SECTION C: DESCRIPTION/SPECIFICATIONS/DRAFT STATEMENT OF WORK

International Space Station (ISS) Common Communications for Visiting Vehicles (C2V2)

Draft Statement of Work (SOW)

1. Statement of Work

This Statement of Work (SOW) defines the requirements for the design, development, test, certification, and delivery of the International Space Station (ISS) Common Communications for Visiting Vehicles (C2V2) Transceiver and Processor Assembly (CTPA).

1.1.Scope

The scope of the Contractor's tasks includes all labor, project management, supervision, materials, travel, facilities, and integration functions necessary for compliance to this SOW. The C2V2 Contractor shall design, manufacture, certify, and deliver a two-way CTPA that provides ISS to Visiting Vehicle (VV) communication coverage for the required data types throughout rendezvous, departure, attached, and proximity operations as specified in this SOW. The Contractor shall deliver flight-certified hardware and software and associated ground support equipment, including training hardware, engineering units, flight equivalent units, compatibility test sets, and qualification units. The Contractor shall perform all work necessary to satisfy the requirements in this SOW.

1.2.System Description

The C2V2 is a two-way communications system for use between the ISS and VVs during rendezvous, proximity, departure, and attached operations.

Space Station Program (SSP) Document 50808 (SSP 50808), ISS to Commercial Orbital Transportation Services (COTS) Interface Requirements Document (IRD), defines the requirements for two-way communications between the ISS and VVs. Communication is required to provide the following primary data exchanges:

- Two-way audio between crewmembers on the ISS and the VV for crewed VVs
- VV and ISS navigation data exchange for all VVs
- Commands from the ISS to the VV for uncrewed VVs
- Other two-way data exchanges for situational awareness and to support vehicle operations

The C2V2 must provide communications coverage throughout the required VV trajectories and during docked operations for all identified docking ports and trajectories. The C2V2 requirements documented in SSP 50930, ISS C2V2 Prime Item Development Specification (PIDS) were derived from the concept of operations documented in JSC 65991, Concept of Operations (ConOps) for the International Space Station Common Communications for Visiting Vehicles (C2V2) System.

Figure SOW-1 depicts the relationship between this contract, other elements of the C2V2 project, and the VV's compatible communication subsystem.

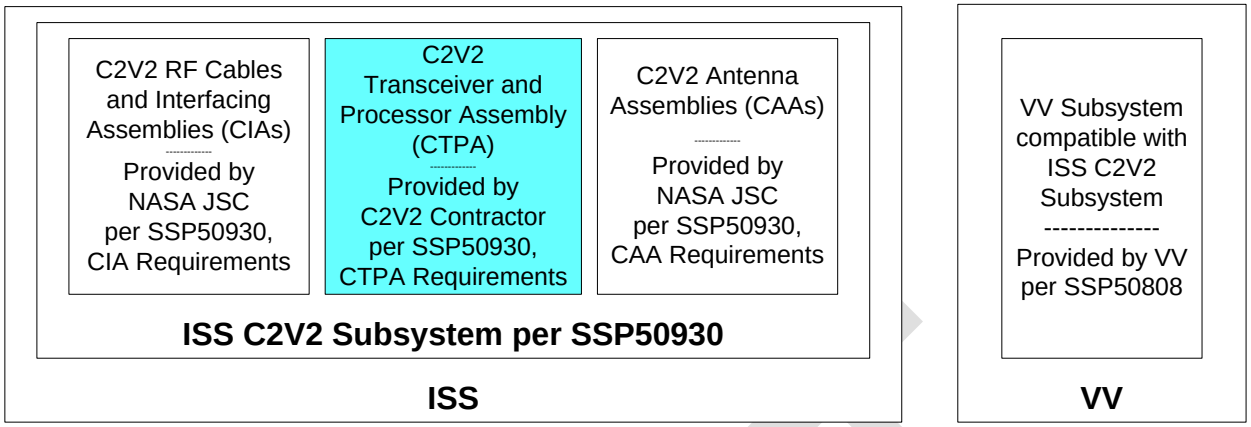

Figure SOW-1: CTPA relationship to the C2V2 project.

