

LAUNCH CAN DO MORE: UPPER-STAGE INNOVATION AT ULA WILL CREATE NEW VALUE FOR SPACE

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ABSTRACT

United Launch Alliance (ULA) is developing a revolutionary new upper-stage called the Advanced Cryogenic Evolved Stage (ACES). ACES is a unique transportation system, delivering unprecedented maneuverability, power, and auxiliary payload capacity in space to a wide range of customers. Its game-changing technologies will enable new approaches to space industrialization, constellation maintenance, and security.

INTRODUCTION TO ACES

ULA's ACES upper-stage will revolutionize the launch industry by delivering more capability on orbit than any other rocket in the world. Coupled with ULA's new Vulcan booster, ACES provides up to 30% more lift performance than the Delta IV Heavy and at one-third the price. With significantly greater performance, ACES also offers first of its kind capability for on-orbit maneuverability and electrical power generation – expanding the realm of possibilities for in-space transportation and delivery.

ACES is based on Centaur, a high performance second stage. Centaur has an extensive flight history, successfully delivering commercial, NASA, and national security payloads safely to space. ULA has delivered 126 missions, with 100% mission success, over the last ten years. ACES will continue this record of reliable and regular transportation, while increasing performance and decreasing cost.

The key enabling technology for ACES is the integrated vehicle fluids for power and propulsion. This system provides an entirely new paradigm for space launch, offering flexible in-space transportation options not available by any other system. ACES represents a pivotal advancement in power generation, utilizing the byproducts of internal combustion to provide clean, efficient power and thrust with substantially lower cost and weight than traditional solutions. Trans-orbital maneuvers expand range and opportunities for secondary payloads and post-delivery missions.

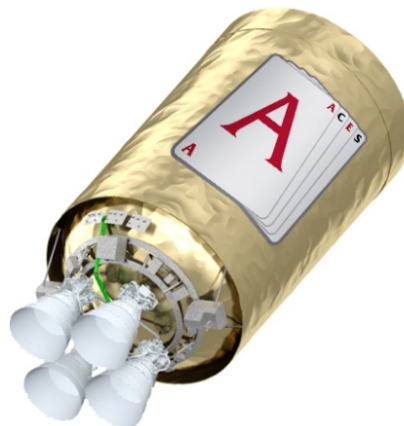


Exhibit 1: ACES Upper Stage

In-Space Capabilities

ACES is the next leap-forward in optimized orbit delivery with the potential to dramatically extend satellite life. ACES enables primary and secondary payloads to conserve limited fuel, thereby maximizing their expected life on orbit. With unmatched delta V capability—coupled with the ability to burn its main engines dozens of times—ACES also dramatically increases speed to orbit, enabling commercial satellites to achieve initial operating capability much faster. Precision orbit insertion, a hallmark of ULA’s mission planning advantage, also enables commercial payload providers to realize a faster return on their investment.

As a payload delivery vehicle, ACES provides valuable cost and time savings by “piggy-backing” additional functionality onto planned launches. ACES extends resiliency by delivering payloads into any orbit on-demand—weeks, months, or even years after launch—providing continuous and surge power to extend and enhance mission value.

Integrated Vehicle Fluids

A significant enabling technology for ACES is its integrated vehicle fluids. The subsystem utilizes “waste” propellants to produce power, reaction control, and pressurization. ACES is a liquid hydrogen and liquid oxygen stage and the subsystems use these same propellants. The ability of the stage to use a single set of propellants eliminates several limiting resources, such as main batteries, hydrazine, and helium, enabling more mission capability including long duration on orbit.

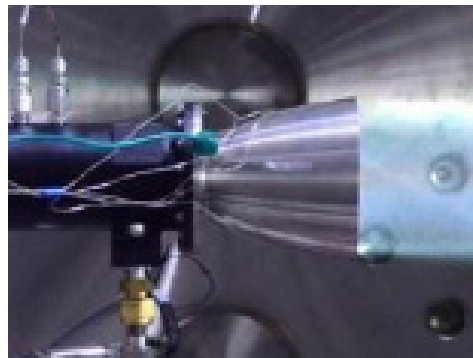


Exhibit 2: H2/O2 Thruster

Exploration

Through Vulcan ACES, ULA will bring about transformative access to and through cislunar space (the area of space between the Earth and the moon, including the moon’s surface). Leveraging the tremendous resources in cislunar space will enable the growth of a whole new space economy – generating a new era of economic and human value. Vulcan ACES is the space transportation system for a new era of access to space.

As a cislunar transportation enabler, ACES creates a whole new arena of possibilities in this fast-growing marketplace of ideas. The availability of water on the moon could provide fuel for ACES, which runs on hydrogen and oxygen, vastly extending economic activity in space.

Conclusion

ACES builds on ULA launch expertise, proven over decades to be the world's most reliable launch provider. As a technology demonstration platform, ACES provides capability for rapid, low-cost tech refreshes. ACES offers unprecedented power, maneuverability, and persistent duration to enable ten or more tech demonstrations a year, on launches already paid for by primary payload customers. With an ACES on every launch and modularity up to final assembly, the performance parameters on ACES enables rapid support and reconstitution of satellite networks as needs arise.

High-payload power, delta V, and potentially multi-year duration creates value through new mission opportunities. ACES enables will a new era of scientific discovery and cislunar transportation.



Exhibit 3: ACES in Flight