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Paper Session III-A - Government Trends: Future Launch Vehicles

Janet Grondin

Charles Warrender

GOVERNMENT TRENDS: FUTURE LAUNCH VEHICLES

AUTHORS:

Capt Janet Grondin

Capt Charles Warrender

INTRODUCTION

National policy advocates improving the economy by investing in U. S. industrial competitiveness and encouraging technology transfer from defense to U.S. commercial industry. National space policy emphasizes the need for assured access to space. To achieve these objectives the Space Launch Modernization Plan (SLMP) recommended four options. The option selected, investing $2 billion to evolve existing technologies, will result in an Evolved Expendable Launch Vehicle (EELV) that:

1. Significantly reduces the annual recurring cost of launch (at least 25% less than current systems with an objective of 50% reduction in the annual cost of spacelift).

2. Consists of a family of vehicles that is technically achievable.

3. Uses a standard payload interface, standard launch platforms, and infrastructure capable of launching all the configurations of EELV.

4. Launches safely, effectively, and responsively in accordance with long range, deliberative, and reactive planning.

Cost reduction considerations dominates these requirements. Other nontradeable parameters include Performance, Design Reliability, and Standardization. To the extent that these primary objectives are achieved, the other areas of responsiveness, timeliness, and supportability will be traded. This paper will address the genesis of the EELV, the requirements trade space, and the acquisition strategy employed to implement the SLMP recommendation.

GENESIS OF EELV

Space is becoming more critical in an information-dominated world. The Department of Defense (DOD) needs the assured capability to routinely deploy payloads or replenish on-orbit failures to meet peace and wartime requirements in a very predictable timeframe. Without this capability on a day-to-day basis, space assets may not adequately support our forces in crisis or war. Coincidentally, our

nation needs to lower the annual cost of spacelift to regain its world class competitiveness. The genesis of the Evolved Expendable Launch Vehicle stems from the Nation's basic need to transport material into space and our inability to do so economically. On 5 Aug 94 President Clinton directed the Air Force to improve and evolve Expendable Launch Vehicles (ELVs) with the objective of reducing cost while improving reliability, operability, responsiveness, and safety. Note that, although the President identified several deficiencies in the way we perform spacelift, the key deficiency is cost.

Space Launch Modernization Study

The National Defense Authorization Act for Fiscal Year 1994 directed the Secretary of Defense to develop a spacelift plan. The Space Launch Modernization Plan (SLMP) was commissioned in response. The plan addressed requirements not only for the Department of Defense, but for the nation as a whole.

The study noted a major shift in the tone of national policy. Past national space policies were dominated by the theme of assured access to space. Current space policy, to which the EELV program responds, acknowledges the importance of assured access but stresses technology transfer from defense to U.S. commercial industry and improving the Nation's economy by investing in U.S. industrial competitiveness. The Nation has been interested in modernizing our spacelift capability, but the divergence in views and interests has prevented our ability to reach consensus.

The national space community consists of defense, intelligence, civil, and commercial sectors. The defense sector wants spacelift that is responsive, efficient, and cost effective, with a focus on medium lift capability. The intelligence sector needs highly reliable heavy lift capability. The civil sector focuses on lower cost human spaceflight, scientific exploration, and earth sensing satellites. The commercial sector currently emphasizes inexpensive, predominantly geosynchronous spacelift capability and dependable launch schedules. Future commercial spacelift requirements will include Low Earth Orbit constellations requiring replenishing missions. To address these disparate needs the study team established a process to capture the common set of requirements.

The study group recognized early on that they needed a means to define, develop, and rank system requirements. They employed a Quality Function Deployment (QFD) process that facilitated the development of a preliminary set of requirements. This preliminary set represents the desires of all four sectors: Capability, Operability, Economics, Mission Success, and Responsiveness.

The SLMP team developed four options keeping this set of requirements in mind. The first option, to sustain existing launch systems with only minor upgrades, would maintain the current fleet of launch systems indefinitely. NASA would pursue a reusable technology program, in cooperation with DOD technology investments, with the objective of reaching a shuttle replacement decision in 1999-2000. The second option, to evolve current expendable launch systems, would fly

out current contracts and then transition to an evolved expendable replacement. NASA would pursue the same strategy as before. Option three, develop a new expendable launch system, would replace current expendable and could potentially replace the Space Shuttle with an entirely new expendable system designed to correct deficiencies in current systems. Option four, develop a new reusable launch system, would focus efforts on developing reusable technology and providing demonstrations. These efforts would lead to a decision on building a prototype system and producing a fleet of operational vehicles.

