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Data Communication

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EXECUTIVE SUMMARY

The aim of this report is to demonstrate the technologies now in place and those emerging, which can provide high-bandwidth data communications.

The objectives of this report are to explain recent subscriber demands, to identify the inadequacy of PSTNs for high-bandwidth data, and to illuminate the different types of connections that have been used in recent communication technology.

This report begins with an introduction to and an explanation of the importance of recent user demands, and further on, browses the types of networks and the differences between public and private networks. Service paradigms and methods of connection are examined to achieve a better understanding of recent technology protocols.

At the end of the report, network technologies are evaluated in order to explore the basic components for each technology and the differences between them.

The information in this report is intended to be general, in scope and presentation, in order to make this report adequate as a reference guide for all IT departments located in any organization or company.

This report evaluates recent technology and how it has promoted procedures and applications for doing business, and evaluates how the technology has differentiated special technologies to meet recent user demand.

1. Introduction:

The idea of Networking began with the appearance of Micro Computers in the middle of the 1980's. Needless to say, this innovation caused alterations to industry and business practice in many different sectors by providing to these sectors the opportunity to share, access, and transmit data or information and to develop complex multimedia, whether locally or internationally, through the available network type in an organization or enterprise, and also through the technology that is used for this network.

[i]

1.1: Users' Recent Demands and the Inadequacy of PSTN :

The rapid expansion of technology has fundamentally changed the way organizations conduct business and this is due to the persistent demand for services needed by the users, which have come gradually or coincidentally as demands or desires have arisen after using networking technology. Most of these

demands, are designed to facilitate and to raise the business processes between B2B [ii] or B2C [iii]. Most of these demands are in relation to high- bandwidth data such as:

- A. Audio: Voice conversations, sounds systems and effects, etc.
- B. Video: movies, virtual meetings or video conferencing camera locators, etc.
- C. Images: "Presentation materials, three dimensional images, design specifications and pictures" [1].

For instance, one of the demands that were highly recommended in the business environment was a solution for the high cost of telephone calls. Recent technology offered several alternatives and solutions for this dilemma by providing IP-Telephony, which is a way of transmitting voice conversation via Internet technology. Furthermore, this service has recently been developed, not only for voice application systems, but also for transmitting text messages and e-mails, graphics, and IP Audio/Video Conferencing, all of which give at the end a high level of communications control.

Nowadays, technology is trying to find different solutions and paths to transmit these types of complex multimedia via internet and networking technology. However, there are several problems that face the technology developers, such as cost, time, effort, and security. These are not only the dilemma but also the problems with the inadequacy of the PSTN system. PSTN was designed in "1876 for transmitting voice conversations" [2]. After the appearance of the digital age during the 1960's, developers started trying to transmit digital data through the PSTN system, but they faced several problems such as converting the PSTN system for transmitting analog signals to digital. Also, the cost of converting the local loops transmitting the analog signal to digital is very high.

1.2: Types of Networks and the Difference between Public and Private Networks:

There are three types of networks depending upon the size of the networking system. These are:

- A. "A Local Area Network (LAN), can span a single building or campus.

- B. A Metropolitan Area Network (MAN), can span a single city.
- C. A Wide Area Network (WAN), can span sites in multiple cities, countries, or continents."[3].

1.2.1: Private Network:

The private network is a network that is designed for certain organization specifications with topologies, address assignment, routing, and switches connected by a LAN or dedicated to WAN. Before the appearance of the internet, most of the private networks for large corporations were Local Area Networks (LANs). At the time, when this private network was distributed between different and wide geographical locations (WAN), there was a need for connecting these (LANs) together, but the organization or the company needed to be able to afford a leasing cable, known as the Lease Line, from telephone companies. There are several advantages with the Private Network, but the most important one is privacy, which means that the data which is transmitted through the Lease Line between the telephone company and the organization is secure. However, the essential disadvantages of this network are the high cost and the need for full time network administrators.

1.2.2: Public Network:

In contrast, a public network is more flexible and any subscriber can connect to it. The organizations share the connections between the sites in the public network and all the data or the information of the organization commingles on one network line. The internet is the most distinguished example of a public network. The cost is one of the advantages of the public network, as it is much cheaper than the lease line. However, the major disadvantage of the public network is security and the privacy is limited.

