DOCUMENT RESUME

ED 136 798 IR 004 589

TITLE	Common Carrier Services.
INSTITUTION	Federal Communications Commission, Washington, D.C.
PUB DATE	Jul 76
NOTE	21p.; Information Bulletin No. 8. For related document, see ED 064 942
EDRS PRICE	MF-$0.83 HC-$1.67 Plus Postage.
DESCRIPTORS	Administrative Agencies; *Communication Satellites; Federal Legislation; Government Role; Technological Advancement; *Telecommunication; *Telephone Communications Industry

ABSTRACT

This bulletin outlines the Federal Communications Commission's (FCC) responsibilities in regulating the interstate and foreign common carrier communication via electrical means. Also summarized are the history, technological development, and current capabilities and prospects of telegraph, wire telephone, radiotelephone, satellite communications, ocean cable telegraph, and radiotelegraph. (SC)

ED136798

Common Carrier Services

Federal Communications Commission, Washington, D.C.

8 7/76

INFORMATION BULLETIN

Common Carrier Services

PUBLIC INTEREST

The public has a vital stake in common carrier wire and radio communication. In 1974 it paid more than $20 billion for such service over facilities representing an investment of about $90 billion.

EARLY FEDERAL REGULATION

Though several earlier acts of Congress related to specific telegraph matters, Federal regulation of interstate electrical communication may be said to date from passage of the Post Roads Act in 1866. This legislation was intended to foster the construction of telegraph lines by granting, among other things, rights-of-way over public lands.

Federal regulation of the rates and practices of interstate communication carriers was initiated by the Mann-Elkins Act of 1910. This extended certain provisions of the Interstate Commerce Act to cover common carrier services, both wire and radio.

COMMUNICATIONS ACT OF 1934

The Communications Act of 1934 coordinated in the Federal Communications Commission regulatory powers formerly exercised by various Federal agencies and broadened considerably the scope of such regulation. A major purpose of this statute is "to make available, so far as possible, to all the people of the United States a rapid, efficient, nation-wide, and world-wide wire and radio communication service with adequate facilities at reasonable charges . . ."

COMMUNICATIONS SATELLITE ACT OF 1962

The Communications Satellite Act of 1962 provided for the establishment, in cooperation with other countries, of a commercial communications satellite system as part of an improved global communications network.

The United States' participation in this system is through the Communications Satellite Corporation (Comsat), a private corporate entity organized under this Act and subject to governmental regulation. Comsat's principal roles in this system are to act as manager of the space segment, and operator of the U. S. earth stations, and to lease satellite channels to conventional U. S. communications common carriers for overseas services.

REGULATORY RESPONSIBILITIES OF THE FCC

The FCC regulates interstate and foreign communication such as telephone, telegraph, facsimile, telephoto and broadcast program transmission, whether by wire or radio, including cable and via satellites. Common carrier communication that is purely intrastate in character is not, in general, subject to Commission jurisdiction but comes under the authority of state utility commissions. Broadcast stations are not deemed "common carriers" by the Communications Act. In brief, a communications common carrier under the law is one whose services are open to public hire for handling interstate or foreign communications by electrical means.

The Communications Act recognized two types of such common carriers--those fully subject to the Act, and those only partially so. The latter do not engage in interstate or foreign communication except through connection with the wire, cable or radio facilities of nonaffiliated carriers. They are exempt from certain provisions of the Act that apply to fully-subject carriers.

The Act requires that every subject common carrier furnish service at reasonable charges upon reasonable request. No such carriers may construct, acquire or operate facilities for interstate or foreign communication without Commission approval. Likewise, they cannot discontinue or curtail service without Commission approval. All their charges, practices, classifications and regulations must be just and reasonable. The common carriers file tariff schedules with the FCC, and those schedules are subject to review and regulation by the Commission.

The Commission has authority to prescribe the forms of records and accounts to be kept by the fully-subject carriers. Under this authority, it has established uniform systems of accounts for them to follow, including the establishment and maintenance of original cost accounting, continuing property records, pension cost records and depreciation records. The Commission also requires the carriers to retain records for varying periods.

The FCC also prescribes the depreciation rates for the larger domestic telephone and telegraph carriers to be used in determining the depreciation charges to be included under operating expenses.

The larger fully-subject carriers file monthly and annual reports with the Commission giving specified financial and operating information.

The Commission regulates the interlocking of officers and directors of carriers fully subject to the Act, it being unlawful for any person to hold office in more than one such carrier unless authorized by the FCC.

