SEAS Task Order Statement of Work (SOW) for LCRD System Engineering Support

Date: ~~June~~August 2020
Task Name: LCRD Systems Engineering Support Statement of Work
Task No. / Mod: 45/~~8~~ 9
Task Monitor (TM): John Staren
Contract number: NNG15CR66C
Contract SOW Reference: FUNCTION 2- IMPLEMENTATION PHASE SERVICES
Extension until April 14, 2021.

I. Scope

a. **Background** – The Laser Communication Relay Demonstration (LCRD) Mission is a Principal Investigator (PI) based research project to develop and demonstrate the feasibility for space-based laser communications. This demonstration mission will chart a course for NASA's operational use of optical communications. The flight segment of LCRD will be a hosted payload on a commercial communications satellite. The LCRD Ground Segment is managed by NASA Code 450.

b. **Summary of work**

The LCRD Mission Systems Engineer (MSE) requires systems engineering expertise to assist in continued implementation and management of various systems engineering processes as defined in the LCRD Systems Engineering Management Plan (SEMP) including requirements management, interface management, and mission-level verification program definition, implementation, and management.

This task includes ~~four~~ five active subtasks; 1) support in developing required project documentation and systems, verification and validation planning activities and 2) subtask ~~in~~ is inactive, 3) support for instrument and mission systems engineering activities, 4) systems engineering support for mission operations, ~~and~~ 5) Mission Integration and Test support, and 6) Information Technology/Information Assurance/Communications Security support.

c. **Required skills/knowledge –**

Subtask-1: Mission Systems Engineering

The subtask-1 contractor personnel should have the following MSE experience and skills:

a. Experience as a Systems Engineer for a flight mission
b. Knowledge of System Engineering Best Practices

c. Communication Systems Engineering Best Practices for ground and flight communication systems
d. Knowledge of Systems Engineering Processes and Requirements
e. Expertise and experience in using DOORS requirements management tool for space flight mission

Subtask-2: Information Assurance

The subtask-2 contractor personnel should have the following MSE experience and skills:

a. Experience as a Systems Engineer for a flight mission
b. Knowledge of System Engineering Best Practices
c. A minimum of a SECRET clearance with a COMSEC endorsement, that covers the engineering activities associated with the design, development, fabrication, test, and operation of government-approved COMSEC equipment.
d. Functional knowledge of digital and analog circuitry along with the ability to use circuit analysis tools such as SPICE to provide independent analysis of suspect circuit failures.
e. A background in Reliability and Survivability is needed so that insight into possible failure modes can be provided.
Subtask 2 will end by April 4, 2018.

Subtask-3: Instrument and Mission Systems Engineering Support

The subtask-3 contractor personnel should have the following MSE experience and skills:

a. Experience as a Systems Engineer for a flight mission
b. Knowledge of System Engineering Processes, Best Practices, and Requirements
c. Communication Systems Engineering experience
d. Requirements verification and validation planning
e. Spacecraft-Instrument interface requirements management expertise

Subtask-4: Mission Operations Systems Engineering Support

The subtask-4 contractor personnel should have the following MSE experience and skills:

a. Experience as an Operations Lead for a flight mission

b. Knowledge of System Engineering Processes, Best Practices, and Requirements
c. Communication Systems Engineering experience
d. Experience in planning and executing mission operation readiness activities.
e. A minimum of a SECRET clearance with a COMSEC endorsement.

Subtask-5: Mission Integration and Test Support

The subtask-5 Mission Readiness Test Lead contractor personnel should have the following experience and skills:

a. Substantial expertise and experience in performing mission (flight and ground) readiness I&T, mission operations, and other mission integration work on space flight projects
b. Mission operations experience
c. Launch and early orbit activities planning experience
d. Implementing and managing mission I&T activities and integrating them into a ground test program.
e. A broad and in-depth knowledge of the MSE process for space flight missions, including an understanding of NASA and GSFC systems engineering directives and GSFC-STD-1000 GOLD Rules.
f. Well-developed organization, leadership, writing, and people skills.
g. A minimum of a SECRET clearance with a COMSEC endorsement.

