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ADVANCED COMMUNICATIONS SATELLITE: THE NEXT GENERATION OF COMMUNICATIONS SATELLITES

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ABSTRACT

The communications satellite industry has looked to NASA in the past for leadership in technology development. Since the launch of NASA's last experimental satellite in the 1970's, the competitive edge for the United States has started to slip and the advancements in communications satellite technology have started to lag. With the launch of the Advanced Communications Technology Satellite (ACTS) in 1989, NASA moves back into the forefront in experimental satellites while providing opportunities to test the latest in satellite technologies: scanning multibeam antenna, advanced switching and processing systems, and narrow spot beams. The success of the ACTS program depends on the interest and participation of public and private sector corporations, universities, and government agencies to test and evaluate the key technologies over a two-year period of experimentation following the launch.

Final comments concern the planning and utilization of telecommunications. Capacity, economics, and program relatedness are pointed to as keys to proper integration when exploring telecommunications alternatives.

ACTS: THE NEXT GENERATION OF COMMUNICATIONS SATELLITES

This morning, I represent the Public Service Satellite Consortium and would like to share with you information on the "next generation of communications satellites: the Advanced Communications Technology Satellite program" or ACTS program as we call it. At PSSC, I am the ACTS Librarian and have been with the program for three months.

When PSSC was created in 1975, satellite communications applications in the public service sector were still novel. Members joined to form a united front to further the uses of this new technology and to take advantage of PSSC's specialization in nonprofit issues and interests.

Today in 1985, satellite technology is entering a new era while at the same time competing with a burgeoning number of alternative technologies. This proliferation of transmission and distribution systems, along with related hardware and software, has meant that PSSC's services continue to be in demand.

In keeping with the trend toward informational activity, PSSC has added a number of member services in the past year. New services include:

1. Regular member briefings via audioconference on selected pertinent subjects;

2. Discounted rates and technical assistance in using the Confertech International Audioconferencing Bridge now installed in PSSC's Washington office;

3. Access to Scan-Net, a slow scan television teleconferencing network;

4. Opportunities to participate in NASA's Advanced Communications Technology Satellite experiments and other new projects; and

5. Opportunities to participate in conferences and workshops at discounted prices.

These services reflect PSSC's efforts to offer members opportunities to experiment with a variety of alternative technologies at reduced cost, along with the informational services necessary to use them.

PSSC continues to track current telecommunications-related legislation and regulation, and is called upon semi-regularly to share the views of the public service sector with congressional committees on matters relating to telecommunications issues. In addition to maintaining and serving its membership, PSSC has conducted a number of projects for both member and non-member clients. The most prominent by far has been PSSC's roles as ACTS user experiment evaluation and coordination support for NASA. PSSC has negotiated with NASA for multi-year funding which reflects the long-term nature of this project.

As ACTS user experiment evaluation and coordination support, PSSC functions as a matchmaker between potential experimenters and the NASA experiments development team. Almost 70 companies and organizations with requirements for high volume electronic data transfer, high resolution television, distributed computer processing, as well as mobile and emergency communications have been recruited as experimenters on the satellite.

PSSC also functions as a consultant. Other projects and studies conducted by PSSC include:

1. A study for the Mississippi Authority for Educational Television to determine the feasibility of establishing a statewide library

telecommunications network;

2. A study for the marketing division of COMSAT General on setting up a database of potential clients and competitors;

3. Technical assistance to the National Space Technology Laboratories in development and implementation of a worldwide database network for the United Nations environmental program's project grid.

4. Assistance to NASA in identifying and evaluating alternative to ATS-1 Satellite for communication by education and governmental agencies in the Pacific basin.

5. A study for WCNY-TV/FM to determine the market feasibility of purchasing an uplink and establishing transmission services for the central New York area; and

6. Technical assistance to National Communications Services to establish an emergency by-pass phone network as an alternative to existent telephone trunk lines in the event of a national disaster using PSSC's transportable earth station and fixed uplink.

