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Report to the Chairman, Subcommittee on National Security, Committee on Appropriations, House of Representatives

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SATELLITE CONTROL CAPABILITIES

National Policy Could Help Consolidation and Cost Savings

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The Honorable C. W. Bill Young
Chairman, Subcommittee on National Security
Committee on Appropriations
House of Representatives

Dear Mr. Chairman:

As you requested, we have been reviewing several issues associated with the Department of Defense (DOD) and intelligence community space programs and activities. This report discusses the potential opportunity for consolidating satellite control functions within the government.

Satellite control is an operation that uses ground antennas for (1) tracking satellites to record their location and trajectory, (2) collecting satellite health and status data by telemetry, and (3) commanding satellites to perform certain functions. This operation is commonly referred to as tracking, telemetry, and commanding.

Background

Congressional committees have expressed concern about the (1) lack of standardization, commonality, and interoperability associated with national security satellite control networks and (2) high costs associated with operating, maintaining, and upgrading these networks.[1] Within the defense and intelligence space sectors, the Air Force, the Navy, the Army, and the National Reconnaissance Office (NRO) operate separate satellite control networks. Within the civil space sector, the National Aeronautics and Space Administration (NASA) and the National Oceanic and Atmospheric Administration (NOAA) also operate separate networks.

Defense and civil (excluding intelligence) agencies budgeted a total of $806 million in fiscal year 1996 to control over 132 communications, missile warning, navigation, meteorological, environmental, and scientific satellites or missions. Based on the President's fiscal year 1996 budget, these agencies plan to spend over $1.3 billion on upgrading their satellite control systems during the next 5 years.

[1]Senate Armed Services Committee's July 27, 1993 report (103-112) accompanying the fiscal year 1994 DOD authorization bill, p. 86 and House Appropriations Committee's June 27, 1994 report (103-562) accompanying the fiscal year 1995 DOD appropriations bill, p. 43.

Results in Brief

Development of separate satellite control networks parallel the historical establishment of the three space sectors—defense, intelligence, and civil—within the government. These sectors were created over three decades ago and evolved under separate organizational structures for management, budgetary control, and policy oversight. Despite the potential for overlapping programs and duplicate facilities, these sectors were maintained for national security reasons and to benefit from an open, unclassified civil program. One result, however, was a lack of strong coordination and cooperation incentives among the respective agencies, which encouraged both different solutions to similar problems and overlap in capabilities in such areas as technology development, launch, and support services. As the agencies tended to independently customize their satellite systems to fit particular needs, including satellite control networks, the result was a lack of interoperability among the systems and less than optimal use of resources and facilities.

Efforts to reduce costs by combining government satellite control capabilities need more attention. Two studies completed within the past 2 years by the U.S. Space Command and one study completed last year by an interagency working group discussed opportunities to combine satellite control capabilities.[2] Although these three studies focused on increasing network efficiency and effectiveness and achieving economies, they were either limited in scope, lacking in detailed analysis, or subsumed by another study. Now, a fourth interagency study, addressing the same topic, is ongoing by DOD and NASA to examine the potential for cooperation and savings.

Implementation of the past studies' recommendations have been hampered by the lack of a national policy that could provide the necessary impetus and direction for more efficient use of the nation's satellite control capabilities. The government has several space policies that direct inter-sector cooperative efforts, including special management structures, but none that specifically apply to satellite control. Considering the opportunities for (1) interoperability and standardization among satellite control networks and (2) cost savings and greater efficiencies through network consolidation, it appears prudent to view satellite control from a governmentwide perspective. We, therefore, believe that a national satellite control policy that addresses the objective of interoperability and standardization through integration, consolidation, and sharing of the

[2]The group consisted of representatives from DOD; NASA; and the Departments of Commerce, Energy, and Transportation.

defense, intelligence, and civil space sector's satellite control capabilities is needed.

In November 1993, the President established the National Science and Technology Council (NSTC) by Executive Order 12881 to coordinate science, space, and technology policies throughout the federal government. The President is the NSTC Chairman and membership consists of the Vice-President and cabinet-level and other officials. Included among the principal purposes of the NSTC is to ensure that science, space, and technology policies and programs are developed and implemented to effectively contribute to national goals. The NSTC developed specific space policies within the last 2 years and is currently reviewing other existing space policies for possible revision.

We believe the NSTC could provide the necessary impetus and direction for integrating the nation's satellite control networks to reduce costs. Similar to other space policies, inter-sector guidelines are needed to address interoperability, common requirements, network standards, and the potential use of commercially available designs. The guidelines also need to address an inter-sector management structure with participation by defense, intelligence, and civil space agencies to ensure policy implementation, that includes establishing schedules, coordinating network upgrades, and reporting on the progress being made.

Recommendation

We recommend that NSTC develop an inter-sector space policy, to be included with its revisions of other space policies, that would direct integration, consolidation, and sharing, to the extent feasible, of the nation's satellite control networks. Moreover, NSTC should require the Secretaries of Defense and Commerce and the Administrator of NASA, with appropriate input from the Director of Central Intelligence, to establish a coordinated management structure to implement the policy by completing the necessary studies, preparing an integrated architecture, and making cost-effective decisions on the respective agencies' network upgrades.

Agency Comments and Our Evaluation

The Assistant to the President for Science and Technology, DOD, NASA, and the Department of Commerce provided official comments on a draft of this report (see apps. III, IV, and V, respectively).

The Assistant to the President stated that the Office of Science and Technology Policy and the National Security Council are leading a

comprehensive review of the administration's national space policy and are looking at opportunities for convergence and consolidation of facilities and operations where it is cost-effective and feasible. In this context, the Assistant to the President stated that national satellite control facilities will be addressed and this report will be a useful input to the process.

