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WEATHER SATELLITES

Economies Available by Converging Government Meteorological Satellites

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International Affairs Division

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To the Chairmen of Selected
Committees and Subcommittees

This report discusses the United States' two separate, but similar, polar orbiting meteorological satellite systems—the Department of Defense's Defense Meteorological Satellite Program and the National Oceanic and Atmospheric Administration's Television Infrared Observation Satellite. Converging these two systems could result in substantial cost savings.

We made this review to determine if the two satellite systems could be converged to eliminate duplicative practices and overlapping functions, and still provide the necessary services to the systems' users.

We are sending copies of this report to the Secretaries of Defense and Commerce. Copies are also being sent to the Secretary of the Air Force; the Administrator, National Oceanic and Atmospheric Administration; and the Director, Office of Management and Budget.

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National Oceanic and Atmospheric Administration
TIROS Satellites and Satellite Meteorology

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Executive Summary

Purpose

The United States operates two separate, but similar, polar orbiting meteorological satellite systems. The need for separate systems has been an issue since the early 1970s. Interagency studies have concluded that the two systems should be consolidated into one program or at least converged to a greater degree. Several hundred million dollars in cost savings may be possible.

GAO's objective was to determine if the two satellite systems could be converged to eliminate duplicative practices and overlapping functions, and still provide necessary services to the systems' users.

Background

The two meteorological systems—the National Oceanic and Atmospheric Administration's Television Infrared Observation Satellite (TIROS) and the Department of Defense's (DOD's) Defense Meteorological Satellite Program (DMSP)—each consist of two operational satellites for a total of four in orbit. They have nearly identical operational characteristics—type and altitude of orbits, data handling methods, and data relay patterns.

In addition, each satellite's bus (the framework in which environmental sensors are installed) is manufactured by the same contractor who is also responsible for installing the sensors supplied by other contractors. Each satellite is launched by booster rockets from the same launch pad at Vandenberg Air Force Base, California. However, each system has its own command and control facilities, readout stations, and data processing centers that disseminate data to users for global weather forecasting purposes.

Results in Brief

There is considerable evidence to justify initiating action to converge the DMSP and TIROS systems. What has been lacking is sufficient impetus for the federal agencies involved to take such action. In the short term, planned procurement of the next set of satellites (DMSP S-16 through S-20 and TIROS K, L, and M) could be combined in fiscal year 1989 to start the convergence process. Long-range convergence efforts could also be initiated by integrating the National Oceanic and Atmospheric Administration's and the Air Force's requirements for a future generation of meteorological satellites.

Principal Findings

Opportunities for Convergence and Cost Savings

Convergence of polar meteorological satellite systems is supported by national policy, is technically and operationally feasible, and could offer benefits to the government. During the past 8 years under two administrations, national policy statements have clearly and consistently encouraged increased coordination, cooperation, and elimination of unnecessary duplication between civil and military space programs.

Interagency studies and meteorological satellite experts point to the technical and operational feasibility of convergence while still providing needed services to civil and military users. Although differences exist in the measurement and accuracy of the data, both systems collect similar types of data and have several common features that would promote efficiencies and remove obstacles to convergence.

Studies performed in 1979 on polar meteorological satellite convergence determined that several million dollars could be saved by reducing the two systems of four satellites to one system of three satellites. There are also areas of duplication that, if eliminated, could result in further economies. Other measures such as multiyear procurement contracting and larger quantity purchases of parts may offer other potential savings if the two systems were converged.

Current Trends Show Increased Divergence

The National Oceanic and Atmospheric Administration and the Air Force have independently taken steps or are planning actions that would further separate the polar meteorological satellite systems. These diverging trends are likely to make convergence more difficult. For example, the National Oceanic and Atmospheric Administration wants to change its approach from using expendable conventional satellites to installing sensors on serviceable platforms. The Air Force plans to continue using its current, conventional design of DMSPs (expendable and rocket launched) into the late 1990s before redesigning a new system.

In addition, fewer electronic components are interchangeable between the two systems now than they were several years ago. This is because the Air Force established higher quality control standards for these components, at a higher cost, to increase reliability. The National Oceanic and Atmospheric Administration primarily continues to use less expensive components.

Alternatives for Achieving Convergence

Alternative ways of converging polar orbiting meteorological satellite systems range from a fundamental form of sensor integration, that would leave the separate systems intact, to total convergence that would combine the two systems into a redesigned single system of three satellites operated by one agency.

GAO identified a hybrid alternative consisting of three satellites that could be started immediately without redesigning the satellites. It could not only take advantage of sensor integration, but also multiyear procurement and single agency management. The two systems could still be jointly redesigned for a future generation of meteorological satellites.

The responsibility for coordinating all federal meteorological programs, except meteorological satellites, is assigned to an office within the Department of Commerce. The function of this office could be expanded to include meteorological satellites, and the office could assist in the convergence process.

Recommendation

GAO recommends that the Secretaries of Defense and Commerce jointly take the initiative to converge the DMSP and TIROS polar orbiting meteorological satellite systems to the maximum extent possible.

Matter for Congressional Consideration

Effective coordination among the executive agencies involved in substantive meteorological satellite convergence efforts will be necessary. As a result, the congressional oversight and appropriations committees should consider supporting greater convergence in both the short and long term.

Agency Comments and GAO's Evaluation

DOD's and Commerce's comments on a draft of GAO's report are provided in appendixes II and III, respectively. DOD and Commerce both said that current needs require separate systems.

DOD stated that although interdepartmental debate on meteorological satellite convergence in the early 1980s resulted in continuing with separate programs, it is willing to assume responsibility for a fully converged system. DOD stated that this would be technically and operationally feasible during the next DMSP block change scheduled to be deployed in 1998 (concept design studies beginning in fiscal year 1988).

Commerce agreed that the National Oceanic and Atmospheric Administration and DOD should increase the use of common instruments and facilities to obtain cost savings, but expressed serious reservations about convergence of the two satellite systems. Commerce disagreed for the following reasons: (1) a timing problem associated with procuring satellites K, L, and M in conjunction with DOD's next procurement of five satellites, (2) no current cost studies to show savings, (3) the belief that DOD's weather needs would receive top priority over the civilian sector if conflicts arose, (4) concern that international relationships could be threatened, and (5) the possibility that the best option for future civilian weather instruments could be on a platform system instead of conventional spacecraft.

GAO incorporated DOD's and Commerce's comments and addressed them throughout its report. In some cases, GAO modified its report to reflect concurrence with the two agencies' comments. However, in general, GAO retains its position regarding the feasibility and benefits of greater meteorological satellite convergence.

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Abbreviations

DMSP	Defense Meteorological Satellite Program
DOD	Department of Defense
IRS^2	Integrated Remote Sensing Systems
METSATs	meteorological satellites
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
NROSS	Navy Remote Ocean Sensing System
PDs	Presidential Directives
POOMSCOB	Polar Orbiting Operational Meteorological Satellite Coordination Board
TIROS	Television Infrared Observation Satellite

Chapter 1

Introduction

Weather related environmental data are acquired for civilian and military purposes in a variety of ways, including the use of meteorological satellites (METSATs), balloon-carried radiosondes, ground based radars, aircraft pilot reports, and observers. The data are exchanged daily through agreements with almost all countries of the world.

Systematic observations of the atmosphere began in the early 1900s. Instruments attached to balloons provided periodic monitoring of the high-altitude atmosphere. In the 1950s, the introduction of radar and computers permitted weather patterns to be continuously monitored thus producing vast amounts of data. Meteorologists then began studying and forecasting atmospheric motion on a global basis—a technique known as numerical modeling—which allowed for more long-term and accurate forecasts. Numerical modeling is the basis for weather forecasting today.

Global forecasting requires data from the entire earth, including the vast unpopulated regions of the world, particularly the oceans. This led to two types of METSATs. In the early 1960s, a relatively low-altitude (about 450 nautical miles) polar orbiting system was developed which routinely provides data over the entire earth's surface. In the mid-1970s, a much higher altitude (22,300 nautical miles) geosynchronous[1] system was developed which provides data from a vast area of the earth beneath it, including the eastern and western United States and the adjacent ocean areas.

The United States has two polar orbiting METSAT systems—the Television Infrared Observation Satellite (TIROS)[2] operated by the National Oceanic and Atmospheric Administration (NOAA) within the Department of Commerce, and the Department of Defense's (DOD's) Defense Meteorological Satellite Program (DMSP) operated by the Air Force. Each system consists of two operational satellites for a total of four in orbit. (NOAA also operates the geosynchronous METSAT system consisting of two satellites.)

Each satellite's bus (the framework in which sensors are installed) is manufactured by the same contractor—RCA Astro-Electronics—who is also responsible for installing the sensors supplied by other contractors.

[1]Refers to a satellite whose orbit lies in the plane of the earth's equator and whose period of revolution is equal to the period of the earth's rotation, thus remaining in a stationary position relative to the earth.

[2]Also referred to as Polar-Orbiting Environmental Satellite.

Currently, NOAA has one TIROS (referred to as D) available for launching, three nearing completion of production (H, I, and J), and three more (K, L, and M) in the beginning stages of production. The Air Force has one available for launching (referred to as S-8), six in production (S-9 through S-14), a prototype development contract for one (S-15), and five more (S-16 through S-20) being planned for production starting in fiscal year 1989. According to agency officials and budgetary documents, the cost of the more recent satellites (including sensors) is approximately $100 million each. In addition, both agencies are planning newly designed METSATs, which are to be more capable than the existing design.

Each satellite is installed on top of an Atlas E booster rocket and is launched from the same pad at Vandenberg Air Force Base, California. Launch costs for each system range from $20 million to $30 million. The supply of Atlas rockets is expected to be exhausted upon launch of DMSP S-14 and NOAA's J. The agencies then plan to use refurbished surplus Titan II booster rockets for about $40 million per launch.

The need for separate polar orbiting METSAT systems has been an issue since the early 1970s, and studies have concluded that the two systems could be consolidated into one program or at least converged to a greater degree. The studies advocated the use of more common parts, integrating various sensors, designing like satellites, and designating one federal agency to manage the programs. Policy decisions following the studies supported greater convergence. Some progress has been made such as sharing data processing capabilities, using a common spacecraft bus and launch vehicles, and cooperating in studies aimed at common sensor development. However, despite these actions, DMSP and TIROS remain as separate systems. There is even some evidence of trends toward greater separation (divergence).

Evolution and Operation of Polar Orbiting METSATs

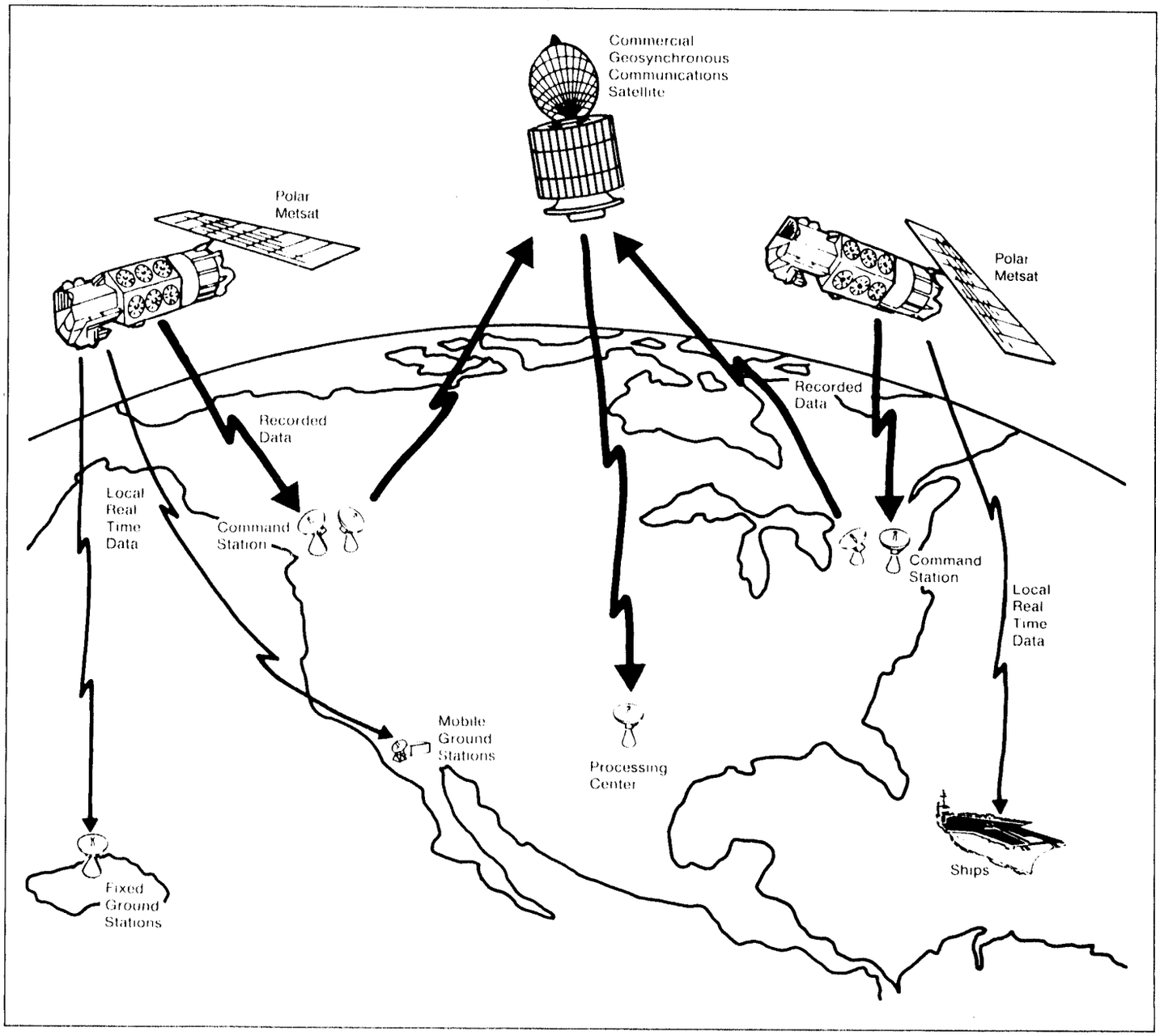
Development of the first polar orbiting METSAT began in the late 1950s as the TIROS program under DOD. In 1959, TIROS was transferred from DOD to the National Aeronautics and Space Administration (NASA) which was created as the lead agency for civil space activities by the National Aeronautics and Space Act of 1958. In 1960, the first TIROS was launched and its success led NASA, DOD, and the Federal Aviation Administration to plan for a satellite system that would provide worldwide weather observations to all the agencies. In the mid-1960s, the civilian system became operational and was transferred from NASA to the Department of

Commerce. DOD saw the need to satisfy some unique and critical requirements and began developing its own system. The mid-1960s therefore marked the beginning of the two separate programs—DMSP and TIROS.

The DMSP and TIROS systems have nearly identical operational characteristics—type and altitude of orbits, data handling methods, and data relay patterns. Each satellite orbits in a fixed vertical plane over the North and South Poles taking about 101 minutes to complete one orbit and making about 14 orbits each day. The four satellites operate in staggered orbits permitting them to view predetermined areas of the earth during daylight hours. They are referred to as the early morning DMSP, mid-morning TIROS, late morning DMSP, and early afternoon TIROS. As the earth rotates beneath them, each satellite is able to view the entire earth's surface twice a day.

