh, Rajasthan and Uttaranchal with projects like project Janandhar, project Jaikisan.org, e-mitra, Gyandoot have installed kiosks in rural areas. But these projects after initial success have struggled. The main reasons given were lack of awareness, citizen involvement and feedback. If the governments however take initiative and create online forums to facilitate e-governance which would make it easier of these people to access resources, register complaints, register for IDs, ration cards etc., and save time spent in queues, they could derive some benefits (xxxviii). Mr Shinde from the PMC however spoke negatively about the likelihood of such e-government initiatives. He said that they had not been thought about as yet. Mr. Ranade^{xliii} from PMC said that even though most e-governance projects are launched with fanfare, they hardly have an impact on more than 90% of the Indian population. Even though some of the projects have been successful, as the systems have been implemented correctly, the overall impact of these projects has been minimal with most of the population not using them extensively (xliii). Madhya Pradesh has issued smart cards in the transport department and has computerized the land records; taxation department^{xliiv} while Rajasthan has also automated various government departments though the usage of these by most people is limited.

According to statistics even though the PC penetration of Pune is the highest in the country, most people don't possess laptops, which are still relatively expensive, and this would definitely be another hindrance for the success of Wi-Fi. Mr RSP Sinha, CMD MTNL, accepted that the high costs of handheld devices would be a major hindrance in

the success of Wi-Fi in India because without mobility the whole purpose of wireless and the convenience it may provide would be lost. Uttaranchal has an added issue, with the taxation two times that of Delhi and NCR due to which the PC and laptop prices are higher. There is no wholesale market and the retailers have to pay sales tax in U.P. or Delhi as well as in Uttaranchal. Poor Internet services provided by VSNL and BSNL have also resulted in low PC sales (xix). Lack of access devices like laptops was put across as the biggest hindrance in the adoption of wireless by all respondents. They also said that development of kiosks would be essential for the state/city governments, if they realistically wanted to help increase Internet penetration levels. Wireless Internet access for municipal schools and colleges was also suggested. Respondents also said that wireless Internet could be provided in a phased manner with schools and colleges as first targets, this could help them tremendously as well as give the rest of the city some time to accept a new technology. Respondents agreed that students who have high online usage would be amongst the primary users of wireless Internet.

Another factor worth consideration is that the literacy rate in the city is not 100%, which would cause further problems to mass adoption of the technology. Also, a large section of the population in the city is not well versed with English and thus special care taken towards content development. Local language interfaces will have to be used additionally on the Internet which would have to be made bilingual. This was confirmed by Mr Ramesh Shinde from the PMC, who recognize this as a big issue also (xxxviii). Interestingly even the website of the PMC maintained by the statistics and computer department of the city is not bilingual. Even with high literacy rates Uttaranchal doesn't have a high e-literacy rate, some initiative in that regard has been taken by the state government with the project Arohi in association with Microsoft to teach computer schools in government schools especially to the teachers. Computer literacy is seen as a way by which ICT jobs can stay within the state^{xlv}. Madhya Pradesh is also promoting ICT literacy in all schools by 2008 (xxxix), though a lot still needs to be achieved in this direction. Lack of ICT manpower has resulted in Rajasthan signing a MoU with Infosys to train engineering students in IT^{xlvi}. Currently there is a mismatch between the existing and required skills in the state^{xlvii}.

3.2 Political Issues:

Political and bureaucratic delays have often led to faulty or slow implementation of various policies in the country. Nearly 44% respondents said that political issues could lead to faulty deployments / implementation. Respondents said that any change in the ruling political party of the state/ city could result in implementation delays and decision making could get adversely affected. One respondent from BSNL also said the wireless deployments in the states were political gimmicks to attract FDI¹⁴ into the state and get political support. Respondents also admitted to having a preconceived notion against the state bodies and felt that even with the presence of a private partner, the project would not be implemented well.

