The Future of Launch Vehicle Systems for the US Air Force

Abstract

The Air Force Scientific Advisory Board's Future Launch Vehicle study was chartered to assess the state of U.S. space launch technologies and capabilities and to recommend a path forward.

U.S. military and civil payloads are required to launch on domestic vehicles, and most of these launches take place on Evolved Expendable Launch Vehicles (EELVs). The EELV inventory consists of the Atlas V vehicle, with a LOX/hydrocarbon (RP-1) first-stage engine, the RD-180, produced in Russia, and the Delta IV vehicle, with a LOX/hydrogen (LH2) first-stage engine, the RS-68, produced in the U.S. The different upper stage RL-10 LOX/LH2 engines and Solid Rocket Motor (SRM) boosters for these vehicles are produced domestically. EELV costs often price these vehicles out of the commercial market; commercial satellite launches have accounted for less than 20% of the EELV manifest since 2006, with the U.S. commercial satellite industry increasingly launching payloads on foreign vehicles.

The study finds that there are three possible paths forward for U.S. launch systems: 1) to continue the status quo, with no new technology investments, 2) to invest in evolutionary concepts, for example, development of a U.S. version of the RD-180 or implementation of upgrades to EELVs, or 3) to invest in newer or more revolutionary launch concepts such as a partially reusable booster system with a reusable first stage and expendable upper stage(s). The study finds several technical options that could lead to either evolutionary or newer/revolutionary launch systems, and thus could be of widespread benefit.

Development of a LOX/hydrocarbon staged combustion cycle engine has the greatest potential for multiple future paths for U.S. launch systems, and thus is the study's highest recommendation for investment in a cost-constrained environment. Other concepts that could have broad impact for alternative future vehicles include: a) widespread use of "clean" launch pads, b) development of LOX/LH2 upper stage engines, either as upgrades to the RL-10 engines or as larger upper stage engines for a partially reusable system, and c) launch operations and fleet improvements that could enable "white tail", flexible launch capabilities. There are additional technical developments, e.g., in alternative liquid and solid propellants, which could have impact for alternative future systems. The study finds that a partially reusable launch system, with a reusable first stage and expendable upper stage(s), has the potential for operational flexibility, but extensive technical analysis of alternative concepts as well as technology demonstrations are required now to be able to reduce uncertainties before making a major investment in this future capability.