The PSSC headquarters is in Washington, DC while the technical center located in Denver, Colorado operates a fixed/steerable earth station for satellite video/audio uplinking and downlinking, plus a transportable earth station capable of facilitating satellite transmission from virtually any location. Through the use of these two earth stations, PSSC has been able to transmit continuing education programs, news, sports, music, entertainment, a variety of video-teleconferences and emergency relief information.

Telecommunications via satellite is now in its third decade and has revolutionized our lives in highly visible and more subtle ways. Most people now take for granted live coverage of news and sports events from the four corners of the world via communications satellites. But few appreciate the fact that the same technology reduces the cost of domestic and international telephone communications; makes widespread distribution of entertainment programs and wire service information commonplace; provides reliable and instantaneous communications between shore stations and ships; and enables rapid restoration of communications with areas of the world ravaged by nature, as in the recent Mexico City earthquake.

Following the opening of the space age by the Soviet Union's SPUTNIK Satellite in 1957, NASA became a prime mover in a series of experimental space communications projects in the early 1960's: ECHO - which demonstrated two-way reflected transmission; COURIER - which accepted and stored data for later transmission to the ground; RELAY - which received and transmitted simultaneously from a low earth orbit; and

SYNCOM - the first communications satellite at geosynchronous altitude. Out of this work came the spacecraft and earth station technologies that make today's satellite communications possible.

After the successful demonstration of SYNCOM II, the privately owned Communications Satellite Corporation (COMSAT) was created by Congress and given the mandate embodied in the Communications Satellite Act of 1962: "To establish a global commercial communications satellite system in conjunction and cooperation with other countries via the Intelsat Organization." When the first Intelsat became operational in 1965, only five countries had access to the satellite; today over 150 countries are full-time users of global satellite services. The success of Intelsat in providing cost effective communication services and the continuing advances in technology gave impetus to the U.S. domestic satellite industry. Since the launching of WESTAR 1 in 1974, 22 U.S. domestic satellites have been put into operation, and their number is growing.

NASA's role in satellite communications remained in high gear through the middle 1960's and early 1970's as six applications technology satellites and one communications technology satellite were developed and launched. These demonstrated several innovations including communications to mobile receivers and TV broadcasting to small portable earth terminals. In 1973, the NASA program in satellite communications technology was phased down considerably based on the belief that the private sector would carry on the future development.

Indeed, the communications industry did make note-worthy advances; such as the number of circuits per satellite was increased, satellite weight per circuit was decreased, antenna design was improved, frequency reuse was achieved, and varying degrees of access to satellites was also achieved. As noteworthy as these advances are, they were undertaken by industry because they offered 1) a modest risk for the cost, 2) a relatively near-term market payoff and 3) affordable development costs. The private sector's ability to fund long-term high-risk, and high-cost satellite communications research is limited. The proliferation of communications satellites supplied by U.S. industry has provided the United States with a substantial competitive edge in this market over others; that lead, however, is now being seriously challenged.

With efforts by the Japanese and similar efforts in Europe, particularly in the areas of "spot-beam" technology and "Ka-band" advances, it has become clear that without appropriate government support the U.S. lead in satellite technology, systems, and market share will be lost. The factors leading NASA's re-entry into satellite communications research and development are multifaceted and interrelated, but of foremost significance is the recognition that the present rapid growth of domestic voice, data, and video traffic addressable by satellites will exceed the capacity of conventional satellites within a decade. As of a year ago, applications before the Federal Communications Commission contained requests for permission to launch more that 60 additional satellites, although the limited geostationary arc above the U.S. will not support such a large number. Therefore, we must look to tomorrow's technology needs, today.

Communications satellites were first conceptualized by Arthur Clark in 1945 and were tested in the early 1960's. The communications satellite concept centers on using a satellite as a radio relay between earth stations and taking advantage of the satellite's view from space to provide wide area communications services. To permit the satellite to appear as a fixed relay station to its earth stations, it must be placed in a geostationary orbit. This orbit forms a ring around the earth's equator and is over 22,000 miles deep in space.

