

Implementation of DSL in Pakistan-Growth, Potential and Bandwidth Impact - A Technical Report

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ABSTRACT

The wide spread use of Internet and specially the WWW (World Wide Web) have opened a need for greater bandwidth network services that can be brought directly to subscriber's homes. These services will provide the required bandwidth to surf the Web at faster speed.

This paper critically analyses DSL (Digital Subscriber Line), as the future technology that not only can sort out all the speed and disconnection problems, but also helps to access Data and Voice over same connection simultaneously. In addition, this paper also provides some recommendations to those companies, which are offering DSL service in Pakistan, in order to increase the browsing capabilities by implementing the DSL network in every city of Pakistan. Though DSL has already being implemented in Pakistan, but still lot more need to be done in this regard, because 7.5 million DSL lines were installed by 2003-generating \$6.2 billion-turn over for the USA DSL market alone.

Key Words: Digital Subscriber Line, Splitter, Digital Subscriber Line Access Multiplexer, Integrated Service Digital Network, Discrete Multi Tone, Carrierless Amplitude Phase.

1. INTRODUCTION

Traditionally, large corporations or government departments use broadband network services. They used to avail these services by means of ISDN (Integrated Service Digital Network) or high speed E1 or E3 lines. However, with the advancement in information technology, a number of high technology services are becoming wide spread. Although, general consumers still do not have direct access to high-speed networks but several service providers are delivering less costly and high-speed services to the general consumers.

They are using the cable technology for this purpose. In addition to this, some new entrants in the market are also offering more advanced services to the general consumer such as the DSL.

DSL is an emerging modern technology that converts existing twisted pair telephone lines into access path for high-speed communication of various sorts. Fig. 1 illustrates how ADSL (Asymmetric Digital Subscriber Line) (one of the flavor of DSL technology) modems attached

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to standard telephone wiring in parallel with existing along telephone equipment. Because the service is asymmetric, the modems used at the two ends of a line differ slightly.

DSL technology offers bandwidth ranging from 64 Kbps to 6 Mbps on telephone subscriber's existing phone line. With DSL, one can stop worrying about "busy" signals or waiting to be connected to the Internet. No more "dropped connections" or frustrating disconnects since you are ALWAYS ON! Never "hang up" the phone again to use the Internet. You can use the same phone line for making calls while you are simultaneously connected to the Internet. Then there is unlimited downloads on a flat, monthly rate. It gives you 24 hours connectivity.

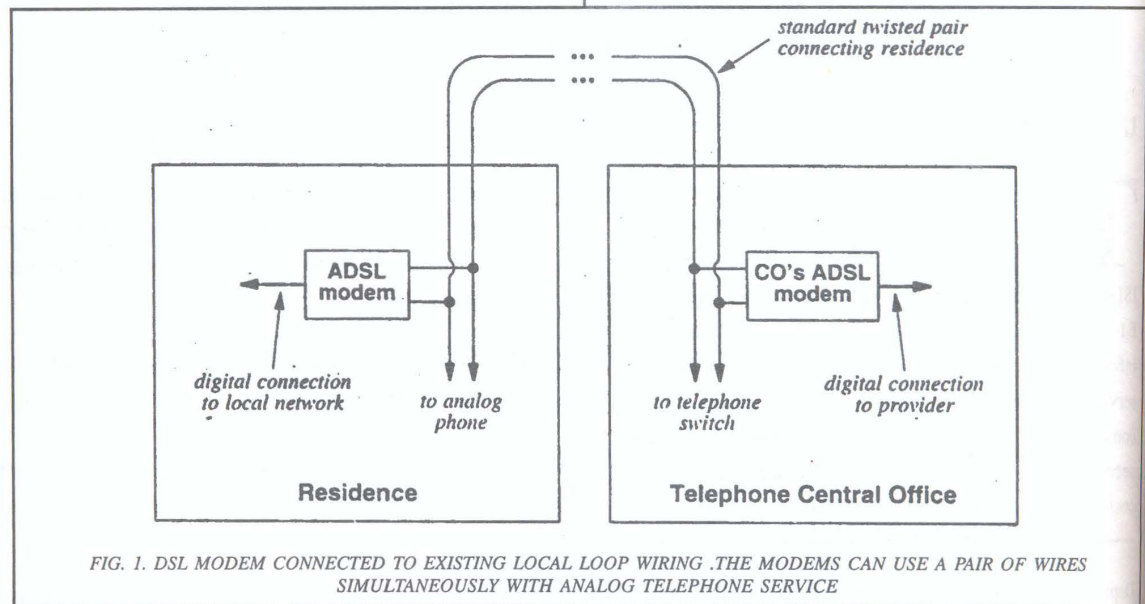
2. WORKING PRINCIPLE

Conventional modems (i.e. voice grade base band modems) transmit signals through the switching network without alteration; the network treats them like voice signals. The data rates achieved by these modems are now approaching a theoretical maximum, but copper wire can pass much higher frequencies and subsequently allow much greater data rates. The DSL technologies utilize this available

