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Navy Satellite Communication System - In Transition

John W. Newell
Program Manager, Satellite Communications, Code PME106-1, Naval Electronic Systems

NAVY SATELLITE COMMUNICATIONS
SYSTEMS IN TRANSITION

CAPT John W. Newell, USN
Program Manager, Satellite Communications
Code PME106-1, Naval Electronic Systems
Command, Washington, D. C.

ABSTRACT

In the space age, satellite system engineers and program managers are blessed by ever improving satellite and ground system technology and performance, and are challenged by the changes in their systems required to take advantage of these improvements. An extended period of time is required to bring total satellite communications systems to maturity, or full operational capability. Consequently, as today's systems are being deployed, the follow-on programs are moving through early development and offering improvements and tradeoffs requiring careful analysis and transition planning.

The several Navy SATCOM programs in being and in development, present the full spectrum of challenge for system engineering, program management and long-range planning. Solutions are being developed to unique Navy transitional issues within the framework of the total Defense MILSATCOM Architecture. Significant gains in overall satellite communications capability for the near term through the 1990's will result from the coordinated deployment and use of current assets, the development of more capable future systems, and an optimal transition to these systems. This paper reviews several Navy SATCOM transition issues currently being addressed as the Shuttle introduces a new dimension to space age communications.

Current Navy SATCOM Baseline. The current U. S. Navy UHF satellite communications system has evolved since the 1970's into a highly reliable and capable tactical communications asset for enhanced worldwide command and control of our Naval forces. After interim leased service by three GAPFILLER (MARISAT) satellites, a constellation of four geosynchronous FLTSATCOM satellites has now been fully established with the successful launch of FLTSAT F-4 in October 1980. A fifth spare FLTSAT satellite is nearing completion at TRW and should be ready for deployment by an ATLAS CENTAUR launch here at the Cape this summer. To take full advantage of the excellent transponder and processing capabilities of the various channels available on these complex satellites, ship and shore communications sites for the Fleet (and many other Department of Defense units) are equipped with a large number of UHF SATCOM terminals, and the entire network is managed by several computer-based link control and information exchange systems. With consideration for this extensive SATCOM terminal population, with lifetimes extended well into the mid-1990's, planning is now in progress for system improvements and a follow-on space segment.

DAMA. In 1976 the Navy commenced development of a demand-assignment time-division multiple access (DAMA) system to permit a more efficient use of the 25 Kilohertz FLTSAT hard-limiting transponders. By 1978, the improvements in the satellite channel availability stemming from the use of DAMA were valid enough to permit a reduction in the number of spaceborne transponders per satellite necessary to meet requirements. The DAMA technique is certainly not an entirely new concept in the SATCOM business. The system acquisition and efficient transition into the various classes of ships in the Fleet, does however present a unique operational transition for the Navy. It requires a close coordination of ship installations, communications net configuration and satellite channel assignments for various ocean areas.

Transition to LEASAT and DAMA. Congressional guidance and other factors have resulted in the procurement of a leased satellite (LEASAT) system to replace FLTSAT. LEASAT will provide extended UHF SATCOM service at four geosynchronous orbital locations for at least five years. The design and development of this follow-on LEASAT series of satellites is predicated upon several factors which represent Navy SATCOM transition issues, primarily the introduction of the DAMA system, and the space segment replenishment timing problems represented by continuing slippages of the Shuttle.

The channel capacity of LEASAT was specified to be lower than that of FLTSAT in order to reduce the cost for the satellite by taking advantage of the improved efficiency of channel utilization provided by DAMA. It is now planned to introduce the DAMA system during the lifetime of FLTSAT in order to have the advantage of a greater channel availability and greater system flexibility during the difficult early transition period. Additionally, selected netting cutover to DAMA channels is planned. Modem by-pass options to increase connectivity for ships with and without DAMA, will also help.

The LEASAT satellites are to be leased from Hughes Communications Services Corporation, and to be designed and built by Hughes Aircraft Company. LEASAT has been designed to take advantage of Shuttle launch economies and is totally dependent on Shuttle launches. During the critical Space Transportation Systems (STS) transition period, alternatives are therefore being evaluated to insure continuity of space-segment service to the widely distributed UHF SATCOM terminal population.

A major transition from available expendable launch vehicles services to Shuttle launch capabilities invites a limited number of space segment planning options. Interim satellites construction schedules and launch costs must be considered in conjunction with the schedule for the ultimate availability of LEASAT. For example, current NASA projections include the availability of expendable launch vehicle facilities for ATLAS CENTAUR through at least 1984 on a shared cost basis. Thereafter, launch expenses escalate rapidly for the sole user. Evaluations thus include, among many factors, tradeoffs between the potential STS launch economies vs. the risk of a decrease or loss of service in an area for an unknown period. The consequences of such a loss of service could be devastating, should a crisis, or armed conflict develop at that time.

