National Aeronautics and Space Administration

NASA**facts**

Space Technology
Game Changing Development
Autonomous Systems

The Autonomous Systems (AS) project is developing an integrated suite of intelligent system technologies to extend ground support for deep-space exploration missions. These technologies will enable autonomous operation of systems such as spacecraft, habitats, and propellant loading systems for future NASA missions. The project is a part of the Space Technology Mission Directorate's Game Changing Development Program.

The project is led by NASA's Ames Research Center at Moffett Field, CA.

Automation is the ability of a system to perform a function without human support. Autonomy is the ability of a vehicle (or other system) and its onboard systems, such as computers and crew, to perform functions without remote support. AS must operate independent of external communication, commands or control (such as commands from Mission Control on Earth). Such systems can involve crew and software during nominal or contingency operations.

Currently, a team of experts at NASA's Johnson Space Center (JSC), in Houston, TX, controls the International Space Station. Missions to destinations such as Mars will face speed-of-light communication delays of up to 22 minutes each way. Astronauts will have to make more decisions without the assistance of people on Earth, especially when responding to unexpected challenges, onboard anomalies, or failures.

The AS project is developing ways to help astronauts make such decisions. AS software detects and diagnoses system failures, informs the crew about failure consequences, and advises the crew about what recovery actions must be taken in what order and timeframe. It achieves this using complex reasoning algorithms.

The AS project includes two separate but complementary elements: Advanced Caution and Warning System (ACAWS), a decision-support tool for space missions, and Autonomous Cryogenic Loading Operations (ACLO), a high-fidelity software suite to perform analysis and real-time diagnostics for an operational

The ACAWS console in a control room at JSC.

The ACLO testbed at Kennedy Space Center.

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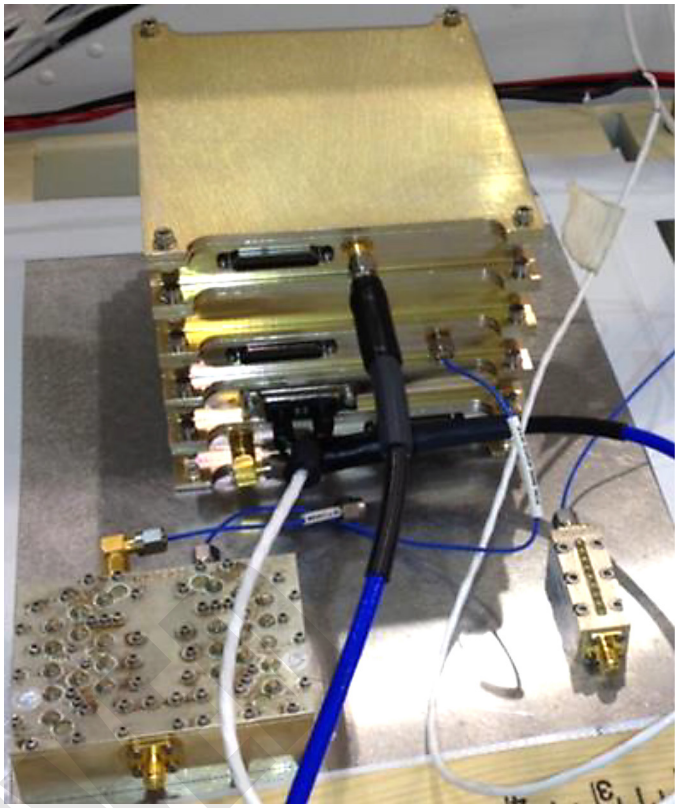
cryogenic propellant loading system at NASA's Kennedy Space Center in Florida.

The AS portfolio also includes tasks to build communications hardware called the Programmable Ultra Lightweight System Adaptable Radio (PULSAR), and to field-test wearable smart headset displays for Mixed Reality Crew Assistance (MRCA).

AS is exploring new ways to automatically generate an anomaly detection model from spacecraft telemetry data for Spacecraft Autonomous Fault Evaluation and Management (SAFEM), and to create flight software architectures with planning and diagnostic inference engines for a Reusable Vehicle Systems Manager (RVSM).

The Game Changing Development (GCD) Program investigates ideas and approaches that could solve significant technological problems and revolutionize future space endeavors. GCD projects develop technologies through component and subsystem testing on Earth to prepare them for future use in space. GCD is part of NASA's Space Technology Mission Directorate.

For more information about GCD, please visit http://gameon.nasa.gov/



PULSAR.

Aquanaut wearing an MRCA headset.

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