Operating under licenses granted by the Commission, common carriers now use radio facilities over a substantial portion of their long-distance communication pathways. These as well as other radio facilities must be regulated to curb interference and avoid inefficient use of the limited frequency spectrum.

The common carrier radio license privilege is limited by the Act to citizens of the United States. It is denied to corporations in which any officer or director is an alien or of which more than one-fifth of the capital stock is owned by aliens or foreign interests.

The Commission also passes on applications of carriers to construct wire or cable transmission facilities to assure that the proposed facilities are adequate, but not excessive, and that their costs are reasonable and prudent.

After obtaining the approval of the Secretary of State, the Commission can issue and, after hearing, withhold or revoke licenses to land or operate submarine cables in the United States.

The Commission is charged with domestic administration of wire, cable and radio communication provisions of treaties and other international agreements to which the United States is a party.

The Communications Satellite Corporation is subject to the same FCC regulatory controls as are other communications common carriers, as well as to certain additional regulatory requirements. For example, the Commission must ensure that there is effective competition in all procurement of equipment and services required for the satellite system by Comsat or other common carriers and that small business has an equitable opportunity to participate in such procurement. The Commission must also approve all Comsat financing except for the initial issue of capital stock.

The FCC also must approve the technical characteristics of satellite systems to be used by Comsat and by domestic satellite common carriers, and authorize the construction and operation of each earth station either by Comsat or by other carriers, or by both, as it determines will best serve the public interest, convenience and necessity.

TELEGRAPH

Invention

The concept of transmitting intelligence by electricity over a wire and the principle of the electromagnetic telegraph was developed by Samuel F. B. Morse, an eminent portrait artist and professor at New York University. In 1835, Morse built the first telegraph instrument and tested it by stretching 1,700 feet of wire around his room and sending signals from one end to the other.

As with many new inventions, immediate interest and ac eptance was not forthcoming. Even after a demonstration before President Martin Van Buren in 1838, it took Congress five years before it agreed to appropriate $30,000 to build an experimental telegraph line from Washington to Baltimore.

In April, 1844, members of Congress witnessed the sending and receiving of messages over the partially-completed line. The Whig party held its national convention in Baltimore, where on May 1, 1844, Henry Clay was nominated for the Presidency, then held by John Tyler, who had succeeded William Henry Harrison when Harrison died in office. This news was hurried to Annapolis Junction (between Washington and Baltimore) where Morse's partner, Alfred Vail, wired it over the completed portion of the line to the capital. This was the first news dispatch carried by electric telegraph.

The official opening of the completed line was May 24, 1844, when Morse sent his famous first message "What hath God wrought?" from the Old Supreme Court chamber in Washington to his partner in Baltimore.

Three days later the Democratic national convention in Baltimore nominated James K. Polk for the Presidency. Since a former President, Martin Van Buren, had been regarded as the likely choice, skeptics refused to believe the report telegraphed to Washington until persons arriving by train from Baltimore confirmed the story. The telegraph then became an accepted, valuable tool in communications.

Development

Morse and his associates obtained private funds to extend their line to Philadelphia and New York. Other firms entered the field and small telegraph companies began springing up in the East, South and Midwest.

Wire telegraph played an important part in the Nation's development. It speeded communication at the time the West was being opened. It aided the extension and operation of railroads. The dispatching of trains by telegraph began in 1851 and side by side, the iron rail and iron wire pushed over plain and through wilderness to make new settlements possible and to bring regions into closer contact. This association of telegraph and railroad built communities and opened markets.

On April 1, 1851, a group of Rochester, N. Y., businessmen organized The New York and Mississippi Valley Printing Telegraph Company, which started operation with 550 miles of wire and the license to use a telegraph printer invented by Royal E. House.

This device, resembling a small piano, was the first telegraph instrument to print roman letters, numerals and punctuation marks -- instead of Morse code. While it only had limited use then, the House printer established the basis for development of today's high-speed, automatic printing telegraph machines.

When the new company began operation there were 50 other small telegraph companies. There was no interconnection of lines, messages were transferred physically from one company to another, and rates were as high as $20 for a single telegram. The New York and Mississippi Valley Printing Telegraph Company set out to establish a unified, efficient service on a nationwide basis.

During the first five years, the company acquired 11 other lines operating in the five states north of the Ohio River. On April 4, 1856, the name of the company was change to The Western Union Telegraph Company, signifying the union of "western" lines into one system.