DOD generally concurred with the draft report's findings and recommendations. However, it stated that the draft report did not adequately reflect (1) DOD's efforts to reduce costs, consolidate activities, or increase standardization; (2) the history of cooperation among the agencies involved; or (3) the fact that there are fundamental technical incompatibilities among current generation satellites that preclude direct consolidation of satellite control capabilities in the near future.

We recognized some shortcomings of the draft report in these areas and have incorporated additional comments provided by DOD, where appropriate. However, our focus was not oriented toward individual agency efforts as much as it was toward inter-sector opportunities for consolidations and cost savings. In fact, if greater interoperability and standardization among the space agencies had been a goal in the past, there would not be the fundamental technical incompatibilities among satellite control capabilities today. Although achieving governmentwide consolidations and significant cost savings may be a long-range prospect, we believe it is an effort that needs to start as soon as possible.

NASA concurred with (1) the draft report's assessment of interoperability and consolidation of satellite control capabilities, (2) the report's recommendation that would enhance these desirable goals, and (3) most of the report's factual content. NASA commented that under the ongoing DOD-NASA study of satellite control, the study team has recognized that interoperability can be achieved in a variety of ways. One way is to implement capabilities to communicate with various agencies' network resources, and another way is to implement the same architectures at all agencies' network and control facilities.

This latter method, according to NASA, would result in (1) high ground system cost to achieve commonality and (2) the need for two issues to be addressed by an inter-sector space policy. The first issue was identified as "an apparent incompatibility between national security and the goal of international cooperation." According to NASA, it concerns the defense and intelligence space sectors' reluctance to involve themselves in areas of civil and international cooperation (such as the use of international

standards for interoperability), whereas the civil space sector seeks such cooperation and establishes agreements with foreign space agencies that often preclude DOD involvement. The second issue deals with "the use of the frequency spectrum that allows the spacecraft to communicate with the network systems." According to NASA, government space agencies operate in different parts of the radio frequency spectrum, not necessarily because they wish to, but because national and international regulatory bodies have partitioned the spectrum to meet distinct agencies' needs.

NASA stated that the ongoing study team is formulating recommendations to mitigate these issues in the short term and establish forums to deal with them in the long term. It encouraged the NSTC to build upon these forthcoming recommendations, if it seeks to develop the inter-sector policy. In addition, NASA expressed concern about congressional authorization and appropriation committee coordination and budget approval that will be required if the space agencies establish closer relationships.

The Department of Commerce provided official comments on a draft of this report to the Assistant to the President for Science and Technology.

Commerce stated that the majority of the our (draft) report historically recounted several efforts over the past years of looking at alternative ways to "consolidate, converge, and standardize" satellite TT&C. It agreed with the fact that most of the previous recommendations have not been acted upon, only studied repeatedly. It stated that most satellite TT&C systems have been designed with a specific satellite in mind and with different mission requirements.

Commerce stated that the two recommendations in the draft report—that (1) an inter-sector space policy on the nation's satellite control networks be developed and (2) the government's space agency heads establish a coordinated management team to implement the space policy—seemed to be a good idea from a cost and efficiency standpoint as long as implementation is sensitive to programmatic concerns.

Scope and Methodology

We reviewed three satellite control studies that represented DOD's and other agencies' efforts to determine how to improve efficiencies and achieve economies in satellite control operations. We examined the scope and terms of reference associated with these studies, the extent of various agencies' participation in the studies, and whether the agencies' satellite

control assets were evaluated as part of each study. We ascertained the reasons for not implementing study recommendations and reviewed the status of recommendations being implemented. In addition, we discussed the objectives and scope of an ongoing satellite control study with DOD and NASA representatives. Finally, we reviewed guidelines contained in national space policies and analyzed plans and budgets associated with operations, maintenance, and upgrades of various agencies' satellite control networks.

We performed our work primarily at the U.S. and Air Force Space Commands, Colorado Springs, Colorado, and Air Force Space and Missile Systems Center, Los Angeles, California. In addition, we held discussions with representatives and obtained documentation from NASA Headquarters, Washington, D.C.; NOAA's Satellite Operations Center, Suitland, Maryland; Naval Space Command, Dalgren, Virginia; Naval Satellite Operations Center, Point Mugu, California; Air Force Space Command's 50th Space Wing, Falcon Air Force Base, Colorado; and Air Force's Phillips Laboratory, Albuquerque, New Mexico. We also interviewed representatives of the Office of the Secretary of Defense, Joint Staff, Naval Research Laboratory, NRO in Washington, D.C., and of the Onizuka Air Station, Sunnyvale, California.

Appendix I provides more information on efforts to combine government satellite control capabilities. Appendix II briefly describes agency satellite control networks.

We performed our work from February 1995 through December 1995 in accordance with generally accepted government auditing standards.

We are sending copies of this report to the responsible authorization and appropriations committees and subcommittees of the Senate and House of Representatives. We are also sending copies to the Assistant to the President for Science and Technology; the Director, Office of Management and Budget; the Secretaries of Defense, the Air Force, the Navy, and the Army; the Acting Secretary of Commerce; the Administrators of NASA and NOAA; and the Directors of Central Intelligence and the NRO. We will make copies available to others upon request.

This report was prepared under the direction of Thomas J. Schulz, Associate Director, Defense Acquisition Issues, who may be reached on (202) 512-4841 if you or your staff have any questions. Major contributors are listed in appendix VI.

