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THE FUTURE OF MISSION OPERATIONS - ON THE PATH TO A SPACE TRAFFIC CONTROL SYSTEM

Abstract

Based on trends in the area of space mission operations, it is possible to reasonably extrapolate that within the next 10-20 years there will be a need for a Space Traffic Control System (STCS). The ultimate goal of human and robotic spaceflight operations is similar to that of current aircraft operations, where the humans or main computer onboard the spacecraft with the help of the onboard systems, are able to monitor and control the spacecraft with no intervention from the ground, except in emergencies. This STCS will depend, at a minimum, on three key advancements; dramatically improved onboard knowledge of spacecraft location, reliable communication of locations amongst all spacecraft, and a clear demarcation between the STC zone and that of Air Traffic Control (ATC). The STCS will then be responsible for managing the dissemination of locations, defining rules for autonomous spacecraft responses, and transitioning spacecraft between the STC and ATC zones.

In this work we propose a STCS that would manage both spacecraft and orbital debris in a multi-nodal architecture. "Aware" nodes would maintain knowledge of their own locations, while "non-aware" nodes would be tracked by the system as a whole. Locations, as well as transitions through ATC air space, would be shared throughout the system. "Aware" nodes would be responsible for determining responses to developing conditions based on their knowledge of the environment and standard rule sets.

At the Hawaii Space Flight Laboratory, we developed the Comprehensive Open-architecture Solution for Mission Operations (COSMOS) under a NASA grant, which is a prototype for a System of Systems that integrates both flight and ground software with other diverse assets. COSMOS is a system capable for developing prototypes of a future STCS and examine the ramifications of developing and implementing such a system. This paper presents the framework in which a STCS can be developed, the methods and results of this intial development with simulations and proposes a standard protocol for sending alerts to traveling spacecraft on possible collisions and the corrective maneuvers for safe travel.