At the outbreak of the Civil War, fast communication with the Far West became essential. The only rapid communication with the West at that time was by Pony Express, which required as many as 10 days to carry telegrams and mail from the western telegraph terminal at St. Joseph, Mo., to Sacramento, Calif. A telegraph line was needed to bridge the gap, but the task of stringing a 2,000-mile pole line across plains filled with hostile Indians and over the rugged Rockies was a formidable one. Engineering experts predicted the project would require 10 years to complete.

A young and resourceful Western Union general agent surveyed several different routes for the transcontinental system and finally followed the Pony Express route. Next, he organized two teams of builders, one to work from the west and the other from the east.

The strands of wire, uniting the Nation in rapid communication for the first time, were joined at Salt Lake City on October 24, 1861--exactly three months and 20 days after the project had started; the experts were amazed.

Competition

Until 1877, all rapid long-distance communication depended on the telegraph. However, the advent of the telephone in that year brought rivalry. Patent litigation between Western Union and the infant telephone interests was terminated in 1879 by an agreement that largely separated the two services.

In 1881, the Postal Telegraph Company, a competitive system, entered the field. For economic reasons, Postal was merged with Western Union in 1943. The result is that today only one company--Western Union--offers a nationwide public message telegraph service.

Progress

The last half-century saw major improvements in Western Union's nationwide communications network. Nonrusting, low resistance copper wire was substituted for the iron wire used initally. Overhead telegraph wires in congested areas were replaced by underground cables, which are constantly being improved and enlarged to handle the growing volume of record communications.

The company's coast-to-coast microwave beam system was completed in 1961, exactly 100 years after the completion of the first transcontinental telegraph line. This system is designed to handle forms of communication including data, voice and video, at high speeds and in large volume. Plans are under way to add digital equipment to handle the growing demand for data communications and provide even faster service. The company also operates a domestic satellite system.

The original Morse telegraph involved code printing and reproduction on tape, and in most countries this mechanical feature was retained. In the United States, however, the industry for many years depended on the operator's ear a well as his "fist." In those days a good Morse code operator could send 40 to 50 words a minute.

Teleprinter or teletypewriter machines started to come into general use about 1925. A message is typed on a typewriter-like keyboard and reproduced on a like instrument at another point. In addition to their use by telegraph companies, these machines are a particular aid to news services and other business, as well as government entities. Modern equipment can transmit up to 150 words a minute through the use of automatic tape drives.

In addition to conventional telegram message and money transfer services, Western Union offers teleprinter exchange service (Telex/TWX) for more than 100,000 customers, and a variety of leased transmission services to commercial and government users.

The company also provides the landline handling of international and ship-shore messages originating and terminating in the continental United States outside of the so-called "gateway" cities. (Gateway cities are those in which the terminals of international carriers are located.)

Another rapidly growing system is Mailgram, an electronic mail service operated jointly by Western Union and the U. S. Postal Service. By combining the message switching and transmission capabilities of the telegraph system with the delivery capability of the 250,000 letter carriers of the Postal Service, Mailgram service is designed to provide next-business-day delivery to any location within the 49 continental United States and Canada.

Mailgram messages may be filed by telephone, over the counter at Western Union offices or over Telex/TWX or other subscriber terminals. Transmission is made to a receiving post office in or near the destination city, where the message is placed in a specially designed envelope for first class mail delivery.

Principally, because of a steady decline in the volume of telegrams over the last 25 years, the Commission in recent years has authorized Western Union to convert many of its company-operated offices to agency operation.

Telegraph agencies are operated by local business concerns under contract with Western Union, and in most cases provide the same extent and quality of service as that of the former company-operated office. Telephone acceptance of telegrams is available to the public 24 hours a day through three centralized telephone bureaus that can be reached toll free from any telephone in the United States.

TELEPHONE (WIRE)

Invention

> "If I can get a machanism which will make a current of electricity vary in its intensity, as the air varies in density when a sound is passing through it, I can telegraph any sound, even the sound of speech."

So declared Alexander Graham Bell in 1879 while experimenting with his "harmonic telegraph." On June 2 of that same year, by fashioning a makeshift diaphragm, this teacher of deaf persons discovered he could hear over a wire the sound of a twanging clock spring. Bell then knew it was possible to do what he had hoped--send vocal vibrations over a telegraph wire so they could be transformed into sound for a listener at the other end.

