



NASA's
Game Changing Technology
Industry Day
June 29-30, 2016



Satellite Servicing

Presented by
Charles Bacon

NASA Satellite Servicing Capabilities Office

TECHNOLOGY DRIVES EXPLORATION



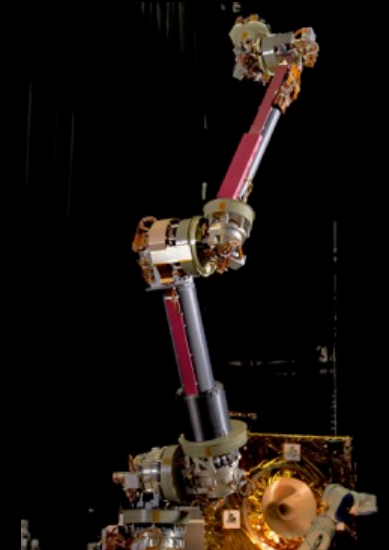
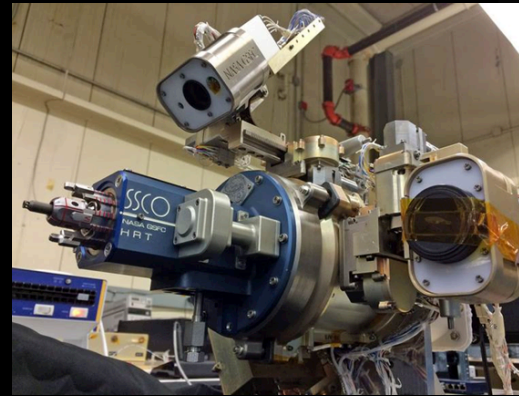
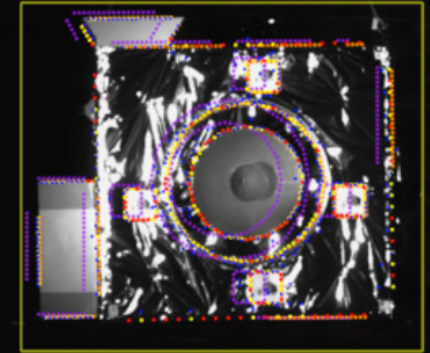
Satellite Servicing



Satellite Servicing encompasses a group of technologies that work together to enable in-space life extension, upgrades, assembly, replenishment, replacement, or repair of spacecraft

SSCO is executing projects to advance the state of satellite servicing technologies that will enable:

- Routine servicing of legacy spacecraft in government and industry
- Exploration of the solar system
- U.S. to be a global leader of in-space servicing





Satellite Servicing Capabilities Office



Current satellites cannot be repaired on-orbit and are disposed of even if a majority of the spacecraft is still functional

Future exploration missions will not be possible without servicing technologies:

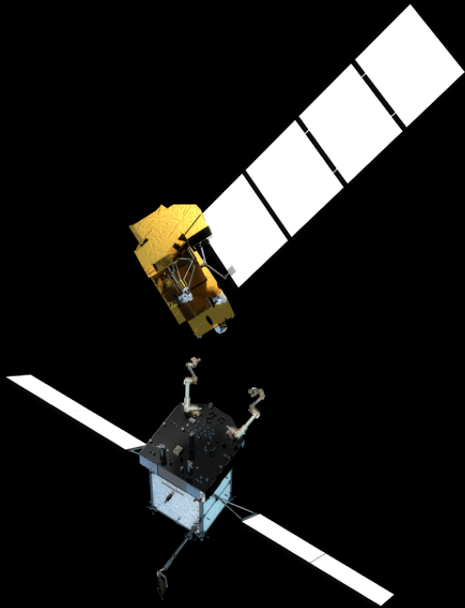
- Relative Navigation for autonomous rendezvous
- Robotics with sophisticated tools to support assembly, upgrades, or repairs
- Propellant Transfer in-space refueling

The technologies required to repair legacy satellites or enable future exploration missions are immature and must be enabled through technology demonstration missions. This is the goal of SSCO, a world leader in the field of satellite servicing.

