*Report of the*
*Defense Science Board/*
*Air Force Scientific Advisory Board*
*Joint Task Force*
**on**

# Acquisition of National Security Space Programs

May 2003

*Office of the Under Secretary of Defense*
*For Acquisition, Technology, and Logistics*
*Washington, D.C. 20301-3140*

# Report Documentation Page

*Form Approved*
*OMB No. 0704-0188*



| 1. REPORT DATE | 2. REPORT TYPE | 3. DATES COVERED |
|---|---|---|
| **MAY 2003** | **N/A** | **-** |

| 4. TITLE AND SUBTITLE | 5a. CONTRACT NUMBER |
|---|---|
| **Report of the Defense Science Board/Air Force Scientific Advisory Board Joint Task Force on Acquisition of National Security Space Programs** | 5b. GRANT NUMBER |
| | 5c. PROGRAM ELEMENT NUMBER |
| 6. AUTHOR(S) | 5d. PROJECT NUMBER |
| | 5e. TASK NUMBER |
| | 5f. WORK UNIT NUMBER |
| 7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Office of the Undersecretary of Defense for Acquisition, Technology and Logistics Washington, DC 20301-3140** | 8. PERFORMING ORGANIZATION REPORT NUMBER |
| 9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) | 10. SPONSOR/MONITOR'S ACRONYM(S) |
| | 11. SPONSOR/MONITOR'S REPORT NUMBER(S) |

12. DISTRIBUTION/AVAILABILITY STATEMENT
**Approved for public release, distribution unlimited**

13. SUPPLEMENTARY NOTES
**The original document contains color images.**

14. ABSTRACT

15. SUBJECT TERMS

| 16. SECURITY CLASSIFICATION OF: | | | 17. LIMITATION OF ABSTRACT | 18. NUMBER OF PAGES | 19a. NAME OF RESPONSIBLE PERSON |
|---|---|---|---|---|---|
| a. REPORT | b. ABSTRACT | c. THIS PAGE | | | |
| **unclassified** | **unclassified** | **unclassified** | **UU** | **82** | |

This report is a joint product of the Defense Science Board (DSB) and Air Force Scientific Advisory Board (AFSAB). The DSB is a Federal Advisory Committee established to provide independent advice to the Secretary of Defense. The AFSAB is a Federal Advisory Committee which provides a link between the Air Force and the nation's scientific community. Statements, opinions, conclusions, and recommendations in this report do not necessarily represent the official position of the U.S. Air Force or the Department of Defense.

**This report is UNCLASSIFIED.**

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

DEFENSE SCIENCE
BOARD

MEMORANDUM FOR UNDER SECRETARY OF DEFENSE (ACQUISITION, TECHNOLOGY & LOGISTICS)

SUBJECT: Final Report of the Defense Science Board (DSB) Task Force on Acquisition of National Security Space Programs

We are pleased to forward the final report of the DSB Task Force on Acquisition of National Security Space Programs. The Task Force was chartered by the Under Secretary of Defense (ATL), Secretary of the Air Force, and Undersecretary of the Air Force/Director of the NRO. It was asked to investigate systemic issues related to space systems acquisition, to include all aspects from requirements definition and budgetary planning through staffing and program execution; and to recommend improvements to the acquisition of space programs from initiation to deployment.

Over the course of this study, the members of this team discerned profound insights into systemic problems in space acquisition. Their findings and conclusions succinctly identified requirements definition and control issues; unhealthy cost bias in proposal evaluation; widespread lack of budget reserves required to implement high risk programs on schedule; and an overall underappreciation of the importance of appropriately staffed and trained system engineering staffs to manage the technologically demanding and unique aspects of space programs. This task force unanimously recommends both near term solutions to serious problems on critical space programs as well as long-term recovery from systemic problems.

This report highlights our nation's dependence on space assets to perform our national security mission and delineates appropriate remedies for a strategic recovery to US National Security Space programs. I endorse all of the Task Force's recommendations and propose you forward the report to the Secretary of Defense.

Given the significance of this report, the task force should reconvene in approximately one year to review the progress of the corrective actions.

Dr. Daniel E. Hastings
AFSAB Chairman

Dr. William Schneider, Jr.
DSB Chairman

Defense Science Board
DSB
Department of Defense

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

DEFENSE SCIENCE
BOARD

MEMORANDUM FOR CHAIRMAN, DEFENSE SCIENCE BOARD

SUBJECT: Final Report of the Defense Science Board/Air Force Scientific Advisory Board Joint Task Force on Acquisition of National Security Space Programs

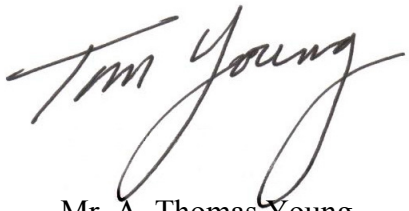
Attached is the final report of the Defense Science Board/Air Force Scientific Advisory Board Joint Task Force on Acquisition of National Security Space Programs. The task force was chartered by the Under Secretary of Defense (ATL), Secretary of the Air Force, and Undersecretary of the Air Force/Director of the NRO to review the acquisition of national security space programs, identify and characterize systemic problems, and recommend improvements. Additionally, we were tasked to review the current status of three specific programs: the Space-Based Infrared System (SBIRS) High, the Future Imaging Architecture (FIA), and the Evolved Expendable Launch Vehicle (EELV).

Recent operations have once again illustrated the degree to which U.S. national security depends on space capabilities. We believe this dependence will continue to grow, and as it does, the systemic problems we identify in our report will become only more pressing and severe. Needless to say, the final report details our full set of findings and recommendations. Here I would simply underscore four key points:

1. *Cost has replaced mission success as the primary driver in managing acquisition processes, resulting in excessive technical and schedule risk.* We must reverse this trend and reestablish mission success as the overarching principle for program acquisition. It is difficult to overemphasize the positive impact leaders of the space acquisition process can achieve by adopting mission success as a core value.
2. *The space acquisition system is strongly biased to produce unrealistically low cost estimates throughout the acquisition process. These estimates lead to unrealistic budgets and unexecutable programs.* We recommend, among other things, that the government budget space acquisition programs to a most probable (80/20) cost, with a 20–25 percent management reserve for development programs included within this cost.
3. *Government capabilities to lead and manage the acquisition process have seriously eroded*. On this count, we strongly recommend that the government address acquisition staffing, reporting integrity, systems engineering capabilities, and program manager authority. The report details our specific recommendations, many of which we believe require immediate attention.

4. *While the space industrial base is adequate to support current programs, long-term concerns exist*. A continuous flow of new programs—cautiously selected—is required to maintain a robust space industry. Without such a flow, we risk not only our workforce, but also critical national capabilities in the payload and sensor areas.

The task force would like to express its appreciation to all those who contributed their knowledge, insights, and hard work to this effort.



Mr. A. Thomas Young
Chairman

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# 1.0 EXECUTIVE SUMMARY

The Undersecretary of Defense (Acquisition, Technology, and Logistics) and the Secretary of the Air Force cosponsored the Joint Defense Science Board (DSB)/Air Force Science Advisory Board (AFSAB) Task Force on the Acquisition of National Security Space Programs and directed the task force to

- Recommend improvements to the acquisition of space programs from initiation to deployment;
- Assess the nation's dependency on space;
- Characterize problems by looking at underlying causes and systemic issues such as cost growth and schedule delays that impact all space programs; and
- Analyze the Space-Based Infrared System (SBIRS), Future Imaging Architecture (FIA), and Evolved Expendable Launch Vehicle (EELV).

Over the course of its deliberations, the task force met with responsible representatives of acquisition- and operation-oriented government organizations, visited national security space contractors, and reviewed a broad spectrum of space programs and issues. The panel also interviewed senior government and industry officials, both active and retired. The scope of the study included both classified and unclassified space acquisition activities.

The task force conducted meetings during the latter part of 2002 and evaluated issues that have developed over years of acquisition activity. In so doing, we observed many positive steps already being taken to try to correct deficiencies in the space acquisition process. We did not attempt to investigate or evaluate initiatives that were already underway.

## 1.1 Key Findings

During the 1990s, several changes occurred in the national security space environment:

- Declining acquisition budgets,
- Acquisition reform with significant unintended consequences,
- Increased acceptance of risk,
- Unrealized growth of a commercial space market,
- Increased dependence on space by an expanding user base,
- Consolidation of the space industrial base.

All of this took place in the face of changing national security needs as the Department of Defense (DoD) transitioned from the structured cold war environment to the more global and unpredictable threat environment we see today. The following list summarizes the task force's key findings:

- *U.S. national security is critically dependent upon space capabilities* and that dependence will continue to grow. Pressing requirements exist to monitor activities and events throughout the world, transfer massive quantities of data, and project force on a global scale. As a nation, we require robust space assets to meet these requirements effectively. We rely on the current generation of operational

space systems to support national security needs on a daily basis. While nonspace systems clearly contribute major capabilities that help meet national security needs, we see no viable alternative to the unique capabilities that space systems provide.

- The task force found *five* basic reasons for the significant cost growth and schedule delays in national security space programs. Any of these will have a significant negative effect on the success of a program. And, when taken in combination, as this task force found in assessing recent space acquisition programs, these factors have a devastating effect on program success.

  1. *Cost has replaced mission success as the primary driver in managing space development programs*, from initial formulation through execution. Space is unforgiving; thousands of good decisions can be undone by a single engineering flaw or workmanship error, and these flaws and errors can result in catastrophe. Mission success in the space program has historically been based upon unrelenting emphasis on quality. The change of emphasis from mission success to cost has resulted in excessive technical and schedule risk as well as a failure to make responsible investments to enhance quality and ensure mission success. We clearly recognize the importance of cost, but we can achieve our cost performance goals only by managing quality and doing it right the first time.

  2. *Unrealistic estimates lead to unrealistic budgets and unexecutable programs*. The space acquisition system is strongly biased to produce unrealistically low cost estimates throughout the process. During program formulation, advocacy tends to dominate and a strong motivation exists to minimize program cost estimates. Independent cost estimates and government program assessments have proven ineffective in countering this tendency. Proposals from competing contractors typically reflect the minimum program content and a "price to win." Analysis of recent space competitions found that the incumbent contractor loses more than 90 percent of the time. An incoming competitor is not "burdened" by the actual cost of an ongoing program, and thus can be far more optimistic. In many cases, program budgets are then reduced to match the winning proposal's unrealistically low estimate. The task force found that most programs at the time of contract initiation had a predictable cost growth of 50 to 100 percent. The unrealistically low projections of program cost and lack of provisions for management reserve seriously distort management decisions and program content, increase risks to mission success, and virtually guarantee program delays.

  3. *Undisciplined definition and uncontrolled growth in system requirements increase cost and schedule delays*. As space-based support has become more critical to our national security, the number of users has grown significantly. As a result, requirements proliferate. In many cases, these requirements involve multiple systems and require a "system of systems"

approach to properly resolve and allocate the user needs. The space acquisition system lacks a disciplined management process able to approve and control requirements in the face of these trends. Clear tradeoffs among cost, schedule, risk, and requirements are not well supported by rigorous system engineering, budget, and management processes. During program initiation, this results in larger requirement sets and a growth in the number and scope of key performance parameters. During program implementation, ineffective control of requirements changes leads to cost growth and program instability.

4. *Government capabilities to lead and manage the space acquisition process have seriously eroded*. This erosion can be traced back, in part, to actions taken in the acquisition reform environment of the 1990s. For example, system responsibility was ceded to industry under the Total System Performance Responsibility (TSPR) policy. This policy marginalized the government program management role and replaced traditional government "oversight" with "insight." The authority of program managers and other working-level acquisition officials subsequently eroded to the point where it reduced their ability to succeed on development programs. The task force finds this to be particularly important because the program manager is the single individual (along with the program management staff) who can make a challenging space program succeed. This requires strong authority and accountability to be vested in the program manager. Accountability and management effectiveness for major multiyear programs are diluted because the tenure of many program managers is less than 2 years.

   Widespread shortfalls exist in the experience level of government acquisition managers, with too many inexperienced personnel and too few seasoned professionals. This problem was many years in the making and will require many years to correct. The lack of dedicated career field management for space and acquisition personnel has exacerbated this situation. In the interim, special measures are required to mitigate this failure.

   Policies and practices inherent in acquisition reform inordinately devalued the systems acquisition engineering workforce. As a result, today's government systems engineering capabilities are not adequate to support the assessment of requirements, conduct trade studies, develop architectures, define programs, oversee contractor engineering, and assess risk. With growing emphasis on effects-based capabilities and cross-system integration, systems engineering becomes even more important and interim corrective action must be considered.

   The government acquisition environment has encouraged excessive optimism and a "can do" spirit. Program managers have accepted programs with inadequate resources and excessive levels of risk. In some cases, they have avoided reporting negative indicators and major problems and have been discouraged from reporting problems and concerns to higher levels for timely corrective action.

5. *Industry has failed to implement proven practices on some programs*. Successful development of space programs requires strong leadership and rigorous management processes both in industry and in government. Government actions, contract provisions, and fee structures can cause industry to lose focus and can even penalize sound program implementation practices. It is of paramount importance that industry leadership assures that these programs are implemented utilizing proven management and engineering practices. The task force found instances in SBIRS and FIA where this leadership was deficient.

- *The space industrial base is adequate to support current programs, although there are long-term concerns*. Nearly every mission area in national security space is in transition, with development of an entirely new satellite system or a major block upgrade. Other major space system developments are in the formulation stage. These factors have led to concerns that the industrial base may not be adequate to support the required range of activities. The task force found that prime contractors have an adequate workforce to handle the current and near-term planned programs, and excess production capacity exists. Today, turnover of skilled work force is low and sufficient new hires are available. Second- and third-tier contractors are having problems, primarily due to low demand for the components they produce. In some circumstances, domestic capabilities required to support national security space are at risk. This will require proactive government involvement for a small number of selected cases. On balance, the industry can support current and near-term planned programs.

  Commercial space activity has not developed to the degree anticipated, and the expected national security benefits from commercial space have not materialized. The government must recognize this reality in planning and budgeting national security space programs.

  In the far term, there are significant concerns. The aerospace industry is characterized by an aging workforce, with a significant portion of this force eligible for retirement currently or in the near future. Developing, acquiring, and retaining top-level engineers and managers for national security space will be a continuing challenge, particularly since a significant fraction of the engineering graduates of our universities are foreign students.

## 1.2 Recommendations

The task force found significant, systemic problems in the acquisition of national security space systems that require immediate attention, both to correct current deficiencies and to prevent these deficiencies in future programs. The panel recommends the following *immediate actions*:

1. The Under Secretary of the Air Force/Director National Reconnaissance Office (USecAF/DNRO) should establish *mission success* as the guiding principle in all space systems acquisition. This requires incorporation of the principle in policy statements, leadership actions, and contractual provisions and incentives.

