The Return of PEACESAT

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This paper discusses the return of PEACESAT Program, the use of the GOES-3 satellite provided by the National Oceanic and Atmospheric Administration, and the status of the PEACESAT Sites.

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1. ABSTRACT

The Pan-Pacific Education and Communications Experiments by Satellite (PEACESAT) Program was founded by the University of Hawaii in 1971 and provided a single-channel, push-to-talk satellite telecommunications network which served over twenty Pacific Island locations. PEACESAT used the ATS-1 satellite for the exchange of social, environmental, health, and educational information until August 1985, when the satellite ran out of station-keeping fuel and had to be silenced.

In 1987, the U.S. Congress appropriated funds to the National Telecommunications and Information Administration (NTIA) of the Department of Commerce for the restoration of PEACESAT service. Through the cooperation of the National Oceanic and Atmospheric Administration (NOAA), another division of the Department of Commerce, PEACESAT service is now being reestablished using the S-band frequencies of the GOES-3 satellite. The satellite was repositioned to 175 degrees West longitude; and new, low-cost earth terminals were developed to work at the GOES frequencies by a manufacturer in New Zealand. NTIA funded the purchase of twenty-seven terminals for the purpose of restoration of PEACESAT in the Pacific Islands. With the GOES system, signal quality and system flexibility are greatly improved from the ATS-1 technology. Each PEACESAT user has the capacity for selecting one of several program networks at a time, including voice or high speed data transmission services, and is able to transmit one channel of voice or data at a time.

2. BACKGROUND

When NASA Launched its first Applications Technology Satellite (ATS-1) in 1966, nobody in the Pacific area even dreamed that it would serve to introduce communications by satellite to the small island countries of that vast area. However, three years later NASA completed its experiments, and requested proposals for additional experiments to be conducted on the satellite. The University of Hawaii submitted a proposal to conduct the Pan-Pacific Education
and Communications Experiments by Satellite. In 1971 the proposal was approved, and the PEACESAT Program was born. For the next fourteen years, until August 1985, PEACESAT provided educational, medical, environmental and emergency communications to non-profit organizations in the Pacific Islands on a non-cost basis. Operating in a mesh-type system, various network evolved which spanned the equator, the dateline, thousands of miles of ocean, and old colonial boundaries. PEACESAT provided unprecedented connectivity to the people of the Pacific with affordable, appropriate technology, with each member of the network providing its own support.

In mid-1985, the ATS-1 ran out of station-keeping fuel, and began an uncontrolled drift away from the Pacific area. On August 1 of that year, the satellite was silenced, leaving its many users without their voice to the outside world.

In December 1987, recognizing the importance of the PEACESAT Program to the Pacific Island, the U.S. Congress authorized funds ($3.4 mil) for the re-establishment of PEACESAT, and designated the National Telecommunications and information Administration (NTIA) of the U.S. Department of Commerce as the administering agency. The Congress appropriated $1.7 million to NTIA for FY 88, $200,000 in FY 89, and $1 million for FY 91 for the restoration of PEACESAT services.

In early 1988, after the Congressional authorization, the ATS-1 completed its orbit of the earth and again appeared over the pacific, providing PEACESAT with the unique opportunity to reactivate the network through the ATS-1 terminals were reactivated, and PEACESAT users were reunited until the satellite once again drifted out of range in late 1989.

3. PRIOR PEACESAT SERVICE

The success of the PEACESAT system was based on the use of low-cost technology and the availability of a no-cost satellite. The ATS-1 terminals, which operated on VHF frequencies (149 MHz uplink, 135 MHZ downlink), cost an average U.S. $3,000, and in several instances were assembled by enterprising amateur-radio operators from off-the shelf equipment. These no-frills earth terminals operated on a single "push-to-talk" channel that could support voice and electronic data traffic. A typical ground terminal consisted of an amateur-radio type VHF transceiver, two Yagi antennas, a High power amplifier, preamps and packet switching equipment for data transmission. Because they were low tech, the ATS-1 terminals could be easily operated and maintained by operators located in the islands.