bandwidth and attain greater data rates by taking advantage of breakthroughs in error correction coding, modulation, equalization, echo cancellation, and digital signal processing.

Unlike its acronym it doesn't really refer to a line, but the modem that convert a line into a high-speed digital pipe. The modem technology converts the copper twisted-pair telephone lines in the existing telephony system just before it enters your home, into access paths for multimedia and high-speed communication. It works over regular phone lines that are already present and provide a high-speed access to the Internet and remote networks. ADSL transmits more than 6Mbps downstream (to the customer) and up to 640 Kbps upstream, depending upon line length and the modem capabilities [1]. Upstream is the data that is transmitted from the user e.g. URL (Uniform Resource Locator), E-mail etc and down stream is the data that is bombarded in return like movie on demand web page etc. [2].

DSL is a technology for bringing high bandwidth connectivity to homes and businesses over ordinary copper telephone lines. DSL line allows for one line to carry both voice and data signals and for the data part of the line to be continuously connected. DSL achieves



higher data transfer rates by utilizing more of the available bandwidth spectrum. Ordinary telephone service only makes use of the 3400 Hz frequency range, which accounts for the 56 Kbps speed limits on standard analog modems. DSL eludes the 3400 Hz frequency boundary by outmoding the digital-to-analog conversion the modems perform and connecting both ends digitally. Hence, larger bandwidth is available, allowing higher transfer rates [3].

Traditional phone service connects your home or business to a telephone company office over copper wires that are wrapped around each other. The wires are called twisted pair. The digital modem, located at your location, accesses the local telephone companies' central office, where a DSLAM (Digital Subscriber Line Access Multiplexer), which translates your DSL signal, has been installed. The signal is then transmitted from the copper telephone line onto a network backbone, and directed to the ISPs (Internet Service Providers) location, where the ISP verifies the access to the network and delivers users to the Internet through the ISP's relationship with a backbone network provider [4] as shown in Fig. 2.

A DSL router or modem is installed at user's premises connected through a POTS (Plain Old Telephony System) splitter to user's Ethernet hub or USB (Universal Serial Bus) port of your PC. Once installed, the DSL router/modem facilitates continuous connectivity to the Internet and use of the telephone/fax at the same time.

For getting the DSL connection, the customer is provided with ADSL modem, a Splitter and a network card for their Personal Computer. The Splitter is a low pass filter splitting the phone line into two frequency ranges. Low frequencies are reserved for regular telephone calls (voice), while higher frequencies are used for Internet (data), making it possible to use the phone line for both telephone calls and for Internet access [5].

There are two competing and incompatible standards for ADSL. The official ANSI (American National Standard Inter change) standard for ADSL is a system called DMT (Discrete Multitone). According to equipment manufacturers, most of the ADSL equipment installed today uses DMT. An earlier and more easily implemented standard was the CAP (Carrierless Amplitude Phase) system, which was used on many of the early installations of ADSL.

CAP operates by dividing the signals on the telephone line into three distinct bands: Voice conversations are carried in the 0 to 4 KHz (kilohertz) band, as they are in all POTS circuits. The upstream channel (from the user back to the server) is carried in a band between 25 and 160 KHz. The downstream channel (from the server to the user) begins at 240 KHz and goes up to a point that varies depending on a number of conditions (line length, line noise, number of users in a particular telephone company switch) but has a maximum of about 1.5 MHz (megahertz).

