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ACHIEVING AFFORDABLE OPERATIONAL REQUIREMENTS ON THE SPACE BASED INFRARED SYSTEM (SBIRS) PROGRAM: A MODEL FOR WARFIGHTER AND ACQUISITION SUCCESS?

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Well defined, warfighter customer generated operational requirements are the most significant determinants of successful military systems. If the warfighter customers and the acquirers do a good job early of defining the operational requirements, the warfighters will have a much higher likelihood of obtaining a capable system that meets their needs in less time and at less cost. The Space Based Infrared System (SBIRS) Program, a complex ?system of systems? satellite development effort, followed a different philosophy than was the norm to define and refine operational requirements that meet the needs of the warfighters. Drawing upon the management, systems engineering, and business reforms called for by several national commissions over the last 15 years and advocated by the Office of the Secretary of Defense, SBIRS followed three basic principles to produce an effective and affordable JROC-validated set of multimission operational requirements to satisfy several warfighter customers. These principles included (1) close partnership between warfighter customers (users, operators) and acquirers (military acquisition personnel and defense contractors) throughout the requirements generation process with the warfighters having the final decisions on operational requirements; (2) disciplined system requirements and affordability analysis from a system of systems perspective, using cost as an independent variable; and (3) streamlined business and acquisition environment. The SBIRS Program applied these principles within the basic existing Department of Defense acquisition framework. The SBIRS Program effectively overcame potential roadblocks to producing an effective warfighter-supported operational requirements document (ORD) in a severely constrained environment of competing customer and fiscal requirements priorities. The program accomplished this by providing structure, analysis methods, and mechanisms that facilitated effective stakeholder communication, mutual understanding, and consensus decision making at all levels. Despite some limitations experienced at the working level, the basic SBIRS approach to requirements generation was effective in achieving success for the SBIRS Program. It is concluded that it was an improvement over the previous methods for defining operational requirements on unclassified programs, thereby better meeting the needs of the nation?s warfighters. Furthermore, SBIRS appears to provide a validation point for some of the reforms to the Defense Acquisition System regarding requirements definition contained in the latest Department of Defense (DOD) Directive 5000.1 and DOD Regulation 5000.2, dated 15 March 1996. The SBIRS Requirements Generation process also appears to be a valid model for other new systems, particularly complex ones with multiple missions and warfighter customers. Therefore, the SBIRS Requirements Generation Process should be studied for its suitability as a model for not only USAF system programs, but joint service programs as well.

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Preface

As a member of the Space Based Infrared System (SBIRS) Program Office at Los Angeles AFB for just over a year, I helped establish and lead the multifunctional team that worked closely with the Air Force Space Command (AFSPC), the organizations that will depend on SBIRS, and the two competing contractor teams to refine and help AFSPC and the warfighters finalize the SBIRS operational requirements. This was a very fast-moving and challenging experience. I selected the SBIRS Requirements Generation Process as my topic because this initial phase of SBIRS is an important test case for reforms to then existing DOD-wide policy, practices, and procedures. Nobody to my knowledge had yet described and analyzed the structural mechanisms, analysis processes, and environment, particularly at the program office-level, that led to the validated set of SBIRS operational requirements. I wanted to capture and evaluate the experience to determine what aspects are applicable to future programs. I have attempted to point out both the successes and drawbacks of the effort from my perspective as well as others external to the SPO. I hope this will be a useful contribution to ongoing research into the effectiveness of recently proposed and implemented reforms to make the Defense Acquisition System more responsive to the needs of the nation's warfighters.

My thanks go out to members of the always busy SBIRS Program Office at Los Angeles AFB. Specifically, I want to thank Ms. Rita Antonelli and Ms. Linda Jeter for collecting and sending program documents, and Lt. Col. Roger Robb, Mario Miranda,

Dr. Mike Jacobs, Bruce Stafford, and Mike McDonald for answering questions. My appreciation also goes out to Lt. Col. Jim Bloise, USSPACECOM/J5, and Lt. Col. Jim Martin, DUSD (Space), for providing copies of requested correspondence and answering questions.

Abstract

Well defined, warfighter customer generated operational requirements are the most significant determinants of successful military systems. If the warfighter customers and the acquirers do a good job early of defining the operational requirements, the warfighters will have a much higher likelihood of obtaining a capable system that meets their needs in less time and at less cost.

The Space Based Infrared System (SBIRS) Program, a complex "system of systems" satellite development effort, followed a different philosophy than was the norm to define and refine operational requirements that meet the needs of the warfighters. Drawing upon the management, systems engineering, and business reforms called for by several national commissions over the last 15 years and advocated by the Office of the Secretary of Defense, SBIRS followed three basic principles to produce an effective and affordable JROC-validated set of multimission operational requirements to satisfy several warfighter customers. These principles included (1) close partnership between warfighter customers (users, operators) and acquirers (military acquisition personnel and defense contractors) throughout the requirements generation process with the warfighters having the final decisions on operational requirements; (2) disciplined system requirements and affordability analysis from a system of systems perspective, using cost as an independent variable; and (3) streamlined business and acquisition environment. The SBIRS Program

applied these principles within the basic existing Department of Defense acquisition framework.

The SBIRS Program effectively overcame potential roadblocks to producing an effective warfighter-supported operational requirements document (ORD) in a severely constrained environment of competing customer and fiscal requirements priorities. The program accomplished this by providing structure, analysis methods, and mechanisms that facilitated effective stakeholder communication, mutual understanding, and consensus decision making at all levels.

Despite some limitations experienced at the working level, the basic SBIRS approach to requirements generation was effective in achieving success for the SBIRS Program. It is concluded that it was an improvement over the previous methods for defining operational requirements on unclassified programs, thereby better meeting the needs of the nation's warfighters. Furthermore, SBIRS appears to provide a validation point for some of the reforms to the Defense Acquisition System regarding requirements definition contained in the latest Department of Defense (DOD) Directive 5000.1 and DOD Regulation 5000.2, dated 15 March 1996. The SBIRS Requirements Generation process also appears to be a valid model for other new systems, particularly complex ones with multiple missions and warfighter customers. Therefore, the SBIRS Requirements Generation Process should be studied for its suitability as a model for not only USAF system programs, but joint service programs as well.

Chapter 1

Introduction

The operators and operational users of military systems, collectively referred to hereafter as the warfighters, have traditionally complained that the systems delivered to them do not completely perform to needs and expectations, and that the time to develop and field systems takes too long. The warfighters usually direct the blame at the acquirers and the defense acquisition system, citing unresponsiveness and inefficiency. Despite problems inherent in the bureaucratic way the United States (US) develops and produces increasingly complex military systems, the root source of much if not most of the complaints can be fundamentally attributed to inadequately defined operational requirements by the warfighters and the acquirers at the beginning of the system life cycle. Without properly identifying and expressing the mission problem and the needed performance to solve it, the resultant system will not fully satisfy the needs of the warfighters. This is because, validated operational requirements defined at the beginning of a program are the primary determinants of what the system will actually do. If the warfighters and acquirers do a good job early of defining the operational requirements, the warfighters will have a much greater likelihood of obtaining a capable system that meets their needs in less time and at less cost than if it is done poorly.

Based on the failures and difficulties of past military acquisition programs, the following is a list of possible problems that hinder definition of effective operational requirements for a system, especially when many customers are involved:

Not all of the appropriate warfighter customers participate in the process for defining the operational requirements. The system acquirers have an inadequate understanding of the warfighter customers needs and desires. The warfighter customers do not have control over the final selection operational requirements to support their needs. Stakeholder organizations refuse to compromise with one another on operational requirements. There is no formal mechanism established for deciding among competing requirements priorities. There is no disciplined process for generating the technical information needed to decide on appropriate system performance levels. Not all the appropriate coordinating and approval authorities for operational requirements documents understand the issues. These all are possible problems that can impact the resulting operational requirements and therefore have implications throughout the system life cycle.

These problems primarily point out what has been a chronic lack of communication and common understanding between the warfighters, who identify mission needs, and the acquirers, who develop the systems to meet those needs. The first and most important point at which they meet is the requirements generation system residing predominantly at the front end of a system's life cycle. This complex process, or more accurately collection of many processes, focuses on the development of an operational requirements document (ORD). Both warfighters and acquirers have lacked mechanisms to enable each community to more effectively communicate and work together to produce requirements documents better reflective of warfighter needs and available funding. For a requirements

generation process to be effective, it must be designed to counter the problems listed above.

The issue of requirements definition is particularly important for joint programs and single service programs with joint customers, because the impact of requirements problems are more widespread. As military systems become more joint in practice and budgets become smaller, each new system will have a larger number of stakeholders. This complicates the process with which to achieve agreement on expected system performance.

The Space Based Infrared Systems (SBIRS) Program, a satellite system development effort identified by the Office of the Secretary of Defense (OSD) as a "flagship streamlined acquisition program,"[1] followed a different approach than normal to define and refine affordable operational requirements and reach joint service warfighter customer consensus. SBIRS tried out many of the proposed management, systems engineering, and business reforms called for by several national commissions and study groups over the past 15 years, as well as innovations developed on its own.

During the upfront requirements generation period, the program practiced the following basic principles:1) Close partnership between warfighters (users, operators) and acquirers (military acquisition personnel and defense contractors) throughout the process with the warfighters having the final decisions on operational requirements; 2) disciplined system requirements analysis and affordability assessment from a system of systems perspective, utilizing cost as an independent variable; and 3) streamlined business and acquisition environment.

This paper investigates to what extent the SBIRS approach to defining and refining operational requirements was successful, whether or not it represents an improvement over approaches previously followed, and whether or not it is a valid model for other programs to emulate. Given the trends of reduced military budgets, falling government manpower, increasing joint service usage of systems, and the need for shorter acquisition timelines, SBIRS provides an important example for study. The following chapters will describe and analyze what the SBIRS Program did to produce a validated operational requirements document by providing a background description of SBIRS, outlining the framework for basic requirements generation, analyzing and evaluating the SBIRS Requirements Generation Process, and providing conclusions and recommendations concerning the effectiveness of the approaches and methods implemented.

Notes

[1]Department of Defense, Acquisition Decision Memorandum, 8 February 1995.

Chapter 2

SBIRS Background

The Space Based Infrared System (SBIRS) is a satellite system being developed by the United States Air Force (USAF) to provide crucial information to a variety of customers in the military and the government. SBIRS addresses four basic mission areas: missile warning (strategic and theater), missile defense (strategic and theater), technical intelligence, and battlespace characterization. Missile warning concerns the fast detection, identification, and predicted impact point location of ballistic missiles launched against the US and its deployed military forces and allied forces throughout the world. SBIRS will contribute to missile defense by providing to future weapons systems the midpoint tracking and target discrimination information on ballistic missiles in boost to early terminal flight phases. SBIRS will also support the technical intelligence mission by providing infrared spectrum data to the intelligence community. Finally, SBIRS will support the evolving battlespace characterization mission by contributing to US forces anywhere in the world with information that supports situation awareness, wide area surveillance, intelligence preparation of the battlefield, battle damage assessment, and order of battle information.[1]

SBIRS is a "system of systems" that will consist of several major system components when fully deployed. (See Figure 1.) The High Component is a constellation of four

satellites in geosynchronous earth orbits (GEO) and two sensors riding on satellites in highly elliptical orbits (HEO). The Low Component is a constellation of approximately two dozen satellites in low earth orbit (LEO). The Low Component, a crucial link for adequately supporting missile defense operations, is also an integral component of the Ballistic Missile Defense System architecture. Both SBIRS component systems make up the space segment, and they are supported by a ground segment consisting of signal relay, mission processing, communication, and operations infrastructure. The High Component is set to begin deployment in 2002, and the Low Component deployment is set for 2004 or earlier. The life cycle cost of the entire system has been estimated at about $22 billion over a 20-30 year operational life.

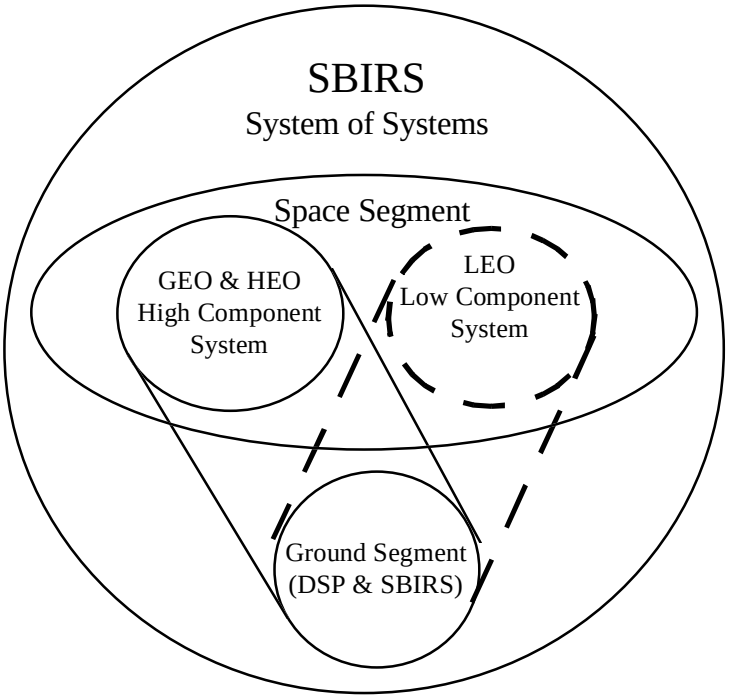

Figure 1. SBIRS System of Systems

SBIRS, particularly the GEO/HEO High Component, is intended primarily as a follow-on to the Defense Support Program (DSP), a formerly classified system of

satellites that has been operational since the early 1970s. The classified community designed DSP an early warning system for detection of large land-based and sea-based intercontinental ballistic missiles, and it is a very effective system for detecting such large missiles. However, with the world proliferation over the last 15 years of theater ballistic missiles (TBMs) and weapons of mass destruction that threaten US forces overseas, detection of smaller, low infrared signature missiles has become imperative. Despite performance improvements achieved through enhanced data processing in the Attack and Launch Early Reporting to Theater (ALERT) Program in the early-to-mid 1990s, the DSP has inherent limitations preventing its effectiveness against emerging threats. Therefore, the USAF determined in the early 1990's that upgrading the DSP was not a viable option. As further impetus to develop a new system, Congress canceled some outstanding orders for DSP satellites and initiated closure of the DSP production line just after initiation of the SBIRS Program.

