PUBLIC SERVICE SATELLITE COMMUNICATIONS OPPORTUNITIES

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Abstract

A Public Service Communications Satellite study has been undertaken at the NASA Goddard Space Flight Center (GSFC) to define the problems and opportunities of a renewed NASA role and the form such NASA involvement should take. Civilian communications satellite technology could be applied now to the betterment of life on earth. Citizens who reside in remote regions do not enjoy the quality of public services available to those in more densely populated areas. There are people in the United States without access to the normal communications services (telephone and television). There are people in thinly populated rural areas that lack the services of medical professionals enjoyed by urban residents. The use of satellite techniques holds tremendous promise for increasing the effectiveness of public safety personnel by enabling more rapid response and coordination to emergency situations. Small portable, mobile, and hand-held communication devices are an essential ingredient for efficient services for ambulances, police, fire and rescue vehicles.

Background

The National Aeronautic & Space Administration (NASA) was actively involved in the development of communications satellite technology from its inception until January 1973. During that period NASA developed several low-orbiting satellites as well as the first geostationary communications satellite, Syncom. This geostationary satellite led to the commercial implementation of both new international communications satellites (Intelsat) and domestic communications satellites. NASA pursued the development of technology with the Applications Technology Satellite (ATS) series of which ATS-1, -3, -6, are still being used to perform satellite communications experiments and demonstrations. NASA cooperated with Canada in the development of the Communications Technology Satellite (CTS) which is also being used for experiments and demonstrations.

A Public Service Communications Satellite study has been undertaken at the NASA Goddard Space Flight Center (GSFC) to define the problems and opportunities of a possible new NASA program and the form such a program should take.

The concept that has evolved has resulted from careful consideration of experiments that have already been undertaken on existing satellites, information obtained at a Users Requirements Workshop[1] held in October 1976, and other information.

Opportunities

The United States has failed to exploit civilian communications satellite technology already developed at taxpayers' expense. This technology could be applied now to the betterment of life on earth. Citizens who reside in remote regions do not enjoy the quality of public services available to those in more densely populated areas. There are people in the United States without access to the normal communications services (telephone and television). There are people in thinly populated rural areas that lack the services of medical professionals enjoyed by urban residents. There are people in remote areas that receive inferior educational services. During times of emergencies and disasters, communications for warning and coordinating are often inadequate. Some opportunities are shown in Figure 1.

One opportunity for a public service communications satellite system is the direct delivery of health services. Spiralling costs, lack of public confidence, archaic practices, and increasing demands for greater service from an overburdened health care delivery system have set the stage for a potential future crisis in health care. The application of communications satellites could eliminate some and ameliorate many of these problems. The use of satellites could result in better emergency medical services in rural areas, better utilization of expertise in large urban medical centers, the wide broadcast of preclinical sciences to student audiences on a regional basis, implementation of a continuing medical education system, the availability of expert consultation in medical specialties for the rural primary care physician, the rapid daily transmission of data and the transmission of advice from a remote specialist to the emergency medical technician at the scene for real-time decision making.

A public service communications satellite system offers the potential for increasing the delivery of education services. Productivity losses exist at all levels of education with fewer students, more teachers, more administrators and increased pay for school personnel with no comparable increase in student test scores. Direct reception from communications satellites has the potential for increasing teacher effectiveness and broadening the spectrum of educational opportunities.

The use of satellite techniques holds tremendous promise for increasing the effectiveness of public safety personnel by enabling more rapid response and coordination to emergency situations. Small portable, mobile, and hand-held communication devices are an essential ingredient for efficient services for ambulances, police, fire and rescue vehicles.

Specifid health care communications requirements include voice broadcasting for patient and community health education; two-way voice interaction for doctor-patient communications and emergency mobile medical communications; data transfer for computer data bank files of patient records and medical practice information in fields such as epidemiology and pharmacology; and broadcast television for professional and para-professional education, telediagnosis and communications between physicians, health care centers and patients. Confidentiality is required for many applications.

Education communications requirements include audio broadcast for students, teacher training, and continuing education; data transfer for the transfer of students records, student instructional material and computer aided instruction; television broadcast for classroom students, in-service teacher training, occupational and continuing education, education of the handicapped, mass distribution of professional society meeting materials, and inter-school teleconferencing; two-way interactive television for students requiring special instruction and teacher-educator collaboration.

Public safety communications requirements include voice broadcasting for disaster alerting and safety education; two-way audio for emergency mobile communications; data transfer for transferring criminal history files, criminal justice planning, intelligence and laboratory data, fingerprints, mug shots, and administrative information; television broadcasts for remote area self-protection and safety training, disaster training and other in-service professional training; and two-way video for surveillance of special situations. Many of these applications require confidentiality and secure communications.

