Program Solicitation

DARPA-PS-16-01

for
Robotic Servicing of Geosynchronous Satellites (RSGS)

May 18, 2016

Defense Advanced Research Projects Agency (DARPA)
Tactical Technology Office (TTO)
675 N. Randolph St.
Arlington, VA 22203-2114

Table of Contents

OVERVIEW INFORMATION

- **Federal Agency Name:** Defense Advanced Research Projects Agency (DARPA), Tactical Technology Office (TTO)

- **Funding Opportunity Title:** Robotic Servicing of Geosynchronous Satellites (RSGS)

- **Announcement Type:** Initial Announcement

- **Funding Opportunity Number:** DARPA-PS-16-01

- **Catalog of Federal Domestic Assistance Numbers (CFDA):** Not Applicable

- **NAICS Code:** 541712; **Small Business Size:** 1,500

- **Dates**
  - Posting Date: May 18, 2016
  - Proposers' Day: May 25-26, 2016
  - Executive Summary Due Date: July 5, 2016, 5:00 p.m. (ET)
  - Proposal Due Date: TBD

- **Total amount of money to be awarded:** $15M

- **Anticipated individual awards:** One

- **Types of Instruments that May be Awarded:** Other Transactions

1 INTRODUCTION

The Defense Advanced Research Projects Agency (DARPA) has established the Robotic Servicing of Geosynchronous Satellites (RSGS) program within the Tactical Technology Office (TTO). The objective of the RSGS program is to create a dexterous robotic operational capability in Geosynchronous Orbit (GEO) that can both provide increased resilience for the current U.S. space infrastructure and be the first concrete step toward a transformed space architecture with revolutionary capabilities. The long-term vision of the RSGS program is to enable persistent robotic servicing capabilities in GEO, beginning with the robotic servicer developed under the RSGS program and operated by a commercial entity, with the goal of achieving an enduring, reliable, cost effective GEO satellite servicing presence.

This solicitation solicits Other Transaction (OT) proposals under the authority of under 10 U.S.C. § 2371b for a U.S. space industry builder-owner-operator team that will partner with DARPA to jointly develop and demonstrate a robotic servicing vehicle (RSV) in or near GEO. DARPA expects this team to have the ability to manufacture a GEO-qualified spacecraft bus, integrate a Government-provided payload onto that bus, provide ground communications across the GEO belt, and operate the vehicle commercially for many years after successful completion of DARPA-specified demonstrations on-orbit. It is anticipated that the RSV owner will benefit from revenues derived from servicing operations provided to both commercial and Government operators of GEO satellites.

1.1 Motivation

In no other field of human endeavor would a high-technology system worth over $1 billion be left isolated, uninspected, unrepaired, and unmodified for its entire useful life. Terrestrial assets of such great value are frequently upgraded to extend and improve their utility; they are inspected and monitored to detect signs of trouble and the need for repair; and fleet maintenance schedules are implemented to spread the cost of support equipment across multiple units. This is not the case in space. Every year, approximately 15 commercial communications satellites and one or two Government satellites, having reached their end of design life, are sent to the graveyard orbit beyond GEO—uninspected, unrepaired, and unmodified—with many of their systems functioning perfectly. Many spacecraft become obsolete during their lifetimes because of the inability to upgrade their capabilities to meet changing markets and missions.

The difficulty of access is the primary reason why these valuable assets have not, to date, received logistical support comparable to terrestrial systems. A few satellites have been maintained by astronauts in low Earth orbit (LEO), and the Mir space station and International Space Station (ISS) have been maintained and replenished frequently during their lifetimes. But these activities have been expensive, requiring the presence of highly trained astronauts with a huge support infrastructure and involved a priori design work to enable servicing.

The access problem is more severe in GEO, where radiation levels prohibit human extra-vehicular activity (EVA). Large amounts of chemical propellant are required to reach GEO, placing restrictions on the frequency and number of payloads that can be delivered.

The same radiation that prohibits the presence of EVA astronauts also damages electronics, so more expensive radiation-tolerant parts must be procured to operate there. Time delays and drop-outs in round-trip communications present additional challenges.

Through a public-private partnership, DARPA intends to implement a GEO servicing capability in a manner that benefits all GEO satellite operators. The United States is expected to derive multiple benefits from this capability. Since GEO contains the largest concentration of unserviced high-value assets, many of which perform critical defense and economic roles, it would be of great value to the Government to have a reliable and responsive servicing capability available in GEO. The U.S. Government operates far more satellites in GEO than any other nation. GEO satellites have experienced failures, malfunctions, schedule delays, coverage gaps, unforeseen maneuvers, and other anomalous events. Because GEO satellites reside on or near a single orbital path, a servicer in GEO can travel among them with little propellant consumption, enabling it to perform many servicing missions before using up its own propellant. Such a vehicle could provide inspection, repair, upgrade, and repositioning services to Government spacecraft when required, while deriving revenue from servicing commercial spacecraft. Specific servicing needs that are unavailable today include inspection to determine the cause of on-orbit anomalies; anomaly resolution to repair malfunctioning satellites; orbit modification for relocation, transfer to the disposal orbit, or correction of propulsion system underperformance; and capability enhancement, the transfer of packages with new capabilities and installation on GEO satellites.

DARPA has developed approaches for providing these services to spacecraft currently on orbit or in production, none of which have been specifically designed to be serviced. However, this could also foster a transformation in GEO spacecraft design and operation. An example of such a transformation is the on-orbit upgrading of satellites. Customer bases for GEO operators are changing more rapidly than in the past, even as satellite mission lifetimes have lengthened beyond 15 years. This means that an operator may be burdened with a perfectly functioning satellite that loses revenue-generating ability over time. Satellite servicing could provide approaches for delivering the latest payload technologies and installing them on orbit rather than accepting the looming obsolescence that faces today's satellites the moment they are launched. Robotic systems could also be used to construct very large antennas and structures in GEO, which could fill multiple Government needs in communications, tracking, and data relay.

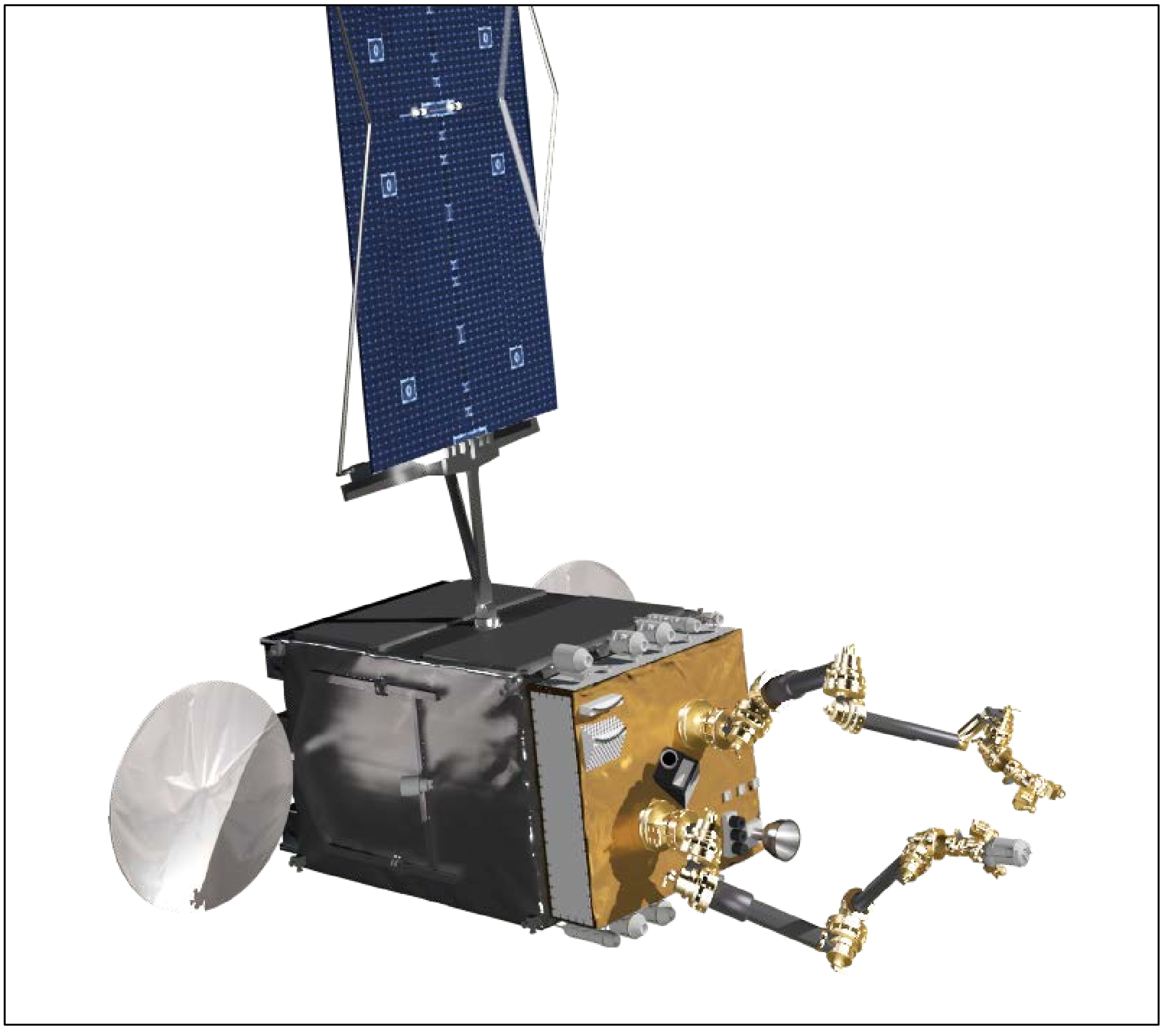


Figure 1-1. Conceptual Robotic Servicing Vehicle

1.2 Government Developed Satellite Servicing Technology

In the early 2000s, DARPA began to examine concepts in space servicing, looking to identify value-added services that could be provided to the satellites then on orbit—which lacked any sort of special fixtures, fiducials, or adaptations for servicing. What hardware, software, and operational approaches would be required to add value to the existing GEO fleet? How could these approaches be validated on the ground and brought to a high readiness level suitable to send into orbit?

The first value-added service that was explored was repositioning of GEO satellites, either to other GEO slots or into the "graveyard" orbit beyond GEO. This is executed by docking with the client satellite, maneuvering it to a new orbit, releasing it, and going on to the next mission. Early studies and experiments led to the following observations pertaining to this approach of servicing satellites:

- Every satellite has booster attachment features that are used to attach the satellite to its launch vehicle; these features are very strong, usually accessible, and are based on a small set of industry standards.
- A flexible, robust, and achievable method of docking a servicer to a client satellite is to use multi-jointed robotic arms equipped with the appropriate tools.
- In order to achieve safe docking in the presence of communications time delays and dropouts, portions of the docking sequence may be more efficient and reliable if automated.

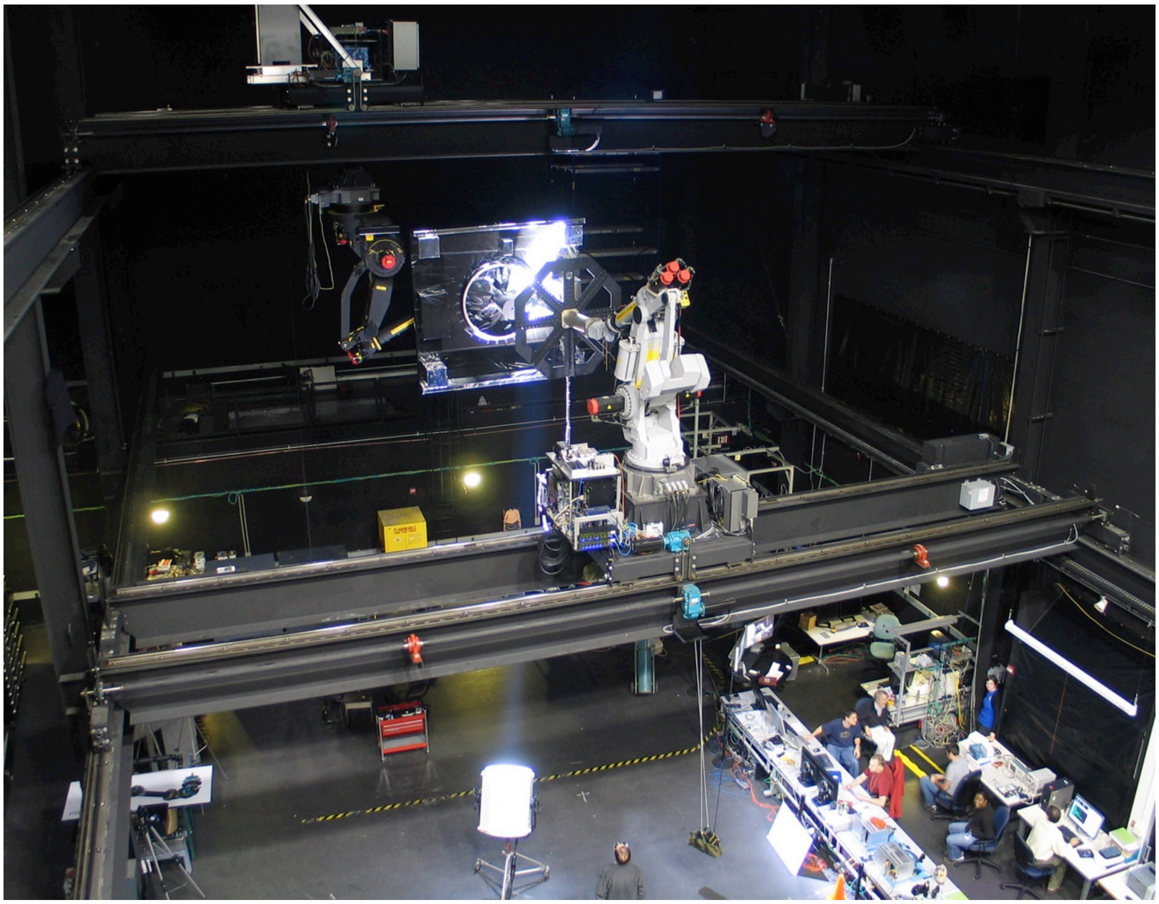


Figure 1-2. Robotics Rendezvous and Docking Testing in NRL Proximity Operations Testbed

Over the next dozen years, DARPA invested in the hardware and software technologies that would be required for value-added servicing based on these principles. Today, these technologies are mature enough to begin the development of a prototype robotic servicing vehicle. A key player in this technology development has been the U.S. Naval Research Laboratory (NRL), where robotics expertise has been combined with a highly experienced spacecraft development center in support of this research. One of the program's key assets has been the NRL's Proximity Operations Testbed, where hardware-in-the-loop simulations of servicing missions have been conducted under realistic solar lighting and orbital dynamics conditions, at full scale. Robotic hardware and software have proven themselves in integrated tests of docking and other servicing operations. These facilities will continue to be available and used for RSGS flight system development.

Industry has noted that there is significant economic potential in developing a service for life extension of GEO satellites. Life extension has been proposed in two forms: by attaching a supplemental propulsion capability or by adding fuel to a satellite's propulsion system. The DARPA RSV is not intended as a life extension vehicle, but rather one that provides services uniquely enabled by dexterous robotic operations. However, placing DARPA-developed advanced robotics on a commercial vehicle designed for life extension will be entertained under this solicitation. Life extension services would be complementary to the advanced robotic capabilities DARPA proposes to enable. Life extension-specific tools and systems would need to be developed by the partner.

1.3 Anticipated Capabilities

For reasons of national security, and economic competitiveness, the U.S. must develop and grow a robust space robotics capability. DARPA's RSGS program is the first concrete step toward that future. The goals of the RSGS program are to provide increased resiliency to the present-day GEO satellite fleet through on-orbit servicing and to begin the transformation of the GEO satellite architecture into one that provides rapid technology refresh, repair of anomalies, fleet flexibility, and construction of large structures with vastly expanded capabilities in GEO.

The nature of the RSGS program is not merely a demonstration of capability. The robotic payload will be built for an extended lifetime supporting dozens of servicing operations. The spacecraft bus on which the payload is integrated must support this extended lifetime, both in terms of component lifetimes and in carrying sufficient propulsion capability to enable a large number of servicing calls. Once a period of checkout and demonstration is completed, it is the expectation that the servicer will be "open for business"—that is, the business of providing value-added servicing and upgrading of satellites in GEO.

