Evolved Expendable Launch Vehicle System

The Next Step in Affordable Space Transportation

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A unique U.S. Air Force/industry partnership is completing development of the Evolved Expendable Launch Vehicle (EELV) systems, opening a new era of affordable space transportation for the 21st Century. EELV is an Acquisition Category (ACAT) 1D program structured to buy commercial launch services rather than launch vehicle hardware, associated infrastructure, and operations support as is done on current launch programs.

Air Force Col. Robert K. Saxer, Evolved Expendable Launch Vehicle Program Director, is nearing final countdown for the first commercial launches of the Lockheed Martin Atlas V and Boeing Delta IV—first in a new generation of space launch vehicles.

Competitively Priced, Assured Access to Space

EELV's overarching objectives are to develop a national, expendable launch capability that reduces the overall recurring cost of launch by at least 25 percent over existing systems, while at a minimum maintaining the reliability, operability, and capability levels of current launch systems. These objectives are reinforced by an EELV acquisition strategy that promotes competition over the life of the program, leverages the commercial marketplace, and encourages continued EELV contractor investment and technical innovation—all keys to achieving program life cycle cost, schedule, and performance goals.

Control Center in Lockheed Martin's Atlas Spaceflight Operations Center, Cape Canaveral.

The EELV program consists of two modular families of commercially owned and operated launch vehicles (Delta IV and Atlas V), and their associated launch site and manufacturing infrastructure, ground support systems, standard payload interfaces, and mission integration

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Photos courtesy EELV System Program Office

Russian RD-180 engines provide the main propulsion for the Atlas V at Lockheed Martin's Atlas V manufacturing facility near Denver, Colo.

and launch operations activities. Evolved from current expendable launch systems and developed via a revolutionary cost-sharing commercial business strategy, both EELV systems will support the entire range of U.S. military, intelligence, civil, and commercial mission requirements.

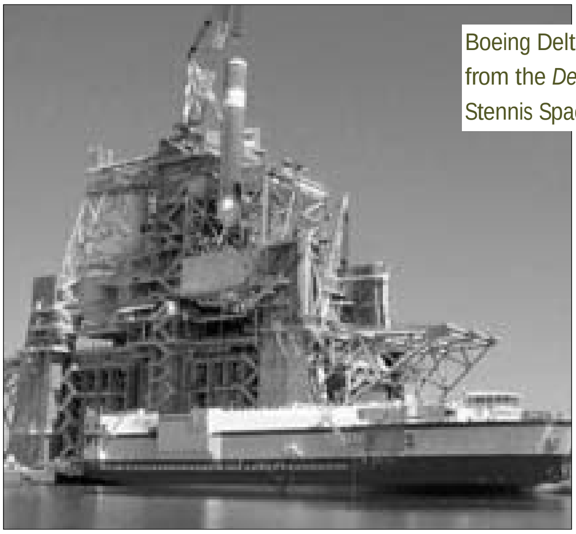
EELV features design simplicity and commonality, new applications of existing technology, and streamlined lean manufacturing and launch operations. When combined with flexible market-based contract terms and conditions, balanced financial incentives, and an aggressive risk management system, the Delta IV and Atlas V families of launch vehicles will provide reliable, competitively priced assured access to space for the U.S. Department of Defense (DoD) as well as the international launch services customer.

Lockheed Martin Atlas V Common Core Booster in the Atlas Spaceflight Operations Center, Cape Canaveral Air Force Station, Fla.

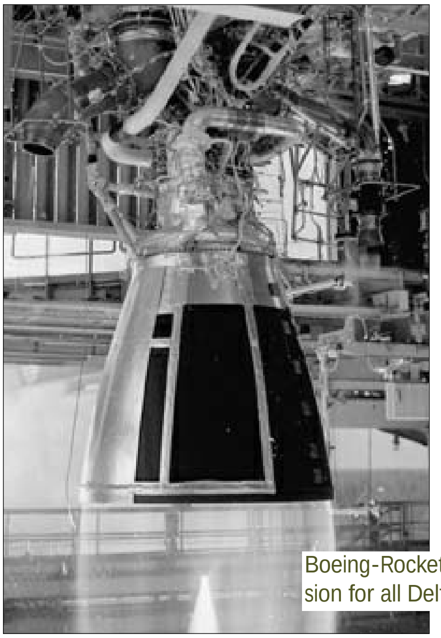
History and Genesis

The post-Cold War era presented DoD a new set of space launch and acquisition challenges as declining DoD budgets and personnel levels encountered a growing demand for military and commercial access to space. In addition to preserving the nation's access to space, a compelling need to reestablish U.S. preeminence in the international commercial space launch industry was also emerging. New foreign launch service providers, international partnering agreements, and the prohibitively expensive launch and sustainment costs associated with the existing U.S. fleet of Delta II, Atlas II, Titan II, and Titan IV Expendable Launch Vehicles (ELV) were all contributing to an accelerating shift in space launch market share toward Europe and Asia, and an erosion of America's space launch industrial base. Launch service customers now had competitive foreign alternatives and the flexibility to trade launch service price, performance, availability, and reliability to meet their mission-specific needs and operating constraints.

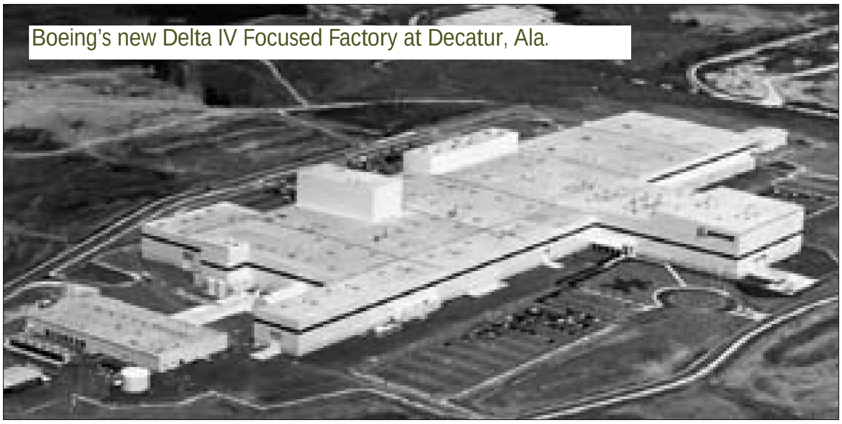
In the late 1980s and early 1990s, the U.S. Government conducted numerous studies and explored without success various launch system concepts that promised increased performance and lower launch costs. In December 1993, after several false starts and approximately $600 million, the U.S. Congress



Boeing Delta IV Static Fire Unit is offloaded from the *Delta Mariner* transport vessel at Stennis Space Center, Miss.



Boeing-Rocketdyne RS-68 main engine, the primary propulsion for all Delta IV vehicles, is tested.



Boeing's new Delta IV Focused Factory at Decatur, Ala.

formally tasked DoD to develop a Space Launch Modernization Plan (SLMP). Then Deputy Secretary of Defense Dr. John M. Deutch assigned this responsibility to the U.S. Air Force (USAF); Air Force Gen. Thomas S. Moorman Jr., was commissioned to lead the effort.