The subtask-5 Mission I&T Support Engineer contractor personnel should have the following experience and skills:

a. Substantial expertise and experience in performing mission (flight and ground) readiness I&T, mission operations, and other mission integration work on space flight projects
b. Mission operations experience
c. Launch and early orbit activities planning experience
d. Implementing and managing mission I&T activities and integrating them into a ground test program.

A minimum of a SECRET clearance with a COMSEC endorsement.

Subtask-6: Information Technology (IT) /Information Assurance (IA) /Communications Security (COMSEC) Support

~~c.~~ The subtask-4 contractor personnel should be proficient with Systems Engineering, Information Technology, and Information Assurance, and COMSEC development, requirements definition and flowdown, instrument verification, technology readiness levels, etc. Contractor requires TS/SCI Level Security Clearance. Subtask-4 is a continuation of SEAS Task 44, subtask 1.

Formatted: Indent: Left: 0.31", Space After: 10 pt, Line spacing: Multiple 1.15 li, No bullets or numbering

II. Period of Performance

The period during which the work for this task order shall be performed is from task award through ~~October~~ April 14, ~~2020~~2021.

III. Subtask Description

Subtask-1: Mission Systems Engineering

The contractor shall provide system engineering expertise to the LCRD mission system engineer. The contractor candidate shall have experience performing system engineering functions across the system life cycle for NASA and an understanding of NASA System Engineering processes and procedures including NPR 7123.1. In addition the contractor shall have experience and expertise in requirements definition and management, operations concept development, mission architecture development, and system verification and validation.

Support the LCRD MSE in subtask-1 related development activities for the following:

1. LCRD Mission Operations Concept.
2. Maintenance of Level-2 and Level-3 requirements.
3. Support the Flight and Ground element systems engineers in verification of Level-4 requirements.
4. Continue implementation of the LCRD requirements management process. Support the maintenance and implementation of the LCRD System Engineering Management Plan.
5. Provide DOORS support for LCRD.
6. Support mission architecture and operations concept development and maintenance of the Mission ConOps document.

7. Assess Host Spacecraft requirements, architecture, operations concept, and verification plans as they impact LCRD. Represent LCRD in Host Spacecraft forums.
8. Support maintenance of the LCRD technical baseline documents and hierarchy. This includes coordination across the flight and ground elements of the LCRD project.
9. Provide input and assist in preparation of LCRD Flight Operations Review materials and presentations, including updated Mission Systems Engineering Peer Reviews (EPR) if required.
10. Support responses to actions generated at the LCRD reviews.
11. Provide expert insight and oversight to the LCRD Ground Segment design development and integration and test. Support Ground Segment EPRs and activities leading up to the Flight Operations Review.

Subtask-2: Information Assurance

The contractor shall provide information assurance engineering services, including IA and COMSEC services for the payload and mission operations including requirements development, design review, procurement support, and operational implementation. This support includes tailoring of standard national security encryption requirements for LCRD and the development and/or review of required deliverables to meet the national security requirements. Subtask 2 will end by April 4, 2018.

Subtask-3: Instrument and Mission Systems Engineering

The contractor shall provide system engineering expertise to the LCRD mission system engineer. The contractor candidate shall have experience performing system engineering functions across the system life cycle for NASA and an understanding of NASA System Engineering processes and procedures including NPR 7123.1. The contractor shall have expertise in requirements definition and management, system verification and validation, spacecraft-to-instrument interfaces, risk management, and NASA milestone reviews. In addition the contractor shall have experience with instrument development and data relay satellite systems.

