# Defense Science Board
# Task Force
on
# SATELLITE RECONNAISSANCE


## January 1998

**Office of the Secretary of Defense**
**Washington D. C. 20301-3140**

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OFFICE OF THE SECRETARY OF DEFENSE
3140 DEFENSE PENTAGON
WASHINGTON, DC 20301-3140

'ENSE SCIENCE
BOARD

3 Feb 98

MEMORANDUM FOR UNDER SECRETARY OF DEFENSE (ACQUISITION & TECHNOLOGY)

SUBJECT: Defense Science Board (DSB) Task Force Report on Satellite Reconnaissance.

I am pleased to forward the final report of the DSB study on Satellite Reconnaissance. The Chairman, Dr. Robert Hermann, and the Vice-Chairman, Gen Larry Welch, USAF (Ret), established their team and reviewed both the Future Imagery Architecture (FIA) and the Surveillance and Targeting Light Satellite (Starlite) System. Their review included the operational, technical, industrial, and financial aspects of these NRO and DARPA initiatives.

The Task Force arrived at five major recommended actions for the Department. As they constructed these recommended actions, they also accounted for the different points of view between those involved. Their major conclusions are:

- The FIA must proceed on schedule to provide next generation systems and FIA program decisions should be decoupled from Starlite program decisions.
- The objectives of Starlite are an appropriate basis for investment.
- The FIA should accommodate some of the Starlite attributes.
- The DOD should create a Military Space Radar Surveillance Program.
- The future roles and relationships of defense organizations need to evolve to support future military operations.

I support these findings and recommend you forward the report for appropriate action and distribution.

Craig I. Fields
Chairman

OFFICE OF THE SECRETARY OF DEFENSE
3140 DEFENSE PENTAGON
WASHINGTON, DC 20301-3140

DEFENSE SCIENCE
BOARD

January 20, 1998

MEMORANDUM FOR THE CHAIRMAN, DEFENSE SCIENCE BOARD

SUBJECT: Defense Science Board Report on Space Surveillance

The attached Report on Space Surveillance is forwarded in response to the tasking Terms of Reference dated 23 September 1997. The study was requested by Directors of DARPA and NRO to review the operational, technical, industrial and financial aspects of NRO's Future Imagery Architecture (FIA) effort and DARPA's proposal to demonstrate a space radar surveillance system (Starlite).

The report makes several recommendations:

- FIA must proceed on schedule with next generation systems and FIA program decisions should be decoupled from Starlite program decisions. FIA comes from a mature process that must provide a high confidence path to providing for identified needs of the Nation and the Department. Starlite is a much more speculative proposal involving questions of technical risk, product value and cost. It should be judged on its own merit as an advanced technology program.

- The objectives of Starlite are an appropriate basis for investment. Future military operations will need the combination of day, night and all-weather access, the rapid revisit of imagery and broad-area, moving-target surveillance represented by this proposal. Achieving these objectives is best achieved through the proliferation of low-orbit satellites that must and can be greatly reduced in cost from past practices.

-The FIA should accommodate some of the attributes emphasized in the Starlite proposal including increased application of MTI and reduced revisit times, reduced classification of systems and product information and increased attention to integrating FIA systems with military operations.

- The Department of Defense should undertake a program to create a Military Space Radar Surveillance Program targeted to achieve broad-area, all-weather and near continuous radar access for integration with military operations.

- The future roles and relationships of defense organizations need to evolve for these missions. The treatment of roles and missions is of particular interest because the report recommendations require some evolution of relationships among the NRO, Military Departments and Joint Military Organizations.

