Lessons Learned: POES as a Pathfinder for Commercialization using a GSaaS Solution

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Abstract

Just 438 days after the initial kick-off meeting, the National Oceanic and Atmospheric Administration (NOAA) successfully transitioned its aging Polar-Orbiting Environmental Satellites (POES) fleet—NOAA-15, NOAA-18, and NOAA-19—from traditional government operations to commercial, cloud-based operations. This shift marked a significant milestone as NOAA adopted a Ground System as a Service (GSaaS) approach under a new contract called POES Extended Life. The transition supports continued use of these legacy satellites, which, while no longer the primary weather and climate observation tools, still offer valuable supplementary data from low Earth orbit. NOAA awarded the GSaaS contract to Parsons Corporation and its partner ASRC Federal, who utilized the Kongsberg Satellite Services Lite ground antenna service. The new ground system, hosted in Microsoft Azure Cloud, is set to operate at least through September 2025. Moving spacecraft (s/c) launched between 1998 and 2009 into a modern architecture presented major challenges. However, through close collaboration between contractors and NOAA's internal teams, the effort successfully integrated cloud-based control and data services, including s/c health monitoring with real-time alerts via SMS. The result is a leaner, more flexible, and geographically distributed operations model. Virtual operations eliminate the need for centralized control rooms and physical presence, reducing costs and increasing resilience. Automation has also minimized the need for constant on-console staffing while maintaining mission effectiveness. Now, more than a year into operational status, the project stands as a successful pathfinder example for federal agencies aiming to modernize satellite operations. Project stakeholders are openly sharing their technical lessons, implementation experiences, and organizational insights to help other agencies embrace cost-effective, cloud-based solutions while pursuing operational excellence.

Keywords: commercialization, modernization, cloud, GSaaS, NOAA, POES

Acronyms/Abbreviations

commercial-off-the-shelf (COTS)
concept of operations (CONOPS)
cooperative research and development agreement (CRADA)
ephemeris loads (EPHEM)
European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT)
Factory Compatibility Tester (FCT)
Federal Communication Commission (FCC)
global area coverage (GAC)
government-furnished equipment (GFE)
government-owned, government-operated (GOGO)
Ground System as a Service (GSaaS)
high resolution picture transmission (HRPT)
Kongsberg Satellite Services (KSAT)
Kongsberg Satellite Services Lite (KSATLite)
NASA Procedural Requirements (NPR)
National Environmental Satellite Data and Information Service (NESDIS)
National Oceanic and Atmospheric Administration (NOAA)
NOAA Satellite Operations Facility (NSOF)
Operations (OPS)
Office of Satellite and Product Operations (OSPO)
Polar-Orbiting Environmental Satellites (POES)
POES Extended Life (POES EL)
Raven Industries antenna in Albuquerque, NM (ROOST)
Request for proposal (RFP)
satellite operations center (SOC)
Satellite Operations Management Subsystem (SOMS)
spacecraft (s/c)
Special Temporary Authority (STA)
statement of work (SOW)
Stored Command Table (SCT)
Subject matter expert (SME)
Svalbard (SVL)
technical interchange meeting (TIM)
telemetry, tracking, and commanding (TT&C)
Time Stamp File (TSF)
TIROS Emulation Processor (TEP)
validation and verification (V&V)

1. Introduction

The first s/c of the NOAA-K series started development with the contract awarded to Lockheed Martin in the early 1990s (as shown in Figure 1). This was the beginning of the new generation of polar orbiting s/c equipped with a suite of instruments to gather data for weather predictions and other Earth science observations. Launched on May 13, 1998, NOAA-15 began operations following the traditional GOGO model for ground operations and data delivery. NOAA-18 launched May 20, 2005, and NOAA-19 launched February 6, 2009, both s/c being added to the ground system stood up to support this series.

NOAA's next-generation fleet, the Joint Polar Satellite Series (JPSS), introduced a sophisticated new ground system when it became the agency's primary mission from low Earth orbit in 2017. However, the older satellites—NOAA-15, NOAA-18, and NOAA-19—remained valuable providers of complementary Earth science and weather information. The benefit of this supplemental data led NOAA to pursue an innovative commercial GSaaS approach that allows older satellites to operate within an efficient, sustainable commercial cloud architecture.