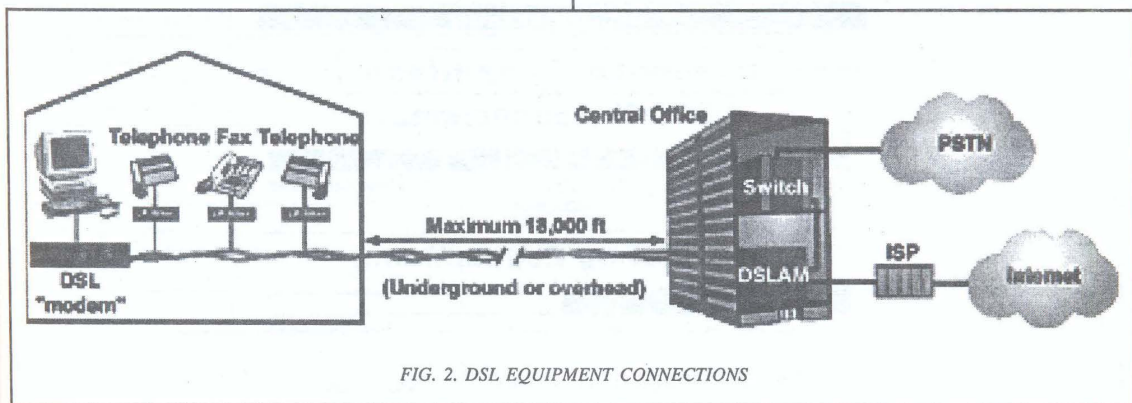


FIG. 2. DSL EQUIPMENT CONNECTIONS

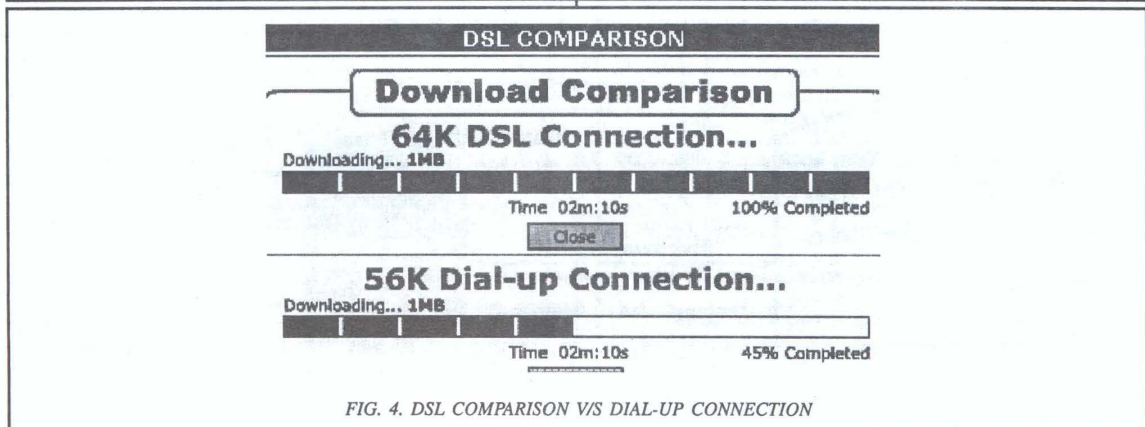
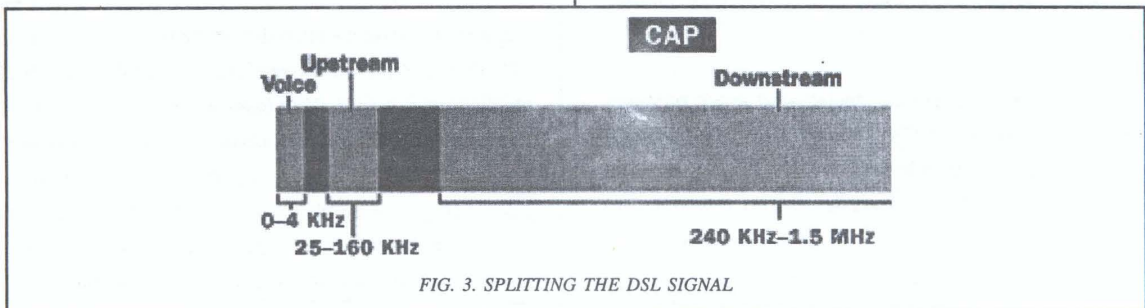
This system, with the three channels widely separated, minimizes the possibility of interference between the channels on one line, or between the signals on different lines as shown in Fig. 3.

