Restore-L Mission Information

Package for NASA Solicitation #NNH15HEOMD001

Spacecraft Bus Concepts To Support The Asteroid Redirect Robotic Mission And In Space Robotic Servicing

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Content

This package contains relevant information about the NASA Restore-L mission concept to aid potential respondents to NASA Solicitation #NNH15HEOMD001.

Outline of contents:

- Overview of NASA's In Space Robotic Servicing Efforts
- Restore-L Mission Overview
- Restore-L Concept of Operations
- Restore Servicing Vehicle – Notional Design
- Bus High-Level Requirements
- Servicing Payload Description
- Servicing Payload (SP) Mass and Power Budgets

All images are notional and all content is in draft form.

Overview of NASA's In Space Robotic Servicing Efforts

Concept/Tech Development

Mission Concept Studies

Restore-G
2009-2014 study.
GEO servicer.

Restore-L
2014 onwards study.
LEO servicer.

Technology Development Areas

Rendezvous & Prox Ops system

Avionics

Dexterous Robotics

Advanced Tools

Propellant Transfer

Restore Reviews

Systems Engineering
Aug 2012

Payload Systems Requirements
Mar 2013

Community Engagement & Research

RFIs & RFQs

Ongoing engagement with:

- **Legal community**
- **Investment bankers**
- **Commercial bus manufacturers**
- **Fleet owners/operators**

