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APPLICATION OF COMMUNICATION SATELLITES TO THE MILITARY COMMAND STRUCTURE

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FOREWORD

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ABSTRACT

Communication satellites (COMSATs) promise to have a great impact on military communications, and the difficulty in deciding the "who" and the "how" in their use has been evident to system planners from the first considerations of this new technology. The purpose of this paper is to call attention to particular advantages which COMSATs offer to meet peculiar needs in times of national emergency, and to suggest that the specific needs of joint commands should be given more attention in the planning of military COMSAT programs.

GLOSSARY OF TERMS

ALCOM	Alaska Command
CINC	Commander-in-Chief
CINCAL	Commander-in-Chief, Alaska
CINCEUR	Commander-in-Chief, Europe
CINCLANT	Commander-in-Chief, Atlantic
CINCMEAFSA	Commander-in-Chief Middle East, Africa, South Asia
CINCNORAD	Commander-in-Chief, North American Air Defense
CINCPAC	Commander-in-Chief, Pacific
CINCSAC	Commander-in-Chief, Strategic Air Command
CINCSOUTH	Commander-in-Chief, South
CINCSTRIKE	Commander-in-Chief, Strike Command
COMSAT	Communication Satellite
CONUS	Continental United States
DCA	Defense Communication Agency
DCS	Defense Communication System
DSCP	Defense Satellite Communications Program
DoD	Department of Defense
EUCOM	European Command
HQ	Headquarters
IDCSP	Initial Defense Communications Satellite Program
JCS	Joint Chiefs of Staff
JCSAN	Joint Chiefs of Staff Alerting Networks
JTF	Joint Task Force
JTG	Joint Task Group
LANT	Atlantic Command
MAGV	Military Advisory Group Vietnam

MEAFSA	Middle East, Africa, South Asia
MHz	Megahertz
NATO	North Atlantic Treaty Organization
NCA	National Command Authority
NCS	National Communication System
NEL	Naval Electronics Laboratory
NMCS	National Military Command System
NORAD	North American Air Defense
PACCOM	Pacific Command
SAC	Strategic Air Command
STRICOM	Strike Command
TACSAT	Tactical Satellite Communication Program
UHF	Ultra High Frequency
VHF	Very High Frequency

CONTENTS

I. INTRODUCTION

When radio was under consideration for use in the U.S. Navy at the turn of the century there was much opposition from captains and flag officers. Their fear was that their preogatives as commanders would be jeopardized by receiving orders by wireless from great distances. In 1904 the Navy recognized that "the meaning of the terms 'beyond signal distance,' 'within signal distance,' and 'senior officer present' may be modified somewhat in the future on account of the introduction of wireless telegraphy."[1] The introduction of communication satellites today is bound to have similar repercussions on military organization and doctrine.

When a new technology of great promise appears, the questions of who is to use it and how are often difficult to fathom. Tasks that are being accomplished in normal ways suddenly develop a requirement for the new technology, and requests for services become extravagant in terms of both capabilities and real needs. The new technology is applied to tasks which may be important, but for which the technology is not really appropriate, while other tasks for which it is extremely well suited are not considered sufficiently important. New capabilities are also misused by adherence to procedures appropriate for old capabilities.

[1]Captain L. S. Howeth, USN (Retired), History of Communications-Electronics in the United States Navy, Washington, GPO, 1963, pp. 65-66. Quotation is from the Annual Report of the Secretary of the Navy, 1904.

Communication satellites (COMSATs) promise to have a great impact on military communications, and the difficulty in deciding the "who" and the "how" in their use has been evident to system planners from the first considerations of this new technology. The purpose of this paper is to call attention to particular advantages which COMSATs offer to meet peculiar needs in times of national emergency and to suggest that the specific needs of joint commands should be given more attention in the planning of military COMSAT programs.

