Telecommunications and Networking II

Telecommunication involves sending messages for the purpose of communication. Telecommunications is a general term for a vast array of technologies that send information over distances. Mobile phones, land lines, satellite phones and voice over Internet protocol (VoIP) are all telephony technologies -- just one field of telecommunications. Radio, television and networks are a few more examples of telecommunication.

2.1 History of radio and History of television

The RCA 630-TS, the first mass-produced television set, sold from 1946 to 1947. In 1832, James Lindsay gave a classroom demonstration of wireless telegraphy via conductive water to his students. By 1854, he was able to demonstrate a transmission across the Firth of Tay from Dundee, Scotland, to Woodhaven, a distance of about two miles (3 km), again using water as the transmission medium.[24] In December 1901, Guglielmo Marconi established wireless communication between St. John's, Newfoundland and Poldhu, Cornwall (England), earning him the Nobel Prize in Physics for 1909, one which he shared with Karl Braun.

On 25 March 1925, John Logie Baird of Scotland was able to demonstrate the transmission of moving pictures at the Selfridge's department store in London, England. Baird's system relied upon the fast-rotating Nipkow disk, and thus it became known as the mechanical television. It formed the basis of experimental broadcasts done by the British Broadcasting Corporation beginning 30 September 1929. However, for most of the 20th century, television systems were designed around the cathode ray tube, invented by Karl Braun. The first version of such an electronic television to show promise was produced by Philo Farnsworth of the United States, and it was demonstrated to his family in Idaho on 7 September 1927.

Television, however, is not solely a technology, limited to its basic and practical application. It functions both as an appliance, and also as a means for social story telling and message dissemination. It is a cultural tool that provides a communal experience of receiving information and experiencing fantasy. It acts as a “window to the world” by bridging audiences from all over through programming of stories, triumphs, and tragedies that are outside of personal experiences.

History of video-telephony

The 1969 AT&T Mod II Picture-phone, the result of decades long R&D at a cost of over $500M. The development of video-telephony involved the historical development of several technologies which enabled the use of live video in addition to voice telecommunications. The concept of video-telephony was first popularized in the late 1870s in both the United States and Europe, although the basic sciences to permit its very earliest trials would take nearly a half century to be discovered. This was first embodied in the device which came to be known as the video telephone, or videophone, and it evolved from intensive research and experimentation in several telecommunication fields, notably electrical telegraphy, telephony, radio, and television.

The development of the crucial video technology first started in the latter half of the 1920s in the United Kingdom and the United States, spurred notably by John Logie Baird and AT&T's Bell Labs. This occurred in part, at least by AT&T, to serve as an adjunct supplementing the use of the telephone. A number of organizations believed that video-telephony would be superior to plain voice communications. However video technology was to be deployed in analog television broadcasting long before it could become practical—or popular—for videophones.

Video-telephony developed in parallel with conventional voice telephone systems from the mid-to-late 20th century. Only in the late 20th century with the advent of powerful video codecs and high-speed broadband did it become a practical technology for regular use. With the rapid improvements and popularity of the Internet, it became widespread through the use of videoconferencing and webcams, which frequently utilize Internet telephony, and in business, where telepresence technology has helped reduce the need to travel.

2.2 Satellite

The first U.S. satellite to relay communications was Project SCORE in 1958, which used a tape recorder to store and forward voice messages. It was used to send a Christmas greeting to the world from U.S. President Dwight D. Eisenhower. In 1960 NASA launched an Echo satellite; the 100-foot (30 m) aluminized PET film balloon served as a passive reflector for radio communications. Courier 1B, built by Philco, also launched in 1960, was the world's first active repeater satellite.

Telstar was the first active, direct relay commercial communications satellite. Belonging to AT&T as part of a multi-national agreement between AT&T, Bell Telephone Laboratories, NASA, the British General Post Office, and the French National PTT (Post Office) to develop satellite communications, it was launched by NASA from Cape Canaveral on 10 July 1962, the first privately sponsored space launch. Relay 1 was launched on 13 December 1962, and became the first satellite to broadcast across the Pacific on 22 November 1963.

The first and historically most important application for communication satellites was in intercontinental long distance telephony. The fixed Public Switched Telephone Network relays telephone calls from land line telephones to an earth station, where they are then transmitted to a receiving satellite dish via a geostationary satellite in Earth orbit. Improvements in submarine communications cables, through the use of fiber-optics, caused some decline in the use of satellites for fixed telephony in the late 20th century, but they still exclusively service remote islands such as Ascension Island, Saint Helena, Diego Garcia, and Easter Island, where no submarine cables are in service. There are also some continents and some regions of countries where landline telecommunications are rare to nonexistent, for example Antarctica, plus large regions of Australia, South America, Africa, Northern Canada, China, Russia and Greenland.

