

2009 JPL SURP Strategic Topic Areas

Topic Area:	7. Enabling Autonomous Human Missions to the Moon and Mars
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Summary:

Provide the high-performance human-rated automation and robotics to enable human crews on long-duration missions to the Moon and Mars to perform their missions independently from Earthbound mission control.

Description:

For the entire history of human spaceflight, mission control teams on the ground have provided real-time monitoring of spacecraft and crew state, instructions, and anomaly-recovery support to crews in flight. Yet, as we begin to contemplate sending humans to distant destinations such as Mars, it becomes clear that this operations paradigm must change.

The challenges of human Mars missions, particularly roundtrip communications time delays, interplanetary transit times of many months, and human presence in unstructured, natural planetary surface environments, will require the evolution of new mission scenarios and operations approaches far less dependent on rapid response by Earthbound operations teams. Functions that can no longer be performed by Mission Control will need to be addressed by systems or personnel local to crew activities. Robotics and automation will provide an essential means to reduce risk for crews to acceptable levels, augment human capability, and enable the transfer of traditional mission control tasks from the ground to crews.

This mission-enabling automation and robotics will be integrated into the human space program only if it can be demonstrated to actually reduce risk to missions and crew, rather than merely trade new risks for old. Crews and operators must trust these systems to perform safely and effectively, and the systems must be worthy of that trust. Automation and robotics must be truly human-rated, essentially guaranteed safe, while also significantly reducing crew workload. To achieve such human-rated capabilities in time for missions to Mars, initial versions must be developed—and demonstrated under flight conditions—much earlier, during the upcoming return of humans to the Moon.

If achieved, this capability will revolutionize human space exploration, cutting the cord that ties crews and spacecraft to the Earth.

In addition to establishing fundamental automation/robotic capabilities related to mechanism reliability and system lifetime, achieving high-performance human-rated automation and robotics will require advances in such areas as:

- Human-robotic interfaces
- Modeling and Simulation
- High-level and/or goal-based commanding
- Software reliability
- Unambiguous specification of intent
- Sensor-based command execution
- Command/sequence verification
- Performance accountability and intent compliance

To be considered for this strategic topic area, proposals must directly address the challenge of enabling human crews to effectively conduct aspects of their missions independently of Earth-based operators.