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DATOS

DETECTION AND TRACKING OF SATELLITES

471.96 SPADATS

Report of the

Ad Hoc Working Group on Department of Defense Space Detection, Surveillance, Tracking and Data Processing

OFFICE OF THE SECRETARY OF DEFENSE
WASHINGTON, D.C.

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March 1965

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Office of the Secretary of Defense
Washington, D. C.

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PREFACE

This is the final report of the Ad Hoc Working Group established to study the Department of Defense's overall space detection, surveillance, tracking and data-processing effort. This DATOS (Detection and Tracking of Satellites) Group was organized in the summer of 1964 and completed its work in the early spring of 1965.

The people selected by the Military Departments and other Department of Defense agencies to participate in these deliberations brought to the Working Group a broad knowledge and understanding of their organizations' activities and interest in space surveillance. The DATOS Group takes this opportunity to thank those individuals for their cooperation throughout the period of this study.

For the reader's convenience, the principal findings and specific recommendations of the DATOS Group are presented in "Summary and Recommendations," which precedes the main body of this report.

Daniel J. Fink
Assistant Director (Defensive Systems)
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SUMMARY AND RECOMMENDATIONS

BACKGROUND

In July 1964, by direction of the Deputy Secretary of Defense, a working group was organized to review the Department of Defense's space detection, surveillance and tracking systems for the purpose of determining their capability, adequacy, redundancy and efficiency with respect to their primary missions. This DATOS (Detection and Tracking of Satellites) Group was to recommend, on the basis of its study, policy and guidance relating to suitable reductions and consolidations, allocation of resources and organization of the systems concerned, especially with a view to their operation as a coordinated program. (See Appendix A.)

In amplifying its review responsibilities, the Group defined as DATOS facilities all ground-based sensors, communications, computers and control centers used by, or available to, the DoD for collecting, analyzing and disseminating data on orbiting space objects. The primary systems are clearly NORAD SPADATS (composed of the Navy SPASUR and the Air Force SPACETRACK) and the Intelligence Sensor Network. Contributing sensors are the Air Force Satellite Control Facility, certain DoD test-range and R&D radars, and the various NASA sensors, when they are used under the NASA-DoD agreement (Appendix D). Actually, the Group concentrated its efforts on SPADATS and the intelligence network. The Group did not, however, examine the intelligence system from cost or technical standpoints but judged it mainly on the quality of its output and its interaction with SPADATS. The contributions of other sensor systems and their potential are meager, fundamentally because the sensors provided by the SCF and NASA have virtually no skin-tracking capability. Moreover, owing to their technical shortcomings and limited availability, they offer little potential assistance or redundancy in noncooperative space surveillance.

The DATOS review was prompted by uncertainties in both the adequacy (or redundancy) of systems performance and the legitimacy of purpose of space-surveillance and satellite-tracking efforts. Depending on the space-surveillance purposes that one is willing to accept, systems performance could be considered as ranging from extreme inadequacy to an unwarranted excess of capability.

In attacking this dilemma, the DATOS Group placed a good deal of emphasis on an evaluation of the real utility of space-surveillance information. It is important to note that, while SPADATS is assigned to NORAD, the fundamental mission of the system goes considerably beyond NORAD's classic role in the defense of North America. But it is the defensive purpose that often makes the most severe demands on DATOS facilities. One cannot, therefore, overlook their interfacing with forces and defensive systems that operate in the space arena. The acquisition of space-surveillance data is not an end in itself; but the fact that continual surveillance of space is practical offers the temptation to do what can be done rather than what needs to be done. With existing systems, we can now observe most enemy actions in space far better than we can place his forces at sea or on land.

The requirements for space-surveillance data often sound as if there is—or is about to be—an offensive force in space and the weapon systems to counter such a threat exist. The DATOS Group endorses the national intelligence estimate on the Soviet space program; while the U.S.S.R.'s military interest in space is clear, the orbital weapon remains in the uncertain future. The Group concludes, therefore, that the implications of the Soviet space program with regard to DATOS facilities will probably be governed more by U.S. assessment of, and reaction to, the program than by the threat itself. For example, the U.S.S.R. already has reconnaissance satellites. U.S. response to this program does not depend on the existence of a Soviet threat but rather is based on U.S. decisions to take such counteractions as camouflage and evasion by surface forces. Even if there were firmer predictions of the Soviets' deployment of offensive weapons in space, the implications relative to DATOS facilities would not be clear without a definition of the countering U.S. active defense systems. There is little utility in requirements for space-surveillance and tracking systems which imply that all uncertainties regarding the threat and the defensive forces have been resolved.