To create multiple channels, ADSL modems divide the available bandwidth of a telephone line in one of two ways--FDM (Frequency-Division Multiplexing) or echo cancellation. FDM assigns one band for upstream data and another band for downstream data. The downstream path is then divided by time-division multiplexing into one or more high-speed channels and one or more low-speed channels. The upstream path is also multiplexed into corresponding low-speed channels. Echo cancellation assigns the upstream band to overlap the downstream, and separates the two by means of local echo cancellation, a technique well known in V.32 and V.34 modems. With either technique, ADSL splits off a 4 kHz region for basic telephone service at the DC end of the band.

DSL modem organizes the aggregate data stream created by multiplexing downstream channels, duplex channels, and maintenance channels together into blocks, and attaches an error correction code to each block. The receiver then corrects errors that occur during transmission up to the limits implied by the code and the block length. The unit may, at the user's option, also create superblocks by interleaving data within subblocks; this allows the receiver to correct any combination of errors within a specific span of bits. This in turn allows for effective transmission of both data and video signals [6].

3. SCOPE OF DSL

DSL is much faster than both ISDN and leased line, yet is more cost effective. With DSL Internet connection is 'always on', and the users have unlimited access to Internet. DSL makes downloading speed ten times faster than that of an analogue modem as shown in Fig. 4. "In addition, it enables single line users to remain connected to both telephone and the Internet at the same time".



3.1 Speed Comparison

If you're looking for more speed out of the Internet, then DSL is the best solution for you. You can download a 2.5MB file in just under 3 min. and browse through 25 web pages in about 13 sec. [7]. The speed comparison from analog to digital is shown in Table 1.

3.2 Factors Affecting the Experienced Data Rate

DSL modems follow the data rate multiples established by North American and European standards. In general, the maximum range for DSL without a repeater is 5.5 km (18,000 feet). As distance decreases toward the telephone company office, the data rate increases. Another factor is the gauge of the copper wire. The heavier 24-gauge wire carries the same data rate farther than 26-gauge wire (Table 2).

4. DSL GROWTH POTENTIAL

More new DSL subscribers were signed up globally in the first quarter of 2003 than in any previous quarter, 5.5 million lines were added around the world, bringing the total to 41.4 million, according to market research firm Point Topic Limited [8].

Japan experienced the greatest growth, adding 1.4 million DSL subscribers in the first quarter, giving it 7 million in total. This puts Japan at the top of the world DSL league table, a fraction ahead of the U.S., with South Korea not far behind (Fig. 5). China showed the second-highest aggregate growth, adding 680,000 lines for a total of nearly 3 million.

Up to the end of second quarter of the year 2003, there were 46.7 million DSL subscribers around the world, 10.7 million of whom signed up during the first six months of 2003, according to the DSL Forum and broadband research house Point Topic Ltd. More than 75% of that growth was added by just seven countries (Table 3).

Table 4 provides DSL and Phone lines Penetration rate of Top 20 countries around the world at the end of the first quarter of 2003.

5. INTERNATIONAL DSL PRICES

DSL prices are reducing tremendously in worldwide. Table 5 shows the price of DSL in USA for year 2003.

TABLE 1. SPEED COMPARISON FROM ANALOG TO DIGITAL

TYPE OF DATA	FILE LENGTH	28.8Kbps MODEM	DSL-384 Kbps	DSL-1.5Mbps
Browsing the Net-25 web pages with text and graphics	2.5Mb	12 Minutes	52 Seconds	13 Seconds
A 20 -second Video	8Mb	37 Minutes	2 ¾ Minutes	43 Seconds
Download entire Netscape 4.0 or Internet Explorer 4.0 browser software	25Mb	120 Minutes	8 2/3 Minutes	2 1/5 Minutes

TABLE 2. CLAIMED DSL PHYSICAL-MEDIA PERFORMANCE

Data Rate (Mbps)	Wire Gauge (AWG)	Distance (Feet)	Wire Size (mm)	Distance (Kilometers)
1.5 or 2	24	18,000	0.5	5.5
1.5 or 2	26	15,000	0.4	4.6
6.1	24	12,000	0.5	3.7
6.1	26	9,000	0.4	2.7

6. DSL IN PAKISTAN

In keeping with the pace of development in Information Technology and Telecommunication around the world, the state telecom, PTCL (Pakistan Telecommunication Company Limited), has been taking initiatives to modernize its network and introduce as many new services and solutions as possible. In this connection, one of the initiatives taken in January 2002 has yielded results through launch of Project for DSL in collaboration with the private sector. This new Project, providing both narrow and broad

services is operative enabling Pakistan to join the countries providing broadband access to their customers.