After commercial long distance telephone service was established via communication satellites, a host of other commercial telecommunications were also adapted to similar satellites starting in 1979, including mobile satellite phones, satellite radio, satellite television and satellite Internet access. The earliest adaption for most such services occurred in the 1990s as the pricing for commercial satellite transponder channels continued to drop significantly.

Digital cinema

Realization and demonstration, on October 29, 2001, of the first digital cinema transmission by satellite in Europe of a feature film by Bernard Pauchon and Philippe Binant.

2.3 Computer networks and the Internet

On 11 September 1940, George Stibitz was able to transmit problems using teleprinter to his Complex Number Calculator in New York and receive the computed results back at Dartmouth College in New Hampshire.This configuration of a centralized computer or mainframe computer with remote "dumb terminals" remained popular throughout the 1950s and into the 1960s. However, it was not until the 1960s that researchers started to investigate packet switching — a

technology that allows chunks of data to be sent between different computers without first passing through a centralized mainframe. A four-node network emerged on 5 December 1969. This network soon became the ARPANET, which by 1981 would consist of 213 nodes.

ARPANET's development centred around the Request for Comment process and on 7 April 1969, RFC 1 was published. This process is important because ARPANET would eventually merge with other networks to form the Internet, and many of the communication protocols that the Internet relies upon today were specified through the Request for Comment process. In September 1981, RFC 791 introduced the Internet Protocol version 4 (IPv4) and RFC 793 introduced the Transmission Control Protocol (TCP) — thus creating the TCP/IP protocol that much of the Internet relies upon today.

However, not all important developments were made through the Request for Comment process. Two popular link protocols for local area networks (LANs) also appeared in the 1970s. A patent for the token ring protocol was filed by Olof Soderblom on 29 October 1974, and a paper on the Ethernet protocol was published by Robert Metcalfe and David Boggs in the July 1976 issue of Communications of the ACM. The Ethernet protocol had been inspired by the ALOHAnet protocol which had been developed by electrical engineering researchers at the University of Hawaii.

2.4 Key concepts

A number of key concepts reoccur throughout the literature on modern telecommunication systems. Some of these concepts are discussed below.

Basic elements

A basic telecommunication system consists of three primary units that are always present in some form:

- A transmitter that takes information and converts it to a signal.
- A transmission medium, also called the "physical channel" that carries the signal. An example of this is the "free space channel".
- A receiver that takes the signal from the channel and converts it back into usable information.

For example, in a radio broadcasting station the station's large power amplifier is the transmitter; and the broadcasting antenna is the interface between the power amplifier and the "free space channel". The free space channel is the transmission medium; and the receiver's antenna is the interface between the free space channel and the receiver. Next, the radio receiver is the destination of the radio signal, and this is where it is converted from electricity to sound for people to listen to.

Sometimes, telecommunication systems are "duplex" (two-way systems) with a single box of electronics working as both a transmitter and a receiver, or a transceiver. For example, a cellular telephone is a transceiver.[39] The transmission electronics and the receiver electronics in a transceiver are actually quite independent of each other. This can be readily explained by the fact that radio transmitters contain power amplifiers that operate with electrical powers measured in the watts or kilowatts, but radio receivers deal with radio powers that are measured in the micro-watts or nano-watts. Hence, transceivers have to be carefully designed and built to isolate their high-power circuitry and their low-power circuitry from each other.

Telecommunication over fixed lines is called point-to-point communication because it is between one transmitter and one receiver. Telecommunication through radio broadcasts is called broadcast communication because it is between one powerful transmitter and numerous low-power but sensitive radio receivers.

Telecommunications in which multiple transmitters and multiple receivers have been designed to cooperate and to share the same physical channel are called multiplex systems. The sharing of physical channels using multiplexing often gives very large reductions in costs. Multiplexed systems are laid out in telecommunication networks, and the multiplexed signals are switched at nodes through to the correct destination terminal receiver.

