Technology Roadmaps for Space Exploration (09)
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SPACECRAFT FLIGHT SOFTWARE TECHNOLOGY ROADMAP

Abstract

Modern robotic spacecraft have become heavily reliant on flight software to achieve increasingly challenging mission objectives. In a typical vehicle, software can be found not only in traditional areas such as command and data handling and guidance and control, but also other subsystems including power, communications, and payloads. As spacecraft processors become more powerful, systems engineers, mission designers, and operations personnel are relying on software to perform actions previously executed in hardware or with a human in the loop. These advanced architectures open new avenues for spacecraft mission design including event driven science, increased communication bandwidth and reliability, and next generation fault management and autonomy. However, as with other spacecraft technology, applying these improvements requires long lead times and proper planning for raising the technology level to a suitable level for spacecraft applications. Without an overall direction, sporadic or misplaced investment can result in software development that is underused or an improper fit for long term architectural improvements.

To further the goal of advancing these development efforts, we detail a technology roadmap for spacecraft flight software for the next decade of robotic space exploration. We address multiple broad research areas including flight software applications, system architectures, hardware and software-in-the-loop testbeds, testing and verification, information assurance, and enabling advanced mission concepts. Each theme is subdivided into a set of milestones and technology objectives that are mapped to a developmental timeline to build capabilities incrementally from mission to mission. This building block method of technology infusion mitigate risks while still expanding individual spacecraft functionality. Using examples from past, current, and future projects, we categorize the impact of these software improvements on overall mission costs and increased mission capability. These qualitative metrics serve as a guide for mission planners and system engineers in balancing functionality and cost in developing the next generation of robotic probes.