Mars Absolute Positioning System (MAPS): An Innovative Design to Advance the Exploration of Mars

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One area actively under development at NASA's Jet Propulsion Laboratory is the entry, descent, and landing phase of missions to Mars. Work is needed to reduce the size of landing ellipses. If achieved, mission planners could place spacecraft in areas that were previously unreachable due to dangerous terrain, greatly advancing the exploration of Mars. A clear solution is a Martian GPS system. A possible system has been proposed by Georgia Tech, but is extremely expensive, approaching $3 billion. The core idea of this project is to use an innovative "mothership" design to transport multiple small GPS satellites to Mars along with a another mission, conserving launch costs. I developed a Python program to analyze different satellite configurations around Mars and selected the best configuration for my system. For the Satellite Transport Vehicle and GPS navigation satellites, I researched similarly-sized spacecraft and common flight components to construct initial designs with mass and cost estimates. After developing a preliminary mission timeline, I calculated the amount of propellant that would be required to perform the necessary orbital maneuvers. Using NASA's General Mission Analysis Tool, I validated the proposed mission timeline and verified my calculations. I was able to demonstrate the plausibility of launching two missions at once by confirming that the total mass of a combined mission would be considerably less than the largest mission sent to Mars. In all, I developed, using the strategies of engineering and the tools of computer science, the initial concept, satellite configuration, spacecraft designs, and mission timeline of a GPS system for Mars that would provide excellent precision and be less than a fourth the cost of alternative proposals.

Awards Won:

Fourth Award of $500