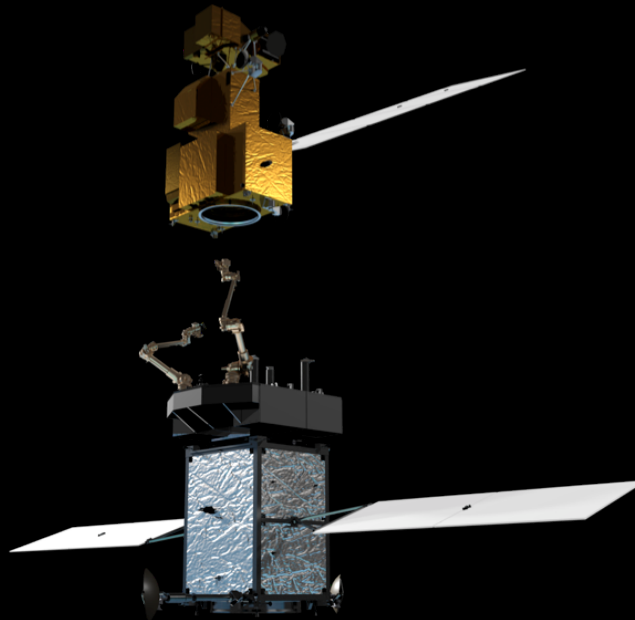




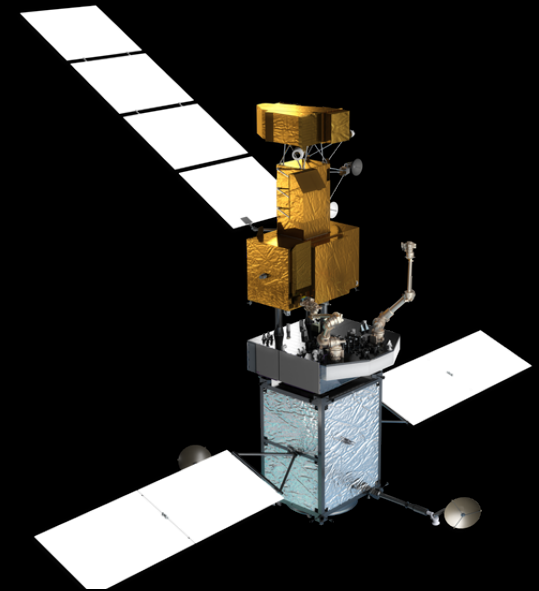
Restore-L Servicing Mission



Rendezvous



Grasp



Refuel
& Relocate

Restore-L is a technology demonstration mission to repair a legacy satellite that encompasses all satellite servicing technology areas and represents a culmination of decades of satellite servicing technology development

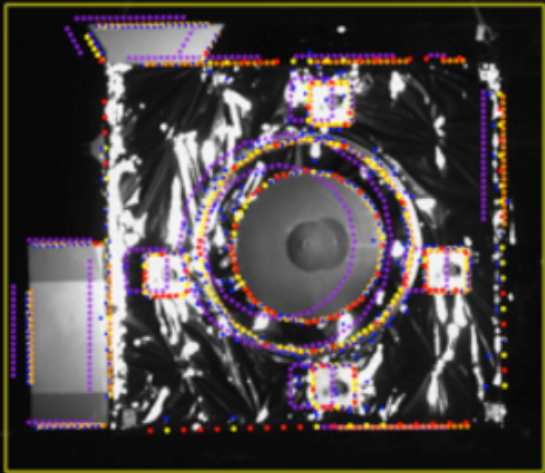
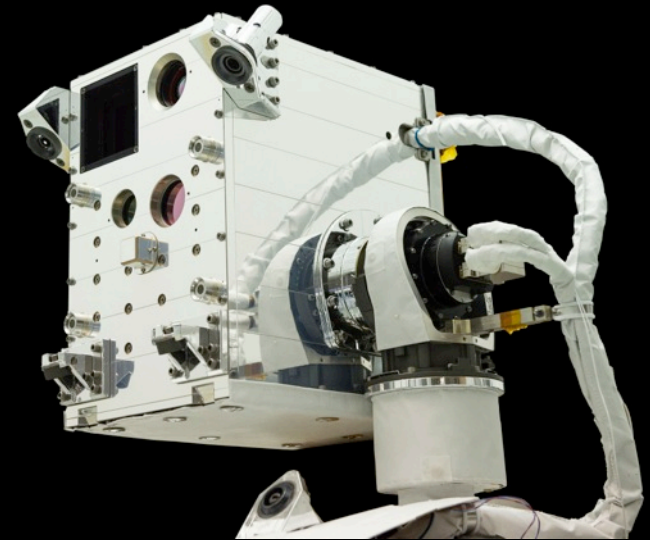


Relative Navigation

Current TRL: 3-4



- Heritage development on RNS (SM4), Argon, and Raven
- Covers vision-processing algorithms, visual and ranging sensors, and high-speed computing
- Provides client pose data for control of the servicing spacecraft during autonomous rendezvous
- Goal is to provide an off the shelf government technology set