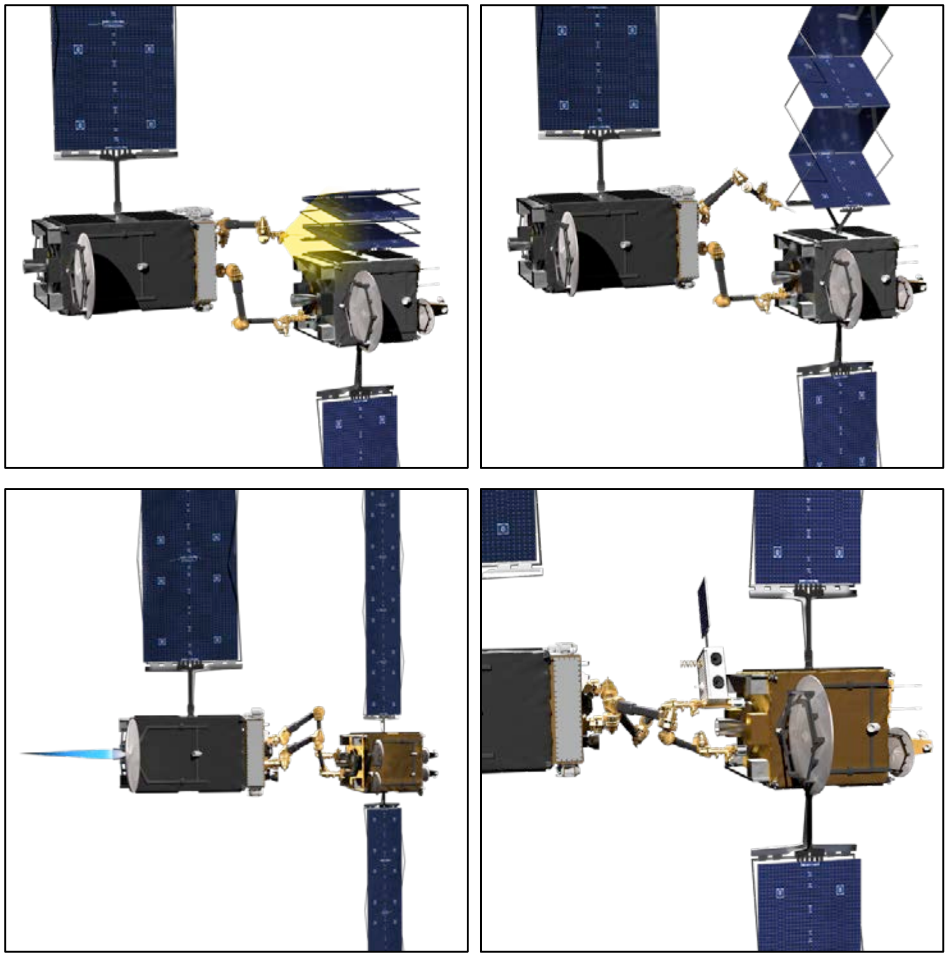


Figure 1-3. DARPA Mission Set: Inspection, Repair, Relocation, Upgrade

The servicing missions that are of primary interest to DARPA (the "DARPA mission set") include:

- cooperative, diagnostic inspection of functional spacecraft operating in GEO that may have experienced anomalies;
- correction of some mechanical anomalies, such as solar array and antenna deployment malfunctions;
- cooperative assistance with orbit change maneuvers (relocation to a new operational station or transfer to the disposal orbit, correction of propulsion system underperformance, conservation of propellant following unplanned maneuvers, and extension of mission life for short periods in the event that a replacement spacecraft is delayed in arriving on station); and
- cooperative installation of upgrade packages on operating spacecraft to provide them with new capabilities.

This mission set was selected for the following reasons:

- Each of the missions has both high economic value and high importance for U.S. national security. The DARPA mission set could potentially contribute both to cost stabilization and to the improvement of space architecture resilience. Cost stabilization and resilience will be achieved through correction of deployment anomalies (avoiding the cost of replacement spacecraft); repositioning (conserving the propellant of GEO satellites by using the servicer's propellant instead); providing a means for introducing new payloads to spacecraft on orbit (avoiding the cost of creating fully integrated free-flying spacecraft for those payloads); providing an ultra-close inspection capability (which may enable distinguishing between natural, engineering, and hostile activity failures); and providing payloads that contribute to resilience.

- Each of the missions is compatible with the space robotic technologies that DARPA developed.
- The mission set is complementary to life extension approaches being considered by industry, making new capabilities available that would lead to a more robust and transformative space servicing enterprise.
- These missions are capable of being performed in a fully cooperative manner, where the ground control teams for the servicer and client are coordinating the execution of the mission. For example, the removal of debris, which cannot be cooperatively controlled, is not in the DARPA mission set.

The DARPA mission set will be enabled by an advanced robotic payload to be incorporated on the spacecraft provided by the partner team ("Partner" or "Partner team") selected under this solicitation. NRL will be the payload integrator and the principal technical interface with the Partner.

A proposing team may wish to incorporate the DARPA robotic payload on a servicing vehicle also capable of other servicing capabilities, which would be acceptable if the mission set described above can still be achieved as well. A proposer may also wish to include the capability of refueling the servicer itself, but this should depend on the business assessment and is not a requirement. Any refueling-specific tools and systems will not be funded by DARPA, but may be developed by the proposer.

Looking even further to the future, DARPA envisions a vigorous set of activities in GEO that include the robotic assembly of very large antennas, structures, and bases; the continuous upgrading of GEO assets in response to technological improvements and security threats; and the incorporation of off-Earth resources when those become available. The operator of the prototype RSV developed under this solicitation may wish to execute experiments on-orbit that reduce risk for the implementation of these longer-term activities, although this is not in the baseline mission set. An enabling feature of the robotic payload will be a "tool changer," installed at the end of the servicer's robotic arms, which delivers tremendous flexibility to the operations that the payload can execute. The DARPA-developed Payload Orbital Delivery (POD) system represents the capability to deliver additional materiel to the servicer—new tools, upgrade packages, and experimental hardware. While not part of the RSGS program, the POD system represents a step toward a future space logistics infrastructure. More information on POD can be found at http://www.darpa.mil/news-events/2014-11-10. A POD Capture Tool will be part of the DARPA robotic payload.

2 PROGRAM STRUCTURE

Under the RSGS program, DARPA will award an OT agreement between DARPA and a U.S. commercial Partner team. The Partner team must include a bus manufacturer and the ultimate robotic servicing satellite owner/operator (which may be the same or different commercial entities).

2.1 Program Approach

DARPA challenges American industry to develop, own, and operate the world's first GEO satellite servicing system, one that could provide services to the DoD and other customers for several years. DARPA seeks a Partner team that, at a minimum, would (1) provide a bus with significant heritage that is suitable for GEO operations and for conducting rendezvous and proximity operations (RPO); (2) work with the Government to integrate and test the robotic payload pre-launch and post-launch; (3) execute a series of Government demonstration tasks near GEO (to be defined jointly with the Partner); and (4) own and operate the vehicle for several years while offering fee-for-service operations to GEO satellite operators, including the U.S. Government.

The end state of the RSGS program is to be a U.S. commercially-owned and -operated robotic servicing vehicle, which carries the Government-furnished robotic payload. Accordingly, the satellite bus will not be purchased by the Government, but instead it must be provided and continuously owned by the Partner selected under this Solicitation. The commercial owner will be able to leverage Government contributions, including the development, manufacture, integration and testing of the robotic payload and its advanced automation and payload mission management software; participation in integration of the payload and bus; a launch vehicle to deliver the RSV to GEO or to Geostationary Transfer Orbit (GTO); development of a terminal for the mission operations center that enables both simulation of proposed servicing missions and teleoperation control of the RSV; extensive operational support during the operator qualification, on-orbit checkout, and demonstration phases of the mission; and potentially the provision of some milestone-based payments. In exchange for some consideration to be proposed by the Partner, the use of the Government-furnished robotic payload will be made available to the Partner (after completion of Government demonstration tasks) for follow-on commercial operations.

Commercial ownership and operation of the RSV is integral to the RSGS program. In GEO today, there are five times the number of commercial communications satellites as there are U.S. Government-operated satellites. This represents five times the opportunities to exercise the RSV's capabilities and learn from them. The operational experience gained will flow directly to the operating team, leading to further innovation and improved design of the next servicer. DARPA will be seeking the partner team that demonstrates the greatest commitment to the growth of space servicing as a commercial business, and to the transformation of spacecraft design and operations resulting from the persistent availability of space robotics.

There are significant advantages to the Government from this partnership model. Because there are many fewer Government GEO satellites, services to them would be required only infrequently, with the RSV spending much of its time idle. Being able to obtain services as-needed on a fee-for-service basis eliminates the need for the Government to provide a full-time RSV operations team. The Government may also develop experiments in robotic assembly for the RSV to execute between commercial servicing tasks. DARPA anticipates that revenues from RSV servicing operations would be more than adequate to cover the costs of ongoing operations, supporting an enduring capability that both the Government and the commercial satellite industry could leverage.

DARPA is seeking a Partner that shares the belief in the transformative power of space robotics, and is committed to a significant investment to make it happen—not merely an investment of labor and funds, but an investment of its most qualified and creative talent to bring about the transformation of space logistics and spacecraft design. DARPA envisions that the successful Partner team would find ways to develop the market for long-term GEO servicing, but would also join with the Government to bring about a revolution in spacecraft operations and design. This transformation would naturally go hand-in-hand with the emergence of a market environment in which satellite servicing is readily available to both commercial and Government clients, which in the long run supports a sustained servicing industry. The successful Partner team will demonstrate the strong commitment to this long-term transformation, with the accompanying economic growth and space resilience it can bring. For proposal evaluations, please see Section 4.2.2.

DARPA envisions the following breakdown of technical work areas:

2.1.1 Government

- Deliver the robotic payload as described in Section 3 for integration into the Partner bus
- Provide the Integrated Robotics Workstation (combines planning, simulation and teleoperation capabilities for payload operations) as described in Section 3 for integration into the Partner ground segment
- Provide payload systems engineering support for all DARPA-provided robotic payload capabilities (autonomous grapple, teleoperations, relocation, repair, and upgrade)
- Provide payload operation models and simulation software
- Provide a launch for the RSV to GTO or direct to GEO (launch vehicle and performance not yet determined)
- Support mission systems engineering, space vehicle systems engineering, and space vehicle integration and test (I&T) efforts that involve the robotics payload
- Provide technical insight into the DARPA-provided payload, ground, and mission simulation efforts as appropriate for partnership success
- Provide milestone payments as outlined in the final signed OT
- Support the development of robotic servicing standards efforts with Government and industry

2.1.2 Partner

- Provide a bus capable of meeting the needs outlined in Section 3
- Provide a communications solution consistent with the RSGS missions and objectives
- Lead mission systems engineering, space vehicle systems engineering, space vehicle I&T efforts including integration of the DARPA provided payload, and operations
- Share technical insight into the Partner bus, mission, and (if applicable) other capabilities with the Government
- Provide location, facilities, personnel, and support equipment for integration of the robotic payload onto the spacecraft bus
- Provide test facilities for the integrated spacecraft with payload
- Provide technical insight into the Partner space vehicle, bus, mission, and other efforts as appropriate for partnership success
- Obtain liability insurance for mission operations
- Provide ground terminals, a mission operations center, and staffing for operations through the mission life
- Develop customer relations that lead to commercial servicing missions
- Execute the on-orbit Government-defined demonstration phase
- Support the development of robotic servicing standards efforts
- Develop mission simulation software that combines bus GNC/RPO simulations with payload operation simulations

2.1.3 Joint or Negotiable Tasks

- Approach to RPO sensor suite and control
- Approach to payload accommodation on bus
- Integrated spacecraft-payload test facilities
- Contracting for/arranging for cooperative vehicles for the on-orbit Government-defined demonstrations
- Operators and subject matter experts to support pre-launch training, space vehicle I&T, post-launch demonstration operations, and post-launch commercial operations
- Other mission capabilities per Section 3.5.8
- Launch (if partnership has an alternative approach to launch that reduces overall cost or provides other benefits)

This breakdown of technical work items and facilities is consistent with available Government resources.

If a Partner team is unable to demonstrate in the proposal that it can successfully perform all the technical work areas in Section 2.1.2, the Partner team is unlikely to be successful in the selection process.

2.2 Program Plan

The RSGS capability will be developed in the following sequential phases:

- Spacecraft and Payload Development: the Government will continue the development of the robotic servicing payload (described herein) while the Partner builds a satellite bus capable of carrying the payload and executing the servicer missions; the Government will also develop mission simulation capabilities and robotic hardware-in-the-loop multi-degree-of-freedom mission simulation capabilities to validate missions on the ground and provide for operations team training.
- Integration: the Partner, with support from the Government, will integrate the payload onto the Partner-owned bus
- Launch: the Government will provide a launch of the integrated servicing vehicle into GTO or directly into GEO or near-GEO in late 2020 or early 2021. Launch arrangements are not yet determined, and the Government is amenable to other launch options that the Partner may wish to propose.
- Capability Demonstration: the Partner operations team, with Government support, will execute a series of Government-specified exercises to demonstrate payload functionality and safe mission execution.
- Commercial Operations: the Partner will operate the servicing vehicle to provide services to Government and commercial GEO satellites, with defined benefits to Government customers that the Partner proposes.

Key dates to support a Q2FY21 launch include:

- Bus System Requirements Review (SRR) and Bus-to-Payload Interface Control Document (ICD) Release – Q3FY17
- Bus Preliminary Design Review (PDR) – Q1FY18
- Payload PDR – Q2FY18
- Bus Critical Design Review (CDR) – Q4FY18
- Payload CDR – Q3FY19
- Bus Delivery – Q4FY19
- Integrated Robotics Workstation (IRW) Delivery – Q2FY20
- Payload Delivery – Q2FY20
- Ground System Readiness Review – Q4FY20
- RSV I&T Complete – Q1FY21

2.2.1 Spacecraft and Payload Development

After the Government selects the Partner, the development phase will begin with the joint development of the Bus-to-Payload ICD. This joint effort is expected to enable largely independent development of the robotic payload by the Government, and the bus by the Partner, with cross-representation at the two development sites. Design reviews and technical interchange meetings will be scheduled regularly and co-attended. The two separate components (payload and bus) will be environmentally tested to the maximum extent practicable prior to integration; test regimes will also be jointly specified. This phase will culminate with an Integration Readiness Review.

2.2.2 Integration and Launch

During this phase, the payload and spacecraft teams will work together to ensure a flawless integration and launch process. Launch of the RSV will be provided by the U.S. Government, although the launch vehicle and its performance are not yet defined. It is anticipated that the bus-to-payload integration, launch preparation, and launch vehicle coordination will be led by the Partner team. While it would seem more practical to perform these tasks at the bus builder's facility, the Partner may have a different preference, which should be explained clearly.

2.2.3 Capability Demonstration

The scope of the Capability Demonstration involves the operation of the RSV on-orbit, including independent robotic operations, automated docking via robotic grappling, tool changing, mechanical manipulation, and coupled stack operations. The demonstrations will culminate with a series of operations with one or more operating GEO or near-GEO satellites. DARPA intends to arrange for such an operational satellite to act as the orbital active test bed, either a Government satellite or through a contract with a commercial GEO satellite operator. Partners may propose an alternative orbital test bed for the Capability Demonstration.

2.3 Management Approach

The Partner will lead the systems engineering and payload-to-bus integration with extensive assistance from NRL, will own and operate the integrated system, will have primary responsibility for achieving the RSGS demonstration objectives, and will continue to operate the RSV for the remaining lifetime of the spacecraft. NRL will be the integrator of the robotic payload.

As the U.S. Government partner, DARPA is responsible for the overall management of the DARPA RSGS program, including technical matters, acquisition, and security. DARPA requires sufficient and timely insight to insure that the Partner is executing its commitments under the agreement—effectively executing the project and leveraging the Government investment. Use of an OT agreement, authorized under 10 U.S.C. § 2371b, provides significant flexibility to enable streamlined program management and collaboration between Government and industry. The Government is committed to a vision of working with the Partner as a true partnership, facilitating the best technical development and program outcome within program constraints. DARPA will employ a technical support team leveraging NRL's expertise as well as other Government and contracted subject matter experts. As appropriate, the DARPA Program Manager may occasionally include other Government stakeholders in Partner-led program reviews and other major events for program liaison, visibility, and advocacy, including policy matters. An OT allows the Partner to propose a range of collaboration alternatives, to leverage Government personnel and facilities as desired and appropriate, and to define the most effective Government/industry working relationship. DARPA encourages potential partners to offer a management approach that will enable the most efficient and cost-effective program that meets mission objectives.

