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Harnessing The Potential Of New Communication Technologies
For Rural Development In The Asia-Pacific

By

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HARNESSING THE POTENTIAL OF NEW COMMUNICATION TECHNOLOGIES
FOR RURAL DEVELOPMENT IN THE ASIA-PACIFIC

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INTRODUCTION

The population in Asia-Pacific, which constitutes over one half the population of the world, live primarily in the villages. The rural population in several countries are sizable, some being as high as 80% or more. In many countries, such as China, India, Indonesia, Australia the villages are spread out sparsely, while in some countries such as Bangladesh, villages are clustered. The rural population in most countries have by and large been ignored, in so far as provisions for telecommunications has been concerned. The emphasis has been primarily towards servicing the needs of the urban population, since this is where the operations are highly profitable. However, with the rising demands from the large rural population, the political and the economic compunctions are forcing governments to put greater stress in expanding the rural networks, and make the basic services available in the villages. In many countries, the profits from the urban and long distance operations are being used to subsidize the rural networks, while in several others rural networks are being privatized and the private operators given incentives to operate in the villages.

John Nesbit, the author of the popular book MEGATRENDS, states that Asia Pacific with its spending power, the spread of new technology, growing capital resources, and increase in intra-Asian trade has reached the critical mass needed for self-sustained economic growth and influence. He predicts that by the year 2000, the Asian market will be more economically powerful than the EC, and that the rise of the Asia Pacific region, along with the fall of communism and the revolution in telecommunication are the three most significant contributors to the shaping of the New World Order. Privatisation, free trade, multiparty democracy and prosperity based on the market place are the shared values of this New World Order. The task before the countries in the Asia Pacific is now to focus on the large rural populations for whom this prosperity has been to a great extent, a distant dream. The new revolution in telecommunications is today paving the way towards the realization of this dream.
New communications technologies, with its associated reduction in subscriber per line costs, and availability of new service features, are helping the expansion of the rural networks in Asia Pacific. The cost of providing rural telephone lines has been expensive, being typically several times that in the urban areas, while demand for service is very low, leading to very poor utilization of the network. The operating and maintenance conditions in the villages are usually very primitive, and hence the reliability of the equipment has also played a major role in contributing to low productivity and revenue generation. The new technologies are providing us with the means to overcome these hurdles, and enabling us to provide reliable service, at reasonable costs, so that Rural Telecommunications can become a profitable business.

An example of how the developments in new communication technologies have been used for meeting the needs of the villages, is the experiences in India, where the telephone density is one of the lowest in the world, i.e. 8 telephones per 1000 population. The telephone densities in the villages is even lower at about 0.9 per 1000 population. The Centre for Development of Telematics (C-DOT) an autonomous R&D organisation established in 1984, has developed a number of switching and transmission products which have been licensed to over 70 manufacturing companies. Nearly two million lines of telephone exchanges have been manufactured based on C-DOT design. Of these more than one million lines are presently in the national network, servicing the rural areas of the country. The developments of rural communication equipment by C-DOT, using new technologies, is given below:

### RURAL SWITCHING

The advent of the digital stored program (SPC) telephone switching systems, has brought highly reliable telephone exchanges to the villages. Though it had been the large digital switching systems installed in the metros and urban areas that had greatly benefited from the reliability, quality and the varied services that are available in such systems, C-DOT's small Rural Automatic Exchanges (RAXs), have now brought some similar advantages to the rural areas. These have now extensively replaced the unreliable old electro-mechanical manual as well as automatic exchanges through out the villages in the country.

#### 128P/256P Rural Automatic Exchange (RAX)

Designed specifically to meet the stringent environmental as well as operational requirements of the Indian villages, the 128/256 port exchanges have transformed the telecommunications scenario
of the country. There are presently over 13,000 of these RAXs installed and operating in the Indian Telecom Network. The exchanges operate in the extreme temperatures from the highs in the Rajasthan deserts of over 50 degrees centigrade to the sub-zero temperatures in the Himalayas, without any air-conditioning. The packaging of the exchange has been done to even cater to the nuisance of rodents, which is so common in the Indian villages. The system has been designed to be very rugged, requiring minimal maintenance and cater to the very poor quality and erratic power supply normally found in the rural districts. There is duplication of all the critical electronics in the systems, so that at the worst, no failure affects more than 8 terminations at a time. An automatic on-line diagnostics have been designed in for fault isolation and recovery, along with an easy to use, exhaustive set of subscriber, maintenance and system features, these being achieved at very low per line cost.

