

**National Aeronautics and Space Administration  
Request for Information: Development of an  
On-Orbit Robotic Servicing Capability for Spacecraft**

**Introduction**

Maintaining existing and growing commercial, governmental, and national security orbital assets indicates a need for extending the development and dissemination of on-orbit robotic servicing capabilities for existing and future spacecraft. NASA acknowledges that the commercial satellite industry has the proven capability to finance, design, develop, integrate, operate and own complex satellite systems. NASA is also aware that some in the industry are interested in providing satellite servicing as a commercial service. NASA seeks suggestions on methods for the agency to energize/stimulate/enable the development of a domestic and commercial capability in robotic satellite servicing.

NASA is soliciting information through this RFI to gather market research to assist NASA in developing strategies for supporting the development and dissemination of on-orbit robotic servicing capabilities for existing and future spacecraft, particularly including strategies involving collaboration with private domestic entities that leverage the Government's existing intellectual property, technological resources, and expertise in this area. NASA does not intend to establish a Government operated on-orbit satellite servicing capacity but rather to foster the creation of a domestic capability which may meet both future Government and non-government needs. Satellite servicing capabilities may include satellite recovery, repair, relocation, refueling, inspection, subsystem or component replacement, or other services that extend the life or capabilities of on-orbit assets.

This is a Request for Information (RFI) only and does not constitute a commitment, implied or otherwise, that the National Aeronautics and Space Administration (NASA) will take procurement action in this matter. Further, neither NASA, nor the Government will be responsible for any costs incurred in furnishing this information.

**Background**

NASA conducted a study to assess the feasibility, practicality, and cost of servicing satellites using elements of currently planned and future NASA human spaceflight systems and/or robotic technologies. To that end, on December 8, 2009, NASA issued an RFI seeking information on the feasibility of using human spaceflight or robotic missions for servicing existing and future spacecraft. In conjunction with the 2009 RFI, NASA conducted an open workshop March 24-26, 2010 to bring potential users and providers of on-orbit servicing capabilities together with the NASA study team. Additional information on the On-orbit Satellite Servicing Study and the 2010 satellite servicing workshop can be found at [http://ssco.gsfc.nasa.gov/servicing\\_study.html](http://ssco.gsfc.nasa.gov/servicing_study.html).

NASA has been developing systems to facilitate satellite servicing since 1976. Eleven repair missions have been conducted in low Earth orbit (LEO) to date, with each mission utilizing the unique advantages and competencies offered by the space shuttle transportation system and the astronaut corps. Extending satellite servicing capabilities from LEO to geosynchronous Earth orbit (GEO) requires new technologies and the use of robotic methods, as restrictions on human travel to GEO prevents astronauts from performing near-term servicing activities.

NASA developed the Robotic Refueling Mission (RRM) demonstration which was flown to the International Space Station on STS-135 in July 2011. RRM will use the space station's Special Purpose Dexterous Manipulator robot or Dextre to cut and remove insulation, access test ports, cut wires, remove safety caps, access fill and drain valves and transfer a representative fluid demonstrating tele-robotic capabilities to service spacecraft not designed for on-orbit servicing. Additional servicing technologies continue to be developed including robotics, and rendezvous and capture.

To best meet America's current strategic, exploration, and scientific needs, NASA is investigating strategies, including partnerships, toward the development of a domestic and commercial satellite servicing capability. To this end, NASA seeks information it will use to help develop methods to further private sector participation and to enable robotic refuel, repair, and orbit modification services to satellites in GEO. NASA seeks information from domestic commercial entities about their interest in and ability to work with NASA to promote the development and availability of satellite servicing capabilities in GEO.

### ***Timeline***

The goal is servicing operations in orbit in the 2015 to 2016 timeframe. However, respondents are invited to provide feedback on the estimated lead-times of their approaches.

### ***Government Resources and Capabilities***

As noted above, NASA has been developing technology used to service satellites since 1976 and, as a result, has a unique core of expertise and competencies for in-space satellite servicing (human and robotic) developed by the NASA Goddard Space Flight Center (GSFC) and implemented by GSFC's Satellite Servicing Capabilities Office. A complimentary set of expertise and competencies, particularly in the areas of robotic arm technology and acquisition and rendezvous sensors, are available from other U.S. Government agency partners.