In Pune PMC has been riddled with controversies often in case of infrastructure development. It has been accused of having a lackadaisical attitude towards development

¹⁴ Foreign Direct Investments

after failing to execute ten major road projects in 2006.^{xlviii} Taking decisions until they are passed by the state government is not possible, this may take up time on important issues, and again delays may result. The elected body of the PMC has often openly taken a stand against the commissioner. The PMC and other state governments have often been accused of not showing keen interest in various development projects which have required immediate attention. Development projects in Rajasthan have had a similar fate. They have suffered considerably due to slow speed of execution. The Uttaranchal government lacks initiative and is playing a waiting game, being more concerned about how other places are dealing with connectivity issues rather than formulating plans of its own. The findings of a Himalayan trust and UNESCO project have revealed absence of government policy support and aid are major hindrances in implementing technologies for connectivity (xxxiv). Even private bodies, which have taken steps in the right direction, have not been supported much like the ULIPH¹⁵ pilot Wi-Fi connectivity programme in Gauchar in Chamoli (xxvii). Officials of the state IT department though brushed the project aside, not showing interest. Lack of back-end support and connectivity at the government end has resulted in many a pilot programmes struggling in these states. In Madhya Pradesh projects which received initial successes have not been able to make much impact in recent times much due to the complacency on part of the government.

PMC has confirmed that BSNL and other cellular companies will be asked for help with infrastructure- mainly with the usage of their already existing towers, but role of BSNL is not well defined. BSNL may have to compete with other ISPs. If the project is successful, BSNL may have a huge loss of revenues, as the broadband services provided by BSNL are very successful, and it is not necessary that those people will again be with BSNL, for wireless services if they shift. BSNL is already losing landlines with the success of wireless (mobile phones) and badly needs another revenue source.^{xlix} In the past the PMC-BSNL relationship has had rifts. The other states however, due to underdeveloped broadband services will actually be leapfrogging to wireless broadband. A respondent from BSNL said that the telecom operators including BSNL would be reluctant to share their resources with any civic body for wireless deployments, as there was no defined revenue-sharing arrangement, and more so, there were hardly any huge gains from such projects. More so, wireless Internet priced around the same range as fixed broadband would pose a threat to the telecom operators providing broadband services.

Also, the PMC as well as other state governments have in the past displayed complete lack of transparency. This can become an issue while the tenders for ISPs and for implementation of the Wi-Fi project are decided upon due to the lack of transparency in the whole procedure. It is likely that the process would be politicized (xxxviii).

3.2 Implementation and Maintenance Issues:

The download speeds of wireless Internet (using Wi-Fi) are still doubtful and would specially affect high population density areas of the city where the bandwidth sharing would mean low speeds anyhow. The poor deployment of Wi-Fi so far in the country has meant that ISPs have backed out¹. WiMax claims are still thought of as optimistic by

¹⁵ Livelihood improvement project for the Himalayas

researchers. These factors will be important while considering the adoption of the technology.

In a city-wide or a state-wide since the scale of implementation is high, the time taken as well as the maintenance would be high (xxvii). In Pune, after the initial implementation and installation, it is not yet clear as to who will take over the maintenance of the project, or for how long Intel is responsible. Also in past the PMC has implemented projects which were rendered useless in sometime^{li}.

Security is another thing which will have to be taken care of by implementing multiple layers of security. A robust authentication protocol for protection from malicious wireless clients as well as the protection of wired assets like routers in public places has to be considered. Also, longevity of the networks and the technology would have to be looked into along with a provision for upgradeability and standardization for future applications and deployments^{lii}. Scaling the network is going to be tough mainly for places like Pune etc in these states which have grown in a haphazard manner.

In all these places another big infrastructural issue is the lack of a reliable power supply. Mobile devices are battery operated but battery-life is a bottleneck, especially since the back-up power is not available sufficiently. Severe and frequent power cuts are common. The cheap PC- Jagruti, which uses alternate sources of power (e.g. car battery), could be a viable option; another one would be to use solar energy, which is being experimented with in Green Wi-Fi¹⁶. It is not clear what option the states will choose, but the power issue may prove critical for mobility.

The quality of service parameters for the network thus would have to be a tradeoff between cost, convenience, ease of use and geographic coverage (xl). It would have to be a network which is cheap, while maintaining some decent level of quality with it which would be as good as (if not better) the current broadband quality.