State and local governments require radio and television broadcasts for education of government personnel and the public. Two-way radio is required to coordinate emergency situations. Data transfer is required for multi-agency and multi-state access to data banks. Arraignment of people in locations remote from the courts can save both energy and manpower.

Library services require radio broadcasts for public information transfer among users; data transfer for access to computers and large data banks; and television braodcasting for public instruction, library training and extension education.

System Concept

The program to take advantage of the above opportunities would provide the technology and mechanism for demonstrating and evaluating communications with small affordable stationary, portable, and moving ground terminals. The stationary terminals will serve the health, education and other public services provided by federal, state and local government agencies and nonprofit organizations. Portable terminals could be set up during emergencies and disasters. The mobile terminals would serve moving vehicles for emergency medicine, safety, and law enforcement needs.

The system concept has been developed to provide communications between any two points in the United States with both fixed and moving terminals on a continuous twenty-four hour basis. The communications available would include two-way video service between the stationary terminals and two-way audio service between the mobile terminals.

The system concept has been developed in a manner that is compatible with the capabilities of realizable technology and with the existing spectrum regulations.

The system concept based on the user requirements for stationary terminals includes operation at Ku-Band (14 GHz up, 12 GHz down), the use of a 1.8 m diameter earth terminal antenna, use of 100 W spacecraft traveling wave tube transmitters, and simultaneous coverage of the United States using four regional beams for continental United States plus spot beams for Alaska, Hawaii and Puerto Rico. In addition, two movable spot beams would be provided for special regional experiments. Each regional zone beam would utilize a 100 W transmitter while the spot beams would be served with 30 W transmitters. The ground station would utilize a 200 W transmitter for transmission of a video signal and a 10 W transmitter for audio. This ground receivers would have approximately 600°K noise temperatures.

The services for moving terminals would be implemented at UHF (900 MHz). The mobile terminal would have an omnidirectional antenna and a 10 W transmitter. The spacecraft would have an antenna with a continental U.S. beam and a 300 W transmitter.

This system concept requires the development of some new technology. Among the more significant developments are the design and realization of low-cost ground terminals to minimize the entrance fee for new satellite communications users. The 860 MHz land mobile service is a space capability not presently available. Multiple access and modulation studies and technique development are required to accommodate a large number of low duty cycle users for this mobile service. Public safety users require use of secure communications techniques.

The Ku-Band communications between stationary terminals also requires the development of low-cost ground terminals. Beam switching will be implemented so that uplink signals into any one of the beams can be rebroadcast to any one or more down-link beams. A beam switching or scanning technique will be required to move the regional spot beams over the U.S. Multiple access and thin route techniques will be needed to accommodate rural telephone service. Telemedicine users require implementation of privacy techniques.

These communications services will require the development of some spacecraft technology. The simultaneous operation of all transmitters will consume over 2 kW of dc power. A Ku-Band antenna with surface tolerances of the order of 2 mm and a diameter of approximately 2 m is required. The UHF antenna will have an elliptical aperture approximately 5 by 10 meters. Precise attitude control and station keeping (0.05°) will be needed to permit the stationary ground terminals to remain unattended in a fixed position.

The system concept is shown in Figure 2.

Reference

1. Wolff, Edward A. (Ed.), Public Service Communications Satellite User Requirements Workshop, Final Report, NASA Goddard Space Flight Center, October 1976.