The satellites gather a variety of environmental data in the form of imagery, temperature and moisture soundings, and other data unique to DOD and the Department of Commerce. The data may be immediately transmitted to ships, or land-based ground stations that are within direct line of sight of the satellite, allowing the recipients to view local environmental conditions on a near real-time basis. Militarily, real-time data can be used to support tactical operations. Global data are usually stored in onboard recorders and later transmitted to ground readout stations when the satellite passes overhead. The ground stations then relay the data via commercial geosynchronous communication satellite to a central ground data processing center. At the processing center, the global data becomes part of the numerical model and are used to support strategic and tactical missions and long-range forecasting. Figure 1.1 represents a generic data relay pattern of polar orbiting METSATs and how they get their data to ground stations and processing centers.

Figure 1.1: Generic Data Relay Patterns for Polar METSAT Systems



Both DMSP and TIROS have their own command and control facilities, readout stations, and data processing centers. For DMSP, the command and control function and the data processing center is currently located

at Offutt Air Force Base, Nebraska. New command and control facilities are being constructed at Fairchild Air Force Base, Washington, for redundancy and survivability purposes. The readout stations are located at Loring Air Force Base, Maine, and Fairchild Air Force Base, Washington. The Loring station is considered obsolete and its function will be transferred to Thule Air Base, Greenland, by 1988. For TIROS, the command and control function and the data processing center is located near Suitland, Maryland. The readout (also called data acquisition) stations are at Wallops Island, Virginia, and Gilmore Creek, Alaska. The Navy also has a data processing center in Monterey, California, that is used to analyze oceanographic data received from DMSP and TIROS.

Objective, Scope, and Methodology

Our objective was to determine if the United States' two polar orbiting METSAT systems—DMSP and TIROS—could be converged to eliminate duplicative practices and overlapping functions and still provide necessary services to their respective users. We also examined the Navy's plan to acquire the Navy Remote Ocean Sensing System (NROSS) and the feasibility of adding such a capability to a converged METSAT system. We did not include the activities associated with the data processing and distribution centers, the geosynchronous satellites, or the remainder of the weather forecasting network within the scope of our review.

We compared the overall operations of the systems, including the ground systems used to control the satellites, and the individual components making up the satellites. We analyzed program documents and reports, including several interagency studies on convergence of the systems. Some of these studies (the latest being in 1979) provided estimated cost savings that could have been attained by converging the systems. To provide perspective, we updated these estimated savings to 1986 dollars using Office of Management and Budget indexes. We also interviewed several government and contractor officials associated with the two programs.

Within the Air Force, we performed work at the Systems Command's Space Division in El Segundo, California. We visited the Military Airlift Command's Air Weather Service at Scott Air Force Base, Illinois; the Space Command in Colorado Springs, Colorado; Global Weather Central at Offutt Air Force Base, Nebraska; and the satellite launch facility at Vandenberg Air Force Base, California.

Within the Navy, we visited the Fleet Numerical Oceanography Center in Monterey, California; the Navy Space Systems Activity in El Segundo,

California; the Space and Naval Warfare Systems Command in Arlington, Virginia; and the Polar Oceanography Center at the Navy/NOAA Joint Ice Center in Suitland, Maryland.

The civil agencies we visited included NOAA's National Environmental Satellite Data and Information Service in Suitland, Maryland; Commerce's Office of the Federal Coordinator for Meteorological Services and Supporting Research in Rockville, Maryland; NOAA's Environmental Research Lab in Boulder, Colorado; NASA's Goddard Space Flight Center in Greenbelt, Maryland; the Office of Management and Budget in Washington, D.C.; and the Department of State's Bureau of Oceans and International Environmental and Scientific Affairs in Washington, D.C.

We also visited RCA Astro-Electronics in Princeton, New Jersey; the Westinghouse Defense and Electronics Center in Baltimore, Maryland; the Harris Corporation's Government Information Systems Division in Melbourne, Florida; and the Aerospace Corporation in El Segundo, California.

Our work was performed in accordance with generally accepted government auditing standards.

Similar Systems Offer Opportunities for Convergence and Cost Savings

Converging the polar METSAT systems is supported by national policy, is technically and operationally feasible, and offers cost savings to the government. Eliminating duplication has been consistently encouraged by presidential policy documents associated with civil and military space programs. On several occasions, the need for separate METSAT programs has been studied with the same conclusions—that it is possible for a single system to satisfy civil and military user needs. Economies should result from a converged system by eliminating one satellite, minimizing areas of duplication, and procuring items on a multiyear contract basis and in larger quantities.

National Policy Supports Convergence

Although current national policy does not require convergence, it supports the idea by emphasizing the elimination of unnecessary duplication. Prior policy statements were even more strongly worded in support of convergence. In 1978, during the Carter administration, concern over growing interaction and potential overlap between civil and military space activities prompted a review of national space policy. As a result, Presidential Directives (PDs) 37 and 42 were issued to define national policy regarding the need for separate overall space programs and to determine the extent to which meteorological space programs should be converged.

PD 37 set forth certain space principles which were to govern space policy and establish responsibilities for military and civilian space related activities. It designated environmental monitoring as a military activity and encouraged close coordination and information exchange between the civil and military space sectors to avoid unnecessary duplication and to allow maximum cross utilization of all capabilities.

PD 42 required a study to determine whether it was necessary to maintain separate METSAT programs, and if not, the degree to which they could be consolidated. Two interagency studies were performed, both of which concluded in favor of increased convergence and presented several alternatives, including total consolidation of the polar METSAT systems. In 1979, following these studies, PD 54 provided for future systems to be converged. It essentially said that although currently developed systems would continue to be separate, any new systems would be jointly developed and procured by DOD, Commerce, and NASA to maximize technology sharing and minimize cost. However, according to the Air Force, there was insufficient time to coordinate each agency's acquisition plans, thus no new systems were initiated under the Carter administration.

In 1982, the Reagan administration's National Security Decision Directive 42 superceded PDs 37, 42, and 54 and addressed overall national space policy. It does not specifically address METSATs as the previous directives did, but it does address overall civil and national security (military) space programs, encouraging close coordination, cooperation, and information exchange between them to avoid unnecessary duplication. It also allows for maintaining separate programs when differing needs of the programs dictate. Specifically, it says:

> "The United States space program will be comprised of two separate, distinct, and strongly interacting programs—national security and civil. Close coordination, cooperation and information exchange will be maintained among these programs to avoid unnecessary duplication. . . . The national security and civil space programs will be closely coordinated and will emphasize technology sharing within necessary security constraints. . . . The United States Government will maintain and coordinate separate national security and civil operational space systems when differing needs of the programs dictate."

During the past 8 years under two administrations, national policy has clearly and consistently encouraged increased coordination, cooperation, and elimination of unnecessary duplication among civil and military space programs. Nevertheless, the Air Force and NOAA continue to operate separate polar METSAT systems consisting of two satellites each when the need to do so may no longer exist.

DOD and Commerce Comments and Our Evaluation

DOD and Commerce emphasized that they were in compliance with current policy and that current needs require separate systems. They cited some specific requirements that are unique to each system.

We recognize that there are some differences in the use of each system, and are not questioning unique agency requirements. Instead, we believe the questions are whether the two systems as a whole are different enough to warrant continued separation, and whether the unique requirements would be unacceptably jeopardized under a converged system. The key point here is that current policy advocates avoiding unnecessary duplication and would therefore support convergence if it is determined that the needs of each system do not dictate separate programs.

Convergence Is Technically and Operationally Feasible

According to detailed studies and METSAT experts, it is both technically and operationally feasible to converge the DMSP and TIROS systems into a single national polar orbiting METSAT system while still providing needed services to civil and military users. Although differences exist in the way data is measured and in the accuracy of the data, both systems collect similar types of data, and have several common features that would promote efficiencies and remove obstacles to convergence.

Studies and Expert Opinions Support Convergence

Between 1972 and 1979, three interagency studies examined the potential for converging the DMSP and TIROS systems. The first study, known as the Duffy report, was issued in May 1972. It was requested by the Deputy Secretary of Defense to determine the usefulness of maintaining separate METSAT systems and the degree to which the TIROS system could satisfy DMSP requirements. As a result of this study, the Air Force and NOAA began procuring a common bus for their satellites.

The second study, issued in March 1979, was performed by representatives from the Air Force, NOAA, and NASA known as the Polar Orbiting Operational Meteorological Satellite Coordination Board (POOMSCOB). Its objective was to satisfy requirements set forth in the 1978 PD 42.

In July 1979, a third study known as the Integrated Remote Sensing Systems (IRS^2) study was performed by an interagency task force and was also designed to satisfy PD 42 requirements. These three studies concluded that the systems could be converged into a single system which could satisfy civil and military needs. Although they pointed out some obstacles to convergence, the obstacles were presented as matters to be dealt with, not as reasons for continuing separate systems. Table 2.1 provides summary information from these studies.

Table 2.1: Summary of Key Convergence Studies

Study	Objectives	Conclusions	Recommendations
Duffy (1972)	Determine the degree to which a converged system can meet DOD and NOAA needs.	A single national METSAT system can be responsive to both NOAA and DOD needs. Until it is done, greater stress on interdependence, joint planning, and hardware and technology exchanges can both increase total system effectiveness and probably reduce costs.	Develop a joint plan to converge the two systems.
POOMSCOB (1979)	Determine feasibility of more complete convergence of the two polar orbiting METSAT systems.	Further convergence is technically and administratively possible. Total cost can be reduced.	Consolidate two polar METSAT systems into a single system of three satellites in common use by DOD and NOAA.
IRS² (1979)	Determine option for converging current and potential remote sensing systems into a single national system.	Convergence of polar orbiting METSAT is technically feasible and would reduce costs.	No specific recommendations made.
		Merging of meteorological and oceanographic satellites is also possible and would further reduce costs.	

In addition to these formal studies, current and former officials associated with the programs support the feasibility of converging the DMSP and TIROS systems. For example, we discussed this matter with DOD's Chairman of the Joint Environmental Satellite Coordinating Group. This group of meteorological experts was formed in 1975 to coordinate METSAT activities among the military services. The Chairman pointed out that duplicate METSATs have been an issue since 1970. The Chairman also referred to a DOD position paper issued in 1979 that supported convergence of the two systems, but the paper emphasized the need for a significant degree of control by DOD over a converged system because of national security missions. The paper stated that DOD would be willing to assume leadership in procuring and operating a fully converged system. The Chairman testified before the Senate Subcommittee on Science, Technology, and Space of the Committee on Commerce, Science, and Technology in April 1986 that DOD finds little reason to change its 1979 position. The Chairman did, however, express some caution associated with convergence, suggesting that it be undertaken as a long-term program if shown to be acceptable and cost effective.

We also discussed METSAT convergence with the Federal Coordinator for Meteorological Services and Supporting Research—an office located within the Department of Commerce. The coordinator said that the office was established in 1964 to eliminate duplication among federal

meteorological programs. Although the coordinator's authority was not extended to the METSAT programs, the coordinator was familiar with DMSP and TIROS capabilities and applications, regarded the existing duplication as significant and unnecessary, and strongly supported converging the two systems.

When the NOAA Administrator was NASA's Deputy Administrator in the late 1970s, a position paper was prepared recommending converging the DMSP and TIROS systems. Although the administrator still supports the idea and believes it is technically feasible and could save money, he expressed some reservations concerning military control over the program. The administrator is primarily concerned over how much influence NOAA would have if a national METSAT system were controlled by the Air Force.

We also discussed convergence with several other individuals associated with the two programs, including the Air Force's DMSP manager, current and former RCA officials, and the Office of Management and Budget's examiner for NOAA activities. All agreed that convergence is feasible and would probably save money. However, many stated that potential management and political problems could arise.

User Needs Could Still Be Satisfied

DMSP and TIROS have some very similar data collection capabilities. For example, according to Air Force and NOAA officials, there are nine major types of atmospheric and oceanographic data requirements that are considered important for the polar systems. Of these, four are currently collected by both DMSP and TIROS and one is collected only by TIROS. The remaining four cannot be collected by either system. Table 2.2 shows the similarities and differences between DMSP and TIROS for the nine data requirements.

Table 2.2: Important Types of Atmospheric and Oceanographic Data

Types of data	Collected by DMSP	Collected by TIROS
Cloud cover	yes	yes
Atmospheric vertical temperature profile	yes	yes
Atmospheric vertical moisture profile	yes	yes
Surface temperature-infrared	yes	yes
Sea surface wind (speed and direction)	no	no
Sea surface temperature-microwave (night/day and all weather)	no	no
Sea ice (cover, thickness, and age)	no	yes
Sea waves (height and direction)	no	no
Sea surface topography (fronts and eddies)	no	no

Although not all the data is measured in the same way or with the same accuracy, experts have concluded that some of the two systems' sensors could be modified and made compatible to all users' needs. For example, both DMSP and TIROS have infrared sensors, but the TIROS sensor is capable of providing surface measurements better suited for the joint Navy and NOAA ice center which analyzes sea ice conditions for civil and military users. In 1980, the Air Force examined the possibility of DMSP providing the type of data needed by the ice center and determined that such capability could be added with a minor modification.

System Commonalities Would Promote Efficiencies

Besides the similarities in data collection capabilities, we noted several existing features that are common to DMSP and TIROS that would make convergence easier and more efficient. For example, both satellite systems use the same structural framework, referred to as the bus, which is built by the same contractor that also installs the sensors. According to DOD officials, the bus parts are about 70 percent common, and with bus and sensors combined the satellites are about 50 percent common. For example, the satellites use similar attitude control (maintenance of the satellites' orientation with respect to the earth and sun) and power supply subsystems, and the same heat shield and thermal control components. In addition, both systems have many similar operational characteristics and requirements such as low-altitude polar orbits, command and control units, launch support requirements, and life expectancies.

DOD and Commerce Comments and Our Evaluation

DOD concurred that convergence is technically and operationally feasible. Commerce concurred regarding technical feasibility, but questioned operational feasibility. Commerce's main concern was that mission activities could be disrupted due to management and political problems arising from conflict between mission priorities. The differences between the two agencies seems to be one of perspective. DOD's position is that it must have complete control of a converged system. Commerce envisions competition between the civil and national security mission leading to priority attention to DOD requirements if problems developed.

We believe that the feasibility question has been sufficiently addressed in prior studies. Although management and political matters may need to be addressed (see ch. 4), this would not appear to be an insurmountable matter if a serious commitment were given to convergence based on cost savings and benefits.

Convergence Offers Several Benefits

The studies performed in 1979 on polar METSAT convergence determined that cost savings could be realized. The savings were based on the view that the four DMSPs and TIROSs could be merged into one system of three similar satellites with the on board sensors distributed among the satellites to provide optimum data collection capabilities. The estimates represented savings over an 8-year period—1985 through 1992—and were presented in 1980 dollars. To provide better perspective regarding these savings, we updated them to 1986 dollars using DOD's inflation indexes provided by the Office of Management and Budget. Table 2.3 shows that depending on whether expendable or serviceable satellites were used, savings from $250 million to $708 million might be realized. We recognize that actual amounts could vary because of some changes that have occurred in the two systems since the studies.

Table 2.3: Potential Cost Savings From Convergence Based on Studies in 1979

Dollars in millions

Study	Estimated savings (1980 dollars)	Estimated savings (1986 dollars)[a]
POOMSCOB (expendable satellites)	$180	$281
IRS[2] (expendable satellites)	160	250
IRS[2] (serviceable satellites)	268	418
IRS[2] (serviceable satellites, including oceanography)	454	708

[a]1980 to 1986 inflation index is 1.56.