Moorman's SLMP team developed four modernization options:

- Sustain existing launch systems.
- Evolve current expendable launch systems.
- Develop a new expendable launch system.
- Develop a new re-useable launch system.

The SLMP led to the signing of National Space Transportation Policy Directive PDD/NSTC-4 by President Clinton in August 1994, tasking DoD to provide an implementation plan for improving and evolving the current ELV fleet. In October 1994, DoD identified the EELV program as DoD's solution for meeting this new requirement.

During the same period, then Secretary of Defense William Perry made sweeping changes to DoD acquisition procedures and policy, significantly influencing EELV's system acquisition strategy and business operations. One of the key acquisition reform tenets was streamlining the government's role throughout the procurement cycle, replacing prescriptive government "oversight" of contractors with less intrusive collaborative "insight." This approach shifted greater responsibility to system providers, allowing them greater freedom and trade-space to determine the best processes, procedures, and resource solutions for satisfying their customers' requirements.

In parallel, Darleen Druyun, the Principal Deputy Assistant Secretary of the Air Force for Acquisition, championed USAF acquisition reform via a series of Acquisition Lightning Bolt Initiatives. Her "Bolts" form the backbone of EELV program and business strategy; and are "designed to streamline organizations, develop superior acquisition strategies, focus attention on risk management vs. risk avoidance, and encourage the use of teaming as an acquisition workforce multiplier." They also seek to encourage the broad application of commercial best practices, Civil-Military Integration, international partnering, innovative contracting, market research, and market-based solutions to reduce total ownership costs.

EELV's ultimate objective is to enhance the competitiveness of the U.S. launch industry in the international launch services marketplace by delivering more capable, more responsive launch solutions while simultaneously reducing launch costs.

EELV was conceived as a "system of systems" to improve operability while achieving significant reductions in launch site infrastructure and recurring operations and maintenance (O&M) costs. Today's heritage systems occupy 10 separate government-owned and -operated launch facilities. Through a "system of systems" application of modularity, commonality, standardization, and lean manufacturing and operations, EELV eliminates government-furnished property and dramatically reduces infrastructure and recurring O&M costs by requiring only three commercially owned and operated launch sites.

The single most important tool within the EELV "system of systems" design trade-space is Cost As an Independent Variable (CAIV). Both EELV contractors have made CAIV an integral part of all EELV system design, development, production, and operations activities since program inception. CAIV is a powerful tool, providing for the establishment of aggressive, realistic cost objectives and the equally aggressive management of all associated risks. The emphasis on CAIV is the major reason why EELV has been able to achieve its substantial life cycle cost-reduction goals and better position the U.S. commercial launch industry to be more competitive in the international marketplace.

The EELV program operates with an overarching management philosophy that firmly balances government and contractor requirements, operational risk management, and acquisition excellence with the day-to-day realities of developing commercially owned and operated products and services that can compete successfully within the highly competitive international launch services marketplace. EELV market and customer demands are matched daily with flexible and responsive launch solutions through the use of small government/contractor Integrated Product Teams (IPT) and contractor program documentation, thus eliminating the need and costs associated with government-specific Contract Data Requirements List (CDRL) information or formats.

Every member of the EELV program operates with the singular focus of adding cost-effective product and service value. As a result, the EELV program office is structured and staffed to actively measure, track, and minimize system development risks, recurring launch service risks, mission risks, and business risks, while allowing maximum flexibility for the contractors to efficiently conduct a program that meets EELV's dual-use requirements.

A key risk management objective is to continuously balance the needs of a market-driven, fast-paced development program with a strong emphasis on protecting fragile eco-systems surrounding launch sites and factories. EELV environmental improvements include redesigned launch trajectories for reduced noise and land impact or overflight, leak- and spill-resistant fuel systems, elimination of Ozone Depleting Substances, self-contained "green" factories, cleaner-burning engines, and aggressive environmental mitigation efforts at all EELV operating sites.

EELV's elimination of the large Titan-IV class solid rocket motors will improve launch site air and water quality by annually eliminating nearly six million pounds of toxic materials from launch operations. The RD-180 and RS-68 engines are more environmentally friendly, eliminating the need for 500,000 pounds of toxic propellants annually. An example of improved factory environmental design is the self-contained chemical treatment facility, cutting fluid/metal chip recycling center, and power plant at the Delta IV factory.

The EELV program represents a national commitment to reengineering the business of space launch through the innovative use of industrial partnering and cost sharing and the application of comprehensive business and acquisition excellence initiatives. The program is specifically responding to the SLMP by requiring a recurring operational life cycle cost reduction of 25 percent to 50 percent over current launch systems, while at the same time improving system reliability and availability.

In 1995, then Secretary of the Air Force (SECAF) Sheila Widnall designated EELV as one of her four SECAF Flagship Acquisition Reform Programs. Speaking of her 1995 source selection, she identified "[a]ward of the EELV contracts [a]s the first step in our nation's long quest to reduce the cost of space launch." In a few months, her vision will become reality with the first commercial launches of the Atlas V and Delta IV, marking the first time in nearly two generations the United States has fielded truly new families of launch systems.

EELV was conceived as a "system of systems" to improve operability while achieving significant reductions in launch site infrastructure and recurring operations and maintenance (O&M) costs.

First Lockheed Martin Atlas V prepares for flight in the Vertical Integration Facility (VIF) at Cape Canaveral Air Force Station, Fla.

Boeing Delta IV Common Booster Core on the launch pad at Space Launch Complex-37, Cape Canaveral Air Force Station, Fla.

Execution of a Modular Approach to Acquisition

The EELV program is being executed in a three-phased, streamlined development approach, leading to two commercially owned and operated commercial launch services capabilities. This phased approach, consisting of Low Cost Concept Validation (LCCV); Pre-Engineering, Manufacturing, and Development (Pre-EMD); and Engineering, Manufacturing, and Development (EMD)—now referred to as Development—along with a companion Initial Launch Services Module, has served to focus and maximize industry involvement and ownership, scope and minimize development risks, and capture and employ commercial best practices.

Low-Cost Concept Validation

In August 1995, $30 million in Firm Fixed-Price LCCV contracts were awarded to four companies: Alliant Techsystems, Boeing Defense and Space Group, Lockheed Martin Astronautics, and McDonnell Douglas Aerospace. The objectives of the LCCV module were to define system concepts, mitigate risks by trade analyses and technical demonstrations, complete system designs to a Tailored Preliminary Design Review (TPDR) level of maturity, and draft system design specifications.

Pre-Engineering, Manufacturing, and Development

In December 1996, a competitive down-select at the end of the 12-month LCCV phase resulted in the award of 18-month, $60 million Pre-EMD contracts to Lockheed Martin and McDonnell Douglas (subsequently acquired by The Boeing Company). Pre-EMD objectives included completion of risk-reduction demonstration efforts, system specifications, and draft product specifications; demonstration of critical manufacturing processes and submission of manufacturing plans; updated life cycle cost estimates; completion of an environmental analysis; and the successful completion of a Down-select Design Review (DDR).