Specifically, with other Government partners, NASA has the capability to provide the following resources and capabilities:

- Six Government patents related to satellite servicing,
- Family of tools to conduct precision repair and replacement activity,
- Family of special robotic tools for refueling,
- Integration and Test Facilities,
- Autonomous Rendezvous and Capture (AR&C) sensor technology,

- Space Cube high speed computer systems,
- A robotic front-end system that includes active arms (each arm having a seven-degree-of-freedom capability),
- An approach and rendezvous system (with a vision capability from 10 km to customer satellite capture),
- A variety of end-effectors and tools to accomplish capture, repair, and replacement tasks,
- Mission integration and testing of the entire system at NASA's Goddard Space Flight Center,
- Launch support,
- The initial operations control center, and
- Conduct of, or assistance with, servicing operations for one or more missions.

***Additional Required Resources and Capabilities***

NASA anticipates that additional resources and capabilities are necessary to the development and deployment of satellite servicing capabilities. These may include a spacecraft bus, launch services, and operations as well as other unique capabilities the respondents may wish to present.

Interested respondents are encouraged to propose various combinations of roles and responsibilities between the Government and the commercial sector in order to propose the most cost-effective partnering approach. Proposed models detailed below are used as examples; respondents are encouraged to submit other models in their responses. Please remember, if a Government role is suggested, all proposed collaborations that may include an acquisition strategy must comply with the Federal Acquisition Regulation and other legal and regulatory requirements. The Government wishes to provide constructive resources and assistance towards the establishment of a domestic and commercial service to collaborating domestic U.S. firms on a fair and equitable basis.

**Objective for Request for Information**

NASA seeks information that would assist NASA in promoting the development and deployment of sustainable on-orbit robotic satellite servicing capabilities in GEO, including by collaborating with private domestic entities and leveraging existing Government strengths, resources, and capabilities. To that end, NASA seeks feedback on the feasibility and viability of the three models detailed below, including any suggested revisions. NASA also seeks respondent-proposed collaboration models that meet its objectives.

Because of U.S. commercial objectives and various legal constraints, the RFI is intended for U.S. commercial entities only.

## **Proposed Models**

NASA intends to conduct individual discussions with respondents as necessary to fully understand respondents' feedback and proposed models.

Proposed models, including procurement strategies, are shown below; however, respondents are encouraged to submit alternate models.

**Model #1.** This framework utilizes the technical expertise of the Government team to develop the techniques for on-orbit satellite servicing. A competitively selected Commercial Partner assumes responsibility for the purchase/cost, and therefore ownership, of all flight hardware (hardware to be acquired in consultation with NASA). Following a competition to select the Partner, Government and Partner enter into an agreement, with potential roles and responsibilities as follows:

### **Government**

- a. Contributes a license to existing Government intellectual property (IP), expertise, and personnel/labor;
- b. Designs, fabricates, and tests all engineering and development hardware for the Autonomous Rendezvous and Capture (AR&C), robotic, and refueling systems;
- c. Provides project management, systems engineering, and mission assurance;
- d. Identifies a U.S. Government-owned operational satellite for the initial servicing operation;
- e. Assists with or operates the spacecraft to service a U.S. Government-owned operational satellite in the initial operation; and
- f. Retains Government-purpose rights in any new IP developed.

### **Partner**

- a. Procures and retains title to all flight hardware, including spacecraft bus;
- b. Procures a commercial launch service;
- c. Operates the spacecraft to recoup investments;
- d. Partner would obtain a license to all IP rights in Government-developed technology, subject to any limitations on such rights due to existing Government patent/IP rights; and
- e. Procures fuel for refueling sorties and GEO insertion.

**Model #2.** NASA issues a competitive solicitation for on-orbit satellite servicing for Government-owned satellites and pays fixed amounts for the services. The Government furnishes property (e.g., robotic arms & end effectors/tools, AR&D system, I&T facilities, or other). The contractor contributes launch, spacecraft bus, operations or other. The mix of which entity furnishes which property or capability is open to discussion. The contractor may rent the servicing vehicle for non-government commercial use, paying the Government appropriate rent for use of the vehicle. Government use of the servicing vehicle has priority over commercial use. If the

Government buys the fuel, the contractor reimburses the Government for fuel consumed while being rented. If the contractor provides the fuel, then the Government reimburses the contractor for fuel expended during Government use of the servicer. The service vehicle's last operation (at end of life) must be for a Government purpose (*e.g.*, disposal or refueling a U.S. Government satellite).