Nine months later, on March 10, 1876, Bell transmitted the first complete sentence heard over a wire. What he said was, "Mr. Watson, come here, I want you." It was received by his associate Thomas A. Watson, in an adjoining room of their tiny Boston laboratory.

Development

United States Patent No. 174,465, issued to Bell in 1876, became known as the "most valuable patent." Yet, even as had been the case with the original telegraph, early efforts to popularize the telephone met with disappointment. Though people paid to hear Bell lecture on "the miracle discovery of the age," for a time they seemed unaware of its possibilities.

However, 1877 witnessed the erection of the first regular telephone line--from Boston to Sommerville, Mass. By the close of 1880, there were 47,900 telephone in the entire United States. The following year brought telephone service between Boston and Providence, Boston and New York were connected in 1884. Service between New York and Chicago started in 1892, but not until 1915 was transcontinental service inaugurated.

Operation

The telephone is an electrical device that picks up a spoken word and speeds it invisibly and inaudibly by wire, cable or radio to another point. In this process the telephone instrument performs two functions--it converts the sound waves of the human voice into electrical waves for transmission and, at the receiving end, it transforms this electrical energy back into sound waves that can be recognized by the human ear.

The telephone system provides the highways that carry this electrical speech. Strands of copper wire link rural subscribers; more populous places use cable. In big cities, the cables are placed in underground conduits or buried directly in the ground. City-to-city transmission is over cables or microwave radio.

Switchboards

Telephones were first leased in pairs. The subscriber had to put up his own line to connect with another listener. The first switchboard was set up in Boston in 1877. New Haven saw the first regular telephone exchange in 1878. Early switchboards were manned by boys.

Development of the switchboard permitted interconnections to be made with fewer lines. For example, to join six subscribers with one another by private lines would require 15 separate circuits. One switchboard can handle many times that numer of lines. Thus a switchboard serving 10,500 telephones is a substitute for 55,119,750 separate wire connections. In busy areas, "multiple" switchboards duplicate subscribers' line terminals for speed and convenience in making connections.

Dial Telephone

Development of the modern telephone system is revealed in the evolution of its instruments. For example, it is a far cry from the streamlined dial handsets of today to the cumbersome wall hand-rung models of a generation ago.

It is an oddity that the dial telephone was invented by an undertaker--Almon B. Strowger of Kansas City, about 1889. The first dial exchange was installed at La Porte, Ind., in 1892. By 1921, dial telephones came into general use. Today, about 98 percent of all telephones are dial-operated. In addition to local dialing, almost all subscribers can dial distant telephones. More than 125 million telephones in the United States can be interconnected by more than 18,000 central offices.

Cable

Toward the close of the 19th Century, the myriad of overhead telephone wires in large cities became such an obstacle to effective fire fighting and were so subject to storm damage that it was necessary to develop sturdier overhead cables composed of numerous wires. Success in enclosing many wires in a single cable eliminated need for many cross-arms on telephone poles.

In 1888 it was possible to squeeze 100 wires into a large cable; today more than 5,000 strands can be encompassed in a cable about the size of a man's wrist. Some cables are maintained under inert gas pressure to keep out moisture that could cause short circuits. The gas also helps detect leaks in the cable sheath. Today, many of these cables are located underground.

Experiments with underground telephone cable date back to 1882 but it was not until 1902 that the first long-distance buried cable was placed in operation--between New York and Newark, N. J. In 1913, Washington and Boston were so linked. The original transcontinental telephone line was of open wire. The first cross-continent cable line was opened in 1942.

Coaxial cable was a development of multichannel experimentation. It had its first practical test between New York and Philadelphia in 1936. Commercial service was inaugurated between Stevens Point, Wis. and Minneapolis in 1941. It proved so successful that the American Telephone and Telegraph Company has constructed many coaxial links in its national cable microwave system.

Coaxial cable is designed to carry radio and television programs as well as telephone and telegraph traffic. Its ability to transmit currents on an extremely wide range of frequencies permits the handling of a much larger number of communication channels over a single pair of conductors than was possible previously.

One pair of coaxial units can carry as many as 9,000 telephone conversations simultaneously. Each of these voice pathways also can be equipped to provide up to 18 telegraph circuits. The most modern coaxial cable consists of 22 tubes--20 (10 pairs) are used for regular service with two in reserve. Thus, at normal capacity, a coaxial cable system can handle as many as 90,000 conversations simultaneously.