2. Requirements

2.1.Project and Contract Management

2.1.1. Project and Contract Management Plan

The Contractor shall plan, organize, control, and report on all activities required by this contract to assure accomplishment of all outcomes and deliverable products required by this contract. The Contractor shall provide overall contract management and administration for this contract.

The Contractor shall perform all business and administrative functions and integrate these functions across all areas of performance. The Contractor's on-going business analysis shall support the ISS Program business process.

The contractor shall submit a project and contract management plan in accordance with Data Requirements Document (DRD) DRD-C2V2-03, Management Plan.

2.1.2. Contract Work Breakdown Structure (CWBS)

The Contractor shall develop, provide, and maintain a CWBS dictionary per the Contract WBS and Dictionary contained in DRD-C2V2-03, Management Plan. The CWBS shall serve as the framework for contract planning, budgeting, cost reporting, schedule resource loading, and schedule status reporting to the ISS Program. The NASA C2V2 project WBS is included in Sections J-1 through J-3, NASA C2V2 Project WBS.

2.1.3. Financial Reporting

The Contractor shall utilize a contract financial system which discretely tracks resources by fund source, CWBS, and elements of cost including direct labor, materials, overhead, other direct costs including but not limited to travel and subcontracts, and indirect costs. The Contractor shall provide inputs to NASA-JSC budget processes (e.g., program planning, budgeting, and execution budget calls - but not limited to), and special requests for budget impacts. The Contractor shall provide financial reporting in accordance with the DRD-C2V2-08, NF533 Monthly Cost Reporting.

2.1.4. Contract Performance

The Contractor shall use an earned value measurement system in accordance with NASA Federal Acquisition Regulations Supplement (NFS) clause 1852.234-2, Earned Value Management System ALT 1. The Contractor shall provide a contract performance report per DRD-C2V2-10, Monthly Project Report.

2.1.5. Schedules

The Contractor shall develop, maintain and deliver an Integrated Master Schedule (IMS) and a high-level project schedule in accordance with DRD-C2V2-04, Contract Schedules.

2.1.6. Integrated Data Environment

The Contractor shall implement an integrated data environment to support effective communication and timely exchange of information. The Contractor shall submit data in electronic format by posting it to the NASA-JSC Electronic Document Management System (EDMS) per Contract Section J-8. The Contractor shall establish and maintain an account to gain logical access to NASA-JSC Information Technology (IT) systems including completion of required IT training.

2.1.7. Meetings and Reviews

2.1.7.1. Coordination and Technical Meetings

2.1.7.1.1. Contract Kickoff Meeting

The Contractor shall conduct a Contract kick-off meeting at the Contractor's facility within thirty (30) calendar days after contract award. Teleconference capability is to be provided by the organization hosting the meeting. Key project personnel from both NASA-JSC and the Contractor shall participate. The purpose of the meeting includes but is not limited is to review of all top level requirements, the communications plan, integrated data environment, points of contact, CWBS, data requirements content, all deliverables, IMS, and milestone reviews plans.

2.1.7.1.2. Status and Technical Interchange Meeting

The Contractor shall participate in coordination teleconferences and technical interchange meetings as defined in DRD-C2V2-14, Coordination and Integration Products.

2.1.7.2. Milestone Reviews

2.1.7.2.1. C2V2 Milestone Reviews

For each hardware and software deliverable item type, the Contractor shall conduct the milestone reviews identified below per the schedule provided in contract Section J-List of Documents, Exhibits, and Other Attachments, and generate review data packages in accordance with the DRD-C2V2-13, Hardware and Software Life Cycle Reviews. In accordance with required delivery schedules, configuration items may be combined into single reviews.

- Contractor Specification Requirements Review
- Preliminary Design Review (PDR)
- Critical Design Review (CDR)
- Acceptance Review (AR)

The Contractor shall conduct a Functional Configuration Audit/Physical Configuration Audit (FCA/PCA) per DRD–C2V2-18, FCA/PCA for each flight class configuration item.

