Role of Telecommunication and Networking Technology in the Development of Digital Libraries

Mamata P K G Gopal Reddy
Praveen Kumar Kumbargoudar

Abstract

Many observers have praised the Internet for its omnipresent nature and argued that this global medium is revolutionizing the nature of modern communications. The rise of the internet, is challenging the telecom infrastructure, management and accessibility in India. Telecom in developing countries faces a distinct challenge as compared to developed countries. As the Internet continues to grow, questions of accessibility and infrastructure equity persist. This paper provides an overview of the developments in telecommunications and networking in India.

Keywords: Internet, Telecommunication, Networking

0. Introduction

Invention of computers and Networks (especially internet) are great milestones in the history and development of Libraries. There has been a convergence of a number of developments in computer technology in the last few years, which has significantly affected the way computers can be used in libraries. Emergence of compact disks(CDs), digital versatile disks(DVDs) and high speed processors have large information storage capacity. The internet technology made it possible to access information from any part of the world easily and quickly.

Larson defined digital libraries as not single, stand-alone, repositories of digital data. Instead they are a heterogeneous collection of network based repositories using a variety of protocols for user (and repository) interaction, data encoding and transmission.

Digital library is a logical extension of the networked environment and the development triggered thereof and provides the users with coherent access to a very rare, organized repository of information and knowledge. In a sense it is a global virtual library- the library of thousands of networked electronic libraries/databases.

There is an increasingly wide range of digital resources from formally published electronic journals and electronic books through databases and datasets in many formats, that is, bibliographic, full-text images, audio, video, statistical and numeric datasets. Further, a digital library is not a single entity although it may have digital contents created in-house or acquired in digital formats stored locally on servers.

A digital library may also act as a portal site providing access to digital collections hold elsewhere through the networks.

Digital Libraries Operated with the digital information and Internet Technology for Communication and transmission of information. Conventional or handwritten or printed text can-be converted into digital format easily. It is also easy to store the Digital Information in Compact form. Digital information can be transmitted and received anywhere in the world where infrastructure to send and receive is in place.

For the transmission and communication of Digital Information, form one place to another, Internet is the most popular technology. Internet today is not just another means of communication. Those who use Internet regularly, know that Internet is power. It gives a user not only all kinds of information, but also enables him/her to do things one could not even dream of till recently. Internet gives to its users so much competitive advantage that those without access will face significant disadvantages. In other words, access to the Internet can enable people in all kinds of ways including providing access to education, removing barriers of distance and remoteness, and enabling one to get all kinds of information and to close business deals. But at the same time, lack of Internet access would put a person at a tremendous disadvantage. Earlier the Internet was costlier. But increasing Research and developmental activities of Telecommunication and Networking Industry made the Internet easier, reliable as well as economical.

For the success of digital libraries the universal access to Internet is very important. In others words, universal access here refers to all kinds of people from all the parts of India must be able to access the Internet and digital libraries. India today has about 22 million telephones and less than 0.7 million Internet connections for its one billion people.

In India, there are more rural areas, where internet connection is not accessible. Even though accessed, it is not problematic and not economical. For providing solutions to such problems, Telecommunication and Networking Technology has developed and the present paper explains on such technology.

1. Internet : Its Problems

Today, Internet access is becoming increasingly important. Those who have Internet access have rapid access to all kinds of information, and this could create another divide between the haves and have-notes. A telecom network installed today must provide widespread access to internet.

Internet access on the existing telephone network appears to be very simple-just connect a modem to your telephone line, dial up a router of an Internet Service Provider (ISP), and get searching. Unfortunately, there are several problems in using Internet in this manner, accentuated by the specificities of the telecom network in India. The various problems are discussed as under:

The PSTN, in many parts of the world and especially in India, has been designed to handle 0.1 Erlang ????? traffic per subscriber. While this is largely sufficient for voice telephony, Internet access complicates the matter. While a voice call lasts only for a few minutes, an Internet call usually lasts much longer. Most studies have shown that an Internet user offers a load as high as 0.3 Erlang during peak hour. As the ratio of the Internet users to the total users grows, the PSTN will just not be able to handle the load. The network will get congested and fail to complete a large number of calls. The second problem in accessing the Internet by making a switched telephone call to the ISP, has to do with the analogue modem connection between the subscriber and the ISP. The analogue link, in India, is just not reliable, mainly due to the variable quality of the copper local loop. This is even more so when a subscriber is located in a small town, where the trunk could also be analogue. The quality of the dial-up link varies, and while it does provide 28.8 kbps connectivity occasionally, it often provides only 9.6 kbps or 4.8kbps, Sometimes the modem link also drops, requiring redialling and a new connection. Besides, this method of access works out to be very expensive in India. If one is situated in a metro and uses a local call to an ISP for Internet connection, the telephone charges alone works out to nearly Rs.28 per hour. The charges paid to the ISP are extra. For subscribers in small towns and rural areas making toll calls to an ISP, the amount become astronomically high. If one is located around 250 kms from the nearest ISP, the call charges for one hour of Internet access works out to Rs. 1,200. The third bottleneck occurs at the ISP end. The investment in telephone lines and modems increases rapidly and linearly with the number of customers an ISP serves.

2. Telecom and Networking Technology

To solve the problems of Internet, certain networking technology is operated as under:

2.1 Remote Access Switch

In India, the solution to this Internet tangle is emerging in the form of a low-cost *Remote Access Switch (RAS).* Here, one explicitly recognises that the telecom network is a circuit-switched network whereas the Internet is packet-switched. Circuit-switched voice connections occupy a full circuit, but only for a short duration. Internet connections, however, last for much longer durations, but utilisation is very bursty. When such a connection is made over the circuit-switched PSTN, the advantage of bursty traffic cannot be exploited. Yet, the circuit-switched telephone network is the only available access at homes and offices. The Internet cannot avoid this network, especially when millions of connections are to be made.

RAS equipment is co-located with the local exchange (or even RLUs or RTs of a Fibre Access Network, as we will show later) and connected to it using standard El interfaces. A subscriber desiring an Internet connection, dials up the RAS and sets up a circuit-switched local call, as shown in Fig. 1. The call uses only the local exchange port of the PSTN. These exchanges today have very little blocking and can therefore handle the much longer holding-times (and therefore, higher Erlang traffic) of an Internet call When several subscribers set up Internet calls to the RAS, the RAS multiplexes the bursty data from all these subscribers, and routes the data to the ISP using one or more 64 kbps channels. The 64 kbps connections between the RAS and ISP router could be leased or on dial-up basis, and as shown in Fig.3, the calls take the RAS-Exchange-PSTN-ISP route.

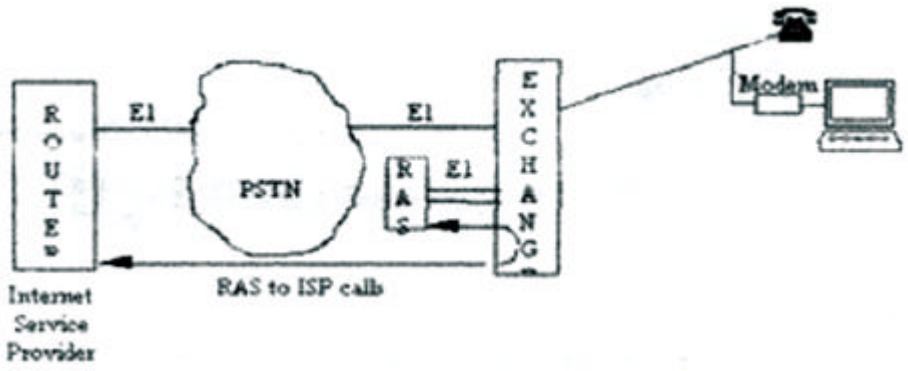

Fig. 1. Remote Access Switch

The call charges can now be low as only intra-exchange calls are being made for such access. The number of connections between the RAS and ISP are now small, and utilise only the reliable digital trunks. No modems are required at either end. Further, multiple subscribers are now being served on each 64 kbps link between a RAS and ISP. Assuming that upto 10 Internet connections use one 64 kbps slot, a single El link (consisting of thirty 64 kbps slots) to router could serve 300 Internet calls. The RAS, while providing an attractive solution to Internet tangle, contributes to a very low per-line cost.

