Abstract for SpaceOps 2018 Topic 3: Ground Systems Engineering and Data Management

Automated Impact Assessment: A New Approach to ISS Payload Operations Anomaly Response

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The International Space Station (ISS) Payload Operations and Integration Center (POIC) is undergoing rapid growth as the space station program focuses on science and commercial activities. The ISS is expanding its onboard capabilities to support additional science activities. In parallel, the POIC is expanding the capabilities of our operations tools to support the higher pace of payload activities being executed each week. An effect of these changes is that anomaly resolution has become more challenging. In the event of a real-time system fault, operators are responsible for analyzing telemetry displays, anomaly monitoring tools, documentation, and system models in order to produce failure impacts and recovery strategies. This approach to operations relies on the operator to ingest, process, and analyze information from an array of deterministic sources to provide actionable data on impacted systems and activities. Changing the existing approach of anomaly response is necessary if the ISS community is to succeed in the age of science and commercialization of space. The creation of a tool that captures deterministic technical systems knowledge and integrates existing telemetry, documentation, and planning information will allow the burden of impact assessment to be automated, thereby allowing the operator to focus on non-deterministic tasks, such as recovering failed systems and restoring critical payload operations.

The POIC has several established technologies that assist payload operators in monitoring and analyzing onboard systems. Telemetry measurements are available in user-customizable displays for quick-look assessments. Monitoring tools can be configured to automatically scan telemetry for specific conditions of interest, and, upon meeting those conditions, notify the operator. The operator has access to both generic and system-specific planning data for scheduled activities and detailed resource allocations. Repositories of system documentation, payload regulations, flight rules, procedures, and anomaly records are available for reference. A communications dashboard provides efficient information exchange between POIC operators through the integration of operator logs, chat, and remote payload operator status. All of these related technologies, although individually providing detailed information in their respective context, do not convey higher level concepts such as systemic power failures. Also, current tools do not easily convey how problems in one system area may affect other system areas. For these higher concepts, operators must integrate the connectivity of onboard systems, various telemetry inputs, and other information sources. This manual assembly is both time consuming and error-prone, therefore making it an ideal candidate for integration and automation.

Existing concepts for ISS payload operations are built around a process where the operator plays a central role in collecting, analyzing, and reporting information regarding an anomaly. The immediate goal following an anomaly, once crew and vehicle safety is confirmed, is to identify what systems and payloads have been impacted. Identification of impacts involves determining primary, secondary, or even tertiary impacts stemming from the initial failure. Vehicles have known system dependencies, documented flight rules/regulations, planning information, and specifically designed monitoring tools, yet are not integrated. At POIC, the operator is responsible for the time intensive and, at times, error-prone analysis of each of the above information sources to build the impact assessment. Most spacecraft have well understood systems making the process of impact assessment highly deterministic and thereby suited for automated impact derivation. This frees the operators from the demands of procedural impact assessment, allowing them to focus on the more difficult, and usually non-deterministic, task of restoring functionality. When compared to a manual assessment, an automatic assessment can be produced faster, more comprehensively, and communicated instantly to all relevant

disciplines. Automated tools free the operators from manual assessments allowing them to focus on tasks where humans excel.

This paper will explore the operational and architectural challenges, and benefits, of a tool to automate anomaly impact analysis for complex flight systems. Solutions to these challenges will be discussed with particular emphasis on capturing onboard systems connectivity in a user-friendly electronic model, leveraging established operations technologies, and translating system failures to continually evolving payload configurations. The secondary benefits of an automated tool will also be discussed. The goal of this paper is to share our strategies for designing such a tool and collaborate with the international space operations community to advance the commercialization of space.