II. COMMUNICATIONS IN TIMES OF NATIONAL EMERGENCY

One effect of a crisis is that the amount of communication traffic increases. Another effect observed in crises is that there is great urgency in connecting people who normally have no need to communicate with each other. COMSATs can help to solve the problems created by both effects, but this discussion is concerned with the latter effect, and the advantage of COMSATs in meeting needs for the "unique and vital" communications required in times of crises.[1]

In normal times, command and control is exercised by the chain of command. Communication between a high echelon and a low echelon proceeds serially through the intervening echelons as indicated in Figure 1a. In time of emergency this procedure is too slow and is subject to misinterpretation (or at best filtering) at the numerous echelons. These shortcomings of the serial connection produce the phenomenon of "command jumping" illustrated in Figure 1b.

In command jumping, communications bypass intervening echelons. These echelons might remain uninformed of developments and often make contradictory reports to the higher echelons and give contradictory commands to lower echelons. Moreover, the information known to these intervening commands does not get fed into the system. This also leads to confusion and can result in serious mistakes. Despite these

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[1]Hearings before a subcommittee on Government Operations House of Representatives, Ninetieth Congress, 1st Session. 24-25 July 1967, pp. 57-59. "Unique and vital" is the expression used in the President's Annual Report to Congress for 1964.

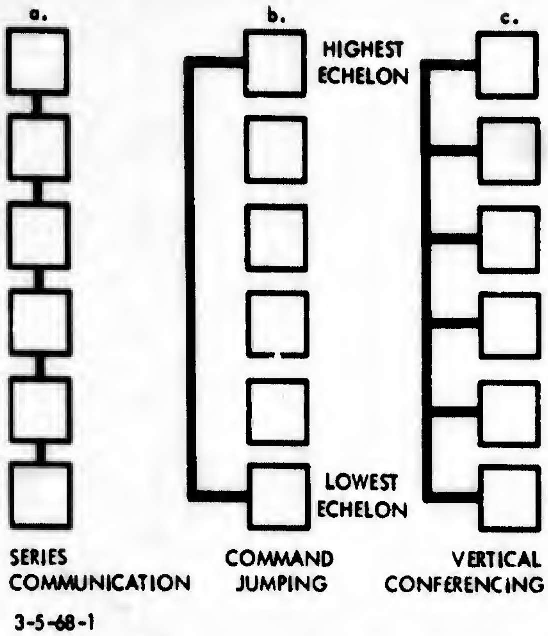

FIGURE 1. Operational Modes

drawbacks, it is necessary at times for those at the highest echelons to communicate directly with selected units at low echelons and vice versa. The Cuban Missile Crisis and the crises in the Tonkin Gulf and the Dominican Republic provide examples in which such communication was necessary. Emphasis on extending service from the highest echelons to the lowest is in accordance with the plans of the NMCS.

Command jumping, however, has a serious potential danger when one of the intervened echelons (being jumped) has vital information related to the conversation being held between the top and bottom echelons. This undesirable feature of command jumping can be avoided by "vertical conferencing." In vertical conferencing, as shown in Fig. 1c, the high echelon can communicate with the low echelon directly, but the intervening echelons are provided listening and, if desirable, break-in capability.

Vertical conferences are only one form of the new interconnections demanded in crises. The usual forms of conferencing involve a commander and a group of his subordinates, or a group of equals. Communication can also be required to take place between two commands well down on different legs of the chain of commands. It can also be of benefit to have the higher commands in both legs conferenced. Most conferencing systems are designed to be used in the horizontal mode but there are vital times when the vertical mode is critical.

COMSAT systems are expecially suitable for the "unique and vital" communications required in times of crisis because they are particularly useful for conferencing and offer a unique opportunity to provide, on short notice, the kinds of unusual interconnections required in times of crisis (see Appendix). The requirements for "unique and vital" communications should be a major consideration in military as well as national planning for COMSAT systems.

It would be disquieting, therefore, if the Defense Satellite Communications Program were to be submerged in the DCS point-to-point system, and the systems for servicing echelons below the CINC level were to ignore the rare but important instances when it is necessary, on very short notice, to interconnect commands at many echelons and in various portions of the command structure.

III. COMMUNICATION NEEDS AT VARIOUS ECHELONS

The National Communication System, including the Defense Communication System (DCS), provides communications from the presidential level down to the unified and specified commands (CINCs). The Defense Communication Agency (DCA) which manages the DCS has additional responsibility to operate long haul, point-to-point communications below the CINC level,[1] but from the level of the CINC components down, communications are still largely the responsibility of the individual Services.

