The Master Enabler: In Orbit Servicing

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Are we alone?
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NASA’s Ambitious Objectives

- Asteroid Redirection
- Human Exploration
- Resilient Fleets
- Very Large Observatories
- Infrastructure Upkeep
- Observatory Servicing
- Planetary Defense
- Propellant Depot
Servicing Supports Multiple Objectives

- Asteroid Redirection
- Human Exploration
- Resilient Fleets
- Infrastructure Upkeep
- Observatory Servicing
- Propellant Depot
- Very Large Observatories
- Planetary Defense
Satellite Servicing Capabilities

Servicing provides capabilities for flexible, resilient architectures.

- Anomaly Recovery
- Life Extension
- Component Upgrade
- In-Orbit Assembly
- Consumable Restoration
  - Propellant Refueling
  - Cryogen Replenishment
  - Xenon Recharging
Servicing Capabilities Help Visions Become Reality

Human Exploration

Autonomous rendezvous and docking
- Enables modular architectures and lower-cost launch vehicles

Construction and self-maintenance of exploration spacecraft
- Supports long-duration stays in orbit

In-situ resource utilization machinery
- Helps crew produce resources to facilitate the return voyage

Servicing capabilities facilitate robust, resilient, on-orbit human architectures.
Transmit vast quantities of solar energy to ground.

Construction of large-aperture observatories

Discovery and characterization of exo-Earths

Construction of commercial space-based solar power satellites

Servicing capabilities facilitate more complex and capable structures to unlock the secrets of the universe.
Servicing Facilitates Exploration
Asteroid Redirect Mission
Asteroid Redirect Mission
Asteroid Redirect Mission
Very Large Observatories
Core Technologies Required for Servicing Capabilities

**Advanced Technologies**
- Rendezvous and Proximity Operations
- Dexterous Robotics
- High-Speed, Fault-Tolerant Computing
- Advanced Tools
- Fluid Transfer

**Robust Capabilities**
- Anomaly Recovery
- Instrument Upgrade
- Life Extension
- In-Orbit Assembly
- Consumable Restoration

Technology readiness of core technologies is an important first step on path to capability realization.
Servicing Technologies Under Development

- **Rendezvous and Proximity Operations**
  - Raven demonstration launches to ISS in 2016

- **Dexterous Robotics**
  - Engineering Design Unit of NASA Servicing Arm undergoing testing and evaluation

- **High-Speed, Fault-Tolerant Computing**
  - Next generation of SpaceCube underway

- **Advanced Tools**
  - Third generation of advanced robotic tools in manufacturing

- **Propellant Transfer**
  - Propellant Transfer System developed & undergoing testing
**Path Forward**

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**Significant technology advancement has resulted in servicing capabilities becoming verified. This solid foundation is enabling mission planners to design rich future architectures.**
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