2.2 corDECT Wireiess Access Network

In the mid-nineties, as the cost of the backbone network and switch core reduced substantially, the emphasis shifted to access technologies. Wireless access was and continues to be the most talked about. However, the key to the successful large-scale deployment of Wireless in Local Loop System in India is the right choice of technology. It is important that the wireless solution chosen has a final deployed cost comparable to and preferably even lower than that of the wired solution. Yet, wireline voice quality and data communications at upwards of 28.8 kbps are required. Further, the system must support subscriber density as high as 5,000 per sq. km. A study of available international wireless standards reveals that the choice narrows down to PCS standards such as DECT, PHS and PACS. These standards can be implemented at low cost, and provide wireline quality, high subscriber density, and high data rate, but have small radio range. While microcellular solutions based on these standards are suitable for dense urban areas, one needs to find *innovative deployment strategies* in other cases, so as to cover a wide area.

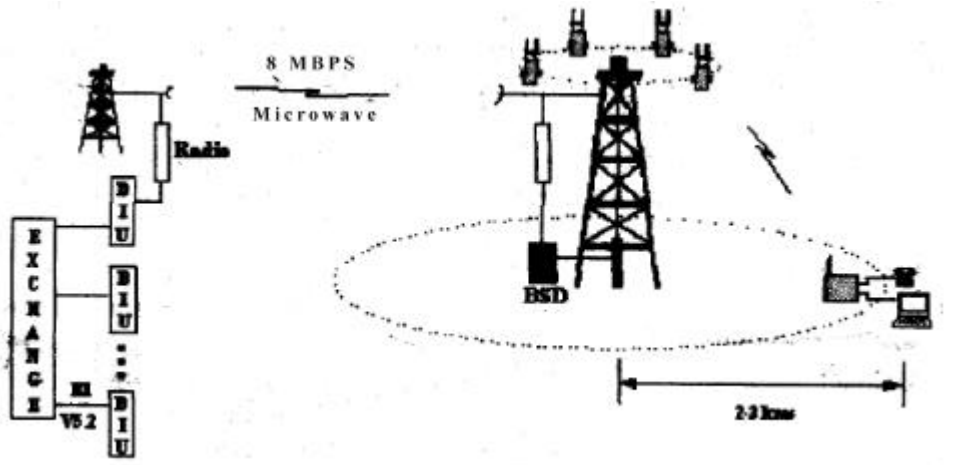

Fig. No.2. corDECT Wireless Access Network

The Telecommunications and Computer Networking (TeNeT) Group at the Indian Institute of Technology Madras (ITTM), located at Chennai, has been playing a key role in defining and developing access technologies suitable for India. Along with Midas Communication Technologies (Pvt) Ltd., Chennai, and in partnership with Analog Devices, USA, for IC development, HIM took up the development of a DECT-based Wireless in Local Loop system.

The system, referred to as corDECT, has an interesting architecture, especially for its fixed part. The fixed part consists of a DECT Interface Unit (DIU) acting as a 1000-line wireless switching unit providing a V5.2 interface towards the main exchange. It also consists of weather-proof Compact Base Stations (CBS) connected to the DIU either on three pairs of copper wire carrying signal as well as power, or onfibre/radio using El links through a Base Station Distributor (BSD). The DIU, CBS and BSD are built primarily using Digital SignalProcessors('(DSP)* with the DIU having nearly 100 DSP ICs. This soft solution, while cutting down the development time, also ensures that the cost of the fixed part is no more than 15% of the total per-line

cost in a fully loaded corDECT system. This, in turn, allows deployment flexibility, and cost-effective solutions can be found for dense urban areas as well as sparse rural areas For example, a new operator who wishes to initially deploy 5000 lines in a mid-sized town/city in the very first year, would use the deployment scenario as shown in Fig.2. Allthe DIUs are co-located with the main exchange and connected to it using the V5.2/E1 interface. Each DIU is connected to a BSD located on a roof-top at a suitable part of the town using a point-to-point 8 Mbps microwave link. At the BSD site, about 12-15 CBS (each serving 50-70 subscribers at 01Erlangs each), along with the micro-wave equipment, are mounted on a 15m roof4op tower to serve an area of 2-3 kms. The subscriber terminal is a wallset (WS), with either a built-in antenna, or a roof-top antenna providing a line-of-sight link to a CBS. The WS has an interface for a standard telephone (or fax machine, modem or payphone) and RS232/V.35 interface for a computer, enabling Internet connection at 28.8/64 kbps. No modem is required as both the wireless link from the WS to the CBS, and the link from the CBS to the DIU, are digital. Digital data is thus routed all the way from the WS to the ISP.