The development of a unified military communication satellite system has been pursued in two parts. The Defense Satellite Communications Program (DSCP) has been concerned principally with needs within the Defense Communication System (DCS), while the Tactical Satellite Communication Program (TACSAT) has been a research and development effort addressed to communication needs below CINC level (primarily corps and below[2]).

The individual military Services, under the guidance of the Joint Chiefs of Staff, have been charged with planning for future operational use of tactical satellite communications.[3] This charge is natural since most communications serving echelons at

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[1]DOD Directive 5105.19, 17 September 1967.

[2]Ninetieth Congress, first session, Hearings before a subcommittee on Government Operations, House of Representatives, July 24 and 25, 1967, p. 7; testimony of Dr. Gardiner L. Tucker, Deputy Director, Defense Research and Engineering.

[3]Memorandum dated 2 October 1965 from Cyrus R. Vance, Deputy Secretary of Defense, to the Secretaries of the Army, Navy, and Air Force; the Chairman, Joint Chiefs of Staff; and the Director, Defense Communications Agency; Subject: "Tactical Satellite Communications Research and Development."

the level of the CINCs and below are the purview of individual Services, but this mechanism for planning can have the effect of overlooking specific needs of joint commands. While it is true that individual Services are relied upon to supply most of the communication needs of the unified and specified commands and of other joint commands, the primary concerns of the Services are for their own individual needs.

Figure 2 is a simplified version of the two chains of command within the command structure of the Department of Defense--one for operations and the other for training and administration. The operations chain of command, which is indicated by solid lines, proceeds from the President and the Secretary of Defense through the Joint Chiefs of Staff and the CINCs (the unified and specified commander exemplified by CINCPAC in Fig. 2) bypassing the Service secretaries and the Service chiefs, to the military forces. The administrative and training chain of command (dashed line in Figure 2) proceeds through the Service secretaries and Service chiefs, bypassing the Joint Chiefs and the CINCs.

The operational and administrative command chains also diverge below the CINC level in ways that are not fully indicated in Fig. 2. This divergence is very often an ad hoc basis, and can occur due to one or more of the subordinate unified and specified commands shown in Fig. 2 (e.g., MAC, JTF, JTG, etc.). At any point, the operational chain of command might merge into the command structure of an individual Service. Even without subordinate unified commands, the operational and administrative chains can diverge within a single Service. In the Navy, for instance, command structures for operations are very different from those for administration and training.