Early communications capacity was severely limited by satellite power and weight limitations. The limited satellite power and the enormous distances involved also dictated that earth stations use high-power transmitters, large antennas, and very sensitive receivers. Advances in technology permit today's satellites to relay thousands of simultaneous conversations to small earth stations, which are now familiar sights throughout the country-side. The wide-band signals used to transmit communications are beamed to the satellite on an assigned earth-to-space uplink frequency; the satellite receives the signal and re-transmits them on a downlink space-to-earth frequency to an earth station that may be thousands of kilometers away from the transmitting earth station.

Current communications satellites operate in the microwave region of the radio spectrum in the "C" and "Ku-band," well above the band used for UHF television broadcasting. This means that satellites used for communications within the U.S. must be located in that portion of the geostationary orbit which is directly above the U.S. Continued growth of satellite supported domestic services and their accompanying benefits can only be achieved if additional capacity can be drawn from our geostationary arc and allocated two-degree space frequencies. Such capacity increases must be accomplished by more effective use of the "C" and "Ku-bands" and by use of other frequency bands, such as "Ka-band" --- the next higher band allocated for satellite communications.

Unlike today's conventional satellites, which cover the continental U.S. with a single, stationary antenna coverage pattern, advanced antenna technology could enable future satellites to concentrate communications capacity into narrow spot beams. Each beam would provide coverage over a spot only a few hundred miles in diameter, and the spacing of these spots across the country would allow use of the same frequency in many beams, hence, frequency reuse. Further technology advances could enable, not only fixed spot beams, but also beams that would be scanned across the country, with the capacity of the beam divided according to the demands of users at different locations. By adjusting the time a beam would dwell on any one location, very efficient use could be made of available satellite capacity. Switching on-board the satellite could provide complete interconnection between the beams, either fixed or scanning. Such frequency re-use could expand the capacity of future satellites by a factor of 5 or 10 times that of today's satellites.

Commercial implementation of "Ku-band" technology advances could also significantly expand available communications satellite capacity. Allocated frequency bandwidth at the "Ka-band" is over two times larger than the combined bandwidths' of the "C-" and "Ku-bands".

NASA's ACTS program is in response to the following needs:

1. To provide advanced technology that will help increase satellite communications capabilities and ensure continued growth in cost effective services,

2. To verify the technology and economic feasibility of innovations for new and existing frequency bands,

3. To provide technology that will reduce the technical risk of improving system effectiveness in using the geostationary orbit allocated frequency spectrum, and

4. To assure that the U.S. can continue to effectively compete in this market.

To these ends, the NASA program is structured to:

1. Establish a government-industry working relationship,

2. Provide for intensive interaction within industry, and

3. Enable technology transfer.

As a final phase in the technology development process, selected technology will be tested in an ACTS experimental flight system to be launched by shuttle in 1989. NASA has initiated the flight experimentation phase of ACTS by signing a contract with an industry-team headed by RCA's astro-electronic group in Princeton, NJ. Other members of the contract industry-team includes TRW, who is responsible for design and development of the multibeam communications package; COMSAT, is responsible for the design and development of the NASA ground station, master control station, and for operations and maintenance during the 2 year experiment period; and Motorola, who is responsible for the base-band processor. RCA is responsible for the spacecraft bus and for integration and test of the system. NASA is currently soliciting an expression of interest from organizations interested in potential experimentation with the ACTS system.

An expression of interest to participate in the program does not require a commitment at this time. That commitment would be required later in response to the NASA ACTS experiment opportunity notice, presently scheduled for 1986. More that 70 experimenters have responded to date and experiments outlined cover a broad spectrum. They include enhancement of interoffice business management, high-speed computer-to-computer data transfer, and determination of ground terminal hardware performance, as well as more scientific endeavors such as rain attenuation studies. NASA will help experimenters in the technical design of their experiments.