Bob Hermann

Dr. Robert J. Hermann
Task Force Chairman

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# DEFENSE SCIENCE BOARD REPORT
# ON
# SATELLITE RECONNAISSANCE

## Introduction

The National Reconnaissance Office (NRO) is in the process of creating a Future Imagery Architecture (FIA) as a basis for acquiring the next generation of imaging satellite systems and their associated ground control and processing. At the same time, Defense Advanced Research Projects Agency (DARPA) is advocating demonstrating a space radar surveillance system (Starlite) incorporating advanced and higher risk technologies with cost and performance attributes that could have future application to the FIA. The Directors of DARPA and NRO have asked that a Defense Science Board (DSB) Task Force be established to review the operational, technical, industrial and financial aspects of each of these initiatives and recommend a course of action for the Department.

The Task Force membership is shown in Appendix B. It includes six members that also served on the Small Satellite Group convened by the Director of Central Intelligence in 1996 to review FIA approaches and alternatives.

The Task Force received a series of briefings from DARPA, NRO, National Imagery and Mapping Agency (NIMA), Air Force, and the Joint Staff. These briefings addressed plans for both sets of systems, the state of requirements definition, and the status of the existing inventory. The issues raised involve resource decisions, military operational concept choices and matters of roles and missions of the Military Departments and several agencies.

### How the Players See the Issues

While the following viewpoints were not explicitly presented to the Task Force, we believe they reasonably represent important viewpoints and also define the fundamental issues that need resolution.

### An NRO Point of View

The NRO is developing, acquiring and operating Satellite Reconnaissance Systems that respond to the needs expressed by the DCI, the Secretary of Defense, the National customer, and the warfighter customer. The NRO is supporting the research and development necessary to achieve that objective. These systems are critical to the security of the U.S. Hundreds of decision makers and thousands of analysts depend on their product. The current inventory of imaging satellites has a finite life and the next generation is needed to assure the continued availability of essential products. The NRO has conducted extensive trade-off studies to define the architecture of the next generation system, its system attributes and the process by which it will be acquired. An elaborate process is in use for the government to define requirements to be satisfied by the new set of systems. This process has matured to the point of an approved draft statement of requirements. The acquisition process is well on its way to

definition. The NRO believes the result is an objective architecture as modern and enlightened as the Department of Defense has ever undertaken.

The NRO is in the middle of a demanding task, already strained in resources and schedule and the proposal by DARPA to design and build a radar satellite system could be seen as troublesome in several aspects:

-The proposal could be perceived as competing with a segment of the FIA without any reference to the requirements rigor associated with the FIA program or a defined relationship with the rest of the FIA system. Further, the Starlite approach is higher risk than NRO considers prudent given the need for continuity in providing needed reconnaissance products. The Director of DARPA has stated clearly it is not in competition since Starlite is on a riskier and longer term path.

-This perception of competition is complicated by a potential future conflict between the role of the NRO and Air Force plans for future migration of key surveillance and reconnaissance capabilities from aircraft to spacecraft. The image of satellite based JSTARS and AWACS are projected as examples. The Starlite program has been presented as a candidate approach to meeting some future mission needs with emphasis on an "operational" vice "intelligence" role. With this formulation, it is likely that the Air Force would expect to be the follow on procurement agency after a successful demonstration.

Starlite appears to need several hundred million for a two satellite demonstration. The NRO fears that they might be the bill payer although they are already short of the amount they think will be required to put FIA in place on the required schedule.

A DARPA Point of View

DARPA has a responsibility to introduce advanced technologies, techniques and concepts into the Department's process for creating armed forces. It has done so for decades with notable successes to their credit. Up to now, there has been little or no DARPA involvement in the satellite reconnaissance business since NRO has been regarded as the cradle-to-grave custodian of that segment of the Department's business to include pushing the kind of innovation that has characterized DARPA's contributions to other force capabilities. DARPA sees, that as NRO has matured and become more focused on evolutionary improvements to satisfy their customers, there is a need for the DARPA approach to help introduce more revolutionary (and higher risk) technologies and concepts. The technologies incorporated in the Starlite program makes it high risk and an on-orbit demonstration of the capabilities is part of the necessary risk reduction.