This deployment scenario of 5000 lines Uses no cables and can be made operational in 2 to 3 months. What is particularly attractive is that the total deployed cost of the corDECT Wireless Access Network works out to Rs. 14,000 per subscriber. Even if the system is not folly loaded to begin with, the cost per line does not increase significantly, since the cost of the fixed part is a small percentage of the total cost.

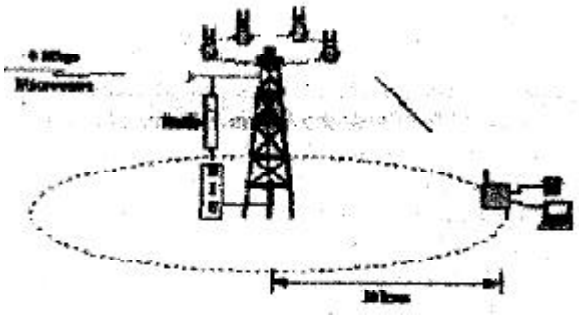

Fig. No.3 CorDECT Wireless Network (for 10 Ions)

In later years, the operator can choose to increase the number of lines to a much larger number, using an optical fibre grid for connecting DIUs to BSDs. The total deployed per-line cost does not alter significantly.

The corDEGT system also offers an excellent deployment opportunity for a small town and its surrounding rural areas. To serve about 1000 subscribers in a small town, an operator needs a tower (about 35m high), somewhere in the town centre. The DIU is located at the tower-base and the base-stations are on the tower. The DIU is connected to the main exchange located upto 30 Ions away using a 8 Mbps microwave link (typically in the 2 GHz frequency band). The base-stations now serve subscribers within a radius of 10 kms using wallsets with roof-top antenna providing line-of-sight links, as shown in Fig.3. The subscriber density served could be as low as 3 subscribers per sq. km, and once again the total deployment cost of the accedd solution works out to Rs 14,000 per line. Internet connectivity at 28.8/64 kbps can be provided to each subscriber at no additional cost.

Deployment in sparser rural areas is possible using the corDECT Relay Base Station (RBS). The solution provides deployment with subscriber density as low as 0.5 subscriber per sq. km at a total cost of Rs. 18,000 per line. A two-hop DECT link is used to provide connection to the subscriber. One link is between WS and

RBS, whereas the other link is between RBS and CBS. Both RBS and CBS use high-gain directional antennas, and are mounted on towers, making a 25 km link possible. The 5 km maximum link distance due to the guard-time limitation of DECT is overcome by use of auto-ranging and timing adjustment. This technique is used in the RBS to support a 25 km link, and to enhance the CBS range to 10 km.

Finally, efficient transmission of packet-switched data on a circuit-switched network is being ensured by the corDECT system, by codeploying a RAS with DIU. Data calls over corDECT are handled differently at DIU from voice calls. The DIU directs an Internet data call from a wallset to the RAS on one 64 kbps slot of the El interconnection. The RAS concentrates Interact data from different subscribers and sends them on one or more shared 64 kbps channels set up between RAS and ISP, via DIU and PSTN.

Here, an Internet call from WS does not enter the PSTN at all. Only themultiplexed data on the few shared 64 kbps channels traverses through the PSTN. The data "calls" from WS to RAS terminate in the Access Network itself.

2.3 Fibre Access Network

The TeNeT group of ITEM along with Vembu Systems (Pvt.) Ltd , Chennai, and Midas Communication Technologies {Pvt.) Ltd., Chennai, has also taken up the development of a cost-effective Fibre Access Network Designed in accordance with the scheme discussed above, the Fibre Access Network again uses a new[7] approach with an aim to provide, apart from the conventional POTS sen ice, large-scale Internet connectivity at a cost affordable in India. As shown in Fig.4, the N-ISDN and HDSL physical layers are exploited in the short copper loop between the RT and subscribers These relatively high-speed digital links carry both voice and data. The digitised voice signals are directed by the Access Server (AS) towards the RT and then to the Main Exchange. However, the Internet data is separated and passed on to a built-in RAS. After concentrating the Internet data from multiple subscribers, the RAS feeds it to the ISP, via the FAN and PSTN, either on leased lines or on dial-up circuit-switched lines. The subscriber terminal provides multiple telephone sockets and an etliernet interface The result is one of themost cost-effective means of providing medium and high-speed permanent Internet connections on a wide scale.

