Health Management Applications for International Space Station

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Abstract:

Traditional mission and vehicle management involves teams of highly trained specialists monitoring vehicle status and crew activities, responding rapidly to any anomalies encountered during operations. These teams work from the Mission Control Center and have access to engineering support teams with specialized expertise in International Space Station (ISS) subsystems. Integrated System Health Management (ISHM) applications can significantly augment these capabilities by providing enhanced monitoring, prognostic and diagnostic tools for critical decision support and mission management. The Intelligent Systems Division of NASA Ames Research Center is developing many prototype applications using model-based reasoning, data mining and simulation, working with Mission Control through the ISHM Testbed and Prototypes Project.

This paper will briefly describe information technology that supports current mission management practice, and will extend this to a vision for future mission control workflow incorporating new ISHM applications. It will describe ISHM applications currently under development at NASA and will define technical approaches for implementing our vision of future human exploration mission management incorporating artificial intelligence and distributed web service architectures using specific examples. Several prototypes are under development, each highlighting a different computational approach. The ISStrider application allows in-depth analysis of Caution and Warning (C&W) events by correlating real-time telemetry with the logical fault trees used to define off-nominal events. The application uses live telemetry data and the Livingstone diagnostic inference engine to display the specific parameters and fault trees that generated the C&W event, allowing a flight controller to identify the root cause of the event from thousands of possibilities by simply navigating animated fault tree models on their workstation. SimStation models the functional power flow for the ISS Electrical Power System and can predict power balance for nominal and off-nominal conditions. SimStation uses real-time telemetry data to keep detailed computational physics models synchronized with actual ISS power system state. In the event of failure, the application can then rapidly diagnose root cause, predict future resource levels and even correlate technical documents relevant to the specific failure. These advanced computational models will allow better insight and more precise control of ISS subsystems, increasing safety margins by speeding up anomaly resolution and reducing engineering team effort and cost. This technology will make operating ISS more efficient and is directly applicable to next-generation exploration missions and Crew Exploration Vehicles.