For each qualification and flight hardware and software configuration item, the Contractor shall allow NASA-JSC participation in the following Contractor-conducted reviews:

- Flight Manufacturing Readiness Review (MRR)
- Qualification and Acceptance Test Readiness Reviews (TRRs)
- Pre-ship reviews

2.1.7.2.2. Participation in Other Reviews

The Contractor shall allow NASA participation in subcontractor reviews including the submittal of action and review items via the Contractor. The Contractor shall provide inputs to and participate in NASA-ISS C2V2 reviews including interface and specification document reviews associated with the C2V2 project in accordance with DRD-C2V2-14, Coordination and Integration Products.

2.1.7.3. Project Management Reviews (PMRs)

The Contractor shall conduct quarterly PMRs and provide monthly integrated management review products in accordance with DRD-C2V2-11, PMR Package, and DRD-C2V2-10, Monthly Project Report, for the work performed on this contract. The reviews shall provide the ISS Program insight into the Contractor's and any major Subcontractors' overall technical, schedule, and cost performance.

2.1.8. Configuration Management (CM)

The Contractor shall utilize, implement, and operate a configuration management (CM) system in accordance with the requirements defined in SSP 41170, ISS Program Configuration Management Requirements. The Contractor shall support a NASA-JSC review of the Contractor's CM system and procedures to assess compliance to SSP 41170. The Contractor shall develop and maintain a CM Plan in accordance with DRD-C2V2-06, Configuration Management Plan.

2.1.9. Risk Management

The Contractor shall conduct regular risk assessments of cost, schedule, and performance requirements. This includes the following:

- Identify project cost, schedule, and performance risks
- Perform risk assessment using techniques included in the risk management process
- Analyze risk level ratings and prioritize risks for follow-on handling

The Contractor shall submit a risk management plan in accordance with DRD-C2V2-03, Management Plan.

2.1.10. System Engineering Management

The Contractor shall prepare, implement, deliver, and maintain a Systems Engineering Management Plan (SEMP) as addressed in DRD-C2V2-03, Management Plan. The Contractor shall utilize a technical management approach that provides NASA-JSC information on design modification decisions and their impact on the performance of the C2V2 system.

2.1.11. Export Control Management

The Contractor shall comply with the export control requirements in accordance with NFS clause 1852.225-70, Export Licenses.

2.1.12. Information Technology

The Contractor shall develop and implement an IT Management Plan per the DRD-C2V2-07, IT Security Management Plan and Reports.

2.1.13. Communications Security

The Contractor shall meet National Security Agency's Communications Security (ComSec) requirements for handling, storage, tracking, and shipment of ComSec material in accordance with issuances of the Committee on National Security Systems (see www.cnss.gov). The Contractor shall complete the required training and certification to handle the ComSec device and demonstrate compliance to the applicable security requirements. This Contractor shall have a ComSec account and custodian. NASA-JSC is responsible for obtaining keying material and the key management plan and providing this data to the contractor.

2.2.Safety and Mission Assurance

2.2.1. S&MA Management

The Contractor shall develop, maintain, and implement a Safety and Mission Assurance (S&MA) Plan in accordance with DRD-C2V2-03, Management Plan.

2.2.2. Safety and Health Program

The Contractor's safety and health program shall comply with NFS clause 1852.223-72, Safety and Health (Short Form).

2.2.3. Safety Requirements

The Contractor shall perform and deliver safety assessments for all hardware and software sustained and developed on this contract in accordance with SSP 30599, Safety Review Process; SSP 30309, Safety Analysis and Risk Assessment Requirements; SSP 50021, Safety Requirements Document; SSP 50038, Computer Based Control System Safety Requirements Document; and DRD-C2V2-22, Safety Analysis and Hazard Reports.