The Partner will clearly describe their management plan to execute their management responsibilities while providing DARPA with the level of insight required to execute DARPA's program management responsibilities and legal and fiduciary responsibilities on behalf of the U.S. Government.

2.4 Intellectual Property Rights

The robotic payload and associated products being provided by the Government include portions of Government-developed and privately-developed intellectual property. In general, the control algorithms, software, structure, payload electronics, subsystem designs, overall payload design, and robotics ground station control system have been developed by the NRL; the robotic arms, tool changer, tools, and various other pieces of hardware have been developed under Government contracts with private suppliers. The Partner may expect to have broad use of all Government-developed intellectual property, including (but not limited to) component designs, performance data, requirements documentation, interface control documents, test reports, error budgets, and parts lists. Designs, operational data, and other information associated with privately-developed components required for design and operation of the RSV will be provided by the Government to the Partner. However, this will not include the right to manufacture those components, resell the intellectual property, or in any way infringe on the suppliers' ability to market their products, as long as that supplier remains a reliable provider in that market. In the event that a key component becomes unavailable from the original supplier, and that component was developed with Government funding, the Government intends to ensure the continued availability of that key component.

Regarding the intellectual property of the Partner, the Government will require sufficient rights to the intellectual property used in RSV development to (1) brief Government stakeholders regarding technical progress and accomplishments; (2) allow validation and simulation of technical performance, capabilities, and accomplishments by independent technical (potentially non-Government) experts; (3) facilitate discussion of technical challenges and transformative applications with the broader U.S. aerospace community; (4) support servicing missions for Government spacecraft through sharing of technical performance data and projections; and (5) document results of the program. It is anticipated that many of these activities will require the Government to perform independent analyses of the Partner's bus performance. The Government desires to have Limited Rights access to all major bus subsystem data for substantiating performance. The Government also desires to have at a minimum Government Purpose Rights (GPR), as defined in Section 7.2, over payload-to-bus and bus-to-ground interfaces that involve the robotic payload operations to analyze the potential for expansion of capabilities and future programs.

2.5 International Traffic in Arms (ITAR) Compliance

All proposers must comply with export control laws and ITAR and be able to protect sensitive and controlled data, including critical technologies. DARPA suggests that appropriate teaming relationships be developed with industry-to-industry contracts, which are significantly simpler than Government-Industry relationships, particularly where foreign companies are concerned.

The following clause will be included in any executed agreement:

(a) Definition. "Export-controlled items," as used in this clause, means items subject to the Export Administration Regulations (EAR) (15 CFR Parts 730-774) or the International Traffic in Arms Regulations (ITAR) (22 CFR Parts 120-130). The term includes:

> "Defense items," defined in the Arms Export Control Act, 22 U.S.C. 2778(j)(4)(A), as defense articles, defense services, and related technical data, and further defined in the ITAR, 22 CFR Part 120.
> "Items," defined in the EAR as "commodities", "software", and "technology," terms that are also defined in the EAR, 15 CFR 772.1.

(b) The Contractor shall comply with all applicable laws and regulations regarding export-controlled items, including, but not limited to, the requirement for contractors to register with the Department of State in accordance with the ITAR. The Contractor shall consult with the Department of State regarding any questions relating to compliance with the ITAR and shall consult with the Department of Commerce regarding any questions relating to compliance with the EAR.

(c) The Contractor's responsibility to comply with all applicable laws and regulations regarding export-controlled items exists independent of, and is not established or limited by, the information provided by this clause.

(d) Nothing in the terms of this contract adds, changes, supersedes, or waives any of the requirements of applicable Federal laws, Executive orders, and regulations, including but not limited to—

> (1) The Export Administration Act of 1979, as amended (50 U.S.C. App. 2401, et seq.);
> (2) The Arms Export Control Act (22 U.S.C. 2751, et seq.);
> (3) The International Emergency Economic Powers Act (50 U.S.C. 1701, et seq.);
> (4) The Export Administration Regulations (15 CFR Parts 730-774);
> (5) The International Traffic in Arms Regulations (22 CFR Parts 120-130); and
> (6) Executive Order 13222, as extended;

(e) The Contractor shall include the substance of this clause, including this paragraph (e), in all subcontracts.

2.6 Partnership Agreement Approach

Partners may propose a system solution targeting only the DARPA mission set, or they may propose a system that adds the DARPA capabilities to another servicing capability set. Due to funding limitations, DARPA anticipates awarding only one agreement under this solicitation.

2.7 Funding

DARPA will be responsible for the payload development, arranging for launch of the RSV, and for other Government-furnished items as listed in this solicitation. **DARPA will not fund the development of the spacecraft bus and integration of the commercial bus with the Government payload**; this is non-negotiable, as Partner ownership of the bus enables the use of the Government-developed robotic payload across a wider client set. The only contemplated transfer of funds to the Partner would be milestone-based incentive payments for successfully achieving specific measureable progress milestones.

In order to gain ownership of the Government-developed robotic payload after the demonstration period, the Partner must offer the Government consideration in exchange. A valuation of the Government-provided robotic payload will be assessed at the Payload Critical Design Review and the Partner will be expected to propose consideration equivalent to value of the payload. Examples of such consideration could include: assured pricing for future missions servicing Government clients; the agreement to perform robotic experiments for Government clients; provision of operational data and lessons learned to the Government; training of Government personnel; or other offers consistent with the Partner's business case. The Government is open to all reasonably proposed consideration packages.

2.7.1 Non-Financial Contribution

DARPA's contribution to the partnership will include: the development, test, and integration of the various components into the advanced robotics payload; development of key software and robotics workstation for the Partner's mission operations center to support the partnership; assistance with integration of the payload onto the Partner's bus; launch of the servicing vehicle to GTO or GEO; and operations team training and mission support during the demonstration period.

2.7.2 Anticipated Progress Payment Funding

DARPA anticipates a total of up to $15 million spread over fiscal years 2020 through 2021 to be available for milestone incentive payments within the OT. The final amount of funding allocated to milestones under the OT will be solely at DARPA's discretion. The specific amount of the milestone payments will be finalized during negotiations; however, DARPA anticipates a significant amount of the milestone payments will be for orbital demonstration milestones tied to key DARPA mission requirements. DARPA anticipates earlier milestones will be tied to key risk areas identified in the Partner's capability demonstration project.

Participants are expected to secure all funding necessary to complete the proposed capability demonstration. Submission of a signed OT at the end of the competitive selection process will include a representation of funding availability and commitment.

The Government's obligation to enter into agreements is contingent upon the availability of appropriated funds. DARPA's contribution will be a fixed amount and will not be changed based on the participant's ability to obtain private funding.

3 SYSTEM DESCRIPTION

The DARPA/NRL team has been developing on-orbit robotic servicing as a revolutionary national capability for U.S. space systems since the early 2000s. We are excited to be able to offer this capability to the U.S. aerospace industry for improving space operations.

During the previous decade, NRL developed requirements and held a competitive procurement for the Front-End Robotics Enabling Near-Term Demonstration (FREND) robotic arm in 2005. The manufacturer, Alliance Space systems (now MDA-US Systems), delivered a flight prototype arm in 2008, which was qualified through environmental testing and functional tests. Two copies of an upgraded version, the FREND Mk II arm, will be procured in the course of the RSGS program and will be the centerpieces of the DARPA robotic payload described herein. The unique, enabling features of the FREND arms for the RSGS mission set include:

- The stiffness to act as a docking system via grappling of client system hard points
- The precision to interact with the client spacecraft and accurately position end effectors
- The ability to accommodate end-of-arm components including tools, cameras and lights, and pass power and data along the arm
- The ability to operate in Earth gravity, enabling flight-like testing of robotic tasks on the ground

As the FREND robotic hardware was being developed, NRL continued the mission development systems engineering to ensure that the robotic payload system would be compatible with available GEO spacecraft buses. Along with the mission development work, NRL also began development of the necessary payload elements to support the FREND robotic system, including the robotic control software system. The robotic control software system includes the algorithms and flight software necessary to control the autonomous, tele-operated, and scripted operations of the robot arm; the trajectory planner; force-limiting compliance control; inverse kinematics; obstacle avoidance; mission sequencer; fault detection/recovery; and machine vision, along with a host of lower-level arm control and arm safety functions.

When the FREND engineering development unit and flight prototype unit were delivered to NRL in 2008, NRL engineers performed extensive system integration testing to validate that the Government-developed robotic controls integrated well with the industry-provided robotic hardware. Through both a series of laboratory integrated tests and spaceflight environmental tests in 2008 and 2009, NRL validated that the ability to robotically rendezvous and dock with satellites not pre-designed for servicing had matured and was ready for mission development that would create a new national capability in space.

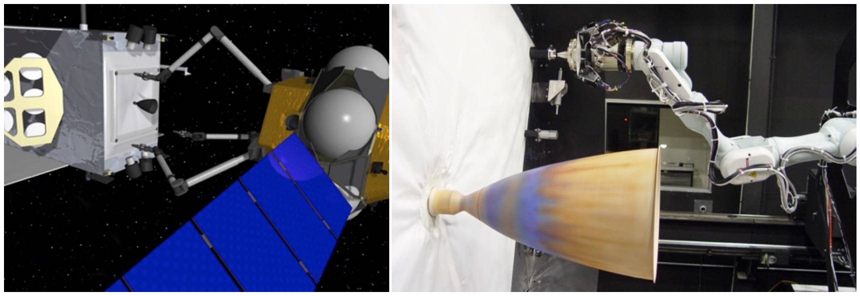


Figure 3-1. Spacecraft for the Universal Modification of Orbits (SUMO) Conceptual Rendering and Proof of Concept Testing

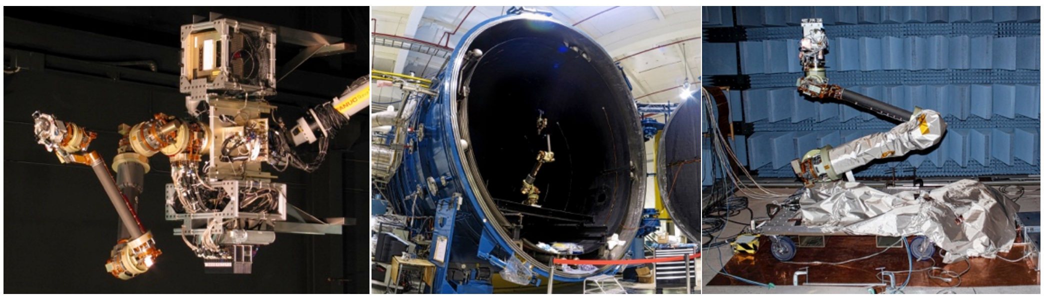


Figure 3-2. FREND Flight Prototype, Functional and Environmental Testing

More recent technology development efforts under the DARPA Phoenix program have focused on not only continuing to develop the robotic arm and software controls, but also maturing other key program elements to be spaceflight mission ready. These include areas such as the robotic end-of-arm system, the robotic tool suite, the robotic payload avionics, the on-board support items like tool stowage, and the necessary ground support capabilities for developing, planning and executing on-orbit robotic operations. With the Government maturing this broad set of capabilities, the programmatic and technical risk has been greatly reduced for this new type of space mission, enabling it to be flown and transferred to U.S. industry to improve efficiency, resiliency, capability, and ultimately affordability of U.S. space operations.

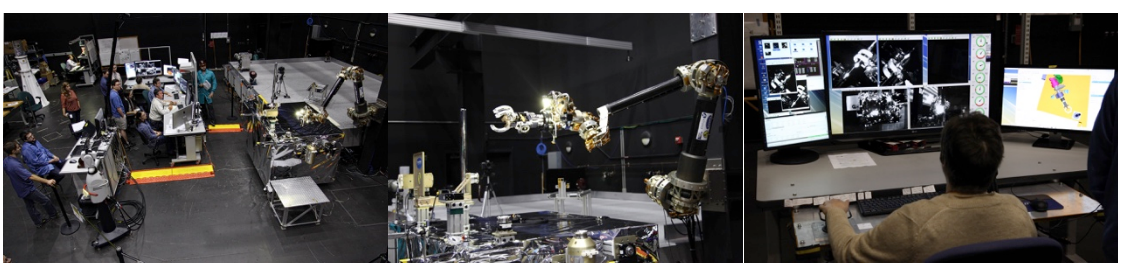


Figure 3-3. Phoenix Tool Testing, Including Tele-Operations

The following sections describe the DARPA concept for the RSGS mission system; the concept of operations (CONOPS); the technologies that will be included; and the division of functions between the robotic payload, the Partner-provided bus, and the ground segment. The overall mission concept and the division of functions should be analyzed by the Partner, and the proposal should indicate the assessed optimum configuration. One of the first tasks of the partnership will be to baseline the division of functions and CONOPS. Non-tradeable items (such as the use of FREND arms and the Government-developed associated software) are indicated below.

3.1 Mission Objectives

This section describes the mission objectives and capabilities desired to meet DARPA's goals and objectives for the RSGS program.

The final design of the Ground Segment and RSV will be determined following Partner selection. It is expected to be a highly collaborative activity between the Partner and the Government teams. As a point of departure, section 3.4 contains a notional RSV design for reference that can be modified by the proposer, as long as it meets the intent of Section 2 of this document. Further modifications following the execution of the OT can be made by mutual agreement of the partners.

Section 3.5 contains a point design for the payload which should be used as a reference to incorporate into proposed RSV and Ground Segment designs.

The RSV is to provide services to both commercial and U.S. Government-owned satellites, hereinafter referred to as "Clients," in GEO orbit. These services include, but are not limited to, the following:

- Inspection – Imaging of Client to detect the presence (or absence) of external abnormalities for the purpose of understanding the Client's current operational state or attempting to discern the root-cause of any anomalous behaviors.
- Repair – Physical intervention via robotic manipulation to induce a stuck mechanism to deploy, (i.e., a solar array or reflector) or realignment of thermal blankets or deployment coordination cables. This will be done by applying carefully metered forces or torques at precise locations on the Client.
- Relocation – Physical attachment to the Client, via a robotic grapple, to adjust its physical position/orbit – example relocation operations include:
    - performing an orbit-raising/adjustment maneuver for a Client that has not reached its planned orbital slot,
    - repositioning a Client from one GEO longitude to another,
    - bringing an inclined Client back to a geostationary position, and
    - retiring a Client at end of life GEO to super-synchronous graveyard/retirement orbit.
- Upgrade – The mechanical attachment of payloads, which are delivered to orbit via the POD system or otherwise, to Clients by the RSV Payload.

The Government has conducted proof-of-principle experiments in the robotic test bed facility at NRL to show that all these services are feasible using the robotic payload.

3.2 RSV Operations Overview

The RSV will be launched on a Government-furnished launch vehicle. The RSV will either be delivered to GTO (and be required to execute the final transfer to GEO) or delivered directly to a near-GEO orbit for activation and checkout.

The RSV will be required to perform a Government demonstration mission that will validate its readiness for transition to commercial use. While the Government demonstration mission has not yet been fully defined, DARPA will arrange for one or two demonstration Clients for RSV rendezvous, docking, and representative servicing tasks. Like all RSV operations, these demonstrations will be cooperative and with the consent of the owner/operator. The demonstration(s) will likely be performed near the GEO protected region and limited in extent so that sufficient maneuvering capability remains for extended follow-on commercial operations.

Representative activities for the Government-defined servicing demonstration to be performed immediately after on-orbit checkout include:

a. autonomous rendezvous and grapple of one or more launch vehicle attachment fittings (Marman ring, bolt capture fitting) on unmodified Clients (no fiducials or cooperative grapple targets installed);
b. relocation of a Client to show stable stack control at thrust levels representative of a relocation maneuver;
c. Client inspection at varying ranges to include precision inspection at camera ranges of less than 1 meter;
d. applied force on a Client structure on the order of 25lbs (TBR); and
e. demonstration and operations of Spacehand (Spacehand is defined further in Section 3.5.4).

After the demonstration sequence, anticipated to take no more than an estimated six to nine months, the RSV will be operated by the Partner for commercial servicing missions and possible “fee-for-service” servicing missions for the Government.

At the end of its mission lifetime, the RSV will be put into a retirement orbit compliant with national standards (U.S. Government Orbital Debris Mitigation Standard Practices). This will likely entail raising the orbit to one with a perigee above 36,100 km and configuring the spacecraft for end of life.

The elements of the RSGS architecture include the RSV, Client, and Ground Segment.