To achieve this, PTCL has signed O&M Contracts with four private sector operators namely Habib Rafiq International, Micronet Broadband, Multinet Broadband and Sysnet Pakistan to deploy countrywide DSL networks. First such service from Islamabad is being inaugurated by the Minister for Science & Technology on 9th July, 2002. To support national and international transport of high-speed services, PTCL has already established a high speed

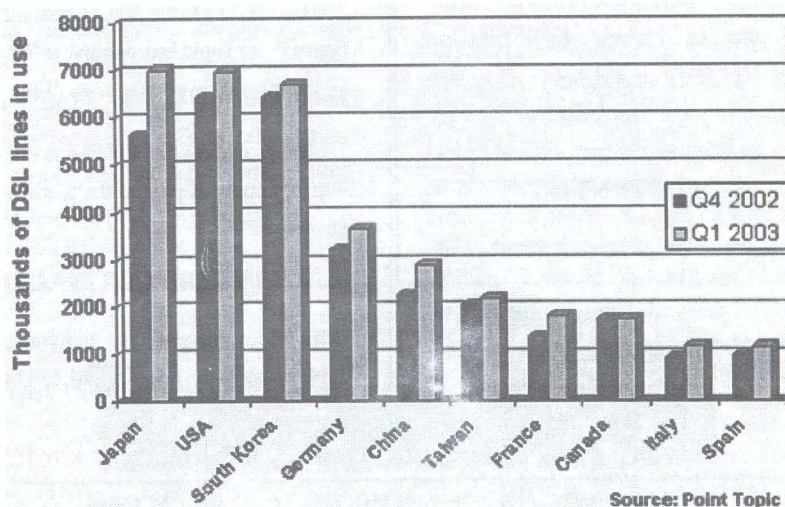


FIG. 5. TOP TEN DSL COUNTRIES BY NUMBER OF LINES

TABLE 3. DSL GROWTH IN Q1 2003-(7 COUNTRIES ADD MORE THAN 500,000)

Country	Total DSL Subscribers* (Million)	Additions During First 6 Months of 2003 (Million)
Japan	8.257	2.617
China	4.100	1.88
US	7.576	1.125
France	2.039	0.673
Germany	3.865	0.655
Italy	1.435	0.525
UK	1.072	0.520
*Figures as of 30th June, 2003 Source: DSL Forum and Point Topic Ltd.		

IP backbone in the country on SMW-3 and arranged large international IP bandwidth. By the launch of DSL service in partnership with private sector, Pakistan will be in the leagues of nations offering state-of-the-art broadband solutions. The Operators of Hybrid Fiber Coaxial, Wireless & Satellite offering broadband services are also in full swing.

In Pakistan MBL (Micronet Broadband (Pvt.) Limited) was the first service provider that has launched DSL services in Pakistan in collaboration with PTCL on 10th July, 2002, which offers high-speed integrated access to data, Internet, and many other exciting services.

6.1. Implementing the DSL in Pakistan

Developed countries may have numerous ways of making Internet connections swifter; some boldly imaginative web commentators can even see power lines being employed for Internet connections. Pakistan, though, has two major and feasible options. These are the use of the DSL and the cable television network all over the country. For over 2 millions Internet users in Pakistan, browsing the web is no ordinary feat. It requires, among other things, tons of patience and perseverance. No matter what Internet browser you are using, or whatever equipment (modem, computer), you have to wait for an eternity, at times much to your chagrin, only to see an obnoxious sign proclaiming "Web page unavailable".

TABLE 4. DSL PENETRATION OF PHONE LINES - TOP 20 COUNTRIES

Country	DSL Penetration (%)	DSL Subscription on 30th June, 2003 (Thousands)	Total Phone Lines (Millions)
South Korea	29.7	6,811	22.93
Taiwan	16.54	2,142	12.95
Hong Kong	16.08	629	3.91
Japan	15.54	8,257	53.14
Belgium	12.65	644	5.09
Denmark	11.5	378	3.29
Iceland	10.47	20	0.19
Israel	10.42	325	3.12
Singapore	9.84	192	1.95
Germany	9.5	3,865	40.67
Finland	9.29	259	2.79
Canada	9.14	1,868	20.43
Sweden	8.13	484	5.96
Norway	8.13	188	2.31
Switzerland	7.75	317	4.09
Estonia	7.53	38	0.50
Spain	7.32	1,301	17.77
France	5.99	2,039	34.03
Italy	5.86	1,435	24.49
Netherlands	5.43	543	9.99

SOURCE: DSL FORUM AND POINT TOPIC LTD.