2.2.4. Reliability and Maintainability

The Contractor shall develop, maintain and deliver the Failure Modes and Effects Analysis (FMEA) and Critical Items List (CIL) Report and worksheets in accordance with SSP 30234, Failure Modes and Effects Analysis and Critical Items List Requirements for Space Station, and the DRD-C2V2-23, Failure Modes and Effects Analysis (FMEA) and Critical Items List (CIL), for hardware developed or sustained under this contract.

2.2.5. Quality Assurance

The Contractor shall develop, implement and maintain a quality assurance plan per Contract Section E.2. The Contractor shall provide a quality plan in accordance with DRD-C2V2-21, Quality Plan.

The Contractor shall establish and maintain a Quality Management System (QMS) that complies with the Society of Aerospace Engineers (SAE) Aerospace Standard AS9100C, Quality Management Systems – Requirements for Aviation, Space and Defense Organizations. The Contractor shall report, promote and participate in the investigation and resolution of applicable problems in accordance with SSP 41173, Space Station Quality Assurance Requirements, and SSP 30223, International Space Station Problem Reporting and Corrective Action (PRACA).

Contractor-developed hardware and software shall be accepted in accordance with SSP 50287, Hardware/Software Acceptance Process. The Contractor shall provide an Acceptance Data Package (ADP) in accordance with SSP 30695, ADP Requirements Specification, and the DRD-C2V2-20, ADP for Contractor-developed hardware and software. The Contractor shall maintain the ADP for hardware and software sustained or maintained on the contract prior to delivery to NASA-JSC or whenever the hardware or software is in the possession of the Contractor.

2.3.ISS C2V2

2.3.1. Technical characteristics

The Contractor shall provide a CTPA that meets the requirements of SSP 50930, ISS C2V2 PIDS and this SOW. The CTPA may consist of either a single or multiple orbital replaceable units.

2.3.1.1. Design and Manufacturing requirements

The Contractor shall design the CTPA to meet all applicable requirements of the following ISS documents:

- SSP 50835, ISS Pressurized Volume Hardware Common Interface Requirements Document (CIRD), for launch, stowage, and transportation environments
- SSP 41000, System Specification for the ISS

The Contractor shall design deliverables classified as Ground Support Equipment (GSE) (see J-5) to meet the applicable requirements of the following ISS document:

- SSP 50004, Ground Support Equipment Design Requirements International Space Station

2.3.1.2. Non-proprietary interfaces

The Contractor shall develop a CTPA with non-proprietary Radio Frequency (RF) signal characteristics.

2.3.1.3. Software Tools and Operating System

The Contractor shall use commercially available software development tools and operating systems for any on-orbit software developed by the Contractor and contained within the CTPA flight unit deliverables.

2.3.1.4. Frequency Authorization

NASA, through its JSC frequency manager, will obtain frequency authorization from the National Telecommunications and Information Administration (NTIA). The Contractor shall support these NTIA frequency authorization activities by providing technical review of and inputs to the authorization requests in accordance with DRD-C2V2-14, Coordination and Integration Products. The frequencies utilized for C2V2 are not final until NTIA frequency authorization is approved. The approved frequencies will be documented in SSP 50930, ISS C2V2 PIDS, and SSP 50934, Common Communications for Visiting Vehicles (C2V2) Radio Frequency (RF) Interface Control Document (ICD). The Contractor shall ensure frequency management requirements, policies and procedures, and RF allocation and assigned authorizations are properly followed.

2.3.1.5. Communications Security

The contractor shall design the CTPA for removal of the ComSec materials for ground transportation and testing of the C2V2 system with all capabilities enabled except data encryption and decryption and without ComSec handling restrictions.

2.3.2. Deliverables

2.3.2.1. Data

The Contractor shall complete and deliver data products in accordance with the Data Requirements List (DRL) and DRDs contained in contract Section J-11 of the RFP, List of Documents, Exhibits, and Other Attachments.

2.3.2.2. Hardware and software

The Contractor shall deliver the CTPA hardware and software items as specified in section 2.3.2, Deliverables as specified in contract Sections J-4 and J-5. The Contractor shall prepare configuration item specifications for each deliverable per DRD-C2V2-12, Contractor Specifications and Interface Documents.