Attempts to develop a follow-on to DSP had foundered for 15 years until SBIRS. (See Figure 2.) The Advanced Warning System Program, started in 1979, was folded into the Strategic Defense Initiative (SDI) architecture in 1984 as the Boost Surveillance and Tracking System (BSTS). With the end of the Cold War, OSD transferred the BSTS program and mission are to the USAF and eventually became the Future Early Warning System (FEWS). Although ranked as the United States Space Command's top priority program at the time, OSD canceled FEWS in 1993. The cancellation resulted from the Department of Defense (DOD) bottom-up review which found the FEWS requirements to be excessive in light of the new post-Cold War world situation.[2] A period of government

studies followed to investigate a less ambitious early warning system. An initial result was the ALARM Program, which was canceled in 1993 just before SBIRS.

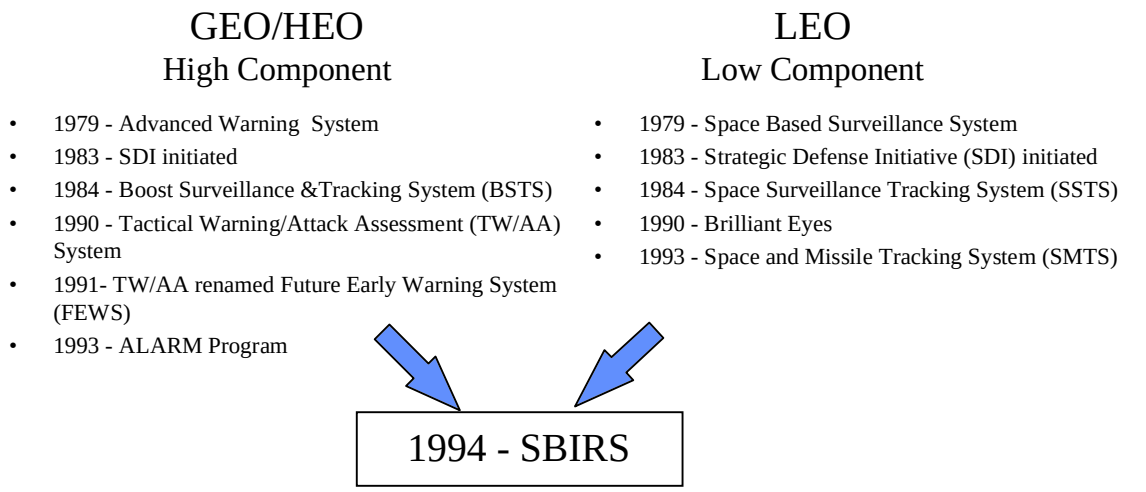

Figure 2. SBIRS Program History

During these same 15 years, considerable work had gone towards developing a LEO, or Low Component, infrared platform for supporting the ballistic missile defense mission. The Space Based Surveillance System program of 1979 was incorporated into the SDI in 1984 as the Space Surveillance and Tracking System (SSTS). In the early 1990s, SSTS became Brilliant Eyes and was transferred to the USAF before becoming the Space and Missile Tracking System (SMTS). The national decision makers had tied the decision to develop and deploy this Low Component to decisions about national and theater ballistic missile defense systems. Due to Anti-Ballistic Missile Treaty considerations, the end of the Cold War, and cost considerations, the Congress and the White House have stopped efforts to authorize early deployment.

In addition to the missile warning and missile defense missions, the intelligence community depend on infrared sensors to fulfill growing technical intelligence

requirements. Also, the need to provide warfighters with more information as to what is happening on the battlefield drives the battlespace characterization needs.

The critical need for improved TBM warning and defense capability, the strong desire to find a more affordable follow-on for performing the crucial national ballistic missile warning mission, and shutdown of the DSP production line all contributed to an environment that produced an unusual consensus of support at the highest level for a new system. What remained to be decided was the cost and operational performance of that system.

In the summer of 1994, organizations in the Office of the Secretary of Defense (OSD) initiated a government study to "consolidate and streamline various alternative approaches to collecting and disseminating space-based infrared (SBIR) data."[3] Motivations were the possibilities of greater synergy and less mission overlap between the different infrared systems being envisioned at the time with consequently less cost. All major warfighter and acquisition stakeholders participated in this three-month effort, including representatives from the Services, Joint Staff, missile defense community, intelligence community, cost analysis community, and warfighter organizations. Therefore, the OSD and SBIR communities recognized the possibility of creating an integrated "system of systems" architecture that would include a DSP follow-on and SMTS with a single ground infrastructure. Reducing cost, in addition to theater missile warning and defense and infrared intelligence, had become a prime driver in the age of falling defense budgets.

The outcomes of the 1994 Summer Study, and a follow-on study in the fall by the Ground Segment Study Group (GSSG), included a single SBIR Capstone Requirements Document (CRD), a baseline integrated architecture described above, an integrated

ground architecture concept, and an acquisition approach to refine and achieve them. The Summer Study recommended that the High Component be developed first, then the Low Component. The Defense Resources Board approved these recommendations on 19 October 1994, and they served as the basis for the new SBIRS Program.

While these studies of 1994 achieved their primary objectives, the government recognized that the defense contractors, who had no direct involvement in the studies other than supplying information, needed to have the opportunity to analyze the proposed requirements, investigate their own possible innovative approaches, perform their own cost/performance tradeoff analyses, recommend changes to the draft SBIRS ORD, and provide their own cost estimates in a competitive environment. OSD believed this would help ensure that the government achieved feasible, affordable operational requirements and system design concepts based on the approved top-level architecture. The government also recognized that this could not be adequately accomplished separately by the contractors in only a few months during proposal preparation for the SBIRS High Component Engineering and Manufacturing Development (EMD) source selection. Therefore, the approach developed by OSD and the executing agency, the USAF, included a 15-month system of systems requirements analysis and risk reduction effort. This period of requirements clarification and refinement with the warfighters, cost/performance trade studies performed by competing contractors working closely with government personnel, and government evaluation of the costs and benefits was called Pre-EMD. The primary objectives of this phase were to refine the draft operational requirements set to fit within affordability constraints, gain validation of SBIRS operational requirements by the Joint Requirements Oversight Council (JROC), and gain approval for entering EMD.

The SBIRS acquisition strategy included awarding $80 million contracts to each of two contractors for the system of systems Pre-EMD phase, and then selecting between them for entry into the High Component EMD. The SBIRS Program planned High Component EMD to involve not only production of the first block of High Component satellites for deployment starting in 2002, but also the consolidation of DSP ground station operations by 1999 to reduce operating costs and facilitate easier transition to SBIRS operations several years later. The USAF selected the Hughes/TRW and Lockheed Martin teams for system of systems Pre-EMD in August 1995. The USAF awarded the ten year, $1.8 billion High Component EMD and initial production contract in November 1996 to Lockheed Martin. A follow-on High Component production contract is expected sometime thereafter. Furthermore, a Low Component Pre-EMD is planned, and Low Component EMD is expected to be initiated no later than 2001. (See Figure 3.)

Upon establishment of the SBIRS Program, the OSD identified it as a pathfinder program for acquisition reform. The basis of the SBIRS acquisition management approach was the reform philosophy and recommendations from a long series of national studies, such as the Grace Commission in 1982, the Packard Commission in 1986, the Defense Management Report in 1989, and particularly the Secretary of Defense 1994 Plan for Acquisition Reform.

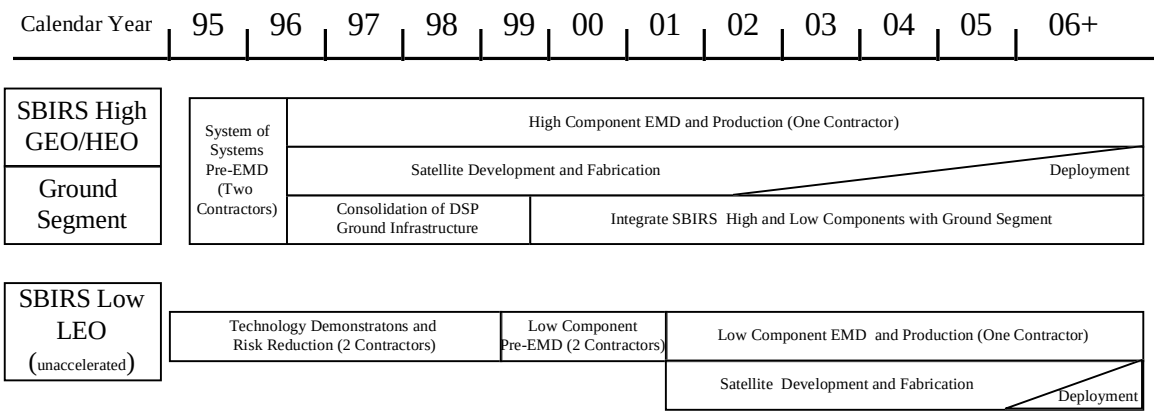

Figure 3. SBIRS Program Schedule

Central to the wide range of recommendations are changes to the requirements generation process involving the organizational structure and relationships of the stakeholders, the technical analysis and requirements decision making methods, and the business and acquisition environment. The DOD and the USAF granted the SBIRS Program much leeway in implementing its requirements development and refinement approach, and the SBIRS Program developed and implemented some innovations of its own. In essence, the SBIRS Requirements Generation Process represents new methods and flexible procedures within the then-existing Department of Defense (DOD) Directive 5000.1 and DOD Instruction 5000.2 (1991) framework for military systems acquisition.

Notes

[1]USSPACECOM/J330, Draft SBIRS Capstone CONOPS Version 7, 4 December 1995, 3.

[2]SBIRS Program Office, Space Based Infrared System (SBIRS) Single Acquisition Management Plan (SAMP) Version 6, 6 February 1995, 6.

[3]Ibid., 4.

Chapter 3

Framework of SBIRS Requirements Generation Process

At the time the SBIRS Program began, Department of Defense (DOD) Directive 5000.1 (DODD 5000.1), "Defense Acquisition," February 23, 1991 and DOD Instruction 5000.2 (DODI 5000.2), "Defense Acquisition Management Policies and Procedures," February 23, 1991, provided the acquisition policy and procedure guidance. These documents address all phases of the system life cycle. The requirements generation process, while continuing throughout most of the system life cycle, is focused primarily at the beginning in what is referred to as Phase 0 Concept Exploration and Definition and Phase I Demonstration and Validation (most recently named Program Definition and Risk Reduction). Integral to the process is a series of milestones for validating requirements and approving the initiation and execution of major systems development programs. Associated with these phases and milestones are numerous documents that require preparation according to strict formats and lengthy sequential coordination. Figure 4 is a broad outline of the process framework. SBIRS had to go through the same basic process during its primary requirements definition period from 1994 to 1996. As an Acquisition Category ID (ACAT ID) program, DODD 5000.1 required that SBIRS pass through the highest level of formal review and approval. However, the Office of the Secretary of

Defense (OSD) significantly reduced the documentation format, reporting, coordination, and oversight within the basic.