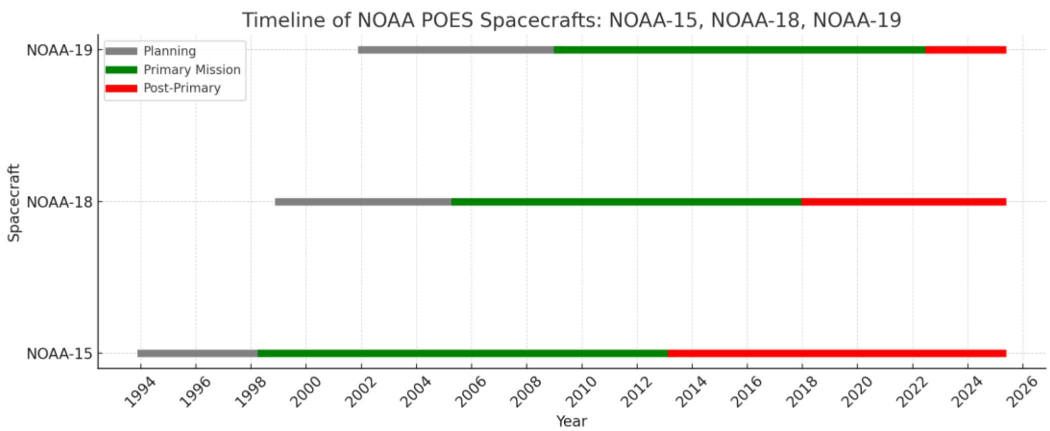

Fig. 1. Timeline of NOAA Spacecraft Phases.

1.1 Advantages of GSaaS

The traditional GOGO model includes an expensive, customized ground system maintained through sustainment contracts [1] that operate separately from engineering support. At NSOF in Suitland, MD, for example, civil servants work in shifts to support 24x7 operations. The move to virtual operations eliminates the need for on-premises operations rooms, enabling geographically diverse teams to support the fleet in real-time without transportation delays or physical location requirements. Automation and optimization have reduced on-console support while fully meeting proficiency and delivery requirements.

NOAA began investigating moving older satellites from the stovepipe legacy ground system and operations to a cloud enterprise system. This effort began with a CRADA [2] for the POES mission in June 2021, during which Microsoft used Azure to successfully process real-time telemetry and send a command to the s/c. A formal RFI was issued in April 2022 that kicked off the RFP process for which Team Parsons secured the contract to transition POES s/c operations.

1.2 POES EL

In September 2022, NOAA awarded a contract to Parsons Corporation for the POES Extended Life (EL) program, enabling the continued operation of the NOAA-15, NOAA-18, and NOAA-19 satellites beyond their expected lifetimes through a cloud-based, commercial engineering services contract. The SOW summary objective states, "The Contractor shall provide a GSaaS capability, in the form of engineering services and information technology (IT) functionality, to assume on-orbit operations responsibilities for the NOAA-15, NOAA-18, and NOAA-19 observatories." This single statement encompasses a broad scope of end-to-end service responsibilities, including Tier-1 engineering support that was set up as a pathfinder for the government finding a lower cost solution to traditional OPS.

Parsons teamed with ASRC Federal as their bid partner, jointly referred to as Team Parsons, to implement the system. Parsons also engaged the KSATLite ground antenna service, using highly available antennas from their SVL site at 78°N, Tromsø, Norway to provide downlink and uplink services.

On November 28, 2023—just 438 days after the kick-off meeting—NOAA transitioned the POES fleet to commercial operations utilizing a GSaaS solution. This trio of polar satellites, previously primary data sources for NOAA's space-based weather and climate data, is now operated through POES EL and exceeding the performance requirements outlined in the SOW.

2. Methods: Transitioning from Legacy to Modern Technology

NOAA's goal was to transition operations to the POES EL GSaaS as soon as possible. The rapid changeover was driven by the increase in new s/c joining the NOAA fleet, and the opportunity to demonstrate how modern applications and a skilled team can lead to quick deployment, particularly when compared to the lengthy development time of traditional ground systems. To accomplish this, several key items were a focus during execution: utilizing COTS products, maintaining transparent communication, defining the known versus unknown aspects of these specific OPS and s/c, mission planning, engineering, networking, network utilization, lean documentation, addressing GSaaS challenges, and enforcing project management rigor.