2.3.2.2.1. Qualification and flight units

The Contractor shall design and build the CTPA qualification and flight units in accordance with this SOW and the requirements specified in SSP 50930, ISS C2V2 PIDS.

The flight units and Qualification Units (QUs) shall be Class I equipment as defined in section J-5 of the RFP. The QU and flight unit design shall be configuration-controlled. The QUs and flight units shall be manufactured under quality control per the approved quality plan with complete records of unit manufacturing, testing, shipping, and handling.

2.3.2.2.2. Engineering units

The Contractor shall design, build, and deliver Engineering Units (EUs) that meet a subset of the C2V2 PIDS technical requirements identified by the contractor and agreed to by the COTR at PDR as requiring demonstration prior to CDR.

The EU refers to the hardware, firmware, and software that are functionally equivalent to the flight unit for an identified and agreed to subset of functional requirements. This unit is used for proof of concept testing and early integration testing with the ISS interfacing systems. The EU is a contract deliverable to NASA-JSC, and the Contractor shall maintain the EU and its development environment throughout the life of this contract.

2.3.2.2.3. Flight equivalent units

The Contractor shall design, build, and deliver Flight Equivalent Units (FEUs) that meet the performance requirements in the C2V2 PIDS. Environmental workmanship testing is not required but may be performed as a means of refining final flight build and test procedures. The Contractor shall document all differences between the FEUs and the flight units. Equivalent parts and processes can be only used if agreed to by the COTR prior to FEU drawing release.

The FEU refers to the hardware, firmware, and software that are functionally equivalent to the flight unit. This unit is used for testing of the detailed design and early integration testing with the ISS interfacing systems. It may be used for verification credit after CDR with quality controls as defined in the approved verification plan(s). The FEU is a contract deliverable to NASA-JSC. The Contractor shall maintain the FEU and its development environment throughout the duration of this contract.

2.3.2.2.4. Training units

The CTPA mock-ups needed for crew training and fit checks with interfacing assemblies will be provided by NASA-JSC based on the Contractor's Computer-Aided Design (CAD) models, per the DRD-C2V2-14, Coordination and Integration Products and DRD-C2V2-15, Engineering Drawings, Models, and Associated Lists, provided by the CTPA Contractor.

2.3.2.2.5. Ground support equipment

The Contractor shall design, build, and deliver GSE that provides all functionality required to support operation and maintenance, including unit functional checkout, configuration, and diagnostics of the deliverable EU, FEUs, and flight units. The GSE shall include the necessary components to emulate all external electrical and data interfaces, perform stand-alone testing and operation of the unit, and display quick look data for configuration or checkout. The Contractor shall provide GSE and associated equipment specifications in accordance with DRD-C2V2-12, Contractor Specifications and Interface Documents.

2.3.2.2.6. ISS C2V2 Compatibility Test Set

The Contractor shall deliver ISS C2V2 Compatibility Test Sets (CCTSs) for use in ground testing at NASA-JSC and VV integration and test facilities. The CCTS shall provide an RF interface that represents the C2V2 signal characteristics as defined in SSP 50934. The CCTS RF interface shall be configurable to represent the expected RF signal at the VV throughout its defined trajectories and attached operations. The RF interface from the CCTS will be used as to interface with the VV's compatible communication system for ground compatibility tests. The CCTS shall provide a user interface for control and configuration of the CCTS. The CCTS shall provide digital interfaces to the ISS Multiplexer/Demultiplexer (MDM) application development environment (MADE) for emulation of the ISS systems. The Contractor shall deliver all CCTS-related hardware, software, documentation, and support products necessary to sustain the CCTS through the operational life of the ISS C2V2 per the C2V2 PIDS. The Contractor shall provide a CCTS specification and user's manual in accordance with DRD-C2V2-12, Contractor Specifications and Documents.