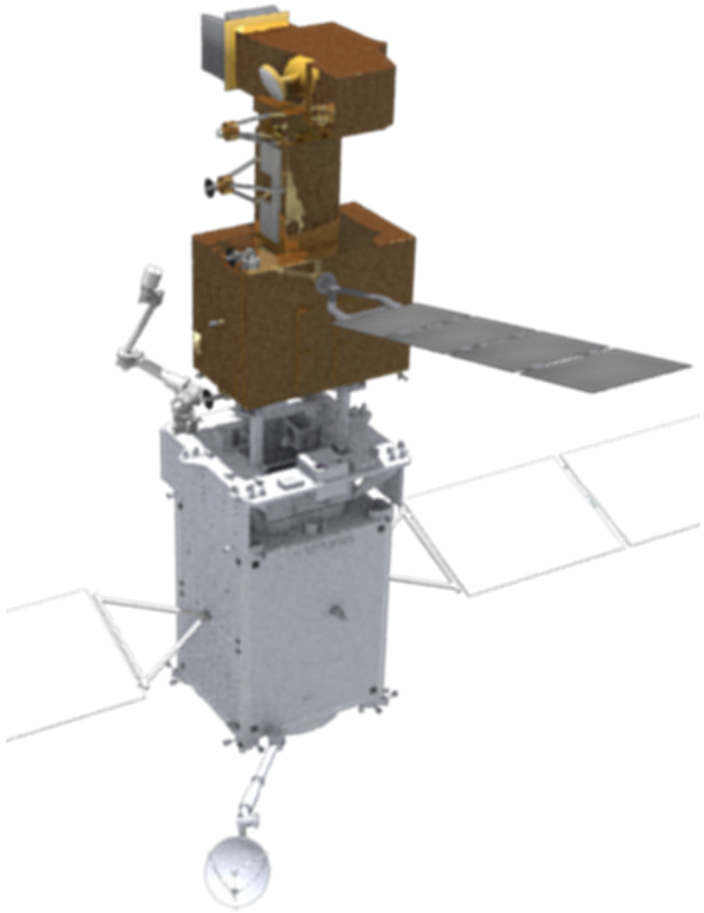
International Workshops 2010 & 2012

http://ssco.gsfc.nasa.gov/

Restore-L Mission Overview

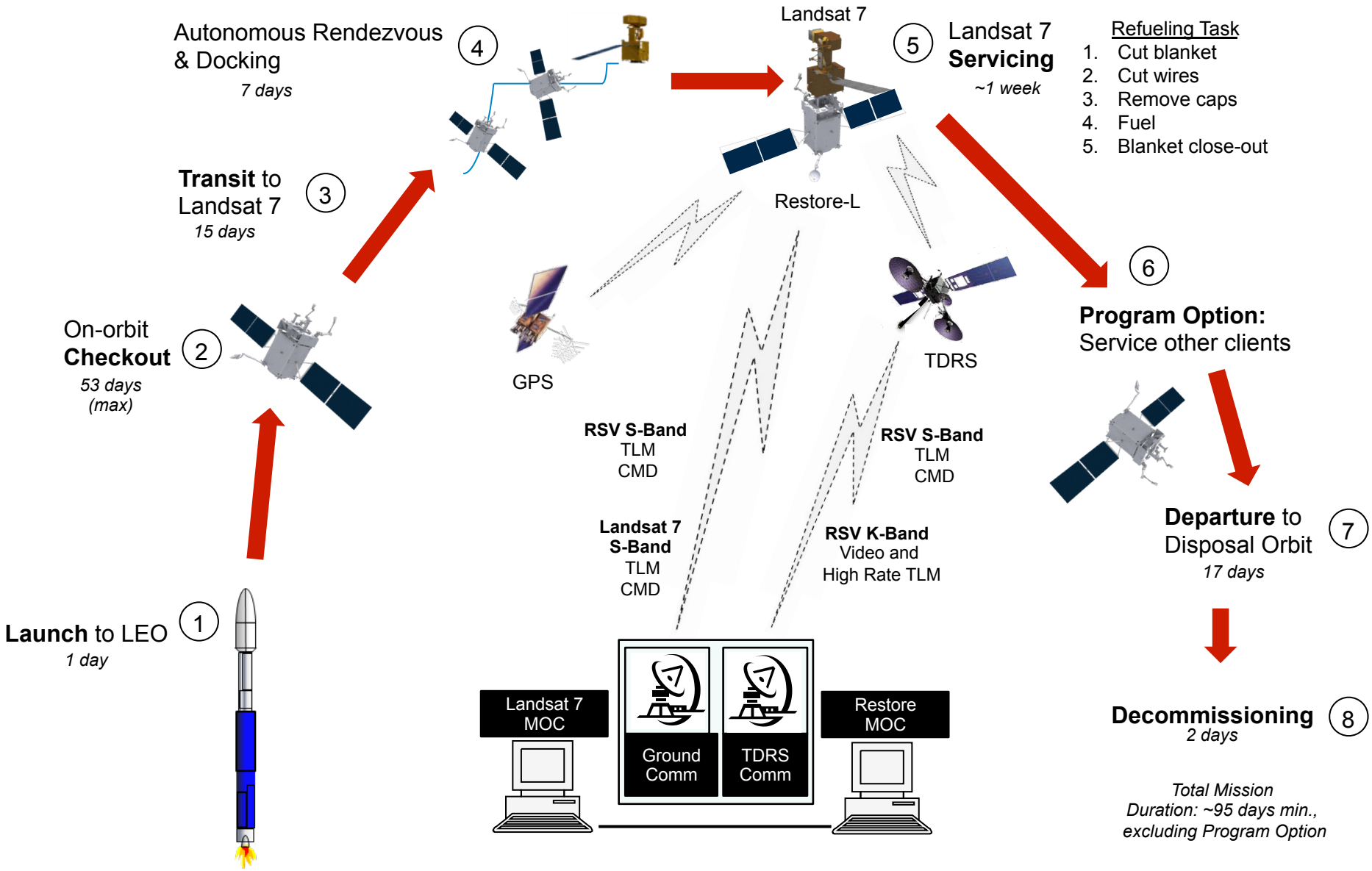
Mission Objectives

- Refuel Government-owned client satellite in low Earth orbit (LEO)
  - Notional client: Landsat 7
- Technology demonstration mission
  - Advance robotic servicing technologies to operational status
- Program Option to service additional satellites



Restore Servicing Vehicle (RSV) (bottom, with conceptual Bus shown) mated to notional client (top)