DOD Implementation

The implementation strategy calls for maintaining the current Medium Launch Vehicle (MLV) and Heavy Launch Vehicle (HLV) expendable vehicles and infrastructure of the U.S. ELV fleet until cost effective alternatives are available. The DOD will lead the effort to evolve current expendable launch systems into a replacement expendable system while NASA leads the technology effort for a new reusable launch system. Consistent with the President's policy, the DOD's immediate spacelift priority is the reduction of recurring costs--by a minimum of 25%. DOD intends to make other improvements in the common requirements set within this constraint, creating a requirements trade space. The evolution of current systems will be achieved by streamlining the acquisition process, increasing the use of commercial products and practices, and minimizing requirements for unique government specifications.

In order to more clearly define our Nation's spacelift needs, a team of representatives from NASA, DOD, CIA, Department of Commerce, and the Department of Transportation, refined the preliminary requirements set developed by the SLMP. The team, named the National Spacelift Requirements Working Group, established definitions and measures for these requirements to resolve the basic problem of common spacelift terminology. The group's charter was to establish specific measurable characteristics for all future spacelift systems. Among the most important requirements are performance and reliability. Human transport, low recurring costs, payload accommodations, responsiveness and schedule dependability requirements are also important, but each of these characteristics are not equally important for all applications. The group agreed that space lift systems must be Capable, Operable, Reliable, and Economical (CORE) for all applications. Air Force Space Command (AFSPC) adopted the CORE requirements in its Mission Area Plan (MAP).

The Spacelift MAP determines the direction AFSPC must forge to meet its assigned mission tasks. The current MAP defines the CORE requirements:

> Capability: Capability is the extent to which a spacelift system meets mission requirements of (a) accurate and sufficient performance to mission orbit for a broad range of spacecraft; and (b) system capacity to sustain needed launch rate.
>
> Operability: Spacelift operability is the ability to respond quickly and dependably to payload deployment requirements, i.e. responsiveness.

Reliability: Reliability is a measure of the ability of the spacelift system to successfully accomplish its intended mission once that mission is initiated.

Economic: Economics is a measure of the acceptability of mission and life-cycle costs of spacelift systems.

The MAP goes on to evaluate the mission area and identify key deficiencies. Not surprisingly, the plan listed the greatest deficiency as the high recurring and Operations and Maintenance (O&M) costs of launch vehicles and infrastructure. In order resolve this deficiency, AFSPC authored a Mission Need Statement (MNS). The Spacelift MNS formalized the SLMP findings and put the National Policy directive into the acquisition cycle.

REQUIREMENTS TRADE SPACE

The Operational Requirements Document (ORD) specifies AFSPC's requirements for the EELV. In general terms, we want to launch our payloads safely and effectively while reducing costs at least 25%. The major cost reduction is expected to result from increased production rates (production efficiencies and throughput), and lower operating costs due to reduced manpower and improved standardization in space launch infrastructure. The system envisioned consists of a family of vehicles using a standard payload interface, standard launch platforms, and an infrastructure compatible with all the configurations of EELV. We need to launch responsively whether as result of long range, deliberative planning, or in reaction to a crisis.

More specifically, there are three non-tradable or "key" parameters the system must achieve and 22 other parameters that can be optimized within a trade space. The intent is to balance cost reduction with improvements. At a minimum, the new system must perform at least as well as current systems and cost 25% less. The key parameters are performance, design reliability, and standardization:

Performance: The ability to deliver required mass to orbit at the best cost effectiveness. EELV must, at a minimum, be able to deliver the DOD portion of the National Mission Model to orbit. As an objective EELV should deliver the DOD portion of the National Mission model with a 15% performance margin.

Design Reliability: Design reliability is defined as the ability to complete the spacelift mission, from launch to payload separation (including a collision avoidance maneuver), at a success rate to sustain constellations. EELV must achieve at least .98 design reliability y in order to sustain our constellations in a steady state. The objective is to gain the highest reliability y we can reasonably afford.

Standardization: The maximum use of common infrastructure, equipment, and processes for launch vehicles, facilities, pads, and payload interfaces. At a minimum, each pad and its facilities must be able to process and launch all configurations of EELV, the vehicle family must employ a standard interface to all payloads, and the support concept must encompass standard operations

processes and standard logistics. The objective is to standardize these components to the extent that cost savings and operability goals are maximized.

The remaining 22 parameters can be grouped either according to the underlying CORE requirement or simply as a constraint. In addition to performance, the characteristics that describe "Capable" include launch performance margin, orbital performance accuracy, launch rate, payload separation, and design flexibility. The characteristics that pertain to "Operable," along with Standardization, include efficient ground processing, resilience, supportability, hold requirements, launch abort, launch recycle, post-launch operations, and recovery & disposal. Design reliability describes "Reliable" and Cost savings captures "Economical." The remaining five parameters (logistics & readiness, safety, launch environment, environmental, and payload considerations) are constraints.