Sincerely yours,

Henry L. Hinton, Jr.
Assistant Comptroller General

Contents

Abbreviations

AACB	Aeronautics and Astronautics Coordinating Board
AFSCN	Air Force Satellite Control Network
DOD	Department of Defense
FITAS	Future Integrated TT&C Architecture Study
GPS	Global Positioning System
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
NRO	National Reconnaissance Office
NSCN	Naval Satellite Control Network
NSTC	National Science and Technology Council
TDRSS	Tracking and Data Relay Satellite System
TT&C	tracking, telemetry, and commanding

Efforts to Combine Government Satellite Control Capabilities Need Greater Attention

Three separate studies completed within the past 2 years by various working groups have discussed opportunities to combine or share intra- and interagency satellite control capabilities. Although these study efforts focused on increasing efficiency and effectiveness and achieving economies, they were either limited in scope, lacking in detailed analysis, or subsumed by another study. Now, a fourth study, addressing the same topic, is underway to examine the potential for cooperation and savings.

Implementation of the past studies' recommendations have been hampered by the lack of a national policy that could provide the necessary impetus and direction for more efficient use of satellite control capabilities from a governmentwide perspective. In addition, a management structure similar to those identified in other space policies does not exist to implement such a policy. As a result, efforts to combine or share satellite control capabilities, achieve greater interoperability among satellite control systems, and reduce costs need greater attention.

Three Studies Discuss Consolidation Opportunities

In January 1994, the U.S. Space Command issued a report on space systems roles and missions as directed by the Secretary of Defense and the Director of the Joint Staff. Among the report's recommendations was one calling for Air Force and Navy satellite bus operations to be merged into a common satellite control network.[1] The recommendation was based on plans that (1) several satellites under Navy control would be phased out in the near term and (2) an upgraded Air Force network could control all Department of Defense (DOD) satellites. The belief was that such a merger would have the potential of improving efficiency and effectiveness, while ensuring maximum support for the combatant commanders. The recommendation called for the merger to be done as soon as possible, but not later than 1999.

Although the scope of the study was limited to the defense space sector, the study group did not determine the full technical capabilities of the Air Force and the Navy networks to control all satellites. As a result, the report stated that another study on merging the networks would be done to determine the most efficient and cost-effective solution. This follow-on study, called the Future Integrated TT&C Architecture Study (FITAS), was initiated by the Chairman, Joint Chiefs of Staff in January 1994—the same month that the U.S. Space Command's report was released.

[1]Bus operations refers to the tracking, telemetry, and commanding (TT&C) associated with the satellite platform—the physical structure upon which mission, or payload, equipment is installed.

In April 1994, an interagency study group consisting of representatives from DOD, National Aeronautics and Space Administration (NASA), Department of Commerce, Department of Energy, and Department of Transportation completed the National Facilities Study—a review of the nation's aeronautics and space facilities. The purpose was to develop a national plan to meet government and commercial needs for aeronautics and space research and development and space operations. The report, issued to top officials of the participating agencies, made numerous recommendations—one of which was oriented toward a unified approach to government satellite control networks to optimize existing capabilities, consolidate operations, increase efficiency, and save money. However, the study lacked a detailed analysis of the subject, and its final recommendation merely called for a multiagency task force to perform additional study on feasibility and implementation planning.

Our review indicated that no action was taken on this National Facilities Study recommendation. Although DOD was to have taken the lead, DOD representatives informed us that plans to take action on the recommendation were overtaken by FITAS, which had already been initiated in January 1994 by the Chairman, Joint Chiefs of Staff.

In April 1995, the U.S. Space Command completed FITAS, which involved participants from DOD, NASA, the National Reconnaissance Office (NRO), and the National Oceanic and Atmospheric Administration (NOAA). FITAS concluded that (1) the government could gain efficiencies through sharing satellite control resources and (2) there was a clear need for a common satellite control architecture.[2] FITAS also concluded that there was no central, interagency authority to coordinate common planning and resource sharing or to effectively orchestrate interagency guidelines and standards with the goal of achieving cost savings through an integrated system architecture.

One of FITAS' recommendations involved establishing an enduring interagency group to guide development of an efficient common user network by addressing various architectural objectives that would lead to cost savings. However, our review indicated that little action had been taken on this recommendation, partly because the study efforts were overtaken by another satellite control study under a DOD-NASA cooperation initiative, which is discussed in the next section of this report. Another FITAS recommendation, which involved merging the Air Force and the

[2]It also stated that some satellites would not be appropriate for a common use network, particularly those requiring continuous contact at high data rates, which was defined as greater than 45 million bits per second, but likely to be redefined as greater than 155 million bits per second in the next decade.

Navy networks, is beginning to be implemented. Hardware and software changes are expected to provide greater interoperability between the Navy and the Air Force networks in the near future.

A Fourth Study Is Underway

In June 1995, top officials from DOD and NASA initiated a cooperative effort to study seven different aeronautics and space topics of mutual interest with a view toward reducing investment and operations costs while enhancing mission effectiveness and efficiencies.

Satellite TT&C was one of the seven study topics. Specific subtopics to be addressed by an integrated product team were identified that could possibly increase efficiencies and allow for consolidations and closures. They included (1) NASA's use of DOD's satellite control network remote tracking stations, (2) DOD's use of NASA's satellite ground stations and the feasibility of DOD assuming operation of these stations, (3) DOD's increased use of NASA's Tracking and Data Relay Satellite System (TDRSS) and the feasibility of DOD assuming operation of TDRSS and other NASA satellites, and (4) the establishment of TT&C standards. Despite the merits of this effort, NASA officials alluded to the study's limited scope by emphasizing that the study excludes (1) the control of satellite mission data, which is often transmitted separately and through various receiving sites and (2) the intelligence space.