Even in the absence of a clear Soviet space threat, there are a number of functions, both defense-oriented and otherwise, that can be delineated and supported but are usually submerged in the furor of requirements based on tactical space warfare. Satisfying those legitimate functions gives the system a basic capability that can support other less certain objectives, as well as provide a basis for handling future developments. The DATOS Group classified the uses and functions of space surveillance in these five all-embracing categories:

(1) Maintaining the space catalog
(2) Support of space missions
(3) Space intelligence
(4) Support of antisatellite systems
(5) Support of other counteractions

USES AND FUNCTIONS OF SPACE SURVEILLANCE

1. The Space Catalog

The catalog of space objects is both an end in itself and an intermediate step toward other space-surveillance objectives, which include the unalerted detection of new space objects, maneuvers of old satellites and breakup of bodies in orbit. All of these are detected by their deviation from the catalog.

The present catalog predicts time of arrival at a given position to better than ±15 seconds in time. The corresponding cross-track errors are considerably less than this in mileage equivalent. The catalog's accuracy has gradually improved over the past few years and may be expected to improve further as operating efficiency and knowledge of orbital dynamics increase. Present accuracy is more than acceptable to most users of SPADATS data. Cases in which extremely high accuracy is needed on several objects can be handled outside the catalog. Judged on the basis of need, requirements for greater catalog precision are not valid. Decisions to alter catalog precision should be based solely on the factor of ability to improve the system's operating efficiency. For example, increasing the catalog's precision could simplify correlation procedures at sensor sites and so improve the sensor's efficiency; it would also allow updating orbital elements less frequently, which would result in an inherent increase of the system's capacity.

A question often raised is whether the catalog should keep track of all objects in space. The answer would appear to be affirmative, since the present space population of about 500 objects does not tax the facility, and it could grow to several thousand before trouble is encountered. Dropping unimportant items, such as space junk, from the catalog would not affect the direct users of the information; but, as an intermediate step toward further reduction of data coverage, it would lead to negating much of the catalog's utility. Even a very large expansion in the space population could be accommodated simply by maintaining the catalog with one sensor such as SPASUR or the AN/FPS-85 (once it is deployed).

2. Support of Space Missions

The DATOS facilities have served—and will continue to serve—many military and NASA space programs, providing special calibration data, the emergency location of malfunctioning objects, impact prediction on decaying objects of special interest, and general policing of the space environment. Usually this function of SPADATS requires precision tracking observations from the sensors and is performed outside the catalog. Up to now, it has not taxed the system, but the fact that SPADATS accuracy can now match that of beacon-tracking networks such as the SCF is causing the demand for this service to grow. For example, the Air Force anticipates an increase in the number of special mission satellites that require SPADATS support—amounting to at least 6 and possibly 14. Because of the large number of observations required for precision prediction, further increases could overload the system. If this occurs, alternate procedures should be investigated, for example, using beacons on the satellites and tracking with the SCF network.

3. Space Intelligence

Regardless of the severity of the Soviet space threat, knowledge of the real intent of their space operations is an important adjunct to U.S. policy deliberations and space planning. In the view of many people, this use of space data is one of the strongest reasons for the existence of DATOS facilities. However, the collection of space intelligence does not merit the priority accorded other militarily more important areas of enemy operations.

The assessment of Soviet space missions is basically an intelligence responsibility. SPADATS contributes two classes of data to the intelligence process—metric information and radar signature analysis. The requirements for metric data to support the intelligence community are similar to those already noted; they include the gross orbital parameters that, in conjunction with past history, help to identify the satellite's mission, as well as precision predictions that are useful in the reacquisition of radiating satellites by ELINT sensors. In some of the stated requirements furnished the DATOS Group, there is an implied need for mission assessment concurrently with first-pass detection, which means much faster assessment than is now the practice. The Group does not see the urgency for such a decrease in mission-assessment time.