Strategy Reassessment

By the spring of 1997, however, significant growth in commercial launch market opportunities and a corresponding desire by the EELV contractors to meet this new demand resulted in a reassessment of the original EELV rolling (4 to 2 to 1) down-select strategy. The original strategy, which was based on the SLMP conclusion that the commercial market could not support two launch systems, was structured as a government-funded cost plus $1.8 billion development program.

By April 1997, the Commercial Space Transportation Advisory Committee (COMSTAC) launch model projected worldwide demand for addressable commercial Geo-synchronous Transfer Orbit (GTO) launches to be 30 to 40 a year. The COMSTAC projections, when combined with Federal Aviation Agency

Col. Robert K. Saxer, USAF

EELV System Program Director
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As Program Director, Saxer leads efforts to ensure that all EELV systems meet the Air Force Space Command's key performance parameters (mass-to-orbit, reliability, standardization), while reducing the cost of space launch by at least 25 percent over existing Titan, Atlas, and Delta launch systems.

At the cutting edge of acquisition excellence, the $18.8 billion EELV program is structured to simultaneously leverage commercial competition and international market forces to reduce development risk, dramatically shorten launch service delivery timelines, and incentivize industry capital investment.

A 1980 graduate of the U.S. Air Force Academy, Saxer holds an M.S. in Aerospace Engineering from Northrop University, an M.S. in Materials Engineering from the University of Dayton, and an M.S. in Public Administration from Harvard University. His military education includes graduation from the Air Command and Staff College and Industrial College of the Armed Forces.

Saxer's 21-year military career includes a number of assignments relating to acquisition and procurement and military space programs.

Prior to assuming his current position, he served as Deputy System Program Director, Evolved Expendable Launch Vehicle Program Office, Space and Missile Systems Center, Los Angeles Air Force Base. That position was preceded by an assignment as Director, Titan Launch Vehicles, Air Force Program Executive Officer for Space, Pentagon, Washington, D.C.

He has also held the positions of graduate assistant, project engineer, project manager, executive officer, program manager, and Research Fellow at Harvard University.

His military awards and decorations include the Meritorious Service Medal with two oak leaf clusters, the Air Force Commendation Medal with four oak leaf clusters, and the Air Force Achievement Medal.

Low Earth Orbit (LEO) launch projections and known NASA and DoD missions, nearly tripled the 1994 SLMP forecast. In addition, the Air Force saw an opportunity to "cost share" development and to further optimize the EELV contractors' system design tradespace by turning over all launch base operations and maintenance responsibilities.

As a result, in November 1997 then Acting Under Secretary of Defense (Acquisition & Technology) R. Noel Longuemare approved a revised acquisition strategy that: 1) positioned DoD to procure commercial launch services instead of separate production and launch operations efforts; 2) maintained an ongoing competition between two contractors rather than down-selecting to one; and 3) provided for government and contractor sharing of the costs of developing a national launch capability that meets government requirements and is commercially marketable. Air Force Space Command subsequently issued a new EELV Operational Requirements Document (ORD) in September 1998, formally documenting this shift in operational philosophy to commercial launch services.

Both DoD and the EELV contractors viewed the acquisition strategy changes as win-win. Each contractor would receive partial development funding, retain ownership and control of their system designs and launch operations, and could target their development and investment strategies to meet their corporations' long-term space transportation objectives.

DoD benefited from the opportunity to retain two proven launch service providers for less than the price of one, captured over $500 million in immediate development cost savings, and leveraged the commercial satellite market to reduce overall program risk. Industry would now fund the additional $3 billion required to bring both systems to market; and if market conditions turned and one EELV provider exited, DoD would be no worse off than if it had stayed with the original down-select strategy. DoD also benefited significantly from the commercial satellite industry's mounting demand for launch services. Viewed as EELV's silent "third partner," the satellite industry's demand for reliable space lift and willingness to "jump" from one launch service provider to another in the event of a launch failure have made reliability a program touchstone.

A single launch failure usually results in the loss of six to eight months of launch service revenue as well as the total loss of all recurring revenue generated by the affected commercial satellites. Although launch/satellite insurance is available and is usually purchased to protect corporate financial interests, the potential adverse financial and publicity impacts associated with launch failures are sufficient to encourage the EELV contractors to make mission success a top program priority.

Marketing EELV Commercially

Prior to the completion of the Pre-EMD module in May 1997, each contractor matured their system designs and realigned their corporate business plans, targeting their development efforts toward a commercial launch capability they could sell in the growing and highly competitive lucrative world market. The government would be only one of many customers, constituting approximately 30 percent of each EELV contractor's commercial base.

In parallel, the EELV program office began exploring various source selection criteria, contracting options, and business strategies capable of striking the appropriate balance between industry's desire to build intermediate-class launch vehicles for the commercial GTO portion of the market and DoD's need for medium and heavy lift capability. To influence this now mostly commercially funded development of a dual-use launch system, the government moved toward a unique value-added contractual arrangement that recognized the contractors' extensive experience in providing commercial launch services (Delta II and Atlas II) and their need for financial and design flexibility to meet both customer needs and changing market conditions.

This included partially funding (cost sharing) the development effort, leasing and licensing launch base properties (including real property, launch pads, and existing buildings) to the contractors; and turning over all mission integration, launch operations, and launch site maintenance to the contractors under a set of commercial launch services contracts. This arrangement allowed for an equitable allocation of these costs over the entire EELV customer base (both government and commercial).

Because of the tremendous benefit to the contractors in marketing the EELV commercially, the government decided to limit its development funding to no more than $500 million each. The contractors agreed to contribute additional funds of their own, as necessary to bring their national launch capability online, in exchange for full ownership rights and control of both EELV systems.

Built on time and on budget via a unique anchor-tenant relationship, the Delta IV and Atlas V systems represent the collective commitment of both DoD and the U.S. space launch industry to deliver high-performance, assured, affordable access to space.

The government considered $500 million in development funding to be an appropriate amount based on extensive contractor communications and the government's desire to establish a fair, reasonable, and compelling business arrangement that would: 1) incentivize the contractors to meet government requirements; 2) facilitate the government's 25 percent or greater cost savings goals; 3) allow each contractor to close its business case and receive corporate approval and bank financing; and 4) acknowledge EELV as a dual-use, national launch system.

Source Selection

During the summer of 1998, the EELV program conducted an exhaustive source selection, which evaluated each contractor's ability to complete development as well as its ability to provide commercial launch services for up to 30 USAF and National Reconnaissance Office satellites. Each contractor was first required to demonstrate its development plans would meet all system performance requirements. Once this was verified, each contractor's launch services offerings were evaluated for price reasonableness, business terms and conditions, ability to execute the services, and industrial base. All four evaluation areas were considered of equal value.

The industrial base area assessed the value of assured access to space and the long-term benefits gained by maintaining two competitive launch service suppliers. Although the government's intent was to maintain ongoing competition, the government reserved the right throughout the source selection process to select both, one, or none, depending on the quality of the proposals received. Special reduced development funding and limited launch service award provisions were also included as part of the solicitation should one of the contractors choose not to build a new launch facility on the West Coast.