The studies cautioned that not all potential areas of savings were considered. In this regard, we identified some areas of duplication that, if eliminated, could result in further economies. We also identified other possibilities for economies such as multiyear procurement contracting and larger quantity purchases of parts if the two systems were converged. These areas are discussed below, together with the major issue considered in the studies regarding the questionable need for a four satellite system.

Areas of Duplication

Past interagency studies and current administration actions indicate that four satellites (two DMSPs and two TIROSS) are not necessary. Instead, it is possible that one TIROS and two DMSPs combined could satisfy user needs. NOAA officials informed us that the morning TIROS has been considered as a backup capability for the afternoon TIROS. However, under a one satellite system, it would not be needed because the launch and call-up schedules would be designed to maintain data continuity. Also, since fiscal year 1983, the President's budget proposal has requested funding for only one polar orbiter even though NOAA wanted two. In fact, in fiscal year 1986, besides requesting funds for only one satellite, the proposal recommended rescinding $38.8 million appropriated in fiscal year 1985 to maintain a two orbiter system. More recently, NOAA testified during fiscal year 1987 congressional hearings that only a one TIROS system is needed.

A second area of duplication involves government procurement and contractor functions. The Air Force procures DMSPs from RCA, and NASA procures TIROSS for NOAA also from RCA. Thus, duplicate procurement functions exist to acquire essentially the same satellites from the same

contractor. In addition, DMSPs and TIROSs are assembled in separate lines at the contractor's plant because of the separate procurement contracts, and not because of assembly requirements. The systems are similar enough that, under a single procurement, common production activities could be consolidated. Contractor representatives showed us where separate commercial satellite assembly operations had been combined allowing for better use of equipment and personnel. The contractor is convinced the change saved money, although they have not determined how much, and believes that the same result could be achieved by combining the DMSP and TIROS lines.

A third area of duplication is computer capacity at the ground stations that send command and control signals to the operational satellites. According to Air Force officials, the station at Offutt Air Force Base has four command subsystems. In addition, the Air Force is in the process of adding three more command subsystems to its Fairchild satellite operations center for redundancy purposes. These seven subsystems can handle three healthy satellites, and can provide backup and training support, launch support capabilities, and capacity for analyzing satellite anomalies. A NOAA official informed us that the station near Suitland, Maryland, has the capacity to handle at least two satellites (and has handled an additional three satellites on a part-time basis). In total, this represents computer capacity for a minimum of five healthy satellites, plus additional tasks. From a government standpoint, there appears to be an opportunity to reduce this capacity under a converged system of three or four satellites. Some modification would be needed according to agency officials. In 1979, before the redundant capacity was planned for the Fairchild center, the POOMSCOB study estimated a savings of over $2 million per year for 8 years in fiscal year 1980 dollars ($3.1 million per year in fiscal year 1986 dollars) by combining certain command and control operations.

Other Economies That Could Be Realized

It is possible that under a converged system, other economies could be realized through the use of multiyear procurement contracting and more economical purchases of parts. Although the desirability of using the multiyear procurement technique should be judged on a case-by-case basis after considering the potential benefits and added risks, some cost savings could be possible. A previous DOD request to purchase DMSPs on a multiyear basis passed congressional scrutiny relative to the stability of design, funding, and program requirements. As a result, the Air Force estimates it has saved about $146 million on its current multiyear buy of satellites versus buying one satellite each year. Merging future buys of

DMSP and TIROS may even be more advantageous. In contrast, our review of TIROS procurement shows that the average cost per satellite increased by 160 percent between two contracts largely due to a smaller number of satellites being procured under the second contract.[1]

The problem of small order quantities is particularly acute with satellite procurement because satellites are commonly purchased in small numbers, usually three to four at a time in case of polar METSATs. Since a large portion of the components in the polar METSATs' major subsystems are very similar or identical (from 50 to 70 percent), convergence could help eliminate the problem of small order quantities by allowing these components to be procured for both systems at once.

We discussed this matter with the RCA contract manager. The manager said that the DMSP and TIROS systems could easily be combined into a multiyear procurement and that a single procurement approach could save significant amounts of money for both programs.

DOD and Commerce Comments and Our Evaluation

DOD acknowledge that cost savings could be achieved through convergence, but stated that the specific savings derived in 1979 studies are no longer valid because of changes in the DMSP and TIROS systems. Commerce took exception to the cost savings by stating that our report does not adjust for the outmoded assumptions in the 1979 studies and fails to account for major costs of convergence. Commerce also stated that the savings should be reduced because of cooperative efforts between the two programs since 1979.

We believe it is important to disclose what the 1979 studies reported to provide some indication of potential savings. To our knowledge, no other studies on convergence were available or equal in comparison. In addition, we updated the savings from 1980 to 1986 dollars merely to provide better perspective in more current financial terms. Finally, our report should not be read to express or imply that the specific amounts disclosed would be the actual savings. We recognize that changes have occurred between the two programs since 1979. However, the single, most important factor in the 1979 savings was that one of the four METSATs could be eliminated. That point alone should not cause the savings from convergence to be substantially limited. The savings may even be higher today because of greater costs of current systems (irrespective

[1] Weather Satellite Cost Have Increased; Problems Have Occurred in Their Manufacturing Quality Control (GAO/RCED-86-28, Oct. 31, 1985).

of inflation) and other potential savings not considered in the 1979 studies.

Regarding duplicate government procurement and contractor functions, DOD acknowledged that the two satellites were up to 70 percent common, but pointed out that other differences meant that the systems were not interchangeable. Commerce stated that an augmented procurement staff would be needed to handle a larger, more complex system. Neither DOD nor Commerce offered sufficient specific information to convince us that some savings would not be possible. Our main purpose was to point out that duplication existed. The extent of current savings through consolidation has not been determined.

Relative to computer capacity for commanding and controlling the METSATs, DOD stated that it had seven computer command subsystems, and did not think that was excess capacity. Commerce also indicated that its computer capacity was fully used. We made some modifications to our report based on the agencies' comments. However, our observations still suggest that if the two systems were converged, the Air Force and NOAA collectively could handle at least five healthy satellites (possibly six considering that Offutt has handled two for several years, that Fairchild is expected to handle two, and that Suitland can handle two). This still appears to be excessive when only three or four satellites (even assuming an NROSS) are necessary. Therefore, some savings could be possible.

Current Trends Show Increased Divergence

NOAA and the Air Force have independently taken steps or are planning actions that would further separate the polar METSAT systems. These diverging trends are likely to make convergence more difficult. In the 1990s, NOAA wants to change its approach from using expendable conventional satellites to installing sensors on serviceable platforms. This would allow for repair and exchange of sensors in space. It would also substantially reduce the similarities and common features relative to DMSP.

The Navy was planning to procure its polar orbiting satellite system called NROSS to provide oceanographic data not now available from DMSP or TIROS. However, in December 1986, subsequent to our receiving DOD's comments on a draft of this report, the Navy terminated the NROSS program because "... the cost exceeded the level of acceptable affordability."

In 1984, the Air Force increased its quality control requirements for basic parts on the DMSP, many of which are common to the TIROS. NOAA plans to continue using the existing level of quality control for TIROS. The contractor (RCA Astro-Electronics) is therefore required to purchase different quality controlled parts and is precluded from jointly purchasing common parts in more economical quantities.

Air Force and NOAA Plan for Different Space Platforms

The Air Force and NOAA are independently moving in different directions in their plans for future weather satellites. The Air Force plans to continue using its current design of DMSPs into the late 1990s. It then plans to upgrade DMSP capabilities through a complete redesign (referred to as the Block 6). Although the Air Force plans to maintain the conventional (expendable, rocket launched) type of satellite, cost-benefit tradeoff analyses are to be done on a dual compatible design (space shuttle and rocket launched) and on an expendable versus an on-orbit service and repair design.

NOAA officials stated that they were considering installing future sensors on serviceable polar orbiting platforms such as on NASA's proposed space station, the European Space Agency's platform, or a commercial project known as Omnistar. In several technical studies, NOAA proposed this approach to serve its needs instead of using a conventional satellite system. These platforms would remain in orbit for an extended period and be maintained by astronauts. NOAA's technical representatives say these platforms would be capable of containing a family of remote sensing instruments that are now on expendable, conventional satellites

or scheduled to be deployed in the next few years, including those on DMSP.

DOD officials said the platform is undesirable for military needs and have expressed concern regarding flexibility, security, and survivability. They pointed out that a platform is inflexible because of its permanent location in space for an estimated 15 to 20 years. They emphasized the importance of being able to launch new conventional satellites into different orbital times should the need arise. They also stated that the numerous instruments planned for the platform created a security problem because classified data might be picked up by other instruments on board. In addition, they questioned the platform's survivability because of its expected size and the numerous electronic signals to be continuously emitted from it, making it easy to detect and track. DMSP officials said they could see no possibility of using the proposed NOAA platform for the military's polar orbiting meteorological sensors.

Navy Planned to Acquire Its Own Polar Satellite

The Navy was planning to acquire its own polar orbiting satellite system—NROSS—to collect oceanographic data not now available from DMSP or TIROS. It planned to launch the first satellite in the early 1990s. NROSS was expected to be very similar to the DMSP and could have been jointly procured by the Air Force as part of a converged system. Initially, the Navy planned to purchase NROSS from the DMSP contractor—RCA Astro Electronics—and take advantage of existing METSAT designs. However, in December 1985, the Navy issued a notice in the Commerce Business Daily seeking other sources with the capability to design and manufacture NROSS. A request for proposals was issued in July 1986 and contractor bids were received in August 1986. After DOD's review of this draft report in early November 1986, the Navy terminated the NROSS program because it was judged to be unaffordable.

The proposed NROSS was expected to be capable of providing some unique oceanographic data as well as other data in greater accuracy than currently available from existing METSATs. For example, the system was to provide all weather sea surface measurements to identify and track eddies (swirls of water which are warmer or colder than the water surrounding them) where submarines could hide virtually undetected. In addition, these measurements were to provide safer and more efficient operations for ship movement, and more accurate sea ice estimates to detect shallow or thin ice in the arctic region where submarines could

emerge. NROSS capabilities would have fulfilled the data requirements shown in table 2.2.

Notwithstanding NROSS's planned unique capabilities and increased accuracies, the satellite's overall characteristics could have been very similar to DMSP. For example, if RCA had won the contract, NROSS would have likely used the same or similar bus as DMSP and TIROS. It would also have likely used some of the same sensors (including some unique ones), had the same onboard command and control system, used the same type launch vehicle, and been launched by the Air Force from Vandenberg Air Force Base. In addition, NROSS would have been placed in the same type of polar orbit and would have used the same method of transmitting information to the earth. (See fig. 1.1.)

DOD officials informed us that the current plans for the next generation of DMSPs (Block 6), expected near the end of the century, will include the same oceanographic capabilities as NROSS. This would have been potentially duplicative of the Navy's program. However, since the Navy terminated NROSS, it intends to merge the oceanographic requirements into the DMSP at the earliest possible time.

Different Quality Control Standards Reduce Parts Commonality

For several years, the military and civil METSATs used similar quality control standards for electronic components such as transistors, capacitors, microcircuits, and diodes. For example, 38 percent of DMSP's parts (24 of 63 items) were interchangeable with TIROS parts. This allowed the prime contractor to purchase these common parts from vendors in larger quantities.

According to the Air Force, as a result of several satellite failures in the 1970s, a decision was made to increase the reliability of all space systems. An increased level of testing was therefore instituted which applied to all Air Force satellite and launch vehicle systems. In February 1984, the Air Force required that DMSP parts be tested to this higher qualification level. These parts, referred to as "S" parts, require more rigorous testing and rigid batch control than was previously done. Although many of the DMSP and TIROS items in the two systems are still physically and functionally identical, they are no longer considered interchangeable because of being tested to differing standards.

Considering the technological and operational similarities of the DMSP and TIROS, it seems that a similar level of quality control over the systems should be necessary. If so, either the Air Force is over qualifying

its parts or NOAA is under qualifying its parts. NOAA and NASA officials informed us that they plan to continue using parts tested to the original standards for TIROS and would use S parts only as a last resort. The officials also said they could not afford the additional quality control measures taken by the Air Force and that they anticipate schedule delays in delivery of S parts because of so few manufacturers. The contractor informed us that joint procurement of parts common to both DMSP and TIROS is not now possible and will have a significant financial effect to both programs. According to a NOAA official, parts prices for TIROS have already risen because of smaller quantity buys.

DOD and Commerce Comments and Our Evaluation

Commerce stated that our characterization of NOAA's interest in serviceable platforms should not be categorized as increased divergence. Rather, NOAA will consider converging with non-DOD satellite system operators by installing its sensors on platforms procured by others. We are aware of NOAA's position on this matter, and our purpose was to point out that a substantial departure from conventional satellites was contemplated. The use, cost, and benefits of serviceable platforms is a separate question dealing with future designs, which may or may not be approved.

Part of DOD's comments regarding NROSS are no longer applicable because the Navy terminated the program in December 1986 after we received DOD comments. We modified our report to reflect the Navy's action. We also followed up with the Navy about its future plans and were informed that (1) the operational requirements for oceanographic data are still valid and (2) expedient actions must be taken to link these naval requirements with DMSP. The Navy stated that since the DMSP mission includes the responsibility for oceanographic data, the Navy's oceanographer will begin discussions with DMSP officials to obtain cost estimates and then prepare a funding profile for Navy assessment and further guidance.

Regarding different quality control standards for METSAT parts, DOD emphasized the necessity for more stringent quality control to satisfy the military requirement for optimum reliability. It stated that the civil system (TIROS) would be required to absorb the added costs of these parts for them to be interchangeable. Commerce stated that although NOAA buys the higher quality parts when they are available, the NOAA mission can operate with a lower quality control requirement, thus reducing costs.

Alternatives and Methods for Achieving Convergence

There are alternative ways of increasing convergence of polar orbiting METSAT systems. They range from a fundamental form of sensor integration that would leave DMSP and TIROS intact to total convergence that would combine the two existing systems, including oceanographic requirements, into a redesigned single system operated by one agency. The alternatives discussed in this chapter represent examples based on interagency studies and our discussions with agency representatives. They are not intended to be all inclusive as other alternatives could probably be devised.

Successful convergence would undoubtedly require close coordination among the federal agencies involved. One method of facilitating this could be through an interagency coordinating group such as the Office of the Federal Coordinator for Meteorological Services and Supporting Research currently located within the Department of Commerce. This office is charged with coordinating responsibilities for all federal meteorological programs, with the exception of METSATs. It consists of representatives from military and civil agencies involved with weather programs. Adding METSATs to its responsibilities would be a logical extension to this office's coordination function.

Potential for Integrating METSAT Sensors

Sensor integration was included as the basic ingredient of the convergence plans in the 1979 studies. It would involve standardizing and modifying the two system's existing sensors where the same type of data is being measured. Standardization refers to using common sensors on both systems where possible. Modification refers to minor changes in sensor design to increase overall system compatibility.

Although primary data requirements differ for the two users (DOD emphasizes imagery and NOAA emphasizes soundings), we found that the same types of sensors considered primary to either system were located on both systems. These sensors were designed and are procured separately. If some sensors were standardized, it could permit larger quantities of parts to be ordered on a more economical basis. If others were modified to provide more compatible data, the two systems could provide better backup capability for each other. Table 4.1 shows the primary sensors on DMSP and TIROS.