Additionally, it should be noted that NOAA's issuance of the email notification to its data product users set a critical foundation for expectations of this 'best-effort' mission, including potential disruptions during the transition with estimated date. Titled "Administrative: POES Data Outages - POES Extended Life (EL) Transitions" and dated April 12, 2023, established new expectations for the support and data to be provided from the POES fleet, enabling both testing and experimentation with OPS. The email stated:

> "Polar Operational Environmental Satellites (POES) Extended Life (EL) is an NOAA initiative to extend the value of the older POES satellite constellation under a best-effort approach. Starting this year, POES data that was once operationally supported will migrate over to a data of opportunity service, as available. Due to this new approach, contingency data recovery will not be performed and extended data disruptions could occur periodically because of operational constraints."

2.1 Utilizing COTS for Parsons Product Line

The Parsons COTS product line for GSaaS activities was key to accelerating the transition schedule and integral to readying the program to meet NOAA's implementation goals. Some of the key products included OrbitXchange™, Ace FCT, SatFlyer™, and Ace CtrlPoint™.

The s/c compatibility, antennas, and system were pre-screened using the Ace Factory Compatibility Tester (FCT), which validates s/c as part of the onboarding for compatibility with OrbitXchange™ and Satellite Control Network (SCN) communication links. Any required data translations are identified at this stage, prior to live link testing.

OrbitXchange™ is used to schedule contacts with the s/c. Using this product, POES EL leverages excess time on existing antennas to provide an automated, cybersecure satellite communications solution that is tested with on-orbit assets in an operational environment. The operational use of KSATLite antennas at SVL requires communicating with KSATLite's scheduling system to assess the resource availability. The POES EL operators can then schedule any available antenna time to meet the needs of the POES schedule through OrbitXchange™.

The end-to-end mission design was planned using the SatFlyer™ toolset. Weekly scheduling was modelled for flight dynamics, providing orbit calculations and attitude determination for locating a s/c and its orientation. This modelling enabled the implementation of lights-out operations with accompanying TT&C automation.

The last and most used product by the POES EL team is the Ace CtrlPoint™ application. Ace CtrlPoint™ is an automated space vehicle and ground station command and control application with a plug-in architecture that provides nearly lights-out TT&C operations. The solution offers overall situational awareness of SOC hardware and software, including ground station status and satellite vehicle data, to give operators an easy-to-use, automated, and customizable product that ensures they can focus on what's important: the mission. The application's capabilities reduced integration time and cost, lowered the manpower needs for operations, improved operational efficiency and performance, and facilitated smoother engineering support by being easily adapted to resemble the legacy system through minor visual tweaks. Minor tailoring of the user interface made the visual transition between legacy and commercial system easy for both the POES legacy experienced team and the POES EL operators.

2.2 Project Kick-off and Early Changes

From the start, a strong relationship of trust was built between Team Parsons and NOAA. This openness allowed both parties to engage in transparent, meaningful conversations and share challenges openly. As a result, right sizing the staff and detailing the project's technical needs was accomplished in tandem, resulting in more expedient testing.

Staffing and operational planning highlighted opportunities to reevaluate the practical constraints of minimal and efficient operations. The initial bid proposed staffing two senior engineers to also serve as operators. ASRC Federal was listed to provide these key personnel, who would serve as engineers and operators—in addition to their full-time positions supporting Tier-2 responses to s/c anomalies and monitoring safety and health on another contract.

As Team Parsons reconsidered its approach with a stronger understanding of the project's operational requirements, they agreed that the original plan was not viable. Instead, ASRC Federal identified the specific skills needed for satellite operations, decoupling them from the responsibilities of experienced, cross-utilized senior engineering personnel. The search began for two ambitious operators who would excel in a testing environment, then transitioning them into operations. The new operators were hired two months after the contract award and proved integral to the success of the mission due to their flexibility, eagerness, and can-do attitude. The program also benefitted from the operators' complementary backgrounds: one operator had satellite operations experience from their time serving in the military, while the other was a mathematic major interested in applying their analytical skills to an aerospace career.

