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1.0 Introduction

Objectives

The purpose of this brief introduction is to:

- Highlight the many attributes of modern communications
- Show the diversity of communications types
- Illustrate the complexity of administering a national telephone system

Minimum Reading

http://www.ee.umanitoba.ca/~blight/telecom.html

http://www.ntia.doc.gov/

http://www.fokus.gmd.de/nthp/telecom-info/

http://home.planet.nl/~wvhwvh/Default.htm

http://www.telecom.paper.nl/

http://www.inetassist.com/urlidx.htm

The average home today contains a wide variety of communications devices: satellite TV, radio, telephone, internet, etc. Of these, the telephone is probably the most useful because it supports two-way communication and gives the end-user the greatest control over its purpose. The other systems however, fall into the category of broadcasting and are principally used for entertainment, advertisement, and to a lesser degree, for education. The end-user has no direct control over what is broadcast, only over what is viewed.

The business world uses communications systems to generate money. Traditionally this meant information transmission and data processing, but present deregulation has allowed communications carriers to enter the much more lucrative entertainment business.

Customer Applications

Customer	Electronic Communication System
Residential	Telephone [wired, wireless, cellular] Television [terrestrial, cable, satellite] Radio [AM/FM, ham]
Business	Telephone [wired, cellular, Fax] PBX, ACD LANs, MANs, WANs Satellite [voice, data, video] Video Conferencing

_____ Notes _____

There are many different ways to classify communications systems:

Attribute	Classification	Examples
Interconnect	Wired	PSTN
	Wireless	Radio, TV, Satellite
Switching/ Non-switching	Circuit	PSTN
	Packet	Most data networks
	Broadcast	Radio, TV, Satellite
Services	Voice	PSTN
	Data	Specialized Carrier
Control	Centralized	PSTN
	Distributed	Most packet networks
Topology	Star	PSTN, computer nets
	Ring/Bus	LANs
Ownership	Public	PSTN, MANs, WANs
	Private	LANs, WANs

It is evident from the above table that the PSTN† appears in every communication system category except video. However, even this is changing. Therefore, it is appropriate to examine the telephone system first, to gain a basic appreciation of communications systems in general.

The PSTN is made up of various components:

CPE†	Telephones Modems Data sets Multiplexers PBX†
Local loop	Analog or digital Radio
Switching Network	Analog or digital Packet or circuit
Transport Facilities	Twisted pair, coax Microwave: digital or analog, terrestrial or satellite Fiber

Since these numerous pieces of hardware need to communicate with each other, it is also necessary to examine:

- Protocols
- Management
- Control

† Public Switched Telephone Network

† Customer Premise Equipment

† Private Branch eXchange

1.1 Network Ownership

1.1.1 Public Networks

Basic telephone service is known as POTS†, but there is nothing ordinary about it. In fact, it would be more appropriate to call it extraordinary. In the U.S. the PSTN has been constructed and managed by the private sector namely. In most other countries, the PSTN has been constructed by government, and is operated as a public utility. Canada has developed a patchwork system where part of the system is owned and operated privately, some parts provincially, and the whole thing regulated federally.

In many countries, government involvement has been necessary to:

- Cover the enormous capital cost
- Resolve right of way issues
- Provide universal access
- Provide a constant grade of service
- Ensure standardization

Urbanization has also had an impact on the development of the communications infrastructure. Today many telcos are creating MAN†s by installing fiber optic rings in major cites. This provides a high-speed backbone to link computer facilities and LANs.

MANs can be connected to form even larger networks called WANs†. Only the largest corporations or governments are able to support networks that span the country, or even the globe. It is expected that with the deployment of fiber optics and SONET†, it will be possible to create MANs and WANs over the PSTN at a reasonable cost. This can be done by time-sharing the facilities among many customers.

Regardless of the political ideology that spawned the telephone system, some degree of regulation is necessary to assure universal access, acceptable grade of service, reasonable profit margins, and standardization. Private companies for example, are reluctant to provide service in remote areas where there is little or no possibility of making a return on their investment.

Large companies desire marketplace domination and the elimination of competition. This can be done directly by cooperate takeovers or subtly by creating proprietary de facto standards to eliminate competition. For these and other reasons, the U.S. government broke AT&T into a number of smaller companies, and regulates their business practices.