Transistor

The transistor was developed by the Bell Telephone Laboratories in 1948. It consisted of a metal tube about the size of a shoelace tip containing two hair-thin wires touching a pinhead-size piece of a solid semi-conductive material soldered to a metal base. It used about one-tenth of the power required to operate an ordinary flashlight bulb and amplified it about 100 times.

Transistor development has progressed rapidly. Today thousands of different types are available to meet specific needs ranging from amplification to high-speed switching. Because of their small size, low-power requirements and reliability, transistors have supplanted vacuum tubes for many communication uses. Transistors made smaller radio receivers possible.

They opened the way to direct distance dialing, and have an important part in many communication functions. They work in many telephone transmission and switching systems as well as in missiles, satellites, computers and all types of data processing equipment. They also have application in hearing aids, artificial larynxes and other devices.

Carrier Systems

Carrier technique permits large numbers of telephone conversations to be transmitted, without interfering with each other, over a single pair of conductors, a coaxial cable or a radio system. This is done at the sending end by translating the speech currents of different conversations from their ordinary voice frequency range to higher frequency bands. At the receiving end, the signals are again translated downward to their original audio frequencies.

One of the most recent developments, designed to increase the capacity of underground cables in urban areas, is pulse code modulation (PCM). PCM takes the sound of the human voice and translates it into a mathematical code of high speed electrical pulses (64,000 per second per voice channel). Using this technique, up to 96 conversations so coded can take place over two pairs of wires simultaneously without interference. At the receiving end, these codes are translated by PCM terminals into the voice you hear on the telephone.

TASI

Time Assignment Speech Interpolation (TASI) is a system employed to increase the capacity and reliability of overseas telephone circuits. The system detects pauses in normal conversation and transmits other active conversations during these pauses. TASI A normally carries 74 circuits on 37 channels. A new system, designated TASI B, can serve up to 235 telephone circuits on 100 overseas channels.

Connections

The first Bell Telephone Company started in 1878. It developed into the American Telephone and Telegraph Company (AT&T), incorporated in 1885. AT&T and its 23 associated telephone companies comprise the Bell System, which provides a great variety of communication services.

Many independent telephone companies provide services, largely in the rural areas. Almost all of them interconnect with the Bell System, permitting a telephone subscriber to call almost any other telephone subscriber in the world.

In the early days of the telephone, many cities and towns had rival telephone systems. Philadelphia, the last major area to give up dual service, did so in 1943.

International Services

Telegraph, telephone, data, television and other communications services between the United States and overseas points are provided by ocean cable, high frequency radio and satellite communications.

Worldwide record (nonvoice communications) services are offered principally by ITT World Communications Inc., RCA Global Communications, Inc., and Western Union International, Inc. Record services also are provided by TRT Telecommunications Corporation, United States-Liberia Radio Corporation and the French Telegraph Cable Company.

Voice services between the U. S. mainland and overseas points are provided by the American Telephone and Telegraph Company and service between Hawaii and the mainland as well as with foreign points by the Hawaiian Telephone Company.

Subsidiaries of ITT provide overseas telephone services for Puerto Rico and the Virgin Islands. Telegraph and telephone services to ships at sea are offered by a number of these companies.

The Communications Satellite Corporation (Comsat) makes satellite channels available to established international carriers for overseas services. U. S. common carriers lease voice circuits from Comsat to provide service between the United States and other parts of the world.

Overseas television service is available by means of satellite circuits between the U. S. mainland and Hawaii, Alaska, Puerto Rico, Guam and numerous countries throughout the world.

The first transatlantic telephone cable was placed in service between Newfoundland and England in 1956, and between Newfoundland and France in 1959. By 1970, six additional cables had been laid connecting North America and Europe.

The latest one, TAT-5, connects Rhode Island and Spain and service is extended from Spain throughout Europe and the Mediterranean by microwave relay and a new Mediterranean cable.

In 1964, the first telephone cable to Japan was placed in service, linking Hawaii, Midway, Guam and Japan. On Guam, connection is made with a cable to the Philippines and with a British Commonwealth cable to Australia, New Guinea, Hong Kong, North Borneo, and Singapore. At Hawaii, the cable is interconnected with two U. S.-Hawaii cables and with a British cable from Vancouver, Canada, to Fiji, New Zealand and Australia.

Several cables interconnect the islands in the Caribbean. Cables have been laid from Florida to Puerto Rico, to St. Thomas, and to Jamaica. From Jamaica, the cable is extended to the Canal Zone and St. Thomas is connected with Venezuela by cable. In addition a cable was laid in 1962 from New Jersey to Bermuda and extended to Tortola. Other islands in the Caribbean are interconnected by satellite, over-the-horizon and high frequency radio and microwave relay.