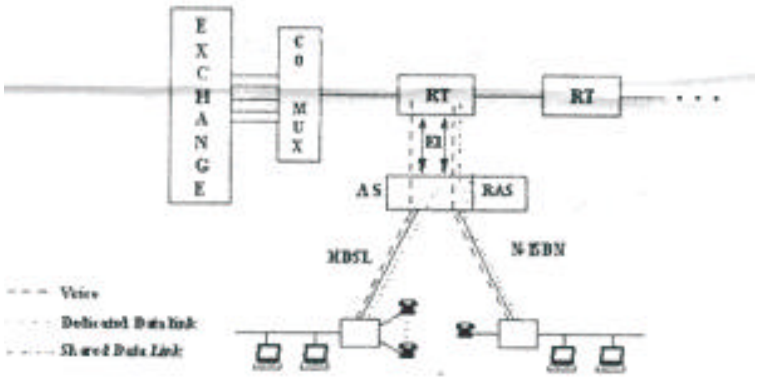

Fig. No.5. Fibre Access Network

Today, the cost of providing Plain Old Telephone Service (POTS) using this FAN is around Rs.9,000 per line. Further, the high-speed permanent Internet Connection costs an additional Rs 8,000.

3. Internet and Management products

The TeNeT Group of 1ITM along with Banyan Networks (Pvt) Ltd., Chennai, is in the process of developing a whole range of Remote Access Switches and Access Servers, including those tailor-made for the corDECT Wireless Access System, and the Fibre Access Network as described above. It is also developing a RAS with built-in digital modems to provide Internet connectivity to existing POTS (Plain Old Telephone Service) subscribers. In all the products, emphasis is on low cost while maintaining high functionality. The additional cost of the RAS amounts to no more than Rs.600 per Internet subscriber.

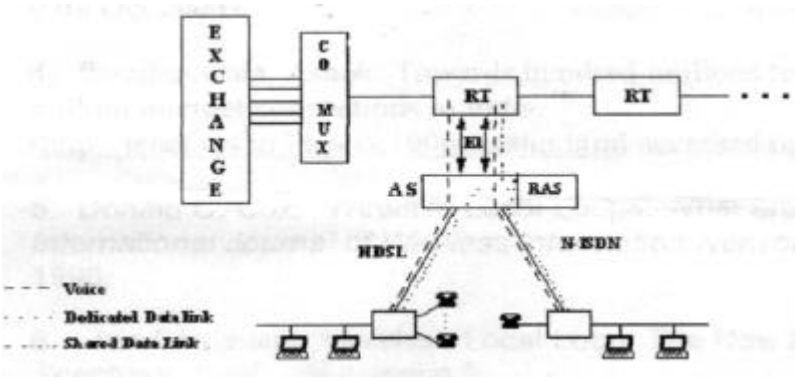

Fig. No.6. Remote Access Switch and Access Servers for Management

Network Management System (NMS) software is today being developed in India by a large number of telecom and computer networking software companies. The capability exists for developing a complex NMS for a large integrated network. Similarly, a number of Indian companies are now developing customer-care and billing systems for clients world-wide.

4. Conclusion

In India, digital Libraries are working only urban areas. In other words, due to networking barriers, till now digital libraries are searched and used by only urban people. This is so because there poor and uneconomical networking facilities in rural areas. The networking facilities in rural area is also costly.

Digital libraries will be successful, only if they will be accessed by all kinds of people both in rural and urban India. For this purpose, the networking technology specified above, are a major revolutionary change in accessing Internet and Digital libraries. These technologies also proved to be economical.

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About Authors

Ms. Mamata P K is working as Assistant Librarian in P.G. Center, Bellary of Gulbarga University, Gulbarga since 1999. She did her MLIS(1998); MCom(2002) from Karnatak University, Dharwad. She has contributed 5 research articles in journals.
Email : kumbargoudar@rediffmail.com

Dr. G. Gopal Reddy is working as Librarian at Rashtriya Sanskrit Vidyapeetha, Tirupati, Andhra Pradesh. He has presented number of papers in seminar, conferences and journals. He is also a member of many professional bodies.

Mr. Praveen Kumar Kumbargoudar, is working as Assistant Librarian in P.G. Center, Nandihalli(Sandur) of Gulbarga University, Gulbarga since 1999. He did his MLIS(1994) from Karnatak University, Dharwad. He is doing research in Department of Library & Information Science from Kuvempu University, Shimoga. He has contributed 6 research articles in journals.
Email : kumbargoudar@yahoo.com