The Satellite Servicing Capabilities Office

These are your people.

Proud to be part of America’s servicing tradition – from Solar Max, to Hubble, to the new robotic servicing frontier.
The Spirit of Innovation at GSFC
1971: Concept of Satellite Servicing

Modular Construction
The Spirit of Innovation at GSFC
1971: Concept of Satellite Servicing

Who we are now and what we will be tomorrow is a direct reflection of who we were then.
The history of satellite servicing missions stretches from 1984 to the current day.
What is our mission?

The Satellite Servicing Capabilities Office (SSCO) at NASA’s Goddard Space Flight Center exists to:

• Advance the state of robotic servicing technology to enable the routine servicing of satellites that were not designed with servicing in mind.

• Position the U.S. to be the global leader in in-space repair, maintenance, and satellite disposal.

• Help to enable a future U.S. industry for the servicing of satellites.

“The United States is committed to encouraging and facilitating the growth of a U.S. commercial space sector that supports U.S. needs, is globally competitive, and advances U.S. leadership in the generation of new markets and innovation-driven entrepreneurship.”
– U.S. Space Policy, June 28, 2010

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Positioning the U.S. as Global Leader in Servicing

The past builds the foundation for the Future.

Servicing capabilities can help enable architectures for industry, science, and exploration.

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What’s Ahead for Our Great Team

• **Satellite Servicing Capabilities Office**

• **RRM: Phase I, II, and III**
  • On-orbit robotic demonstration of satellite servicing

• **Restore** (notional)
  • Free-flying satellite-servicing spacecraft

• **OpTIIX**
  • Robotic assembly of large observatories in space
Satellite Servicing Robotic Development: Our Present Objectives

RRM:
Phase I, II, & III

OpTIIX

ISS & Ground Testbeds

Refueling & Repair/Replacement Technology

Servicing of systems designs

Restore (notional)

Modular Instrument & Spacecraft Design

Support to future systems designs like a repurposed NWT

Restore (notional)

Support to future systems designs like a repurposed NWT

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The Road to Technical Success in Satellite Servicing is Through ISS

We are utilizing the International Space Station as a low-cost test bed for experiments.

- Launch
- Power
- Robotics
RRM is an International Space Station experiment that demonstrates satellite-servicing tools, technologies and techniques for legacy spacecraft.
RRM is a joint effort between NASA and the Canadian Space Agency (CSA), utilizing:

- Space Station Remote Manipulator System (SSRMS) or Canadarm2
- Special Purpose Dexterous Manipulator (SPDM) or Dextre
Argon, the ground-based autonomous rendezvous and docking test, advances the technologies a servicer would need to autonomously rendezvous and dock with an uncooperative spacecraft.
Ground Technology Demonstrations
RRM: Phase 2

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<tr>
<th>Remove</th>
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<tr>
<td>-</td>
<td>1 Task Board 3 (TB3)</td>
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<td>Task Board 2 (TB2)</td>
<td>2 Task Board 4 (TB4)</td>
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<tr>
<td>Safety Cap Tool (SCT)</td>
<td>3 (VIPIR)</td>
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RRM Top Panel

RRM Outboard Panel

RRM Front Panel

SCT  →  VIPIR

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Phase 2 will reconfigure the RRM module with two new task boards and one new tool.

RRM Phase 1

RRM Phase 2
RRM Featured Tools

Multi-Function Tool (MFT)

Visual Inspection Poseable Invertebrate Robot (VIPIR) Tool

Coming soon with Phase 2

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MFT Phase 2 Adapters

- Coolant Line Adapter (CLA)
- Vent Plug Adapter (VPA)
- Electrical Plug Adapter (EPA)
- Wire Harness Adapter (WHA)
- SMA Blindmate Connector Adapter (BCA)
CORD (RRM Phase 3): Cryogenic On-Orbit Refilling Demonstration

- An **additional module** delivered to ISS to demonstrate cryogenic on-orbit refilling by contributing:
  - fluid storage tanks
  - a refrigeration system
  - refined modular robotic tools with satellite components

By the completion of these demonstrations, the mission will have laid a strong foundation for robotic satellite servicing, including the transfer of gaseous fluids in orbit.
To meet these national needs and objectives, SSCO has designed the Restore mission: a free-flying mission conducted with a U.S. industry partner to initiate on-orbit satellite-servicing capabilities to legacy Government and commercial GEO satellites.
Why service satellites at GEO?

With the growing demand for satellites, on-orbit robotic servicing can save time, money, and resources.

The Satellite Servicing Capabilities Office (SSCO) at NASA’s Goddard Space Flight Center works to advance the state of robotic servicing technology to enable the routine servicing of satellites that were not designed to be serviced.

Commercial communication satellites in geosynchronous orbit.
Adapted from Boeing
Global Consumer Internet Traffic

Why service satellites at GEO?

Cisco Visual Networking Index — Forecast and Methodology, 2008–2013, 9 June 2009

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Restore Mission Description (notional)

• **Restore mission objectives are to provide life-extension services to a range of candidate client satellites.** Specific on-orbit servicing capabilities include:
  – Remote Survey: visually inspect, record, and evaluate client satellite external conditions
  – Refuel: transfer propellant to/from client satellite
  – Relocate: reposition client satellite to another orbital location
  – Repair: fix degraded, malfunctioning, or inoperative satellite components
  – Replace: replace degraded, malfunctioning, or inoperative satellite components

• **Restore will allow for a future orbiting resupply via hosted payloads and/or depot/tanker**

• **Baseline Requirements:**
  – The Restore Vehicle shall launch no later than calendar year 2016
  – The Restore Vehicle shall service GOES-12 or TDRS-9
  – Make the Restore spacecraft available to Commercial Partner for rent for commercial use
  – The Restore Vehicle shall service a TBD second government client spacecraft following the completion of the commercial campaign
  – The Restore Vehicle shall be capable of servicing both classified and unclassified clients
Mission Profile (notional)

Servicer provides:
- Remote Survey
- Relocation
- Refuel
- Repair
- Replacement (ORU)

Multi-sortie mission scenario

1. ELV launches servicer into GEO
2. Servicer check-out
3. Orbit transfer to and AR&D with US Gov Satellite
4. Refuel first customer then release
5. Perform servicing tasks on subsequent customers
6. Repeat services until propellant nearly depleted

1. Resupply vehicle operations
2. Repeat

Commercial Partner Takes Over

Resupply Vehicle Operations

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OpTIIX:
Optical Testbed and Integration on ISS eXperiment

The development of cost effective techniques on ISS to accomplish the robotic assembly and alignment of very large observatories in space to make the next scientific breakthroughs possible

- Will include:
  - the components of a large space telescope
  - six mirror segments
  - a wavefront sensing alignment system
  - a small imaging camera

- Proof of concept for a number of technologies including:
  - Robotic assembly of a scalable optical telescope from modular components
  - Advanced wavefront sensing and control for alignment and shaping of the mirror segments
  - Advanced in-flight laser metrology for telescope alignment
  - Robotically installable and replaceable instruments
Satellite Servicing Robotic Development

The Future

RRM:
Phase I, II, & III

OpTIIX

SATELLITE SERVICING ROBOTIC DEVELOPMENT

Restore (notional)

Support to future systems designs like a repurposed NWT

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Our Charter

We are about the people of this planet and the use of our space tools to improve their lives.
Satellite Servicing Capabilities Office
NASA’s Goddard Space Flight Center
Greenbelt, Md.

Online  http://ssco.gsfc.nasa.gov
Twitter  www.twitter.com/NASA_SatServ
Facebook  www.facebook.com/NASA.Satellite.Servicing