Documentation provided on the fleet and legacy ground system was a large data dump of information organized according to the legacy system's operational logic and organizational branch structure. A thorough review, reorganizing and metadata-tagging to align to the proposal requirements would have made it easier to locate the information most relevant to meeting contract requirements.

Similarly, the legacy expectations of the system and how they were used by existing operations was not well defined during the RFP process. For example, the TSF requirements were not listed in the SOW; instead, they were generically listed in the "Perform Telemetry Decommutation and Analysis" section of the SOW as an analysis of "On-board Clock Drift and Error Messages." Once fully understood, it was clear that the TSF requirement was critical to science processing and necessitated access to data that was unavailable through a subcontracted antenna vendor. This activity could not be fully transitioned until a Parsons-owned antenna was brought online. While this was part of the execution OPS plan, other hurdles delayed its deployment and resulted in reliance on a daily pass at the Wallops ground station to complete this activity during that time. Additionally, to gain more confidence and trending with the TSF, we continued Wallops contacts beyond TTO to enable more calibration and system optimization.

The specific requirements for downlink filtering also became a challenge. Focused on mission success, OSPO's Mission Operations Division facilitated a TIM with current site operators to clarify these technical needs. The collaboration with the boots-on-the-ground at NOAA's Fairbanks station, also supported by ASRC Federal, ultimately provided the information needed to hone the downlink configuration to refine the necessary filtering.

Additionally, the lessons learned from the CRADA, and previous commercialization test activities were not initially shared with Team Parsons. When this information was made available, it resulted in a faster resolution in testing. Having this information earlier in the development cycle would have resulted in more targeted, productive testing than was possible with only the documentation provided at kick-off.

2.3 The Known vs. Unknown

In addition to the information shared at or near kick-off, there were other items that were unknown as the team executed the initial transition, and some things that were out of their control. These challenges led to occasional delays; most were able to be overcome through collaboration and communication.

2.3.1 Delay in Spectrum Authority

The team knew from the outset that each transmission site would require a spectrum license. However, each site necessitated a different approach due to existing spectrum utilization and licensing conditions.

The first antennas brought online for POES EL were provided by KSATLite at SVL. As NOAA was already using KSAT antennas at SVL for existing POES operations, the essential frequency licenses were in place. KSAT's confirmation of the existing transmit license was the fastest approach for this site, as the license could apply to the KSATLite service as well. The only remaining step was identifying which specific antenna(s) would be used for POES EL operations and applying the license to those resources.

In contrast, the antenna in New Mexico was not initially approved for transmit nor previously configured to support POES. To help expedite the approval process, NOAA submitted a federal STA request through its Spectrum Management Office, followed by a permanent request through the National Telecommunication & Information Administration (NTIA). Based on the experience of the Parsons spectrum manager, NOAA's internal STA submission was the fastest path to authorizing use of Parsons' New Mexico antenna; NOAA agreed that the NTIA channel available to government agencies was faster and easier than the FCC route used by most private entities. While the FCC path is a viable and usable option, it involved additional cost, more forms, and longer processing periods. Even with NOAA's support, a site license took over a year to secure. The misalignment between the pace at which antenna sites are being brought online and the length of the licensing process remains a challenge to future commercialization efforts.

2.3.2 Data Format Housekeeping

The POES mission was developed prior to data standardization from Consultative Committee for Space Data Systems (CCSDS), meaning requirements for the space-to-ground interface control were unclear and required extensive custom code, particularly for the 'newer' instruments' housekeeping data decommutation. At the same time, it was observed that there was some elegance in appropriately simplifying what was necessary to meet the needs and process effectively of these older s/c with eight-character pneumonics. Both the complexity and elegance were challenging in development and resulted in more complex load builds, thus an increase in time to complete that product build process by operators.

2.3.3 Integrating the Simulator

Getting the simulator integrated into the test bed was a priority, as one of the most critical elements of testing was validating the pneumonics through the simulator. Per the agreement, any items sent to the s/c had to be validated with an existing POES engineer in parallel with an operator running it through the simulator. This approach increased confidence in program success by having the TEP in the loop for testing. While understand the importance of this task, integrating the GFE tools into the POES EL architecture was a struggle, as the tools were not easily transferable to a cloud architecture.

