ORS Space Vehicles
Task Order 01 SARSat Bus Development
Statement of Work

1.0 ORS SARSat Mission Development

1.1 Scope

This Statement of Work (SOW) delineates the tasks the contractor or contractor team shall accomplish to manage the technical, schedule and cost performance necessary to meet the ORS Synthetic Aperture Radar Satellite (SARSat) mission requirements. The scope of this SOW is intended to include the efforts needed to directly meet the flight mission demonstration to include; the modular bus flight hardware, integration of a modular RF payload flight hardware, spacecraft integration, test, and validation, flight software, mission launch support, post launch turn on, calibration, checkout, and user handoff. Additional SOW Scope requirements intended to meet and demonstrate the ORS Tier-2 end-to-end response requirements are more completely described in the "ORS Office Government Reference Architecture Document", but shall minimally include; the support to RRSW for AI&T process refinement, documentation, and ORS SARSat mission hardware AI&T exercises, the refinement of the modular RF payload building block interface specifications for multi-mission compatibility, and the demonstration of a Tier-2 response from simulated mission tasking to handoff to user. This task order does not include actual launch or ground infrastructure development.

1.2 Objective

The objective of this Task Order is to incorporate the modular bus architecture developed by the ORS Office, and Government and industry partners into a hardware development and flight demonstration of a modular Multi-Mission Space Vehicle (MMSV) mission. The Operational Responsive Space (ORS) Office has selected the ORS SARSat mission to be a Synthetic Aperture Radar (SAR) mission that will address key ORS Office objectives to include: 1) Demonstration of the end-to-end Rapid Response Space Works (RRSW) "deploy" response, 2) Demonstration of an open standards-based, modular, rapidly configurable, multi-mission bus architecture, 3) Demonstration of an open standards-based, modular, rapidly reconfigurable, multi-mission RF payload architecture, and 4) Demonstration of an operationally useful, requirements supported radar payload and bus. The specific mission performance, operational user requirements, program requirements and constraints, to be used for this task order is documented under a separate document, "SARSat Government Reference Document" and the baseline government reference architecture is captured in the "ORS Government Reference Architecture". The ORS office has multiple separate developments planned and underway, such as "RRSW" rapid Assembly, Integration, and Test (AI&T), which will require complimentary interaction and support throughout the execution of this task order.

1.3 Applicable Documents

- ORS Office Government Reference Architecture Document
- Space Plug-and-Play Avionics (SPA) Standards
- Integrated System Engineering Team (ISET) Spacecraft Bus Standards

- SARSat Government Reference Document

1.4 Technical Tasks

1.4.1 Mission Systems Engineering Analysis & MSDT Simulation

1.4.1.1 Mission Planning & System Engineering Support. The contractor shall execute an overall Systems Readiness Review (SRR) early in the program. At the SRR, the contractor shall perform an assessment on the overall program plan with an emphasis on the use of systems engineering methodology and simulation. The SRR assessment shall include a look at the SAR payload system performance projections/capabilities, the requirements flow down, and low level specification allocations. The assessment shall contain a risk assessment (including hardware and software) that is tied to the planned risk reduction and prototyping tasks. Systems engineering analysis and simulation shall be performed as required throughout the program to technically guide the overall effort and to generate required technical support analysis for decision making. The contractor shall provide manpower support and interaction to the Government Systems Engineering Integrated Process Team (SEIPT) for providing program technical information, simulation analysis, and guidance in developing the Tier-2 mission tasking response concept of operations. The contractor shall support the SARSat Bus contractor who is responsible for the overall mission plan, development, and execution. The payload section of the mission plan shall be generated and documented. The plan shall be updated to remain current with findings and results throughout the program execution. The mission plan shall contain the detailed plan for the flight experiment to include; OV-1 requirements, specifics on data collection/imaging, areas to be imaged, data processing and analysis plans, and a list of experiments to be executed that are aimed at evaluating and quantifying the spacecraft capabilities and limitations. The ORS Office Government Reference Architecture Document shall be a source for relevant material that may be used for systems engineering trades and mission plan document generation.