In particular, Starlite has the potential to demonstrate several important attributes:

- The operational value of nearly continuous access. Precision weapons require precision sensors to support their potential leverage. The availability of nearly continuous, precise and rapidly reported target information would provide for a major advance in military operations and support the U.S. objectives of information and battlefield dominance.

- Reduced cost of ownership. By exploiting emerging technologies and the industrial process in place or being created, DARPA believes it can design and demonstrate system capabilities to provide nearly continuous access at an affordable cost.

- Easier access by combat units. DARPA believes that by using direct downlink access to combat units without security classification constraints, a potential revolution in capability can be achieved.

- Enabling International cooperation. The unclassified, operational attributes of a systems such as Starlite would be a useful vehicle for engaging Allies in cooperating in satellite reconnaissance. Depending upon one's view of this prospect, it could provide both resource and political leverage for the United States.

Part of DARPA's responsibility is to put forward new technologies and concepts where they see high value added potential. Starlite is representative of the revolutionary programs that DARPA has moved forward in the past with great success and the potential of this approach should not be bureaucratically constrained.

An Air Force Point of View

The Air Force has recently made a corporate judgment that important surveillance and reconnaissance functions which it now addressees in its Title X responsibilities to organize, equip and train Air Forces should be migrated to spacecraft. The family of current and planned aircraft systems that address these needs have significant limitations that can be addressed by migrating some of these capabilities to satellite systems.

The Air Force believes that as these missions are migrated to spacecraft they will be responsible for acquisition and operation of these systems. While it recognizes that the satellite as a military sensor evolved from use in intelligence activities, the maturity of the technologies and the evolution of precision, remotely operated weaponry dictates that space sensors now become fully integrated into the operational military systems and culture.

Starlite promises significant characteristics of what the Air Force considers to be needed in an operational system. It provides near continuous access, direct and timely reporting for the purposes of supporting targeting, and freedom from burdensome intelligence community security classifications and handling procedures. It can be very much like a JSTARS in operational concept without the range and shadowing problems and without the operational and logistics footprint of a multi-aircraft system.

**Task Force Assessment**

There is merit in each of the three view points described. The following presents the Task Force perspective and set of recommended actions that we believe accounts for the merit in each of the preceding viewpoints and that can help avoid the expense and bureaucratic acrimony that might result if they are not treated carefully.

The major conclusions of the Task Force are:

1. FIA Must Proceed on Schedule With Next Generation Systems.

The FIA program and the process that produced it will provide improved capabilities while balancing cost, risk and performance for achieving the next generation of space systems. Its development is integrated into the Department of Defense decision process and the transparency of its creation is as complete as ever achieved for an NRO system. Its schedule is already strained and should not be subjected to the substantially increased risks associated with the Starlite system.

FIA program decisions should be decoupled from Starlite program decisions. FIA comes from a mature process that must provide a high confidence path to providing for identified needs of the Nation and the Department. Starlite is a much more speculative proposal involving questions of technical risk, product value and cost. It should be judged on its own merit as an advanced technology program. It is higher risk than is appropriate for the next generation systems that will make up FIA and is not competitive with the next generation FIA.

2. The Starlite System Objectives Are Important For Military Operations.

The Task Force believes the objectives of Starlite are an appropriate basis for substantial investment. We believe that future military operations will need the combination of day, night and all-weather access, the rapid revisit of imagery and broad-area, moving-target surveillance represented by this proposal.

We agree that achieving these objectives is best achieved through the proliferation of low-orbit satellites. We also agree that, of necessity, they must and can be greatly reduced in cost from past practices. Finally, we agree that major effort and design is needed to integrate these space systems into military force structures, weapons systems and on-going military operations.

3. FIA Should Be Open to Some Starlite Attributes.

The FIA should accommodate some of the attributes emphasized in the Starlite proposal. In particular;

-Increased consideration should be given to achieving Moving Target Indicator (MTI) and rapid revisit image coverage on an evolutionary schedule.