Many countries with public networks are in the process of privatizing their PSTNs in the hope of fostering competition, initiating new services, lowering

† Plain Ordinary Telephone Service

† Metropolitan Area Network

† Wide Area Network

† Synchronous Optical NETwork

costs, and encouraging economic growth. These governments may be realizing that their bureaucratic structures are no longer appropriate for managing dynamic networks. However, it is not clear, whether business will do any better.

1.1.2 Private Networks

Large corporations own enormous private networks to support their business goals and do not allow public access. Multinational corporations have large networks connected by satellite and high-speed land links. These networks mirror PSTN architecture, equipment, and services. They're connected to the PSTN, to supplement their services and expand the number of end-user connections.

Today, many Telcos† offer VPN† service. This allows customers to create and monitor what appears to be their own exclusive network, but is constructed and maintained by the telephone company. The PSTN allocates network resources and shares them with other customers. Automated banking machines and credit card verifiers for example, are connected to large databases through the PSTN.

Even small business today can afford some type of private network. The most common of these include the:

- PBX
- LAN
- Two way radio
- Paging system

1.3 Miscellaneous Networks

Some communications systems are quite specialized and unique:

- Deep space network
- Tropospheric scatter systems
- Meteor burst systems
- Submarine communications

These systems are often at the forefront of technological development. As a result, they are often very expensive and profoundly influenced by government involvement.

1.4 Switched Voice Networks

There is considerable room for debate as to whether telcos are primarily service providers or operating companies.

† Telephone Companies

† Virtual Private Network

As service providers, they must be concerned with customers needs and wants, plus:

- Detect, and report faults
- Advise corrective action
- Provide reliable operation 24 hours a day
- Keep track of lost and abandoned calls
- Measure and report on its own efficiency
- Accept changes in customer features

Operating companies, tend to focus on concerns that maximize return on investment. Equipment is purchased primarily because it reduces costs and increases profits, not because it provides better service. These two perspectives are interrelated, and any astute business person will capitalize on service offerings even if it is not actually provided, simply because everyone wants to be well thought of.

1.5 Switched Data Networks

Any communications system requires a control structure. However, just how much control is needed, and where is it placed? In some systems, all of the decisions are made in one specific location. This has the advantage of easing certain control problems since only one unit makes decisions, and has the required information. On the other hand, this creates certain problems. As the traffic load increases, the controller can get bogged down.

More and more communications systems are using some form of distributed control architecture. Although this may increase system complexity, it can increase reliability by dynamically reconfiguring to meet changing traffic demands and failure modes.

Switching can be done in two basic ways: circuit and packet switching.

1.5.1 Circuit Switching

In this environment, a complete end-to-end connection is established before data transmission can begin. This implies that switches are intelligent enough to devise a route through the system and have enough capacity to handle the request for service. At some point, the system may become overloaded and customers denied access or blocked, but this should be a rare occurrence. This type of connection is typically provided by the PSTN. It also supports data traffic via modems.

1.5.2 Packet Switching

In a packet switch, each message is sorted and buffered at each switching node. A switching node can be thought of as a series of input and output queues. Messages can be sent to multiple destinations, inter node error correction can be performed, and message priorities can be established. Two basic packet switching methodologies are the datagram, and virtual circuit configurations.

1.5.2.1 Datagram

This is also known as the store and forward approach, and is used for telegrams and other forms of mail delivery. The primary application is for short messages. Each standard length packet is treated independently and multiple packets between two parties may take any one of several routes. This technique is not suitable for interactive communications since unacceptable delays may occur as the system load builds.

1.5.2.2 Virtual Circuit

This technique works better for connections requiring long holding times since a logical connection is established before transmission begins, and all packets follow the same route. This is very much like circuit switching except that the data is divided into packets before being sent out over the network.

1.6 Broadcast Networks

Radio and television broadcasting are the two most common networks of this type, but there are others. Data packet radio systems, such as ALOHA and its derivatives, use satellites and ground stations to forward data packets. Every customer gets to see everyone's packet. The access control may be centralized or distributed, with either polling or contention type algorithm. The transmission channel may employ either a synchronous or an asynchronous medium.

1.7 Telephone Companies

 There are 10 major and several minor telephone companies Canada. Most of the larger ones were once owned by provincial governments but have now been privatized. The one exception is Sask Tel. The principle carriers are: Bell Canada, BC Tel, NB Tel, Maritime Tel, PEI Tel, Newfoundland Tel, Manitoba Tel, Sask Tel, and AGT.