1.2.3: Virtual Private Network (VPN):

The basic idea behind the (VPN) technology is to offer the privacy and the security of the network and also to reduce the cost, which makes this technology popular among organizations. There are three techniques that are used to make this technology operative and effective. The first two are: tunneling and

[\[iv\]](#) encryption, basically by specifying a tunnel across the global internet, which is located between two routers, and by using the IP-in-IP to send packets over the tunnel. The third technique which is used to ensure privacy in a (VPN) technology is by securing each out-going datagram before it reaches another during the transmission process, which makes the network traffic between sites restricted only to the organization's sites and disables any external interpreting. For corporate security managers, firewalls came up as a solution to secure confidential data or information from the danger of leaking out of, or into the network system, giving protection against digital pests such as viruses and worms. Firewalls are simply a software application running on a web server using a set of commands supplied by the network

administrator. "Using a VPN in conjunction with a Firewall will allow configurable and restricted access to the necessary data"[4].

2.0: Service Paradigms:

The meaning of service paradigms is "the characteristics of the communication service that the internet provides to its end systems" [5]. There are two distinct techniques used in data communications to transfer data and they are:

A. Connection-Oriented Service

This service is modeled after the telephone network. In this connection the client and the server program in all different end systems, send control packets before sending the data. This application is called the "handshaking" procedure. In addition, this service is supported by stream interface to ensure the safety of data transmission from any errors during the connection. The transmission via this service is distinct, with flow control, and congestion prevention. However, the cost of it is very high. "The most

^[v] distinguished protocols of this service are SPX and TCP" [6]. The technologies which use connection-oriented service are: Frame Relay which is suited for (WAN) only, and ATM for both (LAN) and (WAN).

B. Connectionless Service

In this service there is no "handshaking" procedure which makes the data transfer rapid between the

^[vi] users. "This service is also called (CLNP)." [7]. This service is not characterized by reliable data transfer, flow control, or congestion prevention, which makes the user unacquainted with which packets (datagrams) have been transferred to the destination. (CLNP) is useful for transmitting complex multimedia such as (IP) Telephone and Video Conferencing. Likewise, most of the technologies are characterized by using the connectionless service technologies such as: Ethernet, Token Ring, FDDI

^[vii] and SMDS, whereby, the first two are suited for the (LAN) including hubs, bridged networks, and switching, and the last two are applicable for (WAN). (Note: See below for explanations of most of these technologies in detail).

3.0: Method of Connection

3.1: Dedicated Connections:

Dedicated Connection is one of the most common methods of accessing the internet and depends on two types methods of connection (Permanent Connection and Switched Connection). In this connection all the work stations in the network are able to access the internet with one single leased line. Furthermore,

this connection has the best functionality and flexibility because it provides the ability to connect an unlimited number of nodes, is “always on” 24 hours, seven days a week with access to the internet and allows unrestricted use of internet information resources. However, the cost is very high as well as this connection needing a lot of equipment and technical support.

4.0: Network Technologies:

There are several of technologies which aid the transmission of data across different types of networks and these technologies are as follows:

4.1: ISDN:

Integrated Service Digital Network is a digital phone line that provides greater speed and bandwidth than a regular phone line. This technology provides to the user the ability to transmit complex multimedia. ISDN is a network running over twisted-pair copper wire. Moreover, there are two services with ISDN, Basic Rate Interface (BRI) and Primary Rate Interface (PRI), but the most popular one is the first one. Furthermore, “(BRI) connection through three channels, two “B” (bearer) channels at 64 Kbps to send the data and one “D” (delta) channel at 16 Kbps” [8], is used to connect and disconnect the B channels. In addition, the cost of ISDN is very expensive, especially for telephone calls and for the adapter for the communication.

4.2: Cable:

Cable modems let the user send and receive data across local cable TV lines, toggling between analogue and digital signals. The speed for bandwidth transmission over these cables is between 1.5 and 2.5Kbps, which makes it faster than ISDN (128Kbps).