2. The SecDef should establish the same authority for the USecAF for DoD space programs as the DNRO has for implementing the National Reconnaissance Program (NRP) budget.
3. To ensure realistic budgets and cost estimates, the USecAF/DNRO should
   - Direct that space acquisition programs be budgeted to a most probable (80/20) cost, with a 20-25 percent management reserve for development programs included within this cost; also direct that reserves are not to be used for new requirements;
   - Direct that source selections evaluate contractor cost credibility and use the estimate as a measure of their technical understanding;
   - Conduct more effective independent cost estimates and program assessments and incorporate the results into the program budget and plan; and
   - Implement independent senior advisory reviews at critical acquisition milestones with experienced, respected outsiders.
4. The USecAF/DNRO should compete space system acquisitions only when *clearly* in the best interest of the government (e.g., new mission capability, major new technology, or poor incumbent performance). When a competition occurs and a nonincumbent is the winner, the loss of investment in the losing incumbent must be reflected in the program budget and plan. In addition, provisions must be made to assure continuity between the legacy system and the new system.
5. SecDef and the Director of Central Intelligence (DCI) should designate senior leaders in the DoD and intelligence community with authority to lead their respective requirements processes for national security space systems. The senior leaders must have the support necessary to assess—technically and fiscally—proposed requirements and the authority to couple requirements with funding.
6. The USecAF/DNRO should authorize the program manager to control requirements within the approved baseline. The program manager should continuously trade and challenge requirements throughout the program life cycle. Significant requirements changes should require the approval of the senior leaders for requirements.
7. The Commander, Air Force Space Command, should complete the ongoing effort to establish a dedicated career field for space operations and acquisition personnel.
8. The USecAF/DNRO should require that key program management tours be a minimum of 4 years.
9. The USecAF/DNRO should, through policy and leadership action, clearly define the responsibility, authority, and accountability for program managers, recognizing the criticality of program managers to the success of their programs. In selecting managers, acquisition experience must be a prerequisite.

10. USecAF/DNRO should develop a robust systems engineering capability to support program initiation and development. Specifically, USecAF/DNRO should
    - Reestablish organic government systems engineering capability by selecting appropriate people from within government, hiring to acquire needed capabilities, and implementing training programs; and
    - In the near term, ensure full utilization of the combined capabilities of government, Federally Funded Research and Development Center (FFRDC), and systems engineering and technical assistance (SETA) system engineering resources.
11. The USecAF/DNRO should require program managers to identify and report potential problems early.
    - Program managers should establish early warning metrics and report problems up the management chain for timely corrective action.
    - Severe and prominent penalties should follow any attempt to suppress problem reporting.
12. The USecAF/DNRO should demand that national security space contractors
    - Account for the quality of their program implementation and for mission success,
    - Identify proven management and engineering practices and ensure they are being utilized, and
    - Account for the early identification and open discussion of problems in their program.
13. Program managers should align contract and fee structure to focus industry attention on proven management and engineering practices and mission success.

## 1.3 Specific Programs

In addition to the general findings and recommendations, the task force examined three specific programs. The findings and recommendations for each are given below.

### 1.3.1 SPACE-BASED INFRARED SYSTEM (SBIRS) HIGH

*Findings*. SBIRS High has been a troubled program that could be considered a case study for how not to execute a space program. The program has been restructured and recertified and the task force assessment is that the corrective actions appear positive. However, the changes in the program are enormous and close monitoring of these actions will be necessary.

*Recommendations*. The task force recommends proceeding with the restructured program. However, the program implementation to date has been during an era of questionable program practices. The task force recommends a review of past engineering and test activities to assure acceptable quality of the product. It is critically important that a competent and complete test program be implemented for SBIRS High. This may

necessitate additional testing to mitigate omissions and embedded problems that would otherwise manifest themselves as mission critical failures on orbit. While we were impressed with the current program management, additional experienced managers are required to execute the program successfully.

### 1.3.2 FUTURE IMAGERY ARCHITECTURE (FIA)

*Findings*. The task force found the FIA program under contract at the time of the review to be significantly underfunded and technically flawed. The task force believes this FIA program is not executable.

*Recommendations*. The task force concludes that the FIA deficiencies can be mitigated sufficiently to permit the program to continue. The program funding must be augmented to reflect a most probable (80 percent) cost. Significant program and schedule changes will be required to maximize the probability of mission success. An independent review should be implemented to assess the adequacy of the restructured program. Finally, the same recommendation relative to past engineering and test activities cited for SBIRS High applies to FIA.

### 1.3.3 EVOLVED EXPENDABLE LAUNCH VEHICLE (EELV)

*Findings*. National security space is critically dependent upon assured access to space. Assured access to space at a minimum requires sustaining both contractors until mature performance has been demonstrated. The task force found that the EELV business plans for both contractors are not financially viable. Assured access to space should be an element of national security policy.

*Recommendations*. The task force recommends that the SecDef initiate actions to incorporate assured access to space into national security policy. The task force recommends that the USecAF/DNRO establish a long-term plan for the EELV program. This plan should (1) address the requirement for U.S. production of the RD-180 engine, West Coast launch, and dual manifesting; and (2) define the approach to future contracting, including any potential downselect and associated funding. The government must take funding actions beginning no later than FY04 to assure that both EELV programs remain viable.

# 2.0 CHARTER

The Undersecretary of Defense (Acquisition, Technology, and Logistics), the Secretary of the Air Force, and the Undersecretary of the Air Force/Director National Reconnaissance Office, recognized that there are significant problems in many critical National Security Space Programs resulting in significant cost growth and schedule delays. Given their programmatic concerns and recognition of the importance of the space program to the national security of our country, they concluded that the most effective way to develop a detailed understanding of the relevant issues and potential corrective actions was to establish an independent advisory group. The Joint Defense Science Board (DSB)/Air Force Scientific Advisory Board (AFSAB) Task Force on the Acquisition of National Security Space Programs was thereby established and charged with (1) reviewing the acquisition process of national security space programs from initiation to deployment and (2) recommending improvements to the acquisition process.

## 2.1 Problem Statement

Significant cost growth and schedule delays in many critical space system programs have caused senior DoD and Intelligence Community leadership to question our nation's ability to acquire and sustain national security space systems. The recent series of problems comes at a time when our nation has been growing increasingly reliant on space systems to perform military and intelligence operations. This task force was asked to characterize whether the United States is becoming too dependent on space and whether vulnerabilities arise from this dependency. In addition, the task force was charged with characterizing underlying causes and systemic issues.

## 2.2 Scope

The task force was directed to consider all aspects of the space acquisition process—including industry suppliers as well as government acquirers—and seek to understand why cost growth and schedule delays occur. In addition, the task force was to address the four interconnected sectors of the National Space Program—commercial, civil, intelligence, and military—to derive insights into such aspects as personnel issues (numbers, skills, experience, and demographics of space professionals) and the effects of corporate mergers. The task force assessment was to consider all aspects of the government's role in managing and funding space system acquisition. Finally, the task force was to recommend what industry and the government can do to address the problem. Such remedies should include both near- and long-term actions and should explain how the Air Force, as the DoD Executive Agent for Space should strategically approach current and proposed space programs, specifically the Space-Based Infrared System (SBIRS) High, the Future Imaging Architecture (FIA), and the Evolved Expendable Launch Vehicle (EELV) programs. Additionally, the task force was asked to determine if the problems identified are severe enough to necessitate scaling back additional ambitious space programs until existing programs have been confidently placed on a path toward improvement.

# 3.0 STUDY METHODOLOGY

From the outset, the task force decided on a methodology that would support a thorough investigation of the programs and processes involved. The task force began by examining previous studies, including the *Commission to Assess United States National Security Space Management and Organization*, the *Booz Allen Hamilton Space Systems Development Growth Analysis Report*, and other relevant studies as listed in appendix E. The task force reviewed a broad spectrum of space programs and issues and held reviews with national security space contractors, as well as both acquisition- and operation-oriented government organizations. Sessions were held at the following locations:

- The Pentagon,
- The National Reconnaissance Office,
- The Boeing Company,
- Lockheed Martin,
- TRW,
- Air Force Space and Missile Systems Center,
- Air Force Space Command, and
- The Aerospace Corporation.

The panel interviewed senior government officials, both active and retired. These visits and interviews were conducted in secure environments so that classified programs and issues could be fully discussed.

While conducting the review during the latter part of 2002, the task force became aware of several positive steps already being taken to try to correct deficiencies in the space acquisition process such as Air Force Space Command's planned improvements in the requirements process and SMC efforts to address its acquisition oversight. The panel commends these actions, but no attempt was made to investigate or evaluate "wet paint" on those initiatives that are already underway.

# 4.0 BACKGROUND

The high risk in the current national security space program is the cumulative result of choices and actions taken in the 1990s. The effects persist and can be described as six factors:

- Declining acquisition budgets,
- Acquisition reform with significant unintended consequences,
- Increased acceptance of risk,
- Unrealized growth of a commercial space market,
- Increased dependence on space by an expanding user base,
- Consolidation of the space industrial base.

The national security space budget declined following the cold war. However, the requirements for space-based capabilities increased rather than declining with the budget. This mismatch between available funding and diverse, demanding needs resulted in the commencement of more programs than the budget could support. Unfounded optimism translated into significantly underfunded, high-risk programs.

Acquisition reform was intended to reduce the cost of space programs, among others. This reform included reduced government oversight, less government engineering of systems, greater dependency on industry, and increased use of commercial space contributions. At the same time there was a changed emphasis on "cost," as opposed to "mission success," as the primary objective. While some positive results emerged from acquisition reform, it greatly eroded the government acquisition capability needed for space programs and created an environment in which cost considerations dominated considerations of mission success. Systems engineering was no longer employed within the government and was essentially eliminated. The critical role of the program manager was greatly reduced and partially annexed by contract staff organizations. As the government role changed from "oversight" to "insight," acquisition managers and engineers perceived their loss of opportunity to succeed, and they moved to pursue other career opportunities.

One underlying theme of the 1990s was "take more risk." The result was an abandonment of sound programmatic and engineering practices, which resulted in a significant increase in risk to mission success. A recent Aerospace Corporation study, "Assessment of NRO Satellite Development Practices" by Steve Pavlica and William Tosney, documents the significant increase in mission critical failures for systems developed after 1995 as compared to earlier systems.

The government had significant expectations that a commercial space market would develop, particularly in commercial space-based communications and space imaging. The government assumed that this commercial market would pay for portions of space system research and development and that economies of scale would result, particularly in space launch. Consequently, government funding was reduced. The commercial market did not materialize as expected, placing increased demands on national security space program budgets. This was most pronounced in the area of space launch.

During the 1990s, the community of national security space users grew from a few senior national leaders to a much larger set, ranging from the senior national policy and military leadership all the way to the front-line warfighter. On one hand, this testified to the value of space assets to our national security; on the other, it generated a flood of requirements that overwhelmed the requirements management process as well as many space programs of today.

Finally, decreases in the defense and intelligence budgets necessitated major changes in the space industry. Industry, in part to deal with excess capacity, underwent a series of mergers and acquisitions. In some cases, critical sub-tier suppliers with unique expertise and capability were lost or put at risk. Also, competing successfully on major programs became "life or death" for industry, resulting in extreme optimism in the development of industrial cost estimates and program plans.

# 5.0 DEPENDENCY ON SPACE

The task force found that the United States is critically and increasingly dependent upon space systems for the conduct of its military and intelligence operations. This dependency is both broad and deep for both military operations and national policy execution: communications; intelligence, surveillance, and reconnaissance; early warning; situational awareness; precision targeting; navigation and timing; and meteorology/oceanography. Satellite systems, in turn, depend critically upon space launch capability.

Given this dependency, it is significant that most U.S. space mission areas are currently in transition, meaning that a new system or block improvement is currently being implemented. In summary:

| System | In transition? |
|---|---|
| Early warning | Yes |
| Weather | Yes |
| Communications | Yes |
| Classified communications | No |
| Secure communications | Yes |
| Global Positioning System | Yes |
| Imagery intelligence | Yes |
| Signals intelligence | No |
| Launch | Yes |

The simultaneous execution of so many programs in parallel places heavy demands upon government acquisition and industry performers. Many of these programs have an unacceptable level of risk. The recommendations contained in this report chart a course for reducing this risk.

# 6.0 ACQUISITION SYSTEM ASSESSMENT

During the course of this study, the task force identified systemic and serious problems that have resulted in significant cost growth and schedule delays in space programs. The task force grouped these problems into five categories:

1. *Objectives*: **"**Cost" has replaced "mission success" as the primary objective in managing a space system acquisition.
2. *Unrealistic budgeting*: Unrealistic budgeting leads to unexecutable programs.
3. *Requirements control*: Undisciplined definition and uncontrolled growth in requirements causes cost growth and schedule delays.
4. *Acquisition expertise*: Government capabilities to lead and manage the acquisition process have eroded seriously.
5. *Industry*: Deficiencies exist in industry implementation.

In the following sections, each of these areas is discussed.

## 6.1 Objectives

*Findings and Observations*. "Cost" has replaced "mission success" as the primary objective in managing a space system acquisition. Program managers face far less scrutiny on program technical performance than they do on executing against the cost baseline. There are a number of reasons why this is so detrimental. The primary reason is that the space environment is unforgiving. Thousands of good engineering decisions can be undone by a single engineering flaw or workmanship error, resulting in the catastrophe of major mission failure. Options for correction are scant. Options for recovery that used to be built into space systems are now omitted due to their cost. If mission success is the dominant objective in program execution, risk will be minimized. As we discuss in more detail later, where "cost" is the objective, "risk" is forced on or accepted by a program.

The task force unanimously believes that the best cost performance is achieved when a project is managed for "mission success." This is true for managing a factory, a design organization, or an integration and test facility. It is well known and understood that cost performance cannot be achieved by managing cost. Cost performance is realized by managing quality**.** This emphasis on mission success is particularly critical for space systems because they operate in the harsh space environment and post-launch corrective actions are difficult and often impact mission performance.

Responsible cost investment from the outset of a program can measurably reduce execution risk. Consider an example in which 20 launches, each costing $500 million, are to be delivered. If each launch has a 90 percent probability of success, then statistically over the span of the 20 launches, two will be lost. Suppose that instead of accepting 90 percent reliability, risk reduction investments are made in order to achieve 95 percent reliability. At 95 percent reliability, statistically only one launch will fail. An investment of $25 million of risk reduction in each launch would break even financially. However, there would also be one additional successful launch. This example demonstrates what the task force believes to be a better way of managing a program: prudent risk reduction investment can be dramatically productive. The current cost-

dominated culture does not encourage this type of prudent investment. It is particularly valuable when the program is addressing immense engineering challenges in placing new capabilities in space, with the assurance that they can perform.

The task force clearly recognizes the importance of cost in managing today's national security space program; however, it is the position of the task force that focusing on mission success as the primary mission driver will both increase success and improve cost and schedule performance.

*Recommendations*. Establish "mission success" as the overarching principle for program acquisition. This requires establishing "mission success" as the top priority in policy statements, leadership actions, and contractual provisions and incentives. It is difficult to overemphasize the positive impact that leaders of the space acquisition process can achieve by re-adopting "mission success" as a core value.

## 6.2 Unrealistic Budgeting

*Findings and Observations*. The task force found that unrealistic budget estimates are common in national security space programs and that they lead to unrealistic budgets and unexecutable programs. This phenomenon is prevalent; it is a systemic issue. National security space typically pushes the limits of technological feasibility, and technology risk translates into schedule and cost risk. The task force found that it is the policy of the NRO and the practice of the Air Force to budget programs at the 50/50 probability level. In cost estimating terminology this means the program has a 50 percent chance of being under budget or a 50 percent chance of being over budget. The flaw in this budgeting philosophy is that it presumes that areas of increased risk and lower risk will balance each other out. However experience shows that risk is not symmetric; on space programs in particular it is significantly skewed in the direction of the increased, higher risk and hence increased cost. Fundamentally, this is due to the fact that the engineering challenges are daunting and even small failures can be catastrophic in the harsh space environment. Under these circumstances it is the position of the task force that national security space programs should be budgeted at the 80/20 level, which the task force believes to be the most probable cost.

