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Technology Roadmaps for Space Exploration (09)
Enabling Technologies for Exploration (3)

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A TECHNOLOGY STRATEGY FOR THE AFFORDABLE DEVELOPMENT OF AUTONOMOUS RENDEZVOUS AND DOCKING (AR&D) SYSTEMS FOR NASA'S EXPLORATION MISSIONS

Abstract

The capability of space assets to rendezvous and dock/capture/berth is a fundamental enabler for numerous classes of NASA's missions, and is therefore an essential strategic technological capability for the future of NASA. Mission classes include: ISS crew rotation, crewed exploration beyond low-Earth-orbit (LEO), on-orbit assembly of a variety of space platforms (e.g. propellant depots) , ISS cargo supply, crewed satellite servicing, robotic satellite servicing, space debris mitigation, robotic sample return, and robotic small body (e.g. near-Earth object, NEO) proximity operations. For a variety of reasons to be described in this paper, NASA programs requiring Automated/Autonomous Rendezvous and Docking/Capture/Berthing (ARD) capabilities are currently spending an order-of-magnitude more than necessary and taking twice as long as necessary to achieve their ARD capability, "reinventing the wheel" for each program. NASA has fallen behind all of our foreign counterparts in ARD technology (especially autonomy) in the process. In this paper a strategy is descried to ensure a sufficiently technically advanced and affordable ARD technology base is available to support future NASA missions. The goal is to ensure future missions' reliability and crew safety (when applicable), to achieve the noted cost and schedule savings by eliminate costs of continually "reinventing the wheel", the NASA ARD Community of Practice (CoP) recommends NASA develop an ARD Warehouse (see Figure 2), detailed herein, which does not exist today. The term "warehouse" is used herein to refer to a toolbox or capability suite that has pre-integrated selectable supply-chain hardware and reusable software components that are considered ready-to-fly, low-risk, reliable, versatile, scalable, cost-effective, architecture and destination independent, that can be confidently utilized operationally on human spaceflight and robotic vehicles over a variety of mission classes and design reference missions, especially beyond LEO. The NASA ARD CoP also believes that it is imperative that NASA coordinate and integrate all current and proposed technology development activities into a cohesive cross-Agency strategy to produce this ARD warehouse. This paper will discuss how the current state of NASA's ARD technology readiness affects mission design, performance, planning, cost and scheduling. There is no single mission that can achieve all ARD capabilities needed to populate the ARD warehouse and enable all mission classes, rather a campaign of coordinated missions will be needed to exercise and develop all ARD-enabling capabilities, as Figure 1 shows. Agency-level direction which coordinates technology development over multiple space-based demonstration missions,...