NASA Leverages RTI Middleware for Next-Generation Lunar Robots

Flexible middleware supports extraterrestrial communication with space robots

NASA's All-Terrain Hex-Limbed Extra-Terrestrial Explorer (ATHLETE) rover is being developed by JPL as part of JSC's Human Robotics Systems Project.

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Terry Fong
Director of the Intelligent Robotics Group
NASA Ames

A Demanding Project

Ever since its origin in 1958, the National Aeronautics and Space Administration (NASA) has been famous for impressive accomplishments in science and technology. NASA continues to pioneer advancements in aerospace exploration. NASA's research benefits both space and domestic technology.

The future will require robotic exploration. For instance, astronauts will someday spend months at a time living and working on the moon, requiring assistance for scientific experiments and moonscape investigations. Missions to distant planets will need even more robotic help.

The Human Robotic Systems Project, led by NASA's Johnson Space Center and sponsored by the NASA Exploration Technology Development Program, is a three-part project addressing surface mobility, surface handling of lunar materials and human systems interaction. It directly addresses the challenges of moving and operating on lunar or planetary surfaces.

The Human Robotic Systems Project is engineering four prototype robots at four major research centers. Each robot has a unique mission:

- Ames Research Center is building K10, a robot carrying a selection of cameras and laser scanners. K10 can function in an unstructured environment by itself or with human oversight. One of K10's capabilities is capturing data for ease of travel across the lunar landscape.
- Jet Propulsion Laboratory leads development of the All-Terrain Hex-Legged Extra-Terrestrial Explorer (ATHLETE). A large, six-limbed robotic vehicle, ATHLETE is designed to transport large payloads across varied terrain that includes rocks and steep slopes.
- Johnson Space Center is perfecting a Space Exploration Vehicle (SEV) for transporting astronauts long distances across the moon or Mars. The SEV offers an excellent view from the cockpit as well as the ability to "kneel" so astronauts can examine objects at close range without leaving the vehicle.
- Langley Research Center is constructing a crane-like robot called the Lunar Surface Manipulator System (LSMS) that can help astronauts lift, position and load objects and equipment on planetary surfaces. The LSMS is modular and versatile. It functions autonomously or under human direction.

The Problem

Despite variations in purpose, technology and design, all four robots must be similarly equipped for both high-speed and low-bandwidth, delayed communications. Terry Fong, director of the Intelligent Robotics Group at NASA Ames, evaluated the communications requirements early in the project.

"All of these robots will sometimes be 'teleoperated' with direct joystick control. This requires high-speed communications with the operator," Fong said. "At other times, these robots will be operated with long transmission delays over low-bandwidth communication links. In addition, each system must integrate many modules, including sensors, graphical interfaces and navigation software. The robots also run a variety of operating systems."

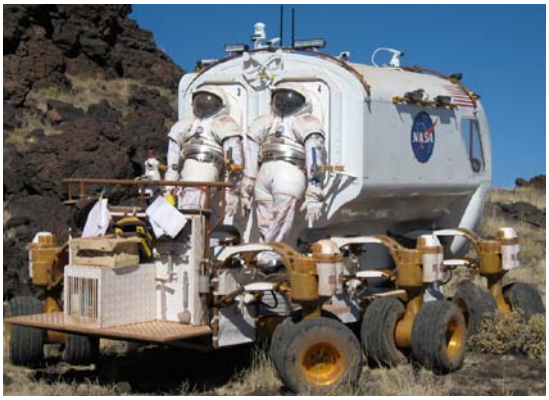
The problem was finding a common, flexible, high-speed data communications interface that would readily integrate across each robot's disparate applications and operating systems. A common architecture was mandatory. Standardization was also important, since a different research center designed each robot.

The Solution

NASA identified the Object Management Group (OMG) Data Distribution Service for Real-Time Systems (DDS)—a widely recognized standard—as the optimal data communications interface. DDS offers flexible parameters that support a common data interface and enable integration across the robotics' systems. Due to the DDS standard's reputation and popularity, all four research centers could readily adopt it.

NASA chose RTI as its DDS vendor for the Human Robotics Systems Project. RTI is the world's leading supplier of DDS-related software and services. RTI Data Distribution Service provides a messaging and integration infrastructure for demanding, mission-critical applications like NASA's. Not only does RTI Data Distribution Service supply a fast, scalable architecture for real-time systems, it also enables loosely coupled integration that significantly reduces long-term software maintenance efforts and costs.

These advantages helped make RTI's DDS solution the Human Robotic Systems Project's data communications interface choice. NASA was already familiar with RTI, since NASA Ames was RTI's first middleware customer in the early 1990s.



NASA is developing a diverse set of robot vehicles for future exploration. A common data interface is essential for reducing costs and improving distributed development.

"Getting four complex robots with very different designs to use a common data system was challenging," stated Fong. "The Data Distribution Service for Real-Time Systems standard supports very flexible service parameters. We found that we could adapt the middleware to the unique needs of each robotic system."

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Lasting Impact

The common data communications interface NASA established through RTI Data Distribution Service brings numerous benefits for the Human Robotics Systems Project. NASA is able to save significant deployment costs, reduce training requirements and leverage code and experience among the four research centers. In upcoming launches, the use of a single communications architecture will eliminate the need for duplicate testing, simplify operator equipment and reduce ground-staffing requirements.

By applying its expertise and leveraging the RTI middleware in the Human Robotics Systems Project, NASA is positioned for the next decade of robotic innovation.

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