Table 4.1: Primary Meteorological Sensors on DMSP and TIROS

Sensors	DMSP	TIROS
Visible imagers	Primary	Primary
Infrared imagers	Primary	Primary
Infrared sounders	Secondary	Primary
Microwave sounders	Secondary	Primary

Although both systems use some of the same type of sensors, the type and accuracy of the data received is different. For example, both systems obtain visible imagery, but do so at different resolution factors.[1] NOAA uses visible imagery for tracking large areas of cloud cover, which does not require high resolution. DOD, however, uses visible imagery where greater detail is very important and a higher resolution factor is required.

Despite these differences, there are indications that some sensors could be standardized and modified to meet users' needs. For example, DOD and NOAA have recently been studying the integration of certain sensors, and according to the Chairman of DOD's Joint Environmental Satellite Coordinating Group, some good prospects exist. Also, sensor integration was a topic examined by NOAA in its Envirosat 2000 report issued in October 1985, which compared the DMSP and TIROS programs. It pointed out that there are areas where increased joint efforts were logical and that DOD and NOAA have already identified mutual interests in instrument developments, including microwave imaging devices, microwave temperature and water vapor sounders, and space environment monitors.

Considering alternative levels of convergence, sensor integration may be the easiest to achieve. This is because the two systems could be independently modified while allowing the programs to remain intact. It also avoids concerns that could be raised under more extensive levels of convergence. Although no cost savings data were available, the potential savings associated with sensor integration would likely be more limited than with greater convergence alternatives. This is because it would only deal with a portion of the total satellite system—the sensors. It is nevertheless the minimum effort that could be taken and a logical first step.

[1]Resolution refers to the degree of detail that can be measured by the sensors.

DOD and Commerce Comments and Our Evaluation

DOD partially concurred with the concept of sensor integration. It cautioned, however, that the civil and military systems do not have identical primary data requirements. For example, requirements vary in terms of accuracy, space and time resolution, and other factors. DOD also pointed out that there could be cost increases related to sensor convergence. Nevertheless, both DOD and NOAA have agreed to study the potential for common sensor design where data requirements are sufficiently similar. Commerce stated that NOAA and DOD have agreed on some common sensor designs and intend to continue to progress toward using common sensors.

We agree with these comments.

Single System With Three Redesigned Satellites

According to the 1979 POOMSCOB and IRS[2] studies, a single METSAT system could be achieved by redesigning the existing four satellite system into a three satellite system with a mix of sensors tailored to the users' needs. The studies noted that the time now covered by four satellites—early morning, mid-morning, late morning, and mid-afternoon—could be adequately covered by three satellites—eliminating the mid-morning satellite. Under this approach, the types of sensors on each satellite could be determined by the importance DOD and NOAA placed on the different orbital times. For example, since DOD places greatest importance on the early morning satellite, the most important sensors to DOD could be installed on that satellite. NOAA places greatest importance on the mid-afternoon satellite; therefore, that satellite could contain sensors most important to NOAA's needs. The late morning satellite could incorporate a mixture of sensors to provide the most critical data for both users.

These studies assumed that NOAA and the Air Force would have redesigned their METSATs by the mid-1980s. This did not occur, however, and is not now expected until the mid-to-late 1990s. This approach therefore involves a long-range effort given the existing status of the DMSP and TIROS programs where satellites are being procured and additional ones being planned.

POOMSCOB Study Proposed a Three Satellite System

The March 1979 POOMSCOB study suggested that user requirements could be satisfied with three satellites, each about 25 percent larger than the current DMSP design in order to accommodate more sensors. It estimated (in 1980 dollars) that about $180 million could be saved over an 8-year period if the programs were converged in this manner. The estimated savings were primarily derived by reducing the number of operational

satellites. Savings were also expected from eliminating duplication in applied research and establishing a single agency to manage the program. However, potential savings from multiyear procurement and from eliminating other duplication such as those in chapter 2 of this report were not considered in the study.

The study's cost savings estimate included about $16 million to consolidate the command and control centers. The study indicated that each center could provide a backup capability to the other for added system reliability. However, in the final analysis, the study recommended that the centers remain separate because of DOD's desire to maintain its own command and control operations for national security reasons, and NOAA's desire to maintain an open TIROS operations for civil and international needs.

IRS² Study Also Proposed a Three Satellite System

A very similar three satellite system proposal appeared in the 1979 IRS² study. The study examined the possibility of integrating various remote sensors. However, it included an option to use serviceable (retrievable and reparable) satellites as well as expendable satellites like those currently in use. It concluded that the polar METSAT systems could be integrated at a cost savings and that certain oceanographic sensors, which were being proposed as a separate system, could be converged with the polar METSATs for additional savings.

The study estimated that by integrating the METSAT systems, about $160 million could be saved using expendable satellites or $268 million could be saved by using serviceable satellites. These estimates were calculated in 1980 dollars for an 8-year period. The study also estimated that $454 million could be saved if oceanographic sensors were included on the serviceable satellites instead of developing a separate system. The estimated savings were derived mainly from reductions in operational satellites. Single agency management was considered, but potential benefits that could be derived from it were not included in the estimated savings. Nor were potential savings considered from multiyear procurement or the elimination of other duplication such as those discussed in chapter 2 of this report.

DOD and Commerce Comments and Our Evaluation

DOD concurred with the information presented in this section regarding a single system with three redesigned satellites. It stated that this approach would be feasible when a new generation of DMSPs (Block 6) is designed. Activities associated with this redesign are scheduled to start in June 1987 when a request for proposals will be issued. Competitive design studies are scheduled to start in fiscal year 1988. Both DOD and Commerce stated that the cost estimates used in the 1979 studies are no longer valid due to subsequent system changes. As we previously discussed on page 25, no other estimated cost savings on convergence were available or comparable to our knowledge. We believe they provide some perspective on the benefits of convergence, since the major element in these estimates is the elimination of one of the four existing satellites.

Single System With Three Hybrid Satellites

Through our discussions with agency representatives and an examination of various METSAT convergence proposals, we identified an alternative that could be started immediately without redesigning the satellites. It could also take advantage of multiyear procurement and single agency management. We refer to it as the hybrid polar METSAT system because it would include three satellites of current design—two DMSPs and one TIROS. The primary basis for this alternative is the questionable need to continue with a two TIROS system, and the conclusions of previous studies that user needs could be satisfied with a three satellite system. In addition, such a hybrid system could be expanded to include an oceanographic satellite if necessary.

Similar to the 1979 proposals, a three satellite hybrid system could cover the same spectrum of time by using an early morning DMSP, a late morning DMSP, and a mid-afternoon TIROS, but without significant redesign. Each satellite could retain its basic identity and operational characteristics. Other modifications planned for the current systems, such as sensor integration, would not be affected. The command and control function could remain the same or be combined under one agency. When appropriate, the two systems could be jointly redesigned.

The most significant advantage of this alternative is the immediacy of its application and thus potential for savings. A single agency such as DOD (the Air Force) could take the lead in acquiring the needed satellites to achieve savings through larger more economical procurement. DOD could procure TIROS for NOAA in much the same manner that NASA does now. As pointed out in the IRS[2] study, funding arrangements need not be

significantly different than what now exists, except for different agencies. It is conceivable that convergence in the form of a hybrid system could begin with procurement of the next block of expendable satellites—DMSP S-16 through S-20 and TIROS K, L, and M that are being planned for production. Appropriations could be requested and contracts awarded in fiscal year 1989. In fiscal year 1988, DOD also plans to award conceptual design contracts for its next generation (Block 6) of DMSPs. At that time, NOAA's requirements could be designed into the hybrid system to produce a national METSAT system.

NROSS Could Be Added to a Hybrid System

Assuming the Navy re-established its NROSS program, such a capability could be easily included in a hybrid system as a separate satellite. Based on our discussions with DOD's Chairman of the Joint Environmental Satellite Coordinating Group, NROSS could be procured, launched, and controlled by the Air Force while the Navy, as the primary user, received the data. If NROSS were included with the procurement of DMSP and TIROS, further economical advantages should be derived through larger quantity buys. There also appears to be sufficient existing command and control capacity to make any additional capacity unnecessary.

DOD and Commerce Comments and Our Evaluation

DOD and Commerce disagreed with our view that a single program with three hybrid satellites could begin with the procurement of the next block of satellites—DMSP S-16 through S-20 and TIROS K, L, and M—because the schedules for the two programs are out of phase. DOD stated that DMSP procurement must begin in fiscal year 1989. According to the contractor (RCA), it takes about 4 years to produce a satellite, thus S-16 would be available for launch in fiscal year 1993. Commerce maintains that satellite K must be available in 1992, which means production must start in 1988.

Although the stated schedules show that the two programs are out of phase, we believe that this does not necessarily warrant a rejection of the hybrid concept because of TIROS's (1) design and operating life and (2) launch interval. The design life of TIROSs is 24 months. Since 1978, the actual operating life of three TIROSs was 27, 41, and 51 months. One other satellite prematurely failed in 1984 after 15 months of operations. One of the two existing satellites (referred to as F before it was launched) has been operating since December 1984, thus it has already exceeded its design life. Currently, NOAA is planning to replace it in December 1987 after 36 months of operation, assuming it does not fail in

the meantime. The other existing satellite (referred to as G) was launched in September 1986.

Regarding the launch interval, replacement launches are determined after analyzing operating satellites. NOAA's policy would be to schedule launches every 18 months under a one satellite system. Since most of the TIROSS have been lasting much longer than 18 months, it may be possible to extend the scheduled launch interval. For example, if the interval were 22 months (less than the design life) NOAA's procurement schedule would not be out of phase with DOD's schedule. Table 4.2 below demonstrates how this would work.

Table 4.2: Possible Launch Dates for a One Polar Orbiting TIROS System

4/87	2/89	12/90	10/92	8/94	6/96
H	I	J	K	L	M

The table assumes that the next TIROS (H) would be launched in April 1987 to replace the oldest fully operating satellite (F). (This could be a conservative estimate because satellite F is currently healthy and may continue to operate satisfactorily for a longer period.) Each succeeding satellite would then be scheduled for launch at 22-month intervals. As a result, satellite K would be available for launch in October 1992 (fiscal year 1993), and procurement would have to start in fiscal year 1989—4 years before. This approach would be compatible to DOD's schedule to begin procurement in fiscal year 1989.

In addition, although not as capable as current TIROSS, NOAA has another TIROS in storage (referred to as D) which is being held as a spare. NOAA testified during fiscal year 1987 congressional budget hearings that in the event of a satellite failure, it would take 4 months to call up another available satellite. This means that a satellite outage could occur for 4 months, but NOAA does not consider this catastrophic. The satellite data that goes into the weather service's prediction model would be affected in terms of long range forecasts (3 to 5 days). The effect on short range warning forecasts (storms) would be very small, according to the testimony. In addition, NOAA testified that DMSP provides backup data that is applicable to the civil community. Also, NOAA stated it would rely more heavily on the data received from its geosynchronous satellite system.

DOD stated that for a common multiyear procurement to be economically beneficial, the DMSP and TIROS would have to be nearly identical, not merely similar. Although DOD may be correct, the RCA contract manager

believed the two systems could easily be combined into a multiyear procurement and money could be saved.

Finally, DOD stated that it would be feasible to include NOAA's unique TIROS requirements in the DMSP Block 6 competitive concept studies scheduled to begin in fiscal year 1988. This approach could lead to a converged civil and military system in the late 1990s. Commerce also stated that convergence would be possible using this approach, but believes that further study is needed before doing so.

Use of Federal Coordinator Could Assist in Converging the Systems

The Office of the Federal Coordinator for Meteorological Services and Supporting Research, within the Department of Commerce, currently has the responsibility of coordinating all federal meteorological programs except METSATs. It was established because the Congress became concerned in 1962 about overlapping meteorological activities and ordered a review of their coordination. The review indicated that weather programs could be planned better. In the Commerce Appropriation Act of 1963 (Public Law 87-843), the Congress required the Bureau of the Budget (now the Office of Management and Budget) to provide an annual budget proposal for the total meteorological activities of the government. The intent, in part, was to show the agencies involved in such activities and the extent of centralization, decentralization, coordination, or duplication.

In 1963, the Bureau of the Budget issued Circular A-62 which established policies and procedures for the coordination of federal meteorological services. It made Commerce responsible for seeing that user requirements were met effectively and economically. Commerce then established the Office of the Federal Coordinator with a mission to promote cooperation and coordination among the federal weather agencies so that the best weather information would be available to users at the least cost to the government. Coordination of meteorological activities, involving satellite development between Commerce and NASA, and special military security considerations were specifically excluded from Circular A-62, even though no such exclusion was required by the Congress in Public Law 87-843.

The Coordinator's office includes representatives from several federal agencies having an interest in meteorological programs, including those that would be involved in satellite convergence. Specifically, it is governed by a standing committee chaired by a representative from Commerce and consists of members from DOD and the Departments of

Agriculture, Energy, State, and Transportation. Personnel assigned to the office include the Coordinator, the director, and representatives from DOD, Commerce, and the Department of Transportation. Personnel to perform studies, investigations, and special inquiries are assigned to the office by the participating agencies. The Coordinator believed that duplication between the DMSP and TIROS programs could be eliminated through convergence and that the needs of the users could still be satisfied.

Reasons Given for Not Converging

The Air Force and NOAA gave some reasons why greater convergence of the METSAT systems have not already been accomplished. These reasons have to do with certain international concerns, security implications relative to foreign country representatives' access to the satellite, NOAA's concern regarding loss of control over the TIROS system, and different METSAT missions. Some of these reasons were also discussed in the 1979 studies, but were characterized as areas to be resolved.

International Concerns

NOAA officials stated that certain countries currently exchange weather data with the United States, but that some countries may not be as willing to do so under a military managed system. Under our alternative for a hybrid system, NOAA could still perform its current role as a conduit of information with the international community. In fact, we do not contemplate changing the structure for processing or distributing weather data. Instead, the primary changes would be in who acquires the satellites and possibly who performs the command and control function for the satellite system.

NOAA representatives also expressed concern about a search and rescue device, located on each TIROS, that detects distress signals. The Air Force has expressed a reluctance to install these devices on DMSPs because of space limitations. We subsequently learned that a one TIROS polar orbiting system would not likely disrupt the search and rescue function. This is because the device's transponder has an inherently longer lifetime (10 to 15 years according to the contractor) than most of the other instruments on the satellite, particularly the primary meteorological sensors. Thus, a failure of these instruments or a partial failure of the satellite could still permit the search and rescue transponder to function well beyond the satellite's normal mission lifetime.

Security Implications

According to NOAA, various TIROS sensors are supplied by foreign countries, and currently, representatives from these countries are granted free access to TIROS in order to monitor the handling and installation of the sensor on the satellite. Although NOAA officials questioned whether this would be possible under a single procurement approach managed by the Air Force, we were informed by Air Force representatives that adequate access could be provided.

NOAA's Concern on Reduced Influence Over TIROS

NOAA officials expressed concern over their ability to satisfy user needs if the Air Force were to take the lead in managing a converged METSAT system. Issues such as sensor design, replacement of failed satellites, and guaranteed access to data were mentioned. Although similar concerns could be raised under many joint programs, a mechanism for alleviating potential problems of this type could be established. Further, DOD has expressed full commitment to ensuring that DMSP would serve civil as well as military users.

Different Mission Data

Air Force and NOAA representatives pointed to the current differences in METSAT mission data. For example, the Air Force is primarily interested in cloud cover imagery, whereas NOAA is mainly interested in vertical temperature and moisture profile soundings. However, this should not be a major concern because each system already has sensors (imagers and sounders) that provide both types of data, although not in the same way or with the same accuracy. Sensor integration studies and METSAT experts have stated that imagers and sounders could be designed to provide adequate data to both sets of users.