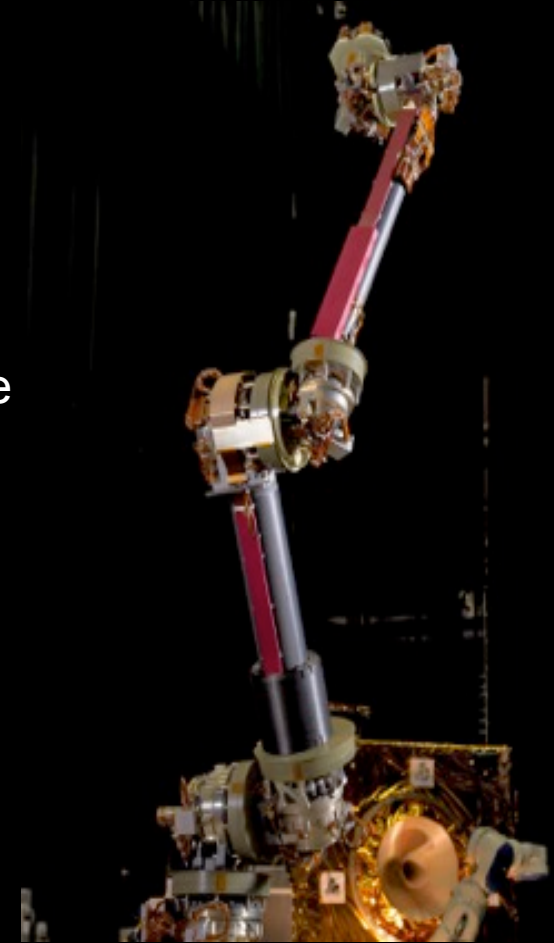
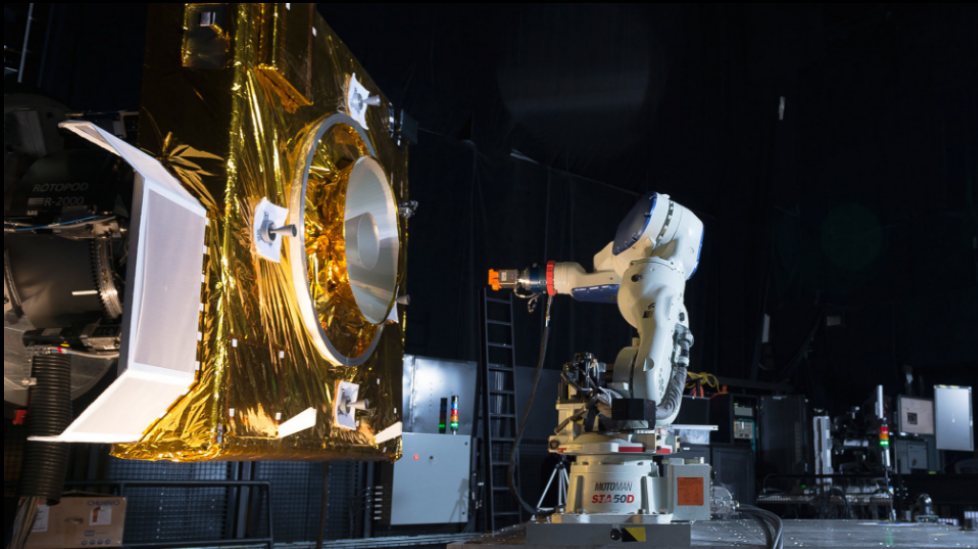


Robotics

Current TRL: 3-4



- NASA Servicing Arm has been in development of several years and has heritage with previous robotic arms developed under NASA and DARPA projects
- System includes the Robotic Arm, Control Electronics, and Software
- Capable of autonomous and telerobotic control modes
- Goal is to provide a qualified robotic system that can be used on a wide range of future missions