It is often implied that SPADATS, virtually by itself, must determine the threat for U.S. antisatellite action. The current 437 and 505 antisatellite systems must be considered as demonstration, or selective-retaliation weapons. Their target satellites, therefore, will be designated either through Soviet "cooperation," i.e., public announcement, or through the full assessment of intelligence. After that, SPADATS will make certain that the designated satellite, and no other, is targeted. This task is well within SPADATS' capability.

Radar signature data have made useful contributions to mission assessment. While current radar "pictures" are crude, there has been a fair amount of success in interpreting radar amplitude-vs.-time records to get rough estimates of the size and shape of space objects, as well as their stability and orientation. The system is basically manual; analysts examine the records and compare results with records obtained from bodies of known shape and size.

The majority of research and development activities in space-object identification (SOI) is now being sponsored by ARPA. It is not clear how much more useful the information gathered by microwave radars will be than the data now provided. If useful signature information could be obtained by making relatively minor modifications in present or planned SPADATS sensors to increase resolution, then the cost would probably be justified by the results obtained. But, if the use of high-resolution techniques requires a new generation of sensors (perhaps with long-baseline interferometers), then one can question the need in relation to the cost of satisfying it. These uncertainties seem to warrant a careful investigation of the potential of SOI to determine how much additional information on orbiting objects we can anticipate gathering—and in what time period, and to identify those programs that have maximum chance for success.

4. Support of Antisatellite Systems

The current U.S. antisatellite programs, the Air Force 437 and the Army 505, are adequately supported by SPADATS. In fact, SPADATS' performance in this mission has now far exceeded original expectations. At present, the system enables the prediction of an orbit, after 12 hours of tracking, 4 to 12 hours in advance (depending on the satellite's altitude) with an accuracy on the order of a nautical mile, both cross-track and along-track.

As an exercise during January 1965, SPADATS maintained special precision orbit elements for 15 Soviet payloads. The net effect is that tracking time to obtain intercept-quality orbit data may be reduced from the quoted 12 hours to 4 or 5. Desires to reduce SPADATS' accurate prediction time still further are based on the premise that the current reaction time exceeds that of the antisatellite weapons. The DATOS Group, on the other hand, finds the systems well matched within the context of their missions. With respect to the concept of using the present weapon systems within a very few hours of a foreign satellite's launch, there are implications that go far beyond reducing the reaction time of SPADATS. The entire concept of the weapon systems—their firepower, basing, etc.—would have to be included as considerations.

Similarly, SPADATS can adequately support currently planned follow-on programs to the existing antisatellite systems, including those carrying photographic and nonnuclear negation payloads. Requests for improving SPADATS to accommodate some future unknown antisatellite system have no merit.

5. Support of Other Counteractions

These are tactical actions, other than antisatellite, taken by any U.S. military force on the basis of space-surveillance information. In this category are the most demanding and controversial requirements placed on the DATOS facilities: To detect, track and determine the mission of all spacecraft, not only before they overfly the United States but prior to their completion of a first circuit, or first pass, over any area of Unified or Specified Command responsibility. Not only are these requirements unwarranted by intelligence evaluations of the Soviet space program, but the DATOS Group found no evidence that receivers of the data had realistic plans for such a tactical use of the space arena.

* * * * *

It should be noted that past and current requirements on SPADATS, as expressed by NORAD in NQR 2-65, are inconsistent with the preceding functional analysis. They submerge the real utility of space data, are clearly geared to a tactical space defense environment, and imply that all uncertainties in the defensive forces have been resolved. They are stated with the implied assumption that all limiting conditions apply simultaneously, i.e., maximum detection probability at maximum range on minimum target on first pass, etc. In systems planning, therefore, the NORAD document loses utility.

It might be argued that such requirements are merely a compilation of stated user needs; but, again, those needs were not demonstrated. Certain demands are unique to specific users; for instance, the intelligence agencies place on SPADATS a requirement for data on deep-space probes and imply a need for NORAD to procure equipment it does not need for any other part of its mission. In such cases, SPADATS is probably not the vehicle for this mission, no matter how valid the need.