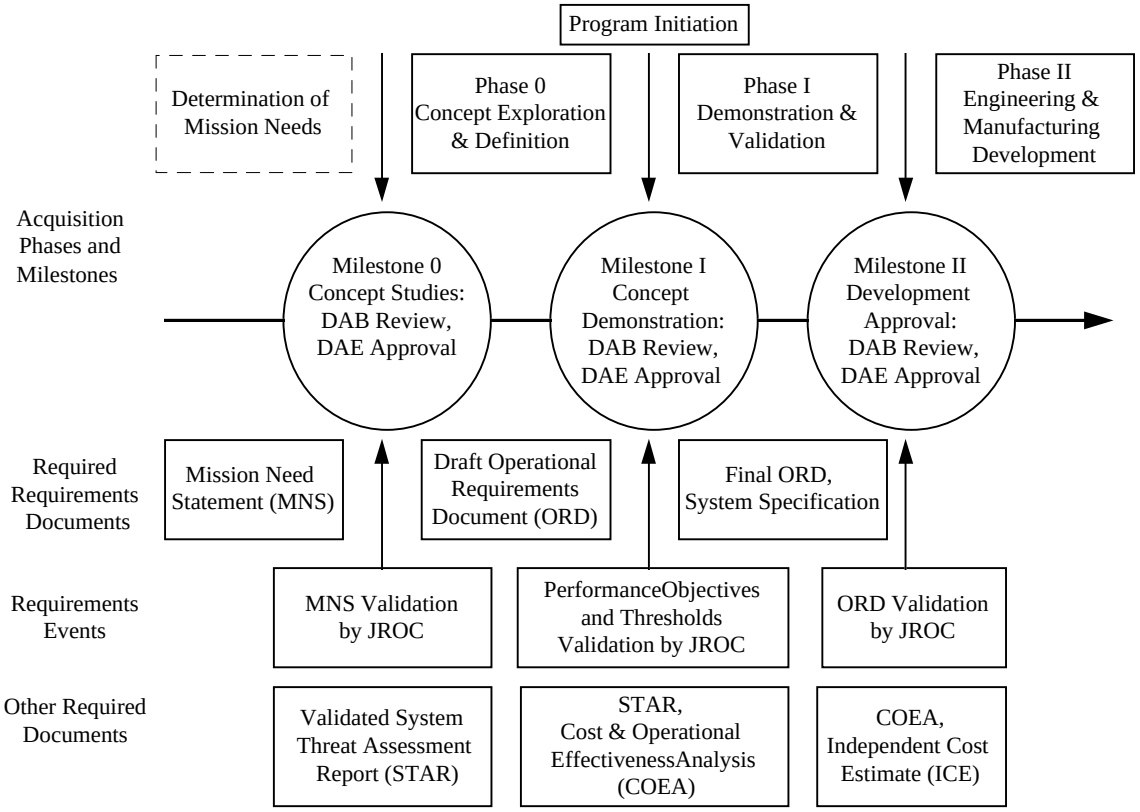

Figure 4. DODI 5000.2 (1991) Requirements Generation Framework

framework, particularly in Phase I. Furthermore, OSD gave the program much flexibility to test out many of the newly introduced management, systems engineering, and business concepts for improving requirements generation and the overall acquisition process. According to Col. Brent Collins, then Deputy Director of Space Programs, under the Assistant Secretary of the Air Force for Acquisition, SBIRS has become a prototype for testing some of the Pentagon's theories about the way acquisition might be speeded up.[1]

According to DODI 5000.2, the objectives of Phase 0 Concept Exploration are: (1) Explore various materiel alternatives to satisfy the documented mission need, (2) define the most promising mission concept, (3) develop supporting analyses and information to

include identifying high risk areas and risk management approaches to support the Milestone I decision, and (4) develop a proposed acquisition strategy and initial program objectives for cost, schedule, and performance for the most promising system concept(s).[2] SBIRS Phase 0 Concept Exploration activities began in 1994, and they followed the spirit of the DOD 5000-series documents. However, OSD did not establish a formal Milestone 0 specifically for SBIRS. OSD officials probably concluded one was not necessary due to two reasons. The first was the existence of an applicable validated Air Force Space Command (AFSPC) Mission Need Statement (MNS), JROC 015-89 dated 4 April 1989. The second was the existence of the System Threat Assessment Report (STAR) for the recently canceled ALARM Program. Another possible factor is that the recently canceled Future Early Warning System (FEWS) Program had achieved Milestone 0 and I approval just a few years earlier.

Concept Exploration activities began in earnest with the 1994 Summer Study. The original goals of the Summer Study were to, consolidate all IR [infrared] requirements into a single set of capstone SBIR requirement documents; develop potential architectures; assess the options against requirements; select the best architecture based on operational utility, technical feasibility, and affordability; and develop a program to implement the chosen architecture. The chosen architecture would be a streamlined and affordable system with greater theater utility than current systems against present and future missile threats and would have flexible platforms for Pre-Planned Product and Process Improvement (P4I) growth opportunities.[3]

The Ground System Study Group (GSSG) Study extended the cost, requirements, and architecture investigation to the ground segment of the system.

These studies provided a quick but fairly rigorous government analysis effort that established the initial baseline system performance requirements and key performance parameters (KPPs) in the SBIR Capstone Requirements Document (CRD). The CRD was essentially a draft operational requirements document (ORD) without the support requirements. The JROC validated the SBIR CRD in January 1995, with the exception of the data availability and survivability parameters, and the document served as the starting point for Phase I requirements analysis. The Summer Study and GSSG Study, along with the resulting SBIR CRD validation, preparation for Defense Acquisition Board (DAB) and Defense Acquisition Executive (DAE) Milestone I approval, and preparation for the system of systems Pre-EMD source selection were the major events of the SBIRS Phase 0 Concept Definition.

OSD streamlined the effort required to obtain approval to enter Phase I. OSD allowed the SBIRS Program to submit the JROC-validated SBIR CRD instead of a complete ORD, the existing System Threat Analysis Report (STAR) from the ALARM Program, cost estimates based on the Summer Study and GSSG Study instead of a formal Independent Cost Estimate (ICE), and the results of the preliminary Summer Study cost/performance trade studies instead of a draft Cost and Operational Effectiveness Analysis (COEA). Most of the other required documents were covered by submittal of a single innovative document called the Single Acquisition Management Plan (SAMP) that was developed by the SBIRS Program Office (referred to hereafter as the SPO) at Space and Missile Systems Center (SMC) at Los Angeles AFB, CA. The SAMP described the SBIRS Program plans and addressed the management, technical, budget, contracting, risk, schedule, and programmatic aspects of the development effort. A group of the program

acquisition and warfighter stakeholders authored the SBIRS SAMP, and it eliminated many of the redundancies and inconsistencies normally found among the separate documents. The SBIRS Program intended the SAMP to serve as a living document that would be updated for each Milestone review.

According to DODI 5000.2, the objectives of Phase I Demonstration and Validation are: (1) Better define the critical design characteristics and expected capabilities of the system concept(s), (2) demonstrate that the technologies critical to the most promising concept(s) can be incorporated into system design(s) with confidence, (3) prove that the processes critical to the most promising system concept(s) are understood and attainable, (4) develop the analyses/information needed to support a Milestone II decision, and (5) establish a proposed Development Baseline containing refined program cost, schedule, and performance objectives for the most promising design approach.[4] SBIRS called its Phase I "Pre-Engineering and Manufacturing Development" (Pre-EMD), and the objectives of SBIRS Pre-EMD were consistent with the DODI 5000.2 guidance. However, OSD and the USAF gave SBIRS the freedom to tailor procedures where it deemed appropriate.

Milestone I approval by the DAE, contained in the 8 February 1995 Acquisition Decision Memorandum, authorized SBIRS to enter Phase I Pre-EMD, thereby allowing the SPO to proceed with the Pre-EMD source selection. Pre-EMD activities formally began with the selection of the Hughes/TRW and Lockheed Martin teams in August 1995. These contractors worked with the government to conduct cost/performance trade studies in order to refine the operational requirements and define system concepts to meet warfighter needs within a firm funding profile and top-level architecture based on the Summer Study and GSSG results. It was also a period for the government and

contractors to prepare to enter SBIRS High Component EMD. The government's original outline for Pre-EMD after contracts award included system requirements analysis and definition activities along with concept development culminating in a formal system requirements review (SRR) and a system functional review (SFR) with each contractor team separately. The rest of Pre-EMD consisted of SBIRS ORD preparation, JROC review and validation of the final version of the SBIR CRD and the SBIRS ORD, selection between the two contractor teams for SBIRS High Component EMD, and DAE Milestone II approval. Warfighter customer organizations were involved directly or indirectly in all of these activities.

DODI 5000.2 required a formal COEA to be submitted for the Milestone I and II decisions. The objective of a COEA is to identify the relative advantages and disadvantages of the alternatives being considered and show the sensitivity of each alternative to possible changes in assumptions or variables for the purpose of aiding government decision makers.[5] However, Dr. Paul Kaminski, the Under Secretary of Defense for Acquisition and Technology, the DAE for the program, directed the SBIRS Program in the 8 February 1995 Acquisition Decision Memorandum, to do "instead of a formal COEA for the EMD decision, during the pre-EMD period an IPT [integrated product team] will review cost-driving requirements, analyze cost/performance tradeoffs, perform military effectiveness tradeoff analyses, and document the resolution of each requirement-versus-cost issue."[6] This gave the program flexibility to innovate in terms of the focus and scope of the analyses performed.

Documentation requirements for the Milestone II review were flexible in much the same way as they were for the Milestone I review. At the end of Phase I Pre-EMD, the

SBIRS Program submitted the JROC-validated SBIRS ORD and the Defense Intelligence Agency (DIA)-validated SBIRS STAR. The OSD Cost Analysis Improvement Group (CAIG) provided a separate ICE, but the OSD CAIG developed it by working closely with the SPO and USAF CAIG. Nearly everything else was contained in the updated SAMP.

All the planned elements of Pre-EMD occurred approximately on schedule. Other major events occurred, however, that the DOD 5000-series documents did not required or were not originally planned. These events added to the uniqueness of the SBIRS Requirements Generation Process. These requirements events not originally envisioned included two Interim Progress Reviews (IPRs) and two meetings of the Senior Warfighters Forum (SwF). (See Figure 5.)

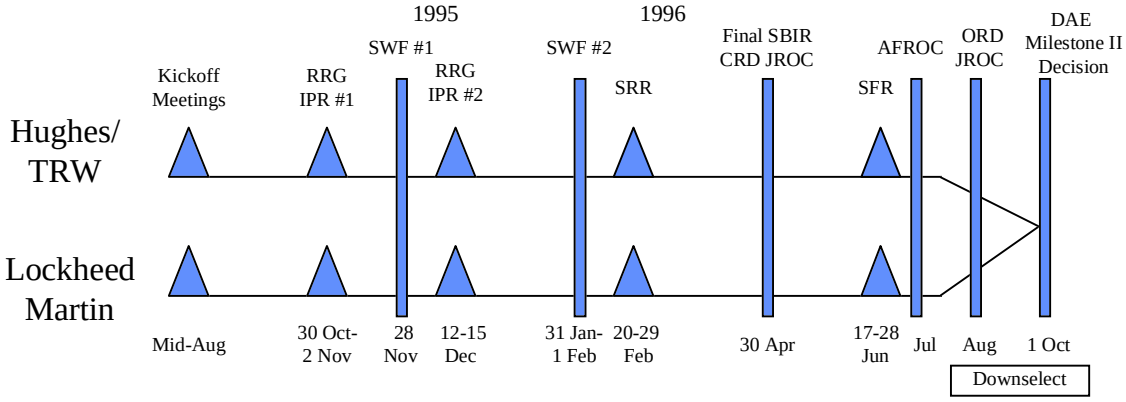

Figure 5. SBIRS Pre-EMD Milestones

The IPRs were progress reviews of each SBIRS contractor teams, Hughes/TRW and Lockheed Martin, under the auspices of the Requirements Review Group (RRG). The RRG was a colonel-level body co-chaired by representatives from AFSPC and SMC, whose purpose was to "refine the SBIRS requirements as defined during the SBIR Summer Study and documented in the draft SBIRS Operational Requirements Document

(ORD)."[7] As part of its charter, the RRG was supposed to analyze the contractor's cost/performance trades, review the cost driving requirements, endorse military utility analysis, approved the proposed requirements allocation between the High and Low components, facilitate requirements consensus among the operational users, and help finalized the SBIRS ORD and Concept of Operations. The RRG's membership consisted of the key warfighters and technical intelligence stakeholder customers. IPR #1 enabled the RRG to review and approve each contractor's trade space, review status of cost/performance analyses, and provide guidance on requirements interpretations and changes. At the IPR #2 meetings, each contractor presented results of the key trade studies to date, an overview of the concepts they were considering, and preliminary cost information associated with various performance-levels of different concepts. At each IPR, the RRG provided the contractors written feedback representing the views and concerns of the RRG's membership.

Twice during Pre-EMD, the ad hoc SwF met to discuss SBIRS operational requirements issues. Although the body initially had no formal charter in deciding on operational requirements, it evolved to play a significant role in helping achieve SBIRS requirements consensus among the warfighter customers.

The Deputy Commander in Chief of USSPACECOM (DEPCINCSPACE), VADM DE Frost initiated and chaired the SwF, a new group formed specifically for addressing SBIRS requirements issues. Just as SBIRS Pre-EMD began, the DEPCINCSPACE tasked his J5 planning staff to recommend actions that USSPACECOM could do to help ensure a successful JROC for the SBIRS Program, with a successful JROC defined by him as, "validation of SBIR Key Performance Parameters (as documented in SBIRS ORD)

enabling and supporting the on-schedule acquisition of a system responsive to warfighter needs."[8] The staff proposed a flag-level forum of warfighters to review the SBIRS trade process and its results. It was composed of three and two-star general/flag officers and civilian equivalents from the warfighting and USAF acquisition stakeholder organizations.

