Case Study: Connecting Rural India with Broadband Wireless

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This Study uses material extracts from some recently published articles (see articles 1,2,3,4,5 in reference section)

Section 1
Introduction

Section 1.1 Background Study

In the last 10 years, India has emerged as a significant economic force in the world. The economic growth that has taken place has been concurrent to its explosive growth in communications and to a significant extent, been fueled by the telecom boom. India used to add less than one million Telephones a year in early nineties. Now it adds six million per month. Wireless technology (both fixed wireless as well as mobiles), has made telecom affordable in India, fueling the growth. This has helped make business more productive, propelling the Indian economy forward. However, the economic growth in India however is limited to urban areas.

For the 700 million people who live in 600,000 villages in India, who are watching this transition, there is a growing cynicism that they are being left out from sharing the benefits of economic growth that are accruing primarily in the urban areas. Due to the low penetration of telecom and communications in the rural areas, the right kind of opportunities has not reached skilled and semi skilled people in these areas. The rural economy is still dependent on the agriculture sector. With more than 70% of India's population living in rural areas with *less* than $ 100 per month, development of these areas poses a challenge for the 'India' that is fast becoming well known for its economic prowess in the world.

The country varies diversely in topography. The northern part of the country is characterized by the presence of plains and flat land. The southern part of the country is characterized by the Deccan plateau that ranges in height between 300 and 600m above sea level. The eastern part has flat land and hilly terrain while the West has desert and flat terrain. A high density of population of 253 to 525 persons per square kilometer can be found in the plain regions in India[a]. In terms of geographical variation, the topography of the plains varies around 20-25 m in terrain with trees up to the height of 10-12 m[b].

Section 1.2 ICT can be leveraged

Given the geography and the distribution of the population density of India in the flat lands, Information and Communication technology (ICT) has the potential of being leveraged using wireless technology. By connecting villages with broadband

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[a] *Density of Population (Chapter 5),* Census of India 2001

[b] Ramamurthi Bhaskar, Broadband Wireless Technology for Rural India, *Indian Journal of Radio and Space Physics* 36 (2007) 168

technologies, and using ICTs to make villages more information inclusive one can imagine a positive transformation happening in these areas. Some companies such as N-Logue communications, Tarahaat and Drishtee, which focus on leveraging ICTs for rural development, have set up Internet kiosks in villages that are run by entrepreneurs in villages. These Internet Kiosks use the current wireless technology to provide a host of online services to people in rural areas. These Kiosks are the precursor to setting up a full-fledged business center in a village, which could connect urban and rural India facilitating the movement of rural goods to urban markets and vice-versa. ICT can also be leveraged to develop and promote credit availability of finance in rural areas, supplement transport and courier services, and facilitate in decentralized energy generation that has the potential to indirectly impact development in the rural areas.

ICT can and needs to be leveraged to develop the following in the rural areas: 1. Education and training, 2. Health Services, 3. Agriculture, 4. Rural BPOs (IT enabled services from rural India), 5. IT enabled outsourcing of production work, 6. Agro-industry. 7. Small Industry, 8. Commons: Community oriented efforts such as water-harvesting, local governance. The development of these areas will have direct impacts on the community as a whole. Some new experiments are being carried out in several of these areas. However, only a few organizations in the country have taken up this in any comprehensive manner and have tried to build services which can be scaled and have a long term sustainable impact on the society. Most others have, at best, set up demonstration projects rather than sustainable ones. Reluctance to commercialize and scale these projects has led to their collapse as soon as the intervening agencies move out.

At the IIT (Madras), a group of scientists with the TeNet (Telecom and Network communications) Society are working together to create cost effective technology that leverages ICT as well can be deployed in rural areas for its development. Around ten years back, they had created the country's first cost effective wireless corDECT technology that can be deployed for less than $250 per user. They are now in process of deploying a cost effective broadband corDECT technology that can provide a dedicated bit rate of up to 256 kbps. In addition, they have incubated number of companies that are developing affordable technology, especially for rural areas. One of them has developed a low cost telemedicine kit, which enables a doctor in a town to remotely measure the blood pressure, heartbeat and the ECG of a patient in the Internet kiosk in the village. The equipment costs less than $ 300. Another product developed is a remote weather monitoring system that can be mounted at the Internet Kiosk and has its backend data server on the Internet. The Internet server will analyze the incoming data and provide accurate weather forecasts. In addition, the TeNet group is incubating companies that are working on low cost ATM machines and soil testing kits for use in the rural areas. They are creating extensive and exhaustive education content on the Internet to support education services for children in these areas.

