Communications at the Bicentennial

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The first 200 years of the United States of America encompass the entire history of electrical (and electronic) communications. From the dawn of history to the days of Paul Revere, a message could move only as fast as a man could run or his horse could gallop.

During those thousands of years, inventive men made valiant attempts to free communications from the bonds of land transportation speed. Alexander the Great came up with the forerunner of the loudspeaker, a giant "horn" which showed knowledge of the principle that sound can be transmitted for considerable distances by concentrating the waves and focusing them to travel in one direction. Julius Caesar sent military messages back to Rome by carrier pigeon. Roman soldiers also used a clever "torch telegraph."

African drum signals and Indian smoke signals were noble early attempts to break through the barrier of land travel speed...as were later ingenious "optical telegraph" systems, using signs, shutters and semaphores. A semaphore system from Staten Island to Manhattan in 1838 is, incidentally, thought to be America's first "communications system."

But all of these systems proved unreliable. Horns had limited range. Pigeons failed to make it home. Rain extinguished torches. Wind played tricks with drumbeats and smoke puffs. And fog shrouded semaphores.

Then, dramatically, man's growing expectations for some sort of electrical communication became a reality as, on May 24, 1844, Samuel Morse sent the first telegraph message over an experimental wire.

Suddenly man's message speed was freed from the limits of land transportation speed, and man could communicate across thousands of miles at close to the speed of light (186,000 miles per second).

During the last 200 years man has not only moved close to the ultimate goal of instant communications anywhere in the world but also has discovered and developed a variety of alternate ways to deliver messages at close to the speed of light.

And not only has all of this happened during America's bicentennial, but also the prime movers have been Americans—giants of invention like Samuel Morse, Alexander Graham Bell, Thomas Edison, Lee de Forrest, and many others.

In Washington, DC, on May 24, 1844, Congressmen, military leaders, and other dignitaries witnessed the first telegraph message over an experimental wire between Washington and Baltimore.

SOUND OVER WIRE

The bonds that had tied man's long distance communication speed virtually inextricably to land transportation speed were broken when Samuel Morse and his partner Alfred Vail perfected the telegraph.

In 1835 Morse completed a working model of his telegraph (from the Greek: "to write at a distance"). In 1837 he filed for a patent. And on May 24, 1844, Morse, using his now-famous code, demonstrated his telegraph with a wire stretched from Washington to Baltimore, tapping out the historic message, "What hath God wrought?"

The Baltimore-Washington circuit soon proved its worth as a means of rapid communication, but when Morse offered his invention to the Government for $100,000 the Postmaster turned thumbs down, unable to believe that the investment was sound. Private capital, however, clearly saw the possibilities and in practically no time covered the world with telegraphic networks which in the course of years earned great profits.

In 1861, while a politically divided nation was embroiled in civil war, Western Union, in an epic achievement of American enterprise, unified the Nation geographically with the completion of the first transcontinental telegraph line. "Experts" had said that it would take 10 years to build the 2,000-mile wire line from St. Joseph, MO, to Sacramento, CA. Two Western Union teams, building from both east and west, did the job in 3 months and 20 days! The famed Pony Express, which took 10 days to carry messages from St. Joseph to California, was suddenly obsolete.

By 1866 the Western Union owned 2,250 offices, and their original wires had expanded from 660 miles to 74,570 miles. And on July 27, 1866, the Atlantic cable laid by the "Great Eastern" came in at Heart's Content Bay in Newfoundland. By August America was linked to Europe by regular public telegraph service.

Alexander Graham Bell and his associate, Thomas Watson, are credited with developing the first working telephone on March 7, 1876. It is interesting that the 100th birthday of the telephone falls in the same year as the 200th birthday of the nation that spawned both the telegraph and the telephone in its first 100 years.

Alexander Graham Bell was born in Edinburgh, Scotland, on March 3, 1847. Both his grandfather and father were elocution teachers, and, as he grew

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up, Bell became deeply involved in the study of speech. While he attended the University of London, he used "Visible Speech" (a system of code symbols his father had invented) to teach deaf children to talk.

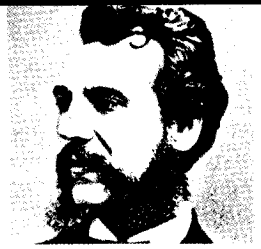
While teaching back in Edinburgh in 1866, Bell started a series of experiments on the changing resonancies within the human vocal cavities as the tongue moves in producing vowel sounds. In his research, he came across a book by Hermann von Helmholz. In his book, *Sensations of Tone,* the German scientist told about his experiments with electrically driven tuning forks and about how he had been able to produce vowel sounds mechanically with them. Bell didn't read German very well and he got the mistaken impression that Helmholz had, somehow, telegraphed these mechanical vowel sounds over a wire. Although Bell was soon aware of his mistake he couldn't seem to get rid of the idea.