This raises the issue of how to make the cost estimate. In some instances, contractor cost proposals were utilized in establishing budgets. Contractor proposals for competitive cost-plus contracts can be characterized as "price-to-win" or "lowest credible cost." As a result, these proposals should have little cost credibility in the budgeting process. Utilizing the same probability nomenclature, these proposals are most likely approximately "20/80."

To better illustrate the effect of budgeting to "50/50" or "80/20", assume a program with a most probable cost at $5 billion. The difference between "80/20" and "50/50" is about 25 percent, with a comparable difference between "50/50" and "20/80." Therefore, budgeting a $5 billion program at "50/50" results in a cost of $3.75 billion, and at "20/80" results in a cost of $2.5 billion. Given the budgeting practices of the NRO and Air Force, a cost growth of 1/3 (and up to 100 percent if the contractor cost proposal becomes the budget) can be expected from this factor alone.

Another complication of the budgeting process is that the incumbent nearly always loses space system competitions. The task force found that in recent history the incumbent lost greater than 90 percent of space system competitions. If an incumbent is performing poorly, that incumbent should lose, although it is highly unlikely that 90 percent of the corporations that build space systems are poor performers. While the incumbents do go on to win other competitions, transitions between contractors are expensive. The government typically has invested significantly in capital and intellectual resources for the incumbent. When the incumbent loses, both capital resources and the mature engineering and management capability are lost. A similar investment must be made in the new contractor team. The government pays for purchase and installation of specialized equipment, as well as fit-out of manufacturing and assembly spaces that are tailored to meet the needs of the program. Most importantly, the highly relevant expertise of the incumbent's staff—their knowledge and skills—is lost because that technical staff is typically not accessible to the new contractor. This replacement cost is substantial. The government budget and the aggressive "priced to win" contractor bid may not include all necessary renewal costs. This adds to the budget variance discussed earlier. Utilization of incumbent suppliers can soften this impact.

Consolidation of the industry has somewhat complicated our analysis, e.g., Rockwell was the original incumbent for the Global Positioning System (GPS); however, Boeing became the incumbent because it acquired Rockwell. However, this incumbent loss phenomenon is well-documented. The task force suspects that with the emphasis being on competition and the drive to level the playing field in the competition evaluation, the evaluation and decision process is not making decisions that are ultimately in the best interest of the government. These decisions incur excess cost and added risk due to loss of engineering infrastructure and expertise.

Another problem that results from the exceedingly high proportion of incumbent losses is that a non-incumbent can be more optimistic in their assessment of technical complexity, risk, and cost. They may develop an unrealistic budget and an unexecutable program plan.

So, several factors result in the underbudgeting of space programs. They include government budgeting policies and practices, reliance on contractor cost proposals, failure to account for the lost investment when an incumbent loses, and the fact that advocacy (not realism) dominates the program formulation phase of the acquisition process.

Now we turn to discussion of the ramifications of attempting to execute such an inadequately planned program. Figures 1–4 illustrate these ramifications. Figure 1 defines a typical space program: it has requirements, a budget, a schedule, and a launch vehicle with its supporting infrastructure. The launch vehicle limits the size and weight of the space platform. These four characteristics establish boundaries of a box in which the program manager must operate. The only way the program manager can succeed in this box is to have margins or reserves to facilitate tradeoffs and to solve problems as they inevitably arise.

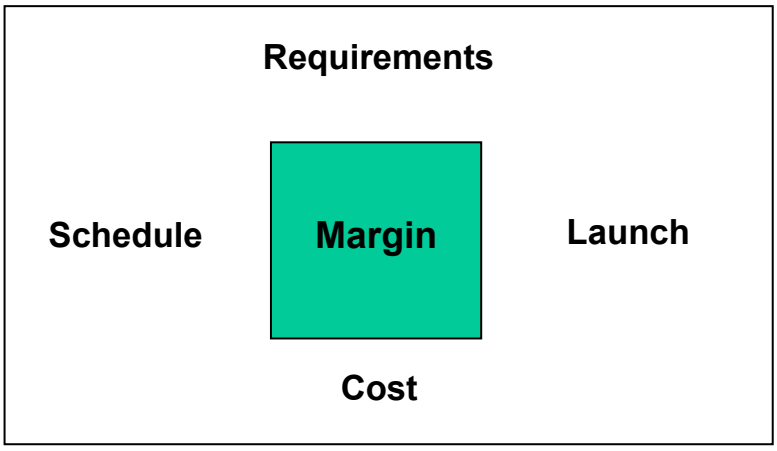



*Figure 1: Program characteristics.*

Figure 2 illustrates what the task force found for poorly planned programs: inflexible and growing requirements, an underfunded budget, and an unrealistic program plan.

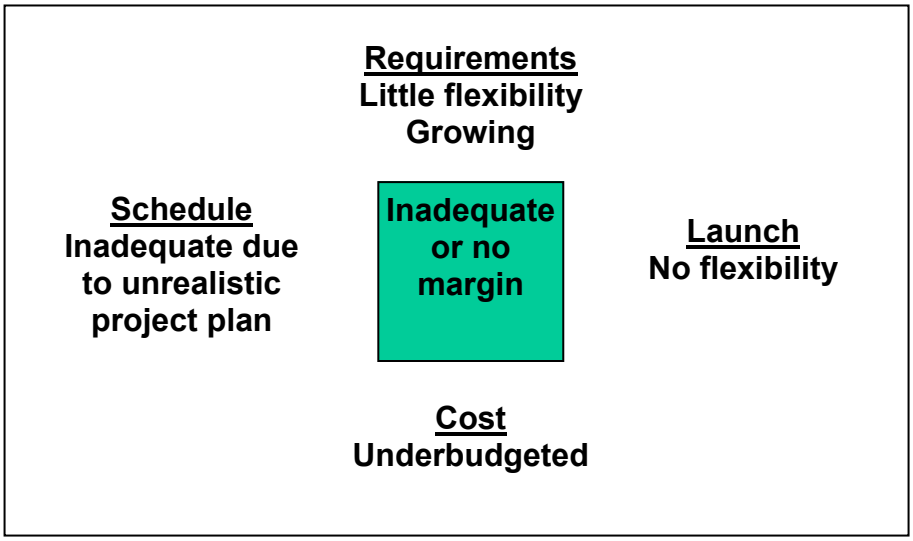



*Figure 2: Observed space program characteristics*.

Figures 3 and 4 show two possible outcomes. With an experienced program manager and program staff, schedule will be used as reserve with corresponding cost increases occurring later in the life of the program. The task force found many programs with schedule delays of more than one year. Significant schedule delay and increased cost can be a route to operational success. In other words, the experienced program manager extends schedule instead of increasing operational risk.

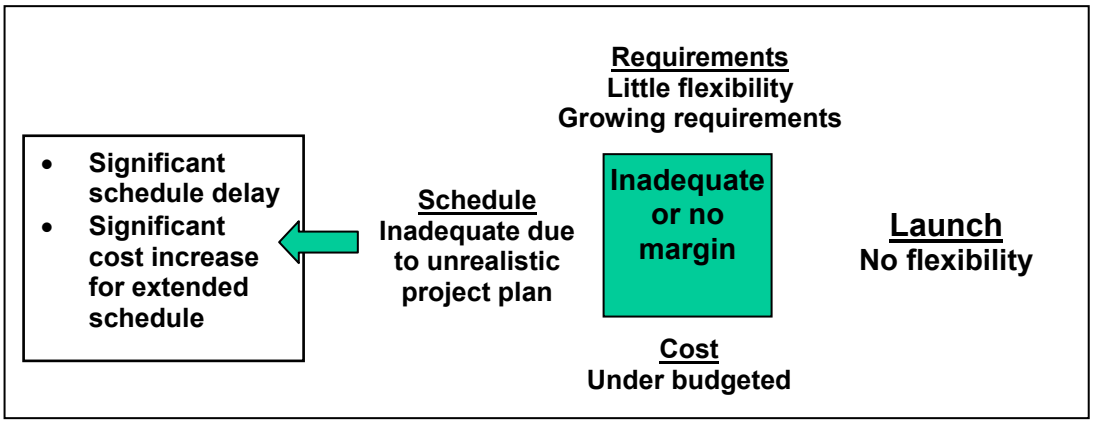



*Figure 3: One route to success.*

Figure 4 illustrates the most troubling outcome: an inexperienced program manager and staff and/or a critical need to adhere to a fixed schedule result in risk being used as reserve. Mission failure becomes more probable.

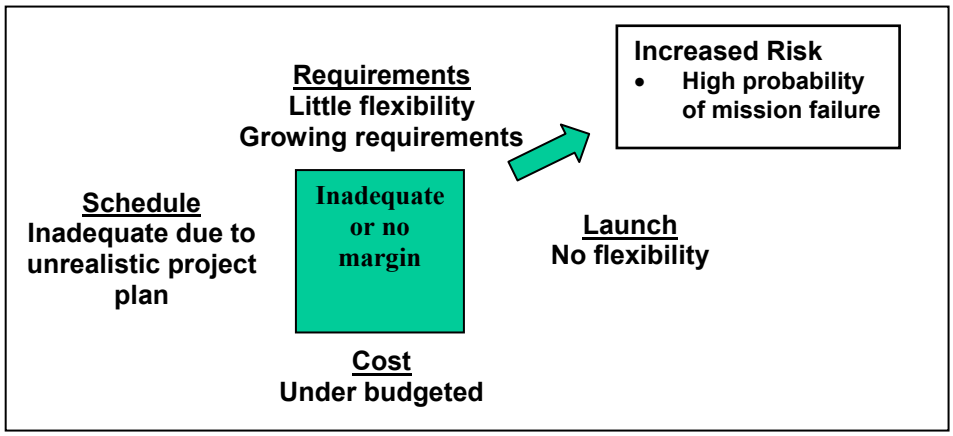



*Figure 4: Inexperienced program manager or an inviolate schedule.*

The task force does not believe any responsible manager knowingly accepts risks that will result in operational failure. However, when cost and schedule margins are inadequate, risk becomes the only "margin" available. Multiple small increments of accumulated risk can result in an unacceptably high cumulative probability of mission failure. The task force believes that the FIA program under contract in the fourth quarter of calendar year 2002 fits this scenario.

*Recommendations*. The task force recommends that:

- National security space programs be budgeted to the most probable (80/20) cost estimate, and the government establish a 20-25 percent reserve within that most probable budget
- The government establish a policy that the reserve be used only to execute the approved program baseline (not for new requirements), and
- Contractor cost proposals for competitive cost-plus contracts not be used to validate government budgets unless changes are made to the source selection process to ensure contractor cost estimate credibility.

The initial thought of the task force was to recommend giving no consideration to the contractor cost proposal in the budgeting process. That remains the recommendation if *no change* is made to the source selection process. Further consideration suggests that there are changes that could be made in the source selection process that would incentivize more credible contractor cost proposals. One option is to use the cost proposal as an indicator of the contractor's technical understanding of the job. For example, if an element of a proposal is technically outstanding and receives the highest score, but the proposed cost for the element is substantially underestimated, the conclusion should be that the contractor does not have sufficient understanding of that element and the technical score for it would be adjusted down. Another option would be to negotiate up, without increased fee, the difference between a low contractor proposal and the most probable estimated cost. Both options require a competent government cost estimating capability.

*Additional Recommendations.*

- Conduct and accept credible independent cost estimates and program reviews prior to program initiation. This is critically important to counterbalance the program advocacy that is always present.
- Hold independent senior advisory reviews using experienced, respected outsiders at critical program acquisition milestones. Such reviews are typically held in response to the kind of problems identified in the report. The task force recommends reviews at critical milestones in order to identify and resolve problems before they become a crisis.
- Compete national security space programs only when clearly in the best interest of the government. The task force did not review the individual source selections and does not imply that they were not properly conducted. However, it is clear that when the incumbent loses, there is a significant loss of government investment that must be accounted for in the program budget of the non-incumbent contractor. Suggested reasons to compete a program include poor incumbent performance, failure of the incumbent to incorporate innovation while evolving a system, substantially new mission requirements, and the need for the introduction of a major new technology.
- When the non-incumbent wins the following recommendations should be implemented:

- Reflect the sunk costs of the legacy contractor (and inevitable cost of reinvestment) in the program budget and implementation plan.
- Maintain operational overlap between legacy systems and new programs to assure continuity of support to the user community.

## 6.3 Requirements Control

The task force found that requirements definition and subsequent control, or lack thereof, to be a dominant driver of cost increases, schedule delays, and incurred mission risk. The current system is not adequate to manage and control requirements. Our consideration of the management of requirements spans the period of time prior to program implementation when the program is being advocated through program implementation.

### Prior to Program Initiation

*Findings and Observations*. As discussed earlier in this report, there was an increase and a broadening of the use of space assets during the decade of the 1990s. Today, users include a large number of operational users, including some with regional interests and niche missions. And, the user base continues to expand in response to the war on terrorism. New users bring new requirements. Those trying to initiate a new program applaud this because new users with new requirements constitute an expanded base of support. However, this support comes at the cost of reduced program manager flexibility because of the increased number of key performance parameters (KPPs) needed to satisfy and maintain the support of the expanded constituency. For too many programs the net result has been dramatically increased requirements with ineffective systems engineering and/or financial assessment of their impact. This has repeatedly overwhelmed the existing requirements management process. One example of the resulting impact is that the SBIRS High program had an excessive number of KPPs: 18. Experience suggests more than 4 to 5 KPPs will overly constrain program execution; the orthogonal KPPs prevent the program manager from making tradeoffs that would assure an execution of a program with prudent risk.

The Advanced Extremely High Frequency (AEHF) program depicted in figure 5 provides an illustrative example of cost and requirements growth.

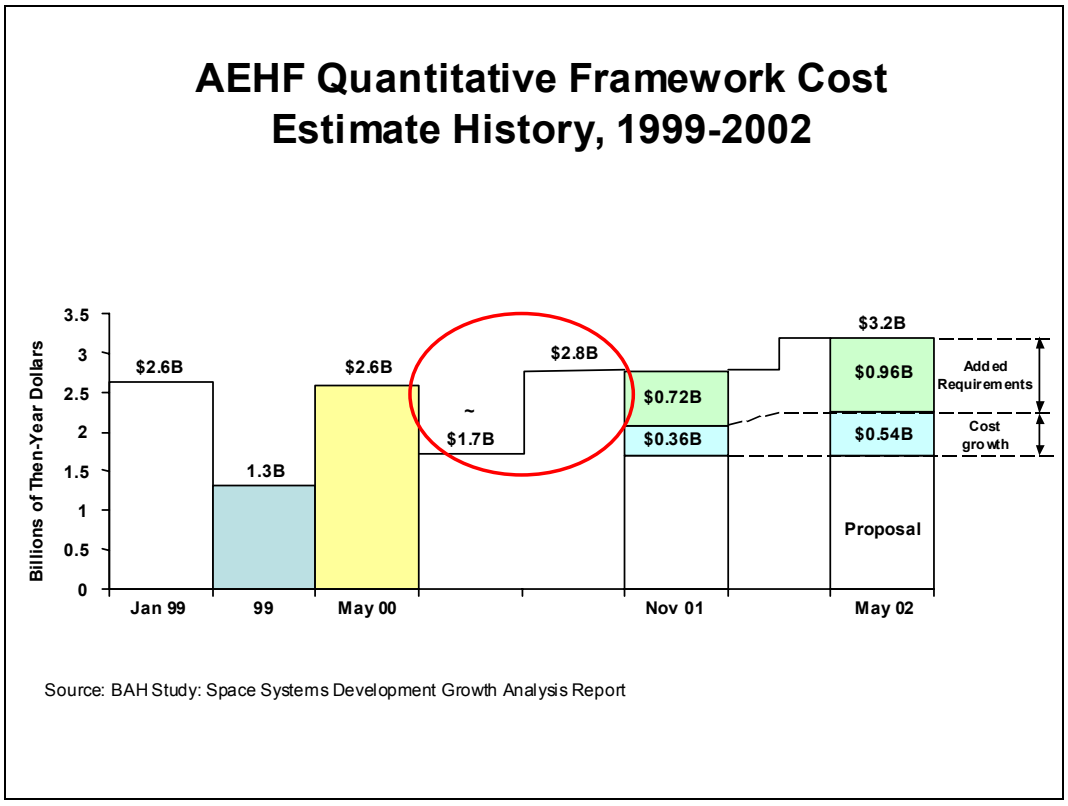



*Figure 5: AEHF case study—requirements growth prior to program initiation.*

Figure 5 is a simplified depiction of a chart taken from the *Booz Allen Hamilton Space Systems Development Growth Analysis Report*. It depicts five successive budgets for AEHF. Early budgets in 1999 and 2000 varied substantially. The initial Service Cost Position in January 1999 was reduced substantially to $1.32 billion in the President's Budget. The number of space vehicles to be built strongly influenced costs. Budgets for May 2000 and subsequent dates assume construction of only two space vehicles. There was a dramatic increase in the AEHF budget between May 2000 and November 2001 (see the circled area). The change has two components: a cost growth of $.36 billion (over 20%) to implement the same requirements as used to define the May 2000 budget and a cost growth of $.72 billion (over 40%) to fund new requirements. The increase of more than one billion dollars illustrates the dramatic impact requirements definition can have on the cost of a program.

