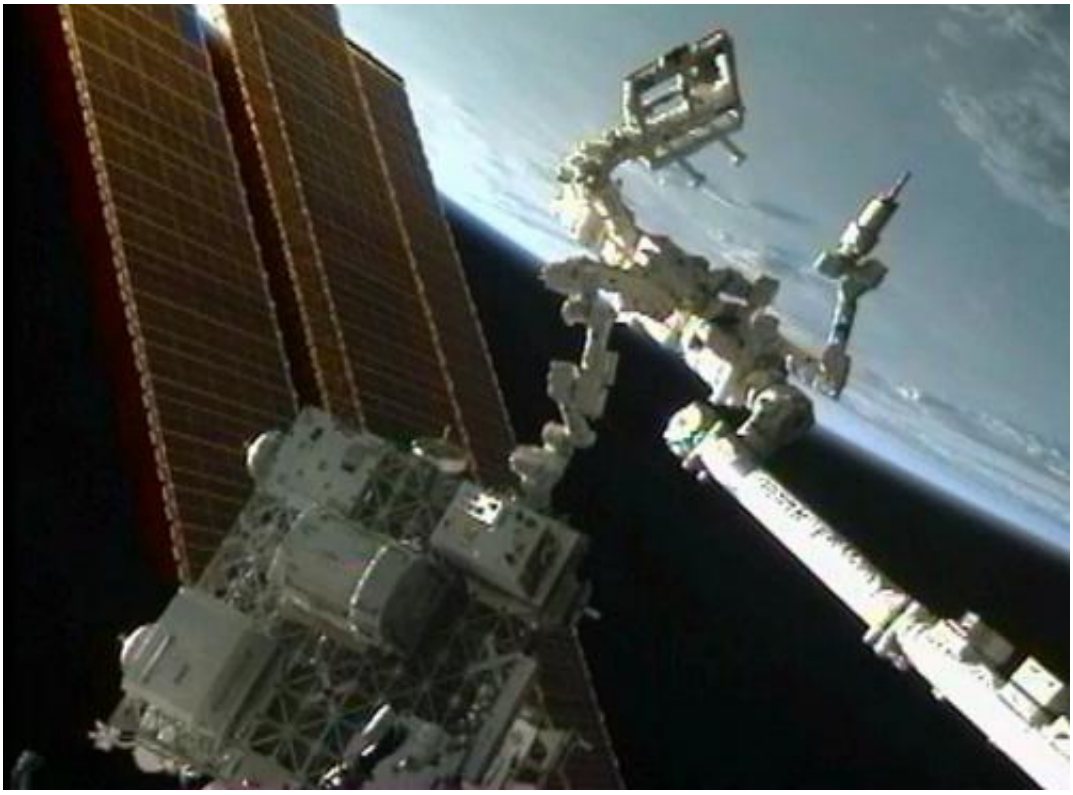
Robotic refueling mission practices new tasks

May 13 2013, by Adrienne Alessandro



The Robotic Refueling Mission investigation (center, on platform) uses the International Space Station's Canadarm2 and the Canadian Dextre robot (right) to demonstrate satellite-servicing tasks. Credit: NASA

(Phys.org) —With a historic robotic refueling demo ticked off its checklist, NASA's Robotic Refueling Mission (RRM) put down the hose and picked up the screwdriver and utility knife. This latest round of satellite-servicing tasks, completed in the early morning of May 10, will show how robots could access and further maintain satellites in orbit.

Five days of operations were held aboard the International Space Station, during which the Canadian-built Dextre robot with RRM tools demonstrated how tiny caps can be retrieved and stowed in space. This task, along with slicing through satellite blanket tape were performed on the RRM module affixed outside the space station.

The conclusion of the May operations wraps up the first phase of tasks for RRM, a modular activity box with tools that launched to the space station aboard the final space shuttle flight. New task boards and tools are slated for launch this summer and again in early 2014, along with another set of activities for this groundbreaking operation.

NASA developed RRM to demonstrate how remotely-operated robot mechanics could extend the lives of the hundreds of satellites residing in geosynchronous-Earth orbit (GEO). "Revolutionizing GEO satellites through servicing is my passion," says Frank Cepollina, primary investigator for RRM and the architect of five successful Hubble servicing missions.

Costly assets traveling about 22,000 miles above Earth, GEO spacecraft deliver such essential services as weather reports, cell phone communications, television broadcasts, government communications and air traffic management. Servicing capabilities could greatly expand the options for government and commercial fleet operators in the future. They could potentially deliver satellite owners significant savings in spacecraft replacement and launch costs.

A joint effort with the Canadian Space Agency, RRM uses the space station as a test bed for technology research and development.

