



Space Congress 2004

NASA's Utilization of Expendable Launch Vehicles

**Steve Francois, Program Manager
NASA Launch Services Program
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Historical Perspective

- **Post Challenger, NASA instituted a Mixed Fleet Launch Strategy and consistent with law and policy transitioned to acquisition of commercial launch services for missions that did not require unique capabilities of the Space Shuttle**
- **Since 1990, the majority of NASA’s free flyer/robotic spacecraft have been launched on Pegasus, Delta II, and Atlas ELV launch systems**
- **Although Pegasus and Delta II - class capability remains a key niche for NASA, future requirements for Delta IV/Atlas V capability, both of which NASA has under contract today are being considered**

	CY90-CY03	CY04-CY11
Scout	6	0
Pegasus	12	7
Taurus	0	5
Delta ii	28	31
Atlas Centaur E/i/ii	14	0
Titan ii/iii/IV	6	0
Delta IV/Atlas V	0	11
To be assigned	N/A	5
Other	2	0

Notes:

- » **Figures only reflect NASA Primary Payloads**
- » **CY04-CY11 contains planning figures – subject to change**
- » **Future Exploration Initiative architecture decisions may increase CY04-CY11 figures**



Past ELV Upgrades

- **NASA's unique requirements have driven ELV upgrades in the past:**
 - **Delta II Star 37 upper stage**
 - **Pegasus performance upgrade to Pegasus XL**
 - **SLC 3E Atlas IIAS Launch Capability**
 - **Delta II 10L Fairing**
 - **Atlas IIA 3m Payload Fairing widening to 4m**
 - **Atlas IIA 4m Payload Fairing 3ft Extension**
 - **Centaur Strengthening for Heavy Payloads**
 - **Atlas IIA TDRSS Transmitter**
 - **Centaur Long Coast Kit**
 - **Delta II Dual Payload Attach Fitting (DPAF)**
 - **Delta II 7920 Heavy performance enhancement**
 - **Delta II Star 48 Break-up System**



Future ELV Upgrades/Capabilities

- **No specific upgrade initiatives are currently planned for the Pegasus and Delta II fleets, other than continuous improvement and mission unique modifications**
- **The new Exploration Initiative may drive the need for capabilities beyond the current ELV capabilities**
- **Past/on-going NASA studies on ELV Upgrades focus in three areas:**
 - **Reliability Enhancements**
 - **Human Rating**
 - **Performance Enhancements**



ELV Reliability Enhancements

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- **Initial Studies performed by NASA, Boeing and Lockheed Martin in 2003**
 - Focused on Delta IV and Atlas V families
 - Documented on baseline design reliability and methodology
 - Identification of single point failures within existing ELV designs
 - Proposed reliability enhancements
- **NASA is exploring the possibility to invest in reliability upgrades that will enhance the entire fleet, as opposed to one-of-a-kind modifications**
- **Potential Reliability Enhancements under consideration for further study**
 - RL-10 engine – benefits to both launch systems' upper stages
 - RD-180 – Atlas V booster engine
 - RS-68 – Delta IV booster engine
 - Fault tolerance upgrades where feasible/practical
 - Initiatives to increase design margins/robustness
 - Potential benefits in process enhancements
- **Plans for future study/requirements development under review**



Human Rating

- **LSP and the Launch Contractors formed a team to support the Orbital Space Plane (OSP) requirements development and preliminary design efforts throughout CY03 and early CY04**
 - Initial studies were performed for OSP over a very short period of time
 - Focus on Unique requirements, especially human rating
 - Existing ELV compliance with human rating guidelines is feasible, but very challenging
- **Preliminary Studies identified some areas warranting further assessment to support human rating compliance for ELV's:**
 - Fault tolerance enhancements (both flight and ground)
 - Unique Analysis: FMEA/CIL, Hazard Analysis, Blast Models, Abort trajectories, Aerodynamics, Probabilistic Risk Assessment (PRA)
 - Custom mechanical and electrical/data interfaces
 - Launch Vehicle Health Monitoring (LVHM) system
 - Human Access/Emergency Egress at Launch Complex
 - Modifications to Flight Termination Systems
- **On-going/Future Work:**
 - Documenting results from OSP Studies – assessing applicability to CEV
 - Next steps to be developed with Space Flight and Space Exploration Enterprises



ELV Performance Enhancements

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- **Past/on-going NASA studies to explore ELV performance enhancements for Jupiter Icy Moons Orbiter (JIMO) and other potential Exploration missions**
- **Enhancement possibilities include the following areas:**
 - Larger diameter fairings
 - Higher thrust upper stage propulsion
 - Higher thrust booster propulsion
 - Lighter weight materials
 - New combinations of solid and liquid core stages
- **Some proposed enhancements drive secondary impacts to existing infrastructure:**
 - Launch Complex – major modification or new Pad
 - Transportation equipment
 - Manufacturing and Test facilities
 - Ground Processing facilities
- **NASA seeks to leverage from existing technology and use spiral development approach to minimize risk**
 - LSP is working with HQ, Customers, and Launch Service Contractors to balance costs of ELV capabilities and associated development -vs.- required Spacecraft capabilities to optimize cost, schedule and acceptable technical risk
 - Where crew may be involved, safety is paramount
- **On-going/Future Work:**
 - Initiated follow on studies with LMA and Boeing to characterize growth paths for current systems

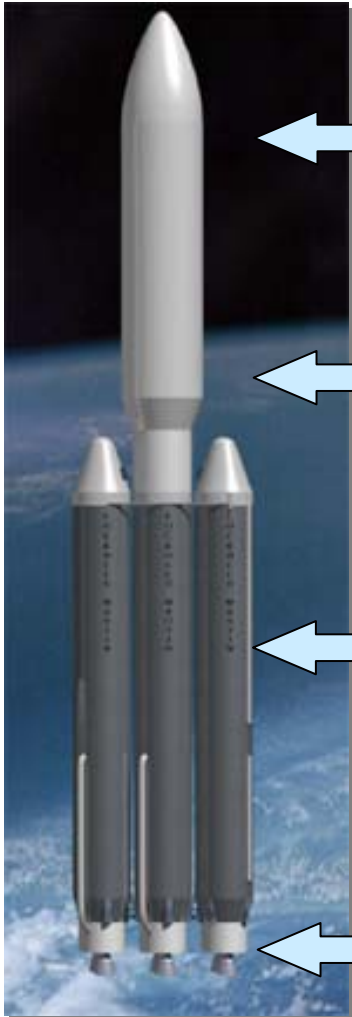


Various ELV Possibilities to Meet Future Exploration Needs

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Atlas V



Delta IV



Larger Fairings and “Unshrouded”
Launch Capability

Upper Stage Reliability and/or
Performance Enhancements

Alternative, Light-weight
Structural Materials

Booster Engine Reliability and/or
Performance Enhancements

We must deal with the new unique requirements with an integrated approach



Summary

- **LSP is leveraging from successful history on proven domestic ELV fleets to minimize risk in future endeavors**
- **LSP is also maintaining a pulse on new launch technologies and emerging companies as they may apply to NASA's future needs**
- **NASA's new Exploration Initiative is driving the study and evaluation of several transportation options (current expendable, shuttle derivatives, clean sheet).**
- **The ELV approach will focus on an integrated launch solution, relying on a combination of reliability, performance and safety (human rating) upgrades to the existing ELV designs.**
- **Agency decisions over the next 12 to 18 months offer exciting opportunities for space transportation utilizing ELV's**