1.4.1.2 ORS Tier-2 Compliance Demonstration Plan. The ORS Office Government Reference Architecture Document contains a description of the “Space Wing” end-to-end demonstration requirements. The contractor shall use these starting requirements to develop a “Space Wing” end-to-end compliance demonstration plan to be executed throughout the ORS SARSat program. The “Space Wing” Compliance plan shall be generated and documented. A key part of the Government implementation path for the “Space Wing” development is being implemented under the separate RRSW facility contracts. The compliance plan shall include interaction and support to the separate Government RRSW developments. Support shall include information exchange, participation in AI&T experiments, providing recommendations to RRSW on AI&T processes/ procedures specifically related to RF payloads and supporting buses, and recommendations on depot hardware cell structure and inventory requirements. The compliance plan shall include planned AI&T process step time allocations, description of key process steps, and C-SWAP analysis for each of the hardware and/or software components required for the spacecraft and mission execution. The compliance plan shall be tracked and updated throughout the program and incorporated in the development of other plans and procedures (such as pre-launch, post launch turn-on, calibration, etc.). The contractor shall maintain close interaction and support with the RRSW team during the development and use of this plan. Another major function of the “Space Wing” analogy is the Mission System Design Tool (MSDT), which takes

a high level mission need as an input and provides a simulated mission implementation option using the available RRSW processes and inventory of hardware and software components. The MSDT software is being developed outside this program with the intent of providing it via GFE to this program. The compliance plan demonstration must execute the MSD function with the intent on using the GFE design tool software. The contractor shall use the ORS SARSat mission to define and develop models for use in the MSDT software, followed by the demonstration.

1.4.2 Modular Multi-Mission Space Vehicle Design & Prototype Validation

1.4.2.1 Modular Multi-Mission Space Vehicle Specification & Interface. The baseline modular multi-mission payload architecture with building block functional allocations, initial specifications and preliminary block interface requirements is defined in the ORS Office Government Reference Architecture Document. The baseline RF payload to be used in this program is broken into 4 major sub-assemblies/modular building blocks ;1) the Reflector Antenna Assembly, 2) the RF radiating Sub-system, 3) the Electronic Chassis, and 4) the Bus Interface. The contractor shall complete the specifications and open interfaces between the government reference architecture modular blocks under this task. For each interface, accepted open interface standards from industry and government shall be utilized. Chosen interfaces should address both physical and informational interfaces (if applicable) between the modular building blocks. The refinement shall incorporate/ consider multi-mission (RF ISR, Tactical EW, & Communications) needs so that each interface can be standard across different missions to the greatest extent possible. The results shall be used for the flight hardware development and serve as an industry modular RF payload user developer's guide. The Modular Open Systems RF Payload User Development Guide shall be developed and documented. The guide shall include as a user example, all Interface Control Documents (ICD) and interface definitions for the ORS SARSat mission payload. All ICD specifications and Modular Open System Architecture (MOSA) interfaces shall be non-proprietary.

1.4.2.2 Hardware Risk Reduction/Verification. The contractor shall emphasize the use of high TRL subsystems in the bus and payload designs. The contractor shall conduct NRE / prototype developments on lower TRL hardware that is part of the spacecraft design. SRR task results shall be used to quantify specific risks and required demonstration metrics required to prove risk reduction. Hardware test results shall be used for the CDR. The contractor shall investigate and execute a back-up plan for critical high risk items. The plan may involve the early inclusion of parallel paths for decisions at key development milestones.

1.4.2.3 Software Risk Reduction / Verification. The contractor shall develop software determined to be high risk and provide quantitative analysis proving risk reduction for CDR. Software may include spacecraft flight payload software. SRR task results shall be used to quantify specific risks and demonstration metrics required to prove adequate risk reduction. All contractor developed software shall be non-proprietary.

1.4.2.4 Spacecraft Design. The contractor shall support the SARSat bus contractor and the Rapid Response Space Works contractor to complete the detailed design of the spacecraft to meet the ORS SARSat mission in compliance to the End-to-End demonstration requirements (modular breakdown, interfaces, etc.). This design shall include the bus and payload and shall be compatible with the rapid AI&T approach. The design shall be developed in line with launch integration, pre-launch checkout, post launch checkout/ turn-on, calibration, and ground system compatibility. The design shall be compatible with the ORS Office Government Reference

Architecture Document, unless deviations are approved. The contractor shall define the design process and procedures and state what historical space requirements (Mil Standards.) are being used and which ones are not. The requirement is not to conform to the expensive and time consuming processes of historical spacecraft development, but to understand the current path and deviations within acceptable levels of risk imposed by the ORS mission. The contractor shall participate in a spacecraft CDR to enable a multi-disciplined product and process assessment to ensure the ORS SARSat mission can proceed into system fabrication, demonstration, and test, and can meet the stated performance requirements within cost (program budget), schedule (program schedule), risk, and other fulfill stated ORS Office objectives. The contractor shall define a more detailed path and schedule (as determined to be necessary) for payload portion of a spacecraft CDR. The path may contain separate bus and payload PDRs and CDRs leading to the final spacecraft CDR. The path may also highlight specific long lead items which would require early approval or release to meet program critical milestones.