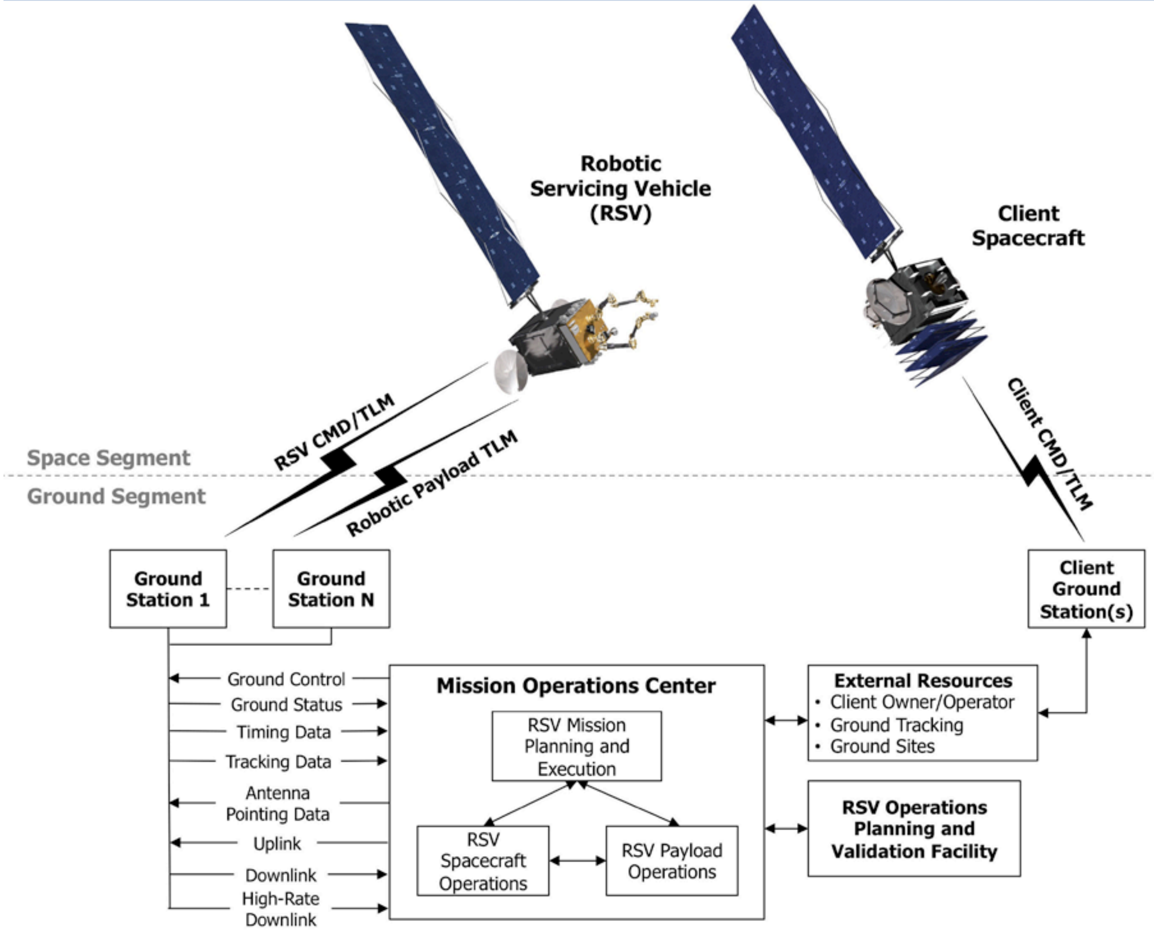


Figure 3-4. RSGS Architecture

3.3 RSV Overview

DARPA envisions the notional complete RSV design (bus with payload) to have the following capabilities:

- Guidance, Navigation, and Control (GN&C) features and a bus propulsion system that support:
  - trajectories from GTO to GEO
  - rendezvous operations with Clients to 1km; and
  - proximity operations from 1 km to contact.
- Standoff inspection of Clients (hundreds of meters range)
- Close inspection (meters)
- Approach and controlled grapple box hold (approximately 1.5 m separation) for Client grapple/docking operations

- Mission manager software (distributed between bus and payload) that coordinates between bus and payload for all mission phases, including critical operations such as supervised autonomous grapple
  - Maintains mission-level goals and state awareness, tasking both bus and payload manager software
  - Plays a critical role in fault resolution during brief autonomous phases of operations, when bus and payload sensing must be combined to determine the response
- Attitude control of RSV/Client stack during mated operations
  - RSV ability to remove angular and translational rates post Client grapple
  - RSV ability to position RSV/Client stack and control attitude, as required, for all servicing operations
  - RSV control of RSV/Client mated stack during delta V maneuvers for relocation
- Mechanical support of robotic payload, enabling the application of force or torque to selected Client elements (e.g., solar arrays, antennas) for repair
- Support mechanical attachment of upgrade modules to Client
- Tool changing capability
- Tool stowage capability
- High-bandwidth communications to ground
  - Highest demand for bandwidth is anticipated during payload tele-operations
- Information Assurance features, such as:
  - Secure collection, distribution, and storage of imagery
  - Cyber security included in bus and payload design
- Ability to receive equipment in flight via on-orbit resupply (POD system)
  - POD system Capture Tool included in tool suite
  - Support rendezvous and proximity operations for POD system
  - Support POD system capture, stowage and disposal

A conceptual RSV will consist of a RSV bus (blue) and RSV payload (green), as pictured in Figure 3-5.

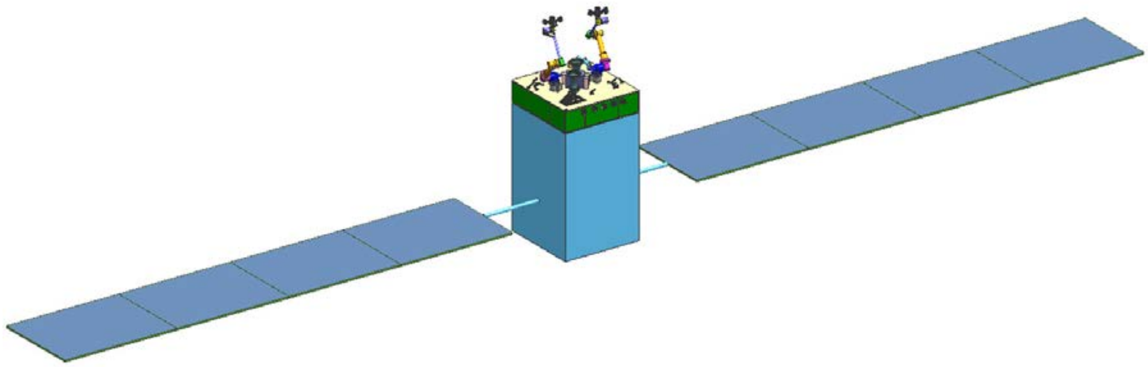


Figure 3-5. RSV Notional Design with Two-arm Payload.

The NRL payload point design notional RSV launch mass is NTE 4500 kg. Depending upon launch vehicle performance (which is TBD), the partnership may decide to vary the launch mass to optimize the mission objectives.

The capabilities for the bus and payload are outlined in Sections 3.4 and 3.5, respectively.

3.4 RSV Bus Description and Desired Capabilities

The capabilities described in this section are based on a notional RSV design and a robotic payload point design that satisfy the mission objectives in Section 3.1 and the payload design requirements in Section 3.3. It is expected that a proposed RSV design could trade functionality between bus and payload subsystems and could consolidate some of these systems.

RSV designs will vary based on factors such as, but not limited to, commercial business case, total number of required servicing missions, frequency of servicing missions, and total mission lifetime. The RSV should be able to perform servicing missions anywhere in GEO.

The bus description and desired capabilities based on the robotic payload are covered in the following sections:

3.4.1 Electrical Power Systems (EPS)

The RSV bus provides power generation, distribution, fault management, and storage services for the bus subsystems. The RSV bus provides both operational and survival power feeds for the RSV payload. The current RSV payload EPS point design is responsible for power conditioning, fault management, and distribution to the payload subsystems, although functions like power conditioning could be performed by the bus. The RSV bus will also need to operate the bus and payload on stored energy for some mission phases, to the equivalent of 300 AHr. The RSV bus provides power to the payload in the range of 30-34 V and contains the Single Point Ground (SPG) for the RSV. **This voltage range is essential for operation of the FREND arm.**

3.4.2 Command, Telemetry and Data Handling (CT&DH)

The RSV bus CT&DH system should provide the capability to monitor the bus state of health and control bus subsystems and payload survival heaters. The bus CT&DH system should provide a timing source for the RSV and provide the command/telemetry interface for the RSV payload to the Ground Segment. The current point design for the bus/payload data exchange is a full duplex differential clock and data interface for ground commands and telemetry, a second full duplex differential interface for commands and responses between the bus and payload for on-board control purposes, and a unidirectional differential clock and data interface for high-speed mission data. Both command and telemetry/response circuits are not expected to exceed a 2 Mbps data rate with actual ground command data rates in the 10 kbps range. The high-speed mission data interface is expected to be a minimum of 10 Mbps. The payload has implemented a SpaceWire network that supports Logical Addressing and RMAP. The payload would entertain an approach where the three interface types identified above could be implemented as part of the SpaceWire network. If not practical, the differential interfaces would be expected to be Low-Voltage Differential Signaling (LVDS) or 422. 1553 is not a desirable option.

Encryption is not expected on any of these three interfaces between the bus and the payload. Encryption is expected between the bus and ground for all three interfaces. It is possible that a shared command authentication process could exist across the bus/payload interface.

Payload ground commands and telemetry may share forward and return communications links with the bus ground commands and telemetry data or could support a dedicated forward/return link if available. Payload command, telemetry, and wideband formats will conform to Consultative Committee for Space Data Systems (CCSDS) recommendations.

The payload will include a truly redundant communications interface to the bus. The RSV bus design should have a primary/redundant CT&DH architecture that complements the RSV payload’s primary and redundant CT&DH point design. The payload design will tolerate a “hot-hot,” “hot-cold,” or “hot-warm” redundancy architecture across the bus-to-payload interface.

3.4.3 Communications and Tracking (C&T)

The RSV bus should provide all communications subsystems for the RSV. The RSV will be required to have continuous communications with ground segments during critical operations for all missions.

Highly desirable capabilities include:

- An uplink during robotic operations of 10 kbps
- A downlink during robotic operations of 10 Mbps
- Encryption of uplink and downlink signals

3.4.4 Propulsion System(s)

The RSV bus propulsion system can use chemical and/or electric propulsion. The propulsion system must be sized to account for the entire mission lifetime, which includes orbit transfer from GTO to GEO (if required based on the launch vehicle), orbit maintenance, RSV activation and checkout, RSV demonstration mission(s), commercial/Government missions (lifetime), and a retirement maneuver out of GEO.

The propulsion system must be sized accordingly to be able to perform RPO as described in Section 3.3 with attention to minimizing pluming of the Client during proximity and grapple/ungrapple operations.

3.4.5 Guidance, Navigation, and Control

The RSV must be three-axis stabilized with an attitude knowledge requirement of 0.05 degrees, attitude control of 0.25 degrees, and an absolute orbit knowledge of hundreds of meters. The bus should carry the relative navigation filter, which receives pose estimates from the RSV payload during RPO at a rate of 1-5 Hz (and returns a 5 Hz filtered pose to the Payload).

For RPO, the payload will provide bearing data to the bus relative navigation filter at a rate of 1 Hz from a range of 160 km to 1 km for a Client rendezvous and 20 km to 1 km for POD system rendezvous. It will provide three-dimensional position data to the bus relative navigation filter at a rate of 5 Hz from a range of 1 km to 100 m, and it will provide six-dimensional position data to the bus at a rate of 5 Hz from a range of 100 m to grapple.

The envisioned concept of operations requires that:

- The RSV be able to maintain RPO sensors orientation on Client while inside of 1 km
- The bus be able to follow way-point trajectories to an accuracy of ~ 1 m (TBR), 3 sigma, in any direction
- The RSV be able to maintain an attitude accuracy ~ 0.1 deg (TBR), 3 sigma, in any direction
- The bus be able to match rates of a Client, with a tumble rate of up to 0.5 deg/sec based on the pose provide by the payload, to within 0.1 (TBR) degree/sec
- The bus be able to establish a relative approach velocity to the Client of 1-2 cm/s
- The bus be able maintain its relative position inside of a position grapple box (20 cm x 20cm x 10cm) and its relative attitude inside of an attitude grapple box (4 deg x 4 deg x 4 deg) within 2m (TBR) of a Client.
- The bus be able to limit translation of the grapple arm base in the position grapple box to <3 mm/s (TBR).
- The bus be able to limit the rotation rate relative to the attitude grapple box to less than~ 0.2 deg/s (TBR)
- The bus can disable (or inhibit) attitude control during grapple operations, upon notification from the payload.

- The bus can execute an autonomous withdrawal upon receipt of command from the payload mission manager
- The bus be able to null any mated stack rates of < 0.5 deg/s (TBR) within 10 minutes (TBR)
- The bus be able to maneuver the mated stack (RSV/Client) to any orientation within 10 minutes
- The bus provide GPS capability for the RSV

3.4.6 Thermal Control System (TCS)

The current assumption is that the payload passes 1,000 W of thermal energy to the bus. Alternative designs of the payload are feasible with no payload-to-bus thermal energy transfer, but at the cost of increased payload mass. The RSV notional design assumes that the bus provides switched power feeds for payload survival heaters and processes survival temperature sensors (~50 PRT and ~32 thermistors). The payload is able to draw survival power during all RSV modes of operations and mission phases.

3.4.7 Mechanical System

An acceptable RSV bus would be able to accommodate a robotic payload in one of the two notional configurations described in Section 3.5. The bus also needs to support payload integration and test in multiple orientations.

3.4.8 Mission Management Flight Software

It is envisioned that mission manager functions will be shared between the bus and payload. The development of this interface will be a critical task for the partnership. The bus Mission Manager will monitor the operational status of the bus and payload in support of mission activities and will reside on the RSV bus.

The Partner-developed bus mission manager provides a configurable multifunction Fault Detection, Isolation and Recovery (FDIR) capability that coordinates the bus and payload FDIR. The RSV mission management function will be capable of scheduling and coordinating mode transitions and activities on the bus and/or payload. The bus Mission Manager is a vehicle level function that responds to requests for action from both the bus and payload, as well as responding to the presence of both bus and payload faults. The bus mission management function will provide status to the bus and payload in support of mission activities.

3.5 Payload Description and Capabilities

The NRL-developed robotic payload is intended to enable high-value servicing activities for years of servicing missions by the Partner following the demonstration phase. The design practices being used, the quality of components, and the design tolerance against single faults should easily result in a five-year to eight-year payload mission life. The Government intends to have the payload fully integrated and tested, and ready for integration with the bus, in Q2FY20.

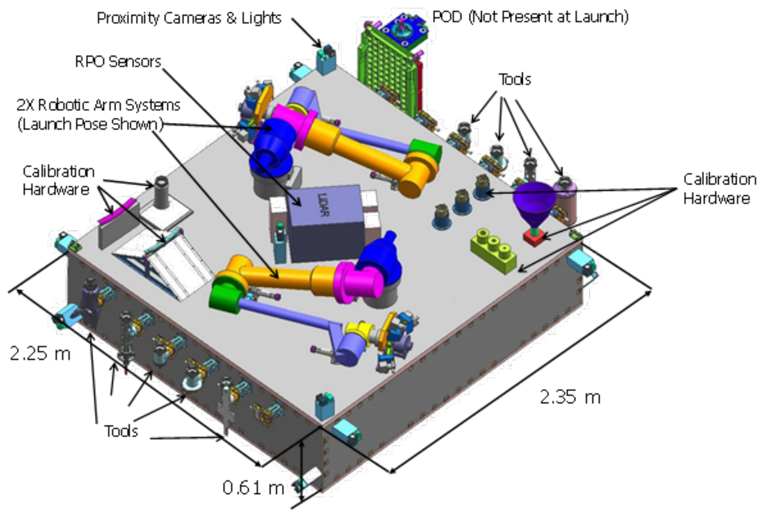
The robotic payload is designed to use high-bandwidth and low-latency/low-jitter communications during servicing operations. It can be operated in scripted, supervised autonomous, and tele-operated modes. Robotic tasks for servicing missions will use the safest combination of these modes. The payload layout (e.g., component/tool layout, robotic arm layout, proximity awareness cameras, etc.) is designed to optimize servicing situational awareness and has fault responses integrated with a payload mission manager (which interfaces with the bus Mission Manager, as noted above).