Engineering, Manufacturing, and Development

In October 1998, the EELV program received Milestone II approval after verifying successful completion of all Pre-EMD exit criteria and a 20-year life cycle cost savings of $6.2 billion (approximately 31 percent) over heritage systems.

Award of Contracts

On Oct. 16, 1998, the USAF awarded two $500 million Development agreements using Other Transaction (OT) authority and two tailored Fixed Price Initial Launch Service (ILS) FAR Part 12 delivery order contracts. A $500 million development OT and a $1.38 billion ILS contract for 19 launches were awarded to The Boeing Company. Lockheed Martin received a $500 million development OT as well as a $650 million ILS contract for nine launches. The period of performance for the Development effort is fiscal 1999 through fiscal 2003.

The ILS contracts support the procurement of commercial launch services resulting from the Development agreements through fiscal 2010. The OT agreements and ILS contracts were awarded simultaneously to establish a formal anchor-tenant relationship between the government and EELV contractors. Concurrency of the OT and ILS awards also permitted the government to take full advantage of competition to obtain quantity discounts, while encouraging full corporate support and financial backing from the EELV contractors.

The ILS contracts with both providers contain common terms and conditions that define the commercial business relationship and application of the contracts to all EELV launch services. The benefits include: a single standard of quality; full funding traceability by mission and source of funds; quantity discounts for economically efficient buys; a single, streamlined government-to-contractor interface; real-time sharing of lessons learned; pre-negotiated launch postponements and delays; and guaranteed most-favored-customer pricing.

Each launch service is implemented via a separate contract delivery order with its own mission-unique statement of work and corresponding specifications established by the mission owner. Each delivery order for a launch service has a standard 24-month period of performance. Individual launch services plans, however, are highly flexible and can be tailored to accommodate spacecraft customer needs and launch dates. Launch service activities for nine government missions are currently underway to support government launches starting in 2002.

Leasing, Licensing, Support Agreements

To complement the OTs and ILS contracts, the USAF executed real property leasing, licensing, and support agreements with the EELV contractors for land and facilities use and operations at Cape Canaveral Air Force Station, Fla., and Vandenberg, Air Force Base, Calif. These arrangements supported the program objectives of contractor facility ownership and commercial launch services, while permitting the EELV contractors' increased financial flexibility in their corporate capital development accounts.

The OT agreements and launch base leases allow both contractors to finance their launch site capital improvements using low-cost third-party financing and facility lease-backs. Both EELV contractors have investment/financing agreements with Space Port Florida, allowing them to recover several hundred million dollars of current year funding. Similar financial arrangements are being explored with the California Space Port authorities.

The government's involvement in each company's EELV development effort was implemented via OT agreements entered into under the prototype project authority of Section 845 of the *National Defense Authorization Act of FY 1994.* In conducting the prototype project, each EELV contractor will develop a family of launch vehicles; construct launch pads capable of processing and launching all vehicle configurations intended to be launched from that site; establish a standard booster-to-satellite interface; and deliver launch services that reduce the recurring Life Cycle Cost for launches between fiscal 2002 through 2020 by 25 percent over existing launch systems. The flexibility associated with an OT agreement and its treatment of "best efforts" performance guarantees and contractor development costs (which in this case are largely contractor-financed) are the principal reasons an OT agreement approach was implemented.

The OT authority previously cited allows the participants to manage this program as a "best effort" commercial development using best commercial practices; Generally Accepted Accounting Principles; and commercial sources of investment, including Independent Research and Development (IR&D) financing, debt, capital financing, and third-party financing. Neither EELV contractor would sign up to a guaranteed performance arrangement for development (firm fixed-price or otherwise) because their fiscal exposure would be unlimited in meeting the program goals, and GAAP would have required them to declare the difference between the government's $500 million in funding and their estimated total development cost (well in excess of $1.5 billion each) as a loss in the year they signed the OTs.

Additionally, because the cost-sharing acquisition approach relies so significantly on contractor funding, international sales and service, commercial operations and maintenance, and protection of the EELV contractors' intellectual property and proprietary data, neither contractor was willing to give up their rights in data. As a result, government approval rights of designs, processes, and procedures, and rights to patents, intellectual property, technical data, and computer software developed for the remainder of the EELV program are limited. Insight to this information, however, is available in accordance with the terms and conditions of the OTs and ILS contracts.

Insight

EELV *insight* is defined as the government gaining an understanding of the contractors' progress through watchful observation. To enable insight, the contractors provide government EELV personnel access to all matters relating directly to the performance of the EELV OTA and ILS contracts. Government personnel may attend meetings, test activities, or configuration control board meetings and offer feedback for the contractors' consideration, but do not have approval/disapproval rights. The government, as a partner in the EELV investment, has complete access to contractor technical and programmatic data, and may reject any flight hardware it believes does not conform to mission needs at replacement cost.

As a result, there are no formal deliverable documents/CDRLs on the EELV contracts. However, the EELV program office has virtually unlimited access to all but some highly sensitive and proprietary cost and pricing data. For example, the U.S. Government participated fully at all levels of over 100 system and subsystem Delta IV and Atlas V Critical Design Reviews (CDR), and had complete detailed insight to provide value-added input/action items as a full partner in the systems engineering process.

EELV Financial Management

Because both EELV contractors have a compelling financial interest in ensuring performance of the Development OT and ILS contracts, significant attention is given to the EELV program's financial management structure, the contractor business cases, and the OT Development and ILS payments process. Combined, the EELV contractors are spending over $3 billion of company funds—much of it front-end loaded—to develop their launch systems.

As a result, the EELV Program Office has developed a set of comprehensive investment and financial analysis models to continuously evaluate the effect of changed market conditions on the contractors' Internal Rates of Return, Return on Investment, future launch service prices, and overall program life cycle cost savings.

The EELV program does not employ a traditional government Earned Value system. Instead, each contractor tracks program costs using its own internal accounting systems, and government OT payments are made to each EELV contractor based upon the successful completion of discrete development milestones. Each has well-defined success criteria, and each pre-negotiated payment milestone represents a significant event such as the completion of a system design review, major test series, major facility, or actual launch. ILS payments are schedule-based and are made at pre-negotiated points during the standard 24-month period of performance, consistent with commercial industry practices.

Overall, this funding approach provides exceptional value to both the government and contractors. The contractors benefit from the lump sum payments, accelerated cash flow for finishing early, and streamlined government payment process, which usually pays within seven working days or less. The government enjoys the benefits of having only a handful of annual payments to track; nearly 100 percent obligation and liquidation within each fiscal year; the ability to close all current fiscal year unliquidated obligations within a few months of the end of each fiscal year; and a financial staff of only 15—less than half the size of most major USAF program offices.

> Today the business of space launch is all about embracing change, building flexible competitive strategies, and developing long-term stable partnerships.

Although EELV financial management has been greatly simplified, among the key challenges affecting the program's long-term viability are the protection of key financial and contractual components of the contractors' business cases, and maintaining a sustainable competitive strategy under continuously changing market conditions. The EELV program office works very closely with both contractors and satellite customers to forecast market demand, capture business case changes, address industrial base issues, and protect key internal financial data. However, unlike other ACAT ID programs where development and recurring unit sales and operations and maintenance costs are fully funded by the government, EELV lives in a state of continuous competition, drawing more than 50 percent of its sales and financial support from the international marketplace.