PERFORMANCE OF DATOS FACILITIES

Having established the utility of space-surveillance information, the DATOS Group evaluated the performance of current and projected hardware to satisfy legitimate needs. An overall conclusion is that the present performance of DATOS facilities is adequate to the tasks and demands made upon them. This should not be surprising, for the facilities were not developed in response to arbitrary requirements but evolved gradually over the years as specific needs and uses became apparent. This supports the general premise that information and command-and-control systems are most successful when they are developed on an evolutionary basis instead of being planned from the beginning as a grand system exercise. The Group's analysis of the DATOS facilities dealt with three principal elements:

(1) sensors,
(2) computers and backup, and
(3) R&D plans.

1. Sensors

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SPADATS sensors comprise the Navy SPASUR detection fence and the various radars assigned to the Air Force SPACETRACK System. The latter system includes a detection fan and tracker at Shemya, Alaska, and at [redacted] a tracker at Moorestown, New Jersey; and inputs of the three BMEWS sites (Clear, EO50x6 OSD

Alaska; [redacted] By far the largest part of the DATOS Group's technical analysis dealt with the sensors, in keeping with the fact that they account for more than half the system costs. It is convenient also to divide this discussion into two parts, the present and the future, defining the future as the time the AN/FPS-85 becomes operational. There is, of course, no single figure of merit that can be used to describe a sensor's worth. The sensors in SPADATS should be examined in the context of the whole system and in terms of such parameters as range, detection and tracking coverage and accuracy.

Range: The present sensors in SPACETRACK are outgrowths of the development of high-power, long-range radars for BMEWS; hence, the range obtainable with them results not so much from a conscious specification of requirements but the fact that they were available. The detection range of these radars on a 1-square-meter target is generally 2000 to 4000 nautical miles, and their tracking range is somewhat greater. Taking geometric factors into account, these detection ranges correspond to satellite apogees on the order of 1500 to 2500 nautical miles. When certain improvements to the SPASUR fence are completed this summer, it will have a detection range out to 6000 nautical miles. Since most satellites of interest are well within the range of current sensors, the DATOS Group recommends no action to increase the system's range beyond continuing research and development on the AN/FSR-2 electrooptical sensor (which is discussed later).

Detection: Perhaps the largest single controversy associated with space surveillance revolves around desires to ensure that satellites in all classes of orbit, i.e., inclination angle and altitude, are detected prior to first pass over a number of widely spaced locations, i.e., various U.S. Unified and Specified Commands and Fleet elements. This requirement demands that the Sino-Soviet land mass be ringed with detection fences. In effect, the system then becomes an extended BMEWS. Since this need has not been established, it is not seriously considered.

A better measure for evaluating the detection capability of a system is early orbit detection, that is, the detection of space objects sometime during the first few orbits without specifying where. The fact is that, within its altitude range, the system detects all Soviet satellites launched from Tyuratam and Kapustin Yar during their first few orbits. The most useful supplement to the detection capability of SPADATS would be the addition of more Doppler filters at the BMEWS Site III (Fylingdales) installation. This feature was not included in the original design of Site III, because it was planned as a ballistic-missile-detection facility and the expected velocity range of threatening missiles is considerably less than that of satellites.

In addition to detecting new launches, the system can detect maneuvers in orbit and the breakup of orbiting objects. Its performance is adequate as long as immediate detection is not a requirement. The provision of full and immediate coverage in all possible circumstances would require an inordinate number of sensors spread over the world. The SPASUR fence is particularly useful in detecting orbital breakups. The BMEWS sensors now develop a number of satellite false alarms, and this tends to slow the detection process. A new computer program called MIP/SIP, for Missile Impact Prediction/Satellite Information Processor, is now being installed for BMEWS and will considerably alleviate this situation.

Tracking: The SPADAT System has excellent tracking coverage. For typical Soviet missions, there is essentially solid coverage above 45 degrees' orbit inclination and some coverage all the way to the equator. Almost every orbit is covered by at least one sensor, and many orbits are covered by several. The coverage of different parts of the same orbit by two sensors is valuable in computing orbital elements and in reducing the time required for precision predictions.

It has long been recognized that sensors in the Southern Hemisphere could improve the accuracy of orbit prediction by providing observations on a part of the orbit that is not now seen. Present system performance, however, is excellent, and the degree of improvement that could be obtained by having such real-time tracking observations does not appear to warrant the installation of a southern sensor.