Analog versus digital communications

Communications signals can be either by analog signals or digital signals. There are analog communication systems and digital communication systems. For an analog signal, the signal is varied continuously with respect to the information. In a digital signal, the information is encoded as a set of discrete values (for example, a set of ones and zeros). During the propagation and reception, the information contained in analog signals will inevitably be degraded by undesirable physical noise. (The output of a transmitter is noise-free for all practical purposes.) Commonly, the noise in a communication system can be expressed as adding or

subtracting from the desirable signal in a completely random way. This form of noise is called additive noise, with the understanding that the noise can be negative or positive at different instants of time. Noise that is not additive noise is a much more difficult situation to describe or analyze, and these other kinds of noise will be omitted here.

On the other hand, unless the additive noise disturbance exceeds a certain threshold, the information contained in digital signals will remain intact. Their resistance to noise represents a key advantage of digital signals over analog signals.

Telecommunication networks

A communications network is a collection of transmitters, receivers, and communications channels that send messages to one another. Some digital communications networks contain one or more routers that work together to transmit information to the correct user. An analog communications network consists of one or more switches that establish a connection between two or more users. For both types of network, repeaters may be necessary to amplify or recreate the signal when it is being transmitted over long distances. This is to combat attenuation that can render the signal indistinguishable from the noise.
Another advantage of digital systems over analog is that their output is easier to store in memory, i.e. two voltage states (high and low) are easier to store than a continuous range of states.

Communication channels

The term "channel" has two different meanings. In one meaning, a channel is the physical medium that carries a signal between the transmitter and the receiver. Examples of this include the atmosphere for sound communications, glass optical fibers for some kinds of optical communications, coaxial cables for communications by way of the voltages and electric currents in them, and free space for communications using visible light, infrared waves, ultraviolet light, and radio waves. This last channel is called the "free space channel". The sending of radio waves from one place to another has nothing to do with the presence or absence of an atmosphere between the two. Radio waves travel through a perfect vacuum just as easily as they travel through air, fog, clouds, or any other kind of gas besides air.

The other meaning of the term "channel" in telecommunications is seen in the phrase communications channel, which is a subdivision of a transmission medium so that it can be used to send multiple streams of information simultaneously. For

example, one radio station can broadcast radio waves into free space at frequencies in the neighborhood of 94.5 MHz (megahertz) while another radio station can simultaneously broadcast radio waves at frequencies in the neighborhood of 96.1 MHz. Each radio station would transmit radio waves over a frequency bandwidth of about 180 kHz (kilohertz), centered at frequencies such as the above, which are called the "carrier frequencies". Each station in this example is separated from its adjacent stations by 200 kHz, and the difference between 200 kHz and 180 kHz (20 kHz) is an engineering allowance for the imperfections in the communication system.

In the example above, the "free space channel" has been divided into communications channels according to frequencies, and each channel is assigned a separate frequency bandwidth in which to broadcast radio waves. This system of dividing the medium into channels according to frequency is called "frequency-division multiplexing" (FDM).

Another way of dividing a communications medium into channels is to allocate each sender a recurring segment of time (a "time slot", for example, 20 milliseconds out of each second), and to allow each sender to send messages only within its own time slot. This method of dividing the medium into communication channels is called "time-division multiplexing" (TDM), and is used in optical fiber communication. Some radio communication systems use TDM within an allocated FDM channel. Hence, these systems use a hybrid of TDM and FDM.

Modulation

The shaping of a signal to convey information is known as modulation. Modulation can be used to represent a digital message as an analog waveform. This is commonly called "keying" – a term derived from the older use of Morse Code in telecommunications – and several keying techniques exist (these include phase-shift keying, frequency-shift keying, and amplitude-shift keying). The "Bluetooth" system, for example, uses phase-shift keying to exchange information between various devices.[42][43] In addition, there are combinations of phase-shift keying and amplitude-shift keying which is called (in the jargon of the field) "quadrature amplitude modulation" (QAM) that are used in high-capacity digital radio communication systems.

Modulation can also be used to transmit the information of low-frequency analog signals at higher frequencies. This is helpful because low-frequency analog signals cannot be effectively transmitted over free space. Hence the information from a low-frequency analog signal must be impressed into a higher-frequency signal

(known as the "carrier wave") before transmission. There are several different modulation schemes available to achieve this [two of the most basic being amplitude modulation (AM) and frequency modulation (FM)]. An example of this process is a disc jockey's voice being impressed into a 96 MHz carrier wave using frequency modulation (the voice would then be received on a radio as the channel "96 FM").[44] In addition, modulation has the advantage that it may use frequency division multiplexing (FDM).