**Model #3.** Model #3 uses no Government technical expertise to develop subsystems or systems for on-orbit satellite servicing. One or more viable commercial companies designs, develops, launches, and fully operates commercial GEO on-orbit satellite servicing missions. The commercial company(ies) is responsible for financing, marketing, and operational support. The commercial company(ies) also assumes all risks, including technical, financial, operational, and legal risks.

Under this model, the Government will not identify a Government spacecraft as prospective first client. If requested and deemed appropriate, NASA IP (including know-how) would be made available on a non-exclusive basis and subject to applicable export control restrictions.

Under Model #3 the commercial company(ies) is responsible for gathering any Government customers. If the commercial company(ies) identifies a U.S. Government satellite system requiring servicing, the responsible U.S. Government Agency would reimburse the commercial company(ies) on a fee-for-service basis. All activities and agreements must comply with applicable laws, regulations, and policies.

### **Description of Information Requested**

RFI responses must include:

1. Respondent Information
  - a. Name of Respondent;
  - b. Respondent's address;
  - c. Name and contact information for primary Respondent Point of Contact (POC), including POC's name, title (or affiliation with Respondent entity), email address, and phone number; and
  - d. General description of Respondent's capabilities and experience in the subject matter of this RFI.

RFI Questions:

The Government requests responses to the following questions:

- 1) Please describe your knowledge of the operational aspects of the communications satellite business, including:
  - a) General company capabilities and experience in the subject matter of this RFI;
  - b) Financial stability and resources;
  - c) Demonstration of a viable and credible path to secure funding for mission; and
  - d) Capability of entering into purchasing agreement for launch vehicle, commercial communication bus (or other suitable bus), flight hardware, and insurance.
- 2) Would your organization be interested in collaborating with the Government under Model #1?
  - a) If yes, please answer the following:
    - i) Please explain your organization's approach to raising the funding needed to fulfill the Partner's obligations under Model #1.
      - (1) What would be the proposed source(s) of funding?
      - (2) What is the estimated amount of time needed to raise sufficient funds?
    - ii) Please identify and explain what Government Furnished Property and what contractor provided cost share your organization feels should be considered in this model. Alternative approaches may be discussed, but please be clear on property requirements and cost share associated with each approach.
    - iii) Please explain your organization's approach to procuring the flight hardware.
      - (1) Does your organization have preferred models of flight hardware and other components?
      - (2) How much input would your organization accept from the Government in choosing components?
      - (3) What is the estimated amount of time needed to procure flight hardware, including a spacecraft bus?
  - b) If no, please explain why not.
  - c) What modifications, if any, do you suggest to make Model #1 more viable and/or feasible? Please describe the business model you would propose under the modified Model #1.
- 3) Would your organization be interested in collaborating with the Government under Model #2?
  - a) If yes, please answer the following:
    - i) Please explain your organization's approach to raising the funding needed to fulfill the Partner's obligations under Model #2.
      - (1) What would be the proposed source(s) of funding?
      - (2) What is the estimated amount of time needed to raise sufficient funds?
    - ii) Please explain your organization's approach to procuring the flight hardware and or needed capabilities such as launch services.
      - (1) Does your organization have preferred models of flight hardware and other components?
      - (2) How much input would your organization accept from the Government in choosing components and or services?