Recently, in October 2006, the group has set up the Rural Technology and Business Incubator (RTBI). The RTBI carries over the concept of 'creating sustainable outcomes from creating scalable businesses' as a philosophy in all its incubates By enabling start up entrepreneurs to build rural inclusive business models using ICT while focusing on development of agriculture, health care, education, production and manufacturing and finance in these areas, the society envisions to double rural per capita GDP in the coming years.

Section 2

Infrastructure & Regulatory Environment in India

Section 2.1 Infrastructure in Rural areas

The average village occupies an area of around 5 km^2, most of which is farmland. Settlements in villages range from tiny hamlets of thatched huts to larger settlements of tile-roofed stone and brick houses. The most common fuel for lighting is still Kerosene and more than 65% of people in villages use firewood for cooking. Sometimes children in villages would have to travel up to 20 kms to reach the nearest school[c]. In terms of access to health services, less than 35% of child deliveries happen in institutions at the all India level[d]. Industrial production in villages has not reached its full potential as of now. Figures show that most villages are typically spaced around 30-40 km apart from the market centers. Each such center serves as catchments of around 250-300 villages. The per capita income of these areas is *less* than $100 (Rs. 3000) per month.

Fortunately most of rural India has some form of roads today and at least one bus plies to a village every day. Highways connect towns, which are rarely farther than 15 Kms from the village. Recently through the 'Prime Minister's rural road development scheme', the Government of India has decided to invest in building roads to connect rural areas to the highways. This is a work in progress. Also, the nearest railway station is at least 20 kms away from the village[e]. This allows for relative easy access to transport in the plains.

Significant numbers of villages have an electrical grid. Though availability of power on the grid is not an issue, the quality of power is questionable in rural areas. The grid has power only during the period when the demand in urban India is low. During peak-demand period, urban India has the capability of sapping all the power produced and the rural areas receive whatever is left over. Even when the power flows into the rural grid (0 hour to 18 hours a day, depending on the state), the voltage could sometimes be as low as 90V (reflecting higher demand in urban areas) or as high as 440V (during nights when power usage in urban areas is very low). There is a urgent need for decentralized power generation solutions to tackle this problem of poor quality electricity at the village level.

Section 2.2 The Telecom Situation Today

The mobile revolution of the last five years has seen base stations sprouting in most towns, owned by three or more operators, including the state-owned company. The base stations of the new operators are networked using optical fiber laid only in the last 5 years. There is a lot of dark fiber, and seemingly unlimited scope for bandwidth expansion in these areas. However, the solid telecom backbone that knits the country ends abruptly at the towns and larger villages. Beyond that, cellular coverage extends only up to a radius of 5 km, and then telecommunication services simply peter out.

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[c] Census of India Department, Chennai, India

[d] http://www.censusindia.net

[e] Census of India Department, Chennai, India

Cellular coverage can and will grow in rural areas, but this will depend on the rate at which infrastructure and operating costs reduce, and rural incomes increase. Fixed wireless telephones have been provided in tens of thousands of villages, but it would be safe to conclude that the telecommunications challenge in rural India still remains the "last ten miles". This is particularly true if one were to include broadband Internet access in one's scope, since the wireless technologies currently being deployed can barely support dial-up speeds.

This then is the rural India in search of appropriate broadband wireless technology: characterized by fat optical-fiber POPs within a range of 15-20 km of most villages, with a fairly homogenous distribution of villages in the plains, poor rural cellular coverage, and low incomes. The last aspect, i.e. low incomes, makes the provision of basic telecommunications as well as broadband internet services all the more urgent, since ICT is an enabler for wealth creation.