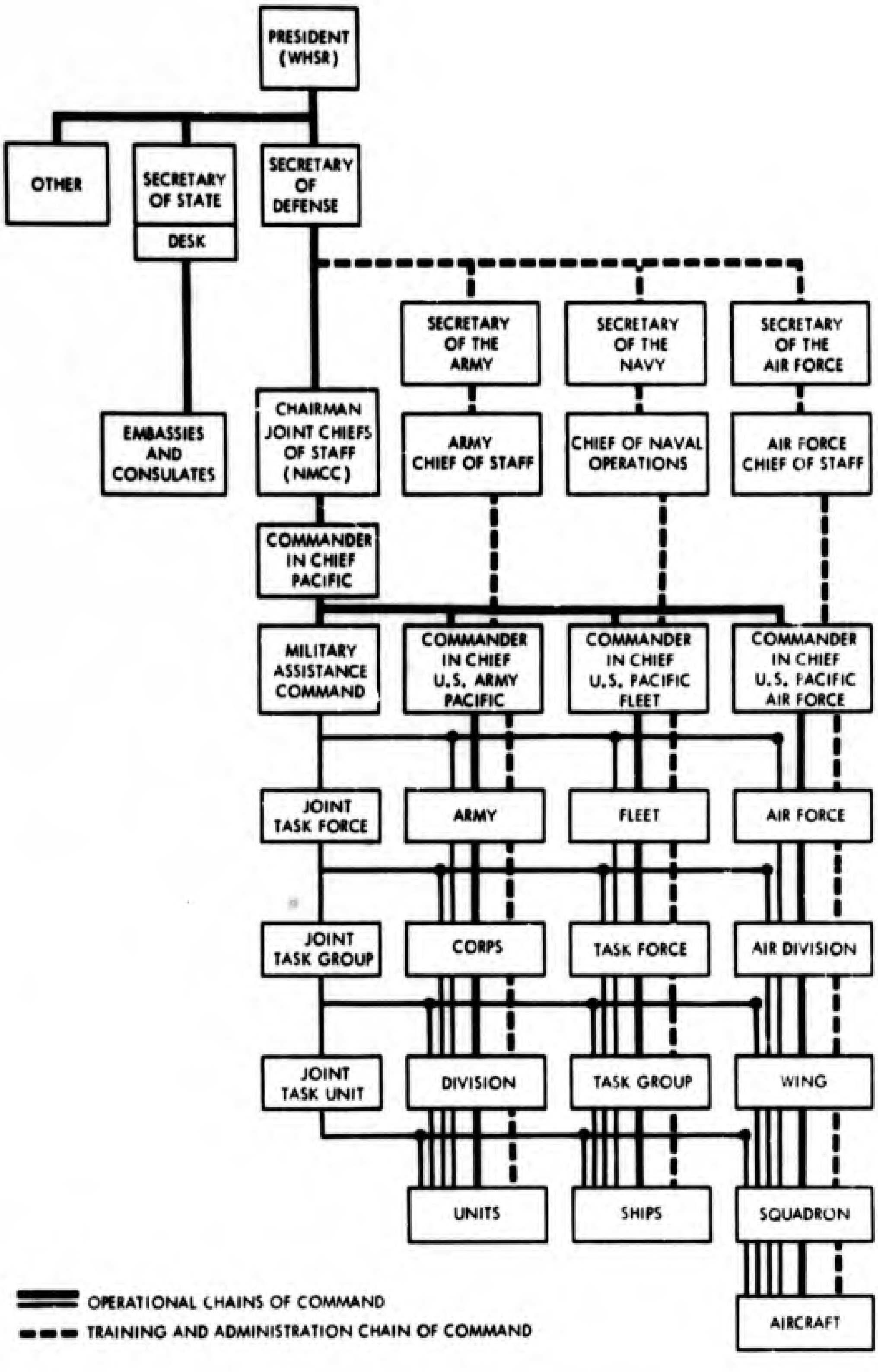

FIGURE 2. A Portion of the National Command Structure

The command structure of the Department of State is also shown, proceeding from the President and Secretary of State through area desks to embassies and consulates. In some instances, particularly in times of crisis, there is a requirement for close cooperation between the various agencies of the National Command Authority.

An important feature of the command structure is that the bulk of day-to-day business is carried on in the administrative and training chains. This has the desirable effect of relieving the strains on operational commanders, but it also has the undesirable effect that military units become more concerned with communication channels which service the normal administrative traffic and, hence, the greatest portion of the traffic. Communication facilities which are intended to serve the needs of these units are often designed with more concern for the administrative chain of command than for the operations chain. One way to avoid this effect is to concentrate specifically on the needs of units, or commands, which are principally operational. Joint commands, the CINCs and subordinate unified and specified commands, are examples of organizations whose missions are principally operational.

Another important feature of the command structure is the so-called "pyramiding effect" which produces a manifold increase in the number of components at each successively lower echelon. The communication capacity and amount of equipment needed at each echelon are very much greater than are needed at the next higher echelon, and in general the constraints on equipment become more and more stringent the lower one gets in the command structure. As a result, in planning a program which is to provide for needs through many echelons, the technological problems at the lowest echelons will be so great that the problems at higher echelons will tend to be ignored. This can occur even when failure to solve the simpler technological problems can be more serious than a failure on the more difficult ones.