To reduce AP¹⁷ costs the governments would have to provide for co-location of space and venues for creating Wi-Fi hotspots would have to be chosen. Mr Bhargava, GM IT of MTNL revealed that lack of interest shown by venue managers for prospective Wi-Fi hotspots is an ongoing problem. The states of Rajasthan, Madhya Pradesh and Uttaranchal lack infrastructure requisite for implementing any connectivity project.

3.3 Sustainability Issues:

Throughout the world various business models have been experimented with incase of Wi-Fi, and nothing as yet can guarantee success. Wi-Fi has only had moderate success contrary to initial industry claims. Commercial WiMax deployments are still new. The model to be chosen would have to be such that it can keep lower prices, while ensuring competition. The model would have to consider that the project is also able to fund itself, keeping capital reserves for future network upgrades also^{liii}.

¹⁶ Green WiFi addresses the lack of reliable electricity in developing areas required to power the network.
<http://www.green-wifi.org/>

¹⁷ Access Points

Mr. Siva Ramamurthy of Intel said that the lack of a working business model could pose a major issue, as the adoption rates of Internet were still doubtful. This is more critical for states like Rajasthan which already has a fiscal deficit and financial liabilities. It is not clear that if costs run over budget whether the taxpayers will be liable for paying excess costs or whether there is any limit to taxpayer liability for these costs (xi). Also, since low prices (free in some cases) have been announced, an issue about subsidy arises. If some private companies come ahead and provide lower prices, and the high end users (which the promoters are banking on) do not take up Wi-Fi, it would mean that the projects may require tax payer subsidy.^{liv} In case of a free service for users wanting only access^{lv}, the state/municipality is actually providing unfair competition to companies who may be interested in providing it for a price, more so to the companies already providing wired services. Effectively the projects can run the already existing companies out of business by the low pricing strategy.^{lvi} This anticompetitive behaviour (by below cost pricing) could result in poor performance.

It is also observed that most consumers access the Net in public indoor spaces, such as hotels, office buildings, airports, and train stations^{lvii}. Yet, most municipal networks are designed to cover only public outdoor spaces, where most of today's users don't go online. In this respect these networks do not provide any additional use to a consumer who is already using a reliable fixed broadband connection.

3.4 Pricing

With increased Internet usage, the prices of Internet access in the country have come down. Dial-up service packages may cost between INR 10 (\$0.22)/hour for a 10-hour Internet Access Plan to INR 500 (\$11) for a 500 hour Internet Access Plan (ix). The pricing for a DSL connection now has dropped consistently with the pricing for a 256 Kbps ADSL link dropped from INR 500 (\$11)/month to less than half that fee. A large and dominant dial-up access population has started shifting towards an always-on mode Internet access pricing varies significantly in India depending on type of access, private or public and access mode (DSL/ Dial-up)(ix). Some 5-star hotels charge high rates of up to INR 150 per hour (\$3.33) while a new crop of mid-range hotels have started offering Wi-Fi access free to customers as added value(ix).

