

**National Oceanic and Atmospheric Administration (NOAA)**  
**National Environmental Satellite Data and Information Service (NESDIS)**  
**Space Weather Follow-On – Lagrange 1 (SWFO-L1) Antenna Network (SAN)**  
**Request for Information (RFI)**

THIS IS A REQUEST FOR INFORMATION FOR MARKET RESEARCH PURPOSES IN ACCORDANCE WITH FEDERAL ACQUISITION REGULATIONS (FAR) PART 10 PROCEDURES. IT IS NOT A SOLICITATION NOR DOES IT GUARANTEE A SOLICITATION WILL BE ISSUED. REQUESTS FOR A SOLICITATION WILL NOT RECEIVE A RESPONSE. IT IS NOT A REQUEST FOR PROPOSALS AND IT DOES NOT OBLIGATE THE GOVERNMENT IN ANY WAY.

The Government will neither award a contract solely based on this notice, nor pay for any information submitted by respondents. This notice is a request by the Government to collect information from interested vendors for the purpose of market research.

## Introduction

NOAA NESDIS is soliciting information through this RFI to survey vendor capabilities in preparation for a possible future release of one or more Request(s) for Proposal (RFP) to procure, develop, deploy, and maintain Telemetry, Tracking, and Command (TT&C) capabilities to support a NOAA Space Weather Follow On- Lagrange 1 (SWFO-L1) Mission.

NOAA requires commanding, ranging, and uninterrupted data acquisition capability for the SWFO-L1 mission, provided through the SWFO-L1 Antenna Network (SAN). SWFO-L1 will be stationed on the Earth-Sun line at Lagrange point L1 and the orbit tracks across the sky around the world like the path of the Sun. NOAA requires the real-time stream of X-band mission data from the SWFO-L1 observatory to be uninterrupted with extremely low ground latency. NOAA requires S-band commanding from NOAA facilities. NOAA requires high precision ranging both from NOAA facilities and from at least one ranging station in the southern hemisphere. The SAN must be in place to support an October 2024 launch date of the SWFO-L1 spacecraft.

NOAA is considering solutions in three categories:

1. NOAA-owned antennas that meet all requirements
2. NOAA-owned primary antennas to meet full coverage requirements with options for services to provide backup capabilities to meet availability requirements
3. A vendor-defined mixture of NOAA-owned antennas and vendor-provided services that together meet all requirements

## SWFO-L1 Mission Description

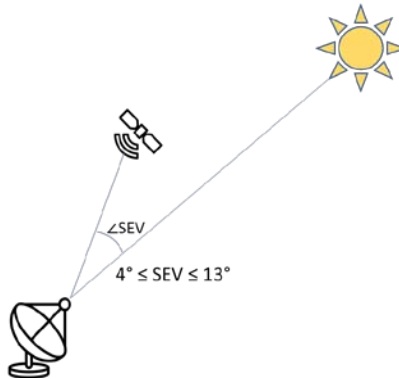
The SWFO-L1 Mission is an operational system to ensure the continuity of solar wind data and coronal mass ejection (CME) imagery, the National Weather Service's (NWS) highest priority for space weather observations. Space weather situational awareness and forecasting is a critical service for the Nation. Without timely and accurate watches and warnings, space weather events can disrupt major public infrastructure systems, including transportation systems, power grids, telecommunications, and the Global Positioning System (GPS). The SWFO-L1 mission will provide the operational space weather observational data needed for the NWS Space Weather Prediction Center (SWPC) to create useful and timely space weather watches and warnings.

The SWFO-L1 mission concept is one spacecraft orbiting about the Earth-Sun Lagrange point L1, taking solar white light imagery of the Sun's corona and in-situ sampling for various solar wind characteristics. This data is broadcast continuously in real time to the SAN, which forwards the data to two CONUS points of presence.