ACQUISITION STRATEGY

The EELV development program represents an investment of $2 billion to significantly reduce the cost of launch. Consistent with the trend to build a strong partnership with industry through streamlining and reforming acquisition, the program manages risk, applies process controls from other industries to spacelift, and minimizes oversight and reviews by replacing them with processes where quality is designed in. In Dec 94 an Integrated Product Team (IPT) was formed to examine innovative acquisition approaches currently being used by programs throughout the Air Force. The IPT forged the acquisition approach after reviewing 111 innovative acquisition approaches in the management, technical, contracting, and financial areas.

Contractor innovation and adequate Government visibility into contractor performance is achieved without costly and unnecessary oversight requirements. A single manager with the responsibility, authority, and accountability necessary for program execution reports through a streamlined management structure. This structure contains only three layers of management - the program manager, the Program Executive Officer, and Service Acquisition Executive.

In keeping with the Acquisition Reform Mandate of 1994, the program office is using commercial practices and streamlining to the maximum extent possible. The program is using performance specifications and non-Government standards in lieu of military specifications and standards, unless no practical alternative exists. Each contractor is identifying specifications, Government or commercial, they believe to be most compatible with their concept and able to meet the Government requirements. The program office is streamlining internal briefing cycles and supplying only the documentation needed to meet statutory requirements or for the staff to meet their responsibilities. For instance, the acquisition and management approach is being documented in a document entitled the Single Acquisition and Management Plan (SAMP). This document describes the EELV program and incorporates many of the traditional documents and briefings into a single

document without being redundant, having to reformat the information, or including superfluous material. The program itself consists of three phases: Low Cost Concept Validation (LCCV), Pre-Engineering & Manufacturing Development (Pre-EMD), and EMD.

Low Cost Concept Validation (LCCV)

Since Aug 95, the EELV program has been in the 15 month Low Cost Concept Validation (LCCV) phase. Each of the four contractors participating in the low risk LCCV phase manage $30 million of resources (material, test, facilities, and personnel) to meet the LCCV module objectives. All four contractors are defining system concepts, mitigating risk by trade analyses and demonstrations, drafting system design specifications, and selecting potential launch base facilities. Each contractor held a Tailored System Requirements Review (TSRR) in Dec 95 and each will hold a Tailored Preliminary Design Review (TPDR) prior to the downselect for the next phase in Aug 1996.

Pre-Engineering & Manufacturing Development (Pre-EMD)

The Pre-Engineering, Manufacturing, and Development (EMD) phase begins in the first quarter of FY97 and will last for 17 months. Two contracts will be awarded for this module for an estimated $65 million each. Competition will be limited to LCCV contractors. In the Pre EMD phase the two winning contractors will complete system product designs, ensure the system designs meet requirements, verify producibility and processes, and verify affordability improvements.

Engineering & Manufacturing Development (EMD)

After Pre-EMD one contractor will be awarded an anticipated $1.5 billion to enter the 8 year EMD phase. Competition will again be limited, this time to the two Pre-EMD contractors. The winning contractor will reach full manufacturing capability, complete site activation, and perform Low Risk Payload Flights (LRPFs) for both medium and heavy lift variants. Since a major issue for any new program is maintaining schedule, the emphasis will be on the program meeting a demonstrated capability prior to the actual IOC need. Two medium LRPFs are planned to occur in FYOO and one heavy LRPF in FY03. The Defense Meteorological Satellite Program Flight 16 and TSX, an Air Force Material Command scientific payload, have been proposed as payloads for the two medium LRPFs. An MLV full rate production decision will be made early in this module to satisfy the scheduled launch requirements. The module will conclude when Initial Operational Capability (IOC) is declared for both Medium and Heavy Lift Variants. Although not fully defined, IOC is an event to be declared by AFSPC after consideration of the readiness of major functions such as launch processing capability, completion of site activation, and completion of all production and acceptance test activities for the vehicle and the system. IOC for medium lift is projected to occur in FYO1, and IOC for heavy lift is projected to occur in FY05.

CONCLUSION

The Evolved Expendable Launch Vehicle Program is the Nation's latest effort to regain control of its launch capability. While previous programs have risen and fallen, the old die-bards Delta, Atlas, and Titan have continued to provide for our Nation's spacelift. We are no longer interested in an engineer's dream machine, but rather an accountant's tally. The EELV program resulted from soul-searching begun in the Space Launch Modernization Study, perpetuated itself as Air Force Space Commands mission need, and continues as the program office employs innovative approaches to streamline the acquisition process. The sensible thing to do is to fly out existing systems while evolving these same systems into a family of launch vehicles. The goal is not only to meet the 25% cost reduction target, but to improve the CORE requirements--Capable, Operable, Reliable, and Economical. The program is on a fast tack with three continuously competitive phases with MLV operations slated for FY02 and HLV operations in FY05. The program represents the Nation's commitment to provide economical access to space.

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