Bell set up a little laboratory where he worked at night, trying to find a way to send several messages over a single telegraph wire simultaneously. Gardiner G. Hubbard and Thomas Sanders supported Bell in his experiments. The three men formed a company and the first thing they did was apply for two patents...which were granted...for improvements in telegraphy.

Bell, by this time, had moved his experiments to Charles Williams' electrical shop in Boston where Williams assigned young Thomas Watson to assist Bell in his work.

At first Bell was still working with what had developed from his mistaken interpretation of Helmholz' tuning forks. He was attempting to activate several different electrically produced tones on several different tuning forks at one end of a wire at the same time to be received by several similar tuning forks at the other end. Bell intended to call the result a "harmonic telegraph." It was the device for which his first patents were issued, but he was never able to make it work. He kept at it, however, substituting metal organ reeds for tuning forks when he decided that the forks were hopeless. Then, suddenly, there came the breakthrough as Bell reasoned that the reeds could possibly be made to vibrate sympathetically, like the strings of a piano, in response to a human voice.

At this point, Bell used his knowledge of the anatomy of the ear. He attached one end of his reed to a diaphragm which he had deducted from the analogy of the eardrum. He reasoned that as the reed vibrated in response to a modulated tone it should cause a current to flow, and that current had to vary in intensity. One day in June 1875, after experimentation with vibration reeds and diaphragms, Watson made the happy mistake of connecting one of the reeds too tightly. When he plucked at it to free it, another moment of scientific truth arrived. That plucking twanged along the wire to be heard distinctly by Bell at the other end of the wire who just happened to be holding another reed and diaphragm pressed tightly against his ear. Watson's twanging message must stand as the first



Alexander Graham Bell in 1876

Bell telephone.

Bell's first patent was issued on March 7, 1876, 4 days after his 29th birthday. Three days later, when he dropped a battery, spilling acid upon his trousers, Bell called out, "Mr. Watson, come here. I want you!" That was the first working telephone, sending the first understandable message consisting of human words along a wire, and interestingly enough, doing a useful communications job right from the start!

The first known telephone "exchange" was opened on Jan. 28, 1878, in New Haven, CT. The first female operator, Miss Emma Nutt, was hired Sept. 1, 1878.

The years of 1878 and 1879 were full of "firsts"—both for communities all over North America getting their first telephone systems and for the Bell people as they developed their first hard-drawn copper wire, first PBX, first pay station, first long distance call, and so on. As early as 1878 competition in the telephone business developed from the Western Union Telegraph Company through its newly established subsidiaries, the American Speaking Telephone Company and the Gold & Stock Telephone Company. These companies used Thomas A. Edison transmitters and Elisha Gray receivers. But by November 1879, again in a far-reaching agreement that very much shaped the course of the future, Western Union acknowledged the validity of Bell's patents and agreed to stay out of the telephone business. The National Bell agreed to buy Western Union telephone properties, and stay out of the public message telegraph held in territories occupied by WU. Bell stock rose from $50 a share to nearly $1,000!

Dial telephones—the first machine-switching telephones with finger wheels resembling those of today—were placed in service in the city hall at Milwaukee, WI, by the Automatic Electric Company of Chicago. Previous installations by this company, which had been formed to develop the Strowger patents, had simply utilized separate buttons.

By 1881, according to a telephone company report, "only nine United States cities of more than 10,000 inhabitants are without a telephone exchange."

By 1900 there were 855,900 telephones in the Bell System...and there were over 700,000 telephones being operated by over 5,000 independent telephone companies that had sprung up.

The total number of independent telephone companies rose to a high of 12,300 in 1910.

Since then, though, mergers and acquisition among independent companies have reduced the total from the peak of 12,300 to today's 1,641 companies operating 25,826,000 of the nation's telephones. The 25 Bell companies today operate 118,146,000 telephones.

CODE THRU THE AIR

While Alexander Graham Bell, Tom Watson, and their associates were filling America with telephones

The Ben Wood original drawings which illustrate this story are from Great Moments in Communication, *by Bruce B. Howat*

during the last years of the 19th century, others were already beginning to fill the air with sound.