The study team plans to provide recommendations to the Aeronautics and Astronautics Coordinating Board (AACB) in April 1996. The AACB is a senior management review and advisory body to DOD and NASA to facilitate coordination of aeronautics and space activities of mutual interest to the two agencies. It was established by the agencies several years ago, and the memorandum of agreement was renewed in 1993 by the Deputy Secretary of Defense and the Administrator of NASA. Although not an official member of the AACB, NOAA is participating in the satellite TT&C study at the invitation of the DOD and NASA co-chairmen.

A significant element of this study, which was not emphasized in the three previous studies, is the potential for increased use of NASA's TDRSS. TDRSS is a space-based communications relay system currently consisting of two operational satellites and one spare satellite in the constellation, which is in geostationary orbit approximately 22,300 miles above the equator. NASA launched the first TDRSS in 1983 as a cost-effective alternative to the network of ground stations that the agency previously used to communicate with its orbiting spacecraft. TDRSS is particularly suited for

almost continuous communications, if needed, with low-altitude satellites, such as a few hundred miles above the Earth. It does so by relaying transmissions to and from these satellites and their ground stations. If only ground stations were used for these satellites, but continuous communications were needed, numerous stations would have to be available around the Earth to ensure that the orbiting satellites were always in view of a station.

The current justification for TDRSS is being driven primarily by the Space Shuttle, Hubble Space Telescope, Space Station, and Earth Observing System programs and by classified users, thus the use of a TDRSS-like capability could exist for some time. NASA has been searching for ways to enhance TDRSS' use within the defense and civil space sectors. NASA has stated that substantial TDRSS capacity remains to meet TT&C and mission data needs for future DOD and NOAA programs. Currently, however, there are radio frequency incompatibilities that limit the use of TDRSS with other agency satellites.

Despite these incompatibilities, an example of increased use did occur in October 1995 when NASA and the Air Force signed a 9-year agreement for TDRSS support during launches of Titan IV/Centaur expendable launch vehicles. This effort is intended to reduce, and in most cases replace, the support provided by the Air Force's Advanced Range Instrumentation Aircraft. The Air Force is claiming some cost savings under this agreement. In addition, the Office of Management and Budget has been studying ways of making improvements and reducing the cost of TDRSS. It asked NASA to respond to several recommendations concerning TDRSS before or concurrent with the agency's fiscal year 1997 budget proposal that involve (1) charging user fees, (2) the impact of off-loading some or all of NASA's future communication needs to commercial and foreign systems, and (3) any "privatization" opportunities.

An opportunity for cost savings may also exist by analyzing the cost-effectiveness of using TDRSS with DOD's and NOAA's low-altitude meteorological and environmental satellite systems. In a May 5, 1994, Presidential Decision Directive, DOD and Commerce were required to integrate their independent systems into a single, converged national polar-orbiting operational environmental satellite system. NOAA was assigned the primary responsibility for all command, control, and communications functions, with DOD having an austere, backup capability. Included in the concept are plans to close Air Force satellite operations centers at Fairchild Air Force Base, Washington, and Offutt Air Force

Base, Nebraska. Although this convergence effort was initiated independent of the various satellite control studies, the two subjects are interrelated and need to be assessed together. In commenting on a draft of this report, Commerce stated that the National Environmental Satellite Data and Information Service's integrated program office has investigated the alternative of using TDRSS and that the initial results showed it may be a viable consideration. It also stated that additional studies were needed and the integrated program office was proceeding with further analysis of this and other options.

In addition, an opportunity for cost savings may exist by using TDRSS to support the Air Force's Global Positioning System (GPS) navigational satellites. We have discussed this idea with NASA and Air Force representatives, but there has not been sufficient technical analysis done on its feasibility. In fiscal year 1996, the Air Force plans to begin developing a follow-on capability (called Block IIF) to its current design of GPS satellites. In doing so, it could make changes to the satellite design that would be interoperable with TDRSS, eliminating some GPS ground antennas. However, an assessment of the trade-offs and cost-effectiveness would be needed.

A National Policy and Management Structure Are Lacking

The government currently has several national space policies directing inter-sector (defense, intelligence, civil, and commercial) cooperative efforts to ensure efficient use of the nation's resources in selected space areas. However, none of these policies specifically address acquisition, operation, integration, consolidation, or sharing of government satellite control capabilities. In addition, there is no existing management structure similar to those identified in other space policies or the one recommended by FITAS, to implement an inter-sector policy on satellite control. The following are four examples of policies that direct specific inter-sector efforts:

- President Bush's National Space Policy, issued as Directive 1 on November 2, 1989, specifically called for maintaining close coordination, cooperation, and technology and information exchange among the national security, civil, and commercial space sectors to avoid unnecessary duplication and promote attainment of U.S. space goals. Specific inter-sector guidelines were established in some high-priority areas such as space transportation. Parts of this policy are still in effect.
- President Clinton's Landsat Remote Sensing Strategy, issued on May 5, 1994, discusses the importance of data acquired from remote sensing

satellites and the benefits to civil, commercial, and national security interests of the United States. Implementing guidelines that restructured management of the Landsat program required substantial cooperation among NASA, DOD, and the Departments of Commerce and the Interior, including satellite development, launch, operations, and funding.

- President Clinton's policy on Convergence of U.S. Polar-Orbiting Operational Environmental Satellite Systems, issued on May 5, 1994, was intended to reduce the cost of acquiring and operating two separate systems, while continuing to satisfy U.S. operational requirements. Implementing actions called for considerable interagency coordination among DOD, Commerce, and NASA, including the establishment of an integrated program office and an executive committee at the Under Secretary level. These management organizations were subsequently established.
- President Clinton's National Space Transportation Policy, issued on August 5, 1994, contained specific guidelines for DOD, NASA, Commerce, and Transportation to (1) share responsibilities for evolving the expendable launch vehicle fleet, (2) develop a next generation reusable vehicle, and (3) promote innovative types of arrangements between the government and private sector. This policy called for the four agencies to provide a common set of requirements and a coordinated technology plan to address the needs of the national security, civil, and commercial space sectors. In addition, DOD and NASA were directed to combine their expendable launch service requirements into single procurements when cost savings or other advantages to the government could be achieved.