4.3: xDSL:

DSL is one of the most recommended technologies in the field of communications. The letters stand for <Something> Digital Subscriber Line. DSL still works over twisted pair cable and it gives the user the ability to surf the web while making a phone call. Furthermore, this technology contains several types of solutions and due to the continual emergence of the technology, it is ideal for acceding to user's demands. These types of solutions are as follows:

4.3.1: ADSL:

Asymmetric Digital Subscriber Line. The speed of this technology is about 576.0K bps for the upstream. The downstream rate alters between 32 and 6.144Mbps. Also, the modem that is used in this technology is different in that it needs a type of modulation called DMT [\[viii\]](#) to divide the bandwidth between the upstream and the downstream.

4.3.2: SDSL:

This is the Single-line Digital Subscriber Line and is also known as Symmetric DSL. Because ADSL was not an ideal solution, especially for the server administrator (needs upstream more than downstream), this technology came up with the speed of 1.544Mbps and provides a balanced bandwidth between uploads and downloads over a single copper twisted pair.

4.3.3: HDSL:

HDSL is one of five DSL technologies. The H is related to the High-Data-Rate, and this technology is similar to the SDSL specifications. However, the operating range in this service is limited to 12,000 feet. Even so, signal repeaters can be installed to expand the service. HDSL requires two twisted pairs, but recently has been developed to HDSL2, or SHDSL, using one single twisted pair.

4.3.4: IDSL:

ISDN Based Digital Subscriber Line. It operates over the ISDN in form of "amplitude modulation" [9] and it is known as 2B1Q. The speed of this technology is up to 128Kbps.

4.3.5: VDSL:

"V" stands for very high bit rate DSL. This technology provides an incredible amount of bandwidth, with speeds up to 52Mbps for downstream and 16Mbps for upstream. VDSL operates over copper wires in the subscriber phone line. The disadvantage of this technology is that this service operates over a short distance, at about 4,000 feet. Thus, some areas are supplied with a device called (ONU) [\[ix\]](#) to expand the data rate to run over greater lengths of copper wires.

4.4: Frame Relay:

"Wiltel introduced the Frame Relay technology during 1992"[10]. Basically, Frame Relay is a connection-oriented protocol determining a method for access to a packet data network over a digital

link. Moreover, these packets are highly shared and they offer better efficiency than circuit-switched and private line networks. Frame Relay standards support Permanent Virtual Circuits (PVC) management, congestion management, and Switched Virtual Circuits (SVC). Furthermore, access to this technology is over a digital local loop, and the protocol of this technology is distributed through implemented programmed software compatible with specific hardware devices.

4.5: SDMS:

This technology “is a high-speed, packet-switched, datagram-based WAN networking technology used for communications over public data networks (PDNs)” [11]. The letters of SDMS are related to Switched Multi-megabit Data Service and it comprises high speed, packet switched, and datagram-based WAN networks. Also, this technology operates over both fibre and copper wire. Furthermore, the protocol of SDMS (SIP) provides a connectionless paradigm across the subscriber network interface.

4.6: ATM:

Asynchronous Transfer Mode is a communication protocol that carries information chunks known as cells and these cells are characterized by a very high speed data transfer. This technology was developed because of developing trends in the networking field to suit recent subscriber demand for home education, video conferencing, videophone, video library, video on demand, and high definition TV. The insistence of users on these facilities introduced the need for a universal network, which is flexible enough to furnish all of these services. Moreover, ATM consisting of these techniques has a very high data transfer rate and is used to connect (LANs) and (WANs) public or private networks. ATM protocol provides a connection-oriented paradigm and offers a support for both switched and permanent virtual circuits. In addition, as has been mentioned above, it is a connection-oriented service and one of the characteristics of this paradigm is congestion abbreviations, after the “handshaking” “the network verifies the connection and specifies a connection identifier to be used” [3]. The connection identifier ticks from a shorter integer than the network address, which makes the computer use it for sending and receiving data, and also lays low the packet size. ATM uses packet switching with fixed-length packets of 53 bytes. Each cell contains 5 bytes of header and 48 bytes for “Payload”. Moreover, beside the header are the virtual path identifier (VPI) and virtual circuits or channels identifier (VCI) to forward the cells toward their destinations. VPI is the logical connection between workstations by dedicating to the switches the final destination to the cells. The VCI is more delicate by dedicating to the switches the appropriate cell. Moreover, when a switch detects an error in the ATM cell header, it attempts to correct it, and if it cannot, it will discard the cell. Recently, the technology of the ATM has been most commonly used by localized regions of the Internet due to the flexibility and reliability of this technology for transmitting high bandwidth data.