DOD and Commerce Comments and Our Evaluation

In DOD's opinion, the reasons stated for not converging do justify the maintenance of two separate, but interacting programs. DOD suggested we obtain the advice of the Department of State on national policies related to "open skies" (unrestricted access to satellite weather data), cooperative international research and development, and the "militarization" of an historically civilian system. DOD emphasized that we did not give adequate weight to the technical differences in the two systems. Commerce expressed similar concerns regarding militarization, and also pointed out that we failed to recognize the management area as a troublesome one.

We met with a Department of State official responsible for space sciences and remote sensors within the Bureau of Oceans and International

Environmental and Scientific Affairs to discuss the international implications associated with METSAT convergence. The official stated that the open skies matter is not a real problem if all the weather data were made available as it is now. However, if there were a diminution of METSAT data into the global international meteorological data system, other countries might accuse the United States of militarizing its weather program. This could then give them a basis to deny the United States local weather data from their countries. (A DOD official subsequently informed us that under a converged system the Air Force could provide access to weather data on the same basis as currently exists. Also, given DOD's willingness to assume responsibility for a fully converged system, this may be at most a minor concern.) Regarding international cooperation in research and development, the official stated that some countries might consider convergence a step backward, but if there were dollar savings, the United States would probably choose convergence anyway.

We recognize that some technical differences exist between the two programs. However, the point of the 1979 studies was to demonstrate that convergence could be accomplished, and DOD's position is that convergence is both technically and operationally feasible. In addition, we recognize that an ideal time for convergence is when the two agencies could coordinate their requirements on a major block change (a system redesign). However, we also believe the opportunity exists to achieve a significant portion of the benefits available from convergence by considering the hybrid concept we offered in this chapter.

Commerce's comments regarding difficulties in managing a converged system center on the concern that DOD requirements would receive priority attention over NOAA's when problems developed. This could be a concern in many consolidated operations and depends on the level of commitment from the outset. DOD has expressed its full commitment to meet both civil and military needs.

Conclusions, Recommendations, Matter for Congressional Consideration, and Agency Comments and Our Evaluation

Conclusions

Since the early 1970s, the need for separate civil and military polar orbiting METSAT systems has been questioned. Subsequently, several studies examined the possibility of converging the DMSP and TIROS systems into a single national system. The studies, and expert opinions, show that convergence is technically and operationally feasible, and that economies could be achieved and user needs satisfied under a converged system. In addition, there are areas of duplication that if eliminated could result in economies. Other economies could also be realized through the use of multiyear procurement contracting and more economical purchases of parts. In the late 1970s, national policy directed that any new polar orbiting METSATs should be jointly developed and procured. Current national policy is not as direct relative to METSATs, but it does call for avoiding unnecessary duplication between civil and national security space systems.

Despite considerable evidence supporting convergence, the two systems continue to operate separately. In fact, there are indications that further divergence is occurring. First, NOAA wants to begin using a totally different type of satellite—a serviceable space platform—to house its sensors, whereas DOD's plans are to continue using expendable satellites. Although DOD plans to consider serviceable satellites in its new Block 6 design, this effort is not scheduled to be completed for several years. Second, different quality control standards used by the Air Force and NOAA for space system parts has already eliminated some of the similarities between the two satellite systems. The effect is to increase costs for both programs. To enhance the prospects for polar METSAT convergence, these two divergent actions should be curtailed or minimized. Finally, due to the Navy's termination of NROSS as a separate program, discussions are underway between the Navy and Air Force to link the oceanographic requirements with the DMSP. If this can be done, it would demonstrate considerable cooperation toward a common purpose.

Reasons given for not converging the DMSP and TIROS programs in prior years include certain international concerns and security implications, NOAA's reduced influence over satisfying civil user needs, and differences in DMSP and TIROS missions. The question is whether these reasons are sufficient to justify two similar and somewhat duplicative systems. Our contact with the Department of State and an assessment of agency comments does not reveal any new evidence that would substantially detract from converging the two systems. What has been lacking is sufficient impetus for the federal agencies involved to take action toward greater convergence. We believe the Secretaries of Defense and Commerce should place renewed emphasis on this matter. Close coordination

between the Air Force and NOAA would be essential and the Office of the Federal Coordinator for Meteorological Services and Supporting Research could assist.

Although there could be various degrees and alternatives to convergence, the alternative we refer to as the hybrid polar METSAT program offers the advantage of beginning convergence and realizing economies almost immediately. This approach includes combining planned procurement of existing designs in the short term. In fiscal year 1989, the Air Force plans to request funds from the Congress for DMSP S-16 through S-20. Although NOAA wants to begin procurement of TIROS K, L, and M in fiscal year 1988, a reassessment of the operating lives of several TIROSS and of the scheduled launch interval could also permit NOAA to begin procurement in fiscal year 1989. It is therefore possible that DMSPs and TIROSS could be procured under a single contract (possibly a multiyear contract) by a single agency (the Air Force). Ongoing sensor integration efforts could continue. This approach would not interfere with longer term convergence concepts. In fiscal year 1988, the Air Force plans to award conceptual design contracts for the next generation DMSP. NOAA could also participate in these design contracts. In view of the potential benefits to the government in both the short term and long term, we believe the procurement of the next set of METSATs could be combined and the two agencies' requirements for future METSATs could be integrated.

Recommendations to the Secretaries of Defense and Commerce

We recommend that the Secretary of Defense and the Secretary of Commerce jointly take the initiative to converge the DMSP and TIROS polar orbiting METSAT systems to the maximum extent possible. Specifically, consideration should be given to combining the procurement of DMSP S-16 through 20 and TIROS K, L, and M under a single agency—the Air Force. Actions should be taken to (1) curtail or minimize the divergent trends associated with the two programs, (2) eliminate unnecessary duplication, and (3) ensure that ongoing sensor integration efforts are maintained. In addition, NOAA and the Air Force should integrate their METSAT requirements into the conceptual design studies that are scheduled to start in fiscal year 1988, with the purpose of developing the lowest cost national METSAT system by the late 1990s.

Matter for Congressional Consideration

Effective coordination among the executive agencies involved in substantive METSAT convergence efforts will be necessary. As a result, the congressional oversight committees (Senate Committee on Armed Services; Senate Committee on Commerce, Science, and Transportation; House Committee on Armed Services; and House Committee on Science, Space and Technology) and the appropriations subcommittees (Senate Subcommittee on Defense; Senate Subcommittee on Commerce, Justice, State, the Judiciary and Related Agencies; House Subcommittee on Defense, and House Subcommittee on Commerce, Justice, State, the Judiciary, and Related Agencies) should consider supporting greater METSAT convergence in both the short and long term.

Agency Comments and Our Evaluation

DOD and Commerce provided written comments on our draft report. (See apps. II and III, respectively.) DOD took exception to the draft's discussion on national policy and some portions of the technical analysis. DOD stated that interdepartmental debate on METSAT convergence in the early 1980s resulted in continuing with separate programs. While DOD stated that current needs require separate systems, it is willing to assume responsibility for a fully converged system. DOD expressed the view that this would be technically and operationally feasible during the next DMSP block change scheduled to be deployed in 1998 (concept design studies beginning in fiscal year 1988).

We have incorporated DOD's comments and addressed them in appropriate sections of the report. In some cases, we modified our report to reflect our concurrence with DOD comments. In general, however, we have retained the original positions as stated in our draft report. Part of DOD's comments concerning the Navy's oceanographic satellite program (NROSS) are no longer applicable because the Navy terminated its program after we received official comments. Accordingly, we have modified our discussion on NROSS, but retained it for background purposes and because a resolution of the Navy's oceanographic requirements is not yet available.

Commerce agreed that NOAA and DOD should increase the use of common instruments and facilities to obtain cost savings, but disagreed regarding convergence of the two satellite systems at this time. Commerce disagreed for the following reasons: (1) a timing problem associated with procuring satellites K, L, and M in conjunction with DOD's next procurement of five satellites, (2) no current cost studies to show savings, (3) the belief that DOD's weather needs would receive top priority over the

civilian sector if conflicts arose, (4) concern that international relationships could be threatened, and (5) the possibility that the best option for future civilian weather instruments could be on a platform system instead of conventional spacecraft.

We have incorporated Commerce's comments and addressed them throughout the report. We also modified our report in some cases to reflect our concurrence with Commerce's comments. In general, we continue to believe there are benefits to convergence and that the problems cited by Commerce have solutions. Although Commerce emphasized tha administration policy calls for a one satellite TIROS system, there have been no substantive actions to bring this about. In fact, subsequent to receiving Commerce's comments on November 26, 1986, we were informed that the administration position is now supportive of a two satellite system.

Our Reports on Weather Satellites and Programs

The following is a list of reports that we issued on weather satellites and programs:

- Weather Satellites: User Views on the Consequences of Eliminating a Civilian Polar Orbiter (GAO/RCED-86-111, Mar. 7, 1986).
- Weather Satellite Costs Have Increased; Problems Have Occurred in Their Manufacturing Quality Control (GAO/RCED-86-28, Oct. 31, 1985).
- National Security Implication of Commercializing Landsat and Weather Satellites (GAO/C-RCED-84-1, Feb. 1, 1984).
- The Federal Weather Programs Must Have Stronger Central Direction (LCD-80-10, Oct. 16, 1979).
- Polar Orbiting Weather Satellite Programs (B-180466, Apr. 11, 1974).

Comments From the Under Secretary of Defense for Acquisition

Note: GAO comments supplementing those in the report text appear at the end of this appendix.

THE UNDER SECRETARY OF DEFENSE

WASHINGTON, DC 20301

ACQUISITION

6 NOV 1986

Mr. Frank C. Conahan
Assistant Comptroller General
National Security and International Affairs Programs
United States General Accounting Office
Washington, DC 20548

Dear Mr. Conahan:

This is the Department of Defense (DoD) response to General Accounting Office (GAO) Draft Report "WEATHER SATELLITES": Economies Available By Converging Government Meteorological Satellites, "Dated August 26, 1986 (GAO Code 395010).

The DoD is in general concurrence with the findings and recommendations of the report, although exception is taken to the GAO interpretation of current national policy and to some portions of the technical analysis.

The interdepartmental debate on civil/military satellite convergence in the early 1980's resulted in the continuation of separate, distinct, and closely-coordinated programs (specified in NSDD 42, 4 July 1982), in recognition of specific national objectives and the significant differences in the civil and military missions. The DoD has stated its willingness to assume responsibility for a fully "converged" (i.e., one that is developed, acquired, and operated by a single agency) satellite system under the Defense Meteorological Satellite Program (DMSP). System convergence would be technologically and operationally feasible, however, only if achieved coincidentally with the next DMSP block change: in 1998.

The GAO predictions of duplication between the DMSP and the Navy Remote Ocean Sensing System (N-ROSS) are inaccurate for two reasons: (1) the timing of scheduled acquisition efforts will not permit economical or timely acquisition of the N-ROSS satellite within the DMSP; and (2), possible duplication in command-and-control functions cannot be evaluated until completion of the on-going competitive system design, anticipated in November 1986. Be assured that the DoD will monitor the progress of this program, and will not permit unjustified duplication of acquisition or command-and-control functions.

Detailed DoD comments are provided in the enclosure.

Sincerely,

Enclosure

GAO DRAFT REPORT - DATED AUGUST 26, 1986
(GAO CODE 395010) - OSD CASE 7116

"WEATHER SATELLITES: ECONOMIES AVAILABLE BY CONVERGING GOVERNMENT METEOROLOGICAL SATELLITES"

DEPARTMENT OF DEFENSE COMMENTS

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FINDINGS

o FINDING A: National Policy Supports Convergence. The GAO reported that the United States has two polar orbiting meteorological satellite (METSAT) systems--the Television Infrared Observation Satellite (TIROS), operated by the National Oceanic and Atmospheric Administration (NOAA) within the Department of Commerce (DoC) and the Department of Defense's (DoD's) Defense Meteorological Satellite Program (DMSP), operated by the Air Force. The GAO found that during the past 7 years under two administrations, national policy statements have clearly and consistently encouraged increased coordination, cooperation, and elimination of unnecessary duplication between civil and military space programs. The GAO further found that although current national policy does not require convergence, it supports the idea by emphasizing the elimination of unnecessary duplication. The GAO noted that prior policy statements were even more strongly worded in support of convergence. Specifically, in 1978, during the Carter administration, Presidential Directives 37 and 42 were issued to define national policy regarding the need for separate overall space programs and to determine the extent to which meteorological space programs should be converged. The GAO concluded that previous national policy directed that any new polar orbiting METSATs should be jointly developed and procured. The GAO further concluded that while current national policy is not as direct relative to METSATs, it calls for avoiding unnecessary duplication between civil and national security space systems. (pp. 10-12, 18-20, 48, GAO Draft Report)

Now on pp. 10-11, 16-17, and 44.

DoD Response: Concur. Previous reviews and previous statements of national policy did strongly support increased convergence. It must be recognized, however, that current policy states "... the United States Space program will be comprised of two separate, distinct, and strongly interacting systems--national security and civil..." when differing needs dictate.

1

Current system needs are, indeed, different. Specific requirements are levied on the civil system which are not within the mission of the DoD. These specific requirements include the afternoon orbit to provide data specifically tailored for the civil numerical weather models; multi-spectral imagery for agricultural, forestry, and fishery applications; search-and-rescue support; data relay; international cooperative programs for basic and applied research; and direct imagery transmissions to other nations. Concurrently, the DoD has specific system requirements that have no analogs in the civil system. Specific DoD requirements include the military requirements for data-encryption, survivability, launch responsiveness, flexibility in orbit selection, low-light imagery, constant-resolution cloud imagery for automated processing, etc.

The mission requirements of the civil and military satellite programs are sufficiently different to justify the maintenance of separate and distinct systems. The DoD and the DoC are, therefore, in compliance with current policy.

FINDING B: Convergence Is Technically And Operationally Feasible. The GAO found that studies and expert opinions support convergence. Specifically: (1) between 1972 and 1979, three interagency studies examined the potential for converging the DMSP and the TIROS systems and concluded that the systems could be converged into a single system which could satisfy civil and military needs, (2) in late 1979, four aerospace contractors also studied various concepts for improving the capability of the DMSP and all four studies came to the common conclusion that a single system of three satellites could satisfy both civil and military needs, and (3) current and former officials associated with the programs support the feasibility of converging the DMSP and the TIROS systems. The GAO further found that user needs could still be satisfied under convergence, noting that the DMSP and the TIROS have some very similar data collection capabilities. In this regard, the GAO further found that although not all the data is measured in the same way or with the same accuracy, experts have concluded that some of the two systems' sensors could be modified and made compatible to all users' needs. The GAO finally found that system commonalities would promote efficiencies. The GAO noted that there are several existing features that are common to the DMSP and the TIROS. For example, both satellite systems use the same structural framework, referred to as the bus, which is built by the same contractor who also installs the sensors. In addition, the GAO further noted that both systems have many similar operational characteristics and requirements such as low- altitude polar orbits, command and control units, launch support requirements, and life expectancies. The GAO concluded that the studies, and expert opinions, show that convergence is technically feasible, and that economies could be achieved and user needs satisfied under a converged system. (pp. 20-26, 48, GAO Draft Report)

Now on pp. 18-22 and 44.