The first of these undersea telephone cables consisted of two cables (one for each direction) enclosed by a layer of steel wire for strength and protection. The amplifiers used vacuum tubes and were spaced about 40 miles apart. These cables could handle about 48 telephone conversations over a maximum cable length of 2,200 nautical miles.

In contrast, the latest cable laid across the Atlantic can handle more than 700 two-way telephone conversations over a maximum cable length of 4,000 miles on a single cable. This type of cable is coaxial with an inner stranded steel wire for strength. This stranded wire is copper plated and acts as the inner conductor of the coaxial cable.

Around this is an insulating layer of polyethylene an inch and a half in diameter covered by a layer of copper that serves as an outer conductor. The entire cable is surrounded by a waterproof layer of polyethylene. The amplifiers are transistorized and spaced about 10 miles apart. Near the shore ends, the cable is protected with a layer of external armor and buried for additional protection from damage by trawling and dredging operations.

TELEPHONE (RADIO)

Development

The ingenuity of many individuals made radiotelephony possible. Besides enabling most of the world's telephones to be interconnected, radio is supplementing or augmenting wire lines in the United States and is extending the telephone network to isolated places, moving automobiles, trains, airplanes and vessels.

Dr. Lee De Forest used radio in 1907 to telephone from ship to shore the results of a yacht race on Lake Erie. In 1915, speech was successfully transmitted from Arlington, Va., to the Eiffel Tower in Paris. Shortwave transatlantic communication with high-frequency radio signals generated by tube transmitters began in 1924. Commercial radiotelephone was opened between New York and London in 1927, and to South America three years later.

In 1935 the first telephone call was made around the world, using a combination of wire and radio circuits.

Overseas Telephony

Before the first underseas telephone cable was laid in 1956, the only method available to place a telephone call overseas was by high-frequency radio. Since then, the underseas cable and the communications satellite have supplanted high-frequency radio for overseas calls. High-frequency radio is used today primarily to reach points not served by either cable or satellite and as a backup to these newer facilities.

Whether cable, satellite, or radio facilities are used, the basic procedure in making an overseas call is the same. The caller initiates a call from any telephone in the domestic telephone system and the long-distance operator switches the call to the appropriate overseas operating office.

If an overseas circuit is available, the overseas operator completes the call immediately. Otherwise, the overseas operator asks the caller to hang up and that she will call him back when a circuit is available.

From the overseas operating office, the call is routed by land-line to the appropriate underseas cable terminal, earth station, or radio transmitter, depending on whether a cable, satellite, or high-frequency radio circuit is used. At the receiving terminal of the circuit, the call is routed to the operating office at the overseas location and then through the local telephone network to the person from whom the call is intended.

Direct distance dialing has been established between New York City and a large part of Europe. Within the next decade, it is anticipated that distance dialing will be expanded to include most of the world.

SATELLITE COMMUNICATIONS

Early Experiments

The use of satellites to relay communications over long distances was proposed as early as 1945 by the British scientist and science fiction writer, Arthur C. Clarke. The first of a series of experimental satellites to test the feasibility of satellite communications was launched in 1960, and within five years the technological foundation was laid for the establishment of a global system of communication satellites.

One of the first of these experimental satellites was Echo I, which was launched in August, 1960. Echo was an inflated sphere of aluminized mylar, approximately 100 feet in diameter. Two earth stations both of which could see the Echo satellite, could communicate with each other by bouncing radio signals off the satellite's reflecting surface. Although communications were successfully accomplished, it was not deemed practical to use passive satellites, such as Echo, for regular communications because of the extremely high transmitting power required and the resulting small capacity provided.

Another type of experimental satellite (Score, Courier, Telstar and Relay) contained active repeaters. These satellites received the signlas transmitted from earth stations, amplified them, and retransmitted them back to earth at a different frequency.

In addition, several of these satellites caused recorders to store messages received from an earth station for retransmission at a later time. This allowed earth stations to communicate with each other even though the satellite was not visible to both earth stations at the same time. Of course, telephone messages could not be handled by this method.

All these satellites were placed in relatively low altitude orbits. As a result, they could be seen simultaneously by two earth stations for only about 15 minutes at a time. This problem was solved by the Syncom satellites in geostationary orbits.