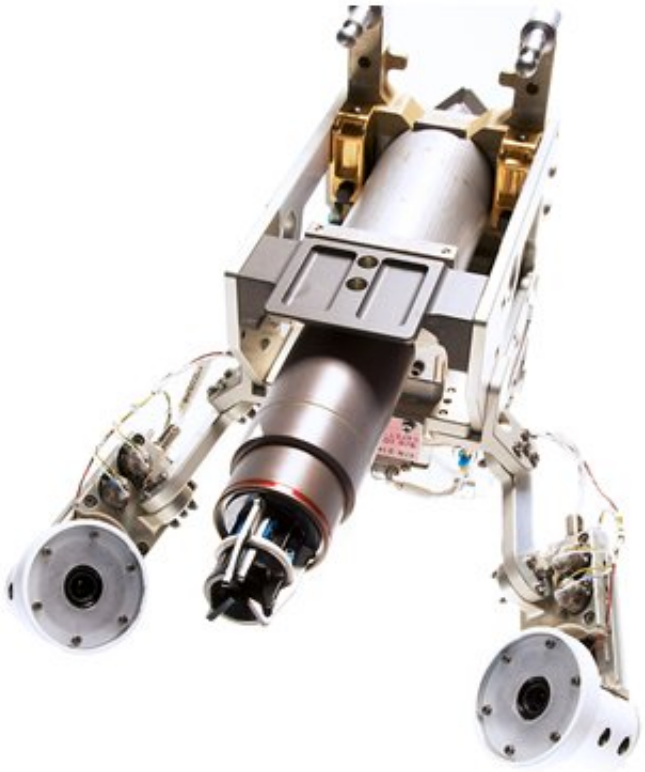
Robots at work: RRM May operations

"Some RRM tasks may sound straightforward at first," says Benjamin

Reed, deputy project manager of the Satellite Servicing Capabilities Office (SSCO) at NASA's Goddard Space Flight Center in Greenbelt, Md. According to Reed, working with robots in space demands a level of foresight, planning and practice that can never be taken for granted.

"What may seem mundane can actually be quite tricky. Having remote-controlled robots service satellites on orbit—satellites that were never designed to be accessed, refueled or fixed in space—is a new frontier," says Reed. He also talked about activities astronauts could perform without a second thought, like aligning the tip of a screwdriver with the head of a screw. For robot operations, such a simple task requires a careful thought process and robot scripting.

RRM gives NASA a platform to work out these problems by practicing them on orbit. "RRM demonstrations are paving the way for increased capabilities on orbit not just for GEO satellites, but for possible future NASA missions," says Reed.



The Robotic Refueling Mission Safety Cap Tool, developed by the Satellite Servicing Capabilities Office at NASA's Goddard Space Flight Center in Greenbelt, Md. Credit: NASA

The RRM team began development by focusing on an assortment of satellite-servicing tasks fundamental to satellite repair, refueling and upgrade. One of the tasks performed this May had RRM working with small screws in microgravity. "We drew a lot from our Hubble Space Telescope servicing mission experience to solve this one," says Reed.

Even for humans on gravity-bound Earth, these tiny fasteners can be difficult to handle. A servicing mission would add the extra challenges of a near zero-gravity environment, a robot mechanic and a mandate not to add space junk to orbit.

One solution the team developed was to build a special adapter for the RRM Safety Cap Tool (SCT) that turns the device into a space power screwdriver. This adapter allowed Dextre to remove screws already affixed into the RRM practice module task boards. Tool cameras gave mission operators the view needed to align Dextre, the SCT and the adapter's tool bit into the right position.

Once released, the screw was trapped within a cage fixed over holes large enough for the screwdriver bit, yet small enough to ensure the screw did not float away. The cage was inspired and adapted from capture plate technology the team developed for Hubble's fourth servicing mission. That capability allowed astronaut Mike Massimino to remove and safely stow 111 individual screws.

Another task demonstrated how the SCT and an additional adapter could remove and stow the tiny coaxial radio frequency connector caps. Such a task would be the first step to allowing a servicer to plug into a spacecraft to diagnose a system problem. This connection is similar to an automotive technician connecting a computer to communicate and diagnosis an automotive system.

The final RRM activity revolved around handling satellite blankets in space. Once a servicer rendezvous with a client, the first hurdle the robot mechanic would face would be removing protective thermal blankets. These blankets are held together over the satellite like a tightly tucked patchwork quilt.

Getting through these blankets is like opening a wrapped present. However, unlike excited humans, robot servicers are under strict orders not to rip and throw jagged pieces of the blanketing into space. RRM demonstrated a technique that mimics what the most tidy of gift-openers do: save the wrapping by heading straight for the taped seam that holds the coverings together.

Ongoing efforts

NASA continues to test capabilities for a new robotic servicing frontier. In conjunction with RRM, the SSCO team has been studying a conceptual servicing mission while building the necessary technologies, including an autonomous rendezvous and capture system, a propellant transfer system and specialized algorithms to orchestrate and synchronize satellite-servicing operations. On Jan. 15, NASA released a Request for Information to seek input on a potential public-private partnership to understand the need for satellite-servicing capabilities for client satellites located in GEO. RRM is proving the technology to achieve such a future mission.

Provided by NASA