Overview of the Current Technology Available in India

Before we look at Broadband technologies for Rural India, let us take a look at mobile technologies of today. This section will mostly focus on GSM technologies, though CDMA systems are also present in India today. Though it may not be readily evident, the bottleneck in rolling out services to rural areas is not the cost of electronic equipment, but is rather due to the following:

i. The most significant cost component is the site preparation and the erection of the tower. The towers are about 40 m tall, and require considerable amounts of expensive steel for its construction. Infrastructure like roads and electricity has to be set up to support the equipment.
ii. The second highest contributor to the cost is the power infrastructure – RF cables running to the top of the tower, the power amplifiers, RF filtering and the transceivers roughly account for 55% of the costs of the base tower. RF equipment is expensive as of now.
iii. The maintenance of cell site infrastructure requires local personnel who should be trained in wireless communications to deal with the problems that arise.
iv. Ultra-low cost (ULC) phones at costs below Rs 1500 with financing packages are not yet available in the markets.
v. There is no proper distribution infrastructure for phones, SIMs, spares and accessories in remote areas, and there is a lack of basic training to users thus increasing the maintenance costs.
vi. Billing and collection infrastructure for pre- and post-paid subscribers is expensive to set up.

If one accepts these factors as the real bottleneck, then it is immediately evident that as soon as there is sufficient GSM voice coverage across India, we are already past the key hurdles.

However, one cannot afford to deploy any new cell sites, but one can only add electronic equipment at existing cell sites. To deploy 3G at a cell site, Node B equipment has to be installed (instead of or in addition to the GSM BTS equipment). The cost of such Node B equipment has been falling by approximately 40% each year over the last 4 years. Taken together with the fact that 3G offer more capacity than GSM, the 3G Node B is just 50% more expensive today than the GSM BTS to deploy the same voice capacity. It has already been seen that 55% of the cost of base station equipment is in the RF. Since a single 3G channel of 5 MHz replaces many GSM channels of 200 kHz required achieving the same capacity – the RF costs of 3G systems should over time be lower than that of GSM systems. Thus 3G will eventually lead to cheaper equipment than GSM, resulting into Mobile Broadband infrastructure in India.

Section 3

Broadband for Rural India

Section 3.1 Affordability

When considering any technology for rural India, the question of affordability must be addressed first. Given the income levels, one must work backwards to determine the cost of an economically sustainable solution. The 200 odd households in a typical village having disposable incomes can spend on an average $1-2 per month for telephony and data services. Assuming an average of two public kiosks per village, the revenue of a public kiosk can be of the order of $100 per month. Apart from this, a few wealthy households in each village can afford private connections. After providing for the cost of the terminals, it is estimated that a cost of at most $ 300 is sustainable for the connection. This includes the user equipment, as well the per-subscriber cost of the network equipment and infrastructure (towers) linking the user up to the optical fiber POP.

Section 3.2 Coverage, System Gain, And Cost Of Towers

It has been mentioned that one needs to cover a radius of 15-20 km from the PoP using wireless technology. The 'system gain' is a measure of the link budget available for overcoming propagation and penetration losses (through foliage and buildings), while still guaranteeing system performance. Mobile cellular telephone systems have a system gain typically of 150-160 dB, and achieve indoor penetration within a radius of about 5 km. They do this with Base Station towers of 40 m height, which cost about $ 10,000 each. If a roof-top antenna is mounted at the subscriber-end at a height of 6 m from the ground, coverage can be extended up to 15-20 km. When the system gain is lower at around 135 dB, as in any line of sight system, coverage is limited to around 10 km and antenna-height at the subscriber-end has to be 10 m in order to clear the treetops. This increases the cost of the installation by about $ 20 per connection.

Thus, rooftop antennas in the villages are a must if one is to obtain the required coverage from the fiber POP. A broadband wireless system will also need a system gain of around 150 dB if it is to be deployed with 6m poles. This system gain may be difficult to obtain at the higher bit-rates supported by emerging technology, and one may have to employ taller poles in order to support higher bit-rates at distant villages.