- (3) What is the estimated amount of time needed to procure flight hardware and/or launch services?
    - iii) Please explain your organization's approach to managing the satellite servicing equipment when not being used to service Government-owned satellites.
    - iv) Please provide feedback on the provision for renting Government servicing hardware for commercial use, including your inputs on developing reasonable and appropriate rental cost estimates.
  - b) If no, please explain why not.
  - c) What modifications, if any, do you suggest to make Model #2 more viable and/or feasible? Please describe the business model you would propose under the modified Model #2.
- 4) Would your organization be interested in pursuing the approach under Model #3?
- a) If yes, please answer the following:
    - i) Please describe your current technical capabilities in the various areas needed to provide on-orbit satellite servicing, including Autonomous Rendezvous and Capture, robotic systems capabilities needed for satellite servicing, as well as spacecraft, launch service, and orbital operations capabilities. Also, please describe any expertise, assistance, and/or property needed from the Government to succeed under this Model.
    - ii) Please describe your assessment of the technical, operational, and financial risks that may be borne by the first on-orbit satellite servicing clients. How would you mitigate these risks?
    - iii) Please describe your plan for financing the development of on-orbit satellite servicing under Model #3, including space and ground segments and launch. Provide evidence for your ability to raise capital. Please describe your business plan and provide evidence of viability. Identify any partnerships and contributions.
    - iv) Please describe a timeline showing when your on-orbit satellite servicing capability would be available to customers (Government or private entities).
    - v) Please describe your methodology for determining how the fee-for-service pricing would be established for Government user of entities using your on-orbit satellite servicing capability.
  - b) If no, please explain why not.
  - c) What modifications, if any, do you suggest to make Model #3 more viable and/or feasible? Please describe the business model you would propose under the modified Model #3.
- 5) Please describe additional models for a Government/Commercial collaborative arrangement that would accomplish the Government's objective of promoting the development and availability of satellite servicing capabilities in GEO, with an outline of the proposed business plan containing sufficient information to assess viability.
- 6) Please discuss the importance/impact of IP rights, including the impact of a non-exclusive versus an exclusive license to Government-owned IP rights in the satellite servicing technology, under Model #1, Model #2, Model #3, and any other models (modified or original) submitted.

- 7) Please discuss the importance/impact of liability and insurance coverage under Model #1, Model #2, Model #3, and any other models (modified or original) submitted. In doing so, please describe what role, if any, the Government would need to play to make any model feasible and viable.
- 8) Please discuss the feasibility of completing this project within the allotted timeframe (*i.e.*, servicing operations in orbit in the 2015 to 2016 timeframe).

### **Disclaimer**

It is not NASA's intent to publicly disclose Respondents' proprietary information obtained in response to this RFI. To the full extent that it is protected pursuant to the Freedom of Information Act and other laws and regulations, information identified by a Respondent as "Proprietary or Confidential" will be kept confidential.

It is emphasized that this RFI is NOT a Request for Proposal, Quotation, or Invitation for Bid. This RFI is for information and planning purposes only, subject to FAR Clause 52.215-3 titled "Solicitation for Information or Planning Purposes," and is NOT to be construed as a commitment by the Government to enter into a contractual agreement. The Government will not pay for information submitted in response to this RFI. No solicitation exists; therefore, do not request a copy of the solicitation. If a solicitation is released, it will be synopsisized in the FedBizOpps or NASA Acquisition Internet Service websites. It is the responsibility of any potential offerors/bidders to monitor these sites for the release of any solicitation, synopsis, or related documents.

The Government reserves the right to consider a small business or 8(a) set-aside based on responses hereto. As part of its assessment of industry capabilities, the NASA-GSFC may contact respondents to this Request for Information, if clarifications or further information is needed.

### **Responding to this RFI**

An entity responding to this RFI must be a U.S. domestic entity. All RFI queries must be submitted via e-mail to both points of contact outlined below.

### **How to Respond**

All final submissions shall be submitted via e-mail to both points of contact listed below no later than January 4, 2012, 5:00 pm Eastern Standard Time. Two hardcopies of the final submission shall be sent to:

NASA Goddard Space Flight Center  
ATTN: Dean Patterson/210.9  
8800 Greenbelt Road  
Greenbelt, MD 20771

Please reference NNG12FA82-RFI in any response.



Files may be submitted in MS Word, PDF, or RTF format. All responses shall be no more than forty (40) pages. A page is defined as one (1) sheet 8 ½ x 11 inches using a minimum of 12-point font size for text.

NO CLASSIFIED INFORMATION SHOULD BE INCLUDED IN THIS RFI RESPONSE.

**Point of Contact**

Name: Dean Patterson  
Title: Procurement Manager  
Phone: 301-286-8085  
Fax: 301-286-1670  
Email: Dean.S.Patterson@nasa.gov

Name: Claudia Canales  
Title: Contracting Officer  
Phone: 301-286-5990  
Fax: 301-286-1670  
Email: Claudia.Canales-1@nasa.gov

Contracting Officer notes:

NASA intends to conduct a workshop in summer 2012 to present early RRM results and discuss potential future standardization of interfaces for satellite servicing. More information on this workshop will be posted on the web at <http://ssco.gsfc.nasa.gov>.