2.3.2.2.7. Spares

The Contractor shall deliver flight, FEU, GSE, and CCTS spares in sufficient quantities to ensure the C2V2 remains functional and sustainable throughout its specified operational lifetime requirements as defined in the C2V2 PIDS. The Contractor shall provide logistics and sparing analysis per DRD-C2V2-03, Management Plan, to support the recommended spares quantities. The Contractor shall procure and deliver piece parts for the flight units and FEUs to mitigate parts obsolescence risks.

2.3.2.2.8. Software and Firmware

The Contractor shall deliver flight and non-flight software, source code, firmware, development environment specifications, and the documentation necessary to test, verify, operate, and service the EU, FEU, flight units, QU, GSE, and CCTS along with the associated hardware deliveries. Non-flight software shall be capable of unit configuration and problem diagnosis. Firmware and software shall be delivered in its native format, along with a complete description of the firmware development environment and specifications.

The flight software shall meet the requirements of the C2V2 PIDS. Flight software documentation shall be delivered per the DRD-C2V2-19, Version Description Document (VDD), DRD-C2V2-12, Contractor Specifications and Interface Documents, DRD-C2V2-13, Hardware and Software Life Cycle Reviews, and DRD-C2V2-20, ADP.

2.3.3. Delivery

2.3.3.1. Hardware

Packaging, handling, transportation, and marking shall be in accordance with the contract Section D-Packaging and Marking.

2.3.3.2. Software

The Contractor shall deliver on-orbit modifiable software to the ISS Mission Build Facility (MBF) in accordance with MBF delivery requirements defined in SSP 50482, ISS Software Management Plan, Section 5.

2.3.4. Operations and Sustaining

2.3.4.1. Post DD250 (Material Inspection and Receiving Report) Delivery

The Contractor shall sustain all hardware and software deliverables until formal transition of sustaining responsibility to the ISS sustaining teams per the DRD-C2V2-04, Contract Schedules. The Contractor shall support mission operations for installation, check-out, and first operational use of C2V2 per the milestones identified in contract Section J-List of Documents, Exhibits, and Other Attachments.

Post DD-250 of the flight software and prior to formal transition of sustaining engineering, the Contractor shall perform software changes as required in accordance with SSP 41170, ISS Program Configuration Management Requirements.

2.3.4.2. Sustaining Transition

The Contractor shall transition the sustaining engineering, logistics, and maintenance roles to the applicable ISS teams per the milestone schedule in Contract Section F. The Contractor shall provide the products and data required to support repair transition per SSP 50276, Depot/Manufacturing Facility Certification Plan. The Contractor shall include the data content and delivery formats necessary to transition the sustaining engineering role to NASA-JSC.

2.4.C2V2 Integration

The Contractor shall coordinate with the software development, data integration, vehicle, operations, quality, configuration management, and safety teams as required for integration of C2V2 into the ISS baseline and operations. The Contractor shall perform integrated ISS C2V2 testing at NASA-JSC for validation and verification of the following ISS C2V2 interfaces: (1) 120 VDC power, (2) Mil-Std-1553B remote terminal, (3) Ethernet, (4) ISS software, (5) RF and (6) structural. The Contractor shall provide the integration products defined in the DRD-C2V2-14, Coordination and Integration Products.

2.5.Value Characteristics

The CTPA size, weight, power, and symbol rate value characteristics, as proposed in contract Section L, shall be incorporated into the Contractor flight unit deliverable specifications.

The contractor shall complete the following (Do not include those items that are not applicable):

1) The CTPA [*insert deliverable name]* dimensions (size) shall be less than or equal to [*insert dimensions – length, width, and height]*. (*Repeat for as many items as applicable*)

2) The CTPA *[insert deliverable name]* mass shall be less than or equal to *[insert mass].* (*Repeat for as many items as applicable*.)

3) The CTPA {*insert deliverable name]* power shall be less than or equal to [*insert power]*. (*Repeat for as many items as applicable*.)

4) The CTPA maximum return link symbol rate shall be *[insert symbol rate].*

(End of Section)