The initial SWF meeting in late November 1995 focused on review of the SBIRS trade space and the overall SBIRS requirements process. DEPCINCSPACE called for a second SWF to occur on 31 January 1996, over a month earlier than originally proposed by USSPACECOM.[9] The objectives of the second SWF were (1) review proposed changes and clarifications to SBIRS operational requirements, (2) document collective perspective on proposed changes and clarification, and (3) advocate service and command acceptance of consensus views.[10] This early meeting date forced the SBIRS Program to accelerate its original schedule for finalizing requirements and necessitated a month-long period of concentrated cost performance analysis activity by the government in January 1995 with data support from the SBIRS contractor teams. In the middle of this month, as progress on several issues stalled, Vice Admiral Frost personally directed the program participants to continue meeting together to achieve agreements before meeting with the SWF on the established date. This pressure helped resolve most remaining issues, thereby precluding major disagreements during the SWF. In essence, the SWF served as a preliminary JROC to help force resolution and achieve consensus before issues could be raised higher. This aided the SBIRS Program as it approached the JROC and Milestone II review.

Concerning Milestone II review, the DAE convened a DAB to review SBIRS. Beforehand, however, the Space Systems Overarching IPT, an OSD oversight team

consisting of most of the DAB membership, reviewed the program and provided its recommendations to the DAE. This high level group includes the Vice Chairman of the Joint Chiefs of Staff, assistant secretaries of defense, assistant secretaries of the services, BMDO Director, Chairman of the OSD Cost Analysis Improvement Group (CAIG), and others including representation by SBIRS service warfighter customer organizations.

To achieve a set of affordable operational requirements to satisfy the warfighter within the framework described in this chapter, the SBIRS Program followed some primary principles in planning and execution throughout Phases 0 and I. These principles included (1) close partnership between the warfighters (operators and users) and acquirers (government acquisition personnel and defense contractors), with the warfighters having the final operational requirements decisions; (2) disciplined system requirements and affordability analysis from a system of systems perspective, utilizing cost as an independent variable; and (3) streamlined business and acquisition environment. The next chapter addresses how the SBIRS Program implemented these principles, primarily in Phase I Pre-EMD.

Notes

[1]Peter Grier, "Requirements are Key," *Air Force Magazine*, September 1995, 96.

[2]DOD Instruction 5000.2, *Defense Acquisition Management Policies and Procedures*, 23 February 1991, 3-8.

[3]SBIRS Program Office, Space Based Infrared System (SBIRS) Single Acquisition Management Plan (SAMP) Version 6, 6 February 1995, 4.

[4]DOD Instruction 5000.2, *Defense Acquisition Management Policies and Procedures*, 23 February 1991, 3-14.

[5]Ibid., 4-E-1.

[6]Department of Defense, Acquisition Decision Memorandum, 8 February 1995.

[7]AFSPC/DRF(S), Space Based Infrared System (SBIRS) Requirements Review Group (RRG) Charter (draft), August 1995.

[8]Lt Col Ward, USSPACECOM/SPJ5S, Point Paper on Engaging the SBIR Process, 3 August 1995.

[9]Ibid.

Notes

[10]USSPACECOM/J5 Briefing Chart on Senior Warfighters Forum, ca. Spring 1996.

Chapter 4

Analysis of SBIRS Requirements Generation Process

Principle of Stakeholder Teaming

The first principle of the SBIRS Requirements Generation Process examined is stakeholder teaming involving close partnership between the warfighters, the acquirers, and other participants with the warfighters having final approval for operational requirements decisions. The SBIRS Program implemented a strong atmosphere of teaming and stakeholder inclusion from the very beginning and it extended throughout Phase 0 Concept Exploration and Phase I Pre-EMD. The fundamental objective of stakeholder teaming was to enhance the communication process between all participants in the requirements generation process, particularly the warfighters and acquirers. This enhanced communication was expected to eliminate or counter many of the problems that hinder development of effective operational requirements.

The SBIRS Program organized requirements generation participation in a manner similar in many respects to the way Boeing did for its 777 widebody passenger jet. This highly successful commercial development, which recently won the Malcolm Baldridge National Quality Award, was based heavily on stakeholder teaming from initial requirements definition through aircraft development. Boeing had done what no major

commercial airline developer had done by including potential airline customers as full partners in the requirements development team. This went well beyond the use of customer marketing surveys, and it helped define an aircraft that better meets the needs of the airlines as evidenced by the large number of 777 orders and sales to date.

The following discussion on the principle of teaming as executed on SBIRS is organized into several sub-sections to include Stakeholders, Organization and Relationships, Contractor Participation, and Warfighter Participation.

Stakeholders

The Department of Defense (DOD) established SBIRS to meet the needs of a variety of warfighter and technical intelligence customers. The program stakeholders included these customers, the acquirers, and a larger number of organizations that had oversight and coordination responsibilities or were responsible for systems that will interface with SBIRS. Table 1 shows the primary stakeholder organizations and their roles and interests in the program, and representatives of most were involved to one degree or another throughout Phases 0 and I. Many of these stakeholder organizations participated in the 1994 Summer Study discussed earlier and helped define the key performance parameters and performance levels in the SBIR Capstone Requirements Document (CRD).

The government stakeholders were involved together throughout requirements generation. Interested stakeholders, including warfighters, participated in the studies, formal reviews, and informal reviews. (See Appendix A.) Most of the stakeholder customers, including the warfighter representatives, also participated in major acquisition activities such as the Pre-EMD Source Selection and the EMD Downselect. Furthermore,

the appropriate stakeholders developed, reviewed, and or coordinated on all the key. requirements documents throughout the SBIRS requirements generation process. Therefore, the program gave all interested government parties the opportunity to participate at whatever level the stakeholder felt necessary.

Table1. SBIRS Primary Operational Requirements Stakeholders

Organization	**Roles and Interests**
Air Force Operational Test & Evaluation (AFOTEC)	Responsible for operational testing. Ensures operational testing requirements are adequate.
Air Force PEO (Space)	Execution management oversight responsibility.
Air Force Space Command (AFSPC) Directorate of Requirements	Responsible for producing SBIRS ORD. Co-led requirements definition activities.
Ballistic Missile Defense Organization (BMDO)	Advocate for missile defense requirements. Maintains Ballistic Missile Defense ORD.
Contractors (Hughes/TRW and Lockheed Martin)	Conducted cost/performance trade studies and concept design during Pre-EMD. Competed for SBIRS High Component EMD contract.
Deputy Under Secretary of Defense (Space)	OSD programmatic oversight responsibility for ACAT ID space programs. Sponsors Space Systems Overarching IPT.
National Air Intelligence Center (NAIC)	Advocates for technical intelligence (TI) requirements. Maintains High Altitude MASINT Requirements Document.
OSD Cost Analysis Improvement Group (CAIG)	Develop Independent Cost Estimate (ICE) for Milestone II decision.
OSD DOT&E	Oversee planning and execution of operational test and evaluation programs.
SAF/AQSS	Funding oversight responsibility.
Space and Missile Systems Center (SMC) SBIRS Program Office (SPO)	Acquiring organization. Co-led requirements definition activities. Primary interface with contractors. Oversaw contracts.
US Air Force	Executing agency (individual organizations listed separately).
US Army	Warfighting user of SBIRS data and information. Advocated missile warning and missile defense requirements. Advocated direct downlink of data to theater processors.

Table1—continued

US Navy	Warfighting user of SBIRS data and information. Advocated missile warning and missile defense requirements.
US Space Command (USSPACECOM)/North American Aerospace Defense Command (NORAD)	Represented space interests of combatant commands not participating. Responsible for providing strategic missile warning.
US Strategic Command (USSTRATCOM)	Responsible for strategic missile warning. Advocate for system survivability requirements.
External interface systems organizations	Responsible for systems that will interface with SBIRS, particularly data and message processing and dissemination systems.
Theater Combatant Commands	Advocated theater combatant command positions. Interests mainly represented by USSPACECOM.

Organization and Relationships

The high degree of teaming and emphasis on warfighter involvement is evident by examining the organizational structure, relationships, and events of Phase I Pre-EMD. The government execution structure of the SBIRS Requirements Generation Process is shown in Figure 6. The right side of the structure represents the "programmatic coordination chain," while the left side represents the "requirements coordination chain." SBIRS implemented the Integrated Product Team (IPT) concept at all levels to bring together representatives from various disciplines and appropriate stakeholder organizations to ensure an integrated approach to requirements definition. The Requirements Systems Engineering (RSE) IPT was the central working-level organization for implementing the Pre-EMD requirements generation activities. The members came primarily from the SBIRS Program Office (SPO) in SMC at Los Angeles AFB and the Headquarters AFSPC Directorate of Requirements (AFSPC/DRF(S)) at Peterson AFB. Most of the SPO members were part of the Systems Engineering, Integration, and Test

Directorate, and they included Air Force officers, civil servants, and Aerospace Corporation personnel. They included mission and requirements analysts, systems engineers, cost engineering and risk analysts, interface engineers, and test engineers. A logistics supportability representative from the SPO also participated. The RSE IPT was co-chaired by two lieutenant colonels, one from AFSPC and the other from the SMC SPO.

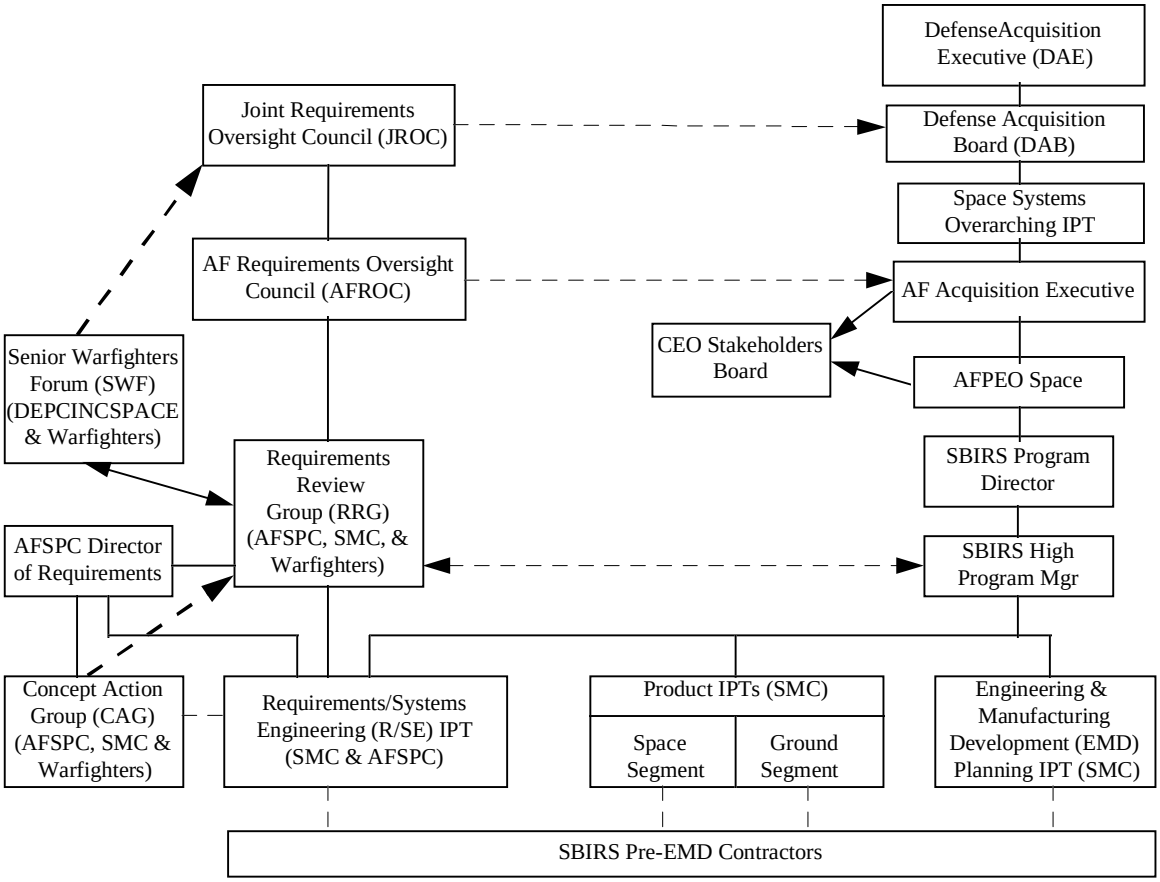

Figure 6. SBIRS Pre-EMD Execution Structure

Even though the primary members of the RSE IPT were from only SMC and AFSPC, the IPT addressed the broader warfighter issues and concerns provided by the SBIRS customers through AFSPC/DRF(S). At times, however, the R/SE IPT served as a forum where the warfighter representatives other than AFSPC could personally discuss issues.

The R/SE IPT also had cognizance over test requirements. The test sub-IPT, co-chaired by representatives from SMC and AFOTEC, brought the developmental and operational testing communities together to work with both SBIRS contractor teams to start defining verification and test programs.

The other government working-level teams, which included the Ground Segment, Space Segment, and Engineering and Manufacturing Development (EMD) Planning IPTs, interfaced with the R/SE IPT but did not have a significant role regarding performance requirements. Members of the R/SE IPT, however, participated in these other teams on a limited basis to help ensure consistency throughout the program. The SPO cost team, although not officially identified as an IPT, worked closely with the USAF, OSD, and SBIRS contractor cost estimating communities and interacted extensively with the R/SE IPT as part of cost analysis and estimating activities.