The contractor shall support the LCRD MSE in subtask-3 related development activities for the following:

1. Update mission documents in preparation for upcoming system reviews (Flight Operations Review and host reviews)

2. Provide risk assessments of host spacecraft issues and non-conformances as they arise in Integration and Test.
3. Maintain host spacecraft Interface Control Document. Complete verification of requirements assigned to LCRD. Establish expectations for and evaluate verification of requirements assigned to the SV.
4. Serve as technical point-of-contact for LCRD interface to Host spacecraft. Coordinate with contractual lead.
5. Provide payload systems engineering support in evaluating flight systems specifications, procedures, test reports, and risk documentation.
6. Participate in LCRD Risk Management processes.
7. Establish and execute verification and validation plans for mission, payload, and ground requirements. Establishing risk reduction plans by taking advantage of engineering model units in early I&T stages. Serve as the lead Systems Engineer for Integration and Test of LCRD on the Space Vehicle. Prepare the plan for initial testing between the SV and LCRD and for testing LCRD through SV I&T and Launch Site.
8. Prepare presentation material and assist in preparation for system reviews (Pre-Ship Review, Flight Operations Review) and related peer review. Assist in closing requests for actions from system and peer reviews.

Subtask-4: Mission Operations Systems Engineering Support

The contractor shall provide mission operations expertise to the LCRD mission system engineer and Mission Operations Team (MOT). The contractor candidate shall have experience in planning and executing mission operation readiness activities. .

The contractor shall support the LCRD MSE in subtask-4 related activities for the following:

1. Complete development of the Mission Operations Training Plan. Coordinate support for the planned activities. Lead execution of the MOT training.
2. Assist in completing the Mission Operations Plan. Include in the Plan a definition of operations across multiple organizations (LCRD Mission Operations Center, Optical Ground Stations, Host Mission Operations Center). Coordinate operations across those organizations.
3. Lead development of the Transition to Operations Document, defining the plan to transfer knowledge and assets from Development/Integration and Test to Operations.
4. Assist in generating the Mission Operations Team Certification Plan.

5. Define and plan Mission Operations Simulations. Serve as MOS Lead.
6. Prepare presentation material and assist in preparation for system reviews (Flight Operations Review) and related peer review. Assist in closing requests for actions from system and peer reviews.
7. Participate in LCRD Risk Management processes.

Subtask-5: Mission Integration and Test Support

The contractor shall one full-time Mission Readiness Test Lead (MRTL) and one full-time Mission I&T Support Engineer. The contractors are responsible for supporting and witnessing LCRD Payload I&T testing, supporting and witnessing ground readiness testing, and leading, executing, and supporting mission readiness testing between the LCRD Mission Operations Center (LMOC), the LCRD Payload and the STPSat-6 Spacecraft Operations Control Center (SOCC). This scope also includes participating in End-to-End tests (ETE) with the Space Vehicle (SV), and supporting the plans for pre-launch rehearsal simulations. They provide test leadership in mission system testing and in development and execution of Mission Readiness Tests (MRT) and End-to-End Tests with the SV. They shall perform duties under direction of the LCRD Mission I&T Manager and will coordinate with the LCRD Payload Project and LCRD Ground Segment Manager to ensure Level 3 ground requirements are tested and verified prior to performing an MRT.

The MRTL shall provide support in the following areas:

1. Provide continuing assessments of the LCRD mission test program. Coordinate, recommend adjustments, prioritize testing activities and bring forward risks due to testing being de-scoped or experiencing failures during testing. Continually assess and suggest re-prioritization of test activities to maintain schedule and to achieve LCRD objectives.

2. Lead preparations for MRT including coordination with NGIS, JPL, the Mission Operations Team (MOT), LCRD Project Flight/Ground Segments and other mission partner in the preparation and participation of Technical Interchange Meetings (TIMs), working groups (WG), and weekly meetings. Lead and support the development of each of the individual MRT Plans. Support development of MRT sequence of events and procedures. Lead preparations for and conduct Test Readiness Reviews and Post-Test briefings/reviews. Support assessment of test results and development of test out-briefs.

3. Support MRT readiness including; leading Test Integration Working Group (TWIG's) team meetings, scheduling and planning technical interchange meetings, developing and managing detailed test schedules, identifying and tracking test resource availability, preparing for and conducting Test Readiness Reviews and Post-Test Reviews, managing test execution, and developing test reports.

