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SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Heavy lift launchers capabilities and new missions (8)

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HEAVY LIFT LAUNCH VEHICLE SYSTEMS ARCHITECTING

Abstract

This paper describes a tradespace exploration study which provides preliminary design of launch system families, by exploring hundreds of concepts using coarse system evaluation metrics. The past year has seen extensive debate about the future of US space launch capabilities. The FY2012 NASA budget calls for research and development of heavy lift launch vehicle technologies, and offers the opportunity to consider new architectures for the future US space transportation infrastructure, including heavy lift capabilities enabling human missions beyond Low Earth Orbit. There is an extensive range of potential new architectures, and evaluation of those architectures requires assessment over a range of dimensions, which can be broadly grouped into technical performance, time to initial capability, and satisfaction of stakeholders' needs and goals. The challenge is to fairly compare a broad range of architectures across these dimensions, while managing detail so that senior decision makers can assess and act on the results of the study. As part of the launch vehicle architecting study, the paper investigates the trade-offs associated with stage propellant selection, launch vehicle configuration and other relevant design parameters. Furthermore, the study investigates the tradeoff involved with the early implementation of hardware commonality in a launch vehicle family. Architectures are evaluated through a broad set of multidisciplinary metrics, including engineering performance, compliance to stakeholder needs and goals, compatibility with existing ground infrastructure and off-design performance. The technical assessment methodology is validated against existing launch vehicles. The paper demonstrates how a field of over 150 possible launch vehicles can be transparently reduced to about eight possible designs on technical considerations, almost all of which are represented by particular viewpoints in the current debate, and how stakeholder screening can further narrow the design space. The paper shows how conducting this coarse tradespace exploration early in the process can inform decision-making on the future space transportation infrastructure. The paper closes with some suggestions for future work in the area.