Restore-L Concept of Operations



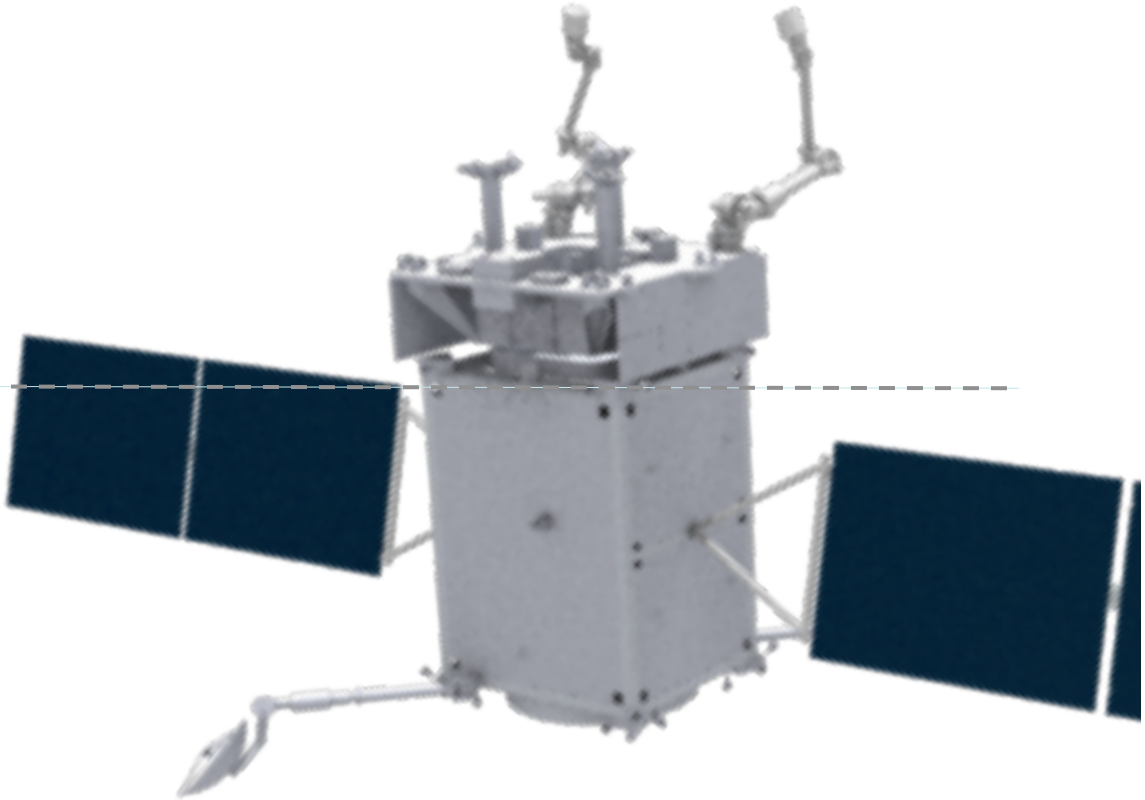
Restore-L High-Level Requirements

Title	Description
Design Life	Restore-L shall have a primary mission lifetime of 1 year.
Rendezvous and Inspection	Restore-L shall rendezvous with and inspect a client satellite in Low Earth Orbit (LEO).
Autonomous Capture	Restore-L shall perform an autonomous capture of a client satellite.
Teleoperated Robotics	Restore-L shall perform teleoperated robotic servicing tasks.
Refueling	Restore-L shall refuel a Government-owned satellite in LEO.
Relocation	Restore-L shall demonstrate relocation of a client satellite.
Re-deploy	Restore-L shall release and safely depart from a client satellite.

Restore Servicing Vehicle – Notional Design

Servicing Payload

- Government Furnished Equipment



Spacecraft Bus*

- Electrical Power System
- Mechanical
- Propulsion
- Communication
- Data
- Thermal

*See Bus functions on next slide

Bus High-Level Functions

Electrical Power System

- Support Servicing Payload Power (see Power Budget, slide 9)
- Low Voltage 28 ± 4 VDC
- High Voltage 100 ± 10 VDC
- Prime and Redundant Heater power
  - Native Bus voltage
  - Approximately 60 heater services

Mechanical

- Support Servicing Payload Mass (see Mass Budget, slide 9)

Propulsion

- 6-DOF chemical maneuverability
- Program Option: reduced-performance version of the ARRM SEP system

Communication

- Assumes bus carries communication mass and power
- S-band low data downlink / high rate uplink for robot teleoperations
- Ka-band high data rate for video / TLM
- CCSDS protocols
- Encryption

Data

- MIL-STD-1553B, RS-422, and/or RS-485 for bus-payload CMD & TLM interface
- LVDS for high speed data

Thermal

- Payload thermally isolated from Bus
- Bus controls heaters on payload

Servicing Payload (SP) Mass and Power Budgets

SP Mass Budget

	Total Mass CBE* (kg)	Total Mass MEV** (kg)
Client transferred hydrazine (per client)	100	100
SP Total (dry)	**785**	**940**
SP Total (wet)	**885**	**1040**
	No contingency	With contingency

**CBE: Current Best Estimate*
***MEV: Maximum Expected Value*

SP Power Budget

	Heaters Only (W)	Rendezvous*** (W)	Capture*** (W)	Robotic Ops*** (W)	Refueling*** (W)
Total Avg.	**540**	**870**	**1340**	**1055**	**1065**
Total Peak	**540**	**870**	**1790**	**1495**	**1145**

****Includes heater power*