While competition is a key enabler for reducing overall program risk, providing assured access and meeting the government's life cycle cost goals, these benefits are only achievable through the successful commercial sale and launch of Delta IV's and Atlas V's. Maintaining a proper balance of the commercial market's "risk-reward" investment equation requires constant communication and planning to flexibly react to evolving business conditions. To date, more than 60 EELV launch services have been sold to a variety of commercial and government customers, and more are expected as Delta IV and Atlas V enter service in mid-2002.

EELV—Two Families of Vehicles

The Boeing Delta IV and Lockheed Martin Atlas V represent a giant step forward in the design, development, production, and operation of launch systems. Each EELV family seamlessly blends government and commercial requirements, vehicle commonality and modularity, standardization, and lean manufacturing and operations to improve overall system operability, reliability, and performance while achieving significant reductions in recurring costs.

Through a combination of heritage lessons learned, lean "value stream" management, and process reengineering, both EELV contractors have achieved dramatic reductions in touch labor, piece parts, single point failures, suppliers, facilities, and processing time. What used to take weeks and months is now accomplished in hours or days thanks to simpler producible designs, automated focused factories, dedicated transportation systems, off-pad vehicle and payload processing, and integrated training centers and data enterprise networks.

Lockheed Martin Astronautics Atlas V

The Atlas V family of vehicles is built around a structurally stable Common Core Booster™ (CCB) powered by the Russian RD-180 engine and the heritage Atlas Centaur upper stage and Pratt & Whitney RL-10 engine.

RD-180

The RD-180 is produced by RD AMROSS in Khimky, Russia, as a joint venture between Pratt & Whitney of the United States and NPO Energomash of Russia.

Developing 860,000 lbf (3.8 MN) thrust at sea level, it uses liquid oxygen/RP-1 propellants (kerosene), and is the only high-thrust staged combustion liquid oxygen/RP-1 engine in production.

The RD-180 engine has been extensively tested, accumulating over 29,000 seconds of test time on 36 test engine builds and 13 production engines. Capable of continuous throttle between 47 percent and 100 percent of nominal thrust, it allows for substantial control over launch vehicle and payload environments. Flight proven on the first Atlas IIIA mission in May 2000, the RD-180 is scheduled to fly again in February 2002 on the first Atlas IIIB mission.

Medium, Intermediate, Heavy Vehicle Classes

The Atlas V family consists of medium, intermediate, and heavy vehicle configurations; and each includes a standard payload interface. Together they offer the flexibility to meet mass-to-orbit requirements for missions from low earth orbit to GTO. By simply adding vehicle components such as solid rocket motors or upper stage engines, Atlas V's flexible "dial-a-ride" designs allow a payload customer to place thousands of pounds of additional capability on-orbit for a marginal cost.

- The medium vehicle class or Atlas V 400 series consists of a four-meter payload fairing, a single CCB with RD-180 main engine, and common Centaur upper stage with one or two Pratt & Whitney RL10A-4-2 engines. From one to three 360,000 lbf thrust Aerojet strap-on solid rocket boosters may also be added for additional mass-to-orbit performance. The basic 400 series vehicle without solids is capable of placing 10,913 pounds into GTO using a single RD-180 and RL-10 engine. This is a 2,713-lb performance increase over Atlas IIAS, which requires nine engines to carry 8,200 to GTO.
- The Atlas 500 intermediate series consists of a Contraves Space composite 5.4-meter payload fairing, a single CCB with RD-180 main engine, as many as five solid rocket boosters, and common Centaur upper stage with RL-10A 4-2 engine (s). The 500 series with five solids is capable of placing 19,114 lbs into GTO and flying many of the payloads currently manifested on the Titan IV.
- The Atlas V heavy launch vehicle consists of three CCBs, each with an RD-180 main engine, Centaur upper stage with RL 10A4-2 engine(s), and a composite 5.4-meter payload fairing. The Atlas V HLV can place over 14,000 lbs directly into Geo-Stationary Orbit (GSO), a 1,300-lb increase over Titan IV.

Increased Performance, Mission Reliability

To increase Atlas V performance and mission reliability, the CCB is 100 percent common across all vehicle types, and over 5,200 parts and 300 suppliers have been eliminated—a 35 percent part count reduction compared to Atlas IIAS. The Centaur upper stage fuel tank has been stretched 10 feet, redundant avionics added, and a new engine-mounting bracket built that can easily be configured to hold either one or two RL10A-4-2 engines to optimally meet various mission requirements.

A dual engine spark igniter system has also been engineered to ensure prompt restarts, and a hydrazine attitude control system provides precise on-orbit maneuvering. The 5.4-meter Payload Fairing (PLF) is a new design derived from the Ariane V fairing manufactured by Contraves Space, Zurich Switzerland, and will be offered in two lengths: one optimized for communications satellites and the other to accommodate large-volume spacecraft missions. The 4-meter PLF is the same fairing used on the Atlas II and III and is manufactured in Harlingen, Texas. The Centaur upper stage will be mated to the CCB via a composite interstage adapter built by CASA in Madrid, Spain. Approximately 25 percent of Atlas V vehicle hardware is procured from foreign suppliers.

Atlas V System Development

Altas V system development has taken a low risk, evolutionary approach to achieve improved operability and reliability. This low-risk approach is centered on the common element design concept, which includes the RD-180 engine, CCB, common Centaur, and common avionics. Rather than attempting to develop and fly an entirely new vehicle all at once, Lockheed Martin has gradually introduced each of these new elements into the Atlas family, using the Atlas III series of rockets as a bridge between the workhorse Atlas II and the new Atlas V.

In addition, heritage Atlas II hardware has been augmented by extensive development testing of new or modified Atlas V hardware. Numerous development and qualification tests have been performed in the last several years. One significant test was the RD-180 stage hot firing at Marshall Space Flight Center, Ala., in late 1998 to support the Atlas III development. The successful Atlas IIIA flight in May 2000 demonstrated many Atlas V subsystems, and the upcoming Atlas IIIB will fly the newly designed Atlas V stretched Centaur upper stage.

Atlas V Streamlined Manufacturing

Lockheed Martin has three major Atlas V manufacturing facilities located in San Diego, Calif.; Harlingen, Texas; and Denver, Colo. Each has its specialties, and all are part of a lean "value stream" production flow.

- The San Diego facility is a world-class welding facility that specializes in resistance and fusion welding of Centaur propellant tanks.
- Harlingen has a diverse array of specialties and is responsible for the fabrication and assembly of major structures, such as the RD-180 aft transition section, 4-meter PLF, and PLF adapters.
- Denver operations focus on aluminum welding of the structurally stable CCB tank, launch vehicle component installation, final vehicle assembly, and system acceptance testing before transport by Russian *Antonov*-124 aircraft to the launch site in flight-ready configuration.

