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Come, my friends,
'Tis not too late to seek a newer world...
To sail beyond the sunset,
and the paths of all the western stars...

ULYSSES/Alfred, Lord Tennyson

MESSENGERS IN SPACE

By JOSEPH KRAEMER/Senior Consultant, Washington, D.C.

The U.S. space program officially began in October, 1958, when the National Aeronautics and Space Administration (NASA) was created. Eleven years later NASA put a man on the moon, and seven years after that a miniaturized laboratory was landed on Mars. These events were the high points in a series of accomplishments in space which spanned two decades. During that time, there were moments of national anxiety as countdowns wound to their fiery conclusions and moments of national pride when missions were completed without loss of life. The space program also provided moon rocks, Tang, former astronauts who are now celebrities, and a cape in Florida which has become a tourist attraction. Paradoxically, now that the space program no longer commands the attention and national resources it once did, the benefits of that program have begun to be evident in the field of communications.

The Background
In October, 1945, in the obscure British journal *Wireless World*, a writer named Arthur Clarke suggested that a space satellite positioned approximately 22,000 miles above the equator could act as a radio relay point from which service could be provided to one-third of the earth's surface. At that altitude, Clarke pointed out, it would take the satellite 24 hours to orbit the earth. Since that is the length of time necessary for the earth to complete one full rotation on its axis, the satellite would appear to be in a fixed position relative to the ground. As such, the satellite would be available to receive radio signals from an earthbound transmitter and to relay these signals to one or more receivers on earth.
The need to use a spacecraft to perform this function arose, according to Clarke, "...from a fact so simple and so obvious that one hesitates to mention it. The radio waves which are now our chief message-bearers travel in straight lines, like light itself. But the world, unfortunately, is round." This is another way of saying, you can't transmit earthbound messages—video pictures, data streams, facsimiles, or FM stereo music—from New York to Los Angeles without passing the signals through a series of radio relay towers, each within sight of one another, all across the country. Or, in another geographical context, to send a signal from New York to London would require a chain of some fifty ships bobbing in the North Atlantic, acting as the nautical equivalent of the relay towers on land.

This is the President of the United States speaking. ... My voice is coming to you from a satellite traveling in outer space. My message is a simple one. Through this unique means I convey to you and all mankind America's wish for peace on earth and good will toward men everywhere.

— DWIGHT D. EISENHOWER
Taped message from space
December 19, 1958

Communications satellites were given a high priority in the space program. In 1958, a Christmas message from President Dwight Eisenhower was broadcast to earth from a satellite, the message originating in an onboard tape recording. An aluminized balloon (Echo), 100 feet in diameter, was launched in 1960 to serve as a passive reflector of radio signals from a position 1,000 miles above the earth. Shortly thereafter AT&T's Telstar went into orbit as the first nongovernmental satellite. Live transatlantic television transmissions were originated via Telstar in 1962; the first program featured David Brinkley delivering European news to American viewers from Paris.

Joe Kraemer has been a major contributor to feasibility studies made by the Washington, D.C. office on the use of communications satellites by the Corporation for Public Broadcasting, the Public Broadcasting Service, and National Public Radio. He managed the extensive consulting support provided by the Washington office to the PBS project, and helped to coordinate the earth station site selection for 160 public television stations.

In response to President John Kennedy's proposal to create a global communications satellite system, Congress passed the Communications Satellite Act of 1962, which led to the creation of the Communications Satellite Corporation (Comsat) the following year. Comsat is owned partially by the public and partially by the large U.S. common carriers. It serves as manager for 95 member countries of the International Telecommunications Satellite Consortium (Intelsat), which has a total of eight communications satellites (four operational and four spares) in orbit today over the Atlantic, Pacific, and Indian oceans.

While Comsat represents U.S. interests internationally, three common carriers have orbited communications satellites in order to serve domestic U.S. needs. These are Western Union (Westar), RCA (Satcom), and Comsat General/AT&T (Comstar). NASA also continues to experiment with communications satellites. The high-powered Applied Technology Satellite (ATS-6) and the Communications Technology Satellite (CTS), a joint venture of the U.S. and Canada, are currently being tested in experiments over the North American continent.

The Advantages

A communications satellite acts as a relay station in space. Faint radio signals transmitted from earth are received, amplified, and retransmitted back to earth.

Each system consists of the satellite and two or more earth stations where the signals are received and/or transmitted. In general, the more powerful (and, therefore, the more expensive) the satellite, the less sophisticated (and, therefore, the less expensive) the earth stations. The cost trade-off between satellite power and earth station sophistication is fundamental to the future of communications satellites in this country.