The SWFO-L1 spacecraft is expected to launch in October 2024 as a rideshare on the NASA Interstellar Mapping and Acceleration Probe (IMAP) mission launch. Operational mission duration for SWFO-L1 is designed for five (5) years, with consumables on-board to last an additional five (5) years.

#### Spacecraft Orbit Description

The SWFO-L1 mission orbit is a Lissajous orbit at the Sun-Earth Lagrange point L1. From Earth, SWFO-L1 will appear to be close to the Sun with a Sun-Earth-Vehicle (SEV) angle of not greater than 13 degrees and no less than 4 degrees and a period of roughly seven months.



*Figure 1 Sun-Earth-Vehicle Angle*

#### Spacecraft Communications Description

The Spacecraft Mission Data and Housekeeping Telemetry downlink will provide an Equivalent Isotropic Radiated Power (EIRP) of 43 dBW, minimum, in the direction of the Earth in the X-band 8400 – 8450 MHz.

- Data rate with all overhead but before Forward Error Correction (FEC) encoding and Transfer framing will be 150 kbps, maximum.
- The FEC encoding will require a theoretical  $E_b/N_o$  of approximately 4 dB/Hz, worst case, for the required Frame Error Rate (FER) of  $1E-4$ .
- A copy of the Housekeeping Telemetry will simultaneously be transmitted on this downlink and the Spacecraft Housekeeping Telemetry downlink.

The Spacecraft Housekeeping Telemetry downlink will provide an EIRP of 18 dBW, minimum, in the direction of the Earth in the S-band 2290 – 2300 MHz.

- Data rate with all overhead but before FEC encoding and transfer framing will be 6 kbps, maximum.
- The FEC encoding will require a theoretical  $E_b/N_o$  of approximately 4 dB/Hz, worst case, for the required FER of  $1E-4$ .
- Simultaneous transmission of Housekeeping telemetry and Ranging will **NOT** be required in this band.
- Housekeeping Telemetry will be directly modulated on the carrier.

The Spacecraft Command and Ranging uplink receiver will have a G/T of -18 dB/K, minimum, in the direction of the Earth in the S-band 2050 – 2110 MHz.

- Data rate with all overhead but before FEC encoding and Transfer framing will be 2 kbps, maximum.
- The FEC encoding will require a theoretical  $E_b/N_o$  of approximately 5 dB/Hz, worst case, for the required FER of  $1E-4$ .
- If simultaneous command and ranging is required, the command data rate will be 1 kbps.

The Spacecraft antennas will have an Axial Ratio of 2 dB within the 3 dB beamwidth.

The Spacecraft will support simultaneous operation of the S-band downlink, S-band uplink, and X-band downlink.

Spacecraft will support two-way S-band coherent Doppler and range tracking.

## SWFO-L1 Ground Segment Architecture

The SWFO-L1 Ground Segment consists of world-wide distributed TT&C ground sites; communications links between these ground sites and the SWFO-L1 Mission Operations Centers (MOCs) (primary and backup); SWFO-L1 MOC at the NSOF in Suitland, MD; backup SWFO-L1 MOC at the Consolidated Backup (CBU) in Fairmont, WV; communication links to SWPC and the NOAA National Centers for Environmental Information (NCEI); real-time data product generation at SWPC; and retrospective data product generation, data stewardship and archive at NCEI. These systems together provide capabilities for mission planning and scheduling; spacecraft and payload operations; data acquisition, communication and processing; data product generation and distribution; data product calibration and validation; data archive; flight vehicle simulation; and system sustainment.

The notional system architecture is shown in Figure 2.