2

DoD Response: Concur. In 1979, the Secretary of Defense concurred with the proposition that convergence is technically and operationally feasible. He stated, however, the position that the DoD must retain complete control of a converged system due to the critical importance of the DMSP to national-security missions. The GAO recognizes this policy in its report by indicating that the Air Force should take the lead in any converged system. The Secretary of Defense enumerated a number of issues related to the concept of convergence. Some examples cited include: (1) the DMSP is the key element of environmental support to special strategic programs of the highest national priority; (2) the DMSP is a primary source of reliable theater-scale weather intelligence for commanders of deployed air, ground, and naval forces; and (3), the DoD must insist that certain stringent conditions (related to security, survivability, and responsiveness) be met before any significant increase in the convergence of civil and military meteorological satellite systems can occur.

Significant convergence has occurred since the early 1970's, with resultant reduced cost. The adoption of the DMSP Block 5D spacecraft bus by the National Oceanic and Atmospheric Administration was a direct result of earlier convergence studies. Today both programs work closely together in areas ranging from factory integration and test activities (where spacecraft components such as inertial measurement units are shared) to agreements between user agencies to share data processing responsibilities.

- FINDING C: Convergence Offers Several Benefits. The GAO found that the studies performed in 1979 on polar METSAT convergence determined that cost savings could be realized based on the view that the four DMSPs and TIROs could be merged into one system of three similar satellites with the on board sensors distributed among the satellites to provide optimum data collection capabilities. The GAO reported that when it updated the savings estimates to 1986 dollars, depending on whether expendable or serviceable satellites were used, savings from $250 million to $709 million might be realized. The GAO noted that the studies cautioned that not all potential areas of savings were considered. In this regard, the GAO found areas of duplication that, if eliminated, could result in further economies. For example: (1) duplicate procuring offices exist to acquire essentially the same satellites from the same contractor, (2) separate Air Force and NOAA payload test facilities exist at Vandenberg Air Force base, and (3) presently there is computer capacity for least nine satellites which appears to be excessive capacity for a three or four satellite system.

See comment 1.

Now on pp. 22-26 and 44.

The GAO finally found that it is possible that under a converged system, other economies could be realized through the use of multiyear procurement contracting and more economical purchases of parts. The GAO concluded that economies could be achieved under a converged system. (p. 4 Executive Summary, pp. 26-31, 48, GAO Draft Report)

DoD Response: **Partially concur.** While the DoD recognizes a probability for cost savings, the specific savings derived in 1979 are no longer valid, due to significant changes in both the DMSP and the NOAA systems. Such changes have occurred in command-and-control systems, survivability, encryption, autonomous-operation requirements, and satellite payloads.

It should be noted also that although the spacecraft are procured from the same contractor, they are common only at the 70% level. Additionally, both payloads and ground systems reflect the major differences in the civil and military missions. It cannot, therefore, be interpreted to mean that the satellites or their supporting command-and-control systems are interchangeable. Joint procurement of the two systems, as they are currently configured, would be extremely complicated.

See comment 1.

There is no NOAA Payload Test Facility (PTF) at Vandenberg Air Force Base. There are, however, separate "satellite processing facilities," which could give the appearance of duplication. The NOAA shares a NASA "satellite processing facility" with other users, and uses that facility only when a NOAA satellite is being prepared for a scheduled launch. The DMSP satellite-processing-facility cannot accept the aperiodic demands of the NOAA system without modification, because the DMSP facility must routinely test stored satellites to maintain their operational readiness at Vandenberg, and must be capable of processing a DMSP launch on demand. Even if the NOAA were to share the DMSP satellite processing facility, the other (NASA) facility would still have to remain in operation. Consequently, there would be no savings to the Government.

The DoD disagrees that there is excess capacity in command-and-control systems. The DoD command-and control system will ultimately have seven computer command subsystems available (four at Offutt Air Force Base, Nebraska, and three at Fairchild Air Force Base, Washington). Because of unique military requirements for survivability, certain elements of redundancy must be designed into the DoD system. The existence of seven command subsystems at the two strategically-separated locations does not mean that the system is sized to support seven satellites. In fact, the planned DoD command-and-control capacity will allow the system to support only the DMSP and the single programmed

N-ROSS satellite. Specifically, the three command subsystems at the Fairchild Satellite Operations Center are adequate to control two healthy DMSP satellites on orbit, with one command subsystem required for day-to-day system back-up and training. The four command subsystems at Offutt Air Force Base are adequate to (1) control the one programmed N-ROSS satellite, (2) support pre-launch, launch, and early-orbit checkout of DMSP and N-ROSS satellites, (3) analyze and resolve all satellite anomalies (because Omaha, and not Fairchild, will have contractor support from satellite engineering specialists), and (4) provide day-to-day system backup and required training for satellite-control crews. Additionally, the implication that either of the current command-and-control systems could assume command of the other satellite system is misleading inasmuch as extensive costs could be involved in resolving hardware and software differences prior to standardizing the spacecraft and the sensor complement.

See comment 2.

- FINDING D: Current Trends Will Increase Divergence. The GAO found that the NOAA, the Navy and the Air Force have independently taken steps or are planning actions that will further separate the polar METSAT systems. First, the Air Force and the NOAA are independently moving in different directions in their plans for future weather satellites. Specifically, the NOAA wants to begin using a totally different type of satellite--a serviceable space platform--to house its sensors, whereas the DoD's plans are to continue using expendable satellites into the 2000s before redesigning a new system. Second, the Navy wants to acquire its own polar orbiting oceanographic satellite called the Remote Ocean Sensing System (NROSS) that is likely to be very similar to the DMSPs and TIROs, except for some unique sensors. The GAO concluded therefore, that NROSS could be jointly procured by the Air Force as part of a converged system. Third, in 1984, the Air Force increased its quality control requirements for basic parts on the DMSP, many of which are common to the TIROS, therefore, although many of the DMSP and TIROS items in the two systems are still physically and functionally identical, they are no longer considered interchangeable because of being tested to differing standards. The GAO reported that it was informed by the contractor that joint procurement of parts common to both the DMSP and the TIROS is not now possible and will have a significant financial affect to both programs. The GAO further concluded, that considering the technological and operational similarities of the DMSP and TIROS, a similar level of quality control over the systems should be necessary. The GAO further concluded that to enhance the prospects for polar METSAT convergence, these three divergent actions should be curtailed or minimized.

Now on pp. 28-31 and 44.

(pp. 32-36, 48-49, GAO Draft Report)

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DoD Response: **Concur.** It should be recognized and re-emphasized, however, that **differing mission requirements** have led to the current differences in the civil and military programs. Future plans of the civil and military systems are likewise driven by differences in future mission requirements -- i.e., the unique DoD requirements for reliability, security, survivability, responsiveness, and flexibility of orbit selection place non-negotiable demands on the system. These demands oppose DoD active participation in the planned NOAA/NASA/international satellite programs.

See comment 2.

Since the GAO visits to Navy offices in 1985, the N-ROSS concept has undergone a significant and highly-relevant change. Rather than the concept of a continuing series of sole-source (RCA/DMSP) operational satellites described to the GAO at that time, the N-ROSS is currently programmed to consist of a single R&D satellite, procured competitively. Competitive, vice sole-source, acquisition was directed in December 1985 by the Assistant Secretary of the Navy for Research, Engineering and Systems, in recognition of the potential for significant cost savings to the Government. The specific characteristics of the spacecraft bus, or of the command-and-control system, are not known at this time. To assert that the N-ROSS will be very similar to the DMSP and TIROS pre-supposes and could prejudice the outcome of the on-going competition. The competition is intended to insure that the N-ROSS satellite will be designed and operated in the most cost-effective manner possible. If, indeed, a "divergent" system, which is separate from the DMSP, is found to be most cost-effective to the Government, the DoD will be obligated to adopt that system. If the competition results in selection of a DMSP bus, it is the DoD position that the procurement of the single R&D satellite and the coincident monitoring of sensor-procurement and integration contracts can most effectively be handled at this time by the Navy satellite program office most familiar with the system.

The stringent quality-control applied to DMSP parts is necessary to satisfy the military requirement for optimum peacetime and wartime reliability of the military system. In order to meet the GAO goal of interchangeability, the civil system would be required to absorb the added costs of these parts. To date, the DoD discussions with the civil satellite community have indicated a reluctance to increase the cost of the civil system in order to "unnecessarily" satisfy a military specification.

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o FINDING E: METSAT Sensors Could Be Integrated. The GAO reported that sensor integration was included as the basic ingredient of the convergence plans in the 1979 studies. The GAO further reported that sensor integration would involve standardizing and modifying the two systems' existing sensors where the same type of data is being measured. The GAO found that the same types of sensors considered primary to either system were located on both systems, however, these sensors were separately designed and procured. The GAO further found that (1) if some sensors were standardized, it could permit larger quantities of parts to be ordered on a more economical basis, and (2) if other sensors were modified to provide more compatible data, the two systems could provide better backup capability for each other. Although both systems use some of the same type of sensors, the accuracy of the data received is different, however, despite these difference, the GAO also found that there are indications that some sensors could be standardized and modified to meet users' needs. The GAO concluded that considering alternative levels of convergence, sensor integration may be the easiest to achieve. The GAO noted that this is because the two systems could be independently modified while allowing the programs to remain intact. The GAO further concluded that the potential savings associated with sensor integration would likely to be more limited than with greater convergence alternatives, nevertheless, it is the minimum effort that could be taken and a logical first step. (pp. 38-39, GAO Draft Report)

Now on pp. 32-34.

DoD Response: **Partially concur.** It is, however, important to correct the implication that the civil and military systems have identical "primary" data requirements. In fact, the primary data type for the military system is cloud imagery, whereas the primary data types for the civil system are soundings and radiance measurements (Reference ENVIROSAT 2000 Report: Comparison of the Defense Meteorological Satellite Program (DMSP) and the NOAA Polar-Orbiting Operational Environmental Satellite (POES) Program, October 1985, pp II-5 and II-9).

When discussing the possibilities of "sensor convergence" on current systems (vice "system convergence"), it is important to recognize associated costs such as spacecraft integration of a new common sensor design, data handling and processing changes, and command, control and communication system changes. The potential for cost increases related to these factors is not adequately addressed. Additionally, it is also important to recognize the significantly different requirements for the "same" data; for example, civil and military requirements for "cloud" and "temperature" data are different in terms of accuracy, spatial and temporal resolution, location, timeliness of delivery, frequency of coverage, security, etc.

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The NOAA and the DoD have agreed to study the potential for common sensor design where data requirements are sufficiently similar; however, incorporation of a common sensor on current spacecraft cannot be considered a foregone conclusion because of the unknown cost, weight, power, and volume of the yet-to-be-designed sensor. Acceptance of common sensors by the DoD may well have to wait until the design of the DMSP Block 6 spacecraft.

- FINDING F: Single System With Three Redesigned Satellites. The GAO found that according to the 1979 Polar Orbiting Operational Meteorological Satellite Board (POOMSCOB) and the Integrated Remote Sensing System (IRS2) studies, a single METSAT system could be achieved by redesigning the existing four satellite system into a three satellite system with a mix of sensors tailored to the users' needs. The GAO noted that under this approach, the types of sensors on each satellite could be determined by the importance the DoD and the NOAA placed on the different orbital times. Specifically, the GAO found that the March 1979 POOMSCOB study (1) suggested that in 1980 dollars, about $180 million could be saved over an 8-year period, (2) did not consider potential savings from multiyear procurement and from eliminating other duplication, and (3) the cost savings estimate included about $16 million of cost savings attributable to consolidating the command and control centers, however, in the final analysis, the study recommended that the center remain separate. With regard to the IRS2 study the GAO found that (1) while the study examined the possibility of integrating various remote sensors it included an option to use serviceable satellites as well as expendable satellites, (2) the study estimated that by integrating the METSAT systems, about $160 million could be saved by using expendable satellites; $268 million could be saved by using serviceable satellites; and an additional $186 million could be saved if oceanographic sensors were included on the serviceable satellites instead of developing a separate system, (3) single agency management was considered, but potential benefits that could be derived from it were not included in the estimated savings, and (4) potential savings from multiyear procurement or the elimination of other duplication were not considered. The GAO noted that these studies assumed that the NOAA and the Air Force would have redesigned their METSATs by the mid 1980s. The GAO concluded, therefore, that this approach involves a long-range effort given the existing status of the DMSP and the TIROS programs where satellites are being procured and additional ones are being planned, whereas the hybrid polar METSAT program offers immediate advantages. (pp. 39-42, GAO Draft Report)

Now on pp. 34-36.

8

DoD Response: Concur. However, the assumptions of the 1979 studies and their cost estimates are no longer valid, due to subsequent system changes (see Finding B). A single system, with three satellites, would be feasible in the DMSP Block 6 era (1998 and later).

- FINDING G: Single Program With Three Hybrid Satellites. The GAO found that it identified an alternative that could be started immediately without redesigning the satellites, taking advantage of multiyear procurement and single agency management. The GAO reported that it refers to their alternative as the hybrid polar METSAT system because it would include three satellites of current design. The GAO further found that (1) similar to the 1979 proposals, a three satellite hybrid system could cover the same spectrum of time but without significant redesign, (2) each satellite could retain its basic identity and operational characteristics, (3) the command and control function could remain the same or be combined under one agency, and (4) a single agency could take the lead in acquiring the needed satellites to achieve savings through larger more economical procurements. The GAO also found that the most significant advantage of this alternative is the immediacy of its application and thus its potential for savings. The GAO noted that it is conceivable that convergence, in the form of a hybrid system, could begin with procurement of the next block of expendable satellites--DMSP S-16 through S-20 and TIROS K, L, and M that are being planned for production. The GAO finally found that, assuming the Navy's needs for NROSS are justified, such a capability could be easily included in the hybrid program as a separate satellite. The GAO concluded that the hybrid polar METSAT program offers the advantage of beginning convergence and realizing economies sooner than if the 1979 studies' proposals were followed because the 1979 studies dealt with new long-term satellite designs and its suggested approach includes short- term planned purchases of existing designs. The GAO further concluded that in view of the potential benefits to the government in both the short-term and long-term, steps should be taken to combine the procurement of the next set of METSATS and to integrate the two agencies' designs for future METSATS, while continuing ongoing sensor integration efforts. (pp. 42-43 and 49-50, GAO Draft Report)

Now on pp. 36-39 and 45.

DoD Response: Partially concur. The DoD does not agree with the immediacy aspect of this approach. The GAO alternative could not feasibly begin with the procurement of the next block of satellites, primarily because the procurement actions for civil and military spacecraft are out of phase. Procurement of the next block of DMSP spacecraft will begin in 1989, while it is the DoD understanding that the procurement of NOAA K, L, and M must begin in FY87 in order to meet their required on-orbit operational dates.

A common multi-year procurement would be economically beneficial ONLY if the satellites were nearly identical, not merely similar. Significant system differences exist in the payload, the command-and-control segment, and in integration-and-test procedures. Prior to design of a new converged satellite, the payload-unique spacecraft systems, such as the sensor mounting platforms, would still have to be different, as would the integration and test procedures.

It would be feasible to include NOAA-unique requirements in the DMSP Block 6 competitive concept studies, scheduled to begin in FY88. These studies could then be used to generate valid cost differentials between the projected independent systems and a possible converged system designed to meet both civil and military requirements. Inclusion of civil requirements in these military studies would require authoritative direction and funding. Time is of the essence, because the RFP for the studies will be issued in FY87; late incorporation of civil requirements could increase the cost and/or unacceptably delay the completion of the military system design.