1.4.3 Bus Flight Hardware Build

1.4.3.1 Bus AI&T Plan – The contractor shall develop, execute, and document a plan for manufacturing the modular bus. The plan shall meet the bus requirements for the ORS SARSat mission, and shall include the plan for supporting multi-mission bus modularity design verification and include recommendations for future inventory needs and control requirements for the RRSW rapid AI&T process. The plan shall include the hardware subsystem component supplier purchase plan. The plan shall contain the step by step instructions for the assembly, disassembly, and integration and test procedures for the sub-assemblies and bus. The documentation shall be sufficient for transitioning to overall spacecraft integration. The instructions shall be provided to the RRSW facility for potential future use on the delivered hardware or process refinement for similar hardware.

1.4.3.2 Bus Sub-system Fabrication & Qualification – The contractor shall execute the manufacturing, test, and RRSW bus inventory plan required for the ORS SARSat mission. This shall minimally include; vendor component procurement, subsystem hardware fabrication, and qualification testing.

1.4.3.3 Bus Assembly, Integration & Verification – The contractor shall integrate the bus sub-system assemblies into a fully functional bus and perform the required (per the plan) testing and qualification requirements.

1.4.3.4 Multi-Mission Bus Compatibility Experiments – The contractor shall execute the multi-mission bus design aspects of the plan. Multi-mission requirements may include, scalable power, HEO & LEO capability, compatibility with RF payload modes of operation (SAR, Communications, etc...).

1.4.4 Payload Flight Hardware Build—Section not used.

1.4.5 Spacecraft Integration & RRSW Support

1.4.5.1 Spacecraft AI&T Plan. The contractor shall develop, execute, and document a plan for AI&T of the payload into the spacecraft. The plan shall incorporate the actual plan for the ORS SARSat mission hardware and software, and shall also contain recommendations from lessons learned on reduced testing requirements and other potential AI&T time reductions. The plan shall contain the step by step instructions for the assembly, disassembly, and integration and test

procedures for the payload. The documentation shall be sufficient for verification for moving to launch integration. The instructions shall be provided to the RRSW facility for future use on the delivered hardware or process refinement on similar hardware.

1.4.5.2 Spacecraft AI&T. The contractor shall assemble at the RRSW the bus and payload together into an integrated spacecraft using the spacecraft AI&T plan followed by the testing and validation of the space craft.

1.4.5.3 Shipping Container. The contractor shall develop the payload shipping container and package the spacecraft as required for shipment to the RRSW and/or launch site. The shipping container shall be capable of re-use for shipment to the launch site, and compatible with any launch site check-out requirements.

1.4.5.4 RRSW Support. The contractor shall provide support to the RRSW facility for spacecraft AI&T experiments and verification for shipment to the launch site.

1.4.6 Launch Campaign & Mission Support

1.4.6.1 Launch Vehicle Integration Support. The contractor shall develop, execute, and document the payload issues with spacecraft to launch vehicle integration procedures. The contractor shall also provide support to the government team for the actual launch vehicle integration. Support shall be as defined as technical advice and troubleshooting integration difficulties.

1.4.6.2 Pre-Launch Checkout. The contractor shall define, execute, and document the pre-launch procedures and process required to give a go for launch decision. The contractor shall also be responsible for conducting the pre-launch checkout procedures. Pre-Launch check out procedures shall be developed in conjunction with the rapid time to launch goals and shall be aimed at meeting the allocated times from the ORS Tier-2 “Space Wing” Compliance Plan.

1.4.6.3 Post Launch Turn on/ Checkout / Calibration. The contractor shall define, execute, and document the spacecraft turn on procedures via a step by step process that is required to be followed for spacecraft checkout. The checkout process shall include the payload sensor calibration procedures.

1.4.6.4 Flight Software. The contractor shall assume responsibility for spacecraft turn on, checkout, and calibration. The contractor shall develop the required software for executing the turn on, checkout and calibration procedures.