A key entity overseeing the output of the R/SE IPT was the Requirements Review Group (RRG) discussed in Chapter 3. Co-chaired by representatives from AFSPC and the SPO, this unique body served as the colonel-level forum for resolving operational requirements issues. Together with the R/SE IPT and representatives of the United States Space Command (USSPACECOM) J5 office, the RRG prepared the groundwork for briefings to the Senior Warfighters Forum (SWF), the Air Force Requirements Oversight Council (AFROC), and the Joint Requirements Oversight Council (JROC).

The working-level equivalent of the RRG was the AFSPC-led Concept Action Group (CAG). It included participants from a wide variety of warfighter organizations, and it served as the primary action officer forum for the warfighter and technical intelligence

stakeholders with AFSPC and the SPO to discuss detailed requirements issues. From these meetings, the R/SE IPT took issues and worked them with the contractors.

Contractor Participation

Supporting this entire execution structure were the Pre-EMD contractors. Both the Hughes/TRW and Lockheed Martin teams conducted most of the requirements and concept design analysis activities during this phase of the requirements generation effort. The contractors essentially led the cost performance trades process, and the government working-level technical participants served primarily in a facilitation role providing nonbonding guidance, suggestions, and information. Since the contractors were competing, the government could not include them concurrently in the government IPTs. However, the government required the contractors to organize in interdisciplinary teams, and the SPO and AFSPC personnel participated in the contractor-led IPTs. Due to the limited availability of government expertise, each government member participated in both contractors' IPTs instead of breaking up into two separate teams. For example, the members of the R/SE IPT were also members of the contractors' Systems Engineering, Integration, and Test (SEIT) IPTs. (See Figure 7.) Therefore, the same government personnel provided impartial technical and management assistance to both contractors while gaining insight into their activities.

Throughout Pre-EMD, the SPO provided feedback on contractor performance with the goal of obtaining the best output from the contractors. This feedback included monthly "grades" for each of the major contractor IPTs by the government counterpart, as well as the formal feedback provided by the RRG at the two Interim Progress Reviews

and the grading sheets at the System Requirements Review (SRR) and the System Functional Review (SFR).

Senior contractor management was also involved in the teaming process through the CEO Stakeholders Board. This group, which included the chief executive officers (CEOs) of the SBIRS contractors and senior USAF acquisition leadership, was intended to give the contractor management a forum to discuss their business concerns surrounding the competition for the SBIRS High Component EMD contract.

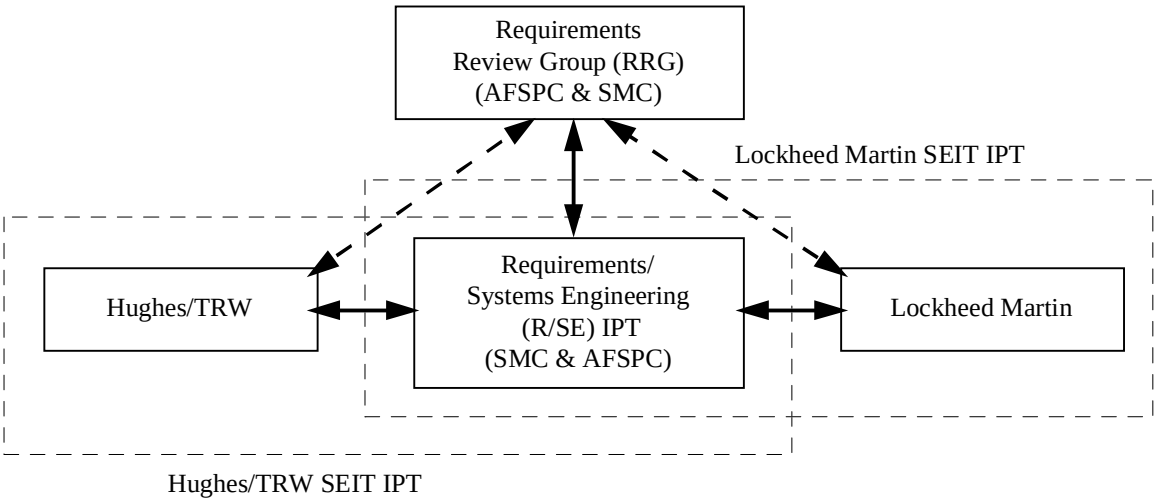

Figure7. Government-Contractor Pre-EMD Teaming Relationship

Warfighter Participation

The warfighters participated in and influenced all aspects of the requirements and programmatic realms. Working within teams, the warfighters drove and had primary responsibility for deciding on the final operational requirements. For example, AFSPC had led the generation of the applicable Mission Need Statement (MNS) years earlier; various user requirements documents were the source of the SBIR CRD and the SBIRS ORD; the warfighter representatives endorsed the key performance parameters (KPPs);

USSPACECOM led generation of the SBIRS CONOPS, chaired the SWF, and staffed the SBIRS ORD package to the JROC; and the JROC validated the MNS, SBIR CRD, and SBIRS ORD. The JROC also identified two requirements areas, survivability and data availability, for particular focus and emphasis during Pre-EMD. The issue surrounding survivability was whether or not to maintain nuclear survivability requirements at costly Cold War levels. As for data availability, the issue was the cost and military utility of providing unprocessed satellite data directly to warfighters in the theater combatant commands for processing instead of depending solely on centralized processing by the USAF in the continental US. These issues would provide the source of some of the most contentious cost benefit tradeoff discussions among the stakeholders as organizations were unwilling to back off on performance for the initially deployed High Component System. Even though survivability was not identified as a key performance parameter in the SBIR CRD, the SBIRS Program treated it essentially as one due to high customer and JROC interest.

The SBIRS teaming structure brought the many stakeholders together, and it was designed to place the ultimate responsibility for deciding on affordable requirements with the warfighters. These stakeholders either participated in or had insight into the system of systems requirements and affordability analysis activities.

Principle Of System of Systems Requirements and Affordability Analysis

SBIRS intended to go farther than any previous large military systems program in approaching the ideal systems engineering process for defining and refining operational requirements. The SBIRS "COEA-like" requirements analysis process emphasized

disciplined system requirements analysis and affordability assessment from a system of systems viewpoint, using cost as an independent variable. It also centralized the affordability decision into the hands of the warfighters, consistent with a recommendation by the DOD Acquisition Reform Oversight and Review Process Action Team.[1] The primary objective of this system of systems requirements and affordability analysis principle was to provide needed cost and technical information to enable easier decision making among competing priorities among multiple customers. Implementing this analysis principle helped counter the problems that hinder generation of effective operational requirements.

The following discussion on the principle of system of systems requirements and affordability analysis as executed on SBIRS is organized into several sub-sections to include System Requirements Analysis, Affordability, Cost as an Independent Variable, Military Utility, and Requirements Documentation.

System Requirements Analysis

The technical analysis and decision making processes that enabled the acquirers and warfighters to translate mission needs into operational requirements is called system requirements analysis (SRA). The first step of SRA is understanding the customers' problem and needs. Starting with a validated MNS and the user requirements documents that AFSPC generated prior to SBIRS, the 1994 Summer Study in Phase 0 Concept Exploration performed the initial steps for SBIRS by selecting a requirements baseline and baseline architecture through cost/performance tradeoff analyses. This included defining the SBIRS Key Performance Parameters (KPPs) and their performance levels through mission needs analysis and threat analysis. The minimum acceptable performance levels

the Summer Study identified were the thresholds, and the desired performance levels were the objectives. The SBIR CRD captured these thresholds and objectives. The results served as the basis for further refinement of the threshold and objective values during Pre-EMD with extensive involvement by the warfighter customers and contractors.

Understanding the tradeoffs between performance levels and costs in greater detail was the next critical concurrent step of SRA. The analysis method called out in DODI 5000.2, 1991, was the Cost and Operational Effectiveness Analysis (COEA) process. However, the DOD and USAF gave SBIRS the flexibility to go beyond this. In SBIRS, instead of the government performing the cost performance military utility trade studies to evaluate the relative advantages and disadvantages of two different contractor concepts, SBIRS followed a process using inputs from both contractors in order to understand and evaluate the generic cost sensitivities of different performance levels of the KPPs. Assessing risk is inherent in the process. This "knee in the curve" information helped identify the cost driving requirements, and the contractors and the government used it to determine which requirements levels were affordable and represented a system of acceptable military utility and risk. The two contractor teams were key in gaining this insight.

Integral to this cost performance trades process was concept development. Figure 8 illustrates the nature of the relationship between operational requirements and concepts development throughout SBIRS Pre-EMD. Using contractor preliminary cost data to develop a SPO cost estimate, the second SWF identified affordable levels of requirements associated with different concepts that would meet nearly all of the customer demanded performance thresholds.

Since the SBIR CRD and draft SBIRS ORD addressed requirements from a mission perspective, the documents did not allocate performance requirements between the system components. Therefore, the contractors had to perform the trade studies from a system of systems perspective and decide on the requirements allocations themselves. That is, they were trying to determine the most synergistically affordable and effective performance requirements allocations between the High and Low Components, between the Space and Ground Segments, and between the different time phased increments of the ground segment. As originally planned, the government gave the contractors tremendous freedom to trade performance objectives, schedules, and other constraints to achieve an affordable system that satisfies the mission ORD requirements for IOC.[2]

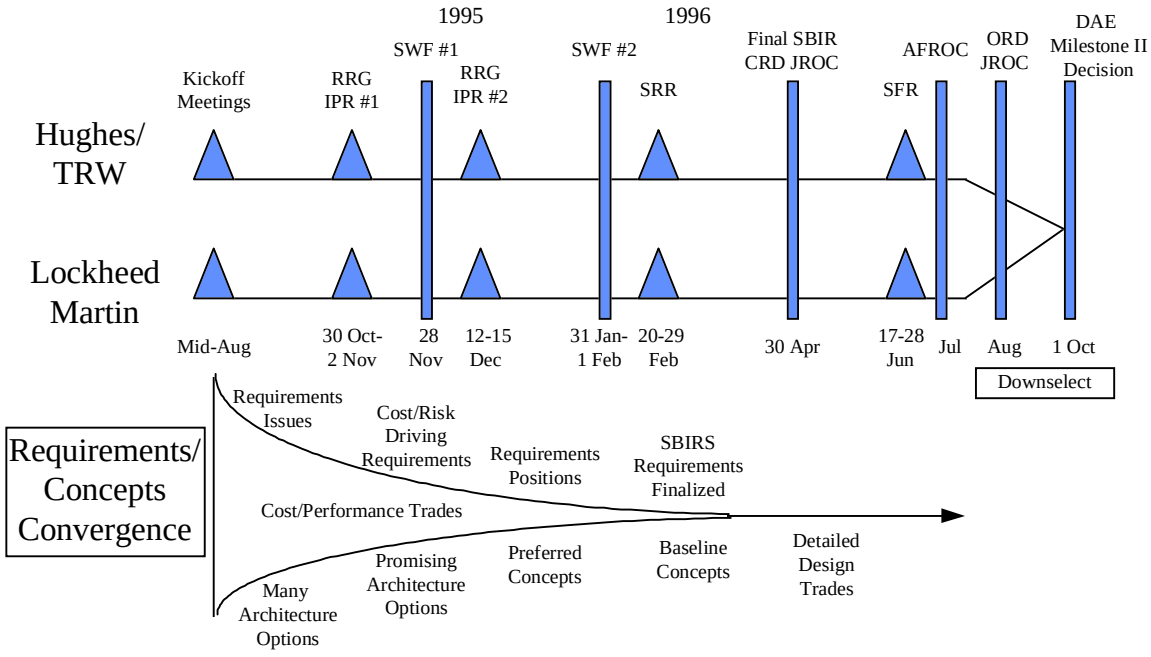

Figure 8. Pre-EMD Requirements/Concepts Convergence

The government did not impose a mandatory list of trade studies for the contractors to conduct. Instead, the R/SE IPT provided a minimal list of suggested trade studies along with the latest draft operational requirements documents, draft SBIRS Concept of

Operations (CONOPS), operational bounds, and intelligence on potential targets and operating environments. The contractors were free to decide what was appropriate to help them gain the insight needed to design a capable and affordable system and to justify it.