4. Assess results of each Mission Readiness Test (MRT). Support preparations for and participate in the MRT Post-Test Out Brief and Consent to Break/Proceed.

5. Provide support to the STPSat-6 Mission I&T Integrated Product Team (IPT) to plan for and participate in the ETE Tests at the SV/SOCC level.

6. Witness and evaluate the results of Ground Readiness Testing (GRT).

7. Support to the Goddard LCRD Project Office and Mission Systems Engineering to ensure that the Flight/Ground Segments are following GSFC best practices and Gold Rules.

8. Monitor LCRD MOT team training and ensure console operators are properly trained for ICT/MRTs.

9. Support LCRD launch and early orbit (L&EO) planning activities, support to working groups, and understanding of the L&EO Plan, integrated mission timeline (IMT), and mission rules. Integrate concept of operations to ICT/MRT objectives.

10. Assist, as needed, in the planning for LCRD and SV High Bandwidth RF operations -related documents and integrate with ICT/MRT planning.

The Mission I&T Support Engineer shall provide support in the following areas:

11. Provide assessments of the LCRD mission test program. Coordinate, recommend adjustments, prioritize testing activities and bring forward risks due to testing being de-scoped or experiencing failures during testing. Continually assess and suggest re-prioritization of test activities to maintain schedule and to achieve LCRD objectives.

12. Support preparations for MRT including coordination with NGIS, JPL, the Mission Operations Team (MOT), LCRD Project Flight/Ground Segments and other mission partner in the preparation and participation of Technical Interchange Meetings (TIMs), working groups (WG), and weekly meetings. Support the development of each MRT Plan. Support

development of MRT sequence of events and procedures. Lead preparations for and conduct Test Readiness Reviews and Post-Test briefings/reviews. Support assessment of test results and development of test out-briefs.

13. Support MRT readiness including; leading Test Integration Working Group (TWIG's) team meetings, scheduling and planning technical interchange meetings, developing and managing detailed test schedules, identifying and tracking test resource availability, preparing for and conducting Test Readiness Reviews and Post-Test Reviews, managing test execution, and developing test reports.
14. Assess results of each Mission Readiness Test (MRT). Support preparations for and participate in the ICT and MRT Post-Test Out Brief and Consent to Break/Proceed.
15. Provide support to the STPSat-6 Mission I&T Integrated Product Team (IPT) to plan for and participate in the ETE Tests at the SV/SOCC level.
16. Witness and evaluate the results of Ground Readiness Testing (GRT).
17. Support to the Goddard LCRD Project Office and Mission Systems Engineering to ensure that the Flight/Ground Segments are following GSFC best practices and Gold Rules.
18. Monitor LCRD MOT team training and ensure console operators are properly trained for ICT/MRTs.
19. Support LCRD launch and early orbit (L&EO) planning activities, support to working groups, and understanding of the L&EO Plan, integrated mission timeline (IMT), and mission rules. Integrate concept of operations to ICT/MRT objectives.
20. Assist, as needed, in the planning for LCRD and SV High Bandwidth RF operations -related documents and integrate with ICT/MRT planning.
21. Lead Test Planning for Risk Reduction Tests such as the PCR to SSU Test, and the SHIM to Orbital ATK FlatSat Test.
22. Assist in leading the Payload Interface Simulator (PIS) development. LCRD builds the PIS for OATK S/W development on STPSat Flatsat at Dulles. Validates HOST S/C SIM (OATK version). Simulates the SHIM C&T, and PVT interfaces. Accepts simulated encrypted commands, performs selected "functional" response (command count) in telemetry.

Ingests PVT and provides back in tlm. Used for future compatibility test with OATK Flatsat. Validates the OATK provided host S/C sim.

