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NASA's Space Launch System: An Evolving Capability for Exploration

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Abstract

Designed to meet the stringent requirements of human exploration missions into deep space and to Mars, NASA's Space Launch System (SLS) vehicle represents a unique new launch capability opening new opportunities for mission design. While SLS's super-heavy launch vehicle predecessor, the Saturn V, was used for only two types of missions – launching Apollo spacecraft to the moon and lofting the Skylab space station into Earth orbit – NASA is working to identify new ways to use SLS to enable new missions or mission profiles. In its initial Block 1 configuration, capable of launching 70 metric tons (t) to low Earth orbit (LEO), SLS is capable of not only propelling the Orion crew vehicle into cislunar space, but also delivering small satellites to deep space destinations. With a 5-meter (m) fairing consistent with contemporary Evolved Expendable Launch Vehicles (EELVs), the Block 1 configuration can also deliver science payloads to high-characteristic-energy (C3) trajectories to the outer solar system. With the addition of an upper stage, the Block 1B configuration of SLS will be able to deliver 105 t to LEO and enable more ambitious human missions into the proving ground of space. This configuration offers opportunities for launching co-manifested payloads with the Orion crew vehicle, and a new class of secondary payloads, larger than today's cubesats. The evolved configurations of SLS, including both Block 1B and the 130 t Block 2, also offer the capability to carry 8.4- or 10-m payload fairings, larger than any contemporary launch vehicle. With unmatched mass-lift capability, payload volume, and C3, SLS not only enables spacecraft or mission designs currently impossible with contemporary EELVs, it also offers enhancing benefits, such as reduced risk and operational costs associated with shorter transit time to destination and reduced risk and complexity associated with launching large systems either monolithically or in fewer components. As this paper will demonstrate, SLS represents a unique new capability for spaceflight, and an opportunity to reinvent space by developing out-of-the-box missions and mission designs unlike any flown before.