This case study is described not to suggest that the incremental AEHF requirements were not justified, but to illustrate that the establishment of additional KPPs has a major impact on program cost. Properly scoping a program prior to implementation necessitates (1) control on the number and scope of KPPs, (2) an effective process for system engineering, (3) cost assessment of the impacts to the program for each new or changed requirement, and (4) a disciplined decision making process to evaluate the importance and impact of each requirement.

*Recommendations*. To derive a more effective requirements process for space programs, the task force recommends that:

- A senior leader be established within the DoD and a senior leader be established within the Intelligence Community with the authority to accept or reject requirements to be utilized by each program and ensure accepted requirements are funded within the most probable budget;
- Appropriate operators, users, and acquisition personnel are included in the requirements development process;
- An effective and credible systems engineering and cost estimating capability is available to support the requirements process;
- Training and certification programs are instituted for managers involved in the requirements process; and finally,
- An approved Requirements Definition Document that results from the "prior to program initiation" requirements process be used during the program implementation phase.

## During Program Implementation

*Findings and Observations*. The task force found that the failure to control requirements during program implementation also contributed significantly to cost increases, program delay, and increased risk. This problem was exacerbated by ineffective systems engineering and the weakened authority of program managers. In recent programs managers have not had the authority to control requirements and take action based on their judgment of tradeoffs in implementation. Figure 6 illustrates this finding by showing the cost history for SBIRS High. It is a simplified version of a chart excerpted from the "Space Systems Development Growth Analysis" report. It depicts a succession of cost estimates and funded budgets for SBIRS High at seven successive points in time. As with the prior figure, we distinguish between cost growth for the original requirements, and cost growth due to "requirements creep." Note that the contractor's bid is the most unrealistic estimate of all. This concrete example illustrates the task force observation that contractor's must "price to win." After award, cost for the original requirements and the cost of added requirements grew substantially—roughly a factor of three.

Figure 6 distinguishes growth of cost of implementing the original requirements and the cost of requirements added after contract award. The acquisition processes are not responsibly serving the public, the Congress, the DoD or the services and other user communities.

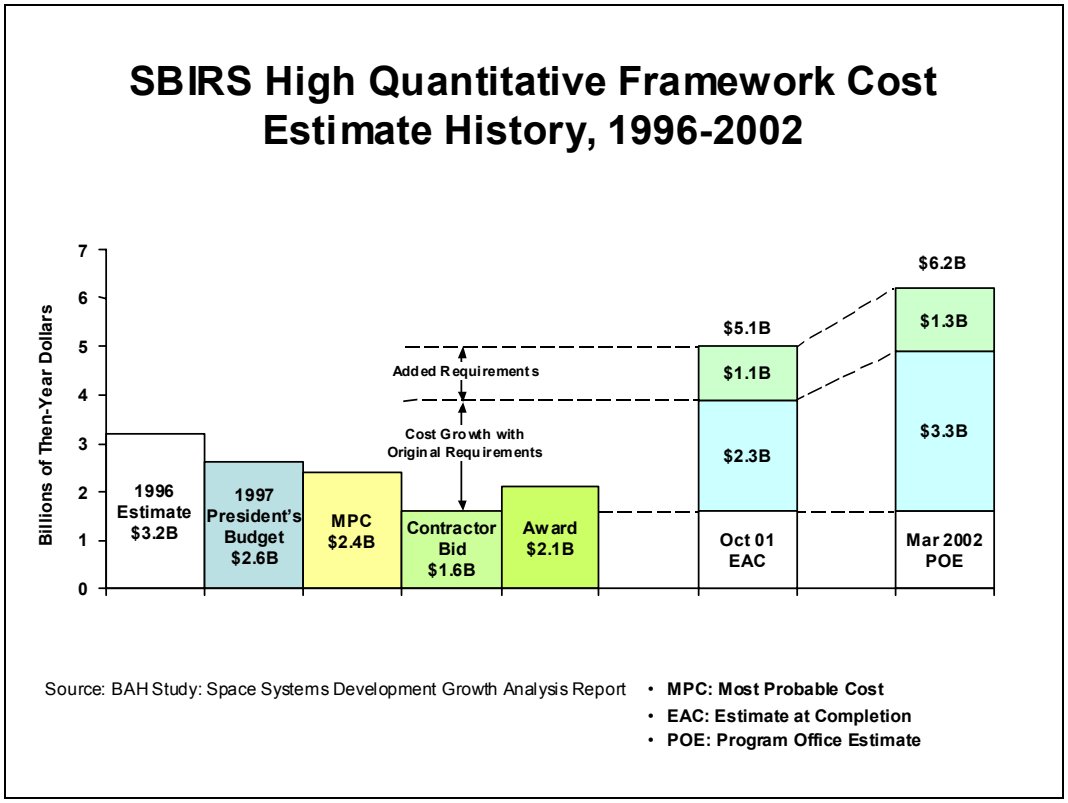



*Figure 6: SBIRS case study—requirements growth during program execution.*

*Recommendations*. The task force recommends the following:

- Give the program manager authority over requirements management during program implementation and make the program manager accountable to the senior requirements leader previously recommended;
- Direct the program manager to continue to assess the impact of requirements in the Requirements Definition Document until preliminary design review (PDR);
- Review and evaluate the requirements in the Requirements Definition Document at PDR; specify that any changes require the approval of the senior requirements leader, and place the resulting requirements under change control;
- Direct that program acceptance of any new requirements must be associated with an identified, adequate funding source;
- Strengthen the systems engineering capability supporting the program manager to ensure sound assessment of the total impact of requirements changes;

- Direct that the program manager chair the program requirements Configuration Control Board and give the program manager the authority to accept or reject requirements changes, including the authority to make reasonable adjustments to requirements to enhance program implementation; and
- Specify that any significant change in requirements affecting the user/operator requires the approval of the senior requirements leader.

## 6.4 Acquisition Expertise

*Findings and Observations*. The government's capability to lead and to manage the space acquisition process has been seriously eroded, in part due to actions taken in the acquisition reform environment of the 1990's. The task force found that the acquisition workforce has significant deficiencies: some program managers have inadequate authority; systems engineering has almost been eliminated; and some program problems are not reported in a timely and thorough fashion.

These findings are particularly troubling given the strong conviction of the task force that the government has critical and valuable contributions to make. They include the following:

- Manage the overall acquisition process;
- Approve the program definition;
- Establish, manage, and control requirements;
- Budget and allocate program funding;
- Manage and control the budget, including the reserve;
- Assure responsible management of risk;
- Participate in tradeoff studies;
- Assure that engineering "best practices" characterize program implementation; and
- Manage the contract, including contractual changes.

These functions are the unique responsibility of the government and require a highly competent, properly staffed workforce with commensurate authority. Unfortunately, over the decade of the 1990s the government space acquisition workforce has been significantly reduced and their authority curtailed. Capable people recognized the diminution of the opportunity for success and left. They continue to leave the acquisition workforce because of a poor work environment, lack of appropriate authority, and poor incentives. This has resulted in widespread shortfalls in the experience level of government acquisition managers, with too many inexperienced individuals and too few seasoned professionals.

To illustrate this, in 1992 SMC had staffing authorized at a level of 1,428 officers in the engineering and management career fields with a reasonable distribution across the ranks from lieutenant to colonel. By 2003 that authorization had been reduced to a total of 856 across all ranks. In the face of increasing numbers of programs with increasing complexity, this type of reduction is of great concern. Of note, when one looks at the actual staffing in place at SMC today against this authorization, one finds an

overall 62 percent reduction in the colonel and lieutenant colonel staff and a disproportionate 414 percent increase in lieutenants (76 authorized in 1992 to 315 authorized in 2003). The majority of those lieutenants are assigned to the program management field. Such an unbalanced dependence on inexperienced staff to execute some of most vital space programs is a crucial mistake and reflects the lack of understanding of the challenges and unforgiving nature of space programs at the headquarters level.

The task force observes that space programs have characteristics that distinguish them from other areas of acquisition. Space assets are typically at the limits of our technological capability. They operate in a unique and harsh environment. Only a small number of items are procured, and the first system becomes operational. A single engineering error can result in catastrophe. Following launch, operational involvement is limited to remote interaction and is constrained by the design characteristics of the system. Operational recovery from problems depends upon thoughtful engineering of alternatives before launch. These properties argue that it is critical to have highly experienced and expert engineering personnel supporting space program acquisition.

But, today's government systems engineering capabilities are not adequate to support the assessment of requirements, the conduct of tradeoff studies, the development of architectures, the definition of program plans, the oversight of contractor engineering, and the assessment of risk. Earlier in this report, weaknesses in establishing requirements, budgets, and program definition were cited as a major cause of cost growth, schedule delay, and increased mission failures. Deficiencies in the government's systems engineering capability contribute directly to these problems.

The task force believes that program managers and their staffs are the only people who can make a program succeed. Senior management, staff organizations, and other support organizations can contribute to a successful program by providing financial, staffing, and problem-solving support. In some instances, inappropriate actions by senior management, staff, and support organizations can cause a program to fail.

The special management organization, the FIA Joint Management Office (JMO), provides an example of dilution of the authority of the program manager. The task force recognizes and supports the need to manage the FIA interface between the NRO and NIMA and the need in very special cases for senior management—the DCI in this instance—to have independent assessment of program status. The task force believes the intrusive involvement by the JMO in the FIA program as presented by the JMO to the task force conflicts with sound program management.

Given the criticality of the program manager, the task force is highly concerned by the degree to which the program manager's role and authority have eroded. Staff and oversight organizations have been significantly strengthened and their roles expanded at the expense of the authority of the program manager. Program managers have been given programs with inadequate funding and unexecutable program plans together with little authority to manage. Further, program managers have been presented with uncontrolled requirements and no authority to manage requirement changes or make reasonable adjustments based on implementation analyses. Several program managers interviewed by the task force stated that the acquisition environment is such that a "world class" program manager would have difficulty succeeding.

The average tenure for a program manager on a national security space program is approximately two years. It is the view of the task force that a program cannot be effectively or successfully managed with such frequent rotation. The continuity of the program manager's staff is also critically important. The ability to attract and assign the extraordinary individuals necessary to manage space programs will determine the degree of success achievable in correcting the cost and schedule problems noted in this study.

A particularly troubling finding was that there have been instances when problems were recognized by acquisition and contractor personnel and not reported to senior government leadership. The common reason cited for this failure to report problems was the perceived direction to *not* report the problems or the belief that there was no interest by government in having the problem made visible. A hallmark of successful program management is rapid identification and reporting of problems so that the full capabilities of the combined government and contractor team can be applied to solving the problem before it gets out of control.

The task force concluded that, without significant improvements, the government acquisition workforce is unable to manage the current portfolio of national security space programs or new programs currently under consideration.

*Recommendations*. The erosion of the government's acquisition management capabilities occurred over a period of years. Correspondingly, correcting these deficiencies will require considerable time, although some—such as resolution of the program manager's authority and responsibilities—can be corrected rapidly. The importance of the program management recommendations cannot be overestimated. Specifically, the task force recommends the following:

- Complete the ongoing efforts to establish a career field for space operations and acquisition personnel, and recognize that the space career field is distinctly different from the ICBM career field;
- Define the responsibility, authority, and accountability of program managers in a manner that is consistent with the critical nature of their role;
- Assign program managers based on both capabilities and experience;
- Extend program management tours to a minimum of 4 years and follow the assignment with positive career opportunities;
- In the near term, utilize Excepted Civil Service and retired personnel with significant acquisition experience;
- Provide program managers with an executable program, including realistic requirements, budgets, and schedules;
- Make adequate resources and resource management authority available to program managers;
- Give program managers the authority to manage and control requirements, including the authority to reject unfounded new requirements;
- Establish policies to identify and report potential problems early;
- Establish metrics for the early warning of problems, and direct program managers and their support staff to report problems up the management chain for timely corrective action;

- Establish severe and prominent penalties for the failure to report problems;
- Develop a robust systems engineering capability to support program initiation and development;
- Reestablish organic government systems capability by selecting appropriate people from within government, hiring to acquire needed capabilities, and implementing training programs; and finally,
- Ensure full utilization of the combined system engineering capabilities of the government, Federally Funded Research and Development Centers (FFRDC), and systems engineering and technical assistance (SETA) organizations in the development and implementation of National Security Space Programs**.**

## 6.5 Industry

*Findings and Observations*. The task force did not find systemic problems with the implementation of national security space programs by industry, although we did observe troublesome implementation problems and issues. These will be discussed in this section and some will be highlighted explicitly in the later SBIRS High, FIA, and EELV sections.

First, it is appropriate to comment on the task force's expectations of industry. We believe that industry has two basic responsibilities:

1. Execute the contract established between the government and the contractor; and
2. Identify and report flaws in the contract that can adversely impact technical, schedule, cost, and/or mission success.

It is with the second responsibility that the task force found the greatest reason for concern. We found a number of space program contracts to be significantly flawed. Accomplishment of stated objectives within established schedules and cost parameters was very improbable and ultimate mission success was certainly questionable. Actions taken in the environment of the 1990s made a dominant contribution to this situation. SBIRS and FIA provide specific examples for concern. The SBIRS software test program was excessively optimistic and ultimately was a major contributor to the required program restructuring. FIA's space segment test program was deficient to the point that mission success would have been in jeopardy. The task force observed instances in which industry did not implement proven engineering and management practices and did not communicate systemic program problems to the government acquisition leadership in a timely manner.

While the task force believes industry has the responsibilities defined above, regardless of the circumstances, we do note that the government is not always receptive to industry concerns or responsive to program issues. Also, contract and fee structure in a contract can cause industry to lose focus on sound program implementation and on reporting.

*Recommendations*. The task force recommends that the government require national security space contractors to

- Account for the quality of their program implementation and mission success,
- Identify proven management practices and ensure that they are being implemented, and
- Be accountable for the early identification and open discussion of problems on their programs.