There is an important relationship between coverage and the heights of the towers and poles, and thus indirectly their cost. The Base Station tower must usually be at least 40 m high even for line-of-sight deployment, as trees have a height of 10-12 m and even in the plains one can expect a terrain variation of at least 20-25 m over a 15-20 km radius. Taller Base Station towers will help, but the cost goes up exponentially with height. A shorter tower will mean that the subscriber-end installation will need a 20 m mast. At around $ 400, this is substantially costlier than a pole, even if the mast is guyed and not self-standing. The cost of 250-300 masts of this type is very high compared to the incremental cost of a 40 m tower over a 30 m one. With 40 m towers, poles are sufficient at the subscriber-end, and need rarely be more than 12 m high.

In summary, for a cost-effective solution the system gain should be of the order of 150 dB (at least for the lower bit rates), a 40 m tower should be deployed at the fiber POP, and roof-top antennas with 6-12 m poles at the subscriber-end. The cost per subscriber of the tower and pole (assuming a modest 300 subscribers per tower) is $ 60. This leaves about $ 250 per subscriber for the wireless system itself, inclusive of both the infrastructure and terminal sides.

Section 3.3 What Constitutes Broadband?

The Telecom Regulatory Authority of India has defined broadband services as those provided with a minimum data rate of 256 kbps. At this bit-rate, browsing is fast, video-conferencing can be supported, and applications such as telemedicine and distance education using multi-media are feasible. There is no doubt that a village kiosk could easily utilize a much higher bit-rate, and as technology evolves, this too will become available. However, it is important to note that even at 256 kbps, since kiosks can be expected to generate a sustained flow of traffic, 300 kiosks will generate of the order of 75 Mbps. This is a non-trivial level of traffic to evacuate over the air per Base Station, even with a spectrum allocation of 20 MHz.

Suitability Of Broadband Wireless Technologies

One of the pre-requisites for any wireless technology for it to cost under $ 250 is that it must be a mass-market solution. This will ensure that volumes and competition drive down the cost of the electronics to the lowest possible levels. As an example, both GSM and CDMA mobile telephone technologies can today meet the above cost target, (however, an even lower cost is needed for a non-broadband technology since the services provided are limited).

The third-generation evolution of cellular telephone technologies will probably continue to meet this cost target while offering higher bit-rate data services. However, they will not be able to provide broadband services as defined above (as at most they will provide 64 kbps to each user).

If one were to turn one's attention to some proprietary broadband technologies such as WiMAX-d (IEEE 802.16d), it is found that at present volumes are low and costs high. Of these, WiMAX-d has a lower system gain than the others (which are all around the required 150 dB). All of them will give a spectral efficiency of around 4 bps/Hz/cell (after taking spectrum re-use into account), and thus can potentially evacuate 80 Mbps at each Base Station with a 20 MHz allocation. However, high cost due to low volumes is the inhibitory factor with these technologies.

Section 4

Technologies for today and tomorrow

Section 4.1 Broadband Wireless Technologies For The Near-Term

While wide-area broadband wireless technologies will be unavailable at the desired price-performance point for a few years, local-area broadband technologies have become very inexpensive. A well-known example is WiFi (IEEE 802l.11) technology. These technologies can provide 256 kbps or more to tens of subscribers simultaneously, but can normally do so only over a short distance – less than 50 m in a built-up environment. Several groups have worked with the low-cost electronics of these technologies in new system designs that provide workable solutions for rural broadband connectivity.

Broadband CorDECT Technology

One of the earliest and most widely deployed examples of such re-engineering is the corDECT Wireless Access System developed in India. It provided toll-quality voice service and 35/70 kbps Internet access to each subscriber without the bandwidth having to be shared. The next-generation Broadband corDECT system has also been launched recently, capable of evacuating 70 Mbps per cell with a 5 MHz bandwidth (supporting 144 full-duplex 256 kbps connections simultaneously). With this system, each subscriber will get 256 kbps dedicated Internet access, in addition to toll-quality telephony. These systems are built around the electronics of the European DECT standard, which was designed for local area telephony and data services.

Broadband corDECT incorporates added proprietary extensions to the DECT physical layer that increase the bit-rate by three times, while being backward compatible to the DECT standard. Thus, the spectral efficiency goes up three times when compared to conventional DECT. Additionally, dual-polarization antennas have been used to exploit polarization isolation while till operating within the DECT MAC framework, and further double spectral efficiency. More importantly, all this has been done while retaining the use of the low-cost DECT chipsets.