Significant tenets of the Atlas V lean manufacturing approach are designing for producibility and the broad application of statistical techniques for analyzing and measuring process variation. Mission success is dependent on reliable processes and, in turn, process reliability is key to manufacturing cycle time reduction.

From the program's beginning, USAF manufacturing engineers have been core Atlas V IPT members responsible for influencing the design to improve producibility and work flow. Lockheed Martin has responded by using "Six Sigma" and Kaizen principles to eliminate waste, focus on predictable processes, and measure output using a variety of proven and well-established metrics, including process capability (Cpk) metrics measured against defects per million opportunities. Kaizen is a culture of sustained continuous improvement to eliminate waste in all the systems and processes of an organization. Kaizen involves everyone in the organization working together to make improvements without large capital expenditures.

Key processes are under control and show continuous variability reduction. Atlas production cycle times have been reduced from 48.5 months for an Atlas II to 18 months for the first Atlas V. The Atlas V steady state production goal is 10 months. Lockheed Martin has achieved this dramatic reduction by eliminating 70 percent of the factory touch labor. It now takes only three people working three months on a single eight-hour shift to complete the final assembly, checkout, and testing of an Atlas V.

Similarly, structural tank welding that required over 100 piece parts and thousands of rivets, and was done manually by 20 people for a Titan IV core now requires only 16 parts for a CCB and is accomplished by an automated welding machine supported by two people. Perhaps the most significant difference from heritage launch systems is that Atlas V flight hardware will now be shipped to the launch site in a flight-ready configuration. The Atlas V CCB and Centaur upper stage are completely assembled and tested at the Denver factory before shipment. As a result, most of the launch base infrastructure and personnel required to support the production assembly, checkout, and testing of heritage Atlas and Titan vehicles have been eliminated.

To date, more than 60 EELV launch services have been sold to a variety of commercial and government customers, and more are expected as Delta IV and Atlas V enter service in mid-2002.

Atlas V Launch Facilities and Operations

The Atlas V system has been designed for very efficient launch site processing using just three facilities. Receiving, inspection, and launch operations are conducted in the Atlas Space Operations Center (ASOC). Off-pad vertical integration of the launch vehicle occurs in the new 280-foot-tall Vertical Integration Facility (VIF), and parallel processing and encapsulation of satellites occur in separate customer-owned or -leased facilities.

Lockheed Martin has reduced launch site processing facilities from 36 for Atlas II and Titan IV to three; required launch site personnel from 1,200 to less than 200; and the number of days on pad from 28-38 days for Atlas II and 180 days for Titan IV, to just one day for Atlas V. Off-pad processing time for Atlas V has been reduced to 18-26 days, depending on the configuration.

Once the CCB and Centaur upper stage have been stacked, the encapsulated payload is transported to the VIF and mated to the launch vehicle. Approximately 16 hours prior to launch, and after a combined systems test, the fully stacked and integrated Atlas V/encapsulated payload is transported, using the Mobile Launch Platform (MLP), to the "clean launch pad" at Space Launch Complex 41 (SLC-41)—a short distance away.

Payload services are provided by a payload services van, which accompanies the integrated vehicle to the pad. Once in position, the MLP accepts nitrogen, helium, and liquid oxygen via auto-couplers resident within the pad complex. All launch vehicle configurations use common processing procedures, and are capable of launching from the same "clean pad."

The Atlas V launch team is currently conducting system activation and pathfinder checkout operations at SLC-41, Cape Canaveral. The first Atlas V flight hardware arrived at the Cape in September 2001 and recently completed two full hardware integration cycles in the VIF, including the "soft" mate of an encapsulated payload in less than four days. Atlas V is now undergoing the first of three planned "wet" dress rehearsals in preparation for a May 2002 first launch.

Along with beating the planned timeline, the assembly operation required no shims, providing further confidence that Lockheed Martin's lean manufacturing approach is taking hold and the launch pad throughput timeline requirements will be met. The execution timeline for a recurring Atlas V launch service is normally 24 months from launch order. Payload integration, data exchanges, reviews, schedules, and operations are completely documented and consolidated for each mission in CD-ROM Launch Services Plans (LSP). The LSP provides a detailed road map of all activities required to execute the launch service for a particular mission.

The Boeing Company Delta IV

The Delta IV family of vehicles is built around a 5-meter-diameter Common Booster Core (CBC) powered by the new Boeing-Rocketdyne RS-68 main engine and a modified Delta III cryogenic upper stage powered by a Pratt & Whitney RL-10B-2 engine.

RS-68

The RS-68 is a 650,000 lbf (2.9 MN) thrust engine using liquid oxygen/liquid hydrogen propellants in a basic gas generator cycle. Twice as powerful as the Boeing-Rocketdyne Space Shuttle Main Engine (SSME), the RS-68 has accumulated over 20,000 seconds of testing on 20 engine builds and three production engines. The RS-68 operates at two set points—58 percent and 101 percent power—during normal operations. The amount of dwell time at each power setting is determined by mission profile and the need to control payload environments during ascent.

Medium, Intermediate, Heavy Vehicle Classes

Delta IV is available in three major classes; each has a standard payload interface and each vehicle type has the same "dial-a-ride" modular design capabilities as Atlas V.

- The Medium class vehicle consists of one CBC, a 4-meter cryogenic upper stage with a single RL-10B-2 engine, and a 4-meter PLF. It is capable of placing 9,255 lbs into GTO.
- The Intermediate, or Medium Plus vehicles, consist of a single CBC, two or four Alliant Techsystems 275,000 lbf thrust strap-on solid rocket motors (graphite epoxy GEM-60), a 4- or 5-meter upper stage with a single RL-10B-2 engine, and either a 4- or 5-meter PLF. The Medium Plus class of Delta IV has been designed to carry up to 14,525 lbs to GTO.
- The Delta IV Heavy Lift Vehicle consists of three CBCs, a 5-meter cryogenic upper stage, and a 5-meter fairing. The 5-meter PLF can be either an isogrid aluminum fairing based on the existing Titan IV fairing, or a newly developed composite fairing built by Alliant Techsystems in Iuka, Miss. The 4-meter fairing is the existing Delta III composite fairing lengthened by three feet.

System Reliability, Overall Vehicle Costs

To improve system reliability and reduce overall vehicle costs, Boeing has dramatically reduced part counts, suppliers, and touch labor. The RS-68 engine has 95 percent fewer parts than the SSME and requires only 8,000 hours of touch labor to assemble vs. 171,000 hours for the SSME. Its advanced design has been enabled by new manufacturing technologies that permit the use of cast vs. welded parts, lower operating temperatures and pressures, and no special coatings. Parts for the Medium Plus and Heavy CBCs are 88 percent and 93 percent common relative to the Medium CBC. All are manufactured using automated tools and a common factory production line. The CBC includes innovations such as friction stir welded tanks, spun-formed domes, and use of composite structures.

Mission risk and cost have been further reduced through the use of a modified Delta III upper stage, which is 85 percent common to the Delta IV design. Much of the Delta IV avionics and flight software has also flown on the Delta II and Delta III, and only 7,000 lines of flight software are required to fly the Delta IV.