The Robotic Arm System (RAS) is designed for safe operations with unexpected loss of communications. It includes compliance control to minimize forces imparted on contact with Clients. The RAS is used in concert with machine vision algorithms to safely execute critical mission functions (e.g., grappling a Client). During robotic servicing operations, slow, controlled movements with high position certainty are used to ensure safety. The payload mission manager is designed for safety by controlling fault responses for the payload based on environmental and task context (e.g., proximity to Client, pre-grapple, post-grapple).

The payload is being designed to comply with the following top-level requirements:

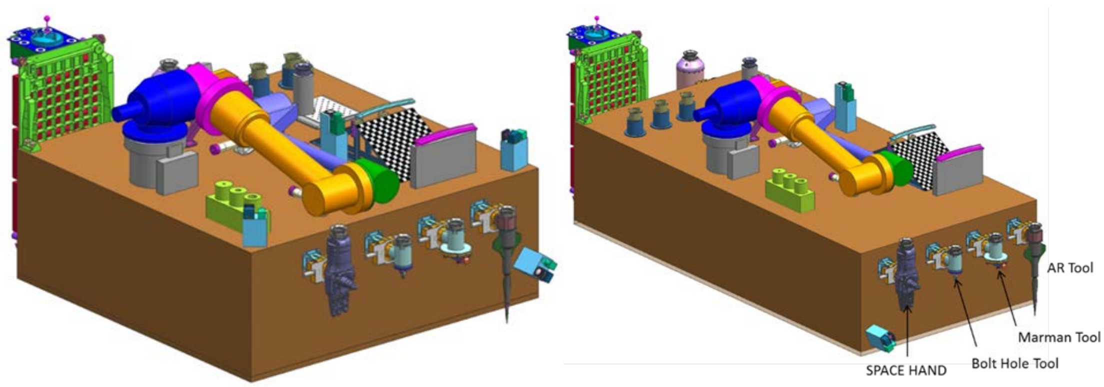
- It is based on FREND robotic technologies
- It is being designed to a DoD Class B Mission
    - Block redundant Robotic Arm Systems (for two-arm RAS)
    - Block redundant avionics
    - Block redundant relocation mission tools (first grapple tools)
    - Functional or block redundant RPO sensors
    - Robotic arm design allows for graceful degradation to arm faults
    - 100 krad/Level 2 Parts per EEE-INST-002
- An on-orbit checkout, commissioning, and demonstration period of nominal 6-9 months duration
- Coordinated control between the Client and RSV operations teams
- The payload will be able to grapple Liquid Apogee Engine (LAE), bolt hole, and Marman ring interfaces on GEO Clients
- The RSV will be able to perform an autonomous grapple/ungrapple of GEO Clients, as well as autonomous abort/withdrawal if anomalous conditions are detected by the payload and/or bus mission manager
- The RSV Payload will use a proto-qualification verification test program

A schematic layout of the point design for the payload can be seen in Figure 3-6. The baseline version is a two-arm system. A one-arm system is shown in Figure 3-7, as an alternative payload configuration that could be incorporated into an RSV design.



Payload baseline, 2.3m x 2.4m x 0.6m

Figure 3-6. RSV Payload Layout (two-arm)



Notional A, 1.6m x 1.6m x 0.6m　　Notional B, 2.4m x 1.2m x 0.6m

Figure 3-7. RSV Payload Layout (one-arm), Notional A and Notional B (Dimensions LxWxH)

The payload has the following components in the two-arm and one-arm versions:

- The two-arm FREND robotic payload consists of:
  - Two (2) FREND MKII Robotic Arm Systems
    - Two (2) FREND Arms
    - Two (2) sets of FREND Arm control electronics (each with two (2) filter boxes and one (1) motor controller box)
    - Two (2) End-of-Arm systems, each of which includes:
      - Tool changer
      - Three (3) (TBR) panchromatic cameras and lights
      - End-of-Arm Control Board (EACB)

  - Payload CT&DH system consisting of two (2) Robotic Processor Modules and six (6) Common Remote Electronics
  - Payload EPS consisting of six (6) power distribution boxes
  - RPO suite to be defined in conjunction with the Partner, but nominally consisting of one (1) LIDAR pose sensor, one (1) Wide Field of View (WFOV) visible camera, one (1) Narrow Field of View (NFOV) visible camera, and one (1) Infrared (IR) camera
  - Nine (9) Tools (Marman Grapple Tool (quantity 2), Bolt Hole Grapple Tool (quantity 2), Liquid Apogee Engine Grapple Tool (quantity 2), Anomaly Resolution Tool (quantity 1), POD system Capture Tool (quantity 1), and Spacehand (quantity 1))
  - 12 tool holders – One for each tool plus one for POD system storage, one for a spare tool, and one open
  - One (1) Color Camera and one (1) Proximity Awareness System (PAS) consisting of 10 panchromatic cameras
  - Four (4) PI (full sky coverage) Situational Awareness Sensor
  - An active close-proximity illumination system consisting of RPO lights, PAS lights, and End-of-Arm lights.
  - FREND Flight Software that provides payload functionality, autonomous grapple functions, teleoperations control support, and bus-to-payload control interface support.

- The one-arm FREND robotic payload consists of:
  - One (1) FREND MKII Robotic Arm System
    - One (1) FREND Arm
    - One (1) set of FREND Arm control electronics (each with two (2) filter boxes and one (1) motor controller box)
    - One (1) End-of-Arm system
      - Tool changer
      - Three (3) (TBR) panchromatic cameras and lights
      - End-of-Arm Control Board (EACB)
  - Payload CT&DH system consisting of One Robotic Processor Module and Three Common Remote Electronics
  - Payload EPS consisting of three (3) power distribution boxes
  - Five (5) Tools (Marman Grapple Tool, Bolt Hole Grapple Tool, Anomaly Resolution Tool, POD system Capture Tool, and Spacehand)
  - Six (6) tool holders – One for each tool plus one for POD system storage
  - One (1) Color Camera and four (4) Proximity Awareness System (PAS) panchromatic cameras
  - Four (4) PI Situational Awareness Sensor

- An active close-proximity illumination system consisting of RPO lights, PAS lights, and End-of-Arm lights.
- FREND Flight Software that provides payload functionality, autonomous grapple functions, teleoperations control support, and bus-to-payload control interface support.

These configurations are the key elements of the NRL/DARPA payload and are described in Sections 3.5.1 through 3.5.7 below. Section 3.5.8 describes some circumstances in which flexibility in the payload components may be entertained. It should be emphasized that the full set of RSV missions described in Section 3 is non-tradeable.

3.5.1 FREND Robotic Arm

The FREND Mark II robotic arm for RSGS is currently under development by MDA U.S. Systems LLC's Space Division located in Pasadena, CA. The FREND Mark II robotic arm is an upgraded version of the original FREND robotic arm, incorporating the lessons learned from multiple years of testing the original FREND robotic arm. These FREND robotic arms are 2-meter class, 7 degree-of-freedom robotic arms designed to operate both in the harsh conditions of GEO and in the 1G environment on Earth. The ability to test the flight robotics on the ground is rare for orbital robotics, but is key, as it permits end-to-end system testing to best be able to predict on-orbit performance before launch. With power-off brakes, a 500 Hz command rate, 5 Hz stiffness, and better than ±1 mm positional accuracy at the end of the arm, the FREND arm is designed for safe, flexible, and reliable operations at GEO.

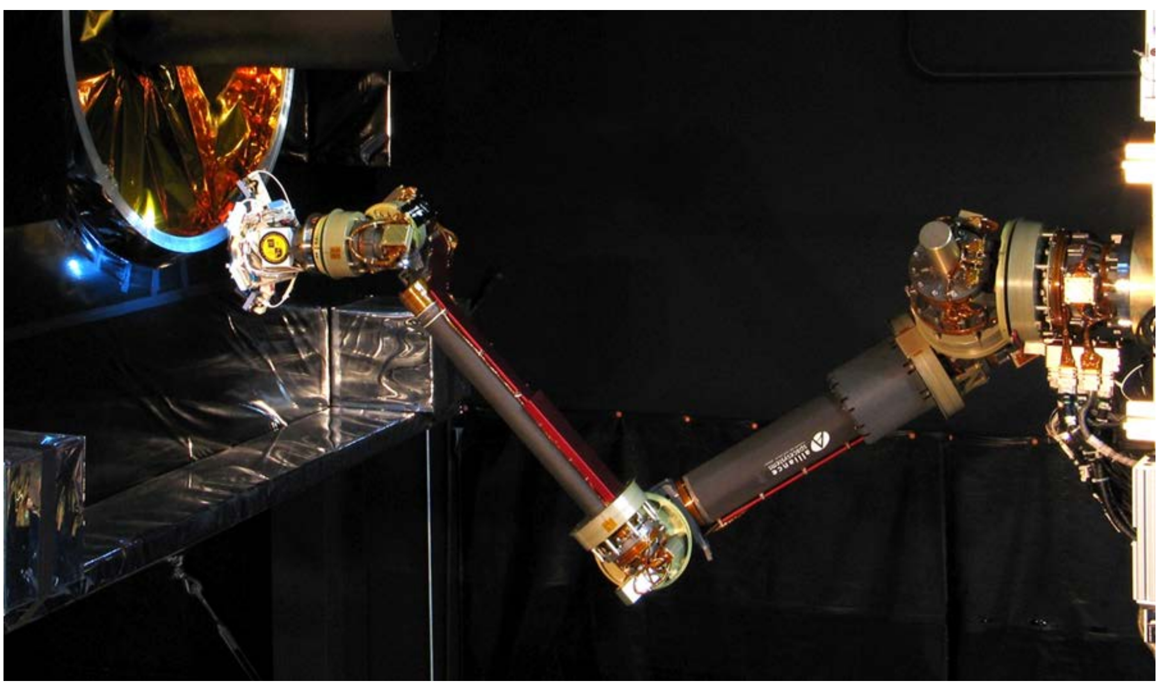


Figure 3-8. FREND Flight Prototype Grapple Testing at NRL

3.5.2 Robotics Payload Flight Software

The robotic control algorithms and flight software are an invisible yet vital component of the space robotics system. NRL engineers have spent over a decade developing the robotic controls necessary to safely operate the FREND robotic arms on-orbit. This software includes a high-level payload mission manager that can carry out scripted, tele-operated, partial, or fully autonomous robotic operations, depending on what the right operations mode is for the wide range of operations that the RSGS mission will be performing on-orbit. Fault Detection, Isolation, and Recovery is included in the payload mission manager, providing a system for using all available on-board data to safely respond to any off-nominal information. This telemetry is also used by the RSV (or RSV bus) mission manager to evaluate and respond to vehicle-level faults. The robotic arm trajectory planner is also included in the on-board processing to safely plan arm operations while avoiding all obstacles in the robotic workspace, as are Cartesian and joint-angle compliance control to limit loads on both the Client and the robotic arm system during coupled operations and machine vision processing that identifies and tracks key features to guide the robot arm during servicing operations. This on-board software suite is designed to constantly verify safe payload operations and is being tested extensively with the spaceflight robotics. Finally, this software also includes CT&DH functionality, such as real-time command and telemetry processing, command sequence handling, time-tagged command handling, thermal and power control of payload electronics, and mass memory unit management.

3.5.3 Robotics End-of-Arm System

The tip of the FREND robot arm provides a rotary tool drive, force-torque sensor, and power/data connectivity. To best perform the tasks needed for a multi-mission servicer, NRL has developed an end-of-arm system which facilitates flexible operations for a variety of servicing tasks. The system includes a tool changer, currently under development by Oceaneering Space Systems of Houston, TX. The end-of-arm also includes task lights, multiple cameras, and necessary control electronics to interface with the FREND robot arm. NRL has procured both a prototype and an engineering model tool changer that have been extensively tested with the FREND arm. This tool changer includes mechanical and electrical interfaces so that tools can be positively locked to the arm. The design also includes a Common Receptacle Subassembly (CRS), which is the interface for all of the tools that will be used by the FREND robot arms (note that the definition of a standard interface to the FREND arm also permits the acceptance of tools delivered post-launch, for example from POD system). This system passes electrical power and data to the tools as well as the torque from the FREND rotary tool drive and is designed to work on a wide range of tool types. Also at the end of the robot arm are the cameras and lights required for visual servo arm control and close-up inspections. These cameras and lights will be used for on-board-processed machine vision feature tracking and will also provide imagery to ground controllers for tele-operated tasks. Design trades and analysis are underway for the flight cameras and lights that can meet the RSGS mission areas. Each robot arm will have multiple lights and cameras to provide operational and functional redundancy. An NRL-developed end-of-arm control board will integrate these functions, provide signal conditioning for the force/torque sensor, digital control of the end-of-arm cameras, lights, and tool changer, and provide control switching between the camera and tool sources.

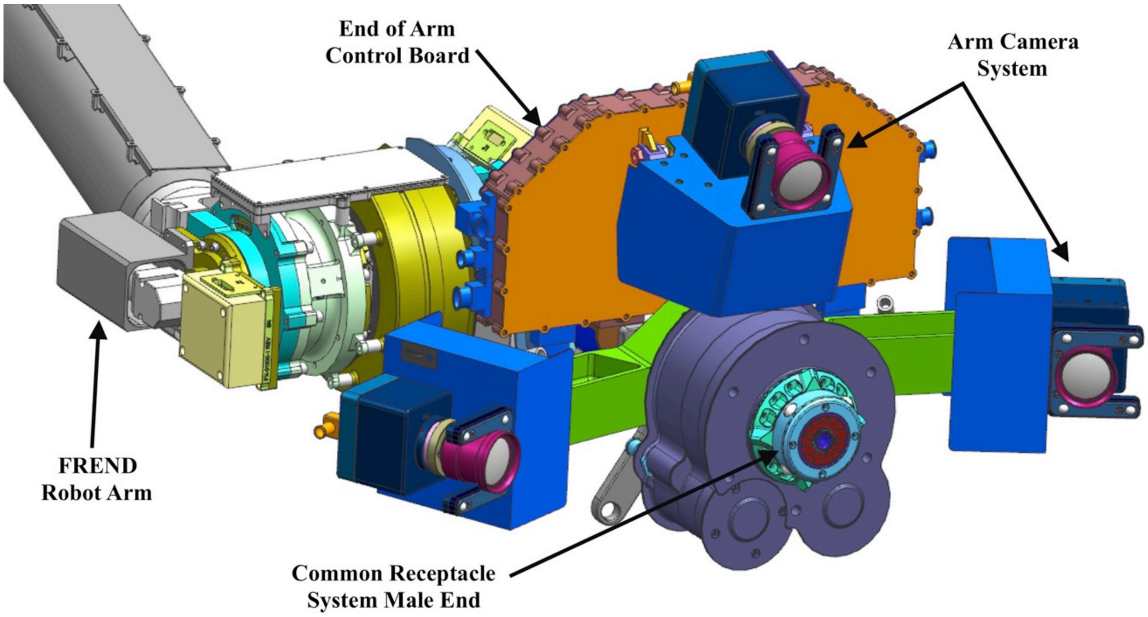


Figure 3-9. Preliminary Design of End-of-Arm System

3.5.4 Robotics Tool Suite

Tools to perform the RSGS mission areas have been a key area of development at NRL. During the SUMO/FREND phases of the development, NRL in-house prototype tools were directly mounted to the end of the FREND robotic arm. During the Phoenix phase of the technology development, numerous prototype tools and a tool changer were procured. The tools have been laboratory tested both on and off the FREND robotic arm, and their performance has been compared against the new requirements developed for the RSGS missions. The tools in the current baseline design for RSGS are:

A. Marman Ring Tool: Designed to provide the initial grapple of the Marman band, the Client's interface to its launch vehicle. While there is some variety in the Marman bands that exist on spacecraft operating at GEO, it is expected that a single tool will be able to encompass the entire range of GEO Marman bands.

B. Bolt Hole Tool: Designed to provide the initial grapple of the launch vehicle interface when the Client was attached to its launch vehicle via explosive bolts. The cup-cone interface has a feature with a round circular hole on the client satellite, and this tool will be able to grip the inner wall of this feature.

C. Liquid Apogee Engine Tool: Designed to provide the initial grapple interface to the client satellite via a probe inserted into the bell of the LAE on Clients for which a Marman ring or bolt hole grapple is not available or desirable.