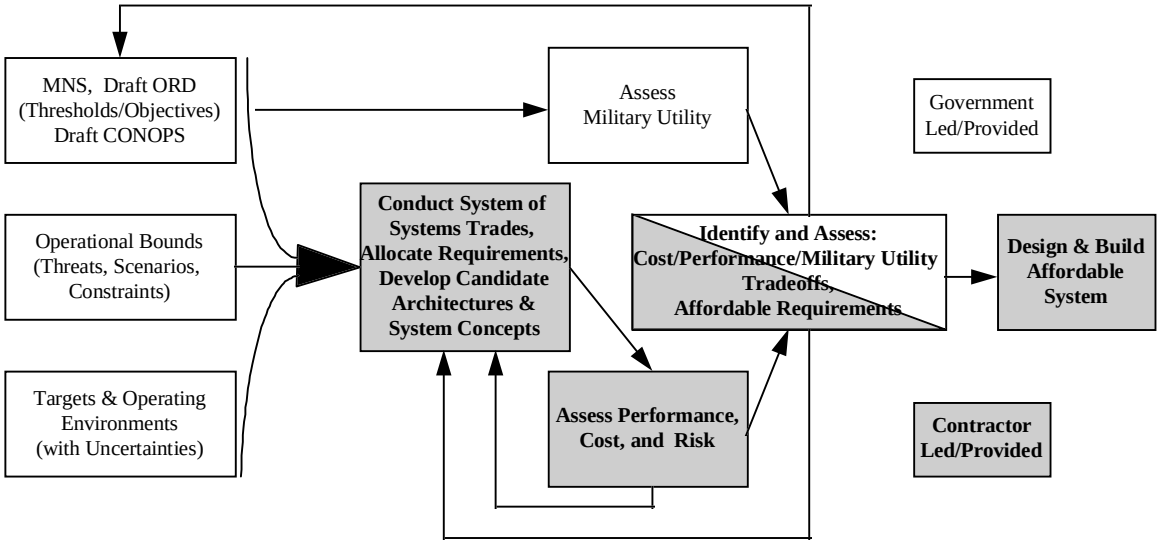

Figure 9. SBIRS Pre-EMD Process Flow

Affordability

For SBIRS, affordability was a critical consideration in selecting the final operational performance requirements levels. With severe High Component EMD funding constraints, DOD believed the performance requirements as contained in the JROC-validated SBIR CRD could not be met in accordance with the schedule for initial operational capability (IOC). One of the budget constraints was the amount of funding in the Future Years Defense Plan (FYDP). OSD and the USAF fixed the amount available to the program, making SBIRS almost a design-to-cost effort. The other key funding constraint was the tight budget planned for government fiscal years (FY) 97 and 98. The

government and the contractors expected these two lean years to cause problems in trying to attain SBIRS IOC. Life cycle cost (LCC) was also a major consideration, but there were no specific LCC goals established. Therefore, affordability of the EMD program was primarily defined by the SBIRS FYDP funding and FY97, 98 funding levels.

Cost as an Independent Variable

By allowing performance requirements levels to be traded off with cost defined by affordability, SBIRS had adopted the concept of considering cost as an independent variable (CAIV). That is, KPP values could be adjusted below thresholds if the overall operational performance costs were too high. The military utility of the affordable performance level had to be considered in this cost/performance balance so as to prevent the assumption by the warfighters of unacceptable levels of operational risk by not fully obtaining the requested level of performance. The government sought to attain the best value by attempting to maximize military utility within the affordability constraints.

Military Utility

To help with the government decision making process to maximize benefit within the affordability constraints, AFSPC/DRF(S) planned to obtain from each of the warfighter customers their quantified military utility associated with the various performance levels of the KPPs and survivability parameter. The warfighter customers, however, did not provide anything more than general linear preference estimates. These estimates generally indicated that more performance is better. Therefore, AFSPC could not perform a quantified analysis to maximize military utility.

The final recommendations on affordable performance levels came down to the process of extended negotiations involving all warfighter customers at the R/SE IPT to the SWF levels. The challenge for AFSPC and the acquirers was to find out how far each would back off from their positions to reveal what was minimally acceptable to them. Although the warfighting customers were not very flexible, there was some relaxation of threshold requirements in the recommendations to the JROC for validation. These changes came primarily in the technical intelligence mission area. The AFSPC-SMC team captured these final performance levels for all mission areas in updates to the draft SBIRS ORD.

Requirements Documentation

AFSPC placed the requirements refinements from Pre-EMD in the SBIRS ORD. To conduct a Downselect between the two contractors for High Component EMD, the SPO developed the High Component Technical Requirements Document (TRD) as the basis for the contractors' proposals. The TRD was the translation of the High Component ORD requirements in the SBIRS ORD based on the contractors' High-Low allocations and the clarifications developed with the warfighter customers. None of these were compliance documents, however. The only compliance document for High Component EMD is the contractor-generated system specification (A-specification) of the winning team.

The SBIRS Program conducted its system of systems requirements and affordability analysis activities in a manner more closely approaching a textbook systems engineering effort than seen before on large unclassified system programs. The less restrictive and more efficient business and acquisition environment facilitated the practices.

Principle of Streamlined Business and Acquisition Environment

To assist the journey to a validated SBIRS ORD, the DOD, USAF, and the SPO sought to create a streamlined business and acquisition environment within and outside the program. A streamlined environment was intended to help facilitate the elimination or countering of the problems that hinder the development of effective operational requirements. Streamlining the environment with regards to the requirements generation system involves simplifying administration and management requirements, enhancing communication mechanisms, and eliminating unneeded support requirements to (1) speed up the process of translating mission needs to operational requirements and system requirements, (2) reduce the government and contractor overhead costs associated with defining operational and system requirements, and (3) reduce life cycle cost by eliminating non-value added requirements. The ultimate impacts of a streamlined business and acquisition environment in the early phases of development can be earlier fielding of more affordable systems. The SBIRS business and acquisition environment is characterized primarily by contractor empowerment, enhanced communications, reductions in overhead, and relaxed documentation requirements.

Contractor Empowerment

Regarding management of the contractors, the government philosophy was to "allow maximum flexibility for the contractor(s) to conduct the program efficiently while still providing the government clear visibility into cost, schedule, technical performance, and risk."[3] In support of this, OSD and the USAF granted the SBIRS Program waivers of specific military standards during Pre-EMD to give the contractors greater flexibility in

organizing and conducting their activities. For example, the Pre-EMD contract did not impose MIL-STD-881A *Work Breakdown Structure for Defense Materiel Items.* Also, the government intended to limit oversight, instead emphasizing cooperation and teamwork. Oversight of the contractors during Pre-EMD consisted primarily of government participation in the contractors' IPTs and the formal and semi-formal reviews.

Enhanced Communications

Directly supporting the SPO relationship with the empowered contractors were means of enhanced communications. In addition to E-mail, the government and the contractors established electronic connectivity during Pre-EMD to enable the SPO on-line access to the contractors' program documentation. Furthermore, they planned to expand the unclassified and classified links to AFSPC, Air Force Operational Test and Evaluation Center (AFOTEC), and several other organizations at the beginning of High Component EMD. Also, the R/SE IPT was able to reduce its traveling to Lockheed Martin in Sunnyvale by attending the weekly contractor SEIT IPT meeting by video teleconference every other week. The rest of the team kept in contact with the R/SE IPT through E-mail and phone calls when not meeting in person.

Reductions in Overhead

The SBIRS Program implemented a variety of changes to reduce operational requirements development and life cycle costs. First, it reduced the number of needed SPO participants in Pre-EMD by assigning a single team to work with both contractors instead of separating them into two separate government teams. Second, SBIRS was also at the forefront in reducing deliverable data requirements. Instead of requiring the

contractors to prepare and deliver documentation specifically for government use, the electronic connectivity allowed the government electronic access to the contractors' documentation. This arrangement also reduced the amount of paper delivered to the government.

SBIRS broke difficult ground in several requirements areas that potentially have significant long term cost impacts. The program implemented direction by the Secretary of Defense in 1996 to no longer require the use of most military standards and specifications when equivalent commercial standards are available. SBIRS went farther, however, and questioned the need for the numerous unique military standards being advocated by the organizations controlling the data and message dissemination systems that will interface with SBIRS. AFSPC/DRF(S) attempted to convince these organizations to tailor and justify their requirements, but they were not responsive. The SPO, therefore called on the SBIRS contractors to review these different interface performance standards and propose for the High Component EMD only what they believed are needed.

SBIRS also broke ground in the logistics arena. The program allowed the contractors to consider and propose contractor logistics support (CLS) if it was financially advantageous to the government. This had the potential of eliminating the need for military personnel to maintain the SBIRS ground infrastructure. Language in the draft SBIRS ORD had to be modified to allow consideration of CLS.

Relaxed Documentation Requirements

To help speed up the process for getting approval to enter EMD, particularly during Pre-EMD, SBIRS took advantage of relaxed documentation requirements. OSD and the

USAF allowed SBIRS to eliminate or ease mandatory formats for major requirements and acquisition documents. OSD required less documentation for the Milestone I and II reviews, with much of the needed material contained in the updated SBIRS Single Acquisition Management Plan (SAMP) as discussed in Chapter 2.

In summary, the OSD, USAF, AFSPC, and the SPO attempted to create an environment for Pre-EMD that would give the SBIRS stakeholders the best chance to successfully perform the needed analyses and reach consensus on final operational requirements. The degree of success of the SBIRS Requirements Generation Process is the focus of the next chapter.

Notes

[1]"Reengineering the Oversight and Review Process for Systems Acquisition," *Program Manager*, May-June 1995, 6.

[2] SBIRS Program Office, Space Based Infrared System (SBIRS) Single Acquisition Management Plan (SAMP) Version 6, 6 February 1995, 4.

[3]Ibid., 12.

Chapter 5

Evaluation of SBIRS Requirements Generation Process

The SBIRS Program achieved the primary objective of its requirements generation effort: JROC validation of the SBIRS Operational Requirements Document (ORD). This was done according to schedule without a "battle of the service four stars." The JROC approved the SBIRS ORD with no opposition by the Vice Chairman of the Joint Chiefs of Staff and the Service Vice Chiefs of Staff and no major requirements concerns. Members of the warfighter and acquisition communities have praised the SBIRS approach for effectively achieving agreement on affordable operational requirements with a broad user community within a tight schedule and funding profile. The philosophy that guided all aspects of SBIRS requirements activities in Pre-EMD is reflected in the new DOD Directive 5000.1 and DOD Regulation 5000.2-R issued on 15 March 1996.

While acknowledging SBIRS's success in producing an affordable validated ORD according to schedule with warfighter consensus, several questions must be considered: First, can it be concluded that the principles of the requirements generation process implemented by the SBIRS Program (i.e., stakeholder teaming, system of systems requirements and affordability analysis, and streamlined business and acquisition environment) uniquely contributed to the success? Or in other words, did SBIRS effectively eliminate or minimize the problems that hinder the generation of effective

ORDs? Second, is the SBIRS Requirements Generation Process an improvement over the standard practices and procedures of the past? Third, does the SBIRS Requirements Generation Process have applicability to other programs? The following is an evaluation of what worked and did not work well during SBIRS requirements generation, particularly during Pre-EMD, in an attempt to provide support for answering these questions.

Principle of Stakeholder Teaming

The teaming concept carried out at all levels of the program worked very well overall by (1) involving the warfighter customers at all levels, (2) creating a positive environment of inclusion for all participants to enhance communication and issue resolution, and (3) helping reduce the inefficiencies of sequential coordination. Several key government members have acknowledged the success of the SBIRS teaming approach. In a 19 September 1996 letter by Mr. Dennis Granato, the Assistant Deputy Under Secretary of Defense for Space Systems Acquisition and the chairman of the Space Systems Overarching IPT, it stated, "we believe the SBIRS requirements process provided unprecedented access for all users with an equally unprecedented level of user support for the baseline requirements."[1] Additionally, in a 25 October 1996 letter by the Deputy Under Secretary of Defense (Space), Mr. Robert V. Davis, concerning upcoming requirements efforts on the SBIRS Low Component, it states, "we are working with USSPACECOM to reinitiate the user forums that served so well for SBIRS High pre-EMD."[2]

The success of teaming at the working-level depended on the strong partnership between personnel of the SBIRS Systems Engineering, Integration and Test Directorate

and the AFSPC Requirements Directorate (AFSPC/DRF(S). The two organizations provided the majority of people on the Requirements/Systems Engineering (R/SE) IPT as well as the leadership for the R/SE IPT and Requirements Review Group (RRG). Good relations characterized by mutual respect existed between these principal representatives of the warfighters and the acquirers. Probably the only significant drawbacks in the arrangement were the limited AFSPC/DRF(S) and SPO manpower and conflicting tasks and priorities. AFSPC at Peterson AFB, Colorado, was unable to support weekly attendance at the R/SE IPT meetings at Los Angeles AFB and the weekly contractor Systems Engineering, Integration and Test (SEIT) IPT meetings in Los Angeles and Sunnyvale in California. The arrangement established early in Pre-EMD called for AFSPC/DRF(S) attendance at the R/SE IPT meeting every two weeks, and AFSPC/DRF(S) attended consistently during the first several months. Telephones and E-mail provided connectivity during other times. Although final resolution of requirements issues would have been more effective and efficient with greater in-person interaction, this overall arrangement worked quite well. The overall teaming arrangement was critical to the SBIRS success because it enabled and forced the warfighter organization responsible for the ORD and the acquirers to communicate and work together on a regular basis.

Despite positive interpersonal and interorganizational relationships, the problem of limited manpower for supporting weekly IPT meetings posed a challenge. The government IPT members had to support two contractor teams concurrently, in addition to supporting meetings of the other government IPTs. The resultant high tempo of activity stressed the ability of the R/SE IPT to perform its other internal government technical and administrative tasks.