Up until recently, these companies provided local service and cooperated to provide long distance service. Today the CRTC has deregulated this aspect of the Bell phone system and as a result, there are numerous competitors in the long distance market. This may seem entirely as good news until it is realized that telcos have traditionally used long distance charges to offset the cost of local service.

The US communications facilities have evolved along different lines than those in Canada, and today forms the largest network in the world. In 1885, Bell incorporated AT&T. It was granted a monopoly to build the equipment and provide telephone services. Eventually it grew into one of the most powerful corporations in the world. This ultimately led to problems, and in 1974 legal proceedings which eventually led to the breakup of the Bell system were started. As of January 1, 1984, the MFJ† divided the Bell system into eight independent companies: AT&T and seven RBOCs†. These companies were further divided

† Modified Final Judgment

† Regional Bell Operating Companies

into 23 BOCs†, two of which remained with AT&T and the balance with the RBOCs. Initially these RBOCs were not allowed to provide long distance services, information services, or engage in manufacturing.

The entire US was divided into 184 market segments known as LATAs†. Today there are 189 LATAs, 161 of which are associated with Bell companies. The rest are independent. LATAs are operated by LECs†. They do not always follow state or area code boundaries.

LATAs are interconnected by long distance service providers known as IECs† or IXCs†. The three largest long distance carriers in the US today are: AT&T, Sprint, and MCI†. These carriers access the LATA at a POP†. RBOCs have recently been allowed to compete in the long distance market.

In many administrations it would seem unlikely that anyone could provide competitive local services, however in the US it is happening with local bypass carriers called CAPs†.

CAPs provide end-users with direct connections to POPs owned by IXCs, thus bypassing the local carrier. The CAP supports LAN interconnection, ISDN, and video services over LATA boundaries, and in some cases bypasses even the IXC.

CAPs include: WillTel with nearly 20,000 Km of fiber; and MFS† with networks in 12 metropolitan areas.

1.8 Equipment Manufacturers

There are many ways to design a telecommunications switch, each with its own advantage and disadvantage. Consequently, it is virtually impossible to assert that one company's system is significantly superior to another. The principle manufacturer of central office equipment in Canada is Nortel Networks.

The primary concern of any manufacturer is to make money. Therefor a great deal of effort is devoted to market surveys which help determine what customers want or need, and their willingness to pay. Manufacturers may have two types of customers; one being a large corporation such as the telco, the other being the end-user who is also a telco customer. Both types of customers have different and sometimes conflicting requirements.

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† Bell Operating Companies

† Local Access and Transport Areas

† Local Exchange Carriers

† Inter-Exchange Carriers

† Inter-eXchange Carriers

† Microwave Communications Inc.

† Point Of Presence

† Competitive Access Provider

† Metropolitan Fiber Systems

Since enormous amounts of money are required to produce, market, and sell telecommunications products, the manufacturers often have the clearest vision of the marketplace.

A major manufacturing concern is quality control, as it ultimately has a big impact on customer complaints. A lack of quality control can increase costs and reduce profits by forcing recycling or scrapping failed products and increasing customer returns, thus damaging a company's reputation and depreciating its stock market value.

Assignment Questions

Solutions

Quick Quiz

1. Government should never be involved in the communications industry. [True, False]
2. All public networks are owned by the government. [True, False]
3. List 4 reasons why regulation is needed in the telecommunications industry:
   a) _____
   b) _____
   c) _____
   d) _____
4. The [virtual circuits, datagram] packet system not suited for most real-time interactive communications.

Composition Questions

To answer these questions, it will be necessary to do some research.

1. What contribution did the following people make to communications?

   Almon B Strowger (Hint: click here)

   Guglielmo Marconi

2. Provide at least 10 examples to show that telcos are operating companies.
3. Provide at least 10 examples to show that telcos are service providers.
4. What are the largest switched and broadcast communications networks today, and what impact do they have on society?

For Further Research

http://www.nortel.com/
http://www.lucent.com/

http://www.ssc.siemens.com/
http://www.ccic.gov/pubs/blue95/
http://www.itu.int/Sites/wwwfiles/tel_gii.html
http://www.lidoorg.com/internetweb.htm
http://www.eppet.pt/seldtcom.htm
http://www.seg.co.uk/telecomm/index.htm
http://www.marconicalling.com/museum/html/archivehome.html
http://china.si.umich.edu/telecom/telecom-info.html
http://www.igigroup.com/