The system gain in Broadband corDECT for 256 kbps service is 125 dB. This can be increased by a few dB, where required, by increasing the antenna gain at the subscriber-end (which is 11 dBi now). This is sufficient for 10 km coverage under line-of-sight conditions (40 m tower for BS and 10-12 m pole at subscriber side). A repeater is used, as in the corDECT system, for extending the coverage to 25 km. The corDECT system, and now the broadband corDECT system, both meet the rural price-performance requirement comfortably, but with the additional encumbrance of 10-12 m poles and one level of repeaters. The first-generation technology is proven in the urban and rural Indian environment, and much is known about how to deploy it successfully. The Broadband corDECT system works with the same deployment strategy. It is being deployed in significant numbers beginning 2006-07.

Wifi Rural Extension (Wifire): A New Wifi-Based Wide-Area Rural Broadband Technology

In recent years, there have been some sustained efforts to build a rural broadband technology using WiFi chipsets. The WiFi bit rates go all the way up to 54 Mbps. The system gain is about 132 dB for 11 Mbps service, and as in corDECT, one requires a 40 m tower at the fiber POP and 10-12 m poles at the subscriber-end. The attraction of WiFi technology is the de-licensing of spectrum for it in many countries, including India. In rural areas, where the spectrum is hardly used, WiFi is an attractive option, provided its limitations when used over a wide-area are overcome.

Various experiments with off-the-shelf equipment have demonstrated the feasibility of using WiFi for long-distance rural point-to-point links. The more serious issue with regard to the 802.11 standard is that the commonly supported MAC protocol is a Carrier Sense Multiple Access (CSMA) protocol suited only for a LAN deployment. When standard WiFi equipment is used to set up a wide-area network, medium access efficiency becomes very poor, and spectrum cannot be re-used efficiently even in opposite sectors of a base station.

A solution for this problem is to replace the MAC protocol of 802.11 with a MAC protocol more suited to wide-area deployment. Such a new MAC, christened WiFiRe, has indeed been defined, and carefully, such that a low-cost WiFi chipset can still be used, and the in-built WiFi MAC in it can be by-passed. The new MAC can be implemented on a separate general-purpose processor with only a modest increase in cost. With the new WiFiRe MAC, it is estimated that using a single WiFi carrier, one can support about 25 Mbps (uplink + downlink) per cell. This would be sufficient for about 100 villages in a 10-15 km radius. Repeaters, possibly operating on a different frequency, will be needed for covering more villages over a greater distance.

Section 4.2 Tomorrow's Broadband Technologies

In about two years, we would see better broadband technologies, which could provide the 150dB gain, while providing the 256 kbps or more for each connection. The three most promising technologies are all standard based and are therefore expected to meet the price targets required for Rural India. These technologies are:

IEEE 802.16 m
3GPP – LTE
3GPP2 – UMB

IEEE 802.16 m

This is a OFDMA based standard emerging out of efforts of IEEE. The earlier version of the standard is IEEE 802.16 e, which was finalized last year and is popularly known as WiMAX. This broadband wireless standard, using state of art modulation, coding, scheduling and multiplexing would use multiple smart antennas at least at the base station side, to enable peak data rates of 100 Mbpsec for mobile users in 20 MHz spectrum. The working group finalizing the standard aims to finalize the requirements, channel model and evaluation methodology by May 2007 and make a proposal to ITU-R Working Party 8F (WP8F) for IMT-advanced requirements by March 2008. The principle stakeholders driving this effort are vendors developing 802.16 products, licensed carriers using 802.16 products and members of WiMAX Forum™.

3GPP LTE

A Third Generation (wireless) Partnership Project (3GPP) Long Term Evolution (LTE) was started with feasibility study on evolution of Universal Terrestrial Radio Access Network (UTRAN) in 2004 and grew with the recommendations for delivery of mobile broadband services by Next generation Mobile Networks (NGMN) initiative in 2006. A Technical Report (TR 25.913) provides detailed requirements, which include downlink peak date rate of 100 Mbps within a downlink spectrum of 20 MHz using the OFDMA technique. The uplink peak data rate is expected to be 50 Mbps with a 20 MHz uplink spectrum using SC-FDMA technique. It is proposed to support at 200 users in active state in each cell for a spectrum of up to 5 MHz. The users are expected to get high performance with mobility as high as 120 kms / hr. MIMO is expected to be used and an enhanced multimedia service is expected to be a part of the standard.