5.0: Conclusion:

Recently, communication technologies have succeeded by facilitating ways of sharing and transmitting information on different formations of destinations, whether over short or long distances. Furthermore, networking technology since it appeared has become one of the most indispensable and important ideas that has affected business structures because it aids businesses to achieve their forecasted revenue. Most corporations are totally dependent upon recent technology and are always trying to be upgraded with the new methods or services in order to reach perfection in their services and products, and hence, to satisfy their customers, as much as possible, and as a result to reach the revenue generation goals of the business.

6.0: REFERENCES:

- 1) Alter, S. Information Systems. Upper Saddle River, NJ: Prentice Hall. 2002.
- 2) Tanenbaum, A. Computer Network. Upper Saddle River, NJ: Prentice Hall. 1996.
- 3) Comer, D. Computer Networks and Internets. Upper Saddle River, NJ: Prentice Hall, 1997.
- 4) International Network Service. The Knowledge Behind the Network.1998, [Online].
http://www.ins.com/downloads/whitepapers/ins_white_paper_vpn_data_privacy_1998.pdf
- 5) Kurose, J. and Ross, K. Computer Networking. USA: Pearson Education, 2003.
- 6) Al-Lebny, Y. Network+. Syria: Shoa for Publishing and Science, 2003.
- 7) Brebner, G. computers in Communication. UK: McGraw. Hill, 1997.
- 8) Introduction to Network and Communications. [Online].

https://secure.linuxports.com/howto/intro_to_networking/c6543.htm

9) Houghton, A and Jeyanthan, K. [Online].

<http://www.iis.ee.ic.ac.uk/~frank/surp98/report/ajh8/index.html>

10) McCann, N. Frame Relay. [Online], 2001. <http://www.intrustservices.com/pdfs/t02011.pdf>

11) Cisco Systems. SDMS. [Online]. <http://www.cisco.com/univercd/home/home.htm>

7.0: BIBLIOGRAPHY:

- 1) Atkins, J. and Norris, M. Total Area Networking. UK: John Wiley & Sons, 1999.
- 2) Bingham, J. ADSL, VDSL and Multicarrier Modulation. USA: John Wiley & Sons, 2000.
- 3) Comer, D. Internetworking with TCP/IP. Upper Saddle River, NJ: Prentice Hall, 2000.
- 4) Halsall, F. Data Communications, Computer Networks and Open Systems. USA: Addison-Wesley, 1996.
- 5) Irvine, J. and Harle, D. Data Communications and Networks. England: John Wiley & Sons, 2002.
- 6) Laudon, K. and Laudon, J. Essentials of Management Information Systems. Upper Saddle River, NJ: Prentice Hall, 2001.
- 7) Sachar, K. Asynchronous Transfer Mode & Its Many Advantages. [Online].
<http://alph.fdu.edu/~levine/networks/sachar/atm-adv.htm>
- 8) Sportack, M. and Johnson, K. High-Performance Networks. [Online].
<http://docs.rinet.ru:8083/NeHi//ch01.htm>
- 9) Stallings, W. and Slyke, R. Business Data Communications. . Upper Saddle River, NJ: Prentice Hall, 1998.
- 10) Sterbenz, J. and Touch, J. High-speed Networking. USA: John Wiley & Sons, 2001.

[\[i\]](#)[\[i\]](#)

PSTN: Public Switch Telephone Network.

[\[ii\]](#)

B2B: Business to Business.

[\[iii\]](#)

B2C: Business to Customer.

[\[iv\]](#)

For ensuring security, **encryption** is the most fundamental technique used to achieve security because it can be used with any type of packets and with any protocols. [5].

[\[v\]](#)

SPX: Sequenced Packet Exchange Protocol.

[\[vi\]](#)

CLNP: Connectionless Network Protocol.

[\[vii\]](#)

FDDI: Fiber Distributed Data Interface.

[\[viii\]](#)

DMT: Discrete Multi-tone.

[\[ix\]](#)

ONU: Optical Network Unit.