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NASA Background on Ares Vehicles versus the DIRECT Proposal

Summary

NASA has spent substantial effort over several years to consider many launch concepts, and the Agency stands by its decision to develop the Constellation architecture, which includes the Ares I Crew Launch Vehicle and the Orion Crew Exploration Vehicle. NASA has chosen these systems based upon significant analysis, and the Agency believes it has the best program in place to meet our Nation's future Exploration needs.

Shortly after arriving at NASA, Administrator Michael Griffin chartered the Exploration Systems Architecture Study (ESAS) in May 2005, comprised of experts at NASA Headquarters and across the NASA field centers. All databases, expertise and analytical models were applied to this critical task. Particular emphasis was placed on the family of launch vehicles that would be needed to support future Exploration goals. A large number of options were evaluated, including quantitative comparisons on the basis of important measures of merit such as development cost, recurring cost, funding profiles, safety, reliability, development risk, schedule risk, and other factors. The launch families considered included various Shuttle-derived options, Evolved Expendable Launch Vehicle (EELV)-derived options and mixes of the two. Outside experts were brought-in to assess the ESAS results.

Several of the Shuttle-derived concepts that were considered during ESAS, and in other studies, were similar to the Jupiter system identified as part of the DIRECT proposal. However, using current ground rules and assumptions, and utilizing validated NASA and industry design and analysis tools, NASA has determined that the DIRECT proposal is unlikely to achieve its claims of improved performance, safety and development costs when compared to the Ares I and Ares V approach. In addition, the limited data available in the online DIRECT proposal do not support the claims of increased safety. Also, analysis shows that the DIRECT proposal would cost more than the Ares family in the near-term and also on a recurring launch basis. Finally, the DIRECT proposal would take longer to develop when compared to the Ares vehicles when factoring in the extensive core stage development effort and the associated acquisitions.

Since completion of the ESAS, NASA has continued to improve the baseline architecture to significantly lower life cycle costs of the Ares vehicles. NASA's analysis confirms that the Ares I and V vehicles enable the lowest cost and safest launch architecture which meets the Agency's requirements for support of the International Space Station, as well as lunar and Mars exploration. Several improvements have been made to the Ares ESAS baseline (such as the decisions to utilize the J-2X for both the Ares 1 and the Ares V Upper Stage engine and the RS-68 instead of the Space Shuttle Main Engines for the Ares V core engine) which reduced life cycle costs by several billions of dollars.

Additional Background on the DIRECT Proposal

DIRECT claims that schedule improvements would be achieved by leveraging existing Shuttle Reusable Solid Rocket Motors (RSRMs) and RS-68 engines and implies that only modest modifications to the Shuttle's external tank (ET) would be necessary. The Jupiter's Shuttle External Tank (ET)-based core stage in fact would require a major development effort, which in turn would drive a longer schedule when compared to the current Ares approach.

DIRECT claims requirements to strengthen ET sidewall and interstage structures on the Jupiter common core are achieved by milling less material during manufacture. NASA has extensively examined such approaches over the past 20 years and concluded that this effort incurs significant expense and development schedule risk and would result in marginally applicable Shuttle ET heritage.

The Jupiter common core requires new design efforts for the main propulsion system, new thrust structure, new avionics, new forward liquid oxygen tank structure and a new payload shroud, substantial intertank/liquid hydrogen tank redesign and aft Y-ring interfacing and a completely new stack integration effort. In addition, recurring ET manufacturing is costly and labor intensive compared with the lower cost, all friction-stir-welded approach being used on the Ares vehicles. Also, the Jupiter core stage engine, the RS-68, would be required to be human rated. Though feasible, it would require a significant development effort and an extensive engine test program, again increasing development schedules.

