Human Robotic Partnerships for Exploration (04)
Human Robotic Exploration Partnership (1)

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THE NEXT GENERATION CANADARM PROJECT – DEVELOPMENT AND INITIAL DEMONSTRATIONS

Abstract

On-orbiting servicing (OOS) using robots to maintain, enhance and extend the life of exploration and commercial spacecraft is a fundamental concept consistent with the goal of sustained exploration presence. This is recognized by the Canadian Space Agency (CSA) and its various international partners, and reflected in strategic roadmaps like the Global Exploration Strategy and the International Space Exploration Coordination Group (ISECG) Global Exploration Roadmap. The use of robots to perform on-orbit spacecraft servicing tasks has significant flight heritage – with Canada occupying a leading international role – based on past and current long-term missions such as the Canadarm on Space Shuttle, and Canadarm2 and Dextre on the International Space Station (ISS). On-orbit robotic servicing plays a central role in a number of current and future initiatives, internationally and commercially. In 2009, CSA initiated the Next Generation Canadarm (NGC) project to produce ground-based prototypes of key elements for an end-to-end robotic on-orbit servicing system, demonstrating next generation technologies and operational capabilities for prepared and unprepared spaceflight hardware in earth orbit and beyond. The resulting NGC Facility is comprised of four hardware test beds to demonstrate: 1) proximity operations between servicer and client spacecraft, 2) spacecraft docking contact operations, 3) deployable boom capability allowing manipulators to deploy from smaller spacecraft, and 4) dexterous servicing tasks such as thermal blanket handling, wire cutting, and valve refuelling using prototype tools and a refuelling subsystem. These test beds are integrated in an end-to-end manner by the Mission Operations Station (MOS), also developed on the NGC project, enabling ground-based control of the test beds using varying levels of autonomy in a simulated mission environment, with mission planning and execution capability. These test beds and MOS were developed from flight system requirements with considerations for path-to-flight technologies such as compact end effectors, tools, joints, and cameras. Further, the MOS, encompassing various human-machine interfaces, allows the evaluation and demonstration of human-robot interactions for different exploration and servicing missions Currently, the proximity operations and docking test beds have successfully completed their Acceptance Reviews, with the balance of the NGC Facility to be completed by early 2012. The project will conclude with a set of End-to-End Integrated Simulations executed from CSA's Exploration Development and Operations Center (ExDOC). This paper describes

the NGC Facility, results from initial utilization, and recommendations for future use. In addition, the paper summarizes how the NGC Facility prepares Canada for emerging space exploration opportunities.