Broadly speaking three factors affect the speed of an Internet connection. Firstly, the number of subscribers online with an ISP (Internet Service Provider) determines the speed of an Internet connection. The more is, unfortunately, not the merrier. An efficient ISP maximizes the number of subscribers without compromising on the speed. If it offers reliable connections, it may get away with charging a little more than what other sloppy ISPs are charging.

If an ISP has acquired, say, 100 telephone lines from the PTCL, how many subscribers should it have? "On 100 telephone connections, 1,000 subscribers may get average speed, 800 fast speed and 1,200 slow speed".

Secondly, the speed of an Internet connection depends on bandwidth quality: "The PTCL offers 2MB bandwidth to ISPs at three monthly rates: \$30,000 (marine cables), \$40,000 (satellite) and \$8,000 (shared access). The costlier, the better". When ISPs choose the shared access option, one 2MB pipe offered by PTCL may be shared by four ISPs, with each ISP theoretically allowed to utilize only one quarter of the bandwidth.

Thirdly, the speed of an Internet connection depends on the computer set employed by an end-user. If user's modem (modulator/demodulator) is faulty or if user's set has networking problems with a large number of undeleted files, he will certainly have a hard time browsing the net. The solution of all these problems is DSL.

As, Firstly, DSL technology allows consumers to access the Internet at much higher speeds than the widely used ISDN. In other words, telephone lines that an ISP acquires from the PTCL have, at present, a certain data-carrying capacity. DSL technology enhances that capacity in a big way. It is heartening to note that the PTCL plans to espouse this technology.

The PTCL is fast realizing the importance of coaxial cables. In western countries, the coaxial cable can serve three purposes at the same instant: it can carry data (Internet), Video (TV Channels), and voice (phone). The advantage of acquiring an Internet connection over a coaxial cable is that it keeps your telephone unengaged, thus keeping your telephone bill within limits.

TABLE 5. DSL PRICES FOR U.S.A FOR THE YEAR 2003

Type	Down Load and Up Load Speed	Bandwidth Included	USA Monthly Price
Residential	384Kbps/128Kbps	N/A	\$55
Residential	608Kbps/128Kbps	20Kbps	\$75
Residential	1.5Mbps/128Kbps	25Kbps	\$100
Residential	1.5Mbps/384Kbps	50Kbps	\$120
Residential	3.0Mbps/384Kbps	80Kbps	\$225
Business	144Kbps/144Kbps	50Kbps	\$170
Business	192Kbps/192Kbps	55Kbps	\$175
Business	384Kbps/384Kbps	80Kbps	\$220
Business	768Kbps/768Kbps	100Kbps	\$275
Business	1.1Mbps/1.1Mbps	120Kbps	\$345
Business	1.5Mbps/384Kbps	90Kbps	\$225
Business	3.0Mbps/384Kbps	120Kbps	\$375
T 1	384Kbps/384Kbps	150Kbps	\$450
T 1	768Kbps/768Kbps	170Kbps	\$600
T 1	1.5Mbps/1.5Mbps	200Kbps	\$750

In the final analysis, the magnitude of success that Pakistan makes in the IT sector will depend on the number of households, which have cable television connections. In India, 30 million households have Cable Television connections, while its National Association of Software and Service Companies estimates that there are 4.8 million Internet users in the country [9]. In Pakistan, even the PEMRA (Pakistan Electronic Media Regulatory Authority) has no clue how many people have cable television connections. Normally Cable operators try to conceal the number of subscribers they serve because PEMRA charges are in proportion to the number of subscribers. Under the Class H (B-1) licence type, if a cable television operator serves Rs. 1,000/- end-users, he has to pay Rs. 50,00/- licence issue fee and Rs. 25,000/- annual fee. If he serves Rs. 5,000/- end-users, he has to pay Rs. 100,000/- licence issue fee and Rs. 50,000/- annual fee.

According to recent research (July, 2004) from PTA (Pakistan Telecommunication Authority), in Pakistan there are two types of DSL operators (a) who are providing DSL service through O&M agreement with PTCL; and (b) who have signed interconnect agreement with PTCL. Currently

there are 2.573 millions Internet subscribers out of home 2852 subscribers are using DSL services in the country. The study was conducted in nine (9) major cities of Pakistan, which includes Karachi, Hyderabad, Lahore, Islamabad, Rawalpindi, Faisalabad, Peshawar, Sialkot, and Quetta. Currently there are five DSL operators in Pakistan.

