The objective of this subtopic is to create an effective and efficient operational interface between a human and a robotic system that is supporting the human. This subtopic seeks to develop automation technology that reduces the risk of Extra-Vehicular Activity (EVA), improves the productivity of Intra-Vehicular Activity (IVA) and facilitates remote operations by both flight crew and ground control. Automation and robotics capabilities include the ability to use robots for operational tasks (assembly, maintenance, inspection, payload transport, etc.), real-time advisory systems that will support the space and lunar based crew, and mission operation concepts and systems that link ground supervisors across time delays to remote spacecraft and robots. Proposals are sought which address the following technology needs:

- Telepresence and variable autonomy teleoperation systems that support human and robot teams operating: (1) in a shared space, (2) close but separated, (3) somewhat remote, and far remote. Particular interest is given to systems that flexibly support human-robot operations in the presence of time-delays of up to 10 seconds.

- Software frameworks and interaction infrastructures that facilitate the creation and operation of joint human-agent teams. Conventional control architectures do not adequately address human-system interaction needs, particularly in terms of coordination, teaming, direct and indirect commanding, and information sharing between humans, robots, and distributed software agents. Of particular interest are extensions to existing NASA human-robot architectures and software frameworks including: automatic event and situation summarization, notification and dialogue based on user state (role, availability, location, interface), centralized task coordination/dispatch, user activity monitoring, and automated detection of domain events.

- Adaptive user interfaces including perception (visual gesturing), speech recognition, context awareness, computational cognitive models and/or collaborative 3D graphics, and EVA display devices (i.e., pressure-suit compatible devices and displays). Specific design objectives include enabling more natural interaction with autonomous systems, facilitating situational awareness, increasing overall productivity by reducing the amount of interaction effort the human has with the robot, and flexibly displaying multi-modal and mission-specific data.

- Embedded real-time advisory and action planning systems for fully autonomous integrated systems that support remote and onboard vehicle operations for the Crew Exploration Vehicle (CEV).

- Engineering systems that support flight demonstrations of dexterous robots working with EVA crew using
CEV and ISS to prove capabilities for space and lunar operations. This will provide human, robotic and human-robot team options for dexterous EVA tasks, robotic EVA capabilities for excursions into high radiation fields beyond Low Earth Orbit (LEO), and the ability to respond to onboard situations with prompt EVA action.

- **Accurate and affordable methods for prototyping and evaluating human-system interaction.** This includes model-based simulation and trade studies for analyzing multiple interaction "dimensions" (spatial distribution, autonomy level, team makeup, task dependencies, etc.) and missions (pre-cursor robotic, short-stay sorties, and long-duration outpost).

- **Vehicle control systems and navigation sensors that support on-board driving, teleoperation, and autonomous operations.** Control systems should support multiple control modes, include activity monitoring and operator intent prediction, and tolerate up to 10 seconds of time-delay. Navigation sensors that utilize passive computer vision (real-time dense stereo, optical flow, etc.) and/or active illumination (for recognizing/tracking non-textured objects and operation in permanently shadowed regions) are of particular interest.