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Author: Mr. Carsten Hartmann
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany

Ms. Franca Speth
SVA System Vertrieb Alexander GmbH, Germany
Dr. Dieter Sabath
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany
Dr. Florian Sellmaier
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany

THE ROAD TO ON-BOARD CREW AUTONOMY: USING ISS' COLUMBUS MODULE AS BASIS FOR GROUND PROCEDURE AUTOMATION

Abstract

Today, International Space Station (ISS) operations still rely on the same principle that was established during the first human spaceflight missions – Mercury and Apollo: The astronauts on-board the ISS perform science experiments, habitat maintenance, and housekeeping activities, while ground teams from all around the world support the astronauts in their daily lives. On the one hand, this has many advantages, e.g. direct feedback and support during science runs, increases in crew efficiency, and direct response to off-nominal situations without the need for crew intervention, to name just a few. On the other hand, this requires ground stations to be manned continuously, (almost) uninterrupted space-to-ground communications, and real-time capable ground infrastructure. Due to the ISS being in Lower Earth Orbit (LEO), those are not serious concerns, and all 16 member states making up the ISS consortium are committed to provide their support to the astronauts until the planned end of operations of the ISS by 2030.

However, in light of the latest objectives set forth by NASAs Human Exploration and Operations Mission Directorate (HEO-MD) – namely: 1. operating a human habitat in Lunar orbit, called Gateway, and 2. supporting human exploration missions to Mars using the proposed Mars Transit Vehicle (MTV) based on the Orion spacecraft – NASA and its International Partners are looking for new ways to improve and ease operations, where direct space-to-ground communication is no longer viable. For Gateway, this applies to foreseen unmanned periods, and for a transit to Mars this applies, due to communication delays making real-time monitoring and control impossible.

As part of the European Space Agencies (ESA) commitment to achieve human presence in Lunar Orbit and prepare for missions to Mars, the goal for future operations is to become independent from ground and enable crews to live and work autonomously. However, as a first step towards on-board crew autonomy, the ground segment itself needs to become more independent. This paper therefore introduces a novel tool, based on Columbus Operations, conducted at the Columbus Control-Center (COL-CC), allowing the interaction between timelined activities and the ground commanding infrastructure, by automatically generating a command sequence, and transferring the command sequence to the ground operators' command interface for inspection. Upon approval, the tool will then execute the command sequence, check the command response after each command, including corresponding telemetry items, and adjust the ground monitoring accordingly.