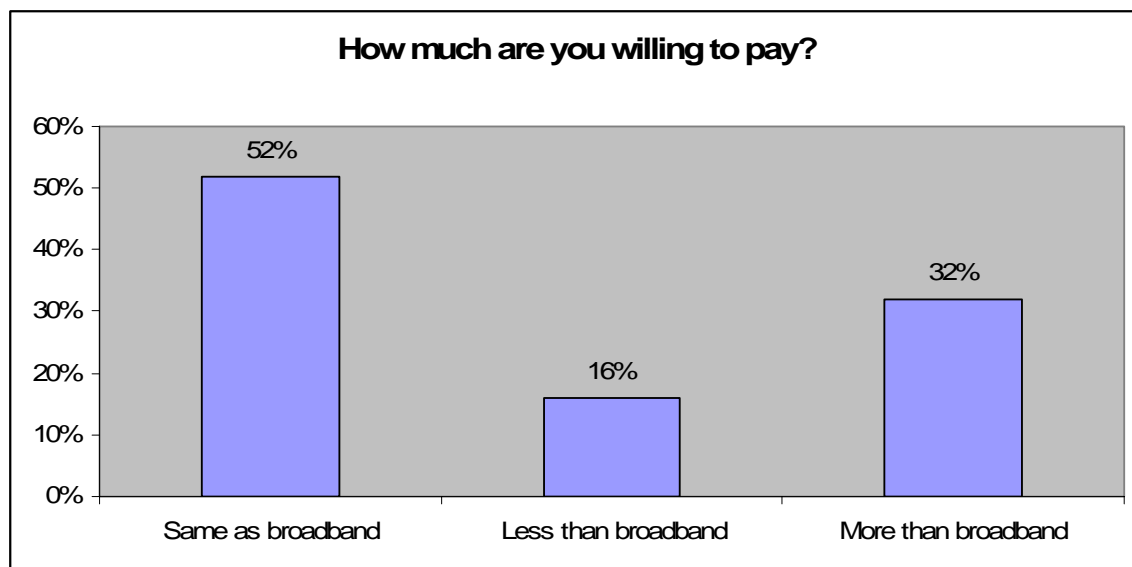
Effective per-hour Rates for Internet Access mechanisms in Nov '06 in India							
Comparison of Typical Rates in India	Wi-Fi HotSpot Net Access	Cyber-Cafe Net Access	Dial-Up Peak Rates Pre-Paid	Dial-Up Off Peak Rates Pre-Paid	Dial-Up Peak-Rates Post-Paid	Dial-Up Off peak Rates Post-Paid	Broadband Unlimited Usage Pack
In INR	Varies from free (some hotels) to Rs.150 per hour	Varies from Rs.20 - Rs.60 per hour	Varies from Rs.14.6 - Rs.32 per hour	Varies from Rs.4.8 - Rs.19 per hour	Varies from Rs.15 - Rs.30 per hour	Varies from Rs.7.2 - Rs.18 per hour	Varies from Rs.3.75 - Rs.5.83 per hour
In USD	0 - \$3.33 per hour	\$0.44 - \$1.33 per hour	\$0.32 - \$0.71 per hour	\$0.1 - \$0.42 per hour	\$0.33 - \$0.66 per hour	\$0.16 - \$0.55 per hour	\$0.08 - \$0.13 per hour

Tonse Telecom, Dec '06
 Effective Rates from top 5 ISPs' select plans, computed on basis of 8hours/day of usage
 Info based on inputs from TRAI, industry, ISPs, hot-spot operators

Several pricing models for wireless have been tried world-wide, all respondents seemed conducive to per month flat rates vis-à-vis per venue rates. According to reports from

OECD, the countries having a fixed rate price have been more successful with a higher penetration of Internet. The user density is higher in such countries and services are more competitive (xl). But the flat rates in itself can be determined either as a measure of per-venue or per-month/user subscription. Several state governments have said that high end users will be charged more, where in high end is with respect to the download volume. This may not be the most ideal way to go about it, as with Wi-Fi hotspots, it may prove to be less profitable for the ISPs. It may well be a better idea to go with the per-venue scheme. Also being community wireless projects; they may be viewed as supplemental by the users. People may be using other Internet services also^{lviii}.

Pricing seems to be the single most important criteria for shifting over to wireless for most respondents. Several respondents said that they were not in favour of “free” services as only paid services would be taken seriously by users. One respondent also mentioned that sometimes even paid commercial services in various areas did not deliver high performance, and so he would be expecting any non-commercial venture to give good performance either. Respondents also said that very low or free services would make wireless Internet anti-competitive for fixed broadband providers, which would eventually bring down quality of service. The following chart shows the responses for pricing of wireless Internet:



Source: Interviews; Broadband refers to fixed broadband

The PMC has announced a flat rate of INR 250 a month for wireless Internet, which is the same as the current minimum broadband prices, which puts wireless directly in competition with fixed broadband.