The [256P] RAX handles up to 256 terminations of subscribers, trunks and tones. It can act as a terminal exchange, integrated line and transit(ILT) exchange or purely as a transit exchange. This could be placed within the secondary switching area as a tertiary centre providing connectivity amongst a number of RAXs, TAX and the manual trunk positions in addition to the local subscribers. The transit facility enables several of the RAXs to be interconnected together to meet the growing demand, as also provide a group dialing facility to a cluster of villages. In order to reduce the operational and maintenance cost of rural exchanges, a centralised Operation and Maintenance Centres (OMCs) are also available.

Remote Switching Unit(RSU)

To meet requirement of larger number of subscribers in bigger villages close to urban centres, the Remote Switching Unit (RSU) has been developed for the C-DOT’s larger series of the Digital Switching Systems the Main Automatic Exchanges(MAX), which have capacity up to 40,000 lines. The RSU is geographically distributed around the main exchange, and is parented, to the main exchange through high speed digital trunks. Through the RSU, subscribers of a remote site can be served exactly as subscribers connected to the host exchange, and they benefit from all the features available at the urban centre. In the event of a break in the digital link, the RSU is still able to perform as a local exchange servicing the subscribers connected to it locally. This technique significantly reduces the per line cost for the exchange including cable cost. Requirements for air-conditioning have also been eliminated in this case, thereby contributing to further reduction in the infrastructure costs.
TDM/TDMA Rural Radio System

In tune with the digitisation of the network, this system provides the features and flexibility inherent in the digital switching and transmission systems of today. An integrated switching and transmission system, it is the ideal solution to the future needs of the rural communications operations. The system consists of a Base Station Unit (BSU) which incorporates a 256p RAX exchange, a controller and the digital radio. Operating in the 1.5 GHz band, the subscribers located remotely within an area of 30 km radius from the BSU, share a common pair of radio channel using the TDM/TDMA technique. The system can be configured as a standalone exchange and can provide local radio loops or a mix of wire and radio loop. It can also be configured as a trunking system to trunk several RAXs.

The one BSU can support up to 64 Remote Station Units (RSU). Each RSU can support 32 subscribers, but traffic considerations limit the capacity of the system to 256 maximum subscribers. 27 voice slots are provided in a 2 MHz RF bandwidth, using 32 Kbps ADPCM for voice coding. The system can be also connected to another exchange either through the standard G.703 interface two wire trunks or 27 E&M trunks. It also supports telex and data services in addition to voice communication. A maximum of 16 telex channels, one per remote, operating at 300 baud and data services at 32 kbps are provided for. The RSU can also support coin collection box type of telephones, making it possible to have a PCO at the remote end.

SATELLITE TRANSMISSION

Satellite Based Rural Telegraph Network (SBRTN)

For remote, inaccessible areas, especially in the hilly regions, satellite transmission has been found to be a cost effective solution. Availability of a domestic satellites, such as the INSAT 2A and INSAT 2B which was launched in July 1993, which has a coverage of the whole country, has enabled satellite transmission to be used for rural communication. A Satellite Based Rural Telegraph Network (SBRTN) was the first system introduced by C-DOT in the North Eastern Region of the country. It is an extremely simple, low cost digital satellite network, developed to meet the low traffic rural telegraph communication requirement needs of India.

The network operates in C band and has a star architecture with TDMA/TDM channel access scheme. It has a design capacity of supporting a thousand small Rural Telegraph Terminals(RTTs). All the RTTs are synchronized to the master station i.e. the hub,
through the TDM Broadcast channel which carries the message and control information to all the RTTs. The synchronized RTTs on the other hand transmit their messages to the hub in the TDMA mode. The network is controlled by a Network Service Centre, which does the network configuration, monitoring, control and analysis of the traffic statistics.

**Very Small Aperture Terminals (VSAT)**

The Integrated Speech and Data (ISD)16 VSAT, is another satellite product, suitable for the low density rural voice and data traffic requirements. The system uses the C-band and extended C-band transponders that are available on the INSAT satellites. The network consists of a number of VSATs connected to a master station (Hub) in a star configuration. In addition to data, voice at 16 Kbps is also supported between the VSATs and the Public Switched Telephone Network (PSTN). VSATs data connectivity is also supported between VSAT and Public Switched Packet Data Network (PSPDN-X25) and Telex network.