1.4.6.5 Ground Infrastructure Compatibility. The contractor shall maintain compliance with the ground system infrastructure for flight control and data downlink.

1.4.6.6 Mission On-Orbit Anomaly Support. The contractor shall provide on-orbit anomaly resolution support to the government on an as-needed basis.

1.4.6.7 Documentation. The contractor shall prepare and maintain program, design, test, and other relevant documentation in accordance with its program plans.

1.5 Programmatic Tasks

1.5.1 Design Reviews. The contractor shall host and conduct for the government a Critical Design Review (CDR), and other Contractor defined CDRs and PDRs.

1.5.2 Design Review Support. The contractor will support government reviews at ORS, the launch site, and the RDT&E Support Center (RSC) including a Test Readiness Review (TRR), Mission Readiness Review (MRR), Spacecraft Pre-Ship Review (S-PSR), and Launch Readiness Review (LRR).

1.5.3 Technical Interchange Meetings. Technical Interchange meetings shall be held with the government, launch vehicle vendor, and ground segment provider as needed to resolve technical interface issues.

1.5.4 Customer Communications. The contractor shall maintain proactive, open and responsive communication with the government. Regular communication shall include support of programmatic and technical interchanges taking the form of weekly telecons and monthly videoconference status reviews. In-person reviews at the customer location and contractor's facility will be performed as required.

1.5.5 Schedule Performance. The contractor shall establish a top-level key event based schedule as a baseline to measure schedule progress. Schedule progress shall be measured monthly. Schedule progress will be determined using pre-defined accomplishment criteria. If the contractor determines that a change to the baseline schedule is necessary, the contractor shall advise the government of the change immediately with explanation and rationale.

1.5.6 Cost Performance. The contractor shall establish a program cost baseline to measure cost progress. Control account cost progress shall be measured monthly. When an individual control account experiences a negative cost variance exceeding ten percent, the contractor shall advise the government of variance and provide a resolution plan.

1.5.7 Contractor Integrated Performance Management. The contractor shall establish, maintain, and use in the performance of this contract, an integrated performance management system. Central to this integrated system shall be an Earned Value Management System (EVMS) in accordance with NASA Federal Acquisition Regulation Supplement (NFS) 1852.234-1, NFS 1852.234-2, and the EVMS guidelines contained in ANSI/EIA-748. To establish the integrated performance management system, the EVMS shall be linked to and supported by the contractor's management processes and systems to include the integrated master schedule, contract work breakdown structure, change management, material management, procurement, cost estimating, and accounting. The correlation and integration of these systems and processes shall provide for early indication of cost and schedule problems, and their relation to technical achievement.

1.5.8 Integrated Master Schedule (IMS). The contractor shall develop and maintain an Integrated Master Schedule (IMS) by logically networking detailed program activities. The schedule shall contain the planned events and milestones, accomplishments, exit criteria, and activities from contract award to the completion of the contract. The contractor shall quantify risk in hours, days, or weeks of delay and provide optimistic, pessimistic, and most likely duration for each IMS activity and event.

1.5.9 Integrated Baseline Reviews (IBRs). The contractor shall engage jointly with the Government's program manager in Integrated Baseline Reviews (IBRs) to evaluate the risks inherent in the contract's planned performance measurement baseline. Initially, this shall occur as soon as feasible but not later than six months after contract award, and subsequently following all major changes to the baseline. Each IBR should verify that the contractor is using a reliable

performance measurement baseline, which includes the entire contract scope of work, is consistent with contract schedule requirements, and has adequate resources assigned. Each IBR should also record any indications that effective Earned Value Management (EVM) is not being used. IBRs should also be conducted on subcontracts that meet or exceed the EVM application threshold. The prime contractor shall lead the subcontractor IBRs, with active participation by the Government. (See NFS 1852.234-2).

1.5.10 Risk Management. The contractor shall identify program risks and individual mitigation plans to retire risks as defined in the Risk Management Plan. The contractor shall assess program risks on an ongoing basis and evaluate risk mitigation progress monthly.

1.5.11 Quality Assurance. The contractor shall develop a quality assurance plan and accomplish quality assurance in accordance with its Quality Assurance Plan.

1.6 Work Breakdown Structure (WBS)

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1.7 Deliverable Documentation

The following table details the Contract Deliverable Requirements List as proposed for this task order. To Be Determined