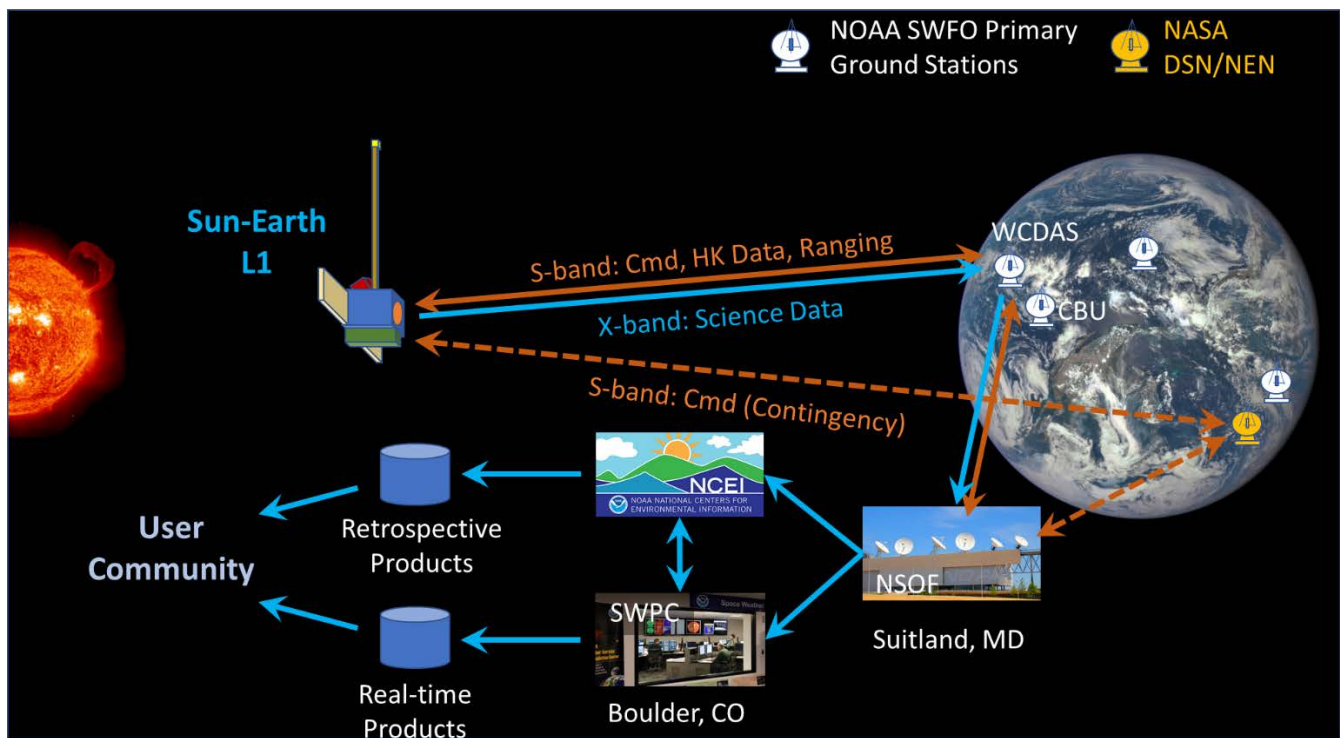


Figure 2 Overview of the SWFO-L1 system showing its Space and Ground-Services segments. NSOF is managed by NESDIS/OSPO; SWPC is an NWS center; NCEI is a NESDIS center; and NOAA ground stations are managed by NESDIS.

## SAN Driving Requirements

- All elements of the SAN shall be at Technology Readiness Level (TRL) 6 or higher.
- The SAN shall store downlinked data and tracking data in local storage for up to five (5) days and be able to re-deliver data upon request.
- Data packets shall conform to CCSDS 133.0-B-3 Space Packet Protocol, CCSDS 231.0-B-3, TC Synchronization and Channel Coding, and CCSDS 232.0-B-3, TC Space Data Link Protocol, for tele-command channel coding and data framing.