-The fact of FIA systems should be unclassified and their essential operating characteristics should be held no higher than SECRET. There may become aspects of each program that should be more closely held but that is achievable without incurring the hindrance to operations imposed by the strong propensity for excessive classification. The data output from FIA should be at SECRET classification or lower consistent with policy makers' and users' needs to protect knowledge of what is being imaged.

-NIMA, NRO, The Military Departments and the Joint Staff should focus particular attention on integrating FIA systems with military operations. It is our judgment that a formal program that addresses operational concepts, system architecture modifications, and the application of new technologies should be organized. An important aspect of such a program will need to be education, training and exercise participation

4. A Modified Starlite Program Should be Initiated.

The Task Force recommends that the Department of Defense undertake a program to create a Military Space Radar Surveillance Program targeted to achieve broad-area, all-weather and near continuous radar access for integration with military operations. We recommend that this program proceed with the following considerations:

-The program should be designed to bring leading edge, higher risk, technologies to provide needed capabilities (sensing, processing, distribution) to meet warfighters' needs at lower cost. Accordingly, a technical risk reduction program should be planned and executed. The program should make appropriate use of existing and planned space systems, airborne systems and laboratory investigation. An on-orbit demonstration system is likely to be needed to complete the risk reduction program but, there are significant risk reduction efforts that need to precede the on-orbit system so that the system definition is more mature and can lead more directly to an operational prototype.

-The primary purpose of this system would be to support on-going military operations and its design must emphasize integration with combat force systems. The Task Force believes this argues for an eventual acquisition, organization and training role for the Air Force under its normal Title X responsibilities. Likewise, DARPA should be expected to play its normal role as a source of innovation in military system capabilities. The NRO will need to participate during this transition phase because of its historical role, its access to space reconnaissance systems competence and the operational interaction between NRO systems application and this new military system.

5. The Future Roles and Relationships of Defense Organizations Need to Evolve for These Missions.

The Task Force believes that much of the intensity of differences involved in this issue can be traced to the structural deficiencies in the assignment and execution of roles and missions in this increasingly important area of intelligence, reconnaissance and surveillance in support of military operations.

We believe that adjustments must be made to avoid continuing and debilitating struggles for turf for the foreseeable future. Accordingly, the Task Force offers the following recommendations:

-The NRO should continue as the acquiring and operating organization for satellite sensor systems that are acquired primarily for intelligence and strategic reconnaissance purposes. These systems will naturally migrate to increasing attributes of real-time and precision and will have very important capabilities for supporting military operations. These capabilities should be exploited fully in support of military operations as priorities demand. This calls for increasingly close cooperation between the NRO and the Military Departments in serving the Warfighter's needs as these systems evolve.

-The Military Departments should transition to an increased role in space sensor systems that are acquired primarily for the purpose of support to on-going military operations and there is a premium for integration with other weapon systems and military force operations. We believe the Air Force is the logical Department to accept Title X responsibility for the Military Space Radar Surveillance Program after DARPA has brought the technologies to an acceptable level of risk. These systems will inevitably have attributes that will be very important to the intelligence agencies of the Nation. These systems should also be exploited to serve intelligence needs. Close cooperation between the Military Departments and the NRO is needed to ensure the highest return from development efforts and operational employment.

-The Secretary of Defense and the Director of Central Intelligence will need to give special attention to preventing unnecessary redundancy and exploiting the complementary value of the systems created in response to these differing motivations.

-DARPA should continue to press innovation, and advanced technologies, techniques and concepts into the Department's process for creating armed forces in this area as it has done for decades in many other areas with notable success. The objectives outlined for Starlite are worthy of their attention and investment. The Task Force believes it would be appropriate for DARPA to take the lead responsibility for the risk reduction phase of the Military Space Radar System Program. We also believe that DARPA has much to offer in the processing and exploitation segment of these mission areas.