Throughout the Pacific these terminals were established by colleges, departments of education, medical centers and other public agencies, all of which were involved in instructional programming, cultural exchanges, medical information and emergency communications. PEACESAT delivered distance education programming from the University of the South Pacific and the University of Guam to remote campus centers throughout the Pacific. Before PEACESAT was shut down in 1985, there were more than 100 earth terminals operating on eight different networks. There were PEACESAT earth terminals in virtually every country and territory throughout the Pacific Island, and in several of the Pacific Rim countries (Australia, Japan, New Zealand, and the United States).

After the ATS-1 satellite drifted out of the Pacific, PEACESAT was able to continue limited service to the Pacific Islands as far west as the International Dateline using the ATS-3 satellite. The ATS-3, a sister satellite to the ATS-1, continues in service from a location just west of Central America (at 105 degrees W, longitude), but is too far east to provide coverage of the islands in the Western Pacific. Unfortunately, the ATS-3 has run out of station-keeping fuel and so cannot be moved west to serve the entire Pacific basin.

4. RE-ESTABLISHMENT OF PEACESAT

PEACESAT enlisted the support of Hawaii Senator Daniel K. Inouye who introduced legislation which provided for the re-establishment of the system. After the initial appropriation was made in 1987. PEACESAT and NTIA joined forces to search for a successor to ATS-1, a process that took the better part of two years.

PEACESAT and NTIA worked with the International PEACESAT Users Group (IPUG) to first define user service requirements and then searched for a satellite which could provide the required interconnection capacity. Satellites were reviewed on the basis of several criteria:
potential availability; orbital position or potential position; earth coverage footprint; recurring space segment costs; earth terminal complexity and costs; spectrum availability; and operational status (interim or long-term potential on the basis of the satellite's ability to maintain orbital position and service). While the study reviewed information regarding several private sector satellites operating in 1988, none of them met all the PEACESAT criteria.

In the absence of any private sector alternative, strong appeals were made by NTIA and PEACESAT for another U.S. government satellite. One of the prime candidates was the GOES-3 (Geostationary Operating Environmental Satellite), which was owned and operated by the National Oceanic and Atmospheric Administration (NOAA), another agency of the U.S. Department of Commerce. The GOES satellite was appealing to PEACESAT because the satellite provided a global footprint and operated on frequencies that would permit the use of relatively small, inexpensive earth terminals.

NOAA responded to the needs of the Pacific Islands and approved the use of the GOES satellite for PEACESAT. In an extraordinary action, NOAA also permitted the temporary use of the meteorological frequencies for PEACESAT purposes. Without the support of NOAA, the current restoration of PEACESAT service would not be possible. In December 1989, NTIA and NOAA agreed that the PEACESAT Program could use the GOES-3 satellite through 1994 while a long-term solution was pursued. Through a cooperative agreement between NOAA and NTIA, the satellite was repositioned to 175 degrees West longitude, where it will be kept in geostationary orbit by the NASA station at Kokee, Hawaii.

Since the GOES satellite operates on frequencies used for meteorological purposes (1688 MHz downlink, 2030 MHz uplink), PEACESAT must operate on a non-interference basis. The orbital location (175 degrees W. longitude) was selected to protect other users of these frequencies while still providing coverage to the entire Pacific basin.

A major problem regarding the use of the GOES was the lack of any commercially available earth terminals which could operate on the GOES frequencies and with the GOES power levels. Before a final decision was made on the use the GOES, a study was conducted by an equipment manufacturer on the feasibility of constructing a low-cost earth terminal. As a result of this study, the University of Hawaii issued a Request for Proposals in October 1989, for the design and manufacture of suitable earth terminals. After a thorough review of the proposals received, a contract was awarded to Marine-Air Systems, Ltd. (MAS), a small company in Lower Hutt, New Zealand, for the manufacture of twenty-seven earth terminals which would be placed in each of the former PEACESAT sites that wished to resume its PEACESAT activities.

Prototypes of the earth terminals were tested in September 1990, and the first operational units were installed at PEACESAT Hawaii in October, 1990. The MAS designed terminals meet or exceed each of the technical specifications developed by the PEACESAT users. Figure 1 shows the desired service requirements specified by the International PEACESAT Users' Group at the outset of their search for an innovative ground segment compared with the resulting equipment provided by MAS. Figure 2 compares the costs of current PEACESAT technology.