A positive factor which eases this problem to some extent is the currently projected increased lifetime of the FLTSATs compared with original estimates, but the uncertainty in the projections still makes the transition planning a difficult problem.

Introduction of SHF Service. A second type of Navy SATCOM transition problem relates to the Navy's plan to increase connectivity, capacity and AJ protection of Fleet Satellite Communications by introducing SHF service in the mid-1980's. Availability of the Defense Satellite Communications System (DSCS) SHF satellites and development by the Navy of improved light-weight SHF terminals (AN/WSC-6), will provide connectivity for selected Navy units among each other and with the National Command Authority, NATO, and with the World Wide Military Command and Control Systems (WWMCCS) Communications net.

Planning for the transition into the Fleet of the total Navy SHF SATCOM system is at this point mainly a ship and shore system engineering problem, but several issues pertaining to satellite-transponder sharing and real-time adaptive control and connectivity assignment are involved. Different user communities may be in different channels requiring gateway connectivity planning,for example, Navy connectivity with Ground Mobile Forces (GMF). Delivery and installation transition problems are similar to those discussed about the DAMA transition. A proper connectivity, degree and mode of interoperability, and set of operating protocols and procedures in future Command and Control nets, using the DSCS III series satellite capabilities, must be defined. Necessary shipboard and shore peripherals must be designed and acquired. Solutions to these transition problems will yield a baseline for the system engineering, networking and related aspects of the planning of satellite configurations for future Navy Satellite Communications needs.

Transition to Advanced SATCOM Capabilities. Transition to the future presents the most exciting possibilities for improved Navy Satellite Communications in the 1990's. The MIT Lincoln Laboratory satellites LES 8 and 9, launched in March 1976, in conjunction with various Navy and Air Force programs, provided a flight demonstration of technologies applicable to advanced strategic command and control communications systems. Both satellite relay and crosslinking capabilities at K band frequencies were demonstrated.

Building on those results and the assessed potential of technology, the Navy and other Services are moving together rapidly to develop Satellite Communications in the EHF portion of the spectrum to meet essential tactical as well as strategic requirements. Initial shipboard and submarine EHF SATCOM terminals are being developed by the Navy for operational evaluation in the mid-1980's. In support of this evaluation, a suitable processing and relay package is planned for spaceborne testing aboard a selected host spacecraft. A total coordinated evolution and development of ground and space segments of the EHF SATCOM system is being achieved under OSD and Congressional guidelines with the assistance of the Military Satellite Office of the Defense Communications Agency.

The Navy EHF SATCOM program presents many transitional problems for solution both in the space and the ground systems. Commonality of waveform with other services is one. Another involves the ultimate satellite design. This will surely be evolutionary as we progress from initial support of minimum essential links to a broader capability covering the full spectrum of peace-time, crisis-management and war-time communications. In periods where existing but aged UHF terminals are being phased out, and new EHF terminals installed (over several years) crossbanding will permit dual connectivity options for EHF uplinks for dual transmission back down to new and old SATCOM terminals alike.

The flexible launch options and economies provided by the Shuttle should be valuable in providing the heavy lift capacities and flexible launch schedules that may be necessary. For example, a particular host satellite for a planned package might be at a threshold for expendable launch vehicle deployment, whereas the Shuttle offers additional flexibility in planning and selecting alternatives during critical program transition periods. Added capability in satellite payloads is also expected to reduce terminal cost burdens, and communications netting problems.

The experience of the past five years of extensive Fleet operation with satellite communications will be reflected in the design of the second generation of Navy SATCOM systems. Various new SATCOM link requirements have been defined for use in future operational scenarios. In addition to the effective utilization of the inherent and operational advantages of the EHF portion of the spectrum, there are other equally challenging concepts for improvements to better serve new requirements.

As the system evolves, many other options for improving communications efficiency and effectiveness are available such as packet switching, data netting, contention-priority-ordered-demand-assignment (CPODA) techniques, and satellite crosslinking. Also, it is expected that the Shuttle will make it easier to deploy a constellation of larger satellites with increased capacity and complexity, and improved reliability which ultimately yields a more reasonable terminal and total program cost profile.

This is most important considering the large numbers of terminals it takes to outfit a Fleet. Also, as the size and weight of terminals comes down, in addition to the cost, the Navy will be able to introduce SATCOM services on its aircraft, (including tactical) as well as its ships and submarines.

Concluding Remarks. In conclusion, then, we have many ongoing transitions in Navy Satellite Communications, in orbit, at sea and ashore. The true value of Satellite Communications has been experienced, and great improvements are being enthusiastically supported for a further transition to broadly distributed EHF SATCOM in the 1990's. We are developing a total Navy Satellite Communications System that provides reliable world-wide command and control in all environments in peace and war.