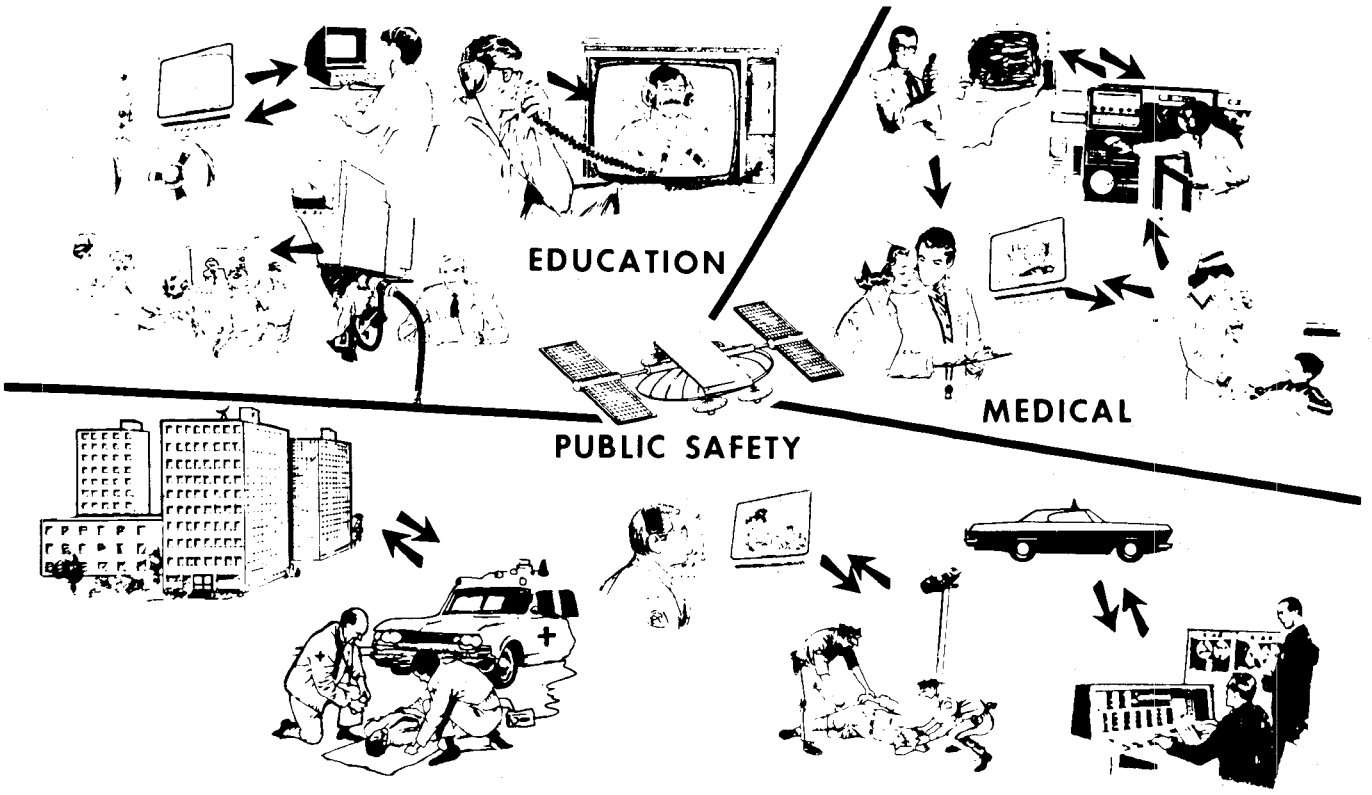
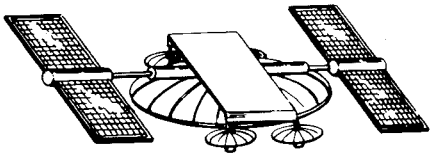


Figure 1. Opportunities



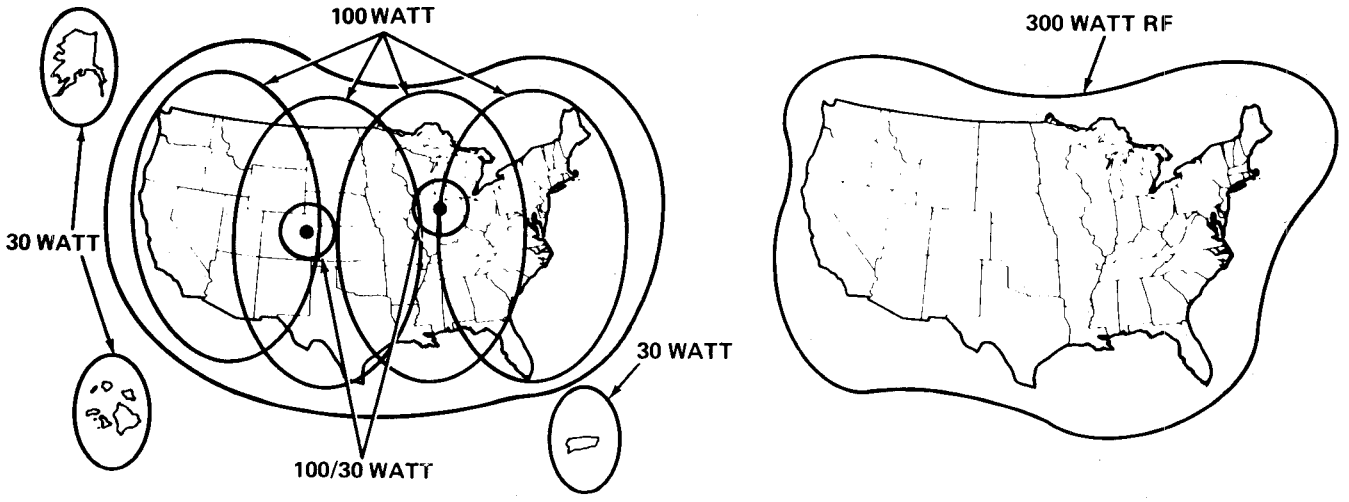


Figure 2. System Concept