When PEACESAT sought funds from the U.S. Congress to reestablish PEACESAT service, the users pledged that each location would contribute U.S. $5,000 toward the acquisition of earth terminals. The Congressional funding was sufficient to subsidize GOES earth terminals in 23 Pacific Island locations and to purchase four terminals for network hub operations, command and maintenance.

In the early stages of re-establishment, a large part of the responsibility will be placed on the PEACESAT headquarters at the University of Hawaii. The International PEACESAT Users' Group (PUG) recently convened in Honolulu, Hawaii at a PEACESAT/Marine-Air Systems (MAS) GOES-3 satellite space and ground segment training workshop with sixteen island countries represented. Top priorities for IPUG were: a) support of the PEACESAT Honolulu headquarters management staff in re-establishment of the technology; b) the continued development of management and technical systems, such as the data communications system; c) the search for a long-term solution; and, d) the development of alternative funding support beyond the Congressional appropriations.

Re-establishment of the PEACESAT networks on PEACESAT GOES begins with four Pacific Island sites in December, two in January, nine in February, and the remaining ten sites in
Redundancy will be emphasized wherever possible. The GOES satellite has two transmitter/receiver systems. Two complete GOES terminals have been installed at the PEACESAT hub at the University of Hawaii. Many Island locations still have single side band HF equipment, which was installed after the ATS-1 satellite was no longer available, or can communicate with PEACESAT through the still operating ATS-3 system, Figure 3. Pacific Island PEACESAT managers and operators trained at the satellite workshop in October, 1990, will install the GOES earth terminals.

All the PEACESAT sites must file an application with the University of Hawaii for re-establishment. After a PEACESAT Pacific Island site has submitted a letter of intent committing U.S. $5,000 and they have been approved as a PEACESAT GOES site, the next step in re-establishment is approval for frequency use, which must be obtained from local licensing authorities. Figure 4 documents the frequencies currently in use by PEACESAT. Since the frequencies PEACESAT is using on the GOES satellite are allocated by international agreement for meteorological use, PEACESAT's use is only temporary through 1994 and must be on a non-interference basis. PEACESAT and NTIA are working closely with the U.S. Department of the Interior and the Federal Communications Commission for the licensing of terminals in jurisdictions where frequencies are coordinated by the United States. PEACESAT ground station management will have to work closely with the Departments of Education and Communications to receive approval from counterpart regulatory agencies in the non-American Pacific Islands.

While Pacific Island terminals are obtaining licensing authority to access the GOES-3 frequencies, the sites will receive their GOES ground segment equipment and install it. The equipment manufactured by Marine-Air Systems, Ltd. has been designed to make both installation and maintenance a task a lay person could perform. NTIA and PEACESAT have supported a training video to accompany the delivery of the MAS equipment.

The PEACESAT GOES ground segment equipment will provide good and reliable telephone quality service for push-to-talk and full-duplex: voice programming; interactive computerized in-house PEACESAT scheduling; electronic messaging; interactive database access; facsimile; slow scan and video phone; automated medical and environmental emergency support; and, automated data and voice access to all of the above services on a 24-hour basis.

No PEACESAT GOES terminal can transmit on more than one channel at any one time. The full PEACESAT GOES system is designed to carry up to nine half-duplex and three full-duplex channels on the satellite. However, this level of service has not yet been tested due to the limited number of operating terminals, and the number of channels ultimately used will be dependent on the level of intermodulation interference experienced when so many channels are operating.

Future services for research and development are: broadcast data in the form of bridging networks and multi-point-to-multi-point data communications; and compressed digitized video in the form of medium freeze-frame video.

The University of Hawaii PEACESAT headquarters will house two PEACESAT GOES terminals. One will be used to monitor for medical and environmental emergency programming, and the other will be used for program participation by the user community in the State of Hawaii. The hub data communications system providing the above data services will also be housed in Honolulu. PEACESAT Honolulu will gateway such services as the University of Hawaii Library On-Line Catalogue Service. As user demand is assessed these data communication services will expand.

Both hub and user software will be made available to PEACESAT GOES sites. Since PEACESAT is based upon an interactive mesh network, it is important that other resource countries offer hub data communication resource countries offer hub data communication resources as well. For example, New Zealand has offered access to its National Library Services, and the Solomon Islands has offered fisheries databases.