The task force also recommends that the government:

- Be open and responsive to contractor program concerns, and
- Align contract structure to focus industry attention on proven management and engineering practices and mission success.

# 7.0 CAPABILITY OF THE INDUSTRIAL BASE

The task force was asked to assess the state of the industrial base. We consider industry capacity and capability for both current and future programs. Section 5 of this report stated that most U.S. space programs are currently in transition, meaning that a new system or block improvement is being implemented. One implication is that there is currently a peak demand for industry. Managing this demand puts a premium on systems engineering and program management, especially for prime contractors.

Specific findings and observations for prime contractors include the following:

- Significant excess "factory" capacity exists today,
- Adequate staffing is available for current programs,
- Acceptance rate for new hires is very high—voluntary turnover is low,
- Concern is developing over acquiring and retaining "top" systems engineers and experienced program managers, and
- Major problems will rise in the future (e.g., a large and growing percentage of the experienced workforce is becoming eligible for retirement).

Changes have occurred in the employment environment. Acceptance rates for new hires are greater than 80 percent and voluntary turnover is low, with some contractors in the low single-digit percentage. The net result is that adequate staff is available for current programs, although a need exists for "top" systems engineers and experienced program managers (a need driven by the large development workload). This need will be exacerbated as new programs are added.

The future workforce situation is of greater concern. The current workforce age is—on the average—in the late 40s, and a significant percentage of this workforce is eligible for retirement. This issue needs to be addressed before it results in a significant decline in the available workforce.

In our judgment industry at the prime contractor level has the capacity and capabilities required for current and near-term planned programs. Below the prime contractor level there do exist industrial base concerns. Second- and third-tier contractors are having problems primarily due to low demand for the components they produce. This is particularly true for space-qualified parts. The problems at the second and third tier will require proactive government involvement for a small number of selected cases.

The task force anticipates problems in the payload and sensor area. In some circumstances, domestic capabilities required to support payload and sensor development for national security space are at risk. Finally, commercial space activity has not developed to the degree anticipated, and the expected national security benefits from commercial space have not materialized.

Industry is most challenged by the erratic demands on their capacity. As an example, space program development activities are currently at a high. One should not conclude that industry cannot accommodate new programs. Programs initiated today will be going into development after some current development programs have moved to the production phase. Each phase requires different capabilities. If new starts could be

commenced in a manner that dampens erratic demands on capacity and capability, industry could perform most capably and efficiently.

On balance, the industry can support current and near-term planned programs. Special problems need to be addressed at the second and third levels. A continuous flow of new programs, cautiously selected, is required to maintain a robust space industry.

# 8.0 SPECIAL ATTENTION PROGRAMS

The task force was asked to examine three specific programs that were of special concern and interest to the government. We discuss each of these programs below.

## 8.1 SBIRS High

*Findings and Observations*. SBIRS High has been a troubled program. It could be considered a case study for how not to execute a space program. The following list of program characteristics (prior to program reconstruction) illustrates this observation:

- Cost-driven,
- Underfunded,
- Optimistic contractor proposal,
- Uncontrolled requirements,
- Limited program manager authority and capability,
- Funding instability (four replans),
- Program manager instability (four government and four industry program managers), and
- Failure to implement "best practices."

SBIRS High is a product of the 1990s acquisition environment. Inadequate funding was justified by a flawed implementation plan dominated by optimistic technical and management approaches. Inherently governmental functions, such as requirements management, were given over to the contractor.

In short, SBIRS High illustrates that while government and industry understand how to manage challenging space programs, they abandoned fundamentals and replaced them with unproven approaches that promised significant savings. In so doing, they accepted unjustified risk. When the risk was ultimately recognized as excessive and the unproven approaches were seen to lack credibility, it became clear that the resulting program was unexecutable. A major restructuring followed. It is well-known that correcting problems during the critical design and qualification-testing phase of a program is enormously costly and more risky than properly structuring a program in the beginning. While the task force believes that the SBIRS High corrective actions appear positive, we also recognize that (1) many program decisions were made during a time in which a highly flawed implementation plan was being implemented and (2) the degree of corrective action is very large. It will take time to validate that the corrective actions are sufficient, so risk remains.

The task force was impressed with the current program management; however, there is a concern that the program lacks experienced personnel and that the "Basket SPO" approach dilutes attention to the critical issue of SBIRS High restructuring and implementation of the revised program. Under the "Basket SPO" concept, the program management is responsible not only for SBIRS High but also the associated legacy program, the ground segment, and SBIRS Low. While this concept may be sound for a stable set of programs, it is viewed as confounding the correction of a troubled program and the start of a new program.

*Recommendations*. The task force recommends proceeding cautiously with the restructured program. Because the program, prior to restructuring, was implemented during an era of questionable program practices, the task force recommends a review of past engineering and test activities to assess their quality. This may necessitate additional testing to mitigate omissions and embedded problems that would otherwise manifest themselves as mission critical failures on orbit. Finally, the task force recommends adding experienced managers to the SBIRS program.

## 8.2 Future Imagery Architecture (FIA)

*Findings*. The task force found the FIA program under contract at the time of our review to be significantly underfunded and technically flawed. The task force believes that the FIA program—thus structured—is not executable.

*Recommendations*. The task force concludes that the FIA deficiencies can be mitigated sufficiently to permit the program to continue. Program funding should be increased to the level of a most probable (80 percent) cost. Significant program and schedule changes will be required to increase the probability of mission success. An independent review should be implemented to assess the adequacy of the restructured program. Finally, we make same recommendation for FIA as for SBIRS High—validate the results of past engineering and testing activities.

## 8.3 Evolved Expendable Launch Vehicle (EELV)

*Findings and Observations*. The only U.S. capability to provide assured access to space for national security space programs is the Evolved Expendable Launch Vehicle (EELV) program. The EELV program was defined assuming the emergence of a robust commercial space program that (in combination with the government space program) would provide the financial foundation for the two EELV contractors. The commercial space program has not materialized and is not expected to materialize in the near future. As a result, the business plans for both prime contractors are financially inadequate. It is unacceptable for the government to make the entire national security space program depend upon launch capabilities provided by contractors with business plans that are so severely flawed.

While the initial mission success of the systems of both contractors is impressive, the task force believes that assured access to space requires that both contractors be retained until mature system performance is demonstrated. Only at this point could a potential downselect take place. However, there is a question of whether it is in the best interest of the country to rely totally on one launch system and one contractor for such a critical capability.

EELV is maturing in a highly cost-constrained environment, and prevailing cost pressures can put mission success at risk. Assured access to space is too critical to the U.S. national security to be handled simply as a budget problem; as a matter of national security policy, risk needs to be reduced to an acceptable level.

The government also needs to recognize that the assumed commercial space program did not materialize to the degree expected. As a result, the government is the

prime user of EELV program products. Absence of market volume has created a funding shortfall for the EELV program.

The government must take the uncertainty out of the EELV by establishing a plan that resolves these issues and make that plan available to the program participants so that informed decisions can be made. Actions should follow that consideration.

*Recommendations*. The task force recommends that:

- Assured access to space be an element of national security policy;
- Government funding be provided beginning no later than FY04 to assure that both EELV programs are viable; and
- A long-term EELV program plan be established to address issues such as the requirement for U.S. production of the RP-180 engine, West Coast launch capability, and dual manifesting; the plan should include an approach to future contracting, including any potential downselect and associated funding.

# 9.0 SUMMARY AND CONCLUSIONS

A robust national security space program is critical to the security of the United States. The space program has evolved over the past several decades. Due to events and actions of the decade of the 1990s, national security space programs incurred cost growth, schedule delays and increased mission failures. National security space is too important to allow these cost, schedule, and mission failure problems to continue.

This report contains specific recommendations to correct cited deficiencies that we assert are the causes of these problems and concerns with individual space programs. A return to a mission success culture, as opposed to a cost-centric culture, is a necessary prerequisite.

Corrective actions for current programs must include:

- Assurance of realistic budgets and executable program plans;
- Implementation of a process to control requirements;
- Revitalization of both the management and engineering of the government acquisition work force;
- Implementation of an independent review process;
- Assurance of credible problem reporting, with metrics on early warning;
- Industry accountability for proven management and engineering practices with appropriate contract and fee structures; and
- Recognition that program implementation has occurred during an era of questionable program practices, requiring review of past engineering and test activities to assure acceptable quality.

The task force believes that all recommendations included in this report should be implemented for new programs.

Assured access to space is a necessary element for the success of each national security space program. Assuring access to space should not be resolved simply as a budget issue. It is a policy issue of the utmost importance. Required launch capabilities should be established by national security policy.

Industry—with the corrective actions cited in this report—has the capability to support the required robust national security space program for the near term. However, there are significant long-term concerns regarding the workforce and sub-tiers that need to be addressed now in order to mitigate their future impact.

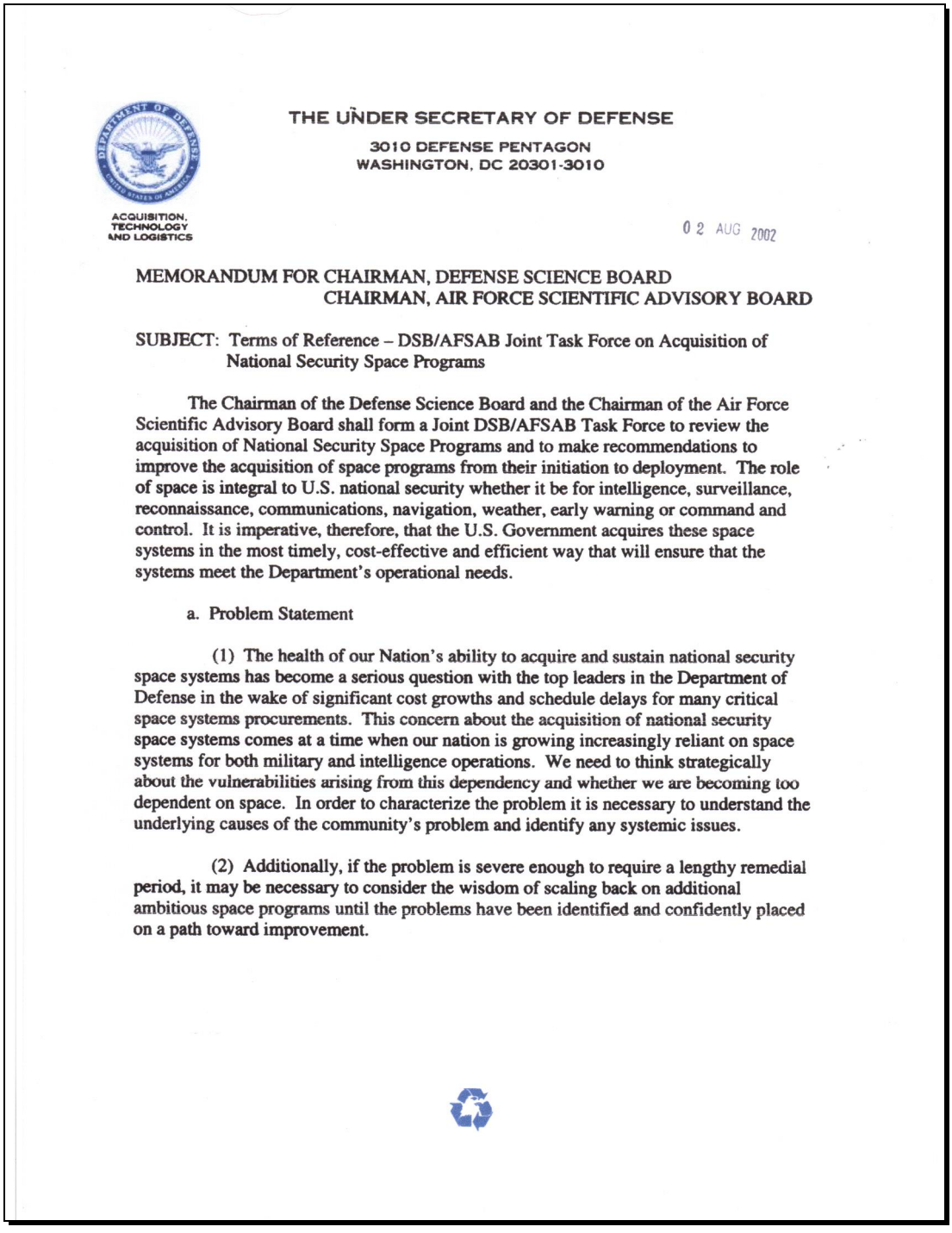
National security space programs have continually pushed the limits of our technological capabilities and can be expected to do so in the future. We expect future programs to be much more interrelated. That will introduce new technical complexity.

It is important that the problems discussed in this report be resolved so that maximum attention can be given to the inherent challenges of current and future space programs. As difficult as it will be to resolve the current problems, failure to do so will result in higher costs and more delays in the future. Failure to correct the cited problems will assure more mission failures.

Even if all of the corrections recommended in this report are made, national security space will remain a challenging endeavor, requiring the nation's most competent acquisition personnel, both in government and industry.

Defense Science Board
DSB
Department of Defense

# A. TERMS OF REFERENCE



THE UNDER SECRETARY OF DEFENSE
3010 DEFENSE PENTAGON
WASHINGTON, DC 20301-3010

ACQUISITION, TECHNOLOGY AND LOGISTICS

02 AUG 2002

MEMORANDUM FOR CHAIRMAN, DEFENSE SCIENCE BOARD
CHAIRMAN, AIR FORCE SCIENTIFIC ADVISORY BOARD

SUBJECT: Terms of Reference – DSB/AFSAB Joint Task Force on Acquisition of National Security Space Programs

The Chairman of the Defense Science Board and the Chairman of the Air Force Scientific Advisory Board shall form a Joint DSB/AFSAB Task Force to review the acquisition of National Security Space Programs and to make recommendations to improve the acquisition of space programs from their initiation to deployment. The role of space is integral to U.S. national security whether it be for intelligence, surveillance, reconnaissance, communications, navigation, weather, early warning or command and control. It is imperative, therefore, that the U.S. Government acquires these space systems in the most timely, cost-effective and efficient way that will ensure that the systems meet the Department's operational needs.

a. Problem Statement

(1) The health of our Nation's ability to acquire and sustain national security space systems has become a serious question with the top leaders in the Department of Defense in the wake of significant cost growths and schedule delays for many critical space systems procurements. This concern about the acquisition of national security space systems comes at a time when our nation is growing increasingly reliant on space systems for both military and intelligence operations. We need to think strategically about the vulnerabilities arising from this dependency and whether we are becoming too dependent on space. In order to characterize the problem it is necessary to understand the underlying causes of the community's problem and identify any systemic issues.

(2) Additionally, if the problem is severe enough to require a lengthy remedial period, it may be necessary to consider the wisdom of scaling back on additional ambitious space programs until the problems have been identified and confidently placed on a path toward improvement.

b. Scope

(1) Diagnose Symptoms. The Task Force should focus on what matters to providing national security advantage to the United States and look at the problem in as holistic a fashion as possible, considering the entire space acquisition process – including industry suppliers as well as government acquirers.

(2) Industrial Base. The assessment should consider what is happening in the four inter-connected sectors of the space business – commercial, civil, intelligence and military – to derive any insights affecting the problem statement above. Personnel issues, including numbers, skills, experience and demographics of space professionals (including CAAS and FFRDC personnel) as well as effects of corporate mergers in all these areas may be included in this assessment or, if appropriate, as a separate topic.