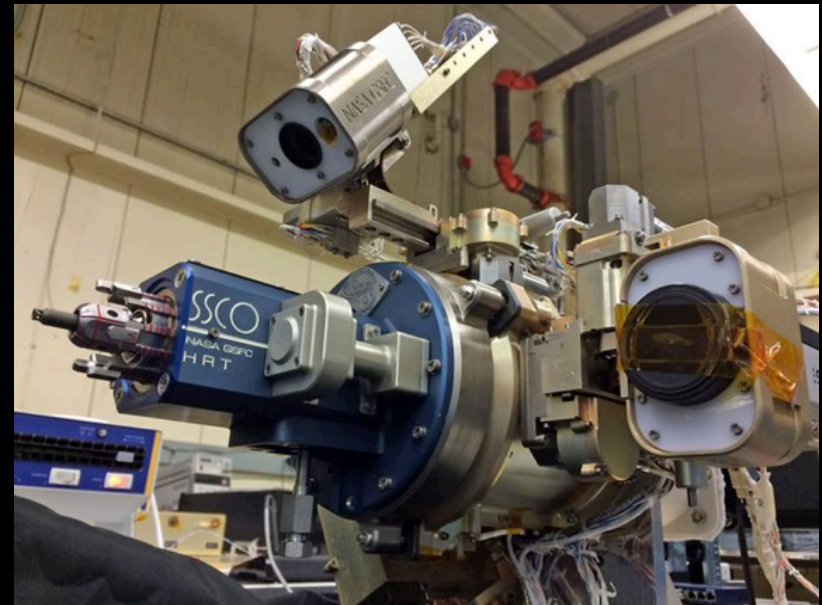
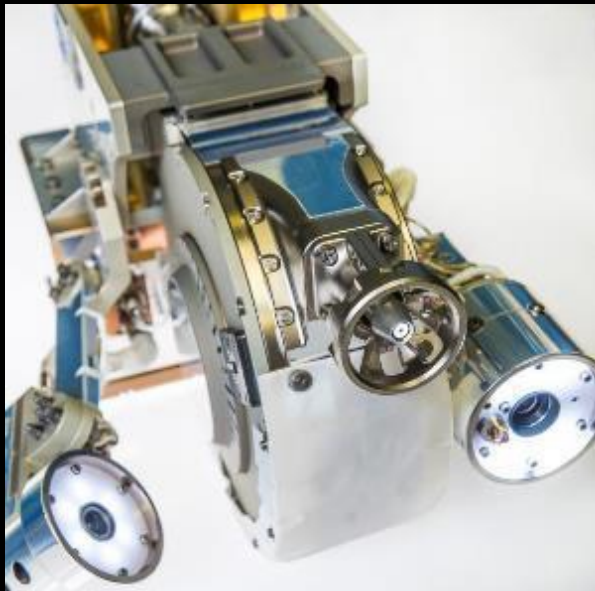
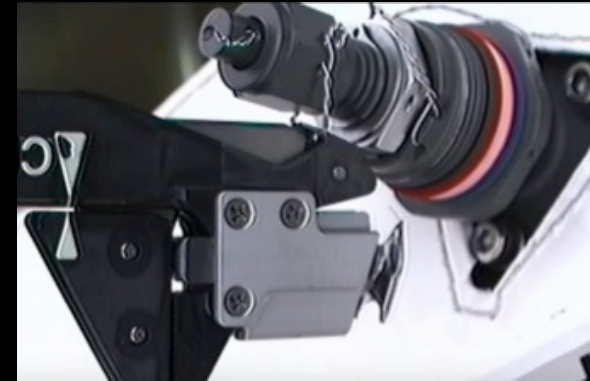


Robotic Tools

Current TRL: 4-7



- Robotic servicing tools are used for interfacing with client satellites to perform a wide range of tasks:
 - Cut wires, remove caps, manipulate MLI
 - Refueling
 - Close-up inspection
 - Repair
- Robotic Refueling Mission (RRM) has given some of these tools successful operation in space
- Goal is to provide a suite of universal tools for future missions to utilize