While the relationships within the requirements coordination chain were effective, the interactions between the government IPTs were not as productive as they should have been. During Pre-EMD, the SPO's members of the R/SE IPT were at the center of requirements refinement and contract management activities. However, the leaders of the Ground Segment, Space Segment, and EMD Planning IPTs were not required to participate in the R/SE IPT. Nor was there a forum by which the heads of the IPTs would meet to discuss and resolve issues. In spite of the situation, the SBIRS Program and the RRG placed priority on resolving the technical requirements issues and facilitating contractor activities. The R/SE IPT performed these successfully.

The SBIRS Program placed considerable attention to system test requirements. The Test sub-IPT, associated with the R/SE IPT, brought the SPO, Air Force Operational Test and Evaluation Center (AFOTEC), OSD, Joint Interoperability Test Center (JITC) and later contractor test communities together to work as a team. Due to good relations between the SPO test director and the AFOTEC project leader, they made progress towards combining developmental test and evaluation (DT&E) and operational test and evaluation (OT&E) requirements with the aim of reducing cost. The working-level AFOTEC personnel, familiar in their normal roles as independent evaluators, initially were not as comfortable working in a teaming arrangement with the SPO and the contractors. However, the participants eventually created an effective team to jointly develop the combined DT&E/OT&E program.

The R/SE IPT with the contractors had responsibility for addressing performance requirements issues during Pre-EMD. Furthermore, the Ground Segment IPT was investigating numerous existing hardware interface issues, and some of them had

performance requirements impact. Interaction between the two IPTs to work issues was less effective than it should have been, due to different priorities. The issue came down to what was driving Pre-EMD: the shorter term ground segment schedule or the long-term affordable system of systems requirements allocation solution. While the system of systems analysis efforts had greater program priority, Ground Segment IPT issues took on greater emphasis as Pre-EMD progressed. The conflict in the short-term may have been lessened by allowing the consolidation of the DSP ground infrastructure to proceed independently. However, SPO program planners had decided that the best arrangement for producing the most cost effective system of systems design in the long-term involved integrating the efforts.

The SPO cost estimating personnel responsible for understanding the cost effectiveness of the projected system concepts were not organized in a formal IPT under the SBIRS High Program Manager. However, they worked effectively with the OSD and USAF cost communities in an unprecedented teaming arrangement to share information including cost estimating assumptions and the cost analysis requirements documents (Card's) provided by the Pre-EMD contractors. This interaction allowed the virtual concurrent development of the program office estimate and the independent cost estimate (ICE) to save time and meet the tight schedule to the Milestone II Decision.

The tone of the relationship between the government and the contractors during Pre-EMD was set at the kickoff meeting by the SBIRS Program Director, Col Craig Weston. He called for partnership and trust, not mistrust; government insight, not oversight; and government facilitation of contractor activities, not government direction. The SPO, as well as AFSPC/DRF(S) and other stakeholders, had positive, nonadversarial relationships

with the Hughes/TRW and Lockheed Martin teams, and the contractors recognized value added from the government participation. The management teams of each SBIRS contractor expressed this sentiment in meetings called by the SPO after they submitted their proposals to solicit the contractors' views on the Pre-EMD process.

The SBIRS contractors generally expressed positive comments regarding Pre-EMD execution. They both supported the government practice of providing formal feedback on contractor performance throughout Pre-EMD. In general, both Hughes/TRW and Lockheed Martin believed that such interaction and feedback enabled them to better understand the government's requirements and priorities and to better focus their analysis activities. However, one contractor team commented that the need to support a large number of formal and informal reviews in a short period of time, several of which were not part of the original government plan for Pre-EMD, hindered their ability to perform the analysis tasks.

The teaming arrangements during Pre-EMD represented a new experience for most of the people involved. An immediate issue for government personnel was knowing how to interact with the contractors. By dealing with two competing contractors concurrently, there were serious issues regarding accidental release of competition sensitive information in meetings or by E-mail. The R/SE IPT developed rules of engagement (Roes) for the government and contractor participants and modified them as unforeseen issues arose. Despite the Roes, several instances occurred where competition sensitive information was inadvertently sent by a government worker to the wrong contractor team. The SPO contracting organization investigated each of the incidents, and it found none of them to be significantly damaging to either contractor. However, in an environment where the

same government personnel work concurrently with competing contractor teams, there are risks that may impact the following source selection.

The contractors, as well as the government, needed to become familiar with the new relationships and working environment. Instead of receiving guidance and direction from government counterparts, the contractors had to get used to taking the lead and proceeding with minimal explicit or implicit government approval. For much of Pre-EMD, the contractors appeared to have a problem with this. They seemed more comfortable with following a clear path laid out by the government than developing innovative ideas and approaches. This attitude may be understandable given the competitive pressures to develop concepts the many government stakeholders would like and support in source selection. The R/SE IPT addressed this situation by repeatedly reminding the contractors of their responsibility for the outcomes of Pre-EMD, regardless of the extent of guidance provided by the government IPT members.

Even though the contractors factored the inputs of the warfighters into the cost performance analyses, several individuals representing the warfighters wanted to have more direct access to and unchaperoned interaction with the contractors. These few individuals generally did not feel that the AFSPC Concept Action Group was a sufficient forum to raise their issues and clarify their needs and desires. The SPO and AFSPC, however, were genuinely concerned with requirements creep as the warfighter and technical intelligence (TI) customers were competing with one another for full acceptance of their respective performance positions. Furthermore, there was a real danger the SBIRS customers could release competition sensitive information and cause technical leveling in their favors. By maintaining control over the government stakeholder

interactions with the contractors, the R/SE IPT, the SPO, and AFSPC/DRF(S) successfully avoided major problems.

Two very important groups in SBIRS Pre-EMD were the RRG and the SWF. Both bodies, first introduced on the SBIRS Program, worked well in helping focus the operational requirements resolution efforts. The RRG effectively brought AFSPC and SPO requirements leadership together with the warfighter customers, and the SWF served as an "800 pound gorilla" to help pressure resolution of open issues. Due to its success, the RRG will continue as an operational requirements forum for the SBIRS Low Component Program, and the SWF will be convened for use on future space systems programs. Both of these groups were instrumental in ensuring the voices of the warfighter customers were predominant during all aspects of the system of systems requirements and affordability tradeoff process.

Principle of System of Systems Requirements and Affordability Analysis

The SBIRS requirements and affordability analysis processes were successful in providing the information that enabled the government to make reasoned decisions regarding affordable operational requirements. SBIRS probably went farther that any prior large systems program in trying to provide insight into the cost/performance tradeoffs at the individual performance requirement level in support of government decision making. Both SBIRS Pre-EMD contractors performed excellent detailed analyses, and the government used the results with military utility inputs to help senior warfighter leadership decide the affordable requirements levels for recommendation to the

JROC. While the outline of the approach had been established before Pre-EMD, details of the processes were refined as the program progressed.

Although the SBIRS system requirements analysis effort was successful, AFSPC/DRF(S) did not fully achieve its difficult goal of quantifying the military utility for the varying levels of KPP performance for each warfighter customer. Such information would allow decision makers to maximize utility in the ORD. Instead, AFSPC/DRF(S) did not get much more than linear preference estimates from each warfighter customer generally indicating that more performance is better. Quantifying utility for a large organization is difficult due to usually wide differences of opinion that exist. The final decisions on performance requirements levels were instead the result of extended negotiations involving all stakeholders at all levels along with intervention of the DEPCINCSPACE to help force a consensus at the RRG level.

Several issues predominated the path to a validated SBIRS ORD. They included survivability, data availability, technical intelligence, and Block 1 SBIRS High Component performance. Survivability was one of the major issues of contention throughout Pre-EMD. The vocal advocate for Cold War-level performance was USSTRATCOM. Initially, its representatives were tenaciously tied to the traditional idea of hardening fixed ground sites against nuclear effects. This caused affordability and schedule problems, particularly with regard to military construction funding. USSTRATCOM became somewhat more willing to discuss alternatives to fixed site survivability, such as through distribution of assets, when trade study results became available showing the high costs of the advocated survivability solutions and the impact on affordability constraints. Until the contractors and the R/SE IPT provided such data, USSTRATCOM was not willing to

entertain alternatives. This showed the usefulness of credible, detailed cost performance analyses in an environment of competing priorities of many customers.

The major issue of contention with the Army was assured data availability. From the beginning of the SBIRS Requirements Generation Process, the Army advocated direct downlink to theater (DDL). While the USAF recognized DDL as one of the possible solutions to the operational requirement of assured data availability, the Army identified it as the requirement itself. The SBIRS Program claimed that government selection of a solution was not warranted since it was the responsibility of the contractors to complete the cost/performance trades and propose the most affordable way to meet the requirements. The program was also investigating centralized processing of SBIRS data at the ground station in the continental US (CONUS) as a feasible and cost effective solution to meeting requirements. Several Army representatives stated the Army did not trust the ability of the USAF to reliably provide the warning message through existing communications networks from CONUS regardless of cost savings. Furthermore, the Army was interested in saving its theater mobile DSP data processor program called the Joint Tactical Ground System (JTAGS) by incorporating it into the SBIRS architecture. The USAF leadership ultimately dropped opposition to DDL when the trade study results indicated the cost of each concept was essentially equivalent. Furthermore, mobile processing units based on the JTAGS design were incorporated into the concepts of both competing contractors, and they contributed to the cost effective survivability solution proposed by the winning contractor. In this case, military utility from the Army's perspective drove the resolution in the face of cost equivalence.

The technical intelligence (TI) performance requirements, advocated by the National Air Intelligence Center (NAIC), were the most stressing on SBIRS. The performance levels for the KPPs of Coverage and Minimum Threat were the problems; fully attaining them was not affordable based on preliminary contractor cost/performance trade studies. Furthermore, the members of the warfighting community did not consider TI requirements as high a priority as the other missions. Despite aggressive efforts by the TI representatives on the program, the SWF consensus recommendations to the JROC called for the SBIRS ORD threshold performance for Coverage and Minimum Threat to be relaxed a minimal amount. This was perhaps the only instance of SBIRS trading cost for minimum performance.

Another analysis issue during Pre-EMD involved the performance allocation between the High and Low Components to meet threshold performance for all KPPs. The validated SBIR CRD required the system of systems to meet performance requirements, not just the High Component. Through their analyses, the contractors had determined that each of their optimum affordable solutions allocated performance to the Low Component, primarily in the mission area of missile defense. Since the High Component was to be developed and deployed first, the initially deployed system of High Component satellites will not meet all the SBIRS ORD requirements. The Army and Navy representatives working closely with the program wanted full performance on the initially deployed High Component constellation to support the theater missile defense mission. Their request, based on military utility, was not consistent with the "High now, Low later" approach that formed the basis of the program. More importantly, their request was not affordable. Therefore, the RRG dismissed the issue.

Although SBIRS Pre-EMD concentrated on system of systems requirements, the SPO also placed emphasis on preparing for High Component EMD. The SPO had originally hoped to have the contractors bid to the validated SBIRS ORD, using whatever High-Low, Space-Ground allocations they had individually decided upon. Instead, the SPO developed a High Component Technical Requirements Document (TRD) to provide the government a common basis for Downselect evaluation of operational performance. The TRD was merely High Component portions of the ORD with clarifications gained from the warfighter and TI customers. The challenge of developing the TRD was that both contractors had differences in allocations. A single set of threshold performance levels had to be chosen without giving each contractor insight into the other's projected performance, thereby avoiding legal and contractual problems. The SPO chose a lowest common denominator approach for defining the TRD levels without explaining it to the contractors. No contractual or legal problems resulted.

In general, the system of system requirements and affordability analysis process worked well in providing needed information for government decision makers.

Principle Of Streamlined Business and Acquisition Environment

SBIRS lived up to its designation as a "flagship streamlined acquisition program."[3] Some of the new practices implemented during Pre-EMD supported the requirements generation process quite well. For one, reduced documentation for the acquisition milestone reviews and the consolidation of documentation in the SAMP reduced the paperwork burden on the SPO team. Also, the relaxation of government management

requirements gave the contractors greater flexibility in efficiently designing and managing their tasks.

Although a good idea, the benefits of electronic connectivity for paperless viewing of the SBIRS contractors' documentation were not fully realized. The SPO and contractors did not establish working links until halfway through Pre-EMD, and much of the contractor material was not available in the systems until even later. However, such connectivity is very valuable during all phases of any program.

From a communications and information management perspective, the SPO computer network and the E-mail links with the contractors were the lifeblood of Pre-EMD despite serious limitations. The reliability of the SPO network was inadequate during the first half of the intensive Pre-EMD phase, and its frequent failure prevented greater government efficiencies from being realized.

The SBIRS Program was successful in implementing reforms regarding military and commercial standards and specifications. These efforts had broad support among the SPO and contractors. The SPO, however, angered some government agencies representing interfacing communications systems by refusing to blindly impose interface standards. Absent of tailored requirements from the sponsoring government organizations, the SPO gave the contractors the opportunity to tailor the military requirements documents before proposal submittal. However, evaluating all of them was a much larger task than anticipated. The contractors were unable to thoroughly review all the suggested military standards and specifications in the short time before the EMD proposal submittal, work that had normally been done during EMD in other programs. However, with the winning SBIRS contractor having accepted total performance responsibility to make the system

work from “photon to shooter,” such detailed delineation of requirements on the contract was regarded as unnecessary by the SPO. Total system performance responsibility (TSPR) requires the SBIRS EMD contractor to ensure end user performance regardless of what military specification or standard is included in the contract. During EMD, the SBIRS contractor will have to work closely with all interfacing systems not under its control to meet the SBIRS ORD. The government, however, should have started addressing this issue with the contractors and sponsoring organizations at the beginning of Pre-EMD.