(3) Government. The assessment should consider all aspects of the government's role in managing and funding space system acquisition – SPO, PEO, Science and Technology, Major Command, Service Headquarters, OSD, NRO, NASA and Congress – to derive insights affecting the problem statement above. In this portion the task force should also consider the personnel issues noted in the Industrial Base paragraph above as they relate to government personnel and the possible need for the US Government to sponsor a systems engineering institute

(4) Dependence on Space. The Task Force should conduct its analysis in context with a strategy/vision for the future that considers the U.S. national security advantages that accrue from exploiting space as well as the risks arising from the resulting dependencies. The strategy/vision should address the nation's ability to access space, protect its space assets, and prevail in any military contest over the use of space. The strategy/vision should also address and evaluate space in two contexts. The first context should address our current and projected plans for increasing reliance on space to enhance national security objectives. The second context should view space as a part of a diversified portfolio of space and non-space capabilities to achieve our national security objectives.

(5) Prescribe Remedies. The task force should consider solution options in terms of what industry, the executive branch of government and the legislative branch of government can do to address the problem statement. This should include:

(a) Identifying remedies that should be done immediately to bring positive results.

(b) Identifying actions that will take longer to show results.

(c) Explaining how the DoD Executive Agent for Space should strategically approach current and proposed space procurement initiatives during the recommended recovery process.

c. Deliverables

(1) The task force shall report its interim findings and recommendations in September 2002 and its final findings and recommendations in a briefing in November 2002 to the Under Secretary of the Air Force. The task force will publish the final written report in February 2003.

(2) The study will be co-sponsored by me as the USD (AT&L) and the SecAF. This task force will be chaired by Mr. A. Thomas Young. Mr. Allen Krum, National Reconnaissance Office, will serve as executive secretary. LtCol Roger Basl, USAF, will serve as the DSB Secretariat Representative and Maj John Pernot, USAF, will serve as the AFSAB Representative.

(3) The task force will operate 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 anticipated that this task force will not need to go into any "particular matters" within the meaning of Section 208 of Title 18, U.S. code, nor will it cause any members to be placed in the position of acting as a procurement official.

E. C. Aldridge, Jr.

Defense Science Board
DSB
Department of Defense

# B. TASK FORCE MEMBERSHIP

| CHAIRMAN | |
|---|---|
| Mr. A. Thomas Young | Mr. Young is the former Director of NASA's Goddard Space Flight Center and President and Chief Operating Officer of Martin Marietta Corporation. He retired from Lockheed Martin in July 1995. Mr. Young is currently a Director of the Goodrich Corporation, Pepco Holdings, Inc. and Science Applications International Corporation. Mr. Young is involved in various advisory and review activities associated with the U.S. Space Program and is a member of the National Academy of Engineering. |
| **MEMBERS** | |
| Dr. Wanda Austin | Dr. Austin is the Senior Vice President, Engineering and Technology Group for The Aerospace Corporation (2001 to present). Prior to accepting her current position, she served as General Manager of Aerospace's MILSATCOM Division as well as its Electronic Systems Division. She is a member of the Air Force Scientific Advisory Board and a consultant to the NASA Aerospace Safety Advisory Panel. Her areas of expertise include satellite communications engineering, space systems engineering, modeling and simulation. |
| Dr. William F. Ballhaus, Jr. | Dr. Ballhaus is President and CEO of The Aerospace Corporation. Previously he served as vice president, Engineering and Technology and corporate officer of Lockheed Martin Corporation and as the director of the NASA Ames Research Center. He is a member of the Defense Science Board and served on the Air Force Scientific Advisory Board for seven years and was board co-chair from 1996 to 1999. Ballhaus is a member of the National Academy of Engineering and an elected member of its Council. |
| RADM (Ret) Tom Betterton | Admiral Betterton is an independent consultant (1992 to present). He served in the U.S. Navy for 35 years, during which time he was a Major Program Manager and senior Navy official, Director Program C, National Reconnaissance Office (1978 to 1992). He has served on a number of Defense Science Board task forces. |

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| LtGen (Ret) Donald Cromer | Don Cromer was president of Hughes Space and Communications Company (HSC), the world's leading manufacturer of commercial communications satellites, from October 1993 to December 1998. Cromer joined HSC as vice president in August 1991, following a 32-year career in the U.S. Air Force. He had attained the rank of lieutenant general, and during his last 3 years in the service, he was commander of the Space Systems Division, Air Force Systems Command, at Los Angeles Air Force Base. |
| VADM (Ret) David Frost | Admiral Frost is currently the President of Frost & Associates, a private consulting company specializing in space systems, missile defense, remote sensing, joint operations, and information systems. His active duty assignments included tours as Commander, Naval Space Command and Deputy Commander, U.S. Space Command. He serves on several governmental advisory boards and has participated in multiple studies in the area of space acquisition. |
| MGen (Ret) Donald Hard | General Hard is currently an independent consultant for government organizations and aerospace industry companies. He retired as an Air Force Major General with 31 years of active duty service, including assignment to several high-level positions in national security space programs. He has 9 years of experience in private industry and is a member of several government-sponsored senior review teams established to provide advice and guidance for national security space programs |
| Dr. Daniel E. Hastings | Dr. Hastings is the Co-Director of the Engineering Systems Division at the Massachusetts Institute of Technology (2001 to present). He is also the chair of the Air Force Scientific Advisory Board (2003 - present). He served as the Chief Scientist for the Air Force from 1997 to 1999. His areas of expertise include space environment interactions, space propulsion, space systems architecture, space policy, and the management of science and technology. |

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| Mr. Jimmie Hill | Mr. Hill retired from the Air Force in 1996, after more than 45 years of service. At the time of his retirement he was Principal Deputy Assistant Secretary of the Air Force (Space) and Deputy Director of the National Reconnaissance Office. Mr. Hill has received a number of awards, including distinguished service medals from the CIA, NASA, and the NRO. In 1996, Mr. Hill was chosen by the National Space Club as its recipient of the Goddard Memorial Trophy. |
| Dr. Anita Jones | Dr. Jones is a Professor of Computer Science at the University of Virginia School of Engineering and Applied Science. She served as Director of Defense Research and Engineering (DDR&E) from 1992 to 1997. Professor Jones has served on many government advisory boards and scientific panels including the Defense Science Board, the Air Force Scientific Advisory Board, as well as boards and panels for NASA, the National Academies, and the National Science Foundation. She currently serves on the Defense Science Board and the National Science Board. |
| Maj. Gen. (Ret) Nathan J. Lindsay | Nathan J. Lindsay is a space systems management consultant with experience in both government and commercial space systems. He served in the U.S. Air Force for 34 years and retired as a Major General. While in the Air Force, he succeeded in a variety of positions involving program management and operations of the Air Force and NRO launch and satellite systems. Mr. Lindsay also retired as a vice president of Lockheed Martin in 1998. He is the recipient of several awards, including the Defense Distinguished Service Medal, the National Intelligence Medal, NASA's Distinguished Service Medal, and the NRO Distinguished Service Award. |
| Mr. Peter Marino | Mr. Marino is a private consultant for government and industry on defense and intelligence issues. He has held senior positions in both government and private industry and served with the CIA from 1970 to 1986. Throughout his career he has received a number of technical and management awards, including the CIA Distinguished Intelligence Medal and Distinguished Officer Citation. He is a member of numerous advisory boards, including the Defense Science Board (1995 to present). |

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| Mr. John McMahon | Mr. McMahon is a consultant to the Lockheed Martin Corporation and currently acts as director on a number of Lockheed boards. From 1951 to 1986, he served with the CIA and was appointed Deputy Director of Central Intelligence in 1982. In 1986, Mr. McMahon joined Lockheed Missiles and Space Company. He served as Executive Vice President for the company and Corporate Vice President until August 1988 when he was elected President of the Lockheed Missiles and Space Systems Group and President and CEO of Lockheed Missiles and Space Company. He retired from Lockheed in 1994. |
| Gen. (Ret) Thomas S. Moorman, Jr. | General Moorman is a Partner in Booz Allen Hamilton (1998 to present). He also serves as a member of the Board of Trustees for The Aerospace Corporation, is an Outside Director on the Board of Smiths Industries, and is the Chairman of the Space Panel of the U.S. Strategic Command Strategic Advisory Group. He served in the United States Air Force for 35 years. General Moorman served as Commander of Air Force Space Command (1990-92). At the time of his retirement in 1997, General Moorman was Vice Chief of Staff, United States Air Force. He is a member of the Council on Foreign Relations. |
| Dr. Bradford W. Parkinson | Dr. Parkinson is the Chairman of the Aerospace Corporation and is on the board of directors of Draper Laboratories and Trimble Navigation. He served in the U.S. Air Force from 1957 to 1978, retiring as a colonel. In 1973, as a U.S. Air Force colonel, he created and ran the NavStar GPS Joint Program Office, leading the definition, development, and testing of the Global Positioning System. Since his retirement in 1978, he has continued working on GPS research and development. A Stanford University Professor since 1984, Dr. Parkinson was named the Edward C. Wells Professor of Aeronautics & Astronautics, an endowed chair (1995) and Emeritus (2001). He is the recipient of numerous and distinguished awards and has been inducted into the NASA Hall of Fame. He received the NAE's Draper Prize ("the Engineer's Nobel") in 2003. |

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| Dr. Tony Pensa | Dr. Pensa is the Assistant Director of Lincoln Laboratory at the Massachusetts Institute of Technology (2001 to present). His areas of expertise include surveillance, radar systems, signal processing, space surveillance, space control, space-based surveillance systems, hyperspectral sensors, and space debris. He is a recipient of the NASA Group Achievement Award. |
| Mr. Vincent Vitto | Mr. Vitto is the President and CEO of the Charles Stark Draper Laboratory. Prior to joining Draper in 1997, he held a number of positions at MIT's Lincoln Laboratory (1982-1997). He has served on a wide variety of advisory boards and panels, including the Defense Science Board and the Air Force Scientific advisory board and is currently the vice chairman of the DSB. He is the recipient of the Navy's Meritorious Public Service Award and the Air Force's Decoration for Exceptional Civilian Service. |
| Dr. Max Weiss | Dr. Weiss is currently an independent consultant, having retired from Northrop Grumman in 1996 as the Vice President and General Manager of the company's Electronic Systems Division. From 1961 to 1986, Dr. Weiss held a number of positions with The Aerospace Corporation, including Group Vice President of the Engineering Group. He has served as Member of US Air Force Scientific Advisory Board, and NRC Committee on Educational Issues. He is also the recipient of the IEEE Fredrik Philips Award (1993) and Centennial Medal (1983). |
| Mr. John J. Welch | From 1987 to 1992, Mr. Welch served as the Assistant Secretary of the Air Force (Acquisition), Senior Procurement Executive, Information Resource Management Executive, and Air Force Acquisition Executive. In 1987, Mr. Welch retired as Senior Vice President, Corporate Business Development following 37 years with the LTV Aerospace and Defense Company. Mr. Welch was Chief Scientist of the Air Force from 1969 to 1970. He has served on a number of advisory panels and boards, including the Defense Science Board and the Air Force and Army Scientific Advisory Boards. His awards include, among others, the Air Force Distinguished Service Medal. |

| EXECUTIVE SECRETARY | |
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| Mr. Al Krum | Al Krum is a CIA senior officer who has been assigned to the National Reconnaissance Office for 20 years. He has served in a number of operational, development and systems engineering management and leadership positions in the both the Imagery and Communications directorates. Mr. Krum has also served with industry working for both Lockheed Martin and TRW. Mr. Krum retired in February 2003 and is now employed by Northrop Grumman TASC. |

| DSB SECRETARIAT | |
|---|---|
| Lt. Col. Roger W. Basl, USAF | Lt. Col. Basl has been serving on the DSB Secretariat since June 2001. Prior to this assignment he served in various acquisition and space leadership roles to include: MILSATCOM Program Element Monitor (1999-2001); Chief, Milstar Development, Test and Engineering (1997-1999); and Deputy Program Manager, Launch Base Support (CCAFS) (1992-1996). LtCol Basl holds a B.S. in Aeronautical Engineering and an M.S. in Aerospace Engineering. |

| AFSAB SECRETARIAT | |
|---|---|
| LtCol John J. Pernot, USAF | Lt. Col. Pernot has been serving on the AFSAB Secretariat since March 2001. Prior to this assignment he served in various acquisition and leadership roles to include: Deputy Chief, Ordnance Division and Program Manager, Dense Metal Warhead (Munitions Directorate, 1998-2001); Chief, Materials Division and Laboratory Director (USAF Academy, 1994-1998). Lt Col Pernot holds a B.S. in Mechanical Engineering and an M.S. and Ph.D. in Aeronautical Engineering. |

SUPPORT STAFF

Mr. Frank LaBelle, SAIC
Ms. Donna Preski, SAIC
Mr. Richard Balzano, SAIC
Mr. Mark Mateski, SAIC

# C. MEETING DATES AND LOCATIONS

| DATE | LOCATION |
|---|---|
| 13–14 Aug. 2002 | Pentagon |
| 28–29 Aug. 2002 | Chantilly, VA |
| 18–19 Sept. 2002 | Seal Beach and Huntington Beach, CA (Boeing) |
| 20 Sept. 2002 | CA (TRW) |
| 3–4 Oct. 2002 | Denver, CO (Lockheed) |
| 15–16 Oct. 2002 | Los Angeles, CA (SMC) |
| 17 Oct. 2002 | Colorado Springs, CO |
| 30 Oct.–1 Nov. 2002 | Chantilly, VA |
| 7–8 Nov 2002 | Chantilly, VA |
| 18–20 Nov. 2002 | Chantilly, VA |
| 24 Jan. 2003 | Chantilly, VA |
| 13–14 Feb. 2003 | Chantilly, VA |

# D. BRIEFINGS RECEIVED

| 13-14 AUG. 2002 | |
|---|---|
| "Overview of NRO Perspectives" | Multiple (see below) |
| "NRO Perspective" | Mr. Vincent Dennis |
| "IMINT" | |
| "SIGINT" | |
| "AS&T" | |
| "COMM" | |
| "SMC Commander's Sight Picture" | LtGen. Brian Arnold |
| "Air Force Space Acquisition Perspectives" | Mr. Richard McKinney |
| "Transformational Communications Architecture" and "Navy Programs" | RADM Rand Fisher |

| 28-29 AUG. 2002 | |
|---|---|
| "FIA and Future Programs Perspective" | Ms. Carol Staubach |
| "Space Systems Development Growth Analysis, Space R&D Industrial Base, and Conclusions from the Space Industrial Base Study" | Gen. (Ret.) Thomas S. Moorman, Jr. |
| "Synopsis Program Management Review" | Mr. Tom Betterton |
| "Assured Access" | Brig. Gen. Thomas Taverney |
| "SBIRS" | Col. Dan Cvelbar |
| "NRO Perspectives" | Mr. Dennis Fitzgerald |

| 18-19 SEPT. 2002 | |
|---|---|
| "Boeing/IDS Overview," "Boeing's Perspective—Assessment of Current Health and Acquisition Environment for National Security Space Programs," and "Boeing Systems and Processes" | Mr. Robert Roberts |
| "Selected National Security Programs Discussions" | Multiple (see below) |
| "Future Imagery Architecture" | Mr. Ed Nowinski |
| "P4500" | Mr. John Werle |