The 2-year experimentation period planned after launch will allow public and private sector corporations, universities and government agencies to test and evaluate the key technologies of the ACTS system: the scanning multibeam antenna, advanced switching and processing systems, and narrow spot beams.

Benefits of this technology are expected to be felt in the following emerging industries:

1. Customer premises services
2. Flexible trucking
3. Shared tenants services
4. Efficient international communications
5. Rapid data base access and transfer
6. Commercial video distribution
7. Emergency communications restoration
8. Mobile communications
9. Electronic mail
10. Teleconferencing
11. Distributed computer processing
12. High definition television
13. Electronic data transfer.

We need your support as experimenters in the ACTS program. If there are those of you who are interested in developing a marine science experiment, please see me after the program for further information.

Now for a few comments on the future, planning, and telecommunications. Telecommunications planning and utilization in the public service sector has evolved to the point where individual organizations rarely possess the inhouse expertise necessary to match the increasingly sophisticated needs with the right technologies. This situation is true not only for public service organizations, but for government and the private sector as well. Basic issues in planning and developing telecommunications systems and services apply across the board, and all sectors can benefit from each other's experiences.

Until recently, a call to the telephone company was all that was needed to satisfy most telecommunications needs. Today, taking into consideration more complex technologies, the breakup of the Bell System, fierce competition between long distance carriers and more sophisticated user needs, the demand for alternative sources of information becomes evident.

The first emphasis is on telecommunications capability and availability. What is the purpose; what are the costs; what is the organization able and willing to pay. Then equivalent capability must be looked at: what does the organization currently have; what are the costs to upgrade;

who makes the communications decisions? The communications decision making process in the public service sector is very different from that in the private sector. Usually funding is provided through some type of government grant. What are the prospects of continuation? These are issues that continually hound public service organizations.

Economic questions are ultimately the bottom line. Does an institution pay now or later; what are the funding sources; how consistent and flexible are the financial and budgetary practices, particularly at the local or state level, that support many of the public service organizations; what are the tradeoffs and what must be sacrificed?

Programmatic concerns are probably the essence of any new dedicated system, particularly those used for courses of study, skills training or continuing education. As the industry has learned from its experience with direct broadcast satellites, it was not the technology that caused the dropouts, but the inability to come up with the appropriate program to feed the system. Users, consumers and providers must constantly be on the lookout for program sources to support and justify the investment in the technology.

In addition to economic and programmatic concerns, legal implications regarding telecommunications must be taken into consideration, particularly when the system involves electronic distribution, copyright and confidentiality. These are just selected examples of questions that PSSC uses to help its clients understand what is available; what are the tradeoffs; what are the alternatives; what are the associated costs of moving from a traditional system of program and service delivery to a more sophisticated telecommunications based system?

Adoption of a telecommunications system means that something is not only a part of day-to-day operations, but an integral and supported part. Employees must be trained and there must be a master plan. This is ultimately what PSSC strives for in working with organizations that are exploring new telecommunications alternatives. The companies must be guided from an awareness phase to a phase of adoption where the technology becomes an integral part of the operations.

A tremendous amount of new technology is sitting in closets being wasted. Computers are probably the best example. Companies have overbought, and the machines are being used primarily for word processing while their larger capabilities go to waste. Part of the problem is a lack of training opportunities leading to true understanding and utilization.

In summary, PSSC has reached the conclusion that a classic marketing problem exists between the telecommunications' industry and its public. Its public has needs and does not quite know how to go about finding a solution that will be correct in terms of capability, benefits and alternatives, and cost. To answer its needs, the public must continually seek to be up-to-date in awareness of the appropriate technologies and their application through seminars and workshops and exhibitions. When access to information is not available, be encouraged to seek the advise and assistance of specialists. Thank you very much for the invitation to speak here today.