* * * * *

Since it is both a detection network and a computation center, SPASUR was examined separately. As a detection network, it currently provides the only detection coverage on satellites with inclinations from 30 to 40 degrees and at altitudes below about 1000 nautical miles. When current improvements are completed in the summer of 1965, SPASUR will furnish the only detection coverage between 2500 and 6000 nautical miles. In the past, there was some difficulty in integrating SPASUR into SPADATS, but it was an organizational rather than technical problem and has largely been overcome.

The Group's overall conclusion regarding SPADATS' sensor system is that, at present, all sensors contribute in a nonredundant fashion to the operation of SPADATS. Multiple detections on the first few orbits aid greatly in the quick determination of orbital parameters. The elimination of any sensor would leave gaps in detection coverage and would also complicate precision tracking. With regard to the nonredundancy of sensors, however, the situation will not remain the same in the future—as shown in the following discussion.

During the DATOS Group's deliberations, the AN/FPS-85 radar at Eglin Air Force Base was destroyed by fire. This immediately raised questions on whether it should be rebuilt and, if so, whether its configuration and location should remain unchanged. The original reasons for constructing this phased-array radar—to improve SPADATS performance and efficiency and to get operating experience with a large phased-array radar—still hold. There were enough salvageable facilities to warrant rebuilding the radar at the same location. An "optimum" location would probably be outside the continental United States, which would not only be costly but would tend to divert the radar from its R&D purposes. The DATOS Group concludes that the AN/FPS-85 radar should be rebuilt at Eglin, incorporating the planned improvements to give it the availability needed for an operational capability.

When the AN/FPS-85 becomes operational in late 1967, its coverage will overlap that of other sensors to a considerable extent. The Group concludes that it should be possible at that time to close down operations at both Moorestown and

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[redacted] The AN/FPS-85 will also largely overlap the detection coverage of SPASUR up to about 2000 nautical miles, and it will have a very useful capability for tracking after detection that will become more valuable as the space population grows and experiments in space become more sophisticated.

The overlapping coverage of SPASUR and the AN/FPS-85 can be put to use if one envisions a close tie between the two sensors so that, when there is a detection in the SPASUR fence, the AN/FPS-85 is alerted to track the object. The value of this tie lies in the fact that, while the Eglin radar can detect space objects only to an altitude of about 2000 nautical miles, it can track to 6000 nautical miles or more, depending on the target's size and integration time. Since the two sensors have a large area of common coverage above 300 nautical miles, this could become a valuable mode of operation. The tie would be an automatic one: SPASUR would feed the AN/FPS-85 computer directly, giving the location and direction of the fence crossing within a very few seconds; after that, the AN/FPS-85 would track the satellite.

While this mode of operation would be primarily for altitudes above 2000 nautical miles, it could be expanded to use SPASUR for all detection and reserve the AN/FPS-85 for tracking. The resulting increase in tracking capability would be equivalent to doubling the power-aperture product of the AN/FPS-85. While this capability is not needed now, the option will always be available to handle any unusual increases in the space population. The DATOS Group therefore concludes that, after the AN/FPS-85 becomes operational, SPASUR should be retained but should be thoroughly integrated with the AN/FPS-85 in an operational sense.

A question that will need further examination is whether the SPASUR headquarters should remain at Dahlgren or the two systems should be consolidated at the Eglin site.

The other potential sensor in R&D status is the AN/FSR-2 Electro-optical Sensor. This device promises a detection capability between 3000 and 300,000 nautical miles, using reflected sunlight. The cost is relatively modest (about $5 million), compared to that of equivalent radar sensors, but the development involves a higher risk. While the program has had some success in proving the feasibility of the technique, its performance is marginal for two reasons: Its requirements for detection sensitivity were set too low, and the hardware has not been able to meet even its design specification. There appear, however, to be several ways of improving the sensitivity of the AN/FSR-2 at a nominal cost. The DATOS Group concludes that R&D on this sensor should proceed, since it offers the only real possibility of obtaining long-range detection with modest expenditures. A decision regarding operational use of the AN/FSR-2 can await the completion of R&D and an evaluation of the need at that time.