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|---|---|
| "MCP" | Mr. Mike Gianelli |
| "GPS" | Mr. Mike Rizzo |
| "Launch Services Program Discussions" | Mr. Gale Schluter |
| "Markets, Capabilities, and Quality Strategies Overview" | Mr. Randy Brinkley |
| "BSS Programs" | Mr. Charles Toups |
| "GPS" | Mr. Mike Rizzo |
| "System Engineering" | Dr. Bill Ballhaus |
| "Operations" | Mr. Mark Weltman |
| "Supply Chain Management" | Mr. Dan Bridleman |
| "Quality" | Ms. Marilyn Davis |

20 SEPT. 2002

| | |
|---|---|
| "TRW Overview" | Mr. Tim Hannemann |
| "System Engineering" | Ms. Joanne Maguire |
| "Program Management Experience" | C. Staresinich, F. Ricker, P. Borzcik, C. Kau, D. DiCarlo |

3-4 OCT. 2002

| | |
|---|---|
| "Denver Operations" | T. Marsh |
| "Sunnyvale Operations" | L. Kwiatkowski |
| "Military Space/SBIRS" | M. Crandall |
| "Assured Access/EELV" | M. Gass |
| "Classified Programs and Technology Insertion" | K. Peters, B. McAnally, D. Klinger |
| "Systems Engineering and Program Management" | G. Hall, M. Crowley |
| "Capture Process—PTW" | K. Tobey |

| 15-16 OCT. 2002 | |
|---|---|
| "SMC Issues Recap" | LtGen. Brian Arnold |
| "Advanced EHF/Transformational Communication" | Ms. Christine Anderson |
| "Global Positioning System II/OCS Briefing | Col. James Haywood |
| "SBIRS High Update" | Col. Mark Borkowski |
| "EELV" | Col. John Wagner |
| "Aerospace Topics: Roles and Responsibilities, Technical View of Main Programs, and Industrial Based Issues" | Dr. Bill Ballhaus and Dr. Wanda Austin |

| 17 OCT 2002 | |
|---|---|
| "Welcoming Remarks/Sight Picture/Space Cadre Presentation" | Gen. Lance Lord |
| Untitled | BGen William Shelton |
| Untitled | BGen John Sheridan |
| "ARSPACE—SMDC/ARSPACE Perspective on Use and Acquisition of Space Capabilities" | Multiple (see below) |
| "Overview and Operational Perspective" | Mr. John Marrs |
| "Army Acquisition of TENCAP and NRO Relationship" | Mr. Thom Revay |
| "USSTRATCOM" | RADM McArthur |
| Untitled | LtGen (Ret.) Roger DeKok |

| 8 NOV. 2002 | |
|---|---|
| "Spectrum Astro Presentation" | Mr. David Thompson |

| 24 JAN. 2003 | |
|---|---|
| Systems Engineering Integrated Defense Systems, Boeing, Seal Beach | Mr. Ron Johnson |

| 13 FEB. 2003 | |
|---|---|
| "Assessment of NRO Satellite Development Practices," The Aerospace Corporation | Mr. Steve Pavlica and Mr. William Tosney |

## E. REPORTS AND PUBLICATIONS OF INTEREST

*6250.01A Satellite Communications.* 10 Dec. 2001.

*Acquisition Management—Directive 7.* 8 Mar. 2000.

Director, CIA. *Direction to Minimize Future Imagery Architecture (FIA) Program Schedule Delays.* 23 Oct. 2002.

Fuhrman, Robert. Report to the Director of Central Intelligence, *DCI Task Force on The National Reconnaissance Office, Final Report* (known as the Fuhrman Report). 13 Apr. 1992.

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Kelly, Geiger. Report to the Director, National Reconnaissance Office; *Volume 1: NRO Restructure Study Briefing.* July 1989.

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*National Polar-Orbiting Operational Environmental Satellite System.* 1 May 2002.

*NRO Review Training Strategies—Executive Summary.* 30 Jan. 2003.

*Our National Security Space Vision 2020.*

Packard, David. *Interim Report of the Blue Ribbon Commission on Defense Management – National Security Planning and Budgeting.* 28 Feb. 1986.

Pavlika, Steve and William Tosney, The Aerospace Corporation. "Assessment of NRO Satellite Development Practices." 2003.

*Report of the Commission to Assess United States National Security Space Management & Organization.* 11 Jan. 2001.

*Report of the National Commission for the Review of the NRO.* 1 Nov. 2000.

Report to Chairman, Subcommittee on Strategic Forces, Committee on Armed Services, and the Honorable Robert C. Smith, U.S. Senate, *Defense Acquisition Improvements Needed in Military Space Systems Planning and Education.* May 2000.

*Science and Technology and the AR Vision: Archiving a More Effective S&T Program.* May 2001.

*Space Systems Development Growth Analysis—Executive Summary.* 28 Aug. 2002.

Thompson, David. *Spectrum Astro Briefing and VHS tape.* 20 Apr. 2002.

Thompson, David. *50 Technical & Program Mgmt Initiatives to Revitalize the NRO—White Paper and VHS Tape*. 29 Apr. 2002.

U.S. Air Force Scientific Advisory Board. *A Space Roadmap for the 21st Century Aerospace Force: Volume 1, Summary.* Nov. 1998.

USecAF. *Space Acquisition Policy 02-01.*

Woolsey, James. *NRO Program Task Force for the Director of Central Intelligence.* Sep. 1992.

# F. ACRONYMS

| | |
|---|---|
| AEHF | Advanced Extremely High Frequency |
| AFSAB | Air Force Scientific Advisory Board |
| DCI | Director of Central Intelligence |
| DNRO | Director, National Reconnaissance Office |
| DoD | Department of Defense |
| DSB | Defense Science Board |
| EAC | Estimate at Completion |
| EELV | Evolved Expendable Launch Vehicle |
| FFRDC | Federally Funded Research and Development Center |
| FIA | Future Imagery Architecture |
| GPS | Global Positioning System |
| JMO | Joint Management Office |
| KPP | Key Performance Parameter |
| MPC | Most Probable Cost |
| MFP | Major Force Program |
| NIMA | National Imagery and Mapping Agency |
| NRO | National Reconnaissance Office |
| NRP | National Reconnaissance Program |
| PDR | Preliminary Design Review |
| POE | Program Office Estimate |
| SBIRS | Space-Based Infrared System |
| SecDef | Secretary of Defense |
| SETA | Systems Engineering and Technical Assistance |
| SMC | Air Force Space and Missile Systems Center |
| TSPR | Total System Performance Responsibility |
| USecAF | Under Secretary of the Air Force |

## G. TASK FORCE BRIEFING

UNCLASSIFIED

# ACQUISITION OF NATIONAL SECURITY SPACE PROGRAMS

# DSB/AFSAB TASK FORCE REPORT

# NOVEMBER 19, 2002



UNCLASSIFIED

## OUTLINE

- Charter
- Membership
- Methodology
- Schedule of Activities
- Acquisition Environment
- Summary Observations
- Government Role in Space Acquisition
- Dependence on Space
- Acquisition System Problems
- Industrial Base Assessment
- Space Based Infrared System (High)
- Future Imagery Architecture
- Evolved Expendable Launch Vehicle

UNCLASSIFIED

# CHARTER

- **Problem Statement**
  - Significant cost growth and schedule delays for many critical space systems
- **Scope**
  - Understand why cost growth and schedule delays occur, considering all aspects of acquisition process
  - Assess industrial base
  - Assess Government's role and base
  - Examine U.S. national security dependence on space

UNCLASSIFIED 3

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# CHARTER

  - Emphasis Areas
    - Space Based Infrared System (High) (SBIRS)
    - Future Imagery Architecture (FIA)
    - Evolved Expendable Launch Vehicle (EELV)
- Recommend corrective actions
- **Deliverables**
  - Interim Report Sep 2002
  - Final Briefing Nov 2002
  - Final written report Feb 2003

UNCLASSIFIED 4

UNCLASSIFIED

# MEMBERSHIP

- **Tom Young, Chair**
- **Wanda Austin**
- **Bill Ballhaus**
- **Tom Betterton**
- **Don Cromer**
- **David Frost**
- **Don Hard**
- **Daniel Hastings**
- **Jimmie Hill**
- **Anita Jones**
- **Nate Lindsay**
- **Peter Marino**
- **John McMahon**
- **Tom Moorman**
- **Brad Parkinson**
- **Tony Pensa**
- **Vince Vitto**
- **Max Weiss**
- **Jack Welch**
- **Al Krum, Executive Secretary**

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# METHODOLOGY

- Examined previous relevant studies
- Performed Structured Reviews
- Conducted Multiple Interviews
- Task Force Discussions

UNCLASSIFIED 6

UNCLASSIFIED

# SCHEDULE OF ACTIVITIES

| DATE | LOCATION | Activity |
|---|---|---|
| AUG 13 | Pentagon | OSD, National Reconnaissance Office |
| AUG 14 | Pentagon, | AF SMC, Air Force, Navy |
| AUG 28 | Chantilly, VA | Faga FIA Panel, Space R&D Study |
| AUG 29 | Chantilly, VA | AF SMC, NRO |
| SEP 18 | Seal Beach, CA<br>Huntington Beach, CA | Boeing<br>Boeing |
| SEP 19 | El Segundo, CA | Boeing |
| SEP 20 | Redondo Beach, CA | TRW |
| OCT 3,4 | Denver, CO | Lockheed Martin |
| OCT 8,9 | Chantilly, VA | DoD, Air Force, and NRO |
| OCT 15 | El Segundo, CA | AF SMC |
| OCT 16 | El Segundo, CA | Aerospace Corporation |
| OCT 17 | Colorado Spring, CO | AF Space Command, BMDC/ARSPACE, US STRATCOM |
| OCT 30,31<br>NOV 1 | Chantilly, VA | FIA, End to End FIA Joint Management Office, DCI Gap Study |
| NOV 7,8 | Chantilly, VA | NPOESS, FIA, JMO |
| NOV 19 | Pentagon | Oral Report |

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# ACQUISITION ENVIRONMENT (DECADE OF THE '90s)

- Declining acquisition budgets
- Acquisition reform
- Greater acceptance of risk
- Changing National Security needs
- Mergers and Acquisitions

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## SUMMARY OBSERVATIONS

- Mission success has been mixed
- National security critically dependent upon space
- Space Acquisition process seriously flawed -- systemic problems from requirements through execution
- Industrial base adequate for current programs; concern about selected payloads/suppliers
- Government acquisition process inadequate for current programs
- FIA and EELV require urgent and critical action—SBIRS(H) corrective actions appear adequate
- National Security Space programs are technologically demanding and will continue to be challenging

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## U.S. National Security is Critically Dependent on Space Systems

**Findings and Observations**

- U.S. National Security is critically *and increasingly* dependent upon space systems
  - Communications
  - Intelligence, Surveillance and Reconnaissance
    - Early Warning
    - Situational Awareness
    - Precision Targeting
  - Navigation and Timing
  - Meteorology and Oceanography
  - Assured Access to Space
- Most of these programs are in transition
- UAV and other programs complement, but do not replace space

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## Most space missions are in transition

| Mission Area | Transition |
|---|---|
| Early Warning | Yes |
| Weather | Yes |
| Communications (normal) | Yes |
| Classified Com | No |
| Secure Com | Yes |
| GPS | Yes |
| "I" | Yes |
| "S" | No |
| Lift | Yes |

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## U.S. National Security is Critically Dependent on Space Systems

**Recommendations**

- Establish program risk consistent with criticality
- Fund launch capabilities consistent with criticality
- Size space system procurements recognizing launch and operational risk
- Establish a program to offset vulnerability of critical space assets
- Maintain continuity of capabilities during program transitions

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## Government Role in Space Acquisition

- Manage overall Acquisition Process
- Budget and allocate funds
- Establish, manage and control requirements
- Manage and control budget, including reserve
- Approve Program Definition
- Assure responsible risk management
- Participate in trade studies
- Assure engineering "best practices" are utilized in program implementation
- Manage contract including contractual changes
- Sustain a viable and competent workforce

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## Acquisition System Problems

- Cost is primary driver in managing acquisition process
- Unrealistic budgets—unrealistic/optimistic Program Plan
- Undisciplined Requirements definition and uncontrolled growth
- Inadequate Government acquisition approach
- Industry implementation deficiencies

Result

Significant cost growths and schedule delays

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# Cost is Primary Driver

**Findings and Observations**

- Cost has become the dominant driver in the acquisition process in Government and industry
- Excessive emphasis on cost can have a detrimental effect on technical performance and the ultimate program cost
- Cost and schedule performance are realized by managing quality not cost
- Responsible cost investment can measurably reduce program execution risk

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# Cost is Primary Driver

**Recommendations**

- Re-establish mission success (quality) as primary criteria in managing acquisition process
  - Requires policy changes
  - Requires leadership actions
  - Improved cost, schedule and technical performance will follow

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# Unrealistic Budgets

**Findings and observations**

- Advocacy dominates program formulation phase of acquisition process
- Independent cost and program assessments have been ineffective or ineffectively utilized
- Most programs are budgeted at 50% probability
  - Most programs have inadequate reserves
  - When reserves exist, they are often used for new requirements
- Contractor cost proposals for Cost Plus contracts have little credibility
  - Inappropriately used to reduce program budgets
  - Creates unrealistic expectations as to true program costs
- Incumbent nearly always loses
  - Non-incumbent can be more optimistic
  - Government loses investment in incumbent (capital and intellectual resource)
- Unrealistic budgets
  - Lead to unrealistic program plans requiring inefficient/costly corrective action
  - Contribute to schedule delays and/or excess program operational risk

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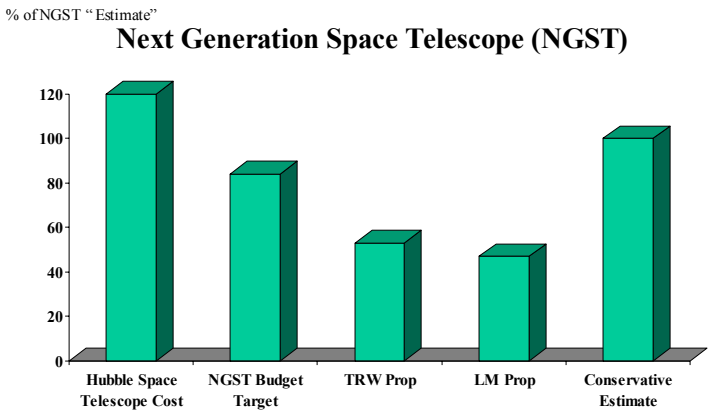
# Program Budgeting – An Example