D. POD system Capture Tool: A tool designed in tandem with a grapple fixture specifically designed for POD system capture. The grapple fixture would be installed on a POD system pre-launch to provide additional design and operational margin for docking with a relatively low mass object, taking advantage of the fact that for POD system resupply launches, RSGS can design both sides of the interface. The POD system Capture tool brings design heritage from the Orbital Express mission.

E. Spacehand: A four-finger humanoid-shaped hand under development by the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) Institute for Robotics and Mechatronics in Oberpfaffenhofen Germany. This tool will remain the property of DLR and post-demo use of Spacehand would require negotiation with DLR.
F. Anomaly Resolution Tool: A conceptual tool that would able to apply carefully controlled forces and torques to provide deployment anomaly resolution services.

All of the above tools support DARPA’s RSGS mission requirements. All of the tools would be fitted with a CRS (as described above) to interface with the FREND arm’s tool changer and will be provided with a launch lock/stowage mechanism (described below) to support both launch loads and storage while on-orbit. Prototypes of most of these tools have been developed, and final flight tool design is expected to begin in the near future. Alternate tool developments may be undertaken by agreement of the Partners.

3.5.5 On-board Support Components

A multitude of on-board support components have been evaluated as part of the ongoing RSGS payload design to provide a variety of support functions. Requirements have been analyzed for all, and some initial prototypes are currently under development. Alternate developments of these support components may be undertaken by agreement of the Partners. Included amongst the key support components are:

A. Tool holders: Provide a standard launch lock and on-orbit restraint and release system to structurally mount tools to the RSV. The tool holder design will be required to provide both mechanical and electrical connectivity to the RSV for both elements launched with the RSV and elements resupplied on-orbit. The RSV payload is planned to launch with spare tool holders to provide on-orbit repositioning flexibility and to support future on-orbit resupply.
B. Proximity Awareness System: The PAS consists of a number of payload body mounted cameras (not yet selected) along with a TBD sensor system to provide 4π steradian monitoring around the entire RSV. The body-mounted cameras will provide a wide range of payload monitoring, mission monitoring, and inspection capabilities and are expected to include both panchromatic and color cameras that can be recorded on-board and provided to the ground in near real-time. The 4π sensor is in design to provide enhanced safety monitoring around the full RSV. This PAS is designed to both provide necessary operational data to ground controllers and enhance overall mission situational awareness and safety.
C. Rendezvous and Proximity Operations sensor suite: The RPO sensor suite requirements are currently under detailed review at NRL and DARPA. Through past solicitations, NRL and DARPA have come to understand that there are a variety of solutions available from commercial industry. The selection and implementation of the RPO sensor suite is tradeable based upon the Partner’s

RPO solution. For this reason, RSGS has not made an RPO sensor suite final selection. An RPO suite is baselined to be part of the two-arm payload option and would include a LIDAR system, a wide field of view camera, a narrow field of view camera and an infrared camera.

3.5.6 Robotics Payload Avionics

NRL has begun development of the robotics control avionics to ensure this critical system is both flight-ready for payload integration and can support ongoing developmental testing for the FREND robotic arms in flight-like scenarios. The robotics payload avionics will interface with the bus, processing uplinked command packets that are received from the ground through the bus communications system as well as collecting and formatting telemetry packets for transmission to the ground from the robotics payload. This avionics system includes the FREND robotic arm motor controller system (under development by Moog Broad Reach), the Robotic Processor Module (RPM), the payload power distribution unit, and distributed control electronics under direct development by NRL.

The RPM consists of two fully redundant units, each with a backplane motherboard with mass memory unit, custom gateway router bridge, multiple identical single board computers, and the power supply card. NRL is also developing a set of Common Remote Electronics (CRE) that will be instantiated in multiple places through the payload. These CREs enable a distributed command and telemetry system, each of which will control interfaces to the many similar interfaces that exist on the robotics payload to the distributed sensors and mechanisms, including the FREND robotic arms, PAS cameras, RPO sensor suite, tool holders, and launch locks, providing connectivity back to the primary RPM. The payload avionics are being designed to support safe and redundant processing operations while being reprogrammable to enable new mission areas that may not even have been contemplated before the RSGS system is operating on-orbit.

The power distribution system consists of two fully-redundant Payload Power Interface Units (PPIUs) that interface with the bus power feeds and fan out power to the rest of the power distribution system. Two High Power Distribution Units (HPDUs), one associated with each robotic arm system, provide power to the arm motors and end-of-arm electronics. Two Low Power Distribution Units (LPDUs) provide power to the other payload avionics, including the PAS sensor and RPO sensors.

3.5.7 Ground Support Systems

Concurrent with the development of the robotics payload, NRL is also developing the mission simulation, planning, and execution capabilities needed on the ground. As controlling a multiple degree-of-freedom robotic servicing mission is very different from most spacecraft operations, a new ground station control capability is needed. Development is underway at NRL on an Integrated Robotics Workstation (IRW) that will provide the RSV robotic operations team with the planning, analysis, situational awareness, and operations systems needed for safe and efficient on-orbit mission execution. This IRW includes various user interface tools needed for the robotic planning and analysis console suite. This software suite allows analysis, ground rehearsals, and flight operations to be performed on a common toolset and will be included with the Payload. NRL is performing all FREND mission development, testing, and validation operations in the laboratory using this IRW interfaced to a simulated ground station running NRL's Neptune ground station control software. Thus, laboratory testing already underway at NRL is being executed, in part, with the same ground station control software that is already in use in multiple operational satellite operations centers.

3.5.8 Modified or De-scoped Payload and Expanded Mission Set

DARPA understands that it may be desirable to fly a modified payload to augment a commercially promising payload in development by the Partner. The point design layout described above is subject to Partner negotiation, as there may be design layouts that more efficiently integrate the payload with the Partner's bus. It may also be desirable to only fly a de-scoped payload (such as a single FREND robot arm with the full FREND autonomous and tele-operations capabilities set, or a reduced tool suite). DARPA is open to learning about novel concepts that integrate the payload, or a subset of the payload, with commercial solutions for an expanded set of on-orbit mission capabilities. Such concepts must still be capable of performing the mission objectives of Section 3.1.

Table 3-1. Mass/Power Maximum Values for Payload Options

Parameter	Two-Arm Payload	One-Arm Payload
Mass	1,000 kg	500 kg
Payload Operational Voltage	30-34V	30-34V
Average Operational Power	3kW	2kW
Peak Operational Power*	5kW	3.3kW
Average Survival Power	1.5kW	650 W
Peak Survival Power	3.3kW	1.4kW
*Peak power duration <30sec for autonomous grapple operations		

3.6 Ground Segment

The Ground Segment for the RSGS program must support RSV servicing operations for the entire GEO ring. It will need to support RSV bus and payload operations as well as planning, training, and execution of servicing missions. With the exception of the robotic planning and analysis console suite described in Section 3.5.7, the Partner is expected to provide the Ground Segment.

The Ground Segment will require a real-time interface with the Client owner/operator to coordinate, plan, and execute all RSV servicing operations in coordinated control.

The Ground Segment should support training and mission engineering support with high-fidelity mission simulators and hardware-in-the-loop test facilities.

The Ground Segment will have a critical role in providing Information Assurance and cybersecurity for the mission. It must provide for secure collection, distribution, and storage of imagery.

The Partner should describe how the RSV operations team will be trained and certified. The flight control team and engineering support team(s) should work in tandem to contribute to mission success.

As an RSGS-related activity, DARPA is interested in stimulating the development of standards and best practices for current and future servicing missions in GEO. The GEO satellite operations community is critical to the evaluation and planning of potential servicing opportunities. They provide an independent source for identifying and evaluating safety concerns for potential servicing opportunities. Potential servicing customers would work with the RSV operations team to coordinate real-time RPO and would be key in evaluating the state of health of their Client before and after servicing operations. DARPA intends to facilitate the development of an established set of norms and standards and a process for information exchange on topics such as:

- Debris assessment
- Space weather
- GEO spacecraft in the “servicing area”
- Ephemeris notification of maneuvers
- Real-time voice communications

The Partner would be expected to support the development of such standards and best practices.

It is expected that the Ground Segment portion of proposals include a mission operations center (MOC) that addresses all of the needs for RSV servicing operations along with a complementary radio frequency (RF) communications plan and infrastructure that enables full GEO coverage.

4 SELECTION PROCESS

DARPA will follow a four-step process in selecting the RSGS Partner. Step 1 will be the eligibility determination phase (via executive summary), Step 2 will be the proposal submittal and development of the negotiation pool phase, Step 3 will be oral presentations and negotiations phase, and Step 4 will be the final evaluation (of the revised proposal) and award phase. The selection process is displayed pictorially in the figure below.

Figure 4-1. RSGS Partner Selection Process

Increased levels of teaming commitment will be required throughout the selection process. For the initial phase when submitting the Executive Summary, a preliminary understanding of the team structure and letters of interest from potential teaming arrangements (that complete a team to address all items listed above) will be required to be considered for selection. Final teaming agreements will be required prior to final selection and OT signature. The final OT must be signed by all key team members, specifically including the bus manufacturer, the RSV owner, and the RSV operator.

All Executive Summary submissions and any follow-on Proposal submissions must be in the following format: All pages shall be 8-1/2 by 11 inch with type not smaller than 11 point and page margins > 0.75”. Smaller font and page margins <0.75” may be used for figures, tables and charts. The page limitation for proposals includes all figures, tables, and charts. All submissions must be written in English.

Classified information must be submitted as an addendum to the submittal document and will count against any page limitation. Do not send any classified information via any means other than the appropriate methods outlined in Section 5.

During any time after the submission of Executive Summaries, the Government reserves the right to request clarifications, if needed, and to conduct communications with any or all submitters, if needed, at any point in the evaluation process. The Government reserves the right to make award(s) without prior communications with any proposers. The Government is under no obligation to request a clarification, and proposers have the responsibility of clearly articulating all aspects of their submissions.

4.1 Step 1: Executive Summary Submission and Eligibility Determination

The Executive Summary submissions are due by **5 p.m. ET, July 5, 2016**. Failure to submit an Executive Summary before the submission timeframe closure will disqualify you from any further participation in the proposal submission process.

4.1.1 Submission Eligibility

To the extent consistent with 10 U.S.C. § 2371b, DARPA's intends to select an RSGS Partner which will enhance the national security, economic competitiveness, and space capabilities of the United States. The following entities may submit an Executive Summary under this solicitation: any entity organized under the laws of the United States or of a State, which is:

A. More than 50 percent-owned and controlled by United States nationals; or
B. A subsidiary of a foreign company and the Secretary of Transportation finds that:

    (i) Such subsidiary has in the past evidenced a substantial commitment to the United States market through –

    a. Investments in the United States in long-term research, development, and manufacturing (including the manufacture of major components and subassemblies); and

    b. Significant contributions to employment in the United States; and

    (ii) The country or countries in which such foreign company is incorporated or organized, and, if appropriate, in which it principally conducts its business, affords reciprocal treatment to companies described in subparagraph A comparable to that afforded to such foreign company's subsidiary in the United States, as evidenced by –

    a. Providing comparable opportunities for companies described in subparagraph A. to participate in Government sponsored research and development similar to that authorized under 42 U.S.C. Chapter 141, Commercial Space Opportunities and Transportation Services.

b. Providing no barriers, to companies described in subparagraph A. with respect to local investment opportunities, that are not provided to foreign companies in the United States; and

c. Providing adequate and effective protection for the intellectual property rights of companies described in subparagraph A.

4.1.2 Proposal Selection Eligibility

To be considered eligible for further consideration beyond the Executive Summary stage, the Executive Summary must:

A. Include a U.S. space industry team member that has built spacecraft that have successfully operated in GEO;
B. Include an approved corporate plan for teaming, financing, execution and follow-on operations; and
C. Demonstrate the ability to comply with ITAR regulations and other legal requirements with respect to any non-U.S. entities on the team, which will perform technical portions of the design and manufacturing effort, or participate in operations.

The full Partner team, no later than the submittal of the signed OT, must in addition:

D. Include a team member with significant past performance in spacecraft rendezvous and proximity operation systems design;
E. Include a team member with significant past performance in spacecraft operations, that will staff, train for and execute follow-on operations; and
F. Include a U.S. corporation that will have ownership of the spacecraft at time of launch, and which will assume liability and obtain insurance for on-orbit operation.

The entire builder-owner-operator team does not need to be identified in the Executive Summary. The Executive Summary must demonstrate a preliminary understanding of the team structure and include letters of interest from potential teaming arrangements (that complete a team to address all items listed above) to be considered for selection. The letters of interest will not count against the **15-page limit** and should be an attachment to the Executive Summary.

4.1.3 Executive Summary Submission Format

All Executive Summary submissions must include a coversheet and official transmittal letter.

The coversheet must include:

(1) Program Solicitation (PS) number (DARPA-PS-16-01);
(2) Organization(s) submitting;
(3) Submitter's reference number (if any);
(4) Type of organization for each organization in the proposal;
(5) Technical points of contact to include: salutation, last name, first name, street address, city, state, zip code, telephone, electronic mail;
(6) Administrative points of contact to include: salutation, last name, first name, street address, city, state, zip code, telephone, electronic mail;
(7) Date of submission.
(8) Organization(s) DUNS Number(s)
(9) Organization(s) CAGE Code(s)

The **15-page** executive summary should describe the prominent and distinguishing features of the RSGS mission, including details that address the following areas:

- A vision for commercial robotic servicing, including near- and long-term possibilities using advanced robotics provided by the Government payload
- An overview of the top-level capabilities of the provided spacecraft bus
- A clear definition of what portions of the Government-provided payload are used in the servicing vehicle (number of arms, number of tools supported, RPO sensors)
- An overview of how the Government-provided payload will be integrated onto the proposed bus
- An overview of how the bus supports payload interfaces, including: structural, thermal, power, and communications interfaces
- An overview of the ground segment including mission operations center, operator training, ground networks, and ground stations
- A description of a successful DARPA demonstration and transition to commercial satellite servicing operations
- An overview of the business plan that supports commercial satellite servicing operations
- An overview of the valuation method anticipated to determine the consideration equivalent to the value of the payload.
- An overview of any key partnerships required for the offer to be successful
- An overview of key technical and programmatic challenges for the mission
- Confirmation of eligibility

4.1.4 Executive Summary Evaluations

The Government will examine the Executive Summaries to determine initial eligibility of each submitter. The Government will then evaluate only those that meet the submission eligibility criteria and assess the overall capability of the participant's ability in meeting the requirements and goals in the solicitation. Submitters will be notified approximately 10 working days after submission as to whether or not they will proceed further in the process. Eligible submitters will be provided a supplementary data package that includes ITAR-restricted information related to the robotic payload, a draft OT for Prototypes Agreement template, and other information that will support the development of strong proposals. Submitters determined to be ineligible at this stage will receive notice of being eliminated from the competition and will receive no further information from the Government.

4.2 Step 2 – Proposal Submission/Evaluation and Negotiation Pool Development

Eligible proposal submitters will have no less than 45 calendar days from notification to submit a full proposal. The Government will specify the submission time and date in the notification of proposal eligibility. The proposal shall have a not to exceed **200-page** limit consisting of an updated executive summary and two volumes, a technical description and a business and management plan. The page count does not include the coversheet, any transmittal letter, and any appendixes such as the completed OT template.

DARPA policy is to treat all submissions as source selection information as defined by 41 U.S.C. § 2101(7), and to disclose the contents only for the purpose of evaluation. Restrictive notices notwithstanding, during the evaluation process, submissions may be handled by support contractors for administrative purposes and/or to assist with technical evaluation. All DARPA support contractors performing this role are expressly prohibited from performing DARPA-sponsored technical research and are bound by appropriate nondisclosure agreements.

NOTE: Proprietary Information

Proposers are responsible for clearly identifying proprietary information in their proposals. Submissions containing proprietary information must have the cover page and each page containing such information clearly marked.

4.2.1 Proposal Submission Format

The proposal formatting is as follows:

The coversheet must include:

(1) Program Solicitation (PS) number (DARPA-PS-16-01);
(2) Organization(s) submitting;
(3) Submitter’s reference number (if any);
(4) Type of organization for each organization in the proposal;
(5) Technical points of contact to include: salutation, last name, first name, street address, city, state, zip code, telephone, electronic mail;
(6) Administrative points of contact to include: salutation, last name, first name, street address, city, state, zip code, telephone, electronic mail;
(7) Date of submission.
(8) Organization(s) DUNS Number(s)
(9) Organization(s) CAGE Code(s)

4.2.1.1 Executive Summary (15-Page Limit)

Resubmit the Executive Summary updated to include the proper teaming arrangement and any other revisions that correspond to the information within the rest of the proposal.