To illustrate the pyramiding effect, at the relatively high echelon of the CINCs, the structure has grown to eight organizations.[1] Also at this level are many officials, such as those in the State Department and the intelligence agencies, concerned with national security affairs with whom the military command-and-control structure is required to maintain liaison. To illustrate the need for liaison with respect to communications with NATO commands, the Master Plan of the National Military Command System (NMCS) makes the following statement:

> Survivable communications with NATO Authorities are necessary and the design of the communications supporting the NMCS must include such considerations.[2]

Below the CINC level where the military command structure divides into the individual Services (or subordinate unified and specified commands such as joint task forces and military assistance commands), the pyramiding effect becomes even more pronounced. Even after careful screening of potential users, low-echelon communication needs still demand large amounts of equipment and capacity.

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[1]CINCAL, CINCSO, CINCNORAD, CINCEUR, CINCLANT, CINCPAC, CINCSAC, and CINCSTRIKE/CINCMEAFSA.

[2]Master Plan of the National Military Command System (NMCS), DoD Directive S-5100.44 (Encl. 1) 9 June 1964, p. 111-32.

IV. SUGGESTIONS FOR A PROGRAM EXTENDING COMSAT SERVICE TO ECHELONS BELOW THE CINCs

Because COMSAT systems are especially well suited to provide the unique and vital links which are needed in times of crisis, it is very important that the two programs should be made as compatible as possible. A suggestion[1] for the use of IDCSP satellites by CINCPACFLT and his subordinate commanders illustrates that this can be done to a large degree. There is need for greater study of how the interface between the two systems can best be handled--by "gateway" stations with switching facilities and access to both systems, by allowing DSCP terminals to gain access to TACSAT satellites and TACSAT terminals to gain access to DSCP satellites (provided only that the terminal has adequate power, antenna gain, and receiver sensitivity), or by integrating the two systems into one.

It is apparent that more consideration should be given to the needs of the unified and specified commanders, and the echelons immediately below them, in military communication satellite programs. Serious consideration should be given to the design of satellites to serve specifically the needs of the CINCs and their operational chain of command.

The area served by a synchronous tactical communication satellite should be related to the strategic areas of the world within the purview of the CINCs, who, for the most part, operate within defined geographical areas. For example, if

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[1] U.S. Navy Utilization of the Interim Defense Satellite Communication in the Pacific area. Uncl. Study by Communication Systems, Inc.--now Communications and Systems, Paramus, N.J. NEL Project Report 2310-0183, March 1967.

four synchronous equatorial orbiting satellites with visible earth coverage (144 deg) were to be positioned around the equator to serve the operational tactical forces, particularly within the CINC chains of command to be served, then the following overhead positions might be selected:[1]

- 105° West longitude, covers North and South America (except Northern Alaska) and extends from Hawaii to the mid-Atlantic. This area includes Washington, SAC HQ and CONUS bases, NORAD, CINCSOUTH, STRICOM HQ, most of CINCAL's area and most of CINCLANT's domain.
- 15° West longitude covers EUCOM, LANT, STRICOM HQ, MEAFSA (minus the South Asia portion) NATO, and Washington.
- 172° East longitude covers all of the PACCOM from Bangkok to San Francisco as well as Japan and ALCOM (minus the Northern part of Alaska).
- 60° East longitude is the last and perhaps optional position which covers the gap left in complete earth coverage (minus polar areas). It also would cover most of the SAC target area including China but excluding Northern Siberia. The range extends from London to Clark Field in the Philippines.

It would be possible, of course, to cover most of the earth with three satellites but the above positioning is selected on the basis of satisfying operational communication links within the geographical areas controlled by CINCs.

The CINCs have some unique communication needs which can be solved by COMSATs. The lines of communication from that level down to the next two, three, or four echelons can be very long and the locations of headquarters can be mobile or indeterminate.

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[1] T.G. Belden, "Satellite Communications in Relation to Tactical Organizations," IDA Study S-211, Tactical Communications Via Satellites, Vol. II, January 1966, pp. 147-148.

The needs of CINCEUR provide some examples of needs appropriate for COMSAT service. COMSATs are well adapted to communication between CINCEUR command posts and the weapon storage units, and also to command and control communications between the CINCEUR command posts (primary and alternate) and the component commanders and specified subordinate elements at both fixed and field locations. COMSATs can also contribute to communication between headquarters and field units in the CINCEUR area.