- FINDING H: Use Of Federal Coordinator Could Assist In Converging The Systems. The GAO reported that the Office of the Federal Coordinator for Meteorological Services and Supporting Research, within the Department of Commerce, currently has the responsibility for coordinating all federal meteorological programs except METSATS. The Coordinator's office includes representatives from several Federal Agencies having an interest in meteorological programs, including those that would be involved in satellite convergence, therefore, the GAO found that including the METSAT coordination would be a logical addition to its responsibilities. The GAO noted that the Federal Coordinator stated that this office could assist in converging the systems and could coordinate the programs with the personnel on hand. There is sufficient evidence to justify converging the government's polar orbiting METSAT program, however, the GAO concluded that what has been lacking is leadership and sufficient impetus for the Federal Agencies involved to take such action. The GAO further concluded that successful convergence would undoubtedly require close coordination among the Federal Agencies involved and the Office of the Federal Coordinator for Meteorological Services and Supporting Research could assist. (pp. 37, 44, 45, 49, GAO Draft Report)

Now on pp. 32, 39-40, and 45.

DoD Response: Concur. The assistance of the Office of the Federal Coordinator for Meteorology would probably be beneficial in any directed convergence effort; however, the conditions for convergence established by the Secretary of Defense in 1979 have not changed. As previously stated, convergence would be viable only by augmentation of the DMSP

to support civil needs, while retaining DoD management. Assuming that convergence were directed, it would not be appropriate to have any official outside the DoD assume any managerial or leadership role in this effort.

- FINDING I. Reasons Given For Not Converging. The GAO reported that reasons cited by the Air Force and the NOAA as to why the METSAT systems have not already been converged have to do with (1) certain international concerns, (2) security implications relative to foreign country representatives' access to the satellites, (3) the NOAA's concern regarding loss of control over the TIROS system, and (4) different METSAT missions. The GAO noted that the NOAA officials stated that certain countries currently exchange weather data with the United States, but that some countries may not be as willing to do so under a military managed system. The GAO found, however, that this should not be a concern because under its alternative hybrid system the NOAA could still perform its current role as a conduit of information with the international community. Various TIROS sensors are supplied by foreign countries, and currently, representatives from these countries are granted free access to TIROS in order to monitor the handling and installation of the sensors on the satellite, however, the GAO further reported that the NOAA officials questioned whether this would still be possible under a single procurement approach managed by the Air Force. The GAO further found, however, that Air Force representatives indicated that adequate access could be provided. While the NOAA officials expressed concern over their ability to satisfy users needs if the Air Force were to take the lead in managing a converged METSAT system, the GAO also found that the mechanism for alleviating potential problems of this type could reside with an independent federal coordinator. Finally, while the Air Force and the NOAA representatives pointed to the current differences in METSAT mission data, the GAO finally found that this should not be a major concern because each system already provides both types of data, although not in the same way or with the same accuracy. The GAO concluded that the question is whether these reasons are sufficiently valid to justify two similar and somewhat duplicative systems--if not, actions should be taken to converge them. (pp. 45-47, 49, GAO Draft Report)

Now on pp. 40-42 and 44-45.

DoD Response: **Partially concur.** The reasons stated for not converging do, indeed, provide sufficient justification for the maintenance of two separate, distinct, and strongly interacting programs.

The GAO does not adequately address the serious and perhaps overriding implications of convergence on national policies related to "open skies," or on policies related to cooperative international research-and-development programs, or on U.S. relationships with countries that may be sensitive to the "militarization" of an historically-civilian system. The advice and opinion of the Department of State should be sought and documented on this issue.

In addition, the GAO does not give adequate weight to the serious impediments to convergence caused by the technical differences in the programs. The differences in the civil and military programs are, indeed, related to the data acquired by the sensors, but are also related to "system" requirements. The civil system characteristics are driven by unique needs for a launch-on-schedule replacement philosophy, multi-spectral imagery, infra-red temperature profiles, timeliness of data delivery from the Pacific Ocean area, search-and-rescue support, data relay system, and real-time direct imagery broadcasts. In contrast, the military system characterisitics are driven by unique needs for launch responsiveness (launch-on-need replacement philosophy), constant-resolution cloud imagery, low-light imagery, security, flexibility of orbit selection, etc. Convergence of these mandatory support capabilities is not a simple matter. While technical differences have never been claimed to present insurmountable obstacles to convergence, their resolution is not trivial, and can most effectively be addressed coincidentally with a major block change (presently planned in the DMSP for the late 1990's).

RECOMMENDATIONS

- RECOMMENDATION 1: The GAO recommended that the Secretary of Defense and the Secretary of Commerce jointly take the initiative to converge the DMSP and the TIROS polar orbiting METSAT systems to the maximum extent possible. Specifically, a plan should be developed to combine the procurement of DMSP S-16 through 20 and TIROS K, L, and M under a single agency--the Air Force. Actions should be taken to curtail or minimize the divergent trends associated with the two programs and to eliminate unnecessary duplication. Ongoing sensor integration efforts should be maintained and conceptual designs for future METSATs should be closely coordinated. (p. 50, GAO Draft Report)

Now on p. 45.

DoD Response: Partially concur. In 1979, the Department of Defense stated its willingness to assume responsibility for a fully "converged" national polar-orbiting meteorological satellite program under the DMSP. The DoD has not changed that position. A high-level decision at that time (ultimately documented in NSDD 42, 4 July 1982) resulted, however, in the continuation of separate, closely-coordinated programs. That decision reflected the importance of specific national policy objectives and the significant differences in the missions of the two satellite programs. The Departments of the Defense and Commerce are in full compliance with current national policy.

The Departments of Defense and Commerce are also continuing to examine opportunities to increase the convergence of the systems. The program for shared processing of satellite data, for example, will distribute the responsibilities for data processing, and will reduce the over-all cost-to-the-government by preventing duplicate processing at the three major analysis centers. The planned study of an imaging sensor designed to meet both civil and military requirements is another example of an effort with the potential for major cost savings.

If current policy should change, the Department of Defense would be prepared to begin the long-term effort to satisfy civil requirements within the DMSP. Such an effort must, however, be initiated in the near future in order to be included in system-design studies for the DMSP Block 6 satellites, scheduled to fly in the late 1990's.

See comment 2.

- RECOMMENDATION 2: The GAO recommended that the Secretary of Defense prevent duplicate acquisition and operational activities from occurring between the Navy and Air Force for oceanographic and meteorological satellite requirements. If the need for the Navy's NROSS system is justified, the contracting, command and control, and data collection function should be combined under a single organization (the Air Force) to take advantage of larger scale purchases and multiyear procurement. (p. 51, GAO Draft Report)

  DoD Response: Partially concur. The objectives reflected in the GAO recommendation are valid, but the suggestion is not relevant to the current Navy R&D program.

  Justification for the N-ROSS lies with the unique oceanographic phenomena that will be observed. Specific oceanographic-data requirements were previously documented in the Joint Chiefs of Staff Memoranda MJCS 251-76, "Military Requirements for Meteorological Data from Satellites," and MJCS 195-81, "Requirements for the Defense Meteorological Satellite Program." The full spectrum of military

environmental satellite data requirements (including those to be satisfied by the N-ROSS) has been revalidated by the Joint Chiefs of Staff and is now documented in MJCS 154-86, 1 August 1986, "Military Requirements for Defense Environmental Satellites." Intelligence derived from N-ROSS observational data is required to support commanders and ships-at-sea for anti-submarine warfare, carrier flight operations, amphibious warfare, and tactical missions. The oceanographic phenomena required to support Navy operations are not measured by the DMSP satellites. The earliest possible opportunity for the DMSP to develop a system to measure these parameters is 1998, with the Block 6 satellite system.

Since the GAO visited the Navy offices in 1985, the N-ROSS concept has undergone a significant and highly-relevant change. Rather than the concept of a continuing series of sole-source (RCA/DMSP) operational satellites described to the GAO at that time, the N-ROSS is currently programmed to consist of a single R&D satellite, procured competitively. The specific characteristics of the spacecraft bus, or of the command-and-control system, are not known at this time. To assert that the N-ROSS will be very similar to the DMSP and TIROS pre-supposes and could prejudice the outcome of the on-going competition. The competition is intended to insure that the N-ROSS satellite will be designed and operated in the most cost-effective manner possible. The DoD will insure that unnecessary and wasteful duplication of functions will not occur.

Long-term needs for oceanographic data will be included explicitly in design studies for the follow-on (Block 6) Defense Meteorological Satellite Program. The Department of Defense will not permit unjustified or uneconomical duplicate acquisition and operational activities for operational remote-sensing satellite systems, whether for meteorological or oceanographic (Navy) applications.

If the competition were to result in selection of a DMSP bus to carry the N-ROSS sensors, command-and-control and other support will be provided by the DMSP, in accordance with the existing Memorandum of Agreement between the Air Force and the Navy. The procurement of the single R&D satellite and the coincident monitoring of sensor-procurement and integration contracts can most effectively be handled by the Navy satellite program office most familiar with the system. Efforts to incorporate N-ROSS procurement responsibilities (beyond the scope of the current agreement) into the DMSP Program Office at this time would be counter-productive. The timing of the procurements is out of phase, with N-ROSS projected to be on contract in FY87, and the next scheduled DMSP satellite buy expected in FY89. Further, combining the systems would NOT gain any benefit from large-scale purchases or multi-year procurement, and would unacceptably delay the N-ROSS launch by two years or more.

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The following are GAO's comments on the Under Secretary of Defense for Acquisition's letter dated November 6, 1986.

GAO Comments

1. Reference to the Payload Test Facility has been deleted from the report.

2. The Navy terminated the NROSS program after we received DOD's comments on our draft report. Therefore, our report has been modified to reflect this program change.

Comments From the Department of Commerce

Note: GAO comments supplementing those in the report text appear at the end of this appendix.

UNITED STATES DEPARTMENT OF COMMERCE
The Assistant Secretary for Administration
Washington, D C 20230

NOV 26 1986

Mr. J. Dexter Peach
Assistant Comptroller General
Resources, Community, and
  Economic Development Division
United States General
  Accounting Office
Washington, D.C. 20548

Dear Mr. Peach:

This is in reply to GAO's letter of August 26, 1986 requesting comments on the draft report entitled "Economies Available by Converging Government Meteorological Satellites."

We have reviewed the enclosed comments of the Administrator, National Oceanic and Atmospheric Administration and believe they are responsive to the matters discussed in the report.

Sincerely,

Kay Below

Kay Below
Assistant Secretary
  for Administration

Enclosure

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Washington, D.C. 20230

THE ADMINISTRATOR

NOV 25 1986

Mr. J. Dexter Peach
Assistant Comptroller General
Resources, Community, and
Economic Development Division
United States General Accounting Office
Washington, D.C. 20548

Dear Mr. Peach:

Thank you for the opportunity to review and comment on the draft report entitled Economies Available by Converging Government Meteorological Satellites. We agree that the National Oceanic and Atmospheric Administration (NOAA) and the Department of Defense (DoD) should increase use of common instruments and facilities to obtain cost savings in their polar orbiting satellite systems, but do not believe that the two systems should be converged at this time.

We cannot converge the systems beginning with NOAA Satellites K, L, and M as the report recommends; rather, NOAA must now proceed with the K,L, and M procurements so that NOAA-K is available for launch in 1992. A delay in this procurement schedule would risk a serious data gap.

In addition to the K,L, and M timing problem, we also have other serious reservations about the proposed convergence with DoD.

First, although the report's main argument for convergence is that it would save money, the report presents no cost studies to actually support such a conclusion. We therefore cannot support a recommendation which is based solely on the expectation of savings, and not on a thorough savings analysis.

Second, in a converged system, if DoD weather mission needs conflicted with those of the civilian sector, it is our belief that DoD missions would prevail. While DoD and NOAA missions might be considered equal under normal circumstances, given the fact that DoD mission foci might change suddenly, and given the national security implications of such missions, we believe it is a reasonable conclusion that DoD's missions would indeed receive top priority.

Third, a converged system under DoD management would subject the U.S. policy on "open skies" to criticism and poses a threat to relationships with countries cooperating in our international programs. These have been pivotal concerns in prior convergence debates and their current sensitivity is untested. The report does not address these issues adequately, or reflect consultation with the Department of State on them.

Fourth, the report fails to note that Administration policy already promotes cost savings by proposing a one-satellite TIROS system rather than the two-satellite system discussed throughout the report.

Finally, the report expresses concern that NOAA plans to procure polar platforms instead of conventional spacecraft. We do not have firm plans on what system should follow NOAA-K,L,M in the late 1990s. NASA, not NOAA, is proposing a platform system for that time period, possibly in conjunction with a European Space Agency platform. We will fly the configuration which most cost-effectively serves the civilian weather mission. The report states that convergence on platforms would probably offer far greater savings than converging conventional spacecraft systems, but that platforms are too inflexible for the DoD mission. We may find that a civilian system of weather, research, and possibly other instruments is the best option for cost-saving, platform-based convergence. We do not support such a system now, but it would be premature to rule it out as your report recommends.

The enclosures provide detailed comments on these and other NOAA concerns regarding convergence.

Sincerely,

Anthony Calio

Anthony J. Calio

Enclosures

ENCLOSURE 1

GENERAL COMMENTS ON THE AUGUST, 1986
DRAFT GAO REPORT ON WEATHER SATELLITES

The question of a converged civil and military polar-orbiting weather satellite system has been examined repeatedly at the highest Federal levels over the past 15 years.

The most recent examination resulted in a national policy, the National Security Decision Directive 42, 1982. It states, "the United States Government will maintain and coordinate separate national security and civil operational space system when differing needs of the programs dictate." Current needs require separate systems. We are in compliance with the policy, and are continuing efforts to save costs through coordinating equipment and facilities with DoD where possible.

We agree with GAO that convegence poses no insurmountable technical problems. But the report further states that convergence would save costs and would not cause serious operational, political or program mission problems. In these respects the report is incomplete. The report cost studies would need to be redone to be reliable, and the report needs to address thoroughly the potential operational, political, and program mission complications. These points are discussed in more detail below.

Cost Savings:

The GAO potential cost savings estimates are based on 1979 cost projections from two Federal studies of convergence, one conducted by the Polar Orbiting Operational Meteorological Satellite Coordination Board (POOMSCOB), the other by the Integrated Remote Sensing Systems (IRS2) study team. "To update the (1979) savings estimates to 1986 dollars," the report simply applies an OMB inflation index. It does not adjust for the outmoded assumptions of the 1979 studies and fails to account for major costs of convergence. The report's recommendation is based on expected cost savings, but the report includes no thorough cost savings analysis or reliable estimates.

GAO must give full consideration to the existing, practical circumstances of the two systems to arrive at defensible cost savings estimates. The differing mission requirements of the two programs have led to real and significant system differences. The ENVIROSAT 2000 Report: Comparison of the Defense Meteorological Satellite Program (DMSP) and the NOAA Polar-Orbiting Operational Environmental Satellite (POES) Program, October 1985, documents these differences in some detail.

Here, it is sufficient to point out the broad areas that need closer examination by GAO before definitive cost projections can be made.

The first area is mission requirements which require further review. The military requirement is for orbit flexibility, while the greatest civil need is for a consistent early afternoon orbit. Where the civil mission calls for quantitative multi-spectral radiance imagery data, the DoD mission emphasizes constant-resolution and low-light cloud imagery. There are mission areas in each program that do not have parallels in the other, including: for the DoD, survivability, encryption of data, very responsive launch capabilities, and high reliability; for the civil, direct data broadcast, international participation, relay of data from platforms, and search and rescue. There are large costs involved in combining mission requirements in one system. The draft report provides no thorough estimates for these.