2. <u>Computers and Backup</u>

The period of the DATOS Group's deliberations was optimum for considering the use of computers and their backup because of the pending transfer of SPADATS operations from the Group I facility at Ent Air Force Base to the Cheyenne Mountain Complex (CMC). A duplex facility for the CMC is planned, the 425L programs in one machine and space defense programs (SPADATS) in the other.

NORAD has proposed that an additional Philco 2000 computer be installed in the CMC, making a total of three computers available to fulfill both the 425L and the space defense functions. The third machine would be used for off-line processing of space-surveillance data and the support of new computer-program development and checkout, training and system analysis, as well as for absorbing the maintenance-time requirement with respect to all three machines.

Computer utilization for SPACETRACK has been running about 600 hours per month, and this can be expected to continue into the foreseeable future. Adding to this 120 hours of maintenance for the 425L machine would indicate a total use of 720 hours, or 100 percent of capacity. Any additional requirements for new services, program debugging, integration of new equipment, etc., would be further justification for the third computer. The Group concludes that the projected computer utilization is sufficient to warrant the installation of a third machine.

A possible source of the additional computer is the SPACETRACK Center Alternate Facility (SCAF) at Hanscom Air Force Base. The Group recommends that the SCAF be closed down and its computer moved to the CMC. This action should result in the saving of $3 million over a 5-year period and the added availability of 65 military personnel with critical skills. The advantages of locating the computers in one place are manifold; the only disadvantage is that a catastrophic failure of the CMC would leave NORAD with no instantaneous-response backup. The Group concludes that adequate emergency backup can be provided by either the SPASUR Center or the AN/FPS-85 (when it becomes operational). Both facilities have standby computers that can be preempted for this purpose. In an emergency, communications from the various centers to the backup site could be established quickly, especially if commercial teletype lines were used. Secure transmissions would not be needed, and the total time lost might be only minutes. This type of backup is satisfactory enough that special standby computers, crews and communications are not justified.

Personnel: Not directly relating to the computer problem, though tied to the movement of SPADATS functions to the Space Defense Center in the CMC, are the personnel requirements for the SDC's operation. Currently there is a NORAD proposal to add 94 spaces to the NORAD complement, amounting to a total of 102 people performing those functions. The proposal does not address personnel requirements of the component commands for space defense operations, which now involve 104 ADC personnel for SPACETRACK and an additional 82 ADC support personnel for equipment operation and maintenance of the computer and communications center at the Group I facility.

Based on observation of SPADATS' present excellent performance, the Group is led to the conclusion that current manning levels are adequate for present and future operations. Thus, the problem of SDC manning must be addressed as an entity; it is a matter of deciding which current functions and associated personnel should be assigned to the NORAD staff to carry out their operational responsibilities and which should go to the component commands to ensure optimum systems integrity.

3. R&D Plans

An objective of the DATOS Group in its investigation of R&D efforts was to determine which areas are properly directed by a system project office and which are more technologically oriented and should be transferred to exploratory development. The Group concludes that, as a general rule, R&D programs belonging under project-office management are either (1) equipments and developments whose near-future use in the system is highly probable or (2) equipments whose immediate use is not highly probable but whose usage is appropriate only to the SPADATS problem. All other R&D efforts would be more properly transferred to ARPA or to the exploratory research programs of the development centers.

On this basis, the two major R&D programs discussed here—AN/FPS-85 and AN/FSR-2—should remain with the project office. Another experimental program associated with SPACETRACK is the ASFIR (Active Swept-Frequency Interferometer

Radar), an in-house project of the Rome Air Development Center (RADC). This FM-pulse radar uses long base lines to triangulate in range on targets, with the object of getting very accurate position and position-rate data. The utility of such accuracy levels in space-surveillance systems is not clear at this time; further, incorporating ASFIR into SPADATS would require a completely new set of sensors. For this reason, the DATOS Group recommends that the ASFIR program be placed in exploratory development at RADC.

Almost all R&D in space-object identification is now sponsored by ARPA. The incorporation of any of these efforts into SPADATS should await results of the recommended SOI study. At this time, the Group foresees no other large-scale R&D programs under SPADATS management.

