

National Environmental Satellite, Data, and Information Service February 28, 2024

NOAA Ground Enterprise Path Forward

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NESDIS Strategic Objectives

Reimagined

OE





Advance terrestrial observational Leadership in geostationary and extended orbits Advance Space Weather observational Leadership in LEO, GEO, and extended orbits. Evolve LEO architecture to enterprise system of systems that exploits and deploys new observational capabilities Develop agile, scalable ground capability to improve efficiency of service deliverables and ingest of data from all sources

Provide consistent ongoing enterprise-wide user engagement to ensure timely response to user needs

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Deliver the best value integrated suite of products and services responsive to user needs



Focus on Establishing the Next Generation Ground Enterprise Architecture 2030-2050

NOAA National Environmental Satellite, Data, and Information Service

Evolving Technology Capability

- Traditional NOAA's ground systems have been based on custom built solutions tailored to meet exacting performance requirements with very high reliability
 - Expensive and time consuming to build and maintain
 - Lack agility to respond to changing mission needs
- Technology Innovation (both flight & ground) has outpaced NOAA's needs
 - What was difficult a generation ago is routine today
 - Many aspects of Satellite & Data Operations can now be delivered through tailoring of off-the-shelf commercial services
- Enables NOAA to buy capabilities that satisfies need rather than build capabilities to meet requirement

Evolving Observing Needs

- Escalation in supported missions driven by:
 - Disaggregation (multiple satellites to carry the observation suite)
 - More rapid refresh (small shorter-lived satellite refreshed more often)



- >3x increase in operational satellites
- >2x of
 pre/post
 operational
 satellites



Sustainability Impact



Mission Cadence in 2035-2050 era will drive costs to exceed current spending levels

 O&M increases from 17% to 21% of Budget

Most alternatives considered can reduce O&M costs to below current spending

- O&M ranges from 9% 13% of budget
- Significant cost avoidance over Baseline



NGES Technology Results

Functions	Space to Ground	Mission Operations	Product Ops	Data Delivery	Algorithm Ops	Environmental Info Ops
Cycle 2 Tactical Recommendation	(LEO) Commercial Ground Station Services	Enhanced NOAA Operations	High Assurance - Demand Driven Production	Commercial Satellite Delivery for COOP and High- Availability products	Shared Infrastructure CSP	Multi-vendor Cloud Archive
Cycle 2 Recommendation Why?	Maximize Exploitation of Commercial Ground Services for LEO Investment to reduce unknowns/risks related to Space-Based Relay. Retain NOAA Ground Stations for GEO & SWO (CONUS)	Enhanced NOAA Mission Operations provides the cost benefits of commercial cloud- based business practices with operational assurance	High Assurance Deployment - Demand Driven production augments data driven production by providing both the flexibility while maintaining operational assurance	Commercial Sat. Com. delivery of High Availability Products for Severe Weather / COOP operations	Shared development infrastructure that has removed technical barriers for access to data and resources for research activities and facilitates agile promotion to operations	Multi-Vendor Cloud Archive provides flexibility and assured operations in alignment with Archival Best Practices
Cycle 2 Strategic Recommendation	Space-Based Data Relay (SBDR)	Combining Enhanced NOAA Operations with outsourced options.	High Assurance - Demand Driven Production	Commercial Cloud Services	Shared Infrastructure CSP	Multi-vendor Cloud Archive
Cycle 2 Strategic Recommendation Why?	Space-Based Data Relay (SBDR) is still considered the long-term solution for LEO and provides flexibility to improve global latency as user needs evolve NOAA Next Gen Ground Stations for CONUS downlink is likely to remain the most cost effective, and provides operational trust & assurance when combined with SBDR	Supplementing Enhanced NOAA operations with Outsourced operations for LE/EOL & LEOP will provide the operational agility needed to support a dynamic collection of observation assets	High Assurance Deployment - Demand Driven production augments data driven production by providing both the flexibility while maintaining operational assurance	Migrate downstream processing (stakeholders) to cloud services	Shared development infrastructure that has removed technical barriers for access to data and resources for research activities and facilitates agile promotion to operations	Multi-Vendor Cloud Archive provides flexibility and assured operations in alignment with Archival Best Practices



NESDIS Enterprise Strategic Path Forward





Enterprise Alignment Approach Achieving the NESDIS Strategic Enterprise Goal



Commercial Services Evolution

- The Commercial Services IPT is an OCS led initiative formed to:
 - Investigate the commercial sector's ability to support OCS' establishment of a NESDIS cloud-based common services enterprise ground system
 - Evaluate suitability for adoption of enterprise aligned commercial capabilities into OSGS provided common services
 - Identify a common set of approaches to incorporate core NESDIS Satellite Communications and Mission
 Operations (SCM/MOP) capabilities into the NESDIS Common Cloud Framework (NCCF)





Tailored Market Research in service of NESDIS Tactical and Strategic Objectives

What is Enterprise Alignment?