One of the most costly factors would be applying military survivability and reliability requirements to the civil components of a combined payload. The price of upgrading the civil components to meet military specifications for wartime levels of reliability alone would be very high. A converged system would have to either apply these military requirements to the civil components, or guarantee a replacement launch when a primary civil-mission sensor failed, even though the spacecraft's military-mission sensors remained operational. Both would be expensive options, but the report fails to investigate this.

The GAO report overestimates the capacities and interchange-ability of the command and control systems of the two programs. Both current command and control systems are "filled-up" and both need upgrades to handle existing mission needs. The DoD system must have survivability and responsiveness factors available; the civil system is also used for GOES operations and for the launches of NOAA and foreign satellites. Neither command and control system could be used to operate the other's satellites or handle its data without extensive, expensive modifications to ground hardware, software, and communications. Further, spacecraft and sensor changes would be needed to enable the modified ground system to control the satellites of a mixed-mission fleet. GAO needs to restudy the command and control area to determine the costs involved, and the costs of DOC continuing GOES command and control in parallel.

See comment 1.

The draft report proposes that under convergence, substantial savings would result from single-manager procurements, elimination of parallel production lines, and termination of duplicate test facilities at the launch site. Substantial savings may not be possible in these areas.

An augmented procurement management staff would be needed to handle a larger, more complex system and because the payloads of the spacecraft series would not be identical, only similar, and would be needed on differing schedules. Further review is required to determine the level of production line savings.

See comment 1.

As for launch site test facilities, they are not duplicated now and there are no intentions to do so. There is no NOAA test facility at the Vandenberg Air Force Base launch site. NOAA shares a NASA satellite processing facility there with other users. The DMSP facility at Vandenberg cannot support NOAA now, because it is used to store and test readiness of DMSP satellites. If the DoD and civil missions were to be converged, an augmented DMSP facility at Vandenberg AFB probably would be required, but the NASA facility would be continued for NASA and other users. Rather than offering a test facility saving, convergence could involve new costs for a test facility augmentation.

Finally, the GAO report gives new estimates of cost savings from convergence that were extrapolated from the estimates provided in the 1979 POOMSCOB and IRS2 studies. However, the earlier estimates were not reduced by amounts proportionate to the savings that the two programs already have made through cooperative efforts. The two programs share data processing responsibilities, factory facilities, spacecraft designs, launch vehicles, and launch facilities. Jointly, they are studying the possibilities for common sensor designs where their data requirements are similar. Significant actual savings have resulted from these efforts, which were part of the total savings postulated by the 1979 studies. Because these savings are achieved already, they must be removed from the sum of "potential" savings.

Operational, Political, and Program Management Issues:

The draft report fails to recognize the management area as a troublesome one, although every person responsible for convergence decisions has seen it as formidable. The basis for the concern about system management issues is that, while there are unambiguous needs for the products and services of the two missions, the civil mission cannot and should not compete with the national security mission. With separate systems, the two managements each resolve their separate problems; with a combined mission, DoD requirements necessarily would receive priority attention when problems developed.

Defined management principles are an essential ingredient of convergence discussions, but lacking in the draft report.

Similarly there is a continuing debate about, and possible international repercussions from, the "militarization" of the civil mission under a DoD-managed convergence. This serious concern is little addressed in the draft report, yet has been a deciding factor in previous convergence reviews. GAO should consult with the Department of State on international ramifications that convergence under DOD would engender.

There may also be funding aspects in this regard; nations that now contribute costly equipment and support to the civil mission might withdraw from this cooperation. To determine the magnitude of the latter situation, consultation with the contributing nations would be required.

Other Considerations:

The draft GAO report recommends that the two programs be combined under DoD procurement for DMSP S-16 through -20 and NOAA K, L, and M. The NOAA K, L, M procurement is now in process and must be continued at an urgent pace to protect the system from total failure in the early 1990s. Even under a sole-source procurement schedule, NOAA-K will not be available in time to back up the launch of NOAA J in 1991. In any event NOAA K must be available for launch in 1992. NOAA understands that the S-16 through -20 contract will not be let until 1989, with an earliest availability date for S-16 of 1993. It would be difficult to bring these schedules together to accommodate these recommendations.

The report's recommendation goes on to assert that the two programs show divergent trends and unnecessary duplications. This is in error. The two programs are closely joined and inter-cooperative, exploring options in full consultation with each other, to better share opportunities. For example, we have agreed to use some common sensors, and are continuing joint studies to design other common sensors for the future. We also intend to launch the K, L, M satellites on refurbished Titan IIs made available by the Air Force. The report should also note that Administration policy supports a one-TIROS system to achieve cost-savings.

Finally, the draft report categorizes the NOAA interest in serviceable platforms for the civil mission as evidence of increased divergence. The converse is true. NOAA will consider converging with other satellite system operators, if the convergence maintains the civil mission and saves money. NOAA does not plan to procure polar platforms; we are looking at options to fly our sensors on platforms procured by others. Polar platforms others violate the DoD requirements of flexibility and responsiveness, making the DoD an unlikely partner in a platform-based convergence.

By contrast, NASA, the European Space Agency, and other non-DoD entities could be partners for a civilian weather/environment platform system. Such a system would be free of the policy and international relations entanglements that have burdened past Federal convergence debates. It would be less technically complex, involving sensor designs instead of the re-design and merging of existing, differing systems. While we have no plans now to share these platforms, they may prove a cost-saving option in the future. We invite GAO to co-study this other line of convergence and share findings.

The NOAA position on the convergence of the civil and military weather satellite missions is that convergence is possible only when the DMSP block change scheduled for the late 1990s takes place. DoD plans to release its RFP for the studies leading to this block change in 1987. NOAA believes further study of convergence is required before an investment is made to add civil requirements to this RFP or for NOAA to underwrite the costs of the additional study work that would result.

Enclosure 2

Specific Comments on the August 1986
Draft GAO Report on Weather Satellites

Now on p. 47.

1. Page 1, para. 3 - The report should note that Administration policy calls for a one-satellite TIROS system, not a two-satellite system.

Now on p. 4.

2. Page 2, para. 2 - The schedules for DMSP S-16 to S-20 and NOAA K,L,M are incompatible for early convergence. NOAA K must be available in 1992 to avoid a total discontinuity in the system; NOAA's understanding is that S-16 is to be contracted for in 1989 and available in 1993 or thereafter.

   An "immediate" convergence would delay NOAA K until circa 1994, causing a gap in service.

Now on p. 5.

3. Page 3, para. 1 - The most recent examination resulted in National Security Decision Directive 42, 1982. It states, "the United States Government will maintain and coordinate separate national security and civil operational space system when differing needs of the programs dictate." Current needs require separate systems. We are in compliance with the policy, and are continuing efforts to save costs through coordinating equipment and facilities with DoD where possible.

Now on p. 5.

4. Page 3, para. 4 - These 1979 cost estimates no longer are valid, as discussed in the General Comments. Administration policy already proposes cost savings through flying a one-satellite TIROS system rather than a two-satellite system.

Now on p. 5.

5. Page 4, para. 1 - Multiyear, larger quantity buys require coordinated procurements; these are not always possible, given the uncertainties of budgets, launches, and in-orbit longevity.

   Current DOC policy is to make multiyear buys whenever possible.

Now on p. 5.

6. Page 4, para. 2 - (Factual update.) The report should clarify that NOAA is not proposing to procure meteorological platforms, but is looking into options to place its instruments aboard the servicable platforms of NASA and the European Space Agency in the era post-NOAA K,L, and M. This would allow us to save program costs by using the spacecraft of others.

Now on p. 47.

7. Page 11, para. 1 - The report should note that Administrtion Policy calls for a one-satellite TIROS system, not a two-satellite system.

Now on pp. 10-11.

8. Page 11, para. 2 - NOAA K,L,M are being procured. The spacecraft costs of NOAA H,I,J are $55M each, the costs of NOAA K,L,M probably $75M each, versus the $100M quoted. DMSP costs are higher.

Now on p. 11.

9. Page 11, para. 3 - Current NOAA launch costs (Atlas Vehicles) are $20M each, verus the $30M quoted.

Now on p. 11.

10. Page 12, para. 1 - NOAA plans to use Titan IIs to launch NOAA K,L,M at a cost of about $42M (FY89 Dollars) per launch for launch services, not to launch satellites on the shuttle.

Now on p. 11.

11. Page 12, para. 2 - The statement ignores the extensive cooperation that continues today, including the current implementation of shared processing, the common use of Titan II launch vehicles for the late 1980s and 1990s, and the on-going joint effort to develop a common imaging instrument.

Now on p. 12.

12. Page 13, para. 2 - The DMSP and NOAA systems are somewhat similar but not identical. NOAA's morning spacecraft are in descending orbits; that is, they are heading toward the South Pole when crossing overhead during local morning hours. NOAA's afternoon spacecraft are ascending, as are DMSP spacecraft.

Now on p. 12.

13. Page 13, para. 3 - The report should note differences in the two programs as well as similarities. NOAA spacecraft gather data about atmospheric ozone, collect and relay information from in situ platforms, and perform the search and rescue function, in addition to the data collection activities cited. NOAA data are transmitted continuously and in real time by radio broadcasts to all listening ground stations, as well as stored in tape recorders for later re-play. The NOAA data are read out in over 120 countries worldwide. DMSP data, however, will be encrypted for DoD use.

Now on p. 13.

14. Page 14, figure - NOAA satellites and their data relays to NOAA, DoD, and other ground stations are not reflected in this figure.

Now on p. 14.

15. Page 15, para. 2 - Failure to take into account NOAA's geosynchronous satellite system (GOES) leads to a false assessment. Savings from converging the civil and military polar systems could be reduced or cancelled out by diverging the civil polar and civil geostationary systems. The study is incomplete until this factor is considered.

Now on p. 14.

16. Page 16, para. 1 - It is not valid to "update" 1979 study results to give 1986 meanings about savings unless changed system characteristics, concepts, practices, and their resulting costs are analyzed. This point is discussed in the General Comments.

Now on p. 16.

17. Page 18, para. 1 - There exist no current, thorough cost studies to substantiate the cost savings claim. The report cites no thorough analyses to confirm operational feasibility. Both DoD and NOAA are concerned that management and political problems arising from conflict between mission priorities could disrupt mission activities; the report should not dismiss these without discussing and analyzing them. Administration Policy already proposes cost savings through flying a one-satellite TIROS system rather thana two-satellite system.

We agree with GAO on technical feasibility. We also agree on the cost advantages of multiyear procurement, but it should be noted that we already procure on multiyear buys whenever possible.

For a through and accurate report, we suggest that this and other summary paragraphs be amended to reflect not only arguments in favor of convergence, but also major unresolved problems and uncertainties such those noted above.

Now on p. 17.

18. Page 19, para. 3 - Coordination and cooperation between the programs is extensive. The spacecraft programs are coordinated in depth at the site of the spacecraft contractor's (RCA) plant, for example. Failure to give credit to this interprogram cooperation obscures the fact that significant savings already are being effected, which must be accounted for in any cost analysis that does not count these savings twice.

Now on p. 17.

19. Page 20, para. 1 - DOC is fully in compliance with this Presidential Directive in its management and operation of the NOAA polar satellite system.

Now on p. 18.

20. Page 21, para. 1 - The "obstacles to convergence" cited here are the significant factors discussed at length in the General Comments. They are not easy to resolve.

See comment 2.

21. Page 23, para. 1 - The DMSP Block II study addressed DMSP requirements only, not those of NOAA. The contractors looked at a single system for a complex of DMSP payloads. The report should note that this study is not a basis for conclusions on convergence.

See comment 3.

22. Page 26, para. 1 - The cost cited should be $1,000,000, not $100,000.

Now on p. 23.

23. Page 28, para. 2 - (Factual correction.) At the time (1984) of the spacecraft replacement cited, NOAA still was receiving data from its morning spacecraft (NOAA 6). NOAA and Administation policy is that only a one-satellite afternoon-orbit TIROS system is needed. A morning satellite is not needed as backup, because the one-satellite system's launchand call-up schedules are designed to maintain data continuity.

Now on pp. 23-24.

24. Page 29, para. 1 - Parallel production lines would be needed in the later stages, as payloads would vary and schedule conflicts could occur with only one assembly line and staff. Additional review is required to determine specific requirements and the level of savings involved.

See comment 1.

25. Page 29, para. 2 - Site facilities would have to be augmented to service addititional spacecraft. The cost of this could cancel out much of the stated savings. The report should note this.

Now on p. 24.

26. Page 30, para. 1 - The question of converging command and control has both technical and operational aspects. In addition to simply adding up the available computer capacity, the report needs to analyze these aspect throughly. The report needs to address the high cost of modifying current ground and space components to establish a converged command and control capability.

It should address how the civil system would continue operating GOES or participating in the launching of GOES and foreign satellites. It should also address operational management questions: would the need of the higher-priority national security mission disrupt command and control of the civilian weather mission? These points are discussed further in the general comments.

Now on pp. 24-25.

27. Page 30, para. 2 - NOAA procures its spacecraft through single contract for multiple spacecraft of a series. Multi-year funding estimates for these contracts are used as the basis for estimating the annual appropriation level required to cover the contractor's cost, plus contingency. The report should note this.

Now on p. 25.

28. Page 31, para. 2 - Joint buys of spacecraft are practiced now, when procurement phasing allows. The report should note this.

Now on p. 28.

29. Page 32, para. 1, and Page 33, para. 1 - The report should clarify that NOAA is not proposing to procure meteorological platforms, but is looking into options to place its instruments aboard the servicable platforms of NASA and the European Space Agency, in the era post-NOAA K,L,M.

This would allow us to save program costs by using the spacecraft of others.

Now on pp. 28-29.

30. Page 33, para. 3 - The report estimates (p. 27) that the greatest convergence savings would result from using servicable platforms rather than expendable satellites. It then notes (p. 33) that DoD cannot use platforms. Assuming the reports' purpose is to identify and encourage potential savings, non-DoD platform convergence options should also be discussed. This could produce more savings than convergence with DoD on expendable spacecraft, with far fewer operational and political problems. We emphasize that NOAA is not proposing this now. We would need to know much more about program and cost aspects before supporting it.

Now on pp. 30-31.

31. Page 36, para. 1 - The conclusion that NOAA and DoD require the same level of quality control is incorrect. While DMSP and TIROS are technologically similar, their missions are different. DoD's national security mission requires a very high level of quality control. DoD cannot compromise this to save costs. But the NOAA mission can operate with a lower quality control requirement, allowing NOAA to save costs. NOAA buys S level parts when they are available, but does not have them designed specifically because of the very high costs and delays involved in these designs.

Now on p. 32.

32. Page 38, para. 2 - The report should mention that NOAA and DoD have agreed on some common sensor designs and intend to continue progress in using common sensors.

Now on pp. 34-35.

33. Page 40, para. 3 - These 1979 cost estimates no longer are valid, as discussed in the General Comments.

Now on pp. 36-37.

34. Page 43, para. 1 - It is too late to change the procurement process for NOAA K,L,M without a gap in service and attendant loss of weather forecast capability. (See item 1, above, and discussions in the General Comments.)

Now on p. 40.

35. Page 46, para. 2 - Many foreign space programs, notably the European Space Agency, refuse to deal directly with military agencies. These programs provide us some of our major instruments gratis, and are increasingly providing important meteorological data through exchange agreements.

The following are GAO's comments on the Department of Commerce's letter dated November 26, 1986.

GAO Comments

1. Reference to the test facility has been deleted from the report.

2. Reference to contractors' studies on DMSP Block II has been deleted from the report.

3. Reference to cost was unverified, thus deleted from the report.

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