**OPTICAL TRANSMISSION**

A low cost point to point communication link using an optical fibre cable in the bit rate of 0 Mb/s, is also seen as an attractive option for rural communication applications. The 2/8 Mb/s Optical Line Terminal Equipment (OLTE), operates on a single mode optical fibre at 1300 nm wavelength window. It is designed to establish a highly reliable point to point communication link over a distance of 50 km. The system is used to provide connectivity between rural exchanges and rural trunk exchanges. This system has decided operational advantages, because of the inherent characteristics of fibre technology. It interfaces with a standard CCITT 2nd order digital multiplexing equipment, and transmits/receives HDB-3 coded optical line signal through the fibre cables.

**CELLULAR RADIO**

With the introduction of Cellular services in the larger cities in the country, the option of using Cellular Radio for fixed applications in the villages are now under consideration. Analog Cellular (AMPS,NMT,TACS), which have benefited from high volume production, now provide a low cost, rapidly deployable alternative to setting up a land based wire line network. The Wireless Local Loop (WLL) developed based on this concept, eliminates expensive
cellular switches while still providing all the basic voice telephony as well as FAX and data connectivity. Use of radio in the local loop also frees the exchange from being required to know the exact location of the subscriber. While the present analog systems provide an attractive low cost alternative, considerable development and volume production will be required to use the GSM standard based system for this type of application.

RURAL DEVELOPMENT - CASE STUDY OF C-DOT RAXs

A number of studies have been carried out by the International Telecommunications Union (ITU), World Bank etc. regarding the benefits of Telecommunications in Rural Development. It has been established that even in a country like India, a telephone can no longer be thought of as a luxury in the villages. It has become an essential requirement for the farmer, who is concerned about his farm yields and market for his produce. With the large number of the C-DOT RAXs installed in the country, a study was undertaken by the National Council for Applied Economic Research (NCAER). The object of the study was:

(1) To appraise the socio-economic impact of installation of C-DOT RAXs in various parts of the country by assessing the impact in a representative set of sample villages out of the existing C-DOT population (villages to be identified by stratified random sampling procedure) through an appropriately designed three tier field survey at the exchange, village and household levels.

(2) To assess the financial impact at the exchange level, examine the distribution of financial IRR, NPV at 12% discount rate, and economic IRR across the regions.

(3) To determine the village characteristics that could explain the response of villages in terms of connections sought through a step wise regression run.

(4) To utilize the strategic framework of analysis in order to examine the "diffusion" of electronic switching capability before and after the advent of C-DOT through appropriate comparisons of "diffusion" levels in other countries.
RURAL TRANSMISSION

The cost of laying the cables and planning and building the communication infrastructure in the rural areas, has been the greatest deterrent to the expansion of the rural network. Use of the new radio technologies, have significantly resolved these problems. The advancement in radio technologies, primarily as the result of the exploding cellular mobile radio market, have resulted in several low cost alternatives, now becoming available for application in the rural areas. Radio based systems are no longer constrained by high costs. They are simple, rugged, require minimal maintenance, consume very little power and are adaptable to different conditions of terrain. Radio based systems, whether analog or digital, are able to provide either point to point or point to multi point (PMP) configurations, to suit the terrain and population requirements in the most cost effective manner. Some examples of these, with respect to developments carried out by the Centre for Development of Telematics (C-DOT), to meet the rural needs for India are given below.

POINT TO POINT SYSTEMS

6RUL0 Digital Radio

To meet the requirements of connecting small villages, or a cluster of villages to the village headquarters, and then onto the district headquarters in the country, a 10 channel digital radio, operating in the 600 MHz band was developed. The equipment uses the state-of-the-art technology to achieve economy in cost and optimization of packaging density. It possesses definite functional advantage due the to the inherent characteristics of UHF technology and partly due to special techniques used in the signal processing and transmission. Its key advantages are:-
- Ease of maintenance and installation,
- Better speech quality
- High reliability
- Low power consumption

Rural locations in India are characterized by sparse populations and remote or inaccessible terrain. Small, local exchanges provide connectivity with nearby villages only. Networking these exchanges using conventional cable technology is expensive. C-DOT’s 6RUL0, operating in the 622 to 712 MHz band, with a point-to-point range of 30 KM, provides a cost effective digital radio based solution that is just right for such low traffic conditions. The inputs into the system are either the 2 wire
physical loop or the 4 wire E&M analog voice circuits. The inputs to the 10 channels are digitised into 64 Kbps PCM format and multiplexed to obtain a 704 Kbps digital stream. The digital signal is frequency modulated and then transmitted in the UHF band. The unit can also be used to interconnect these local exchanges (RAXs) with larger, public digital systems like C-DOT's MAX family of central office switches.