-NIMA must increase its ability to assure effective integration of operational and intelligence oriented space and airborne imagery systems. Since all of these systems will have some similar characteristics and will be capable of multiple applications, there is increased danger of real and apparent overlap and duplication of resources as well as unwarranted restriction of use. It is imperative that NIMA perform its role of rationalizing needs, creating systems and procedures for processing and exploitation, and insuring their proper application to multiple purposes.

-The Joint Staff should continue to develop its system decision process for these mission areas. The Task Force was impressed with the progress reported by J8 in developing a decision for surveillance and reconnaissance capabilities that engaged the system developers, Services, and CINC staffs. The success achieved with the Space Based Infrared (SBIR) System decision and the progress projected for FIA using the Senior Warfighters Forum is impressive. In our view, forcing the operational users and the system advocates into the same venue where resource constraints and military value can be evaluated together is a superior way to make the necessary trades for the Nation.

# APPENDIX A

# TERMS OF REFERENCE

THE UNDER SECRETARY OF DEFENSE
3010 DEFENSE PENTAGON
WASHINGTON, D.C. 20301-3010

SEP 2 3 1997

ACQUISITION AND
TECHNOLOGY

MEMORANDUM FOR CHAIRMAN, DEFENSE SCIENCE BOARD

SUBJECT: Terms of Reference - Defense Science Board Task Force on Satellite Reconnaissance.

You are requested to establish a Defense Science Board Study Task Force on satellite reconnaissance. The National Reconnaissance Office (NRO) is creating a Future Imagery Architecture as a basis for acquiring the next generation of imaging satellite systems and their associated ground control and processing. In parallel, DARPA is advocating the development and demonstration of a Surveillance and Targeting Light Satellite (Starlite) System with attributes that may not be included in NRO's architecture. The Directors of DARPA and NRO have asked that a Defense Science Board Task Force be established to review the operational, technical, industrial, and financial aspects of each of these initiatives and recommend a course of action for the Department.

The Task Force will be sponsored by USD(A&T). Director, DARPA and Director, NRO will provide funding and other support as may be necessary. Dr. Robert J. Hermann will be the Task Force Chairman and General Larry D. Welch, USAF (Ret) will be the Task Force Vice-Chairman. Captain David E. Swanson, from the NRO will be the Task Force Executive Secretary. Maj. Wynne Waldron, will be the Defense Science Board Secretariat Representative. A final briefing report is requested by 1 January 1998.

The Task Force will be operated in accordance with the provisions of P.L. 92-463, the "Federal Advisory Committee Act," and DOD Directive 5105.4, the "DOD Federal Advisory Committee Management Program." It is not anticipated that this Task Force will need to go into any "particular matters" within the meaning of Section 208 of Title 18, U.S. Code, nor will it cause any member to be placed in the position of acting as a procurement official.

R. Noel Longuemare
Acting Under Secretary of Defense
(Acquisition and Technology)

# APPENDIX B

# MEMBERSHIP

## MEMBERSHIP

## DEFENSE SCIENCE BOARD TASK FORCE

## ON

## SATELLITE RECONNAISSANCE

### CHAIRMAN

Dr Robert Hermann *
United Technologies Corporation

### VICE-CHAIRMAN

General Larry Welch, USAF (Ret) *
Institute for Defense Analysis

### MEMBERS

Mr Richard Brandes @
Private Consultant

Mr William P. Delaney #
MIT Lincoln Laboratory

Mr Martin C. Faga @
MITRE Corporation

General Ralph H. Jacobson, USAF (Ret) #
Charles Stark Draper Laboratory

Dr Edward Stone #
Jet Propulsion Laboratory

Mr Howard K. Schue @
Technology Strategies & Alliances Corporation

**Executive Secretary**

Capt David Swanson, USAF

**DSB Executive Secretary**

Maj Wynne Waldron, USAF
OUSD(A&T)/DSB

* DSB Member
\# Approved Consultant
@ Not Yet Approved DSB Consultant

USD(A&T) Approved

7/8/97
Date

Chief of Staff for SecDef

9-22-97
Date