3.5 Regulatory issues

Currently in India 2.5 and 5.8 Ghz bands are delicensed for indoor and outdoor Wi-Fi and WiMax usage. The Department of Telecom (DoT) delicensed an additional 50 MHz bandwidth in the 5.825 GHz -5.875 GHz frequencies recently that can be used for commercial Wi-Fi and WiMax services. The department had already delicensed 80 MHz

bandwidth in the 2.4 GHz band for outdoor Wi-Fi applications^{lix}. The government feels that if the WiMax spectrum is allocated to telecom operators, it will help them expand their broadband network, especially in rural areas due to the large network range of WiMax. And with the government already declaring 2007 as the year of broadband, WiMax will play an important role in broadband expansion in the country. The telecom ministry plans to take the number of broadband subscribers to 20 million by 2010 (lix).

Telecom operators will get a total of 130 MHz for WiMax and Wi-Fi services. On an average, a telecom operator requires about 20 MHz bandwidth to start a WiMax service. MTNL may even consider contiguous spectrum below 5.875 GHz (lix) for delicensing when the spectrum gets vacated by the armed forces^{lx}. T V Ramachandran, director general, Cellular Operators' Association of India (COAI), said that the industry requirement could be more than 130 MHz but it is a with the delicensing of the 5.8 GHz band a good beginning had been made (lix)

Spectrum has been a constant battle for operators. With a 3G policy nearing release, the telecom operators have insisted that the additional 3G spectrum should not be opened for wireless (WiMax) providers. For 3G the government has announced that a circle-wise ascending auction would take place. Telecom operators have categorically mentioned that Wi-Fi and WiMax operators should not be allowed to use spectrum which they would use for 3G services, as there is a scarcity of spectrum even for the existing telecom operators.

These spectrum issues have resulted in delays in the implementation of the wireless projects. As confirmed by the PMC in Pune, there are ongoing issues with spectrum availability, which they claimed had been sorted, but they seemed to have surfaced out again, as Intel started WiMax deployments in Baramati before Pune, stating the fact that the PMC had not decided on the spectrum availability issue^{lxi}. The government policymakers are not sure if WiMax allocation is a priority issue.^{lxii} The Pune project was being delayed owing to change in the TRAI guidelines, and the implementing agencies would currently manage with available spectrum in the 3.3 GHz, 2.4 GHz , 3.4 GHz and 5.8 GHz. Intel confirmed that there is a need for additional spectrum in the proposed policy and other spectrum is in the process of being identified. These issues could surface out later also, as revealed by Mr. Ramesh Shinde from PMC.

4. Conclusions and recommendations

4.1 Key outcomes

- *Will Wi-Fi and WiMax be disruptive technologies?*

- Wi-Fi and WiMax are being touted as 'personal broadband' technologies which if marketed and implemented well could act as disruptive technologies and pose stiff competition to fixed broadband. These technologies are the only standards-based wireless communication technology that is in the unlicensed spectrum that can offer speeds at tens of megabits per second for local networking, can support a broad range of applications. Being in the unlicensed space allows Wi-Fi solutions to be autonomously deployed.

- *Wi-Fi and WiMax as complementary solutions...*
 - Wi-Fi is the technology of choice for WLANs in homes, offices and campuses because it is mature, available, low-cost, easy to deploy, and involves autonomous setup. WiMAX likely to work as carrier/backhaul broadband technology for the next 3-5 years; it will also be used to interconnect connect to Wi-Fi hotspots. In the longer term also Wi-Fi will continue to complement the technology.
 - WiMAX deployments would help connect rural areas, which are unconnected by any fibre links and in the metros, WiMAX could help decongest the broadband network or provide redundancy to existing E1 lines. In both cases, WiMAX will have a positive impact on connectivity. Initial estimates do reveal the fact that these technologies in tandem will have a definite impact in developing countries to help improve their tele-density especially in the rural sector.
- *Is the PPP model in for the long run?*
 - The long term business model for Public private partnerships is unclear to a lot of practitioners. Financial sustainability of city/state wide deployments thus is still doubtful.
 - The challenge for the Indian environment also is creating the right business model. None of the initiatives have a clearly articulated business model yet. The model must result in sustainability of the project and allow for future network upgrades. Also, it is not clear that if costs will overrun budget and whether the taxpayers will be liable for paying excess costs.
 - While government-led initiatives to expand broadband access are encouraging, history tells us the government-led projects could unravel, lose steam, or stagnate at any time. Political and bureaucratic delays have often led to faulty or slow implementation.
 - The Indian regulatory and licensing procedure has often been touted as non-transparent and discriminatory towards the incumbent. These issues will play a role implementation of new technologies in any part of India. The respondents rate bureaucratic issues as one of the top three hindrances that the wireless projects in India would be faced with.
- *Are Indian cities ready yet?*
 - Lack of access devices in the Indian population and the high prices of CPE for WiMax, could adversely affect the adoption level by consumers
 - A big infrastructural issue is the lack of a reliable power supply. Mobile devices are battery operated but battery life is a bottleneck, especially since the back-up