Delta IV System Development

Boeing has taken an evolutionary approach to Delta IV system development, balancing the use of heritage hardware with development of new hardware. The highlight of the new development project is the RS-68 main propulsion system—the first new American large-class cryogenic engine in almost 30 years.

The RS-68 engine development involved extensive testing of major components such as turbo pump, gas generator, injector, and heat exchanger, with the goal of verifying performance parameters such as thrust, specific impulse (Isp), mixture ratio, and main combustion chamber pressure (Pc). A series of hot- fire tests were conducted at the Air Force Research Lab (AFRL), Edwards Air Force Base, Calif., and at the NASA Stennis Space Center (SSC), Miss. Each flight engine is acceptance hot-fired at Stennis prior to delivery to the focused factory in Decatur, Ala., for integration into the CBC.

In addition to the engine-level tests, Boeing ran a series of five static fire tests with a full-up CBC. These tests demonstrated robustness of the design and the performance of the entire booster, with only consumables being replaced between tests. A formal on-pad, hold-down, hot-fire test of the first flight Delta IV will be conducted days before first launch to further reduce risk and fully verify all pad and vehicle operations.

Delta IV Streamlined Manufacturing

Boeing has revolutionized the manufacturing and production of launch vehicles. Instead of modifying their existing manufacturing facilities, Boeing took the lessons learned from their heritage Delta II/III experiences and started from scratch, laying out an integrated Delta IV manufacturing, assembly and test, and transportation flow.

Today, Delta II vehicle components travel over 8,174 miles during a 23-month manufacturing journey before they arrive at Cape Canaveral for final assembly and test prior to going to the launch pad. The Delta II journey to Vandenberg Air Force Base (VAFB) is even longer given the vehicles must first go to the Cape for assembly before they can be transported to the West Coast.

For Delta IV, Boeing built a "green field" Focused Factory in Decatur, Ala.—one mile from the Tennessee-Tombigby Waterway and centrally located near key suppliers at Stennis (RS-68) and Iuka, Miss. (composite CBC shells and PLFs). Raw materials and finished parts enter one end of the 1.5-million-square-foot facility, travel in a single piece flow via a 2.1-milelong moving assembly line, and a completely assembled booster rolls out 15 months later. The Focused Factory, which is capable of producing 40 CBCs a year, has increased efficiency and reduced cycle time through lean manufacturing and optimized workflow processes.

> The EELV program includes an aggressive and proactive risk management program to identify, assess, mitigate, and report system development risk, mission risk, and business risk.

Boeing has emphasized the application of statistical techniques for analyzing/measuring process variation as well as the management of key manufacturing processes using capability metrics. "Team Decatur" actively pursues continuous improvement of their world-class factory and processes; the most recent example is the Delta IV Engine Section Team, which was able to reduce floor space by 15,000 square feet, flow days by 32 percent, and required labor by 69 percent. The result is all eight CBCs currently in flow have non-conformance rates better than any heritage launch vehicle.

Full Integration, Assembly and Check Out (IACO) testing occurs before each vehicle leaves the factory, ensuring only fully tested and ready-to-fly vehicles are loaded on the *Delta Mariner* and delivered to the launch site. The *Delta Mariner* is Boeing's specially built dedicated transport vessel. Constructed in 18 months under a partnership with Foss Maritime, the *Delta Mariner* is a 308-foot-long seagoing vessel, specifically designed to carry up to three Delta IV CBCs. Unlike Lockheed Martin, who had to limit the size of their booster core to meet size restrictions of the C-5 and Russian *Antonov*, Boeing was able to make their CBC 5 meters in diameter and 160 feet long, greatly simplifying their overall design.

Boeing's key partner in the Focused Factory is the State of Alabama, which provided real estate, financial, transportation, workforce, and training support. Boeing, in partnership with the State of Alabama, has developed an extensive training program with nearby Calhoun College. All personnel, including Defense Contract Management Agency (DCMA) representatives, go through an eight-week course and participate in on-the-job-training on the factory floor before they become part of "Team Decatur." Due to Delta IV's lean manufacturing approach, only three DCMA representatives are resident in the factory. All Decatur data are available via Boeing's GENYSIS enterprise data network.

Delta IV Launch Facilities and Operations

Boeing has designed the Delta IV system for efficient launch site processing in a total of three different facilities as compared to the 43 facilities used for heritage Delta II/III.

- Receiving and inspection for the Delta Cryogenic Upper Stage (DCUS) and launch operations are performed in the Delta Operations Center (DOC).
- CBC receiving and inspection, IACO, and final assembly and mating of the CBC and DCUS are performed in the horizontal position in the Horizontal Integration Facility (HIF). The horizontal booster processing flow and vehicle stage mating improve operations by allowing for parallel integration capability, reduced hazardous lifting operations, and reduced pad time when compared to heritage Delta II/IIIs that are assembled on the launch pad. Parallel processing and encapsulation of satellites occurs in separate satellite customer-owned or -leased facilities, not in a Delta IV facility.
- Boeing will launch the Delta IV vehicles from a new 330-foot state-of-the-art Space Launch Complex-37 (SLC-37) at Cape Canaveral, and from the extensively modified Space Launch Complex-6 at VAFB. Total launch vehicle time at the launch base is less than one month, with only 8-11 days on the launch pad, depending on vehicle configuration. Each launch pad is capable of launching all Delta IV configurations, and launch pads are virtually standard between the Cape Canaveral and VAFB launch sites.

The Delta IV launch team is currently conducting system activation, vehicle erection, and pathfinder checkout operations at SLC-37. Unlike Lockheed Martin, which is using the first flight article as a pathfinder, the Boeing Team is using the Static Fire Unit that arrived on May 29, 2001.

The first Delta IV flight hardware arrived at the Cape in December 2001 and recently completed a full hardware integration cycle in the HIF. Along with beating the planned timeline, the assembly operation was flawless, providing further confidence that Boeing's lean manufacturing approach is in place and the launch pad throughput timeline requirements will be met when the first flight Delta IV is erected at SLC-37 in February 2002.

The execution timeline for a Delta IV launch service is normally 24 months from launch order. Payload integration, data exchanges, reviews, schedules, and operations are completely documented and consolidated for each mission in a CD-ROM Integrated Mission Services Plan (IMSP). The IMSP provides a detailed road map of all activities required to execute the launch service for a particular mission. And like Atlas V, the Delta IV also includes the EELV standard payload interface.

Integrated Risk Management and Mission Assurance

The EELV program includes an aggressive and proactive risk management program to identify, assess, mitigate, and report system development risk, recurring launch service risk, mission risk, and business risk. The EELV acquisition strategy was specifically developed to incrementally address these risks as the program progressed from LCCV through Pre-EMD, Development, and ILS.

To minimize development risks, and increase the government's assurance of meeting all objectives in a "best efforts" business environment, the EELV program tied payments to performance, established ILS performance commitments and contingency launch service backups, required successful completion of both a Tailored Critical Design Review and Design Certification Review, established significant term liabilities, and tied final milestone payments to the first two launches.

Other risk mitigators include the presence of two competitors, the sale of launch services to other customers, the contractors' substantial investment in the program, and the fact that contractor investments were heavily weighted toward the beginning of the Development effort.