After the first simulator arrived onsite at the Parsons Colorado Springs facility, the team engaged colleagues across their organization to find someone with the necessary skills and DECnet expertise to communicate with the sim. This effort required development of a proxy service on the Serial Interface Gateway (SIG) to translate TCP/IP traffic to DECnet for the TEP to be able to understand the output. This resource was found by openly sharing issues in team meetings and a team member raising their hand to step up with their prior experience – a testament to the can-do attitude of team members across the Parsons organization in Colorado.

2.4 Mission Planning

Mission planning is one of the most critical functions in the POES EL program and took the largest effort to accomplish in the desired implementation. The work is primarily captured in one line of the SOW: "Perform generation and uploads of SCT loads and EPHEM." However, legacy systems bring a lot of tech debt with them, as each system had its own scheduling system, tools, operations, and other complicating nuances.

2.4.1 Building an Operator-Driven Tool

Creating the mission planning functions required reverse-engineering actual data from the SOMS to build test cases. Reviewing SOMS code showed anomalies between the math specifications and SOMS data outputs, enabling the team to discover some programmatic nuances within the builds. The lead for mission planning analysed six months of data to identify these differences and recognize the cyclical nature of these requirements, then built most of them in advance of the testing phase. His expertise in orbital dynamics also helped to distinguish between true cyclical activity and anomalies caused by other activities.

Some underlying assumptions, such as how RFI connections affected pass assignments, were not immediately understood. Additionally, the full scope of mission planning requirements, including ephemeris generation, was not originally defined. This led to some scheduling delays, as the POES legacy scheduling system rules for creating the on-board schedule were not easily extracted from the legacy POES SOMS.

POES s/c ephemeris was also generated by the SOMS and required replicating a specialized format that took considerable time to reproduce within the required tolerances of the current generation. The POES ephemeris system was very customized, with math specifications that were critical to astrodynamics software for physics calculations. For low Earth orbit mission parameters, nuanced cyclical behaviors could cause "hiccups" in operator builds. The team validated the system's behaviors by running the code back three to six months to ensure most scenarios were captured.

Having access to the algorithms from the s/c provider would have helped the process. These algorithms could have explained many design assumptions and nuances, thus reducing development time. Older s/c pneumonics were limited to only eight characters without the modern convention of easy to read, descriptive identifiers; extended documentation would have helped the team more easily interpret legacy naming schemes.

Related to mission planning was the need to account for onboard clock drift, which affects the post-processing of the payload data. This added the complexity of building a schedule with multiple stations, especially recognizing the TSF generation required complete control of the ground station to capture time stamps at specific equipment in the downlink chain. Parsons used its own ROOST antenna in New Mexico to ensure full control over the downlink environment and this was built into a regular three-times a week cycle for mission planning.

A major goal as the program transitioned from development to steady-state operations was moving the SCT loads and EPHEM from a technical SME responsibility to operator generation. This required designing a truly stand-alone product capable of operating reliably for users without an astrodynamics background. This was a great achievement for this project, given its complexity and the legacy nature of the program.

2.4.2 Engineering Experience and Teamwork

Upfront engineering was essential to determining what the s/c needed before progressing too far in development. Utilizing experienced engineering partners helped identify which unique items were critical to the s/c and which could be set to a default. It was key to prioritize and triage comments on the legacy system – asking: is it a requirement, a desire, or an artifact of legacy operations? The dedicated, knowledgeable vehicle and ground team were key to prioritizing and triaging legacy system behaviors. Additionally, NOAA's willingness to experiment and innovate alongside Team Parsons was instrumental to producing an efficient, reliable system.

The experience of the s/c and instrument engineering team was critical to explaining the commands in the SCT loads—and in supporting the operational approaches that hadn't been tried before. Their Tier-2 engineering proved far more valuable than the technical documents established at the beginning of POES's operations lifecycle; their real-time feedback and willingness to experimentally collaborate made the project possible. Value was derived through quick feedback and online interactions and experimentation partners to try things in different ways. For example, the Tier-2 engineering team proposed a shift from daily SCT 30-hour SCT uploads to twice-weekly, five-day SCT. The changeover had been of interest to the team for some time, and the POES EL model allowed—and encouraged—exploring new efficiencies.