3G-PP2

The CDMA Development group (CDG) is collaborating with Third generation Partnership Project 2 (3GPP2) to define an Ultra Mobile Broadband (UMB) standard as an evolution of CDMA 2000. The systems requirement document was approved in May 2006 and uses scalable bandwidth up to 20 MHz. The forward direction peak data rate is expected to be as high as 500 Mbps in fixed and 10 Mbps in mobile environment using OFDMA. The reverse direction data rate is to be 150 Mbps in fixed and 50 Mbps in mobile environment using qusi-orthogonal transmission based on OFDMA, together with non-orthogonal user multiplexing with layered superposed OFDMA (LS-OFDMA). The reverse link also supports CDMA for control and low-rate, low latency traffic. The advanced air interface agreement has been reached by Technical specification group C (TSG-C) based on a consolidated framework proposal submitted by China Unicom, Huwei Technologies, KDDI, LG Electronics, Lucent Technologies, Motorola, Nortel, Qualcomm, RITT, Samsung Electronics and ZTE Corporation. The detailed technical specification of air interface framework is expected by end of second quarter of 2007 and the Technological Evolution Framework (TEF) outlines the evolution strategy beyond the 2010 time frame.

Section 5
Social and Development Impacts

Section 5.1 Some Interesting Initiatives:

There are some interesting experiments and initiatives going on in the country today, which use the Internet to provide a basket of services to the communities in villages. The Internet can be accessed at kiosks in the villages, which are enabled by wireless technology such as corDECT technologies. N – Logue Private Communications, which was incubated by TeNet at IIT (Madras), and other groups such as Tarahaat and Drishtee have set up such kiosks that are run by entrepreneurs from the village.

The most significant initiative has been on the education front, where several efforts from various organizations have time and again proved to benefit young children. The most common of these programs have been training children from rural areas to obtain computer skills. N-Logue Communications, Tarahaat, Drishtee have trained large number of children, who use these basic computer skills to get jobs. There are other efforts focused on the development of conceptual education. The most interesting initiative has been in providing rural children an Internet based coaching program to help them pass school exams, particularly SSLC[f] exams. The initial results of the experiment of TeNet group of IIT Madras have been fascinating. Out of the 18 villages in which the program was piloted in 2006, 14 villages saw 100% pass rate at the end of the year. While the content developed for educational services has been attractive, there is, as of now, no business model for these initiatives.

In the area of health care, inexpensive tele-medicine kits and ICTs are being used to carry out some interesting experiments. A company called, Neurosynaptics has developed a remote monitoring kit that can measure heartbeat, blood pressure and ECG. Coupled with video-conferencing, remote diagnostics can become a feasible solution to the problem of 'accesses to health care' in India. There is a group at RTBI who is trying to identify and train Local Village Health Practitioners in villages to provide quality emergency health services. The Village health practitioners will use video conferencing facilities at Kiosks to connect up to doctors from the cities and nearby towns for guidance and will use the telemedicine kits to conduct follow up medical services on patients. However the delivery of medicines and interfacing with existing health care efforts still needs to be worked out. Results on these two projects need to be observed over the next year or two.

Timely Credit availability in rural areas has always been a problem. Also, the marginal costs for processing loans in rural areas are very high since the loan amount borrowed is very small. In India, the State Bank of India and the RTBI are trying to overcome this problem. Low cost ATMs, custom made for villages with facilities like a biometric scanner, possibility of reading soiled notes is being developed by VORTEX, a company incubated by the TeNet group at IIT (M); are being deployed across Tamil

[f] SSLC Exam are government exams and are equivalent to the SATs in the US and A Levels in England.