Communications satellites enjoy certain inherent advantages over land systems. These are:

Flexibility. Earthbound communications, such as microwave relay links, are limited to point-to-point distribution, without the flexibility to change end points or simultaneously link several end points. Signals relayed from satellites, on the other hand, can reach a system of nationwide receivers simultaneously, as well as provide access to remote geographic areas (e.g., the Alaskan bush) and/or mobile receivers mounted on aircraft or ships. For example, a New York signal being relayed by satellite to Los Angeles can be received simultaneously (assuming earth stations exist) in Milwaukee, Memphis, Seattle, and Orlando. Such flexibility simply is not possible in a system which depends upon line-of-sight radio relay towers that stretch across a fluctuating landscape from horizon to horizon.
Capacity. A communications satellite can carry simultaneously the basic forms of telecommunications—telephone, data, telegraph, facsimile, teleprinter, television, and high quality stereophonic audio—and it can relay these forms across oceans where no terrestrial system exists. Intelsat IV-A, which is located 22,300 miles above the Atlantic, has the capacity for 6,000 simultaneous telephone circuits, which represents a 50 percent greater volume than the most recently developed transoceanic telephone cable. The satellite, by the way, can carry television signals, while the cable cannot.

Cost. Ground systems must follow a specific, physical path across the surface of the earth. Therefore, costs increase with distance. This is not true of a satellite relay system; costs for satellite use are largely independent of distance, since a satellite can cover an entire area the size of the United States.

Signal Quality. Signals transmitted across 3,000 miles via a series of terrestrial radio relays tend to lose quality as they are received, amplified, and retransmitted at each relay point. In contrast, a satellite system utilizes only a single relay point in the vacuum of space, so signal quality does not decrease. This is particularly important when transmitting television and stereophonic audio signals.

Three Systems

There are three types of satellite systems. The earth stations for some systems are equipped to transmit, as well as receive, while others are strictly receive-only stations. The type of earth station being used is the key to distinguishing which type of communication satellite system is being used.

Point-to-Point Systems. The typical earth station associated with a point-to-point system is located at Etam, West Virginia, where Comsat and four American common carriers have invested millions of dollars. This earth station has two parabolic antennas, each of which is approximately 100 feet in diameter. Etam is the most active earth station in the Intelsat network. It has the capacity to handle simultaneously 1,000 telephone circuits linking users in the U.S. to 40 countries in Europe, Africa, the Middle East, and Latin America. It exemplifies the large, expensive, complex earth station which is owned by a government agency or by a common carrier. These stations are connected with existing terrestrial communications systems and function as extensions of those systems for long distance (e.g., transoceanic) communications. Their cost is approximately $4 million.

Distribution Systems. Earth stations in distribution systems tend to be smaller and to cost less—from $75,000 to $100,000. These stations serve to provide connections between one or more transmit stations and a system of receive-only stations. The system which is currently under construction for the Public Broadcasting Service (PBS) is typical of a distribution type of system. When completed, the public broadcasting system will consist of one master terminal in Washington, D.C., where the signal originates, five regional receive/transmit stations, and 145 receive-only terminals. The antennas in this system will be only one-third as large—34 feet in diameter—as that used by Comsat at Etam. The system will be used to distribute PBS and other programming to public television stations throughout the 50 states, Puerto Rico, and the Virgin Islands. These stations will in turn retransmit the programs to home receivers by means of conventional TV transmitters. The satellite used will be one owned by Western Union, a portion of which will be under long-term lease to public broadcasting.

Broadcast Systems. In this type of system, powerful satellites beam signals to inexpensive earth stations, which may be located at central points (e.g., schools or municipal

Science and technology have progressed to such a degree that communication through the use of space satellites has become possible. Through this country's leadership this competence should be developed for global benefit at the earliest practicable time.

—JOHN F. KENNEDY
July, 1961
buildings) within a community or even located at the residences of individuals. While the latter is still in the future, the ATS-6 experimental satellite is used to provide educational and community services to sparsely populated communities in Appalachia, the Rocky Mountain area, and Alaska. The receive-only stations used with ATS-6 feature a 10-foot antenna; the cost of these stations is approximately $8,000.

The Issues

Communication satellite systems represent a potential benefit to U.S. citizens whose tax dollars underwrote the space program. However, the extent to which such benefit will actually reach these citizens requires the resolution of four basic issues:

—Who benefits?
—Who pays?
—What message?
—Controlled by whom?

The less complex and less expensive the earth station, the more complex, powerful, and expensive are the satellites required. To date, the common carriers with operational domestic satellites—Western Union, RCA, and AT&T—have opted for point-to-point systems. This approach involves high-cost earth stations. The satellite systems then serve to supplement the carriers’ already existing communications networks on earth. The investment in terrestrial lines made by the carriers (and the public, since this is a regulated industry) is preserved. The general public enjoys the advantages associated with communications satellites, pays for the service directly, and probably is never aware (nor cares) that the call made to Los Angeles from New York was routed via satellite rather than by land line.

Broadcast systems, such as ATS-6, are a distinctly different matter. So far, only the federal government has seen fit to orbit the kind of satellite which can be used for community services. Such services benefit the sparsely populated areas of the country which are poorly served by existing terrestrial communications. The users of the ATS-6 services are nonprofit organizations which, to date, have not been able to afford to pay the kind of rates which would encourage investment by the private sector. For example, the provision of in-service education courses to elementary school teachers throughout Appalachia distributed through low-cost earth stations appears to offer a social benefit. However, it is difficult to conceive of the cost of such a service being covered by the school districts involved without direct federal assistance in the form of both an orbiting satellite and available grants. The ATS-6 program thus offers direct benefits to the citizens of particular areas of the country with costs borne indirectly by the general public through their tax dollars.