An SCM/MOP functional capability **supportive of the following**:

- A **Climate Ready Nation** NESDIS Strategic Plan FY22-26
 - STRATEGIC OBJECTIVE 1.5: Enhance Comprehensive Observations and Monitoring Systems
 - 1.5.3: Expand Commercial Partnerships and New Technology
 - 1.5.4: Improve Common Source Data Integration and Common Ground Services
- NESDIS SIP Strategic Objective number four:
 - **Develop agile, scalable ground capability** to improve efficiency of service deliverables to support data from all sources
- National Space Weather Policy
 - Purchase and use United States commercial space capabilities and services, to the maximum practical extent
 - Prioritize partnerships with commercial industry
- NESDIS Ground Enterprise Study (NGES) Business Case aligned with NGES study considerations and capability roadmap
- External Partnerships NASA, USSF
- CS IPT analysis weighed against SCM/MOP evaluation criteria
 - Represents a common service with Enterprise convergence potential



Commercial Service Evolution - Activities Overview

Cloud Based Software Defined Radios (SDR) - Broad Agency Announcement (BAA) FY24

- Vendor conducted demonstrations of cloud-based software defined radio (SDR) capabilities
- Assess feasibility for incorporation into NCCF in support of NESDIS enterprise aligned common service objectives

Enterprise on-ramp considerations

- Cybersecurity implementation evaluation underway by ACIO-S
 - Radios historically considered an appliance
 - NIST has recently circulated draft guidance
 - USSF cybersecurity testing conducted by OSPO/ACIO-S
- Differences in cloud-based versus virtual hardware need to be evaluated

Technology attributes

- Mature TRL
- Interoperable with AWS and MS Azure Cloud Service Providers (CSPs)
- Modular, flexible, scalable architecture
- Support LEO, GEO, SWO extensible to new missions
- Reduces hardware footprint and associated OM&S costs

Space Based Data Relays (SBDR) - SAE Ground BAA FY24

- Market Research for rapidly emerging commercial SBDR capabilities
- Multiple awards for FY24 vendor studies and demonstrations

Enterprise on-ramp considerations

- Rapidly emerging commercial utilization
- Interoperability and Orchestration
- Mesh network many to many untethered to ground stations
- TDRSS NASA targeting commercial service replacement by 2030

Technology attributes

- Maturing TRL
- Space Development Agency (SDA) OISL open standards for interoperability
- High-rate data, low latency (real time), increased security
- Modular, flexible, scalable architecture
- Reduced NTIA spectrum compliance



Commercial Service Evolution - Activities Overview

Phased Array Antennas (PAA) - L3Harris Phased Array CRADA (Completed 12/31/23)

Completed in situ field testing of phased array capabilities against NESDIS mission sets at FCDAS

Enterprise on-ramp considerations

- PAA Technology advancement is emerging and fluid
 - USSF awarded \$1.4B in FY22 to Blue Halo for development
- Disruptive technology and/or industry-funded efforts may significantly drive down costs
- NESDIS should continue to monitor advances and conduct market research
 - NESDIS needs high TRL functionality for X/Ka-band downlink

Technology attributes

- Emerging TRL
- Current capabilities are limited (L/S-band)
- Scalable and extensible to new missions
- Strong LEO business case GEO/SW unproven
- Reduced hardware footprint
- SDR integrated with PAA in some designs

Cloud Based Mission Operations (MOP) - POES Extended Life Acquisition (Commercial Contract ongoing through 2026)

- **EASI** JPSS antenna Scheduling and Mission Management development ongoing in FY24
- MOP Business Case Developed and briefed in FY24

Enterprise onramp considerations

- High TRL
- Number one NGES study recommendation
- Next step in NESDIS roadmap progression

Technology attributes

- POES EL is underway FY22 FY25
- Cloud-based, virtual platform solutions and hybrid approaches
- Interoperable across AWS and MS Azure Cloud Service Providers (CSPs)
- Modular, flexible, scalable architecture
- Primarily LEO w/ some applicability to GEO and SWFO