23. Assist in leading the Payload Operational Simulator (POS) development. This is basically a soft bench instantiation, upgrades from the PIS design. Simulates the SHIM and SSU C&T interfaces. Accepts simulated encrypted commands, performs selected "functional" response (via lookup table) representing canned operational modes in telemetry. Ingests PVT and provides back in tlm. Used for future GRT's and MOS's. Copies of the POS may be duplicated and used for MOT training at WSC.

Formatted: Indent: Left: 0.5"

Subtask-6: Information Technology (IT) /Information Assurance (IA) /Communications Security (COMSEC) Support

Formatted: Indent: Left: 0.19", Hanging: 0.06", No bullets or numbering

Formatted: No underline

The contractor shall provide systems engineering support for the IT and IA formulation and implementation of COMSEC equipment into the LCRD Flight and Ground Segment. This effort may encompass any or all of the following five phases: (1) concept and technology development, (2) preliminary design and technology completion, (3) final design and fabrication, (4) system assembly, integration and test, and launch, and (5) operations. Typical duties include:

1. Interface with the LCRD Chief Security Officer (CSO) regarding IT/IA/COMSEC implementation on LCRD Flight and Ground Segments

Formatted: Indent: Left: 0.5", Numbered + Level: 1 + Numbering Style: 1, 2, 3, … + Start at: 1 + Alignment: Left + Aligned at: 0.25" + Indent at: 0 5"

2. Attend and support various meetings/reviews: technical interchange meetings, reviews, status meetings, configuration management, risk management, etc.
3. Prepare and provide network diagrams, memorandums, and reports as requested/needed.
4. Identify/develop/maintain IA/IT/COMSEC requirements and document. Show links to the mission level or next higher level requirements if required
5. Provide technical leadership for the design, development, integration, and test of the IA/IT/COMSEC equipment in support of the LCRD Flight and Ground Segments
6. Identify and address technical problems and recommend solutions.
7. Perform risk identification and assessment.
8. Prepare the appropriate documents – requirements, interfaces, etc. showing traceability

9. Review and assess the test plans and procedures, and verification of the requirement compliances.

10. Maintain/assure interface compliance of COMSEC equipment during Integration & Test and Mission Operations.

11. Support for the activities involving COMSEC equipment integration during Integration & Test and Mission Operations.

~~23.~~12. Support launch site activities and the on-orbit checkout involving the COMSEC equipment.

IV. Deliverables/Schedules/Milestones

General to task order:

1. Monthly status report. To include progress made during previous month, plans for next month, status of actions, risks and technical issues.
2. Weekly report inputs.

Specific to Subtask-1

3. Updated Level-2 and Level-3 requirements documents, as needed.
4. Updated SEMP, (if required).
5. Updated LCRD V&V Plan.
6. Updated Level-2 and Level-3 RVTMs, final for Flight Operations Review.
7. TPM tracking slides, last week of each month.
8. Updated verification approach for Level-2 and Level-3 requirements with "I" and "A" verification methods.

Specific to Subtask-2:

9. Develop LCRD IA and COMSEC implementation plan which tailors the standard list of deliverables for national security requirements for the LCRD mission.

Specific to Subtask-3:

10. Flight Operations Review presentation material
11. Verification plans and results for host spacecraft interface requirements
12. Verification plans and results for mission and instrument systems requirements

Specific to Subtask-4:

13. Mission Operations Training Plan
14. Mission Operations Plan
15. Transition to Operations Plan
16. Mission Operations Team Certification Plan
17. Mission Operations Simulation Plan
18. Flight Operations Review presentation material

Specific to Subtask-5:

19. Mission Readiness Test Plans
20. Mission Readiness Test Procedures
21. Test Readiness Review materials
22. Post-Test Review materials
23. Test Integration Working Group materials

Specific to Subtask-6:

24. Requirements Documents
25. Interface Documents
26. Verification matrices
27. Technical reports as required
28. Presentation materials for reviews

Formatted: Numbered + Level: 1 + Numbering Style: 1, 2, 3, … + Start at: 1 + Alignment: Left + Aligned at: 0.25" + Indent at: 0.5"