CINCMEAFSA has the requirement to be able to airlift a Joint Task Force (JTF) to deal with contingencies anywhere within his area of purview: the Middle East, Southeast Asia, and Africa south of the Sahara. COMSATs are very appropriate for communication needs between CINCMEAFSA and the deployed JTF, and between the commander of the JTF and his subordinate echelons which can be separated by great distances. Clearly, the other CINCs will also have needs to which COMSATs can be applied.

A proposal for the use of IDCSP satellites by Naval commanders under CINCPACFLT[1] provides an excellent example of the communication needs of the echelons immediately below the CINCs.

Unless the needs of the CINCs are adequately considered in planning for the TACSAT program, there is likely to be a problem of interfacing the DSCP and TACSAT facilities when the need arises, particularly during national emergencies.

Proper concern in the program for the needs of the CINCs and the commanders immediately subordinate to them will tend to allow the two systems to interface more conveniently.

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[1] Op. Cit. NEL Project Report.

APPENDIX

PROPERTIES OF COMMUNICATION SATELLITES

COMSAT systems possess four properties which can be particularly useful in meeting military communication needs:

- They can provide normally reliable high quality, high capacity, long range radio links.
- Service can be established at any location within "view of satellite" by providing an earth terminal at that location.
- A signal transmitted from a satellite can be received simultaneously by any number of earth terminals within view of the satellite without further relay.
- Satellites offer a clandestine transmitter some protection against radio direction finding.

The third item gives COMSATs a special advantage for broadcast and conferencing networks.

These advantages are most evident when the COMSATs are in equatorial synchronous orbit because each satellite is in view from anywhere in a large portion of the earth's surface and because each satellite appears stationary from the earth. At the same time, however, the obstacles or shortcomings in COMSAT service are also more pronounced when the satellite is at synchronous altitude (19,300 nautical miles) than when it is at lower altitudes.

In comparison to terrestrial links, the path lengths of COMSAT links are very long. This means that the cost, complexity, size and weight of terminals are greater than those associated with terminals operating on terrestrial links at UHF and higher frequencies.[1] Because of the large field of view

[1] The radio line-of-sight at these frequencies usually extends for 25 to 35 miles. The distance is more for aircraft and terminals in elevated locations, and at times, it is less due to atmospheric anomalies, certain terrains, or dense foliage.

from a satellite, there is a great problem in radio frequency interference. COMSAT systems are constrained by the need to conserve electromagnetic spectrum.

The question of the vulnerability of COMSAT links, relative to that of terrestrial links, is not easily resolved. The COMSAT at synchronous altitude is in view of potential jamming sites over a large portion of the earth's surface. COMSATs operating at low frequencies, UHF for example, are very susceptible to jamming, but the use of wide bandwidths and directive satellite antennas can make COMSAT systems operating at microwave frequencies very costly to jam, (however with some additional expense to the system). Terrestrial links, on the other hand, have their own vulnerabilities which might be more severe than those of COMSAT systems. If satellites become heavily depended upon for primary or critical communication links, then the temptation to jam them increases. Although costly, there is the possibility of physical destruction of the satellite as well.

Within the next decade, new technology should become available to reduce the effects of these obstacles considerably. High gain, multiple beam antenna systems will be available for satellites, and microminiaturized electronic components will make high gain antennas convenient enough for many potential terminals which are now required to use only antennas with broad beams, or low gain. Principal among such terminals are those which must communicate while in motion, such as high performance aircraft.

The high gain antennas on the satellites and ground terminals will tend to reduce all three obstacles of long range, spectrum limitations, and the threat of jamming. Other expected technological developments which will address one or more of these problems are greater amounts of satellite prime power, more efficient batteries (in terms of energy per pound) for portable ground terminals, and reduced weight of electronic components.

The evolution of COMSATs will not be dependent upon technology developments alone. The inherently unique features of COMSATs are especially adapted to conferencing, netting, and allowing unusual interconnections which will give rise to new possibilities in organization and operational procedures. These procedures should be examined as COMSAT usage evolves and should affect the design of future systems.

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