With regards to the Contractor Logistics Support (CLS) issue, the AFSPC logistics and sustainment community did not support the program position to allow contractor solutions that do not contain military sustainers. A member of the SPO logistics organization saw CLS as a way for the contractors to make greater profit while costing the government more in the long run. Contractor analyses, however, showed cost savings to the government. AFSPC/DRF(S) therefore allowed the SPO to consider the CLS option , and the winning contractor proposed a CLS approach.

Overall Assessment

The principles of stakeholder teaming, system of systems requirements and affordability analysis, and streamlined business and acquisition environment all contributed to the success of the SBIRS Requirements Generation Process. The three principles worked together to effectively eliminate or mitigate most of the roadblocks to achieving an ORD that affordably meets the actual needs of the warfighters, especially when many customers are involved with competing priorities.

Stakeholder teaming with warfighter participation and approval authority contributed greatly to the success of Pre-EMD. This approach addressed most of the problems listed in Chapter 1. SBIRS brought together most if not all the warfighter organizations that would either use the SBIRS information or operate the system in order to make sure all needs and viewpoints were considered in finalizing the ORD, making it a more effective document. Forming formal integrated teams and management structures involving all stakeholders forced these warfighters and the system acquirers to communicate and coordinate with each other at all levels. This facilitated the acquirers in gaining a better understanding of what was important to the various warfighter customers so that the ORD and later the system specification would accurately reflect the actual needs. The fact that the warfighters had final approval authority over the operational requirements through their membership and leadership positions at all levels in the requirements coordination chain guaranteed that they would decide on the alternatives, not the acquirers. Therefore, the warfighters cannot claim that the acquirers failed to be responsive with regards to the SBIRS ORD and system requirements.

The disciplined SBIRS system of systems requirements and affordability analysis activities involving both the acquirers and warfighters provided the detailed cost and performance information needed for decision makers to decide among the alternative performance levels. In a cost constrained environment where some system performance has to be traded away, the warfighter customers will often refuse to compromise. However, such a stalemate was minimized on SBIRS. This was because of the availability of detailed data that clearly delineated the tradeoff issues, as well as by having the formal

and semi-formal teams for discussing military utility aspects and forging consensus decisions.

The streamlined business and acquisition environment also contributed to producing an effective ORD, primarily by facilitating the teaming interactions and analysis activities. Despite some deficiencies, the various electronic communications means tied together the stakeholders throughout the country when they were not meeting in person. The communication network as well as key requirements meeting involving representatives of acquisition oversight and coordination authority organizations enhanced their understanding of the issues and helped them meet the streamlined coordination process timelines.

The next question to address deals with whether or not the SBIRS Requirements Generation Process is an improvement over the standard practices and procedures of the past. Since SBIRS successfully addressed the roadblocks to producing effective ORDs, and those problems are possible on any program, the SBIRS Requirements Generation Process is definitely an improvement. Had SBIRS followed the path of its failed predecessor, the Future Early Warning System (FEWS) Program, the resulting SBIRS ORD would have been an unaffordable, gold-plated, "everything-for-everyone" invitation for program cancellation. Instead, the SBIRS Requirements Generation Process provided the structure and mechanisms to enable the generation of information and force communication among all stakeholders with the objective of forging a consensus on difficult cost and performance tradeoffs.

The third question under consideration is whether or not the SBIRS Requirements Generation Process has general application to other programs as a model to emulate. The

answer is yes. The SBIRS Requirements Generation Process follows fundamental management, systems engineering, and business principles that are recognized as effective in the commercial world. Furthermore, most of the philosophy that guided SBIRS Pre-EMD requirements activities are already incorporated in DOD Directive 5000.1 and DOD Regulation 5000.2, both dated 15 March 1996. The integrated product team approach is now required for large military programs, and SBIRS is another data point demonstrating its usefulness for defining and refining operational requirements. As mentioned earlier in the chapter, the Requirements Review Group and the Senior Warfighters Forum are mechanisms that can and will be used on other space programs, but they could also be established for any type of system programs. Furthermore, the SBIRS-developed streamlined Single Acquisition Management Plan (SAMP) supporting the acquisition milestones, including Milestones 0 and I, is being institutionalized in the USAF. Therefore, new programs will invariable follow in many of SBIRS's footsteps. The contractor-led SBIRS system of systems requirements and affordability analysis approach using cost as an independent variable is applicable to any system program because it represents the actualization of effective and well recognized systems engineering practices.

Notes

[1]Dennis J. Granato, Assistant Deputy Under Secretary of Defense (Space Systems Acquisition), to Principal Deputy Director, Central Measure and Signature Intelligence Office, subject: Intelligence Community Concerns Re Space-Based Infrared System (SBIRS), 19 September 1996.

[2]Robert V. Davis, Deputy Under Secretary of Defense (Space), to Secretary of the Air Force, Commander-in-Chief, United States Space Command, and Director, National Reconnaissance Office, subject: Acceleration of the Space-Based Infrared System - Low Component (SBIRS-Low), 25 October 1996.

[3]Department of Defense, Acquisition Decision Memorandum, 8 February 1995.

Chapter 6

Conclusions

The SBIRS Requirements Generation Process was a success because it produced a JROC-validated and affordable set of joint service operational requirements on schedule and within program cost in a challenging environment. The SBIRS Program accomplished this by implementing principles derived from management, systems engineering, and business reforms called for by several national commissions and study groups over the past 15 years. These principles include (1) close partnership between warfighter customers and acquirers throughout the requirements definition process, with the warfighters having the final decisions on operational requirements; (2) disciplined system requirements and affordability analysis from a system of systems perspective, using cost as an independent variable; and (3) streamlined business and acquisition environment.

The resulting SBIRS approach for defining and refining operational requirements can rightfully claim to be a general improvement over previous policies and procedures because it eliminated or minimized the basic roadblocks to producing an operational requirements document (ORD) reflective of the warfighter customers' actual needs. The SBIRS Requirements Generation Process effectively overcame potential problems by providing the structure, analysis methods, and mechanisms that facilitated effective

stakeholder communication, mutual understanding, and consensus decision making in a constrained environment of competing customer and fiscal priorities.

This SBIRS process is valid for other potential systems; there is nothing about the requirements generation experience that indicates the processes are applicable only to SBIRS or even to just space systems. In fact, the philosophy that guided SBIRS is now contained in the latest Department of Defense Directive (DOD) 5000.1 and DOD Regulation 5000.2-R, dated 15 March 1996. This makes SBIRS an important data point for validating the effectiveness of the new philosophy that will guide all new large system programs.

Based on the success and potential applicability to other military systems, newly forming USAF system programs should study the SBIRS Requirements Generation Process as a potential model to emulate for producing an effective and affordable ORD. Furthermore, others in the Defense Acquisition Community should evaluate the SBIRS process and experience to assess its applicability as a model for meeting the challenges for gaining requirements consensus on joint service programs in an era of reduced budgets and falling manpower levels. Ultimately, producing an ORD accurately reflecting the actual needs of the warfighter customers and maximizing the military utility within limited resources will greatly increase the likelihood that the developed system will be effective to the nation's warfighters.

Appendix A

Government Stakeholders in SBIRS Program

Participating Organizations in the 1994 Summer Study.

Air Combat Command (ACC).
Air Force Materiel Command, Space and Missile Systems Center (AFMC/SMC).
Air Force Program Element Office for Space (AFPEO Space).
Air Force Space Command (AFSPC).
Air Staff Intelligence (AF/IN).
Air Staff (AF/XOR).
Army Space Command (ARSPACECOM).
Assistant Secretary of Defense for C3 (ASD(C3).
Ballistic Missile Defense Organization (BMDO).
Central MASINT Office (CMO).
Department of the Army (DAMO).
Defense Intelligence Agency (DIA).
Naval Space Command (NAVSPACECOM).
National Air Intelligence Center (NAIC).
National Reconnaissance Office (NRO).
National Security Agency (NSA).
Office of the Assistant Secretary of Defense (OASD(ISP).
Office of the Assistant Secretary of Defense, Program Analysis and Evaluation.
OASD(PA&E).
Office of the Secretary of the Air Force, Acquisition (SAF/AQS).
Office of the Joint Chiefs of Staff (JCS).
OPNAV.
OSD Cost Analysis Improvement Group (CAIG).
Theater Combatant Commands.
Under Secretary of Defense for Science and Technology (USD(A&T).
US Army Space and Strategic Defense Command (USA SSDC).
US Space Command (USSPACECOM).
Participants in the Senior Warfighter Forum (SWF).
VADM DE Frost, USN.
DEPCINCSPACE, Chairman.
VADM Walter Davis, USN.

Director Space and Electronic Warfare.
Lt Gen Jay Garner, USA.
Commander, Army Space Command.
Lt Gen Arlene Jameson, USAF.
STRATCOM/DCINC.
Lt Gen Lester Lyles, USAF (sent representative).
Commander, Space and Missile Systems Center.
Maj Gen Dave Vesely, USAF.
Commander, 14th Air Force.
Brig Gen Thomas Scanlan, USAF.
National Reconnaissance Office.
RADM Katharine Laughton, USN.
Commander, Navy Space Command.

Key Stakeholder Participation in.
SBIRS Requirements Generation Process.

Key Stakeholder Organization	Member Pre-EMD Source Selection Team	Member Reqmts/ Systems Eng. IPT R/SE IPT	Member Concept Action Group CAG	Attended Interim Progress Reviews IPRs	Member Reqmts Review Group RRG	Attended System Reqmts Review SRR	Attended System Funct. Review SFR	Member EMD Down-select Team
AFOTEC		X	X	X	X	X	X	
AF PEO Space				X		X	X	
AFSPC/DRF(S)	X	X	X	X	X	X	X	X
BMDO			X	X	X	X	X	
DUSD(Space)				X		X	X	
NAIC	X		X	X	X	X	X	X
OSD DOT&E				X	X	X	X	
SAF/AQSS				X		X	X	
SMC SPO	X	X	X	X	X	X	X	X
US Army	X		X	X	X	X	X	X
US Navy	X		X	X	X	X	X	X
USSPACECOM				X	X	X	X	
USSTRATCOM			X	X	X	X	X	
Theater Combatant Commands - USACOM - USCENTCOM						X	X	
External System Interfaces						X	X	

Glossary

ACAT	Acquisition Category
AFOTEC	Air Force Operational Test and Evaluation Center
AFSPC	Air Force Space Command
ALERT	Attack and Launch Early Reporting to Theater
BMDO	Ballistic Missile Defense Organization
BSTS	Boost Surveillance and Tracking System
CAG	Concept Action Group
CAIV	Cost as an Independent Variable
CARD	Cost Analysis Requirements Document
CLS	Contractor Logistics Support
COEA	Cost and Operational Effectiveness Analysis
CONOPS	Concept of Operations
CONUS	Continental United States
CRD	Capstone Requirements Document
DAB	Defense Acquisition Board
DDL	Direct Downlink
DEPCINCSPACE	Deputy Commander in Chief, USSPACECOM
DIA	Defense Intelligence Agency
DOD	Department of Defense
DSP	Defense Support Program
DUSD	Deputy Undersecretary of Defense
EMD	Engineering and Manufacturing Development
FEWS	Future Early Warning System
FY	Fiscal Year
FYDP	Future Years Defense Plan
GEO	Geosynchronous Orbit
GSSG	Ground Segment Study Group
HEO	Highly Elliptical Orbit

ICE	Independent Cost Estimate
IPT	Integrated Product Team
IPR	Interim Progress Review
JITC	Joint Interoperability Test Center
JROC	Joint Requirements Oversight Council
JTAGS	Joint Tactical Ground Station
KPP	Key Performance Parameter
LCC	Life Cycle Cost
LEO	Low Earth Orbit
MNS	Mission Need Statement
NAIC	National Air Intelligence Center
OIPT	Overarching Integrated Product Team
ORD	Operational Requirements Document
OSD	Office of the Secretary of Defense
PEO	Program Element Office
RDT&E	Research, Development, Test and Evaluation
RRG	Requirements Review Group
R/SE IPT	Requirements/Systems Engineering Integrated Product Team
SAMP	Single Acquisition Management Plan
SDI	Strategic Defense Initiative
SEIT	Systems Engineering, Integration, and Test
SBIR	Space Based Infrared
SBIRS	Space Based Infrared System
SFR	System Functional Review
SMC	Space and Missile Systems Center
SMTS	Space and Missile Tracking System
SPO	SBIRS Program Office
SRA	System Requirements Analysis
SRR	System Requirements Review
SSTS	Space Surveillance and Tracking System
SWF	Senior Warfighters Forum
TBM	Theater Ballistic Missile
TI	Technical Intelligence

US	United States
USAF	United States Air Force
USSPACECOM	United States Space Command
USSTRATCOM	United States Strategic Command

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