## NOAA-Owned Element Requirements

- One full function SWFO-L1 ground station shall be delivered to NOAA's Wallops Command and Data Acquisition Station (WCDAS) in Wallops, VA. This site shall be capable of commanding, ranging, and receiving both housekeeping and mission data telemetry.
- One backup SWFO-L1 ground station shall be delivered to NOAA's Consolidated Backup (CBU) facility in Fairmont, WV. This site shall be capable of commanding, ranging, and receiving both housekeeping and mission data telemetry.
- The SAN NOAA-owned elements shall be able to fail over to redundant components automatically or via remote command.
- The SAN NOAA-owned elements shall provide to MOC remote monitoring, control and automation of antenna control, antenna scheduling, antenna status, and ground equipment status.
- The SAN NOAA-owned elements shall be compliant to NIST SP 800-53 for High Impact system.

## X-band Downlink

- The SAN shall utilize X-band downlink for Spacecraft mission data and housekeeping telemetry.
- The SAN shall provide continuous, uninterrupted acquisition of Spacecraft mission data and housekeeping telemetry from the SWFO-L1 spacecraft.
- The SAN shall provide Mission Data and Housekeeping Telemetry at an availability  $A_0 \geq 0.995$  measured over thirty (30) days, including in cases of natural disasters and credible failures.
- The SAN shall stream all SWFO-L1 mission data and housekeeping telemetry to two CONUS points of presence within 2 sec of packet receipt.
- The link margin shall be  $>3$  dB for mission data and housekeeping telemetry.
- Any SAN mission data and housekeeping telemetry elements delivered for NOAA ownership shall be compliant to NIST SP 800-53 for High Impact system.
- Any SAN mission data and housekeeping telemetry services from non-NOAA elements shall be compliant to NIST SP 800-53 for Moderate Impact system or equivalent.

## S-band Links

- The SAN shall utilize S-band for command uplink and housekeeping telemetry downlink.
- The SAN shall provide SWFO-L1 Command capability from the WCDAS and CBU sites at an availability  $A_0 \geq 0.995$  measured over thirty (30) days, including in cases of natural disasters and credible failures.
- The link margin shall be  $>3$  dB for SWFO-L1 Command uplink.
- Any SAN SWFO-L1 Command uplink elements delivered for NOAA ownership shall be compliant to NIST SP 800-53 for High Impact system.
- Any SAN SWFO-L1 Command uplink services from non-NOAA elements shall be compliant to NIST SP 800-53 for High Impact system or equivalent.

## Doppler and Range Tracking

- The SAN shall utilize S-band for coherent Doppler and range tracking.
- The SAN shall accommodate 1 hour of Doppler and range tracking from the northern hemisphere and 1 hour of Doppler and range tracking from the southern hemisphere each day.
- The SAN shall deliver Doppler and range tracking data to two (2) CONUS points of presence.
- The link margin shall be  $> 6$  dB for Tracking.
- Any SAN Doppler and range tracking elements delivered for NOAA ownership shall be compliant to NIST SP 800-53 for High Impact system.
- Any SAN Doppler and range tracking services from non-NOAA elements shall be compliant to NIST SP 800-53 for High Impact system or equivalent.

## Request for Information (RFI) Regarding the SAN

NOAA will use responses to this RFI to inform and support programmatic planning. Responses to this RFI are not intended to be burdensome, rather this is a request for concepts. The Government is seeking information only, with no obligation to reimburse any costs associated with the preparation and/or submission of a response.

### Areas of Interest

Respondents should describe the architecture they propose to respond to the SAN requirements in whole or in part. The approach and concept for antenna scheduling, ranging operations, security controls, and contingency/failover operations should be described. Respondents should disclose if their solution relies on unique or proprietary hardware or software standards. Respondents should also describe any teaming arrangements that are part of their solution.

Supplemental and/or alternative architectures, service agreements, or business arrangements to meet the mission requirements can be provided as part of this RFI response at the discretion of the respondents.

If NOAA were to award elements of the SAN in FY2021, what risks present the greatest challenges to meeting the schedule and what approaches are recommended to address them?

Which aspects of the proposed architecture, service, or requirements drive the cost estimate? Is there an opportunity for cost savings with some performance degradation from the stated requirements, and/or an opportunity for performance improvements above the stated requirements with low cost impact?

