SPACE OPERATIONS SYMPOSIUM (B6)
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ERA GROUND CONTROL CONCEPT OF OPERATIONS

Abstract

The European Robotic Arm (ERA) will be a crucial piece of equipment on the Russian Segment of the International Space Station, with the Multipurpose Laboratory Module (MLM) as home base from which it will operate. ERA will be used to complete the assembly and activation of the MLM after it arrives on the ISS. It will also work with the new Russian airlock, to transfer small payloads and scientific equipment directly from inside to outside the ISS. Another task for ERA is to transport astronauts like a cherry-picker crane to a position where they can work on the exterior of the ISS, or from one external location to another. In the current baseline, ERA operations are executed by an ISS crew member, using either the ERA Internal Man-Machine Interface (IMMI), running on a standard Space Station laptop computer or the ERA External Man-Machine Interface (EMMI), a command panel used during spacewalks. The ERA system does not exclude that the ground segment can command ERA directly, but the feature is not implemented. This paper will present a concept of operations for controlling ERA from the ground. The concept allows ground controllers to command ERA operations with minimal on-orbit software changes, without involving ISS crew, and while meeting all the ISS safety requirements. The presented concept of operations of ERA ground control is based on the already implemented concept of operations for SSRMS and SPDM which has been approved by the NASA Safety Review Panel. The concept will address issues related to the lack of continuous monitoring, possible unforeseen loss of communication, the command and telemetry latencies, and the reaction time of the ground operator. The paper will show that these issues can be safely overcome by applying various operational constraints. Those constraints include prohibiting operator-in-the-loop control modes; limiting operations to periods of communication with ISS; limiting the motion rates of the moves, and confirming ISS configuration prior to initiating motion using video cameras. The paper will also present the results from a simulations performed to demonstrate the concept. The study of the concept of operations has been funded by the Robotics and Future Projects Office of the ESA Human Spaceflight and Operations Directorate.