power is not available sufficiently. Solar panels are feasible, but they tend to disproportionately add a cost to each access point that needs to be powered.

- For Pune, the wireless Internet prices are same as the current prices for broadband. This however means that wireless Internet is in direct competition with fixed broadband and that unless the project is a huge success, sustainability of the project would not be easy.

- *With clear social benefits, has the society caught up?*

- Socio-economic factors matter and it is not clear whether demand for access to the net will emerge from the broader society. The high costs of handheld devices could be a major hindrance, overall. The impoverished customer base everywhere would need special attention with tailored digital divide programs. The literacy rate is not 100%, which would cause further problems to mass adoption of the technology

- The city of Pune has a unique distinction of being an educational and IT hub. The city has a higher literacy rate than the whole of India and also the highest per capita income. This makes the conditions slightly more favourable than the rest of India, especially for new technology like Wi-Fi and WiMax as more number of people know about it, and may be willing to adopt it.

4.2 Making a business case

Throughout the world various business models have been experimented with incase of Wi-Fi, and nothing as yet can guarantee success. None of the above mentioned states/ civic bodies have a convincing business model, and the adoption rates as well as success rates of the projects are still doubtful.

Even though, wireless deployments have been announced and launched, the civic bodies have not really taken the pulse of their people to sense demand before the rolling out of infrastructures. PMC has put up a feedback form on its website, but the website itself is not working most of the times, and not many citizens are aware of it. It is pertinent to ask residents questions and access whether there a real consumer need/desire for a wireless Internet or whether the residents would rather have fixed access. It is also imperative to know how much the residents are willing to pay for the service and whether users would want to shift over to wireless Internet. The answers to these questions will help determine whether a commercial network is even necessary in the first place — and if so, how consumer subscriptions should factor into the calculation of ROI (lvii).

Another useful exercise would also be to find out alternate revenue streams and not to base the revenues purely on subscriptions and access. Remote parking payment systems and traffic control video surveillance can help cities increase revenue (lvii). While these high-bandwidth networks require additional investment, the services they enable generate much higher revenues than do those aimed at consumers. Networks can also have benefits beyond bringing in commercial revenues, such as increasing communities'

attractiveness to businesses, business travelers, prospective residents, and tourists. Advertising models can also be experimented with.

With low awareness levels within the residents, civic bodies should encourage subscriptions from reluctant consumers and small businesses by offering a free trial period coupled with open discussions and educational meetings at city halls, libraries, and schools. Several respondents wanted trial periods before subscriptions. Pune had a trial period of Wi-Fi on MG road for 3 months, which was taken well by consumers. But the awareness levels were again low.

It would be worthwhile, if all the civic bodies would update their web sites with FAQs and a how-to-get-connected guide. Awareness campaigns online or otherwise could drive home the value of the network by showing consumers how to use the applications the city has put online, such as community information portals, permit requests, and tax forms (lvii).

4.3 Key recommendations for success

The success of a project can be determined by considering parameters like sustainability, socio-economic growth or profit margins. All the Wi-Fi projects promise a lot, but a plethora of issues come into play when the success of the project and its sustainability is considered.

The following chart defines some key defining factors for wireless deployments in the states mentioned in this report.