Although the PEACESAT Honolulu GOES station will be staffed at least eight to ten hours a day, access to the hub will be necessary throughout the long Pacific day, which moves through several time zones. Guam is getting up when Honolulu is eating lunch. It was imperative then to automate the headquarters terminal so that any remote site will be able to access the Honolulu PEACESAT GOES site through voice and/or data services on a 24 hour basis.
In preparation for the restoration of PEACESAT service, PEACESAT management and IPUG have been working for the past year on the development of programming services. Pacific Island government and non-profit user demand currently shows a need for programming in the areas of environmental and medical emergency support, disaster preparedness and prevention measures, art, community service, culture, development, credit/no-credit distance education, health, cross-cultural social issues, remote site field support, research, institutional support, resource-sharing information, science, and technology. PEACESAT management will constantly monitor demand for programming. Emerging issues and concerns will be constantly reviewed by PEACESAT IPUG management and developed into active programming. Figure 5 gives a partial sample schedule of PEACESAT programming, 6 hours of a 24 hour day on four voice channels and two data channels.

PEACESAT is concentrating on the re-establishment of terminals in the Pacific Islands. However, as seen from Figure 6, the GOES footprint covers countries from North America, the Pacific and eastern Asia. PEACESAT anticipates that non-profit organizations in these other areas may be interested in participating in the PEACESAT programming exchanges.

5. Challenges of the Future

The re-establishment of the PEACESAT networks presents some very real challenges. For the last five years, PEACESAT has been without a reliable space segment to support its pan-Pacific networks. The ATS-3 served the eastern Pacific (the Samoas, Tonga, Cook Island, and Hawaii), the Single Sideband radio linked Hawaii and Micronesia, and the drifting ATS-1 was not available long enough to reestablish very much meaningful programming. During the five-year period several of the terminal operators in the Pacific were reassigned to other jobs. In some parts of the Pacific, PEACESAT is only a memory. The first task is to assure the former PEACESAT users that the services have been reestablished, and that the system will provide reliable, high quality voice and data communications. Once the new GOES system becomes operational and the earth terminals and programming are demonstrated, it is anticipated that all of the former ATS-1 users will join the system.

A tremendous amount of remote site local institutional and government support will be required to assist PEACESAT headquarters in re-establishing all of the past ATS-1 sites. Although the new GOES earth terminal equipment has been subsidized by the U.S. Government, each site is still expected to provide a significant amount of support. In addition to the $5,000 contribution, each site is expected to provide a concrete pad for the GOES antenna, a suitable building for housing the equipment, an operator, a personal computer and facsimile machine, and insurance against loss or damage of the equipment. For some of the less developed countries in the region, these requirements will not be easily met.

In the re-establishment process, PEACESAT has by necessity devoted considerable time to obtain the hardware systems required to support the restoration of satellite service. The emphasis must now turn to programming, management systems, and extensive remote site training in order to transfer this technology and its applications to the users. The new and improved technology made available through the GOES system will undoubtedly give rise to new needs and types of programming which must be developed to meet those needs.

PEACESAT must also convince the users that this is not just another short-term arrangement that will soon pass. Barring the unexpected failure of the satellite, the GOES system is guaranteed for at least the next four years. PEACESAT anticipates a long-term solution in sight before the end of 1994, a solution that will carry PEACESAT well into the 21st century. It is hoped that after minor modifications, the MAS S-band earth terminals can be used with any post-GOES system.

Another challenge to the continuation of PEACESAT is funding. Although each site is self-supporting, NTIA is currently funding NASA’s telemetry and command of the GOES satellite. It is not known at this time how long Federal support for this expense will continue or what level of funding might be required from PEACESAT.

Alternative funding to support the PEACESAT networks and their programming will be sought through foundations, science and technology funding agencies, individual user, and through developed and developing country government and non-profit support agencies. Two considerations have frustrated PEACESAT efforts for alternative funding to date: 1. PEACESAT has been restrained from seeking alternative funding until a satellite network
system was established; and 2. funding agencies which support grants of the size necessary for PEACESAT support do not fund projects which are international in the scope PEACESAT involves. Rather, they tend to fund specific countries or combinations of countries.