The existing coverage of DSL operators in Pakistan is shown in Fig. 6.

Table 6 shows the total number of exchanges and cities covered by each DSL operator in Pakistan.

According to the research up to the July, 2004, the numbers of customers using DSL service of a particular company is shown in Table 7.

According to number of customers utilizing the DSL service the market share of the each DSL operator in Pakistan, as per study, is as under (Fig. 7).

Keeping these facts and figures we can analyze the factors, which are hampering DSL market in Pakistan. The following are the major impediments in the development of the DSL market in Pakistan. These are namely:

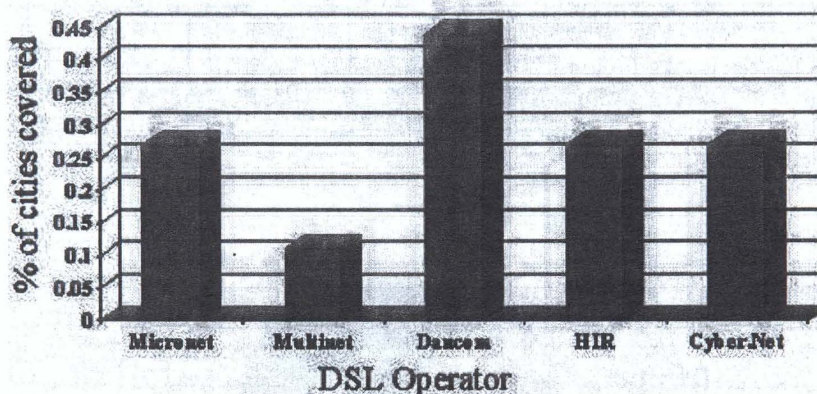


FIG. 6. CITIES WISE COVERAGE OF DSL OPERATORS (OUT OF TOTAL 1819 INTERNET CITIES)
SOURCE: PAKISTAN TELECOMMUNICATION AUTHORITY (<http://www.pta.gov.pk>)

TABLE 6. TOTAL NUMBER OF EXCHANGES AND CITIES COVERED BY EACH OPERATOR

Cities	Micronet	Multinet	HRI	Dancom	Cyber.Net
Total exchanges	32	37	22	27	33
Cities covered	5	2	5	8	5

Source: Pakistan Telecommunication Authority

The coverage of existing five DSL operators is too low (only 9 out of total prospective 1819 cities are being covered at the moment).

Very limited choice is available for both existing and prospective DSL users to select their operator.

Lack of competition in DSL market has resulted in high prices and service with low or no consideration toward quality of service.

In the most cases DSL operators are providing the services with a redundancy-less connectivity -locally and internationally, which adds to the non-availability of the services to the end user.

Most of operators have acquired insufficient Bandwidth and international connectivity despite the fact the cost for the same has been reduced considerably over the past few years [10].

6.2. DSL prices in Pakistan

Prices for DSL in Pakistan vary from one service provider to another. Table 8 shows the price package that the Micronet Broadband (Pvt) Ltd is offering in Pakistan. This package is for customers with limited Internet access requirement; with reasonable uploads/downloads e.g. Individuals, small and medium size businesses.

In Pakistan Multinet Broadband has started DSL service in the some parts of Karachi [11]. Its DSL Broadband shared service from Rs. 7,500/month for 128Kbps (ADSL/SDSL), 256Kbps (ADSL/SDSL) Rs. 14, 000/month and Rs. 26,000/month for 512 Kbps (ADSL/SDSL), apart from these packages their requirements are as follows. One time installation cost is Rs. 5,000/, customer is required to purchase a DSL modem, and estimated cost for DSL modem is Rs. 9,000/.