SPECIFIC RECOMMENDATIONS

(1) The Air Force should be asked to prepare and submit plans for removing limitations on detection coverage and tracker availability at BMEWS Site III (Fylingdales). This should include the addition of extra Doppler filters and any modifications of agreements with the United Kingdom that will permit greater operating freedom without compromising the primary mission of Site III.

(2) A third computer for the Cheyenne Mountain Complex should be approved. NORAD and the Air Force should be requested to prepare plans for rearranging SPADATS' computational facilities and revising backup procedures as follows:

(a) Close the SPACETRACK Center Alternate Facility at Hanscom Air Force Base.

(b) Use the computer now at the SCAF as the extra computer for Group III, Cheyenne Mountain Complex.

(c) Until the AN/FPS-85 becomes available, back up the CMC, in the event of its catastrophic failure, through standby plans for using the SPASUR computers for catalog and weapon-system support. Beyond that time, backup plans should be coordinated with the study on the integration of SPASUR with the AN/FPS-85 (see recommendation 5).

This recommendation is based on the projected work load, on the efficiency in operation and in developing new programs that can be achieved by doing the work at one place, and on the need for backup only in the case of such "natural" catastrophes as fire. This backup need not be instantaneous but could take several hours to become operational.

(3) The Air Force should be directed to continue with plans for rebuilding the AN/FPS-85, in the same location (Eglin Air Force Base) and with the planned improvements, for eventual delivery to SPADATS. This will provide increased performance; SPADATS operating efficiency will be improved and operating costs reduced as a result of shutting down other sensors (see recommendation 4).

(4) The Air Force should be directed to prepare plans for the following actions to be taken after the AN/FPS-85 becomes operational:

- (a) Eliminate SPADATS' support [redacted]
- (b) Close down the AN/FPS-49 tracker at Moorestown.
- (c) Establish standby plans for using the AN/FPS-85 computers as backup to the Space Defense Center.
- (d) Coordinate plans with the study on the integration of the AN/FPS-85 and SPASUR.

(5) The SPASUR network should be retained in SPADATS by being integrated with the AN/FPS-85 (after that radar becomes operational) to provide a high-altitude detection and tracking mode of operation and to enhance the traffic capacity of the AN/FPS-85. Further, consideration should be given the question whether to move SPASUR headquarters from Dahlgren to Eglin Air Force Base. The Joint Chiefs of Staff should be asked to study the integration of SPASUR and the AN/FPS-85 and to decide where SPASUR headquarters should be located.

(6) The Air Force should be directed to submit a detailed plan for concluding R&D on the AN/FSR-2 so as to offer a long-range detection capability if it is ever needed.

(7) The Air Force should be directed to transfer responsibility for the ASFIR program from the 496L Project Office to the Rome Air Development Center, where it should be placed in exploratory development.

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(8) The Air Force should be directed to eliminate the dual-routed overseas communications line [redacted] because alternate facilities can be set up quickly.

(9) The Advanced Research Projects Agency should be asked to study the potential of ground-based radars in identifying satellites by their radar signatures. The study should delineate the amount of improvement over present techniques that may be expected and should give an approximate idea of related equipment requirements.

(10) The Director of Defense Research and Engineering should be requested to investigate the work load imposed on SPADATS by Air Force special-mission satellites and to recommend the most appropriate sensor system for handling the load.

(11) NQR 2-65 should be disapproved as a basis for development, procurement or operational changes in currently programed capabilities; and the Joint Chiefs of Staff should be asked to return NQR 2-65 to NORAD with instructions to prepare a new set of requirements based on the national intelligence estimates, valid uses of space data, national policy and other factors outlined in this report. Especially, any new requirements not only should be identified by time period but should be quite specific in regard to limiting conditions and the particular deficiency or threat prompting the statement of need. The JCS should also be requested to review the scope of NORAD's mission, particularly with respect to deep-space probes.

(12) The Joint Chiefs of Staff should be requested to instruct NORAD to resolve manning problems at the Cheyenne Mountain Complex by treating the matter as an integrated whole, working on the basis of current manning levels, and considering the needs of both NORAD and ADC.

