Space logistics

Space logistics refers to the activities required for sustaining both human and robotic operations away from Earth. In particular, it addresses the aspects of space operations, both on Earth and in space, that deal with functions in three categories. The first is acquisition, tracking, storage, movement, and maintenance of materiel. The second is movement, housing, and health maintenance of personnel. The third is construction, operation, maintenance, and disposition of vehicles and facilities.

With the successful completion of Discovery's STS-114 mission to the International Space Station this summer, the space shuttle reclaimed its place as the nation's preeminent space logistics system, with more cargo capacity (30 tons) and more passenger capacity (two crew, five passengers) than any other system flying today. While the shuttle was grounded, logistics for the space station were supported by flights of Russian Soyuz-TMA spacecraft for crew transfer and escape, and by Progress-M spacecraft for supply transfer and for solid waste disposal.

Among the primary objectives of the Discovery flight was to test new techniques for heat-shield inspection and repair. The mission began with a trial of the extended robot arm that allowed astronauts and mission controllers to see the belly of the orbiter in flight for the first time. This inspection revealed some gap-filler protruding from between black tiles near the nose of the orbiter. Because this material could upset the airflow on reentry, spur early laminar-to-turbulent flow transition, and cause hazardous localized heating, Stephen Robinson, supported by Soichi Noguchi, rode the extended arm to remove the errant insulation manually. These two astronauts also tested NOAX (nonoxide adhesive [experimental]) and emittance wash tile repair compounds, which went on more easily than anticipated from ground tests. They also repaired two failed control moment gyroscopes (out of four) on the space station, and attached the Spacehab-built External Stowage Platform (ESP-2), the world's first commercial logistics platform in space, to the ISS airlock.

Two missions that flew in April demonstrated robotic logistic capabilities. One was the Air Force XSS-11, a 300-lb spacecraft built by Lockheed, designed to rendezvous with and inspect other spacecraft. The XSS-11 achieved orbit and successfully rendezvoused with the fourth stage of its Minotaur launch vehicle about two months later; further rendezvous operations are also planned.

The other April mission was the DARPA-sponsored Demonstration of Autonomous Rendezvous Technology (DART), an 800-lb spacecraft built by Orbital Sciences. DART is part of the Orbital Express project, which is developing robotic capability for refueling, repairing, and upgrading satellites in orbit, using a servicing vehicle (ASTRO) from Northrop Grumman and a client vehicle (NEXTSat) from Ball Aerospace. First launch is scheduled for September 2006. The DART spacecraft successfully rendezvoused with the Multiple Paths Beyond Line-of-Sight Communications satellite (also built by Orbital), without any human intervention. However, when the DART spacecraft closed within 15 ft, it experienced an anomalous loss of propellant. At this writing it was not known whether this was due to DART's striking the target spacecraft or due to excessive consumption of propellant by the autonomous navigation system.

To effectively sustain exploration and commercial development in space, Olivier de Weck and David Simchi-Levi of MIT, Andy Evans of United Space Alliance, Robert Shishko of JPL, and Javier de Luis of Payload Systems are leading studies to define interplanetary supply chain management and logistics architectures. A meeting planned for January 2006 in Washington, D.C., will assemble researchers in this field to brief policymakers on the central role logistics planning must play if space operations are ever to advance beyond the status quo. The space logistics TC website, http://www.aiaa.org/tc/sl/index.htm, has more details.

The External Stowage Platform-2 (ESP-2) was deployed and attached to the International Space Station airlock by the STS-114 crew during a robot-arm-assisted EVA. ESP-2 is an unpressurized stowage platform designed to accommodate up to eight ISS orbital replacement units (ORUs). Four ORUs were launched on the platform, and more will be added on subsequent shuttle missions. ESP-2 is the first commercial logistics platform in space and is planned as a permanent fixture on the station.

by **Ray Erikson**