The Syncom satellites orbit at an altitude of 22,300 miles with zero inclination. The period of a satellite at this altitude is 24 hours so that it appears to be stationary with respect to the earth's surface, hence the name geostationary satellite. All earth stations that can see the satellite can communicate with each other for 24 hours a day. At this altitude, the range of service covers roughly a third of the earth's surface. Since Syncom, all communications satellites launched for regular service have been placed in geostationary orbits.

The Global Communications Satellite System

As a result of the success of these early experiments, the U. S. decided to make this techonology available to the world by establishing a global communications satellite system on a commercial basis.

In 1962 Congress passed the Communications Satellite Act which created the Communications Satellite Corporation (Comsat) and charged it with the responsibility of establishing the system on a commercial basis.

Two years later, on August 20, 1964, the International Telecommunications Satellite Consortium (INTELSAT) was established under the Agreements Establishing Interim Arrangements for a Global Commercial Communications Satellite System. From the original 14 signatories, INTELSAT has grown to a consortium of about 100 member nations.

The first of the commercial communications satellites, Early Bird, was placed over the Atlantic in 1965 and had a capacity of 240 two-way voice circuits, or a single one-way television channel. This satellite was an 85-pound cylinder 23 inches high and 28 inches in diameter and could be used by only two earth stations at a time. By January, 1971, nine additional satellites had been placed in orbit.

In contrast to Early Bird, the fourth generation INTELSAT IV satellite is a 1,500-pound cylinder 94 inches in diameter, with an overall height (including antennae) of more than 17 feet. This satellite can handle up to 9,000 two-way telephone conversations, or 12 television channels, and may be used by any number of earth stations at the same time.

The number of earth stations for use with this system have grown from five in 1965 to an estimated 74 in more than 55 countries by the end of 1974. U. S. earth stations are located at Andover, Maine; Etam, W. Va.; Jamesburg, Calif.; Brewester Flats, Wash.; Talkeetna, Alaska, Paumalu, Hawaii; Cayey, P. R.; and Guam.

The Communications Satellite Corporation

Comsat is a unique entity in the number of roles it plays. It is a private corporation, regulated by the FCC, that furnishes satellite circuits to other U. S. communications carriers. It was financed by an initial offering of 10 million shares at $20 a share. Half of these shares were purchased by U. S. carriers authorized by the Commission to own stock in Comsat and the other half by the general public.

The corporation is governed by a board of 15 directors, three of whom are appointed by the President of the United States and the 12 others elected by the carriers and the public stockholders. The number of directors selected by each group changes from time to time as stock is purchased and sold.

Comsat also is the official United States representative in the International Telecommunications Satellite Consortium (INTELSAT) and casts the U. S. block of votes in INTELSAT in accordance with U. S. policy as directed by the by the Department of State, the FCC, and the Office of Telecommunications Policy of the Exeuctive Office of the President.

In addition, Comsat serves as manager of the global satellite system with the basic responsibility for its planning and managing under the direction of the Interim Communications Satellite Committee, which represents the entire membership of INTELSAT.

Domestic Satellite Communications

To date, satellites have been used primarily for communications across intercontinental distances. In 1965, the American Broadcasting Companies, Inc., requested authorization for a domestic satellite system to distribute television programs to its affiliates throughout the United States.

Because of the difficult technical and legal issues involved, an extensive five-year inquiry was conducted by the Commission. This resulted in a policy decision that domestic satellite systems should be authorized to any qualified entity and subsequently satellite authorizations were granted to five applicants

The first regular domestic satellite services between United States points were provided by RCA Global Communications and its affiliate RCA Alaska Communications in December, 1973, by using capacity in a Canadian-owned satellite. The first two United States satellites (WESTAR I and II) were launched by Western Union in mid-1974. An RCA-owned satellite was scheduled for launch in December, 1975, to be followed in mid-1976 by a satellite jointly owned by Comsat and the American Telephone and Telegraph Company.

TELEGRAPH (OCEAN CABLE)

Invention

In fathering the telegraph, Samuel F. B. Morse also pioneered in submarine telegraphy. In 1842, over an insulated copper wire submerged in New York harbor, Morse demonstrated that electrical impulses could be sent under water. It remained for the perserverance of Cyrus W. Field to make the submarine telegraph cable practical. Transoceanic cable service was accomplished after many disappointments.

With capital obtained from private subscriptions in New York and London and, in part, appropriated by the British and United States governments, an attempt was made in 1857 to lay a cable under the Atlantic Ocean.