NESDIS L3Harris Phased Array CRADA – One Sheet

Overview

- Cooperative Research And Development Agreement (CRADA) with L3H to demonstrate next generation antenna capabilities. No funding exchanged. Jan 3 – Dec 31, 2023
- Fulfilled NESDIS SIP/AOP milestone, NGES and CS IPT enterprise roadmap and common service planning objectives
- Provided critical market research for commercial LEO business case; JPSS and OSPO GS infrastructure assessment





Technical Capabilities Demonstrated

- L/S-band live at Fairbanks Data Acquisition Station (FCDAS) Aug-Oct 2023
 - 400+ satellite contacts per day at LEO and HEO orbits
 - 8 simultaneous live satellite D/L contacts
 - Validated SNPP telemetry through JPSS ground system
 - Successful SNPP uplink commanding (27 NO-Ops)
 - Onboard RFIMS and sky search capability
- Generation 2.0 X-band capability L3Harris anechoic chamber (Melbourne, Fla) June 2023
 - 8 simultaneous telemetry downlink contacts
 - 10x power reduction and 4x cost reduction

NESDIS Enterprise Automated Scheduling Tool – One Sheet

Overview

- EASI's strategic goal is to provide a common Mission Specific Scheduling & Deconfliction support across NOAA NESDIS Missions
- Developed to facilitate a common interface for scheduling across all NOAA Command and Data Acquisition Stations (CDAS)
- Fulfills NESDIS SIP/AOP milestone, NGES and CS IPT enterprise roadmap and common service planning objectives

Technical Capabilities

- EASI utilizes lightly customized Orbit Logic COTS Software (e.g. STK Scheduler & Scheduler Online)
 - Containerized within Windows Docker
- Provides a Web Based Scheduling User Interface
- Compliant with NOAA/NEDSIS IT Security Requirements
- EASI was developed to meet current Ground System Interfaces
 - Reuses existing ICD and Design Specs; where as possible
 - All inputs and outputs are file based (e.g. Flat Files, XML, etc..)

Functional & Operations Readiness

- Operations Readiness Ongoing to support Several NOAA Missions & Partners
 - Shadow Operations Underway for NOAA DSCOVR
 - Verification Testing occurring in support of Replacing existing NOAA JPSS Mission Planning Capabilities
 - Supporting USSF Federal Augmentation End-to-End Scheduling Testing with NOAA CDAS
 - Starting Functional Checkout of replacement SOMS Scheduling Capabilities (In support of various USGS, NASA and Eumetsat Missions)
 - Forecasting Future Integration Activities with additional On-Orbit and Planned NOAA Missions



Figure: EASI Scheduling Interface (Sample)



Enterprise Alignment Approach MOP Case Study - POES Extended Life



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POES Mission Operations Value Assessment

 The POES Constellation and Ground System was initially forecasted to be decommissioned by the end of CY22.

- In November 2021 NESDIS Leadership approved the POES Extended Life (EL) Approach, given the Mission starting in CY23 would be operating in an best effort, data of opportunity manner.
 - This required POES EL activities focus primarily on Schedule and Cost, Technical Risk can be accepted
 - Thus the POES Mission Business Case transitioned to allow the use of more Radical and or Emerging Business Alternatives
- NESDIS Requested all POES EL activities be executed with the below Guidelines:
 - Allowing for a graceful ramp down of POES Operations via Best Effort
 Operations through at least FY25 using a Commercial Ground System
 - Incentivizing growth of Commercial Industries Cloud Based Command and Control Capabilities, to further understand approaches to achieve Strategic NESDIS Cloud Development Goals
 - Allowing a full Decommissioning of the Legacy POES Command and Control Ground System within 1 Year from Contract Award
- In achieving POES EL Milestones, NESDIS will gain valuable insights assisting in the inclusion of Command and Control functions into the future NOAA Enterprise Architecture

			POES EL Approach			
Attribute		Current NOAA Approach	Emerging Alternative	Enhanced NOAA Alternative		
Timeliness of Implementation		R	G	Y		
Scalability of Missions		G	Y	G		
Availability (Performance)		Y	Y	G		
IT Security		Y	Y	G		
Budgetary Performance		R	G	Y		
	Targeted Use of Emerging Satellite Operations Alternatives					
	Incorporation of Alternatives into					