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# Program Characteristics

Performance Requirements

Schedule

Margin

Launch Vehicle

Cost

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# Program Characteristics

Findings and Observations

Performance Requirements

- Little flexibility
- Growing

Schedule

- Inadequate due to unrealistic project plan

Inadequate or no Margins

Launch Vehicle

Cost

- Under budgeted

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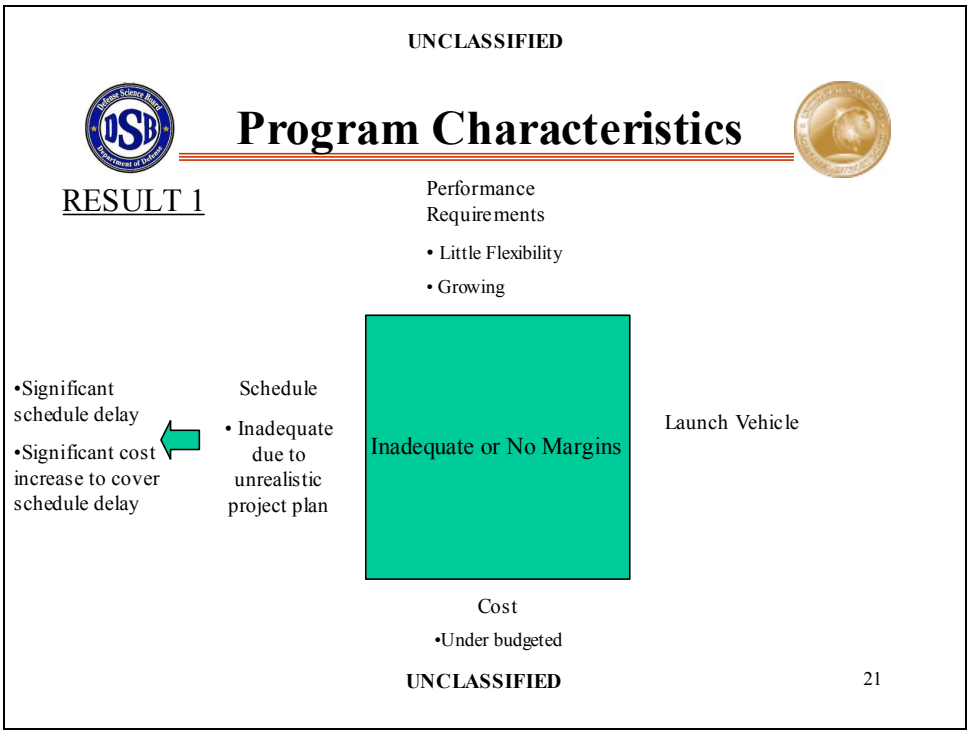
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Program Characteristics
RESULT 1
Performance Requirements
• Little Flexibility
• Growing
•Significant schedule delay
•Significant cost increase to cover schedule delay
Schedule
• Inadequate due to unrealistic project plan
Inadequate or No Margins
Launch Vehicle
Cost
•Under budgeted
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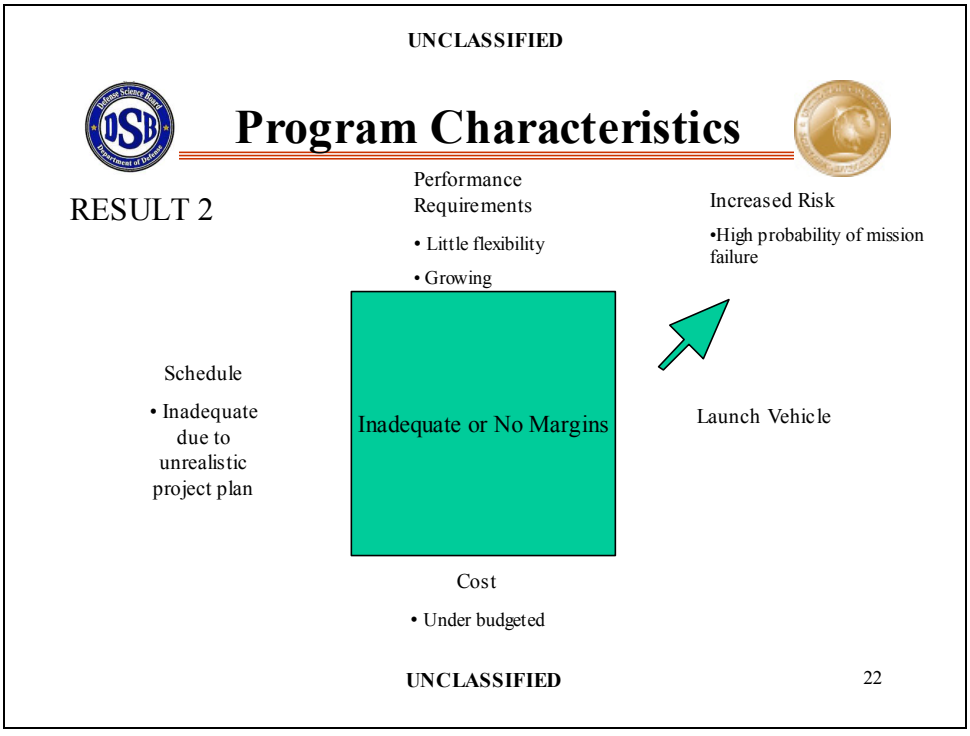
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Program Characteristics
RESULT 2
Performance Requirements
• Little flexibility
• Growing
Increased Risk
•High probability of mission failure
Schedule
• Inadequate due to unrealistic project plan
Inadequate or No Margins
Launch Vehicle
Cost
• Under budgeted
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# Unrealistic Budgets

**Recommendations**

- Budget programs to "80% probability"
- Establish reserve (20-25%) within "80% probability" budget
- Expend reserve to execute approved program—not new requirements
- Contractor cost proposals (cost plus contracts)
  - Delete any use of contractor cost proposals

    or
  - Establish cost credibility evaluation criteria and scoring as part of source selection process
- Require credible independent assessments prior to Program Initiation
  - Independent Cost Estimate
  - Independent Program Review (FFRDC, SETA, etc.)
- Implement independent senior advisory review at critical acquisition milestones (experienced, respected outsiders)

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# Unrealistic Budgets

**Recommendations – Continued**

- Compete only when clearly in the best interest of the government
  - New mission or major new technology
  - Poor incumbent performance
- If non-incumbent wins, loss of Government investment in incumbent should be reflected in program budget and implementation plan
- If non-incumbent wins, maintain program overlap to assure continuity

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## Concept to Assure Greater Credibility of Contractor Cost Proposal

- Utilize cost proposal as measure of contractor's technical understanding
- Reduce high technical score (for a particular element of proposal) if proposed cost is not credible
- Negotiate up contractor's proposal without fee to achieve realistic program plan
- Requires competent government cost estimating capability

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## Requirements

**Findings and observations**

- Requirements growth is a dominant driver of cost increases and schedule delays
- Prior to Program Initiation
  - Growth in number and scope of KPP's
  - Ineffective discipline and decision making
  - Ineffective systems engineering assessment of requirements impact
- During Program Implementation
  - Ineffective control of requirements change
  - Ineffective systems engineering assessment of impact of changes to requirements
  - Weakened authority of PM to exercise judgment to affect trades in implementing requirements

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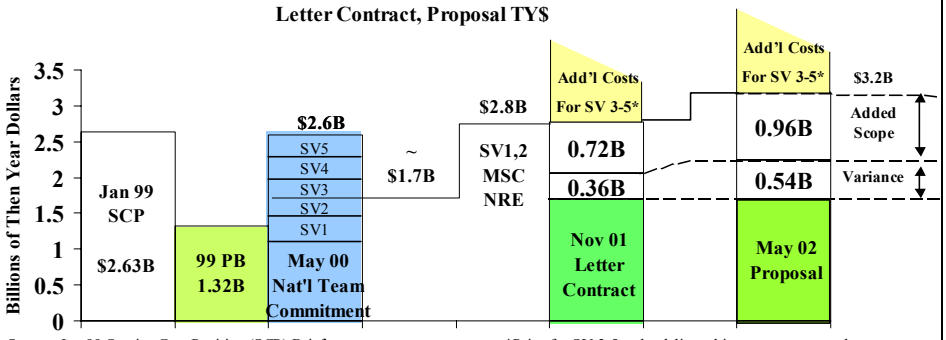
# AEHF Quantitative Framework

## (*A Point in Time*)

**Advanced EHF Development Costs**
**SAR, Commitment Letter,**
**Letter Contract, Proposal TY$**




Source: Jan 99 Service Cost Position (SCP) Briefing
AEHF Cost Growth Briefing (Dec 01, BAH Analysis

*Price for SV 3-5 to be delivered in separate proposal

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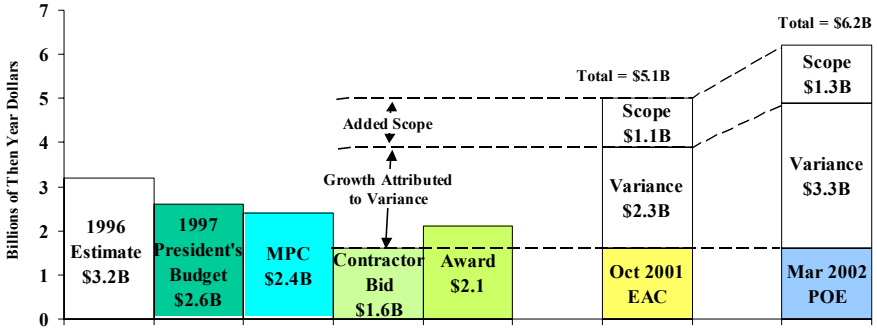
# SBIRS High Quantitative Framework

## (*A Point in Time*)

**SBIRS High EMD Costs Estimate, PB, Bid, Award and EAC TY$**




Note: PB – President's Budget; MPC – Most Probable Cost; EAC – Estimate of Completion
(1) $5.1B from 20 Nov 2001 SBIRS High EMD Cost Tract Briefing. Includes 3600, 3020, and SPO Cost funds (satellites 3,4, &5)
(2) $6.3B from 29 Mar 2001 SBIRS High Program Office Estimate (POE). Includes 3600, 3020, and SPO Cost funds (satellites 3,4, &:5)
(3) Other sources: ABIDES; Source Selection Document; BAH analysis

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# Requirements

- **General Recommendations**
  - Ensure the establishment of a senior leader within the DoD and a senior leader within the Intelligence Community with the authority to accept or reject requirements
  - Ensure the requirements development process includes operators, users and acquisition personnel
  - Provide system engineering support to execute the requirements trades process
  - Institute training and certification programs for requirements managers

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# Requirements

**Recommendations**

- **Prior to Program Initiation:**
  - Strengthen the systems engineering process for assessing the impact of proposed requirements, with particular emphasis on cost
  - Create an approved requirements definition document
  - New or revised requirements must be accepted by Requirements Leader prior to utilization by program
- **During Program Implementation**
  - Make the PM responsible for requirements management
  - PM continues to assess impact of new requirements until SRR or PDR
  - Review and approve Program Requirements at time of SRR or PDR and place them under change control

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# Requirements

- **During Program Implementation (continued)**
  - New requirements must come with an identified funding source
  - Strengthen systems engineering capability to assess total impact of requirements changes
  - PM Chair Program Requirements CCB with authority to accept or reject requirements changes (including authority to reject un-funded requirements) and to make reasonable adjustments to requirements to enhance program implementation
  - A significant change in requirements affecting the user/operator requires coordination with the requirements leader prior to approval

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# Inadequate Government Acquisition Process

- Acquisition Work Force
- Program Manager Authority
- Systems Engineering Capability
- Reporting Integrity

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# Acquisition Workforce

**Findings and Observations**

- Interacted with some excellent Program Managers
- Many senior managers in acquisition chain of command have little or no large systems management experience
- Too few experienced program managers and insufficient emphasis / progress on development
- Average tenure for many Program Managers less than 2 years
- The skill level and experience at the middle management level is inadequate
- SMC and NRO inadequately staffed
- Capable people leave the acquisition workforce due to poor work environment, lack of appropriate authority and poor incentives

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# Acquisition Workforce

**Recommendations**

- Perform a study to determine approach to workforce revitalization at NRO and SMC
- Provide SMC and NRO with adequate staff at appropriate experience levels
- Require minimum PM tours of four (4) years
- Utilize Excepted Service authorities and hire retired personnel with significant acquisition experience to solve near term problem

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## Program Manager Authority

Findings and Observations

- Acquisition environment is such that "World Class" PM would have difficulty succeeding
- PM authority has been eroded by acquisition reform
- Staff and oversight organizations have been strengthened at expense of PM authority
- Inadequate program funding with no margin presents PM with unexecutable program with no ability to manage
- Uncontrolled requirements growth plus no authority to reasonably adjust requirements presents PM with impossible management challenge
- Special management organizations such as "JMO" can dilute PM authority

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## Program Manager Authority

- Only Government PM and contractor PM and their respective organizations can make a program succeed
  - Staff organizations and senior leadership can contribute to success by constructive support
  - Staff organizations and senior leadership can cause a program to fail

**RECOMMENDATIONS**

- Recognize the key role of PM through policy and leadership actions
- Assure Program definition is realistic (requirements, budget, schedule and implementation approach)
- Provide PM with adequate reserve and reserve management authority
- Provide PM with authority to management and control requirements, including the authority to make reasonable adjustments to enhance program execution

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## Systems Engineering Capability

**Findings and observations**

- Government systems engineering capability has eroded significantly
- Capability is not adequate to assess requirements, program definition and program execution

**Recommendations**

- Near Term
  - Utilize combined capabilities of government, FFRDC's and SETA's
- Long Term
  - Re-establish government systems engineering capability
    - Select appropriate people from within government
    - Hire to acquire capabilities
    - Implement training programs

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## Reporting Integrity

**Findings and Observations**

- Many problems are recognized by Government Acquisition organizations and contractors
- Problems not reported to senior government leadership
- Environment encourages over-optimism in ability to work through major problems

**Recommendation**

- Establish environment that encourages problem reporting
- Severely punish failure to report problems

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# Industry Implementation

**Findings and Observations**

- Failure to assure "best practices" were applied (some programs)
- Failure to communicate systemic program problems to Government acquisition leadership in a timely manner
- Contract and fee structure can cause industry to lose focus on sound program implementation practices

**Recommendations**

- Hold industry accountable for quality of program implementation
- Government Program office with support of FFRDC's and SETA's assure "best practices" are being utilized
- Establish an environment that encourages early identification and open discussion of problems
- Align contract and fee structure to balance program risk between government and industry and focus industry attention on "best practices" management and mission success

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# Capability of the Industrial Base

**Findings and observations**

- Most program areas are in transition
- Significant excess capacity in "factory"
- Adequate staffing available
- Acceptance rate for new hires is very high
- Concern is developing, acquiring and retaining "top" systems engineers and experienced Program Managers
- Major future problem (large and growing percentage of workforce eligible for retirement)

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## Capability of the Industrial Base

**Recommendations**

- Monitor corrective actions for existing problems to assure stabilized acquisition environment
- Cautiously add new programs
- Phase new starts so as to avoid highs and lows in staffing requirements

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## SBIRS HIGH

**Findings and Observations**

- Case study in how not to do a Space Program
  - Cost Driven
  - Under funded
  - Optimistic contractor proposal
  - Uncontrolled requirements
  - Limited PM authority and capability—max use of Acquisition reform
  - Funding instability—4 replans
  - PM instability—4 Government PM's and 4 Industry PM's
  - Failure to implement "best practices"
- "Basket SPO" pushes critical program management down a level and dilutes attention of System Program Director
- Corrective action appears positive

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# SBIRS High

**Recommendations**

- Proceed with revised program
- Review past engineering activities to assure acceptable quality of product
- Strengthen SPO with additional experienced managers

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# EELV

**Findings and observations**

- Business plans for both contractors are financially inadequate and probably would not be supported if at program initiation
- National security space is critically dependent upon assured access to space
- Assured access to space requires both contractors---at least until sustainable performance is demonstrated
- EELV program has occurred in highly cost constrained environment---continued pressure can put mission success at risk
- **Recommendations**
- Establish a long term plan for the EELV Program and make visible to both contractors
- Take necessary actions to assure both contractors remain viable---at least until sustainable performance is demonstrated

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# Summary Observations

- Mission success has been mixed
- National security critically dependent upon space
- National Security Space Acquisition process seriously flawed—systemic problems
- Industrial base adequate for current programs
- Government acquisition management inadequate for current programs
- FIA and EELV require urgent and critical action---SBIRS(H) corrective actions appear appropriate
- National Security Space programs are technologically demanding and will continue to be challenging

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