At Tufts College in 1888, an American professor named Amos Dolbears first sent radio waves thru the air. To get distance he attached a wire to a gilt kite and sent it aloft as his "antenna." And later, using an old receiver from a Bell telephone and a homemade microphone, Dolbears was able to transmit understandable speech over a distance of ½ mile.

Dr. Mahlon Loomis was probably the holder of the first United States patent for a wireless system, which he operated between peaks of the Blue Ridge mountains.

But history hands its bouquets to those who make it "big," and something was going on halfway around the world in Italy that was to really write the next chapter in communication progress. Near Bologna a teenager named Guglielmo Marconi was starting to send signals thru the air.

Using the works of such giants as Galvani, Volta, Oersted, Faraday, Hertz, Edison, and others (including the kite-flying experiments of Ben Franklin and the "induction at a distance" discoveries of American physicist Joseph Henry), Marconi developed his homemade wireless set.

Born in 1874, Marconi, the introverted and privately educated son of a well-to-do Italian family, had become interested in electricity early in his teens. His workshop was a room at the top of his father's mansion. Not even his mother was allowed in.

When young Marconi's wireless signals were being received loud and clear across a valley—pulled in by an "antenna" formed by a loop of wire atop a tall pole—Marconi's father offered the invention to the Italian Ministry of Post and Telegraph. Like the American postmaster who turned down Morse's telegraph and Western Union President William Orton who ignored Bell's telephone, the Italian PT said "not interested."

So Marconi and his mother sailed to England, and there Sir William Preece, chief engineer of telegraphs in the British Post Office (and a wireless buff himself), gave Marconi a sympathetic hearing. In government-sponsored tests on Salisbury Plain, Marconi's black box sent signals which crackled across first 1, then 4, and finally, 9 miles.

Soon Marconi Wireless Telegraphy Company was formed with the 23-year-old Marconi getting a job, half of the stock, and the equivalent of $100,000.

Marconi brought his wireless to America in 1900 at the request of a Manhattan editor to cover a yacht race off the New York shoreline between Sir Thomas Lipton's *Shamrock* and America's *Columbia*. Just a month after the successful coverage of the race, the Marconi Company of America was founded in New Jersey with capital of $10 million, representing two million shares. The British parent company retained 365,000 shares, worth 5 dollars each. At 25 Marconi was a millionaire.

And just 1 year later, in 1901, Marconi was in St. Johns, Newfoundland, flying a kite antenna to receive a Morse code "S" (three staccato dots) transmitted across the Atlantic from a tower antenna he had built in Poldhu, England.

Wireless telegraphy had, indeed, arrived in America.

VOICE THRU THE AIR

Marconi's success in transmitting code messages thru the air inspired many to try to transmit voice messages thru the air.

One of the earliest—and most successful—was an American, Reginald Fessenden, a professor at the University of Pittsburgh who had worked for Thomas Edison at Menlo Park and then at Westinghouse.

Fessenden proposed a heresy: that the wave sent out not be a series of bursts made by interrupting the wave (as in the Marconi system) but, rather, a continuous wave on which the voice was superimposed as variations or modulations.

This Fessenden principle was the foundation of radio, and the real birth of broadcasting came in 1906 when Fessenden, backed by General Electric, put together a transmitting station at Brant Rock, MA.

It was another American, Lee de Forest, who earned history's bouquet as the "Father of Radio." After the self-educated de Forest got his Ph.D. at Yale in 1899, he began experimenting with a "triode" (a vacuum tube with three functional elements or electrodes—the filament, the grid, and the plate), and in 1906 he perfected it. His "Audion" multiplied electric current billions of times and made quality broadcasting possible.

Although the early going was tough because his financial backer collapsed, de Forest mounted a publicity campaign (equipping the U.S. Navy fleet with radio for a round-the-world tour, broadcasting from the top of the Eiffel Tower, and broadcasting Enrico Caruso live from the Metropolitan Opera stage) and kept his company alive.

In 1912 he demonstrated his Audion to Bell engineers. They offered him $50,000 for it, and in 1913 he sold it to them for $90,000. Later de Forest sold Bell all his remaining patents for $250,000. Soon Western Electric was making "radio telephone" tests.

By 1916 Bell and Marconi were in court over the use of de Forest's Audion, which, said Marconi, infringed on their diode tube, invented by Sir John Fleming. The outcome of the strange court decision was that neither Bell nor Marconi could use their tubes without the consent of the other!

