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Deep Space Transfer Vehicle

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This paper presents the design for the Deep Space Transfer Vehicle (DSTV) a general-purpose vehjcle for planetary operations. It can be used for orbit transfer, moon and planetary ascents and moon landings. It is sized for the Mars Sample return mission which gives it considerable capabilities for other missions. The DSTV uses the Aerojet-Rocketdyne dual-mode propulsion system. Hydrazine is used for the RCS system and the delta-v engines.

This paper discusses all aspects of the design. Figure 1 shows the ascent and descent stages. The two gimbaled bipropellant engines are seen. These are used both for ascent and descent. The ascent vehicle uses an electromagnetic accelerator to get it a few meters above the lander before main engine ignition. Earth atmospheric entry uses lift for control during the final phases. The paper starts with the DSTV design. It then discusses two missions, the Mars Sample Return and Lunar landing and resource return mission. Simulations for launch from the moon and reentry from the moon are presented. Both Mars and lunar trajectories are designed using optimization. The next steps in the DSTV design are discussed and a program plan is outlined.

The vehicle makes use of space qualified components. This will reduce the development time and cost. The paper discusses all subsystems.

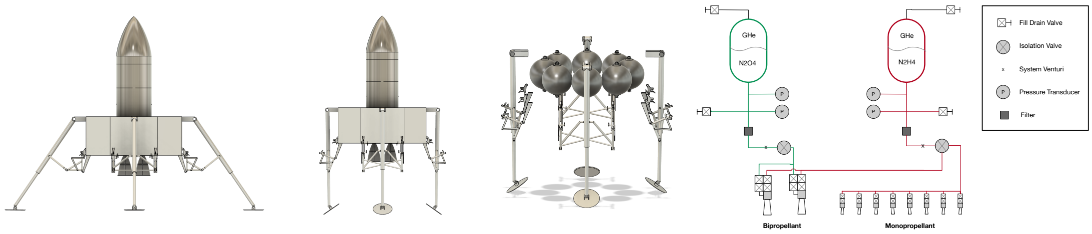

Figure 1: The Deep Space Transfer Vehicle. The upper stage carries the engines. The lander carries landing fuel. The propulsion system is shown on the right.

Mars ascent is shown Figure 2. The first phase is powered ascent into the rising leg of a Hohmann ellipse at 60 km. The stage coasts and then does an insertion burn. The powered ascent is delta-v optimal. It uses MATLAB fmincon to find the solution. This is a locally optimal solution. The starting solution is based on the linear tangent law. The vehicle employs active control and navigation to rendezvous with the Earth Return Orbiter. The Deep Space

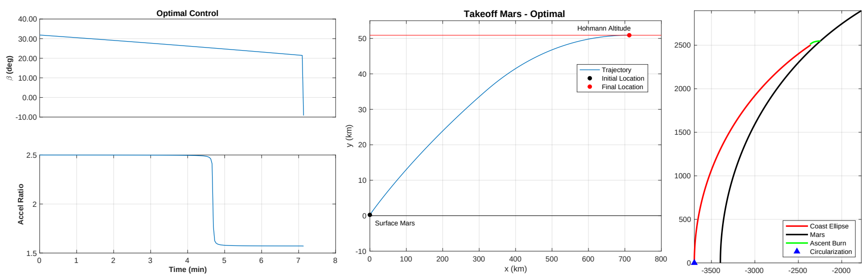

Figure 2: Launch simulation and total ΔV minimization.

Transfer Vehicle is shown in this paper to be suitable for a wide range of deep space missions including lunar resource return, Mars sample return, Europa sample return and many others. Because it is fully radiation-hard it can be used in deep space, including near Jupiter.

The vehicle is at the preliminary design stage. Numerous simulations have demonstrated its performance. Structural, thermal, link and power analyses have been conducted and will be discussed in the paper. The next step is to reach the critical design stage. Given that most of the components are flight proven, this can be down quickly and at a relatively low cost.