These four current space policies are examples of the kinds of impetus and direction that can be provided to ensure more efficient use of national space resources. Considering (1) the lack of interoperability and standardization, (2) the actions of individual agencies to upgrade their own networks without regard for the capabilities of other agencies, and (3) opportunities for cost savings and greater efficiencies and effectiveness through consolidation, it appears prudent to view satellite control from a governmentwide perspective, focusing on ways in which it could be jointly managed.

Regarding a space management structure, DOD began, in December 1994, establishing a central office to consolidate its responsibilities for space policy, architectures, and acquisitions. This office led by a Deputy Under Secretary of Defense for Space and reporting to the Under Secretary of Defense for Acquisition and Technology is intended to provide a DOD focal point for all space matters, including representing DOD in all interagency

space deliberations. Its responsibilities and functions were further delineated in March 1995. In September 1995, DOD established a separate Space Architect organization for the purpose of consolidating the responsibilities for DOD space missions and system architecture development. The Architect reports through the Air Force Acquisition Executive to the Defense Acquisition Executive. The intent was to eliminate unnecessary vertical stovepiping of programs, achieve efficiencies in acquisitions and future operations through program integration, and thereby improve space support to military operations. In December 1995, the Secretary of Defense and the Director of Central Intelligence established a board of directors for defense and intelligence space programs, called the Joint Space Management Board. The purpose of this Board is to ensure that defense and intelligence needs for space systems are satisfied within available resources, using integrated architectures to the maximum extent possible.

Collectively, these three organizational actions established a framework for greater coordination within DOD and between the defense and intelligence space sectors. The importance of these actions is reflected in the fact that the President's fiscal year 1996 budget request included plans for DOD to spend about $84 billion through 2001 on defense and intelligence space programs and activities. This represents over 5 percent of the planned DOD budgets for that period.

Regarding coordination with the civil space sector, the only major management structure we identified was the previously discussed AACB. It is a separate DOD-NASA organization and does not officially include NOAA. Although it does include the Director of NRO as a Board member, it does not provide for full intelligence community representation similar to the Joint Space Management Board. Panels and working groups can be established under the AACB to address functional areas and specific issues, such as satellite TT&C, that are of mutual interest to DOD and NASA. If AACB was expanded to officially include NOAA and full participation by the intelligence sector, or an interagency group was established similar to the one recommended by FITAS, the prospects for implementing a national policy on satellite control would be better assured.

Satellite Control Network Descriptions and Plans

All satellites must be controlled to ensure that they perform as required. Satellite control is usually divided into two parts—platform (or bus) control and payload (or mission) control. Platform control involves monitoring the health and status, and managing the operation, of the satellite's physical structure upon which payload equipment is installed. Payload control involves monitoring the health and status, and managing the operation, of the satellite's mission equipment. Ground antennas communicate with satellite antennas to perform the TT&C function. Tracking involves recording such information as satellite location, trajectory, and velocity. Telemetry involves collecting satellite health and status data, such as temperature, electrical power, and propulsion fuel, as well as the payload data. Commanding involves directing satellites to perform various tasks such as electronic equipment switching, battery charging, and certain payload functions.

The U.S. government operates several separate satellite control networks within the defense, intelligence, and civil space sectors. These networks lack standardization, commonality, and interoperability. This means the lack of compatible operational and technical procedures, the lack of interchangeable equipment or components, and the inability of systems to provide services to and accept services from other systems to enable them to operate effectively together.

Six government agency networks are briefly described below, including plans for network upgrades. Defense and civil (excluding intelligence) agencies budgeted about $806 million in fiscal year 1996 to operate, maintain, and upgrade these networks, which control over 132 separate communications, missile warning, navigation, meteorological, environmental, scientific, and classified satellites or missions. Based on the President's fiscal year 1996 budget request, these agencies plan to spend over $1.3 billion during the next 5 years on upgrading their satellite control systems. (See table II.1.) Intelligence sector networks are not discussed because of national security classification reasons.

Table II.1: Satellites or Missions Controlled by Agency and Associated Funding

Dollars in millions

Agency	Satellites or missions controlled	Fiscal year 1996 budget	Fiscal years 1996-2000 planned upgrades
Air Force	80[a]	$505.7	$569.3
Navy	15	16.2	1.4
Naval Research Laboratory	28	12.1	2.3
Army	11	23.2	Unavailable
NASA	9[b]	206.7	639.1
NOAA	8	42.0	95.3
Total	**132[c]**	**$805.9**	**$1,307.4**

[a]The actual number is larger than 80, but is not shown because of national security classification reasons.

[b]This number refers to NASA missions and does not represent the number of satellites or spacecraft in orbit.

[c]The total does not add because the Air Force and the Navy have split responsibilities for 8 satellites, and the Air Force and the Army have split responsibilities for 11 satellites.

Air Force Satellite Control Network

The Air Force Satellite Control Network (AFSCN) controls over 80 communication, navigation, missile warning, and meteorological satellites and other missions for DOD, NASA, and the United Kingdom. It consists of (1) two operational control nodes located at Falcon Air Force Base, Colorado, and Onizuka Air Force Station, California;[1] (2) 17 TT&C antennas at 9 geographical locations worldwide;[2] (3) a communications calibration site at Camp Parks, California; (4) space vehicle checkout facilities at Cape Canaveral Air Station, Florida, and Vandenberg Air Force Base, California; and (5) communications connectivity among these locations.