The most complex step proved to be building the EPHEM. As EPHEM is established as a weekly load, live testing is limited based on the EPHEM cycle. The once-per-week cycle for testing bug fixes slowed the V&V process down, especially when compared to TT&C items that can be tested roughly 14 times per day. Team Parsons worked with the Tier-2 engineering team to overcome the cadence disparity by collaborating with the Tier-2 engineering team, who reviewed all EPHEM loads on a weekly basis.

2.4.3 Future Mission Planning

There is future value to the virtual exchange for scheduling. As space networks become more complex—as commercial ground stations operated by different vendors spread across the globe and the spectrum grows more congested—mission planning software needs to account for dynamic s/c prioritization.

Building logic rules for mission planning is challenging, even before managing the increasing complexity of traffic, communications constraints, and operational diversity. Starting with an established and proven COTS software is key to accelerating support and operations. Additionally, creating a system that can produce the loads by personnel on the team, such as operators, enables a focus on product improvements and keeping the SMEs focused where their efforts will have the most impact.

2.5 Engineering

One of the biggest obstacles was changing entrenchment regarding what was required to maintain the s/c versus why we were operating it the way we were under the legacy system and OPS plan. This led the team to determine what was the minimum required operational activities and timing of those activities. Since POES was being reclassified as a NOAA 'best-effort' mission, a modified definition of expectations was needed. This changed the expectations for anomaly response for non-critical health and safety anomalies and relaxed the data capture requirement.

Another added improvement was the on-demand trending system which enables zooming easily in and out of the data available to better see finite and long-duration trends. This flexibility created for anomaly investigation did have a trade-off; it requires extra effort to compile full and multiple year data on the POES EL system as there is not a current ability to export reports (PDF or images) nor txt file extracts. This full and multi-year capability is an artifact of the long-running legacy system and how the operations evolved based on this functionality. In the end, it was agreed that a screen capture worked as a good substitute for daily management needs and a waiver was put in place for the annual report. More clarity on specific requirements that are embedded in long-term operations like this would have established better priorities from the start, based on the breakdown of the engineering team such as this item for SatCentral™.

To ease the system change, Parsons was able to transition the POES legacy telemetry pages to POES EL therefore making the system look like the current ops system, allowing easy transitions for Tier-2 Engineers to continue supporting OPS. Team Parsons was also able to a take all the command procedures for nominal and contingency operations and convert them via a script.

One simulator was sent to Parsons's facility to begin integration for testing of the ground system, verify all the procedure updates to command the s/c, and validate the stored command loads. Very early into development, when testing of those products began along with testing of other adjustments to the GSaaS, an additional simulator and additional DEV environments were stood up to support the team's velocity This was supported with a new sim build by NOAA and shipping to Parsons to integrate into the network.

Modifications being implemented to the COTS systems were key to the success, but also led to issues tracking all the fixes resulting in a more widely attended daily tag-up leading up to transition to operations. All parties informally started to realize action tracking was needed. The management of this activity moved from the project and engineering management to a new role formally established as we moved into option year one: DevOps Coordinator. This role was an efficiency and would have been beneficial from the start (for communication, prioritization, documented testing, drafting test procedures, templates, etc.)

Another need was the flexibility of operations implementation by augmenting human staff for automation gaps. The cross-program utilization that included training and certification from operators on another Parsons' program helped to cover the overnight, while two full-time and one half-time POES EL operators supported the passes during the two-day shifts, seven days a week. As the program moved into nominal operations, the automation became proven and the operations was able to move to workday console shifts with more discrete monitoring overnight, weekends, and holidays. This automated move, enabling lights-out operations, it a win for the government and commercially owned, commercially operated solutions as cost efficiency and reduction of off-hour work for Tier-2 support as well.

2.6 Networking

POES EL utilized the AZURE cloud to provide data both in real-time and through playbacks that were transferred to NOAA's repository. Latency is a key requirements driver for NOAA primary missions; they inserted a 13-minute requirement on POES EL as a pathfinder to see how this type of implementation could meet future needs. POES EL implemented the system including necessary operations, delivery, and storage to meet these requirements.