The EELV risk management process has been carefully structured to identify and address all program risks. Technical risks are captured within the program's mission assurance process. Mission assurance spans the technical continuum from contractor design, development, and qualification activities, through production, integration, launch processing, launch operations, and post-flight analysis.

The EELV mission assurance process relies upon the cooperative relationship and integrated activities of the contractor and government organizations. Through the application of acquisition excellence initiatives, innovative contracting strategies, and close-ended funding strategies, the EELV program aggressively reduces business risk.

EELV is now a reality because government and industry have successfully merged their visions, strategies, requirements, and corporate investments in a complementary, yet cost-effective way.

Balancing competing business, commercial market, and financial incentives and penalties to ensure all risks are adequately addressed is the key business risk management challenge.

Technical and schedule risks associated with the EELV development program are inherently lower than those of most new technology programs based on the fact that the EELV program is evolving existing technology. The basic premise of the EELV acquisition strategy is to minimize the risks associated with developing a new launch capability by using evolved designs based on proven launch systems and existing technologies, and benefiting from the lessons learned from heritage vehicles.

Successful execution of launch services requires the integration of more than just the launch system, which includes the launch vehicle, launch facilities, and support equipment. It requires integration of the government-owned and -operated range infrastructure, program security requirements, public safety and protection of government assets, environmental regulation, and foreign involvement risks. Management of risks such as safety, security, and environmental considerations are integrated into the overall risk management activities associated with delivering flightworthy hardware to the launch site, and the processes and procedures needed to provide maximum assurance of successful delivery of a payload to its prescribed orbit.

Important tools in the execution of the risk management process include an active program office Risk Management Council, Aerospace Corporation Independent Risk Assessments, and insight and participation in the contractor monthly Risk Management Reviews.

All program risks are formally documented in "risk maps," which capture probability and severity. Each risk map is an event-based risk mitigation path defining the incremental steps that must be "burned down" to reduce risk to an acceptable level. All risk maps are under configuration control and are formally reviewed monthly to support EELV's overall mission assurance process and to determine manpower allocations and assignments.

The Risk Management Council conducts 30-, 60-, and 90-day look-aheads for each risk to ensure the appropriate technical support is available for each risk event. This process suports program office review of all current and future manpower requirements, as well as the Space and Missile Systems Center Commander's responsibilities under Operational Safety, Suitability, and Effectiveness.

Evolving Launch Services Environment

Maintaining a sustainable competitive business strategy under continuous changing market conditions is the most significant challenge for the EELV program as it transitions to recurring launch service operations. Market stability and demand are critical enablers for ensuring a stable workforce, strong supplier relationships, and mission success.

In the last 18 months, the EELV program has witnessed sizable market fluctuations in commercial launch opportunities as demand for satellite bandwidth has fallen in favor of fiber optics, as deployment schedules for commercial satellite projects have slipped or been cancelled, and as other foreign launch service suppliers such as Sea Launch have entered the market. These factors have created a "supply greater than demand" environment, placing financial pressure on both EELV contractors to greatly reduce their launch service prices, profit margins, and earnings forecasts.

It was in this environment that Lockheed Martin came forward in December 1999 and requested certain requirements of the OT agreement be revised as provided for under the "best efforts" provision. Lockheed Martin determined that the reduced number of "addressable" commercial missions now forecast to be available in 2001-2006, made their continued investment in the EELV program no longer viable.

After several weeks of discussions and analysis, an independent Joint Assessment Team of government and industry officials concluded the current ORD and acquisition strategy were appropriate, but market demand had decreased and the long-term launch forecast did not support the need for two West Coast launch pads. Since the original EELV Development solicitation included a provision for not building a West Coast pad, and it was still beneficial for government to retain two launch service providers on the East Coast, then Principal Deputy Under Secretary of Defense for Acquisition, Technology and Logistics David Oliver concurred with Lockheed Martin's request. As a result, both the OT agreement and ILS contract were restructured to eliminate Lockheed Martin's requirement to build a West Coast pad.

In order to maintain competitive equity between Lockheed Martin and Boeing, adjustments were made to both EELV contractors' OT agreements and ILS contracts so that the maximum possible competition could be maintained for launch services from Cape Canaveral. Approximately 80 percent to 90 percent of all U.S. launches originate from the Cape.

In exchange for not completing the VAFB pad, two West Coast launch services originally awarded to Lockheed Martin were transferred to Boeing. Boeing was also awarded funding to build and fly a Delta IV Heavy Lift Vehicle (HLV) demonstration flight. The new requirement for this demonstration flight in fiscal 2003 was added due to market changes that now made the government the first user of a Delta IV HLV, and a desire by then Secretary of the Air Force F. Whitten Peters to reduce future government HLV mission risks. Despite the recent market fluctuations and the need to readjust contractor requirements, EELV's flexible contract structure and industry partnership continue to provide both contractors with sufficient motivation to maximize performance and market potential.

Lift-Off

In the next few months, the first of a new generation of launch vehicles will lift-off from Cape Canaveral. Built on time and on budget via a unique anchor-tenant relationship, the Delta IV and Atlas V systems represent the collective commitment of both DoD and the U.S. space launch industry to deliver high-performance, assured, affordable access to space. Together, the USAF, Boeing, and Lockheed Martin have brought substantial and fundamental change to the business of space launch in near record time; going from paper designs and "green fields" in Florida, California, and Alabama, to fully integrated and dedicated manufacturing, production, transportation, and launch site centers of excellence in 45 months.

The EELV Program Management Team has won several prestigious Air Force and Department of Defense awards, including the David Packard Excellence in Acquisition Award, the John J. Welch Jr. Award for Excellence in Acquisition Management, the Outstanding Strategic Acquisition Reform (STAR) Award, the Defense Standardization Program Outstanding Performance Award, and the Department of Defense Value Engineering Award.

EELV is now a reality because government and industry have successfully-merged their visions, strategies, requirements, and corporate investments in a complementary, yet cost-effective way. And the long-term benefits are already being seen. More than 60 launch services have been awarded; a dozen are actively underway, with five missions scheduled for launch in 2002; three of 10 heritage launch pads are scheduled for closure in the next few months; and thousands of pounds in additional satellite weight growth has been quickly addressed through the modular addition of a few strap-on solids at a nominal cost. Overall, EELV Program life cycle cost savings are now expected to exceed 50 percent, or $10 billion.

Today the business of space launch is all about embracing change, building flexible competitive strategies, and developing long-term stable partnerships. As EELV transitions to recurring launch services, balancing customer demands for responsive launch service solutions with sustainable competitive business strategies under ever-changing market conditions will be the program's biggest challenge.

Although government development funding is nearly complete, as with any successful partnership continued long-term targeted investments by both government and industry will be required to ensure a stable workforce, maintain a solid industrial base, and achieve mission success. All are necessary to meet the ever-rising expectations of EELV's many customers, shareholders, and financial partners; to add cost-effective product value; to increase mission reliability; and to deliver rapid on-orbit capability to both the commercial as well as the warfighter community.

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