The Air Force divides satellite control networks into two classes—common and dedicated. Its common network can support several satellite systems, allowing its antennas and software to be shared among many satellites and therefore reducing costs. Such a network is generally associated with satellites that are only contacted intermittently using relatively low data rates. The primary function of a common network is platform control. However, it can also provide other supporting

[1]The Onizuka location is to be closed by the end of fiscal year 2000 based on a 1995 Commission on Base Realignment and Closure recommendation that was approved by the President.

[2]DOD stated that an Indian Ocean station would be closed at the end of fiscal year 1996, reducing the antennas and locations to 16 and 8, respectively.

functions such as launch and early orbit tracking of satellites until normal operations are achieved and telemetry and commanding of satellites that are experiencing anomalies. Examples of DOD satellite systems that are controlled by the Air Force common network include the Defense Satellite Communications System and the Fleet Satellite Communications system and its Ultra-High Frequency Follow-On system.

A dedicated network supports only one satellite system, and its assets are generally not shared with other satellite systems. Such a network is usually associated with satellites that require continuous contact using relatively high data rates. A dedicated network usually performs both platform and payload control through the same antenna. Examples of DOD satellite systems currently controlled by a dedicated network include the Defense Meteorological Satellite Program, Global Positioning System, Defense Support Program, and Milstar Satellite Communications System. Despite the dedicated configuration of these satellite systems, only the Defense Support Program and Milstar require continuous contact with their ground antennas. Thus, these antennas cannot be shared with other satellite systems. Conversely, the meteorological and global positioning satellite systems are in contact with their ground antennas on an intermittent basis. Thus, these systems may be more readily adaptable for future operation on a common network.

Planned Network Upgrades

The Air Force fiscal year 1996 budget for operating, maintaining, and upgrading the AFSCN is about $506 million. Currently, AFSCN lacks adequate standards for hardware, software, procedures, and interfaces, making it only partially interoperable with other defense or civil agency satellite control systems. This reduces the ability of AFSCN to provide backup support for some other space missions. Based on the President's fiscal year 1996 budget request, the Air Force programmed about $569 million for AFSCN upgrades alone during the next 5 years. It expects to (1) move from the current mainframe-based, centralized computer architecture to a workstation-based, open architecture using advanced high speed data links and (2) enhance the communications system by applying DOD-wide standard protocols that are to be implemented with standard commercial hardware and software. The stated objective of the upgrade efforts is to reduce future operations and maintenance costs.

Naval Satellite Control Network

The Naval Satellite Control Network (NSCN), which is much smaller than AFSCN, currently supports the operation of 15 communication and

navigation satellites and some communication packages that are hosted on other satellites. NSCN consists of one primary control node and antennas at Point Mugu, California, and secondary nodes and antennas in Maine, Minnesota, and Guam.

Planned Network Upgrades

The Navy's fiscal year 1996 budget for operating, maintaining, and upgrading the NSCN is about $16 million. Although NSCN has not been interoperable with other defense or civil agency satellite control systems, modifications are being made so that the Navy can use AFSCN antennas to begin fully controlling two satellite systems—the Fleet Satellite Communications System and its Ultra-High Frequency Follow-On system—both of which are partially controlled by the Air Force. For fiscal years 1996 through 2000, the Navy programmed about $1.4 million to convert NSCN to standard hardware using open system software.

Naval Research Laboratory Satellite Control Network

The Naval Research Laboratory operates a satellite control network in support of 28 classified and scientific satellite missions. The network consists of one primary control node located at Blossom Point Tracking Facility, Maryland; a remote facility at Vandenberg Air Force Base, California; and transportable antennas.

Planned Network Upgrades

The Naval Research Laboratory's fiscal year 1996 budget to operate, maintain, and upgrade its network is about $12 million. Of this amount, about $2.3 million is for upgrading an antenna. The Naval Research Laboratory considers all facility upgrades to be completed and is not currently planning on new hardware or software systems during the next 5 years.

Army Satellite Communications Network

The Army and the Air Force have split responsibilities for controlling the 11 orbiting Defense Satellite Communications System satellites. The Army controls the satellites' payload equipment and communications network, and the Air Force controls the satellites' platforms. The Army's function basically means that operators control the radio transponders on the satellites, to include reallocating power among available communication channels, configuring communication antenna beams, and changing the characteristics of various antijam features.

The Army operates five Defense Satellite Communications System operation centers located at Camp Roberts, California; Fort Detrick, Maryland; Fort Meade, Maryland; Landstuhl, Germany; and Fort Buckner on Okinawa. In addition, the Army operates three transportable tactical (ground mobile forces) communications network control systems located at Fort Detrick, Maryland; Landstuhl, Germany; and Torii Station on Okinawa. The Army also operates a mobile classified facility that is capable of providing platform, payload, and network control if some of the other facilities became inoperable. In fiscal year 1996, the Army budgeted about $23 million for network operations.

NASA Space Network

NASA's Space Network is a space-based tracking, commanding, and data acquisition capability that currently controls nine NASA space missions, including the Space Shuttle and Hubble Space Telescope, and certain classified missions. The Network consists of TDRSS and its ground processing complex located at White Sands, New Mexico. TDRSS satellites currently in orbit include two fully functional, two partially functional, and two spare satellites that provide two-way data communications relay between user spacecraft and the ground processing complex.