4.2.1.2 Volume I - Technical Description Section (75-Page Limit)

This section shall describe the proposer's system concept approach, performance specifications, mission compatibility, development, manufacturing, test and verification, operator certification, technical risks, safety, and mission assurance. Proposers are asked to propose concepts that satisfy as many of the performance goals discussed in Section 3 of this solicitation as possible. Where those requirements and/or performance goals will not be satisfied in the responding organization's plan, the proposal shall clearly articulate the limitations where and why they will not be met. Innovations and efficiencies should be discussed throughout this section where appropriate. The subsections of the technical section are as follows:

T1. System Concept and Summary of Performance

The proposer shall describe the servicing vehicle system architecture, capabilities, features, system and performance specifications, and concept of operations for the targeted capabilities. Provide RSV conceptual design, including bus and payload subsystem functional allocations and overall RSV integrated capabilities to support the DARPA demonstration mission and commercial servicing missions. **The bus builder must be identified**. For existing bus designs, describe bus modifications (hardware and software) required to accommodate the GFE payload and satisfy DARPA's demonstration mission and commercial servicing missions. Provide a top-level concept of payload accommodation. Identify any capabilities described in Sections 2 and 3 of this solicitation from which the proposer proposes to deviate and the rationale for deviation. If the full two-arm robotic payload is not desired, clearly describe which portions of the payload are included in the RSV concept and which portions are not included. Specifically, identify an RPO approach, assuming the provision of RPO sensor information as described in Section 3. Address how the provided bus is expected to perform the entire DARPA baseline mission set and support all payload interfaces, including structural, thermal, power, and command and telemetry interfaces. The proposer shall describe any expected impacts to the GFE payload by the bus implementation, including hardware/software design and operations. If alternative or additional payload items are proposed, the proposer shall describe how the item(s) will benefit the Government's strategic goals described herein and the proposer's long-term commercial servicing business case, as well as the impact on the existing payload specification and operations concept.

T2. Mission Compatibility and Performance Analysis

The proposer shall describe the servicing vehicle system's expected compatibility with the targeted RSGS Servicing Capabilities (Section 3.1). The proposer shall provide a RSV C&T Plan with details on licensing and operations approach for servicing Clients at any location in GEO. They shall also provide proposed RSV operations for GTO to GEO transfer, servicing calls, quiescent operations (between service calls), and end of life retirement plan. The proposer shall also include the intended nominal Client servicing frequency and estimated number of missions achievable by the RSV over its lifetime.

T3. Development

The proposer shall describe the elements of the system that are either already operational or commercially available and elements that are under development or to be developed, including an indication of the Technology Readiness Level (TRL) for each of those elements. This includes both ground and space segments.

For development elements, describe work completed to date, including modeling results, prototypes, sub-component tests or any other relevant work pertaining to the proposed system. Also describe the technical approach for bringing the concept in its current state to a full-scale system ready for flight demonstration and commercial operations.

T4. Manufacturing

The proposer shall describe the approach for manufacturing the proposed bus, including an understanding of major deviations from the standard manufacturing line used for their GEO products.

T5. Bus to Payload Integration

The proposer shall describe the proposed approach for integration of the bus with the GFE payload. Identify where integration will take place, discuss the expected duration of the integration, and discuss expected Government support during integration.

T6. Test and Verification

The proposer shall describe the approach for functional and environmental testing and for verifying the performance of the servicing vehicle system before initial operational capability.

T7. Ground Segment Approach and Operator Certification

The proposer shall describe any existing ground infrastructure that can be brought to bear for both the DARPA demonstration and the follow-on commercial business plan as well as any proposed development of additional ground segment facilities. The proposer shall provide a description of a proposed ground segment approach that addresses operation of the servicer throughout the GEO belt. Proposed training and staffing plan to support all on-orbit phases should be provided. The proposer shall describe the proposed approach for verifying and certifying that operators can safely operate the on-orbit robotic servicing vehicle. Identify any relevant existing guidelines from space, maritime, military, or other regimes. The proposer shall describe any early design choices that should take operator considerations into account, including hardware/software design and operations.

T8. Technical Risks

Describe the technical risks associated with the effort along with a strategy to mitigate each risk.

T9. Safety and Mission Assurance (S&MA)

The proposer shall describe the approach for safety (range, ground, flight, etc.), reliability, maintainability, supportability, quality, software assurance, and risk management. The discussion may include S&MA organization, including subcontractors, processes, tasks and products.

Specifically discuss an information assurance and cyber security approach deemed appropriate for servicing United States Government space assets. Space systems have been traditionally viewed as isolated simple data systems with limited processing capabilities and code. Further, space systems have also been viewed as too complex for outsiders to understand and penetrate. The reality is that space systems are complex extensions of other networks with complex computing environments (multiple processors, multiple classification levels) and complex software environments that can be modified on orbit. These traditional systems are at great risk for information loss and cyber-attacks. The Department of Defense sees significant risk in this area and has adopted rigorous Cyber Security & Information Assurance requirements as required by DODD 8500.01 and DoDI 8510.01. Further, the DoD sees space systems as an extension of ground systems and requires space systems (per DoDI 8581.01) to meet DODD 8500.01 and DODI 8510.01 requirements. Given these considerations, the proposer should describe their approach to information assurance and cyber security through the life of the program. Please provide rationale about options for how you will demonstrate GEO Robotic Servicing cyber security robustness to a potential U.S. Government satellite customer that may wish to contract for servicing. This rationale should take into account:

- The cyber security posture that DoD is adopting for new space systems
- Any anticipated use of legacy commercial components and subsystems that utilize hardware and software from second and third parties
- The desired encryption approach

4.2.1.3 Volume II - Business and Management Plan (110-Page Limit)

This section shall describe the proposers approach to a joint management structure with the Government during the development phase as well as the plan for multi-year on-orbit spacecraft servicing operations to the GEO market (United States Government and other customers). To address this market, the proposer will determine whether to provide a business plan for the entire corporation, for a division within the corporation, or for a joint venture formed for the express purpose of implementing a robotic space servicing enterprise. It is expected that larger companies will provide a division business plan focused specifically on the space servicing market. Voluminous detail is not desired; rather a clear picture of how the organization will initiate, finance, manage and grow this business. The subsections of the business plan section are as follows:

B1. Organization Information

The U.S. Government’s objectives in requiring the following “Organization Information” is (1) to ensure that the proposer has all capabilities (including access to financing) necessary to develop and demonstrate the RSGS system, (2) to ensure that the proposer has the business and market stability required to sustain the RSGS system and provide cost stability for many years during the operational phase after demonstrations are complete, (3) that ownership and liability are clearly established for demonstration and operations phases, and (4) that the proposer has a well-developed plan for the success and growth of satellite servicing as an industry.

A. Business Strategy

The proposer shall describe the core aspects of its business strategy that will enable it to be successful in developing this market.

B. Market

The proposer shall define and describe the market to which it will provide services, including size, target customers, and needs of these customers. The market should include customers other than the United States Government. Where appropriate, the market can be segmented into smaller sections for clearer analysis. Include data obtained from potential customers.

C. Products and Services

The proposer shall describe in a roadmap the attributes of the services that it will provide to its targeted market and the timing for the introduction of these services. This shall include a description of their plan to grow the market, the size of the servicer fleet over time, and an estimate of the time-phased investments required to realize this plan.

D. Competitor Analysis

The proposer shall describe the apparent strengths and weaknesses of competitors in the chosen markets.

E. Marketing and Sales

The proposer shall describe the plan for marketing and selling organization services to targeted markets. The growth of business for the servicer will be solely the responsibility of the owner once the on-orbit demonstration is complete.

F. Governance Structure

The proposer shall provide information on the decision-making structure that impacts the organization’s continuation in future years. For public companies, this will include financial-return expectations. For private companies, this will include the composition of the board of directors as well as an explanation of corporate covenants that impact the decision-making process. For other organizational types (joint venture, consortium, etc.) provide the analogous information.

G. Management Team

The proposer shall identify its top-level management team and key personnel for this effort, including a description of the reporting structure, biographical information, history of relevant experience and business ventures, and professional references for each.

H. Finance

The proposer shall provide a financial plan that is consistent with Sections A through G listed above. This shall describe future financing events required to achieve positive cash flow including the timing, amount, structure and sources. The proposer shall also describe, to the extent known and allowable, any other material information that will impact future financing events, including but not limited to, litigation, convertible debt provisions, sale-lease back covenants, and preferred stock terms.

The proposer shall discuss the number, type and phasing by fiscal year of servicing activities that are desired to be procured by the United States Government to support the financial plan after launch of the RSV. Recognizing that such contracts are solely at the discretion of the United States Government, the proposer shall describe the sensitivity and impacts to their financial plan of the United States Government's servicing procurements.

The following annotated statements consistent with the financial plan described above are examples of business data that will assist DARPA in evaluating the Partner's plans as outlined in section Appendix 2 Supplemental Business Data:

1) Historical income statement (prior three years or life of the organization, whichever is shorter)
2) Historical sources and uses of cash (prior three years or life of the organization, whichever is shorter)
3) Historical balance sheets (prior three years or life of the organization, whichever is shorter)
4) Historical statements of stockholder's equity (prior three years or life of the organization, whichever is shorter)
5) Historical financing events, including notations explaining material terms that impact valuation or future financing events
6) Pro forma income statement (looking forward five years)
7) Pro forma sources and uses of cash (looking forward five years)
8) Pro forma balance sheet (looking forward five years)
9) Pro forma statements of stockholder's equity (looking forward five years)

B2. RSGS Development and Demonstration Plan

A. Plan and Schedule

The proposer shall provide a plan and schedule for developing and demonstrating the RSGS capabilities to support a launch in late 2020 or early 2021. The Government intends to have the payload fully integrated and tested, and ready for integration with the bus, in Q2FY20. Include a discussion of programmatic risks and strategies to mitigate each risk.

B. Resources

The proposer shall describe key resources such as personnel, facilities and other assets, including intellectual property currently owned and yet to be obtained. The use and/or need of Government resources shall be provided in this section of the proposal.

C. Teaming Arrangements

The proposer shall describe teaming arrangements including respective roles and contributions to the project. A list of all partners and suppliers shall include name, address, country of incorporation, and contact name and phone number. Provide a brief description of any previous experiences working with these partners and suppliers. If foreign participation is included in the proposal, the proposer shall describe the critical elements of the foreign content, an assessment of supplier risks, and any alternatives or mitigation of the identified risks. The proposer shall also describe a process for protecting and exporting (as appropriate) United States Government Furnished Equipment and Information involved in the development of the servicing vehicle and associated support infrastructure.

D. Performance Milestones

The proposer shall provide a proposed schedule of performance milestones for the servicing vehicle development and build, including descriptive title, objective success criteria, rationale, and planned achievement dates (month and year). Milestones should represent the progress of significant technical and/or business development events in the demonstration program. At least one milestone per calendar quarter should be proposed. The milestones described here will be required and incorporated within the proposed OT submitted in accordance with the selection process. Some milestones should reflect the accomplishment of specific prototype demonstration objectives, which establish detailed capabilities for the RSV. Identify progress payment milestones and proposed payment amounts.

B3. RSGS Operational Readiness Plan

The proposer shall describe their approach to offer operational RSGS services, including the most likely best case and worst case operational readiness date with assumptions. The proposer shall describe their approach to mitigate any limitations to the availability of on-orbit spacecraft services to customers, including the United States Government, during the operational life of the RSV. The proposer shall describe their approach to optimize the activities of the servicer during the servicer's operational life.

B4. Compliance

The proposer shall describe compliance with eligibility requirements and applicable federal laws, regulations, and policies specified in the solicitation.

B5. Cost and Price Information

The proposer shall address the following cost and price information and provide them as outlined in Appendix 2 of the proposal:

- C1 - Proposed Government Services, Facilities or Equipment – RSV Development
- C2 - Estimate of Partner total cost in development phase
- C3 - Proposed Government Services, Facilities or Equipment - Operational
- C3 - Estimate of annual operations costs
- C4 - Projected Operational Prices for services

The information provided in the templates shall be consistent with the financial information requested in Section B1.H.

4.2.1.4 Appendix 1: Proposed Other Transaction Agreement

DARPA will award an OT agreement under the authority of 10 U.S.C. § 2371b. Participants are reminded that this process does not involve the procedures set forth in the Federal Acquisition Regulation (FAR), since this solicitation will not result in the award of a FAR-based procurement contract.

The proposer shall provide a proposed OT agreement using the draft OT template included as part of the supplemental package of this solicitation. Any proposed changes to the draft OT template by the proposer shall be highlighted and rationale provided for the proposed change.

The OT for Prototype approach, authorized by 10 U.S.C. § 2371b, provides considerable flexibility in the structure of the agreement between the Government and its commercial partner. However, there are certain non-tradeable responsibilities that the Government expects its partner in the RSGS program to accept. Proposers should be fully aware of and committed to these responsibilities before responding to this solicitation. These responsibilities will include:

1. The Partner shall assume liability for the on-orbit operation of the RSV, including third-party liability, maintaining appropriate insurance throughout the operational lifetime of the RSV.
2. The Partner shall participate in Government-sponsored activities for the development of safety standards for on-orbit servicing.
3. The Partner shall maintain the appropriate level of personnel security for its operations team required to service sensitive U.S. Government spacecraft, throughout the operational lifetime of the RSV.

4.2.1.5 Appendix 2: Supplemental Business Data

Proposers shall provide the supplemental financial data specifically requested in the Proposal Content description under Section B1.H, Finance, and the cost and price data specifically requested in B5, Cost and Price Information. The supplemental data to be provided in this appendix shall be limited to the items specifically requested and shall not include additional information.

4.2.2 Proposal Evaluations

The purpose of the agreement negotiations is to obtain the best partnership arrangement possible and will involve questions about the business, technical, and financial aspects of the proposals; questions about DARPA involvement/requirements; and finalization of the terms and conditions of the Agreement for each organization whose proposal was selected for negotiations.

The Government will conduct an initial evaluation of proposals in order to limit the number of proposals for further negotiations to those deemed the most advantageous. The basic approach will be to make a success-oriented selection, examining both technical success (i.e., the ability to manufacture, integrate, and operate an advanced robotic servicing vehicle) and business success (i.e., the plans, commitment and innovation required to establish and grow an efficient robotic servicing enterprise). All information provided in the proposal will be evaluated, including the executive summary (which may be edited for the proposal submission), business plan, technical approach and financial information. In addition, DARPA reserves the right to assess relevant information available outside of the proposal. The bus builder must be a party to the full proposal. Qualified proposals will be evaluated by a team of experts in this field to identify the proposal's strengths and weaknesses against the evaluation criteria outlined in this solicitation. Based on these findings, a subset of the submitted proposals will be selected for detailed review, site visits, and follow-on discussions. The Government reserves the right to choose all, some or none of the proposals for further negotiations and oral presentations.

The evaluation factors and sub factors include (not ordered or weighted):

4.2.2.1 Technical Description

- Consistency, heritage and supportability of overall approach: Extent to which proposed bus solution retains heritage from reliable bus solution and yet consistently meets RSGS objectives. Extent to which modifications to bus can be designed and bus delivered on RSGS timeline. Extent to which proposed solution is consistent with business approach.

- Rendezvous and proximity operations solution: Extent to which RPO solution has heritage from past/present RPO sensors, control approaches, and operational practices. Extent to which RPO approach relies upon available hardware and software solutions. Extent to which RPO approach is consistent with RSGS objectives.

- Communications solution: Ability of proposed communication solution to obtain required spectrum and to operate in proximity to client satellites without causing electromagnetic interference or damage to client receivers. Ability of proposed communication solution to operate continuously during all phases of RSGS operations. Ability of proposed bus to accommodate proposed communication solution.

- Information and cyber security: Ability of infosec and cyber approaches to assure mission performance in a cyber contested environment.

- Mission assurance approach: Mission assurance approach is consistent with RSGS objective of multi-year operations. Ability to achieve program schedule while implementing proposed mission assurance plans and procedures.

- Payload accommodation approach on proposed bus: Analysis of payload impact on proposed bus, including structure, mass, moment of inertia, thermal, electrical, and control. The degree to which proposed bus has considered and evaluated alternative payload accommodation schemes compared to baseline single-module payload.

- Propulsion solution: Ability of proposed propulsion solution to achieve multiple servicing missions. Ability of proposed solution to provide adequate thruster authority during proximity operations. Ability to minimize pluming of client satellite. Maturity of propulsion solution.