POES Extended Life – Overall Mission Scope

- The POES Extended Life Mission was scoped in the following manner:
 - POES Operations remained on the Legacy Command and Control (C2) instance until successful Transition of individual satellites to POES EL
 - O Post Transition, the Legacy POES C2 was Decommissioned and Resources reallocated across remaining OSPO Missions
 - On-Prem ESPC Polar Prod (Level 2 Products) remain operational and processing POES data through FY25
 - OSPO Spacecraft Flight Engineers will remain on mission, at an decreased LOE, to provide On-Orbit Engineering Support, as required
 - POES EL Contract Commercial Ground System as a Service (GSaaS) Command and Control Capability
 - **O** Contract Type: FFP GSaaS and Operations w/ Labor Hour Transition Component
 - O Contract Ceiling: \$16.5M w/ 3 Year POP; Options exist to decrease cost due to Satellite Failure
 - Parsons provided a commercially delivered C3 Solution, including Operations and Maintenance, within a secure Azure GovCloud Environment
 - O Antenna Services will be provided in full by Commercial Vendors (e.g. KSAT, Parsons Corporate)



POES Extended Life – Concept of Operations

- POES Extended Life is a Significant Change from the legacy POES Concept of Operations; Key Highlights Include:
 - Integration of POES into the existing Enterprise Parsons Ground Architecture supporting other Missions
 - Migration of the Command and Control Subsystem into an Primarily Microsoft Azure Cloud Environment
 - Migration from an L-Band Science Mission Downlink to an S-Band Command & Control + Science Mission Downlink Profile
 - Transition to 9x5 Operations, with No Performance or Latency Requirements levied on POES EL Science Data Collection



POES Extended Life – C2 Cloud IT Security Approach

• NESDIS ACIO developed an approach so an Commercial Cloud-Based Ground System could comply with NOAA Security Requirements while remaining outside of an NOAA FISMA Boundary

	POES EL Approach		
IT Security Function	Contractor-Owned Approach (POES EL)	NOAA Controlled Approach	
Governing Framework	NIST Risk Managem	ent Framework (RMF)	
System Security Plan	Contractor Owned, Government Reviewed	Government Owned, Government Approved	
IT Security Control Compliance	ISO/IEC 27001 or NIST 800-53 Rev 5	NIST 800-53 Rev 4/5	
Continuous Assessment & Accreditation	Contractor Performed, Government Reviews Artifacts	Government Owned, Government Executed	
Continual Security Monitoring	Contractor Performed, Government Accessible	Government Owned, Government Executed	
Required Deliverables	Service Level Agreement (SLA) Interface Control Document (ICD) Information Security Agreement (ISA) Government visibility into Contractors' Continuous Monitoring (CM) dashboards	System Security Plan (SSP), Government-led annual assessments (SSA) and continuous monitoring (CM) Business Impact Assessment (BIA) Business Continuity Plan (BCP) Etc	



POES Extended Life – Transition Execution Summary

- The POES Extended Life Contract expected an transition be completed 6 Months from Contract Award, but was ultimately extended through 14 Months.
 - Baseline (Award to 6 Months)
 - Commercial Authority to Operate(ATO) Issuance
 - o Initial Standup of the Command and Control Azure Instance
 - o Initial End-to-End testing from the Azure C2 Instances to KSAT Lite Antennas
 - Extension #1 (6 to 12 Months)
 - o Completion of Ground System Verification Activities
 - Completion of the Spacecraft Concept of Operations Testing
 - o Transition of the NOAA 18 Spacecraft
 - Extension #2 (12 Months to 14 Months)
 - Transition of the NOAA 15 and NOAA 19 Spacecraft(s)
 - o Decommissioning of the Legacy POES Command and Control Ground System

- **Constraints and Delays** that impacted the Transition, included:
 - Integration of Legacy Capabilities (e.g Simulators, Ground System Configurations, Mission Planning, etc...)
 - Operations Validation of the POES EL Concept of Operations
 - Azure Cloud Network Configuration
 - Ramp Up of Resources around Award





NOAA Ground Enterprise Path Forward Conclusion



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Commercial Services Demonstrations



Enterprise Path Forward Conclusions

- Current NESDIS operational services are not future proofed
 - Operational costs are projected to become a larger fraction of the NESDIS budget
 - NESDIS will need to change its business practices going forward in order to achieve affordable adaptability and resilience
 - Current Satellite Operations capabilities requires further strategic Evolution and Innovation to meet NESDIS Forecasted Constellations
- Emerging technologies and business practices offers a path forward
 - Cloud-based solutions reduces hardware footprint through reduced redundancy
 - New technologies improve asset utilization through multi-mission use
 - Buying commercial services reduces up front investment and ongoing sustainment costs while providing operational scalability
- Further NESDIS demonstrations will assist in the Identification of Common Services & Architectures



Questions?