Planned Network Upgrades

NASA's fiscal year 1996 budget included about $207 million to operate, maintain, and upgrade its space network. The radio frequency used by TDRSS to communicate with satellites and ground stations is not interoperable with DOD radio frequencies, precluding TDRSS' ability to support DOD space operations. For fiscal years 1996 through 2000, NASA programmed about $639 million for its space network, including the recent procurement of three new TDRSS spacecraft to replenish existing satellites beginning in 1999. Design modifications are planned to make the new spacecraft more capable. NASA has installed a second TDRSS ground terminal, and now has plans to refurbish its original ground terminal at White Sands. These terminal upgrades are expected to reduce operating costs. The reliability, quality, and volume of TDRSS service available to users are expected to increase as a result of these upgrades.

NOAA Satellite Control Network

NOAA's satellite control network supports four operational environmental satellites—two in low-Earth polar and two in high-Earth equatorial orbits. In addition, the network supports four standby satellites—two in each of the orbital regimes—that were once fully operational, but are now degraded. The network consists of a satellite control operations facility at

Suitland, Maryland, and two ground stations located at Wallops Island, Virginia, and Fairbanks, Alaska. In addition, a ground station located in Lannion, France, and operated by a French space agency, supports certain telemetry and command requirements.

Planned Network Upgrades

NOAA's fiscal year 1996 budget for operating, maintaining, and upgrading its satellite control network is about $42 million. For fiscal years 1996 through 2000, NOAA programmed about $95 million just for network upgrades. Although a portion of these upgrades are to be coordinated with the Air Force as part of converging civilian and military polar-orbiting environmental and meteorological satellites, NOAA's network is currently not interoperable with other defense and civil networks.

Comments From the Assistant to the President for Science and Technology

THE WHITE HOUSE
WASHINGTON

April 3, 1996

Mr. Henry L. Hinton
Assistant Comptroller General
General Accounting Office
441 G Street, N.W.
Washington, D.C. 20548

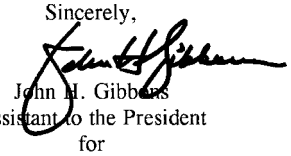
Dear Mr. Hinton:

Thank you for the opportunity to review the recommendations made in the January 30, 1996 transmittal of the draft GAO report entitled "Satellite Control Capabilities: National Policy Could Help Consolidations and Cost Savings" (GAO/NSIAD-96-77). As requested, we have reviewed and coordinated the comments from the agencies as they relate to the report's recommendation. The agencies will provide their assessment of the detailed content of this report separately. The agencies agree that a national space policy could lead to increased integration and cost savings in the U.S. satellite control networks.

As you may know, we have been reviewing the many existing space policy documents in an attempt to update, consolidate and streamline space policy guidance for Federal agencies. Currently, the Office of Science and Technology Policy (OSTP) and the National Security Council (NSC) are leading this comprehensive review, including national security, civilian, and commercial issues. As part of this review we are looking carefully at opportunities for convergence and consolidation of facilities and operations where it is cost effective and feasible. The national satellite control facilities will be addressed in this review and in this context, the results of the GAO report will be a useful input to this process.

Once again, thank you for the opportunity to review the GAO's recommendations.

Sincerely,



John H. Gibbons
Assistant to the President
for
Science and Technology

Comments From the Department of Defense

OFFICE OF THE UNDER SECRETARY OF DEFENSE
3000 DEFENSE PENTAGON
WASHINGTON DC 20301-3000

ACQUISITION AND TECHNOLOGY

04 MAR 1996

Mr. Henry L. Hinton, Jr.
Assistant Comptroller General
National Security and International Affairs Division
United States General Accounting Office
Washington, D.C. 20548

Dear Mr. Hinton:

This is the Department of Defense (DoD) response to the General Accounting Office (GAO) Draft Report "Satellite Control Capabilities: National Policy Could Help Consolidations and Cost Savings," dated January 29, 1996 (GAO Code 707093, OSD Case 1072). The DoD generally concurs with the report.

Although the Department agrees with the GAO findings and recommendations, the DoD does not believe the report adequately reflects the DoD efforts to reduce costs, consolidate activities, and increase standardization, nor does it reflect the history of cooperation among the agencies involved. The DoD maintains that the four studies the GAO referenced were realistic attempts to address tracking, telemetry and commanding (TT&C) issues in manageable pieces. The broad changes recommended by the GAO would require significant up-front investment for even mid-term savings.

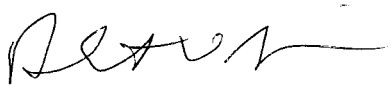
The DoD supports the GAO recommendation to develop a national space policy on satellite control. However, the Department does not believe that the report fully acknowledges the fact that there are fundamental technical incompatibilities (e.g., TT&C frequencies, data rates, wave forms, protocols, etc.) among current generation military, intelligence, civil, and commercial satellites that preclude direct consolidation of control capabilities in the near future.

The GAO recommendation for a coordinated management structure for implementing the policy is consistent with the charter of the DoD Space Architect, and endorses the Future Integrated TT&C Architecture Study (FITAS) recommendation of implementing an enduring interagency TT&C senior steering group (chaired by the DoD Space Architect). In the interim, the Department believes the most effective actions to take are those recommended by the

DoD/National Aeronautics and Space Administration Integrated Process Team on Satellite TT&C to (1) develop and adopt standards and (2) focus on ways to improve efficient use of the frequency spectrum allocated for satellite TT&C.

Suggested technical changes to the report have been provided separately. The Department appreciates the opportunity to comment on the draft report.