- Mission planning and simulation: Ability of proposer's simulation environment to execute high fidelity mission simulations including robotic actions. Ability of mission planning capability to support efficient planning of servicing missions with short lead times.

- Attitude control solution: Ability of attitude control system (ACS) to provide adequate control authority during joined vehicle maneuvers (via propulsion system, wheels, sensors). Maturity of ACS solution. (or ADCS)

- Expertise of technical team: Past performance and expertise in: rendezvous and proximity operations; satellite design, manufacture and operations; bus-to-payload integration; launch campaign support; agile software development; commercial space operations and business practices; government GEO space operations and procedures; information and cyber security.

- Mission operations center: Ability of proposed ground solution to incorporate robotic payload operations. Ability to support efficient RPO and servicing operations, including integration with NRL-developed Integrated Robotic Workstation.

- Ground station and network solution: Ability to provide 360 degree coverage of GEO belt, consistent with proposed communications solution. Analysis of time delays resulting from network infrastructure. Ability to provide cyber secure operations.

4.2.2.2 Business and Management Plan

- Long range vision for space servicing: Consistency of long range vision with corporate capabilities and proposed RSGS solution. Extent to which economic analysis supports long range vision. Growth potential of long-range vision and ability to address national security and commercial interests.

- Investment strategy: Extent to which out year plan for investment results in stable, persistent servicing capability. Extent to which strategy includes assessments and decision points relevant to investment timing. Extent to which investment strategy will promote growth of servicing market.

- Financing terms: Ability of financial approach to support delivery of all required RSGS products on schedule. Extent to which term sheets have been obtained for all external financing. Extent to which internal financing has been approved by Board of Directors.

- Liability and insurance: Extent to which proposer has interacted with insurers to explore rates and terms. Extent to which proposer's liability plan will advance the acceptance of space servicing by commercial space operators.

- Customer outreach: Comprehensiveness of proposer outreach plan for establishment and growth of space servicing market.

- Management approach, plan and schedule: Extent to which management plan will support an effective partnership for design, development and demonstration of RSGS. Extent to which proposed schedule will support RSGS timeline. Extent to which management plan will support prompt resolution of emergent technical issues. Ability of partnership communication plan to maintain ideal partnership functionality.

- Market analysis: Extent to which the market analysis is consistent with long range vision, investment strategy, and financing.

- Servicing road map and servicer fleet growth: Extent to which servicing road map and growth plan are consistent with long range vision, investment strategy, and financing.

- Satellite design transformation: Ability of proposed servicing approach to influence design of future GEO satellites. Ability of team to affect satellite design and requirements. Ability of team to communicate advantages of transformed satellite designs to customers.

- Assured Government terms for servicing missions: Extent to which business case depends upon Government business for sustainability, and what terms are required to achieve sustainability. Extent to which proposers have held discussions with Government customers to establish servicing needs. Extent to which proposers have developed conceptual servicing missions and payloads to address projected Government requirements.

- Desired teaming approach and terms: Extent to which team decision process supports execution of RSGS program. Extent to which terms of the proposed Other Transactions agreement support RSGS objectives, corporate objectives, and long-term development of space servicing.

Approximately 20 business days after proposal submissions, the Government will notify proposal submitters whether or not they have been selected to participate in oral presentations and detailed negotiations.

4.3 Step 3 – Oral Presentations and Negotiations

Teams selected for further discussions and negotiations will establish timeframes for a series of visits by the Government evaluation team for discussions and negotiations at Partner sites. These oral presentations will be conducted over the three months following notification of continuation into this next stage of evaluation. The technical and management topics for the oral presentations will be provided as part of the supplemental information package and two topics are anticipated to be discussed each month. In parallel, the Government will negotiate the proposed terms and conditions of each proposed OT agreement.

4.4 Step 4 – Final Selection and Award

The final step of the process will be for the proposing team to submit a final revised proposal and a negotiated OT agreement signed by the team's builder, RSV owner, and RSV operator. **The builder, owner, and operator (which may be one, two or three firms) must be signatories of the OT agreement and parties in the final revised proposal**.

The Selection Authority will make the final selection after the completion of negotiations based on the proposal evaluation factors previously identified to make a best value determination. Based on the proposal evaluations and the availability of funding for the RSGS effort, an award will be made to the potential Partner whose proposal is determined to be the most advantageous to the Government. This evaluation and award period is anticipated to complete within 20 business days. The Agreements Officer will send successful/unsuccessful award notifications by via Electronic Mail to the Technical and Administrative POCs identified on the proposal coversheet. Work will commence after the parties execute the program agreement under the OT. It is DARPA's objective to announce the selection of the RSGS Partner by the end of January 2017.

5 PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

5.1 Unclassified Submission Instructions

DARPA will employ an electronic upload submission system (https://baa.darpa.mil/) for receipt of both the UNCLASSIFIED Executive Summaries and Proposals submitted under this solicitation. Email submissions will not be accepted.

First time users of the DARPA Submission Website must complete a two-step account creation process at https://baa.darpa.mil/. The first step consists of registering for an Extranet account by going to the above URL and selecting the "Account Request" link. Upon completion of the online form, proposers will receive two separate emails; one will contain a user name and the second will provide a temporary password. Once both emails have been received, proposers must go back to the submission website and log in using that user name and password. After accessing the Extranet, proposers must create a user account for the DARPA Submission Website by selecting the "Register Your Organization" link at the top of the page. The DARPA Submission Website will display a list of solicitations open for submissions. Once a proposer's user account is created, they may view instructions on uploading their proposal.

Proposers who already have an account on the DARPA Submission Website may simply log in at https://baa.darpa.mil/, select this solicitation from the list of open DARPA solicitations and proceed with their proposal submission. Note: Proposers who have created a DARPA BAA Submission Website account to submit to another DARPA Technical Office's solicitations do not need to create a new account to submit to this solicitation.

All submissions submitted electronically through DARPA's Submission Website must be uploaded as zip files (.zip or .zipx extension). The final zip file should contain only the files requested herein and must not exceed 50 MB in size. Only one zip file will be accepted per submission. Note: Submissions not uploaded as zip files will be rejected by DARPA.

Please note that all submissions MUST be finalized, meaning that no further editing will be possible, when submitting through the DARPA Submission Website in order for DARPA to be able to review your submission. If a submission is not finalized, the submission will not be deemed acceptable and will not be reviewed.

Website technical support may be reached at Action@darpa.mil and is typically available during regular business hours (9:00 AM – 5:00 PM ET, Monday-Friday). Questions regarding submission contents, format, deadlines, etc., should be emailed to DARPA-PS-16-01@darpa.mil.

Since proposers may encounter heavy traffic on the web server, they should not wait until the day proposals are due to request an account and/or upload the submission.

Proposers are warned that submission deadlines as outlined herein are strictly enforced. DO NOT WAIT UNTIL THE LAST MINUTE TO FINALIZE YOUR SUBMISSION.

5.2 Classified Submission Instructions

Classified materials must be submitted in accordance with the guidelines outlined herein and must not be submitted electronically by any means, including the electronic web-based system, as described above. Classified submissions must be transmitted per the classification guidance provided by the DoD Information Security Manual (DoDM 5200.1, Volumes 1-4) and the National Industrial Security Program Operating Manual (DoDM 5220.22-M). If submissions contain information previously classified by another OCA, proposers must also follow any applicable Security Classification Guidelines when transmitting their documents. Applicable classification guide(s) must be included to ensure the submission is protected at the appropriate classification level.

a. Confidential and Collateral Secret Information

Classified information at the Confidential or Secret level must be submitted by one of the following methods:

- Hand carried by an appropriately cleared and authorized courier to DARPA. Prior to traveling, the courier must contact the DARPA Classified Document Registry (CDR) at 703-526-4052 to coordinate arrival and delivery.

Or

- Mailed by U.S. Postal Service Registered Mail or Express Mail.

All classified information will be enclosed in opaque inner and outer covers and double wrapped. The inner envelope must be sealed and plainly marked with the assigned classification and addresses of both sender and addressee. The inner envelope must be addressed to:

Defense Advanced Research Projects Agency
ATTN: Robotic Servicing of Geosynchronous Satellites
Reference: DARPA-PS-16-01
675 North Randolph Street
Arlington, VA 22203-2114

The outer envelope must be sealed without identification as to the classification of its contents and addressed to:

Defense Advanced Research Projects Agency
Security and Intelligence Directorate, Attn: CDR
675 North Randolph Street
Arlington, VA 22203-2114

b. Top Secret (TS) Information

TS information must be hand carried, by appropriately cleared and authorized courier(s), to DARPA. Prior to traveling, the courier(s) must contact the DARPA CDR at 703-526-4052 for instructions.

c. Special Access Program (SAP) Information

SAP information must be transmitted by approved methods only. Prior to submission, contact the DARPA Special Access Program Control Office at 703-526-4052 for instructions.

d. Sensitive Compartmented Information (SCI)

SCI must be transmitted by approved methods only. Prior to submission, contact the DARPA Special Security Office at 703-526-4052 for instructions.

5.3 Frequently Asked Questions

All administrative correspondence and questions on this solicitation, including requests for information on how to submit a proposal, should be directed to: DARPA-PS-16-01@darpa.mil. DARPA will provide a consolidated Question and Answer document to proposers before Executive Summaries are due. In order to receive a response to a question, submit questions by June 24, 2016.

DARPA intends to use electronic mail for correspondence regarding DARPA-PS-16-01. DARPA encourages use of the Internet for retrieving the solicitation and any other related information that may subsequently be provided.

6 OTHER ADMINISTRATION INFORMATION

Assuming the receipt of one or more suitable proposals, the Government reserves the right to select for negotiation all, one, or none of the proposals received in response to this solicitation.

6.1 Solicitation Objections

Any objections to the terms of this solicitation or the conduct of receipt, evaluation, or award of agreements must be presented in writing within ten (10) calendar days of (1) the release of this solicitation, or (2) the date the objector knows or should have known the basis for its objection. Objections should be provided in letter format, clearly stating that it is an objection to this solicitation or to the conduct of evaluation or award of an agreement, providing a clearly detailed factual statement of the basis for objection. Failure to comply with these directions is a basis for summary dismissal of the objection. Letters of objection should be sent to the Agreement Officer:

Mark Jones
Agreements Officer
675 North Randolph Street
Arlington, VA 22203-2114
Mark.Jones@darpa.mil

6.2 Anticipated Reports, Meetings and Travel Requirements

The number and types of reports will be proposed and specified in the OT. The reports shall be prepared and submitted in accordance with the procedures contained in the award document and mutually agreed on before award. Because there is a large expenditure of public funds by the Government, even though most of those funds are not transferred to the Partner, the proposer is encouraged to propose frequent and detailed reporting of their progress. Similarly the Government will provide detailed progress reports to the Partner on payload development, launch vehicle selection, and other matters as appropriate on at least a quarterly basis to maintain a collaborative working relationship.

Partners should anticipate regular program-wide meetings and periodic site visits to NRL and the Partner's location throughout the life of the program. DARPA and the Partner should regularly participate in each other's progress and management reviews. The suggested approach to meetings and travel requirements should be outlined in the proposal.

6.3 Public Release or Dissemination of Information

Research to be performed as a result of this solicitation is expected to be Non-fundamental. DARPA permission must be received before publishing any information or results relative to the program. Other restrictions may also apply.

Partners are advised that, as an OT is the anticipated agreement, the language in that agreement will include the requirement for DARPA permission before publishing any information or results on the program and will be considered Restricted Research.

6.4 Agency Contacts

Administrative, technical or contractual questions should be sent via e-mail to DARPA-PS-16-01@darpa.mil. All requests must include the name, e-mail address, and phone number of a point of contact.

7 RSGS ACRONYMS AND INTELLECTUAL PROPERTY DEFINITIONS

7.1 Acronyms

Acronym	**Definition**
AKM	Apogee Kick Motor
C&DH	Command and Data Handling
C&T	Communications and Tracking
CCSDS	Consultative Committee for Space Data Systems
CDR	Critical Design Review
CFR	Code of Federal Regulations
CMD	Command
CONOPS	Concept of Operations
CRADA	Cooperative Research and Development Agreement
CRE	Common Remote Electronics
CRS	Common Receptacle System
CT&DH	Command, Telemetry and Data Handling
DARPA	Defense Advanced Research Projects Agency
DLR	Deutsches Zentrum für Luft- und Raumfahrt
DoD	Department of Defense
DoDD	DoD Directive
DoDI	DoD Instruction
EACB	End-of-Arm Control Board
EAR	Export Administration Regulations
EPS	Electrical Power Systems
EVA	extra-vehicular activity.
FAR	Federal Acquisition Regulation
FDIR	Fault Detection, Isolation and Recovery
FREND	Front-end Robotics Enabling Near-term Demonstration
GEO	Geosynchronous Orbit
GFE	Government Furnished Equipment
GN&C	Guidance, Navigation, and Control
GPR	Government Purpose Rights
GTO	Geostationary Transfer Orbit
HPDU	High Power Distribution Units
HW	Hardware
Hz	Hertz
ICD	Interface Control Document
I&T	Integration and Test
IP	Intellectual Property
IR	Infrared
IRW	Integrated Robotics Workstation
ISS	International Space Station
ITAR	International Traffic in Arms Regulations
Kbps	Kilo-bits per second
Krad	Kilorad
LAE	Liquid Apogee Engine
LEO	low Earth orbit

LIDAR	Light Detection and Ranging
LPDU	Low Power Distribution Unit
LV	Launch Vehicle
LVDS	Low-Voltage Differential Signaling
Mbps	Mega-bits per second
MDA	MacDonald, Dettwiler and Associates
MKII	Mark 2
MOC	Mission Operations Center
NFOV	Narrow Field of View
NRL	Naval Research Laboratory
NTE	Not To Exceed
OT	Other Transaction
PAS	Proximity Awareness System
PDR	Preliminary Design Review
POC	Point Of Contact
POD	Payload Orbital Delivery
PPIU	Payload Power Interface Units
PRT	Platinum Resistance Thermometers
PS	Program Solicitation
RAS	Robotic Arm System
RF	Radio Frequency
RFP	Request for Proposal
RPM	Robotics Processing Module
RPO	Rendezvous and Proximity Operations
RSGS	Robotic Servicing of Geosynchronous Satellites
RSO	Resident Space Object
RSV	Robotic Servicing Vehicle
SRR	System Requirements Review
SUMO	Spacecraft for the Universal Modification of Orbits
SW	Software
TBD	To Be Determined
TBR	To Be Reviewed
TCS	Thermal Control System
TLM	Telemetry
TRL	Technology Readiness Level
TTO	Tactical Technology Office
U.S.C.	United States Code
US	United States
WFOV	Wide Field of View

7.2 Intellectual Property Definitions

"Data**"** means recorded information, regardless of form or method of recording, which includes but is not limited to, technical data, software, maskworks and trade secrets. The term does not include financial, administrative, cost, pricing or management information.

"Government purpose" means any activity in which the United States Government is a party, including cooperative agreements with international or multi-national defense organizations, or sales or transfers by the United States Government to foreign governments or international organizations. Government purposes include competitive procurement, but do not include the rights to use, modify, reproduce, release, perform, display, or disclose technical data for commercial purposes or authorize others to do so.

"Government purpose rights" means the rights to—

> (i) Use, modify, reproduce, release, perform, display, or disclose data within the Government without restriction; and
>
> (ii) Release or disclose data outside the Government and authorize persons to whom release or disclosure has been made to use, modify, reproduce, release, perform, display, or disclose that data for United States government purposes.

"Limited rights" means the rights to use, modify, reproduce, release, perform, display, or disclose data, in whole or in part, within the Government. The Government may not, without the written permission of the party asserting limited rights, release or disclose the data outside the Government, use the data for manufacture, or authorize the data to be used by another party, except that the Government may reproduce, release, or disclose such data or authorize the use or reproduction of the data by persons outside the Government if—

> (i) The reproduction, release, disclosure, or use is—
>
> > (A) Necessary for emergency repair and overhaul; or
> >
> > (B) A release or disclosure to—
> >
> > > (*1*) A covered Government support contractor in performance of its covered Government support contract for use, modification, reproduction, performance, display, or release or disclosure to a person authorized to receive limited rights data; or
> > >
> > > (*2*) A foreign government, of data other than detailed manufacturing or process data, when use of such data by the foreign government is in the interest of the Government and is required for evaluational or informational purposes;

(ii) The recipient of the data is subject to a prohibition on the further reproduction, release, disclosure, or use of the technical data; and

(iii) The partner or any partner subcontractor asserting the restriction is notified of such reproduction, release, disclosure, or use.