State/City	Motivation	Literacy	Applications	Challenges
Pune Unwire	Making Pune IT capital of India		By IT companies, Access for tourists (Commonwealth youth games 08)	Spectrum allocation not decided, Urban poor, Lack of handheld devices, sustainability, Failed PPP in the past, Power back up
Uttaranchal	Rural+ Remote Connectivity		e-health, disaster management, IT jobs	Low e-literacy, High cost of PCs and laptops, Difficult terrain, Lack of initiative by government, Power back up
MP	Rural Connectivity		E-commerce in rural areas similar to ITC e-chaupal model	Bureaucratic delays, Power, Sustainability, low e-literacy, literacy, PC penetration low,
Rajasthan	Rural Connectivity		e-health, disaster management, IT jobs, e-learning	Difficult terrain, low literacy, PC penetration low, Power backup
<i>Source: Press</i>				

- *Defining the target audience, phased deployments...*
- Ubiquitous connectivity is the primary aim of most PPP deployments, but for the projects to sustain, they need to be adopted by people on a mass scale. The PMC is very optimistic about the project and have mainly been citing the fact that the success broadband would be repeated (xxxviii). The main motivation of undertaking a city wide wireless network in Pune seems to be driven by the desire of the PMC to make Pune the IT capital of the country. It would definitely help the IT related industries and people working in those sectors (xxxviii). With 600 odd software companies in

the city and a lot of software professionals as well as students, the adoption rates in these communities would be high.

- It was observed that a phased deployment of wireless Internet with schools, colleges and the IT sector as first targets could help these sectors tremendously as well as give the rest of the city some time to accept a new technology. It was also observed that these groups have high online usage and would be amongst the primary users of wireless Internet.

- *Localised solutions for bridging the divide...*

- The other states however are looking at Wi-Fi as a saviour for all their connectivity needs (emphasizing on rural/remote areas), while maintaining the intentions of taking the states to the forefront of development through the growth in ICT industries. By all means the impoverished customer base everywhere would need special attention with tailored digital divide programs. The states face a dilemma of providing *growth with equity*. It is also important to understand that the digital divide which is present occurs at multiple levels, and is not just limited to the rural-urban divide. In a multicultural and multiethnic country like India, language, caste, culture, religion, gender can also result in substantial biases and hindrances for the success of the any projects like these.

- Local knowledge and content would have to be developed and utilized to make these projects work at the ground levels.

- *Creating the awareness...*

- It was observed during the research that most of the respondents were unaware of the wireless deployments in the country and even in the educated masses the awareness levels with respect to both Wi-Fi and WiMax were really low. Respondents agreed upon the fact the lack of awareness would pose a major hindrance in these projects, and mouth –to-mouth publicity of these services would help people understand, and later adopt these technologies.

- *Pricing based on means or benefits...*

- Pricing will remain a major point of contention. Pune has rightly chosen the price, which is same as the current broadband prices, and this can be a futile strategy, considering that Wi-Fi will be sold as anywhere, anytime access at the same price as fixed broadband.

- The purchasing power of the other states however is lower than Pune, and they would need to price wireless Internet according to local conditions.

- The business models would have to be experimented with, though one thing that is clear is that enough flexibility will have to be provided to the customers on one hand, and the model will have to be feasible (with respect to profits) for the ISPs and network providers.

- Realistic lead time would need to be anticipated when setting up such projects.
- *'Marketing' the private partner...*
 - Involvement of the private sector with the governments has shown increase in efficiency of the existing systems by improvement in operations, maintenance, billing and collections, and this is something, which works in favour of these public-private partnerships.
 - However several cases of failed partnerships have shown that a platform for dialog between the citizens and government authorities is crucial for the smooth collaboration, and thus would have to be worked upon^{lxiii}. Bureaucratic and political delays may also hamper the progress of the projects.

With multitudes of issues related to the project it may not be easy discern whether the project is a success or not but it would definitely not be an easy ask, for the governments even with the involvement of industry partners. The projects may well become successful on paper, but they will be a real success only when they would cater to "all" in the real sense.

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