**Single channel VHF**

For meeting the communication requirements of an even more sparse rural population, especially in the rural hilly areas, a Single Channel Analog Radio system, working in the VHF band has been developed. The system can be used for connection to the Long Distance Public Telephone (LDPT) or coin box telephone with any type of exchange. The system can be used as a junction between two exchanges of any type i.e., either automatic or manual exchange or as a junction between two trunk exchanges with suitable interfaces at either end. It has a provision to extend the line either in the subscriber line (loop) mode or the E&M mode in two wire or 4 wire basis. The system consists of a single hop with a typical hop length of 30 km. In loop mode of working the users telephone can be at the users end equipment or at a distance not exceeding 1 km from there. A repackaging of the equipment is presently under consideration, for mobile application.

**POINT TO MULTI POINT**

**2/15 Shared Radio System**

To further reduce the cost of transmission, this simple analog multi access system was designed to provide communication in the remote areas, where physical connections between subscribers and the telephone exchange is either impossible, time consuming, or highly uneconomical because of the routing of cables across rivers or hilly tracts. The 2/15 shared radio system, links the nearest telephone exchange via VHF radio to remote locations situated less than 30 km away from the exchange. Up to 15 remote subscribers can be provided such radio connections to the parent exchange. There is no limitation on the numbering scheme for the Remote Scriber Unit (RSU), which can be randomly numbered within the numbering scheme of the parent exchange. Some of the key features of the system are its ability to initiate and receive calls, the independence of the channel, the metering and billing facility at the remote end, and the facility for broadcast.
The ultimate goal of the study was to assess the catalytic nature of rural telecommunication services through field surveys so as to record the experiences of rural telecom users and assess the actual cost benefit realized on account of setting up C-DOT’s RAXs.

The study was carried out by making a random selection of 32 RAXs sample out of 1549 C-DOT RAX exchanges installed and commissioned prior to March 31st 1991, distributed in four zones, with eight exchanges being again randomly selected in each zone. Each exchange had several villages connected to it, while in most cases the majority of subscribers were in the village housing the exchange. In the selected exchange villages, twelve household stratification was done according to groups such as agriculture, rural industries, trade/commerce, social/public institutions etc.

The results of the study have highlighted that 90% of the surveyed exchanges have a cost per line (inclusive cables, civil and structural costs and the equipment) that is less than Rs.15,000 (i.e. US$500). Most of them being in the range of about Rs.3,000 to Rs.10,000 (i.e. US$ 270 to 333) or Rs12,000 to Rs.15,000 (i.e. US$400 to 500 ). Survey also revealed that for rural communications the C-DOT RAXs performed three types of roles viz:

a) as a sub-urban exchange / feeder village exchange
b) as an isolated business cluster / village centre
c) as a typical rural exchange in areas with badly developed infrastructure.

Based on the existing tariff structure, 47% of the C-DOT exchanges exhibited a negative IRR, while 28% exhibited an IRR exceeding 15%, indicating the financial attractiveness of setting up rural exchanges. The NPV was found to be negative for 69% of the rural exchanges surveyed at 12% discount rate, while it was positive for the remainder 31%. The payback period varied from two years up onwards, and roughly one third of the surveyed exchanges which had a positive IRR had a typical pay back period of less than 6 years. Finally the Social benefit that was calculated based on a 15 year operating life of the exchange was US$303 per line.

CONCLUSION

Rural connectivity is today a necessity in the Asia Pacific region. The advances in technology has now made feasible the availability of low cost, rugged equipment based on the state of the art technology, that is simple and easy to use and maintain.
The advances in digital radio technology, propelled by the tremendous growth in the area of cellular mobile radio in the urban regions, is providing the means. The example of the rural telecom products developed by C-DOT in India has shown what can be achieved. It has been established, that even with existing tariff structures rural communication can be profitable, and that given the tremendous socio-economic benefits, the investment in the area of rural communication will bring significant wealth to the nations. With the advent of liberalization and privatization of networks, a tremendous fillip is anticipated in the growth of rural telecommunications in all areas of the Asia Pacific.