V. Management Approach

a. Staff Allocation, Expertise, and Skill Mix

The contractor shall staff this work item with the appropriate skill mix and staffing level for the work.

b. Configuration Management

Systems and documents will be covered under the Project Configuration Management Plan.

c. Facilities

The contractor will reside onsite and project will provide appropriate office and workstation accommodations with IT support to maximize productivity.

d. Risk Management and Best Practices

The contractor shall manage schedule, cost, and technical risk through monitoring and reporting of progress and performance metrics, identifying issues well in advance of negative consequences, recommending corrective action to the TM, and implementing corrective actions with the compliance of the TM.

e. Performance Metrics

The work performed for this task will be evaluated by the TM based on the technical merit. Technical evaluation of the task performance is a subjective combination of performance metrics, technical quality of deliverables, cost control, significant events, innovations and meeting requirements set forth in the SOW.

Performance metrics:

1. Planned versus actual progress
2. Delivery dates
3. Actual vs Planned Costs

f. Government Furnished Facilities, Equipment, Software and Other Resources

The Government will provide account and passwords to government-furnished workstations where existing versions of various relevant software packages shall be maintained. It shall be the contractor's responsibility to complete any GSFC required security-related training courses.

g. Quality Assurance Requirements

The contractor providing technical services shall comply with all CMMI Level 2 processes established for the Project and deliverable products. Applicable requirements include, but not limited to:

1. NPR 7120.5E NASA Space Flight Program and Project Management Requirements
2. NPR 7123.B NASA Systems Engineering Processes and Requirements
3. GPR 7120.99 Goddard Project Management
4. GPR 7120.5A Goddard Systems Engineering
5. GPR 7150.4 Goddard Software Engineering Requirements
6. CNSSI 1253
7. CNSSI 4005

VI. ODC (Travel and Procurement)

Planned Travel between October 15, 2020 and April 14, 2021.

Location	Duration	Dates
~~Los Angeles~~Chantilly, VA (subtask ~~1~~6)	~~3 days~~1 day local	~~One trip~~Monthly
Cocoa Beach, FL (Subtask 6)	3 days	One trip
Chantilly, VA ~~Los Angeles~~ (subtask 3)	~~3 days~~1 day local	two Trips
Las Cruces, NM (subtask 4)	5 days	~~5~~ 1 trip~~s~~
Las Cruces, NM (subtask 5)	~~1~~ 3 week~~s~~	~~10~~ 4 trips
~~Pasadena, CA (subtask 5)~~	~~4 days~~	~~2 trips~~
~~Maui, HI (subtask 5)~~	~~4 days~~	~~2 trips~~
Cocoa Beach, FL (subtask 5)	1 week	~~10~~ 2 trips

VII. Work Location

This work shall be performed primarily at the Goddard Space Flight Center (On-site), but the contractor may be required to perform some work at the contractor's facility (Off-site).

VIII. Reporting Requirements

a. Weekly or Bi-weekly status report

The contractor shall contribute to Project weekly reports.

b. Monthly performance report

The contractor shall submit a written status to the LCRD Mission Systems Engineer on a monthly basis. The report shall include accomplishments, at a minimum, for the past month and plans for the following month and the 533 financial.

IX. Security Requirements

The contractor shall comply with Information Technology Security procedures and requirements as defined by NPG 2810.1A in the performance of this task. In addition, the contractor shall comply with all applicable federal rules and regulations and agency directives.

Elements of this task require handling of classified data.

X. Data Rights

This SOW shall adhere to all Data Rights Clauses as stated in the SEAS contract.

XI. Applicable Documents

N/A

XII. References

The latest revisions to the following documents:

1. GSFC-STD-1000-Rules for the Design ,Development , Verification and Operation of Flight Systems
2. GSFC-STD-1001 Criteria for Flight and Flight Support Systems Lifecycle Reviews
3. NPR 7120.5 ,NASA Space Flight Program and Project Management Requirements
4. NPR 7123.1 NASA Systems Engineering Processes and Requirements