Nadu. These ATMs will have back ward linkages into the banks using ICTs so that the bank can monitor the accounts. These ATMs will increase the liquidity of money in villages, thus reducing the need for small loans. The Kiosk operators involved with the project are envisioned to become small bank operators who will be incentivised to facilitate loan borrowings as well as ensure their timely recovery. This will make the villages more credit friendly as well as ensure an affordable interest rate for people in the village.

ICT may enrich poverty alleviation programs in a manner, which has not been possible so far, adding a new dimension to all the rural development efforts. The government of India has come out recently with a '100 days guaranteed work' for 'Below Poverty Line' (BPL) families under the National Rural Employment Guarantee Act (NREGA). The transfer of payments for the work done has been a major problem, since the monitoring costs are high and there is a possibility of moral hazard oh behalf of the officer in charge of distributing the daily wage payments. There is an initiative being carried out to use the low cost ATMs to transfer daily wages to workers directly into their accounts. This will remove scope for red tapism and ensure that all the people are properly compensated for their work.

Another significant initiative that has been carried out is the setting up and running of a Rural BPO[g]. The early signs show this to be a difficult but a potentially successful task. Initially one may see migration of skilled workers from rural areas to urban BPO centers. With time reverse migration it could be possible that, once a person gains experience, they will go back to rural areas to set up the next set of BPO companies themselves. It is not difficult to think of ten to twenty people in each village being employed in a rural BPO center providing quality-outsourced work to clients within the country and outside. The efforts of a company called DesiCrew, a company incubated by RTBI, would be interesting to watch.

There is some initial work on IT enabled outsourcing of production (contract production work done in rural areas for urban business) being conducted. It does seem promising; but a lot more needs to be done to make this a viable and scalable business. As of now, entrepreneurs are trying to see if there is some part of the production process that can be outsourced to rural providers in a cost effective manner using ICT as a platform that can help in effective coordination between industry and rural participants. A company that is being incubated by the RTBI is into such a venture. In addition to providing production jobs to the villages, the project is also trying to support marginalized women workers in the villages by providing them employment opportunities in this project.

[g] BPO – Business Process Outsourcing

Section 6
Other Observations

Agriculture is the Key to Rural Development

It is in agriculture, where the maximum difference needs to be made. More than 65% of the population depends on agriculture for their livelihoods. Contribution of agriculture to the country's GDP has come down from around 23% in the early 90's to 18.5% in 2006. The CAGR of the sector for the years 2001 to 2006 is as low as 3%[h]. Indian newspapers have been reporting nearly every day suicides committed by farmers when they lose everything in agriculture and cannot repay their debts. In order to help improve this situation, Experts and companies are trying to work a solution using the ICTs as a facilitator for development of this sector.

ITC e-chaupal and EID Parry have used ICT for providing support to farmers and carry out their procurement for several years. This has helped reduce the possibility of farmers getting cheated by the middlemen who earn huge margins at the cost of the company and the farmer. Farmers also face the problem of inadequate access to advisory services when their crops are infested. This often leads to the complete destruction of their crops and increases their distress. N-Logue Communications and e-Sagoo project of IIIT Hyderabad, use video-conferencing and photographs to link up farmers with advisory and extension services. However, these efforts do not provide comprehensive support to farmers.

A Possible comprehensive approach would be one where ICT based Rural Agricultural Support Centers are set up in each village, which could provide complete agricultural support to each farm in the village. This would start with creating a Farm History record for every plot, including measurement of soil parameters. The support center would further carry out weather monitoring; provide agricultural knowledge and advisory services, connecting farmers with experts on video conferencing and market information. Linking farmers to commodity exchanges and to finance and insurance companies would be another task. Let us elaborate a possible approach:

One of the biggest issues facing agriculture in many parts of the country is the risk associated with agricultural business. One of the newspapers recently wrote an editorial questioning the viability of farming in India. Factors such as crop-disease, weather (or rainfall) and volatile market prices are the major risk factors in farming. Even when a farmer has followed best practices for farming, a small disease, the failure of rains or a price collapse can wipe out a farmer's earning for the year and put him into a spiraling debt.