How can existing NOAA operational assets/standards be leveraged for the SWFO-L1 implementation?

### Cost and Schedule Estimation

What is the rough order of magnitude (ROM) cost of the non-recurring development of the proposed system, by major subsystem? What yearly phasing of costs is required for the development? What is the cost for 10 years of Operations and Maintenance of the proposed system? What are the key assumptions used in the ROM?

What is the estimated overall schedule and major milestones for providing the proposed system from contract award to system readiness?

### Acronyms

Ao	Operational Availability
Cmd	Command
CBU	Consolidated Backup
CCSDS	Consultative Committee for Space Data Systems
CME	Coronal Mass Ejection
CONUS	Continental United States
DSN	Deep Space Network
Eb/No	Signal Energy to Noise Power Ratio
EELV	Evolved Expendable Launch Vehicle
EIRP	Equivalent Isotropic Radiated Power
ESPA	EELV Secondary Payload Adapter
FAR	Federal Acquisition Regulations
FEC	Forward Error Correction
FER	Frame Error Rate
G/T	Gain over Temperature
GPS	Global Positioning System
HK	Housekeeping

IMAP	Interstellar Mapping and Acceleration Probe
KSC	Kennedy Space Center
LRD	Launch Readiness Date
MOC	Mission Operations Center
NASA	National Aeronautics and Space Administration
NCEI	National Centers for Environmental Information
NEN	Near Earth Network
NESDIS	National Environmental Satellite Data and Information Service
NIST SP	National Institute for Standards and Technology Special Publication
NOAA	National Oceanic and Atmospheric Administration
NSOF	NOAA Spacecraft Operations Facility
OSPO	Office of Satellite and Product Operations
RFI	Request for Information
RFP	Request for Proposal
ROM	Rough Order of Magnitude
SAN	SWFO-L1 Antenna Network
SEV	Sun-Earth-Vehicle
SOH	State of Health
SWFO-L1	Space Weather Follow-On – Lagrange 1
SWPC	Space Weather Prediction Center
TBR	To Be Resolved
TC	Telecommand
TRL	Technology Readiness Level
TT&C	Telemetry, Tracking, and Command
WCDAS	Wallops Command and Data Acquisition Station

## RFI Submittal Instructions

Any questions pertaining to the RFI must be submitted electronically to [David.Marks@noaa.gov](mailto:David.Marks@noaa.gov) not later than 1:00PM Eastern Time on December 6, 2019.

### Additional information requested:

- A. Respondent's name, address, point of contact, phone number and email address.
- B. If a business, then firm's DUNS number and Cage Code as provided under the SAM system.
- C. If a business, then state the firm's SBA certified small business concern status or other socioeconomic status. Specifically identify if your firm is HUBZone-certified, Service Disabled Veteran Owned, Women Owned, or in the SBA's 8(a) program. If your institution is not a small business, please state that it is a large business, FFRDC, university, UARC, or other.
- D. Respondent's previous work experience that is similar to that described above.
- E. Any other pertinent documentation or information.

**Response do not have a page number limit, but we expect the page count to generally be no more than 25 pages.**

## Technical Responses

Technical responses to this RFI will be electronically submitted to [David.Marks@noaa.gov](mailto:David.Marks@noaa.gov) not later than 1:00PM Eastern Time on December 19, 2019. Small business may indicate in its response which areas it is interested in

for possible subcontracting opportunities. The electronic copy of your response must be in a searchable ".pdf format" and readable by the Adobe Acrobat Reader.

#### NOTE:

This RFI is being issued solely for information and planning purposes and does not constitute an Invitation for Bids (IFB), a Request for Proposals (RFP), a Request for Quotes (RFQ) or an indication that the Government will contract for any of the items and/or services contained in this notice. All information received in response to this notice that is marked Proprietary will be safeguarded in accordance with the applicable Government regulations. Responses to this notice will not be returned. In submitting a response, the responder is solely responsible and accountable for all the expenses associated with the response.