Sincerely,



Robert V. Davis
Deputy Under Secretary Of Defense (Space)

Comments From the National Aeronautics and Space Administration

National Aeronautics and
Space Administration
Office of the Administrator
Washington, DC 20546-0001

MAR 4 1996

Mr. Henry L. Hinton, Jr.
Assistant Comptroller General
National Security and International Affairs Division
General Accounting Office
Washington, DC 20548

Dear Mr. Hinton:

We have reviewed the GAO Draft Report "SATELLITE CONTROL CAPABILITIES: National Policy Could Help Consolidations and Cost Savings." NASA concurs with the current assessment of interoperability and the consolidation of satellite control capabilities, as stated in the draft report.

NASA also agrees with the GAO's recommendation of increased interoperability and consolidation of U.S. satellite control functions, which is consistent with this Administration's efforts to reduce the cost of space activities through reinvention initiatives that reduce unnecessary duplication. We concur with most of the factual content of the draft report and have enclosed comments for your consideration. Please contact Mr. David W. Harris, 358-2024, if further assistance is required.

Sincerely,

J. R. Dailey
Acting Deputy Administrator

Enclosure

cc:
OSTP/Dr. John Gibbons

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SUBJECT: Draft GAO Report "SATELLITE CONTROL CAPABILITIES: National Policy Could Help Consolidations and Cost Savings," Dated December 1995, (GAO/NSIAD 96-77)

Reference: Last paragraph on Page 2

Indeed, there have been multiple panels and studies, as referenced in the GAO report, that have addressed the interoperability issue. The latest of these efforts is the National Aeronautics and Space Administration (NASA)-Department of Defense (DOD) Integrated Product Team (IPT) for satellite Tracking, Telemetry, and Command (TT&C) which includes the National Oceanic and Atmospheric Administration (NOAA). It should be noted that this IPT is chartered to seek the benefits of integrated and coordinated mission services in only a small area of support responsibilities, i.e. TT&C. Therefore, mission data, often transmitted separately and through various receiving sites, are excluded. This too excludes a major element in the space business, the intelligence community.

Recognizing that the TT&C is only a microcosm of space operations, the issues faced by the IPT are the same as those faced in consideration of full interoperability. The IPT recognized that interoperability can be achieved in a variety of ways, one of which is for the space mission to be implemented with the capability to communicate with the network resources of various agencies. This dual compatibility allows the user to benefit from the services of multiple agencies and to obtain some cost efficiency in conducting the mission operations. Examples of this include the Space Transportation System (Shuttle) operations, in which the dual onboard communications packages allow the Shuttle to communicate with NASA space and ground networks, as well as the DOD Air Force Satellite Control Network tracking sites. This configuration ensures emergency services to the Shuttle and its crew without NASA's need to implement a worldwide ground network for conducting those emergency services. The second form of interoperability expects the agencies to implement the same architectures at all network and control facilities, thereby reducing complexity in the mission design. However, the cost for ground system commonality is high, and there are two significant issues that need resolution before this form of interoperability can be applied. The issues are as follows:

An apparent incompatibility between national security and the goal of international cooperation, and

The use of the frequency spectrum that allows the spacecraft to communicate with the network systems.

Enclosure

The first issue recognizes that the DOD, National Reconnaissance Office (NRO), and similar agencies have been reluctant about involving themselves in areas of civil, international cooperation. NASA (and possibly NOAA), on the other hand, seeks international cooperation and establishes agreements with foreign space agencies that often preclude the involvement of the DOD. Both commercialization and offloading to international systems are recommended for consideration by NASA in the April 25, 1995, letter from the Office of Management and Budget to the Administrator. Commercial and international alternatives will not be encouraged with a DOD and NASA integration. In fact, during the drafting of the new National Space Policy, now under review, the DOD objected to the wording of U.S. agencies considering the adoption of international standards for the interoperability of civil spacecraft communication and control facilities. The concern was for the potential vulnerability of U.S. operational (as opposed to research) civil spacecraft, including commercial communications satellites, as a result of adopting international standards. Any possibility of DOD missions adopting the international standards was removed from consideration in drafting the policy. The intersector space policy must address and overcome this barrier.

The frequency issue must also be addressed. NASA, DOD, and NOAA operate in different parts of the spectrum, not necessarily because they wish to, but because the national and international regulatory bodies have partitioned the spectrum to meet the distinct needs of the various agencies. Seeking commonality in use of the spectrum is again complicated by the civil agencies' involvement with the commercial sector seeking to provide tracking and data services, as well as the international community, all crowding into limited spectrum allocations.

The IPT for satellite TT&C has recognized and addressed these issues and is presently formulating recommendations to mitigate its effect in the short term and to establish the forums to deal with the issues in the long term. The IPT has recognized that the Aeronautics and Astronautics Coordinating Board (AACB) is presently a NASA and DOD advisory board. The IPT has already recommended to the AACB that the membership be expanded to acknowledge the responsibilities of the other national organizations concerned with the issue of interoperability. The AACB has already approved participation by NOAA in its panel activities.

Finally, past efforts by the civil and defense agencies to establish a closer relationship through cross-support, transfer of responsibilities, or improved interoperability, have been frustrated by the congressional budget authorization and appropriation process, which requires the affected committees to both coordinate and approve their respective budget requests.

Any movement, whether through a new intersector policy, or joint efforts of the respective agencies, must deal with this congressional alignment.

If the National Science and Technology Council seeks to develop the inter-sector policy, it should be encouraged to build upon the forthcoming recommendations from the IPT effort.

Reference: 3rd full paragraph first sentence on Page 11

Modify the sentence to read: The team plans to provide recommendations to the Aeronautics and Astronautics Coordinating Board (AACB) by April 1996.

Reference: 2nd paragraph last sentence on Page 16

Remove NRO because it is represented on the AACB.

Major Contributors to This Report

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