About that time David Sarnoff was moving up the

In 1892 "dial" telephones became a reality. Invented by Almon Strowger, the new system connected calls using 5 buttons on the telephone.

ladder of the Marconi company. Gaining fame for his heroic 3-day stint at a telegraph receiver in Manhattan during the sinking of the *Titanic,* he worked tirelessly and showed great imagination.

The impasse between AT&T and Marconi over the use of the de Forest Audion was finally broken in 1921. Encouraged by the Navy (in the persons of Josephus Daniels and Franklin D. Roosevelt) which was not about to let American radio be controlled by a British Company, a "patent pool" was formed and a new corporation founded—with all board members United States citizens and no more than 20 percent of its stock in foreign hands. Its patriotic founders called it the Radio Corporation of America, and David Sarnoff was made manager of the commercial department.

Fessenden and de Forest might vie for the "Father of Radio" title, but David Sarnoff clearly earned the "Father of Broadcasting" title. As early as 1915 he had memoed his Marconi superiors suggesting the sales of $75 "music boxes" to receive radio broadcasts. In the early 1920's, as an RCA manager, he carried the idea forward.

In 1921 radio broadcasting stations began to spring up all over the United States. Westinghouse joined the RCA patent pool, and radio broadcasting was on its way.

Twenty-five years later there were 2,805 commercial radio stations on the air in the United States, 691 of them FM (another Edwin Armstrong invention). Today, 55 years later, there are 7,828 commercial radio stations in the United States (4,436 AM, 3,392 FM), and there are an estimated 400,000 radios in use in the country, 100,000 of them in automobiles.

PICTURES THRU THE AIR

At the New York World's Fair in 1939, RCA's David Sarnoff announced that television was no longer "just around the corner" and demonstrated that it was a present reality, arousing great public enthusiasm.

World War II intervened, but only served to make the demand for television greater when peace was restored in 1945.

A refugee from Russia, Vladimir Zworykin, went to work for Westinghouse in 1919. His passion was the development of the cathode ray tube, a "gun that shoots electrons." He perfected his "Iconoscope" (from the Greek *eikon,* "image," and *skopein,* "to watch") and, when Westinghouse became a partner of RCA, took his new invention to David Sarnoff, who immediately hired him.

By 1941 Farnsworth, General Electric, du Pont, Philco and Zenith were all ready to compete with RCA in building television sets. At war's end, in 1945, there were nine commercial television stations on the air, and 7,500 sets in use in New York City, Schenectady and Chicago. By 1955 there were 411 commercial TV stations and 11 noncommercial TV stations on the air. Today there are 706 commercial stations (514 VHF, 192 UHF) and 147 noncommercial stations (95 VHF and 152 UHF), and there are 121 million television sets in operation in the United States—64 million of them black-and-white and 57 million of them color. It is estimated that between 97 and 99 percent of all homes in the United States have at least one television set, with more than a third having two or more sets.

ALL THREE THRU SPACE

The crowning achievement in American communications has, of course, been the transmitting of all three—telemetry, voice, and picture—thru space.

Following early communications satellite experiments in the early 1950's, the Courier and Echo satellites, three Hughes Aircraft engineers—Harold Rosen, Donald Williams, and Thomas Hudspeth—led a team which developed the principle of synchronous satellites. In 1961 NASA awarded Hughes a contract to build Syncom I (launched Feb. 14, 1963) and Syncom II (launched July 26, 1963), the world's first successful synchronous satellites.

Bell Labs' "Telstar" was successfully launched and used in 1962, and on Aug. 31, 1962, President John F. Kennedy signed the act which created COMSAT as the United States entity in international satellite communications.

In 1965 the Hughes-built "Early Bird" (Intelsat I) was successfully launched, and America was sharing satellite communications with the world.

Success followed success. Today seven Intelsat IV and Intelsat IVA satellites are in orbit, bids are out for the Intelsat V series, and there are 121 earth stations in operation around the world in 72 countries.

Certainly the high point in the history of communications in the United States came on July 20, 1969, when President Richard Nixon made his historic telephone call to Astronauts Buzz Aldrin and Neil Armstrong on the moon.

And satellites are already playing a key role in United States domestic communications. Western Union has had Westar I and Westar II in orbit since 1974, and RCA has successfully launched RCA Satcom I, the first of its three satellites.

THE WORLD'S FINEST SYSTEM

During these exciting first 200 years of our Nation, American scientists and businessmen have developed the most marvelous communications system in the world.

Our progress in communications technology over the past 200 years has been...there is no better word...*wonderful,* really full of wondrous achievements. And there's more to come: faster facsimile, fiber optics, and a host of new communications tools.