The DIRECT proposal is also taking on development of a new, Saturn V S-II class Earth Departure Stage (EDS) for lunar capable missions. DIRECT proposes to develop low boil-off rate technology and integrate it into the EDS tanks. NASA has studied this type of approach extensively in the past. This development effort would require significant near-term technology maturation before full-scale development can proceed, again lengthening the Jupiter's EDS development schedule due to use of low Technology Readiness Level (TRL) hardware.

Per-flight costs for Orion missions also favor the Ares approach. The Ares I vehicle will have less cost per flight compared with the Jupiter 120 heavy lift counterpart: one five-segment RSRM versus two four-segment boosters and an upper stage with one J-2X versus a core stage with two or three RS-68s.

NASA's assessment of the Jupiter 232, calibrated to Ares and Constellation ground rules and assumptions, and using Agency and industry tools and design standards, found that the delivered gross lunar lander mass falls ~ 50 percent below the reported value for an Earth Orbit Rendezvous-Lunar Orbit Rendezvous (EOR-LOR) mission. This assumes no on-orbit cryogenic tanking, which DIRECT requires (On-orbit cryo tanking is a highly complex, unproven and operationally risky proposition for this mission class). Even with on-orbit tanking, DIRECT falls short by more than 25 percent. For a LOR-LOR mission, proposed in May by DIRECT, NASA's assessment found that the delivered lander mass fell ~ 80 percent below the reported value. This approach cannot meet NASA's performance requirements.

Finally, such development efforts would require new, dedicated acquisitions at the same scale as the current Ares I procurements, which have taken almost two years to put in place. History has shown that it takes six to seven years to bring a new launch capability to flight, as evidenced by SpaceX Falcon I development. This indicates that, with a 2009 start, the DIRECT vehicle would not be available during the time between Shuttle retirement in 2010 and the Ares I Initial Operational Capability planned for March 2015.

Background on NASA's Ares Project

NASA's Constellation program, which contains the Ares project, has made great strides this past year. We have tested real hardware; we have logged hours in wind tunnels; we have fired test rockets; we have contractors on board for all major elements of the Ares integrated stack of the Constellation program; we have an integrated schedule; and we are meeting our early milestones.

Ares I is an in-line, two-stage rocket that will carry Orion to LEO and will become NASA's primary vehicle for human exploration in the next decade. Ares I will be able to lift more than 25 metric tons (55,600 pounds) to LEO. Its First Stage will use a single five-segment solid rocket booster -- a derivative of the Space Shuttle's solid rocket booster. The Second Stage of the Ares I, also known as the Upper Stage, will provide the navigation, guidance, control and propulsion required for the Second Stage of the rocket's ascent. It will consist of a J-2X engine, a fuel tank for liquid oxygen and liquid hydrogen propellants and associated avionics. Like the solid rocket booster, the J-2X will contribute to our plans for human lunar exploration by powering the Earth Departure Stage (the stage propelling both Orion and the Altair human lunar lander) to the Moon.

The J-2X is an evolved version of two historic predecessors: the powerful J-2 engine that propelled the Apollo-era Saturn I-B and Saturn V rockets, and the J-2S, a simplified version of the J-2 that was developed and tested in the early 1970s. By utilizing the J-2X, NASA eliminates the need to develop, modify, and certify an expendable Space Shuttle engine for the Ares I. NASA expects the J-2X to be less expensive and easier to manufacture than the Space Shuttle main engine. Changing from the four-segment First Stage solid rocket motor to the five-stage segment for the Ares I also represents a significant and direct down payment on the solid rocket motors for Ares V, enabling an earlier delivery date for this critical second launch vehicle in the Constellation Program.

The Ares V heavy lift launch vehicle will use two 5.5-segment solid rocket boosters and six RS-68s, thus enabling it to carry up to 70 metric tons (156,600 pounds) of payload to trans-lunar injection orbit. The Ares V represents a capability far beyond that of today's global launch systems, opening the door to exploration and to a range of national and scientific applications in all regions of space.

For more information about NASA's Constellation Program, please visit: www.nasa.gov/constellation.