The communications satellite systems constitute the medium to deliver a message. The question is: what message?

This is the problem faced by public broadcasting as it embarks upon connecting via satellite its nationwide system of television stations. Given the new system’s increased capacity, the higher quality signal, and the ability to simultaneously reach all parts of the U.S. which have a local public television station, PBS faces a challenge to develop the kinds of imaginative programming which use the system to full advantage. One suggestion has been Spanish language programming to link the widespread Spanish population in the Southwest, the Southeast, and the Northeast. This will be possible, once the PBS satellite distribution system goes operational in early 1979. (Should the commercial networks—ABC, NBC, CBS—even choose to utilize communications satellites for simultaneous distribution to network affiliates, they would face the same kind of programming challenge as does PBS.)

The issue of control has both a domestic and an international aspect. In this country, non-governmental communications satellites are regulated by the Federal Communications Commission (FCC). Such regulation is similar to that involved in regulating land lines—approval of tariffs, licensing, and assignment of frequencies. Communications satellites have become embroiled in the current debate over the public benefits of regulation per se. To some, the FCC has not moved fast enough to allow the private sector to exploit new communications satellite technologies,
while to others the FCC has failed to aggressively protect the public interest.

International control also poses questions which are difficult to answer. They arise when satellite systems broadcast directly to community and/or individual receivers. Such systems are planned or in use in India, Pakistan, Indonesia, and Brazil. The problem is that the powerful satellites required for such systems will "spill" programming over into other countries. Although the problem is a future one, it was included in the agenda of a recent international conference on communications satellites. The problem was posed in terms of a broadcast of a Spanish bullfight which "might be acclaimed in Latin America, but be unacceptable to the Indian government."

A single object—the communications satellite—can change the lives of millions of people. Floating thousands of miles above the earth, it can carry telephone conversations, telegrams, and television programs to places where modern communications are now a distant dream.

—CARNEGIE ENDOWMENT FOR INTERNATIONAL PEACE

The Future

Sputnik was orbited in October, 1957. Twenty years, billions of dollars, and many headlines later, the benefits of the space effort are just beginning to become evident. Even now, in the words of *Fortune* magazine, "...the bulk of satellite services simply substitute for conventional land lines. Many of the basic technical possibilities, obvious for years, remain just that—possibilities." This situation would appear about ready to change. Some of the more interesting things on the horizon are:

The entry of Satellite Business Systems (SBS) into the domestic business world is scheduled for 1981. SBS is a joint venture of IBM, Comsat, and Aetna Life Insurance. It will feature two or three powerful satellites transmitting to small rooftop antennas at high frequencies not susceptible to interference from existing terrestrial systems. The SBS system will be oriented to serve the communications needs of large corporations. According to *Fortune*, the earth stations are expected to cost over $300,000, half of which will go for the "satellite communications controller," which will administer the stream of data being transmitted and received. Although advent of the SBS system will not benefit the public directly, it does have the potential to revolutionize how American business communicates.

The year 1979 will see the first television network—the Public Broadcasting Service—abandon its land lines and switch over to Western Union’s Westar. The public will finally be in a position to enjoy the advantages of continuous distribution of television signals via satellite.

The public is already benefiting from the combination of cable television and communications satellites. Special events (e.g., a heavyweight prizefight) are being transmitted live from their city of origin via satellite to earth stations which are owned by cable television companies, who then distribute the event over their cable systems. This combination of satellite and cable has the downstream potential to destroy the virtual monopoly of home entertainment by the three commercial over-the-air networks.

In another development, use of the "electronic letter" will be expanded. The current use of paper to send correspondence has seemingly overwhelmed the U.S. Postal Service. Rapid transmission by communications satellites could reduce correspondence to electronic impulses which are transformed into words and printed at the receiving earth station. This has the potential to affect the manner—and speed—in which both business and individuals correspond.

Finally, the cost and size of earth stations will be decreased. Intelsat has authorized the use of 30-foot antennas (instead of 100-foot) at the new earth stations to be used with the Intelsat V family of satellites. National Public Radio plans to use 15-foot antennas for a distribution system it expects to be operational early in the next decade. The Mutual Broadcasting System radio network has announced a plan to use 10-foot antennas to distribute news and special events coverage to member stations. Smaller antennas mean lower earth station costs, which should facilitate use of the new technology by the general public who financed its development.

Possibly the best approach to what the future holds can be found in the words of Arthur Clarke, whose 1945 article started it all:

Of the many lessons to be drawn... the one I wish to emphasize is this. Anything that is theoretically possible will be achieved in practice, if it is desired greatly enough... To do this—to avoid that failure of nerve for which history exacts so merciless a penalty—we must have the courage to follow all technical extrapolations to their logical conclusion... To predict the future we need logic; but we also need faith and imagination, which can sometimes defy logic itself.