1. INTRODUCTION

In the summer of 1964, an ad hoc working group was organized to study the overall effort of the Department of Defense (DoD) in space detection, surveillance, tracking and data processing. For convenience, it is called the DATOS (Detection and Tracking of Satellites) Group. By memorandum of the Deputy Secretary of Defense, dated 22 July 1964 (Appendix A), the DATOS Group was authorized—

> ... to review the DoD Space Detection, Surveillance and Tracking Systems for the purpose of determining their capability, adequacy, redundancy, and efficiency—both current and programmed—for accomplishing their primary missions....

Further,

> ... the group will recommend policy and guidance relating to suitable reductions and consolidations, resource allocation and organization of the affected systems, with a particular view towards their operation as a coordinated program.

At this point in time, such a review is both necessary and complex. It is necessary because a number of development programs directed toward gathering and disseminating space-surveillance data are complete (or are nearing completion), and technical capabilities for space surveillance are fairly well understood. Judgments must be made on establishing the programs that contribute most effectively to the attainment of national goals. The review is complex because the technical potential for space surveillance is large and because it is hard to identify Defense needs for space surveillance in the future. It is also complicated by the fact that there is a wide gamut of relevant issues, ranging from such broad topics as space policy and utility of data to specific issues such as the future of a particular sensor or the manning of a command and control center. An additional complication was injected into the review by the destruction of the AN/FPS-85 radar at Eglin Air Force Base, Florida, in January 1965.

1.1 DoD Space-Surveillance (DATOS) Facilities

For purposes of this report, DATOS facilities are considered as including all ground-based sensors, communications, computers and control centers that are used by—or are available to—the DoD to collect, analyze and disseminate data on orbiting space objects.

The primary systems are—

(1) the NORAD SPADATS (North American Air Defense Command Space Detection and Tracking System), composed of the Navy SPASUR (Space Surveillance System) and the Air Force SPACETRACK, and

(2) the Intelligence Sensor Network.

Contributing sensors are the USAF Satellite Control Facility (SCF), certain DoD test-range and R&D (research and development) radars and the various sensors of the National Aeronautics and Space Administration (NASA) when they are used under the NASA-DoD agreement (see Appendix D).

The DATOS Group interpreted its charter to include all DoD ranges, sensors and supporting facilities but concentrated its efforts on the primary systems.

Since 1958, space-surveillance systems have evolved from the early Moonwatch and Minitrack along several lines; the primary sensors are now microwave radars with supplemental inputs from optical devices. SPASUR was specifically designed for space surveillance, while SPACETRACK has been assembled from sensors originally acquired for other purposes.

Normally, control of SPASUR and SPACETRACK is exercised by the NORAD SPADATS Control Center at Ent Air Force Base, Colorado, while the Defense/Special Missile Analysis Center (DEF/SMAC) at Fort Meade, Maryland, controls the Intelligence Sensor Network. The contributing sensors generally have their own control centers. All control centers have access to extensive communication nets and exchange data on a routine basis.

1.2 Organization and Operation of DATOS Group

The DATOS Group was organized under its chairman, Mr. Daniel J. Fink, Office of the Director of Defense Research and Engineering (ODDR&E). The members include representatives of the Office of the Secretary of Defense (OSD), the Joint Chiefs of Staff (JCS) and other DoD components. (A list of the Group's membership and the official observers, showing the organizations represented, is given on page ii of this report.)

After its first, organizational meeting, the Group held other meetings at which interested parties presented their views and answered specific questions. In addition, members of the Group visited a number of installations to gather first-hand impressions and detailed data in areas of special interest.

The DATOS Group received information from NORAD, the Military Departments, the JCS, the Defense Intelligence Agency (DIA), the Defense Communications Agency (DCA) and the National Security Agency (NSA) on present and planned systems and on current and projected uses of space-surveillance data. Information was also obtained from NASA on its space operations, sensor capabilities and plans for the future. NASA's plans, however, were considered primarily for information on the potential use of facilities under the DoD-NASA agreement, not as being within the scope of the Group's charter.

1.3 Review Procedure and Report Outline

The raw material used in the DATOS review falls into three major categories:

(1) details on existing and planned facilities, summarized in section 2;

(2) stated needs for space-surveillance data and related actions taken, which are discussed in section 3; and

(3) potential Soviet space operations, discussed in section 4.

Results of the DATOS study are presented in section 5.