TABLE 7. NUMER OF CUSTOMERS UTILIZING THE DSL SERVICE IN PAKISTAN

Month	Number of Customers					
	Micronet	Multinet	Dancom	HIR	Cyber.Net	Total
July 2004	1069	950	400	200	233	2852

SOURCE: PAKISTAN TELECOMMUNICATION AUTHORITY

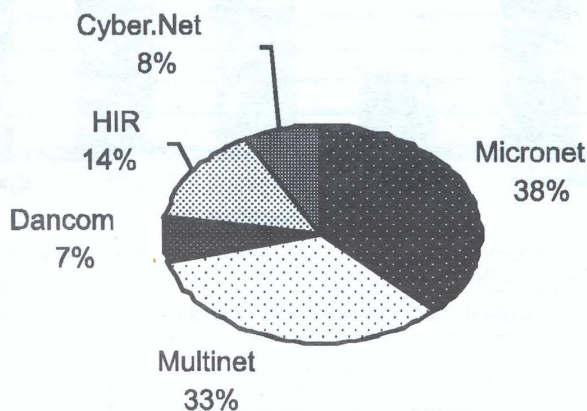


FIG. 7. MARKET SHARE OF EACH DSL OPERATOR
SOURCE: PAKISTAN TELECOMMUNICATION AUTHORITY

7. DSL DOMINATES THE WORLD BROADBAND GROWTH

The broadband market continued the strong momentum it displayed in 2003, adding a record 12.2m lines in the first quarter of 2004, to reach a worldwide total of 111.7m lines by 31 March 2004. DSL remained the main driver of growth, with worldwide lines reaching 73.5m, compared to 38.2m for cable modems and other technologies.

The entire world's biggest or "G7" economies are now in the broadband 'top ten'. They collectively added a massive 10.1m lines, which makes up 80% of the total broadband lines added in Q1 2004 [8, 12]. This continues the general trend of high growth set in 2003 by these countries, and shows the increasing popularity of broadband in general amongst mainstream Internet users.

USA remains the world's largest broadband market, now with over 27.4m broadband lines. China is in second place (overtaking Japan) and is gaining ground on USA with 15.1m lines.

Looking at the DSL and cable modem markets separately, China is the clear leader in DSL with almost 14m lines at

the end of March 2004. It overtook Japan towards the end of 2003, and is now consolidating its lead as the world's largest market for DSL.

In contrast USA remains the leading market for cable modems with almost 17m subscriptions by the end of March 2004. South Korea and Japan continue to lag behind in distant second and third place, approaching 5m and 4m lines respectively.

Comparatively, DSL remains the leading broadband technology with a 65.8% share of the world's mass-market subscribers. The remainder of the market is made up of cable modems and other technologies such as fiber, satellite and fixed wireless access.

8. CONCLUSIONS

The increasing availability of new and diverse technology is helping DSL to take a commanding lead in the global broadband access market. With more than half of the world's broadband subscribers now using one variation of the technology or another and the DSL Forum claiming to be on target for global subscriber numbers to reach 250 million over the next two years.

TABLE 8. THE PRICE PACKAGES THAT MICRONET BROADBAND (PVT) LTD IS OFFERING IN PAKISTAN

DSL Connect - Unlimited Time, Limited Usage Validity: 30 Days						
Package	Traffic Allowed Per Month (Data Upload + Download)	Connectivity				Rate Per Additional 100 MB
		64 K	128 K	256 K	512 K	
DSL Connect 2	2 GB	Rs. 3,600/-	Rs. 3,600/-	-	-	Rs. 145/-
DSL Connect 4	4 GB	Rs. 6,480/-	Rs. 6,480/-	-	-	Rs. 135/-
DSL Connect 6	6 GB	-	Rs. 8,995/-	-	-	Rs. 130/-
DSL Connect 8	8 GB	Rs. 11,610/-	Rs. 11,610/-	-	-	Rs. 126/-
DSL Connect 12	12 GB	Rs. 15,480/-	Rs. 15,480/-	Rs. 15,480/-	-	Rs. 117/-
DSL Connect 24	24 GB	-	Rs. 29,070/-	Rs. 29,070/-	-	Rs. 108/-
DSL Connect 48	48 GB	-	-	Rs. 52,290/-	Rs. 52,290/-	Rs. 99/-
DSL Connect 96	96 GB	-	-	-	Rs. 93,690/-	Rs. 90/-
SOURCE: www.micronetbroadband.net.pk						

According to recent research from UK-based analysts Point Topic, 56.5% of the world's broadband subscribers are connected through DSL, followed by cable modem (38%) and Gigabit Ethernet (4.7%). While the majority of these subscribers are using ADSL for their connectivity, Point Topic notes that VDSL is starting to take hold and a range of new technologies should soon hit the market and further drive growth.

In this paper authors have purposed some recommendations are made to PTCL for future DSL potential.

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