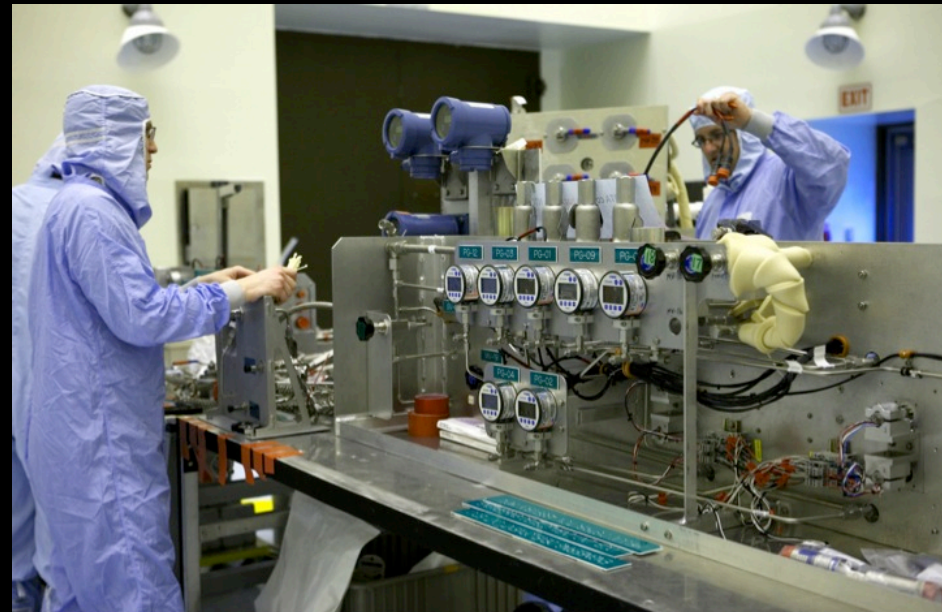
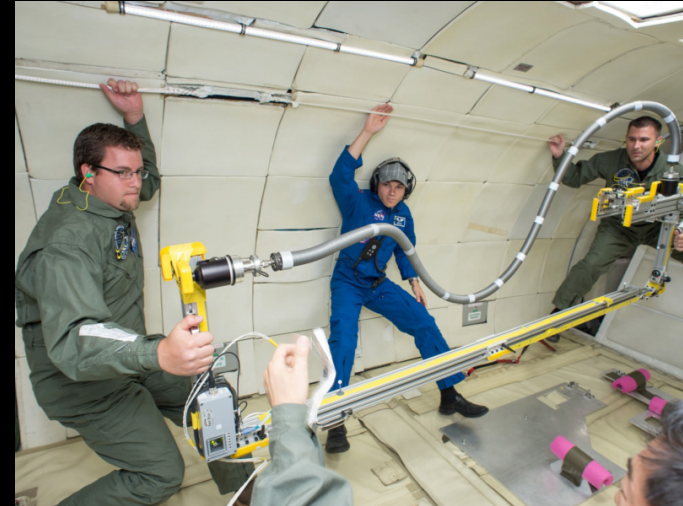


Propellant Transfer

Current TRL: 3-4



- System to transfer fluid in zero-g from one spacecraft to another
- Includes flow meter and flexible hose components
- Development focusing on compatibility with hydrazine, oxidizer, and xenon
- Major development to date came from the Remote Robotic Oxidizer Transfer Test (RROxiTT)
- Goal is to provide a configurable set of technologies that can be used on missions with different propellant needs

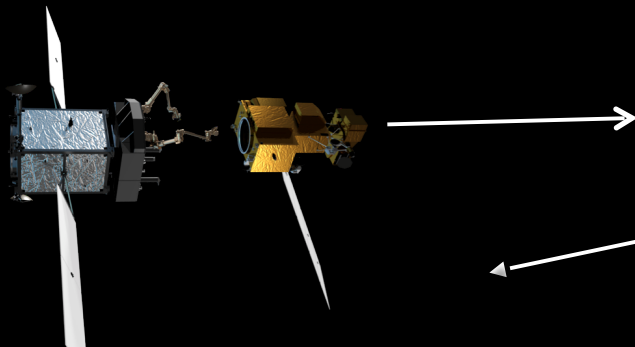




Servicing Technology Benefits



Technologies



Servicing Capabilities



NASA

Expanded options for extending the lives of satellites, observatories and spaceships

Flight-proven technologies that facilitate upgrade and (self) maintenance of robotic and crewed vehicles

Capabilities that support ambitious Science and Exploration architectures: assembly of large space assets



Nation

Global precedence in robotic satellite servicing

U.S. fleet management possibilities

New commercial industry boosting U.S. economy



Industry

Receives flight-proven technologies to jumpstart a commercial industry

Direct transfer of a rolling portfolio of non-exclusive, licensed technologies



What's Next?



SSCO near-term objectives to advance servicing TRLs:

- Complete Raven operations onboard ISS (2016-2017)
- Build, fly, and operate Robotic Refueling Mission 3 onboard ISS (2017-2018)
- ***Complete Restore-L Mission (2020)***

In the meantime SSCO will:

- Release a synopsis of a technology transfer plan for industry feedback (2016-2017)
- Host Industry Days to provide data from major Restore-L reviews
- Begin efforts to transfer technology via non-exclusive licenses
- Educate the space community about how to utilize servicing technology in the development of their projects
- Provide updates on the latest developments in the advancement of servicing technology via media communications and technical papers
- Study how future missions can be enhanced through the application of servicing technology



Contact Information



For more information about this technology or to discuss potential collaboration efforts:



Charles Bacon

charles.e.bacon@nasa.gov

301-614-7017