Atlas I to Atlas V

The Path to an Affordable and Operationally Efficient Launch System

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The Space Operations Community: Other Views and Experiences

Throughout the course of space launch development, the Atlas and Centaur Programs have enjoyed a rich history as the trusted vehicle of choice for America's satellite programs. The Atlas Expendable Launch vehicle family continues to demonstrate reliability and common fleet affordability due to evolutionary improvements that factor in all aspects of a mission. From design and manufacturing (including subcontractors) to assembly and test to operational launch, no detail is overlooked. In addition, Launch costs have been reduced by over 50% compared to heritage Atlas vehicles, and the LC-41 clean pad concept has greatly increased launch capacity per year. Atlas has successfully launched payloads 79 consecutive times to their earth-synchronous or solar system bound trajectories, with increased accuracy and reliability. During the maturation from Atlas I to Atlas V, 8 evolutionary Atlas first flight vehicle configurations combined with the development of 3 new or significantly modified launch pads provided the opportunity to reduce cost and improve operational aspects of the launch system.

Atlas I AC-69 | **Atlas II AC-102** | **Atlas IIA AC-105** | **Atlas IIAS AC-108** | **Atlas IIIA AC-201** | **Atlas IIIB AC-204** | **Atlas V-400 AV-001** | **Atlas V-500 AV-003**

The Atlas Evolutionary approach has successfully proven all 8 of 8 first flight vehicle configurations, with a current flight record of 79 consecutive successes.

This paper addresses the evolutionary path that the Atlas Centaur program developed to accomplish the goals of significantly reducing cost, while improving all other aspects of the launch system. The success of a program is rooted in its ability to control its processes, while evolving and growing to meet the increasing demand for lower operational costs.

I. Introduction

Affordable and reliable space transportation requires an innovative approach that is configured to meet the performance, safety and reliability requirements for each mission. Key measures of Space Transportation's effectiveness are Affordability and Operational efficiency. Several parameters that cannot be sacrificed in the quest for sustained affordability include Safety, Reliability and Extensibility. Centaur's long heritage as a cryogenic propulsion stage that performs both Earth Orbit launches has demonstrated its ability to evolve to support long duration flights to the Moon and Mars, while continuing to perform effectively as a near-earth space transportation system.

Key measures for achieving an operationally efficient launch transportation system are:

Affordability - Maximize crosscutting applications to synergize development and minimize recurring production costs.

Demonstrated Reliability – The 79 successful consecutive flights of Atlas and Centaur provides demonstrated reliability for future flights and evolved configurations.

Evolution – Enhancements fly on all missions, increasing proven reliability and safety for each mission.

Commonality and Extensibility – Multiple elements of the architecture require a propulsion stage with common subsystems and features such as:

- Common production and handling infrastructure
- Common adapters, fairings and separation systems
- Common avionics (including Rendezvous and Docking, Solar arrays, etc.)
- Common tank construction with cylinder lengths enables multiple performance levels
- Long Duration Cryo Fluid Management maximizes propellant storage (sun shield, MLI etc.)
- Common umbilicals for simplified ground and flight operations
- Common engine mounts, gimbals
- Common propulsion (RL10's, RCS, feed system) with multiple engine capability to meet high or low thrust requirements and potential for engine out
- Proven Propulsion (Main, RCS, Pneumatics)

Reliability

8 of 8 First Flight Configuration Successes; 3 New or Modified Launch Pads

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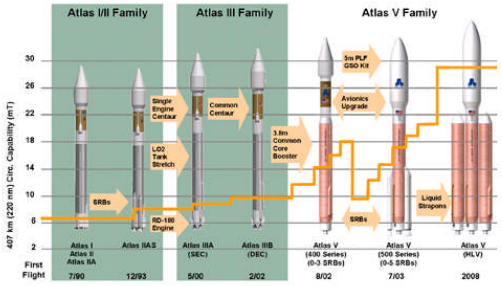
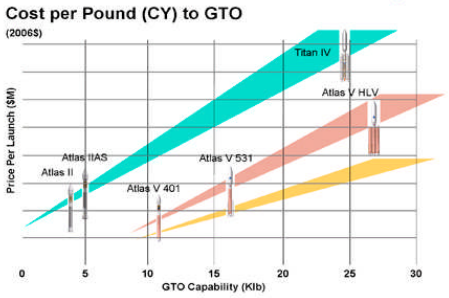
Evolution History

Demonstrated Low Risk Evolutionary Development
By Introducing and Improving Upgrades One Step at a Time



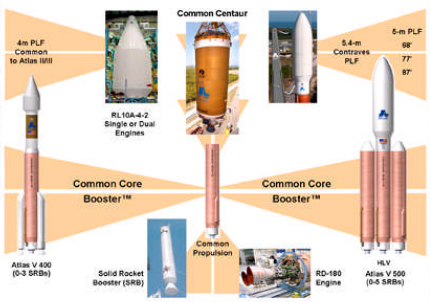
Affordability

The Atlas V/EELV Family Successfully
Reduced Cost to Orbit by 50%



Commonality

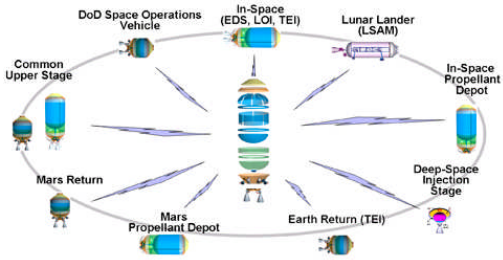
Significant Commonality Between Multiple Vehicle Configurations Minimized Unique Manufacturing Operations



Atlas V Clean Pad Concept Delivers Improved Operational Simplicity and Flexibility

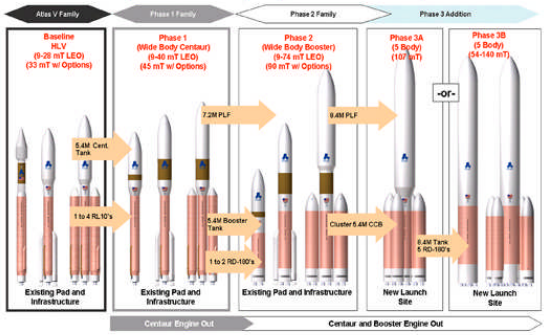
Extensibility

Centaur Evolution is Extensible to
Other Applications to Further Reduce Cost



Future Evolution

Atlas Evolution and Commonality Carried Forward to Improve
Operational Simplicity and Affordability for the Future



II. Summary

The Atlas V Space launch system has benefited significantly from the efficiency of the commonality of booster components, and the clean pad operations concept for launch site operations. The RD-180 and Lox/RP-1 Propellant combination reduced the size of the booster stage and therefore the infrastructure was reduced as well. The integration of common architecture within the tanks, propulsion and cryo management technologies for earth orbit and long duration transportation stages provide significant benefits for Space Utilization and Exploration, while continuing to support the needs of NASA, AF and commercial customers.