It is possible to creatively use ICT to mitigate these three risks. Experiments have been conducted that use video-conferencing to connect farmers to agricultural experts. As soon as there is a sign of a disease, a farmer can consult an agricultural expert, show the crop and the leaves and diseased parts on video. In almost 95% of cases, experts can give

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[h] Economic Survey of India, 2006-07, http://indiabudget.nic.in/es2006-07/agriculture.htm

farmers localized and timely solutions, which mitigate the risk of crop failure due to disease. This initiative needs to be systematized and scaled.

If one examines the rainfall pattern in any area in the country in the last eighty years, it is found that rain fails badly typically once in eight years. In other years, either the farmer gets a very good output or at least enough output to cover his / her costs of the inputs. This is an ideal case for insurance - rainfall insurance. The idea is that the input costs for agriculture could be covered by the insurance at a small premium and can be recovered when the farmer has a good output. To accurately determine the rainfall in a village, it is possible to put an electronic rain gauge in the village that is connected to a data storage system on Internet. The Internet will then manage the insurance payments by keeping track of the risk by monitoring weather patterns. Department of Science and Technology (GoI) has initiated a project to install such low cost weather monitoring stations in 100 villages.

The third problem is associated with agriculture is the market-price risk. Fortunately, commodity exchanges now exist in India, where crops can be sold months in advance, using the concept of FUTURES and OPTIONS, which hedge the prices of the crops assuring returns to the farmers. Coupled with rainfall insurance, this can eliminate all production risks as long as disease can be handled as discussed above. The key need is to make these services available to a small farmer. Given the power of information exchange through ICT, it can play a great role in enabling this.

Risks aside, steps need to be taken to increase the crop-output that has leveled off over the last decade in India. The productivity of all crops in India is lower than the world average. One of the reasons is that very little is being done to understand the specific conditions of the farm and apply appropriate inputs thereby. Here a Farm Historian System could leverage ICT to provide a micro-level history of individual plots. Input parameters would include rainfall recorded, water irrigated, fertilizer applied, soil test results etc. This then could set the infrastructure for a personalized advisory system to help the farmer (esp. marginal farmers) to manage their crop better. The idea is to know the history of the farm so as to decide the kind of crop to be grown and amounts of inputs to be applied in the most efficient way. There is some groundwork being done on this project at the Rural Technology & Business Incubator (RTBI) at IIT (Madras).

Yet another intervention required is in terms of water harvesting for the village as well as nearby village cluster. Once again, a computer could be used to create topographical maps of the village. If the ground water information can also be added, it would help in planning the micro-irrigation works in the village so that water from sporadic bursts of rain can be captured and stored for the future benefit of the villagers.

Agro-industry and small rural industries can also leverage ICT to access markets. In addition, they can use ICTs to develop their own knowledge and skills. Rural Supply chains need to be developed to transport goods from a village and financial services need to be developed so that finance is available in rural areas at 10 to 12% interest rates (instead of 24 to 30% interest rates at which most micro-finance companies provide loans). Several interesting experiments are being conducted with regards to the above.

Summary

Implications for India

These next generation broadband wireless standards are important for India, as it would enable broadband wireless to reach urban as well as rural India, pretty much like GSM / CDMA mobiles do so today. It is likely that one or more OFDMA-based broadband technologies will become widely accepted standards soon. One such technology is WiMAX-e (IEEE 802.16e) that is emerging rapidly. These will certainly have a higher spectral efficiency, and more importantly, if they become popular and successful, the cost will be low. A broadband Wireless Consortium of India (BWCI) has been formed between operators, equipment manufacturers, component suppliers, and academia, which contribute to the standardization efforts based on OFDMA technologies. However, it will be several years before a widely adopted technology derives the benefits of market size and the cost drops to affordable levels for rural India. The obvious question is whether there are alternatives in the interim that meet performance and cost objectives.

Currently, operators are starting to use Broadband corDECT in small towns and rural India. The next generation wireless would have the capability required to get broadband to all villages. The bit-pipes would be there. The challenge would be use the bit-pipes to transform rural economy. For the time being, as the mass-market technology is being evolved, the key is to build some great pilots quickly where ICT is pre-integrated in the rural development network. Interesting projects are taking place around the country currently to support this development. The learning and experiences of the current entrepreneurs will set the platform for the future catapulting of rural areas. This would set the stage for realizing the vision of ‘doubling rural income’.

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