The cable broke after 335 miles had been laid out by a ship operating from Ireland. In June the following year, another attempt failed. Not daunted, these pioneers succeeded in laying the cable the following month. But it soon became inoperative. Another cable-laying effort, in 1865, proved futile.

On July 27, 1866, the steamship "Great Eastern" completed the laying of a new cable from Valentia, Ireland, to Heart's Content, Newfoundland, for the Anglo-American Telegraph Company. Returning to mid-Atlantic, the ship located and raised the cable used in the 1865 attempt, spliced it, and extended it to Newfoundland, where it was landed on September 8. Thus, America and Europe were linked by two cables.

Telegraph cable communication did for these two continents what the land telegraph accomplished domestically. International commerce was stimulated, and the exchange of news became a matter of minutes instead of weeks.

Other transatlantic cables were laid by the American Telephone and Cable Company in 1881 and 1882. Western Union entered the cable business by leasing these two cables in 1882. In 1884, the Commercial Cable Company put into operation two more Atlantic cables. Cable contact with Central and South America was established in 1882 by Central and South America Cables, the predecessor of All America Cables and Radio, Inc. The first transpacific cable from the United States, completed by the Commercial Pacific Company in the early 1900s, connected with Asia but was discontinued in 1951.

Construction

An ocean cable is not suspended from shore to shore. It is too heavy for that, so its rests on the bottom of the sea, miles deep, hugging submarine depressions and climbing and descending undersea mountains just as if laid on exposed terrain.

Whenever there is a break in a cable or disruption of service, engineering tests are made at the shore terminals and special ships locate the point of trouble, grapple for the cable, no matter at what depth, and hoist it aboard ship for necessary splicing or other repair.

With the advent of radiotelephone, underseas telephone cables, and satellite facilities, as well as new modulation techniques, the underseas telegraph cables have been phased out and no longer play a significant role in overseas communications. The major reason for this has been the greatly expanded capacity of the new facilities.

Since a single telephone circuit can be subdivided into more than 20 telegraph channels, three voice circuits in an underseas telephone cable have the same capacity as an entire underseas telegraph cable. A modern underseas telephone cable provides more than 800 telephone circuits, and satellite capacity is measured in thousands of circuits.

TELEGRAPH (RADIO)

Development

Guglielmo Marconi, an Italian inventor, began experimenting with wireless telegraph in 1890. Six years later he obtained an English patent, and in 1897, a British company was formed to exploit the idea.

In 1899, Marconi sent a radiotelegraph signal across the English Channel. This led to installation of wireless equipment on a number of ships. However, transmission range was extremely limited. In 1901, radio was employed for the first time to bring help to a ship--the "Medora"--which experienced difficulty in the English Channel.

Shortly thereafter (also in 1901), Marconi received the letter "S" sent from England to Newfoundland. This was the first successful transoceanic radio transmission.

The first transoceanic radiotelegraph service was established by the Federal Telegraph Company, a predecessor of ITT World Communications Inc. (formerly Mackay Radio and Telegraph Company, Inc.), in 1912, linking San Francisco with Honolulu.

Overseas radiotelegraph service developed slowly, primarily because the initial spark and arc sets were unstable in operation and caused much inteference. The Alexanderson high-frequency alternator and the De Forest tube solved some of these problems.

The United States Government took over all radio facilities in this country when it declared war on Germany in 1917, and throughout that emergency radiocommunication services were operated by the Navy.

On March 1, 1920, the day after the relinquishment of Federal wartime control, the Radio Corporation of America trasmitted its first commercial transatlantic radiotelegraph message, opening a direct circuit between this country and England.

As with underseas telegraph cables, the new higher capacity cable and satellite facilities have supplanted radiotelegraph for the most part. The radiotelegraph facilities in service today are used mainly to connect points not served by cable or satellite and as a backup to the newer facilities.

Ship-to-Shore Service

A major portion of radiotelegraph correspondence between ships and shore is handled in the continental United States and Hawaii by RCA Global Communications, Inc., ITT World Communications Inc., and Tropical Radio Telegraph Co.

REFERENCE MATERIAL

Those interested in greater detail about wire and radio communication services may obtain printed publications of the Federal Communications Commission. These are not distributed by the Commission but are sold by the Superintendent of Documents, Government Printing Office, Washington, D. C. 20402.

A list of FCC publications currently available from that source may be obtained from the Public Information Officer, Federal Communications Commission, Washington, D. C. 20554.

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