The latency requirement was outlined in the SOW as, "Provide SMD to the Government within 13 minutes of receipt on the ground within an Cloud Based Object Store." This was done by tracking delivery times to measure success against contract requirements, which during operations phase had a median delivery time of 3 minutes 55 seconds, and an average delivery time of 4 minutes 21 seconds. Additionally, more than 99% of all deliveries met the 13-minute requirement and thus provided the desired near real-time SMD delivery.

Cloud doesn't mean you don't need people involved as traditional system administration is still required in the cloud (e.g., server restart rhythm of every business day is working). This required coordination with operations to build in a window of passes to do patches in the ops plan for the week. While many patches were smaller and could be accomplished in quiet windows that occurs often in 60-minute intervals. Due to the longer period required for some patches, the system administrators coordinated the patch window as a weekly activity. With mission planning and operators, the team was also able to experiment and implement the schedule to perform a double GAC dump process, thus enabling all data to be delivered – even when passes were intentionally skipped for the patching process.

The requirements for both development and operations environments were better understood as the project completed the initial development build out. It was determined there was a need for more environments for OPS and testing; initially only two OPS and one DEV were proposed. During execution, it was determined that an additional OPS was needed, and the DEV was transitioned to support the TEP. The second dev environment enabled the addition of a second simulator allowing for the parallel engineering testing and operator training / pneumonic verification to meet the planned Operations Readiness Review date.

Another item that ended up being tweaked during operations was the duration of storage for the application logs. These logs ended up having a larger data footprint than realized so it was agreed to, and the team implemented a 90-day log retention management plan and that work. 90-days was determined as more than sufficient if any related activities were needed for research.

The system requirement for cloud-based operations was integral to cost and operational efficiencies as well. The system enabled geographically diverse teams to use the system as all times. When local network outages occurred, another location could become primary operations (see Figure 2). Additionally, this enabled Tier-2 engineering to login to support from their Maryland location while the prime is based in Colorado.

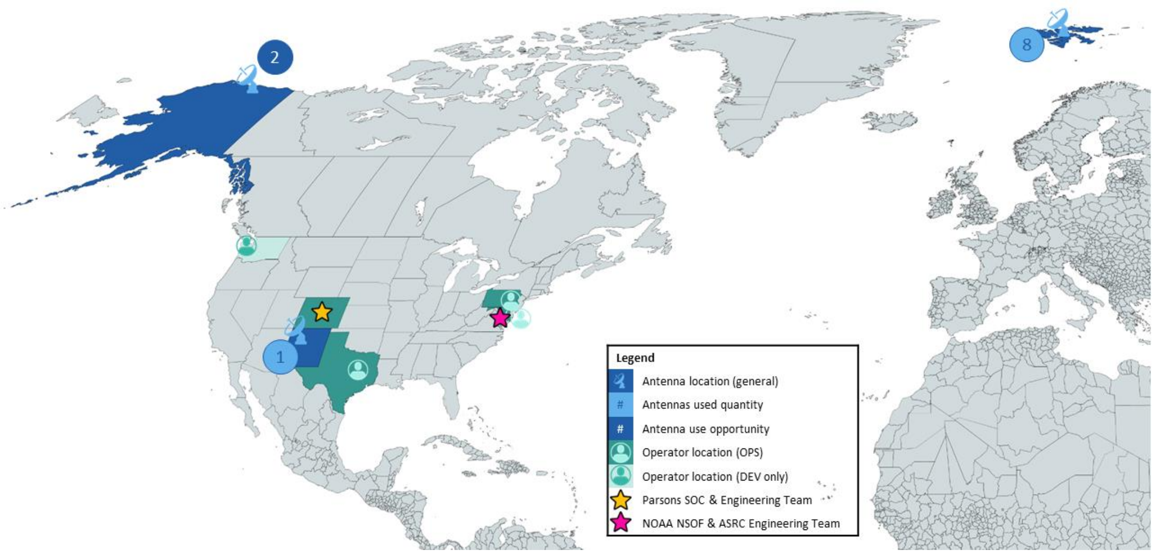

Figure 2. Map of locations for key elements of the POES EL program including antenna sites and operators.

2.7 Planning for Network Utilization

The original assumption was only KSATLite SVL antennas were going to be used for POES EL operations. This baselined the astrodynamics ability as easy, requiring only quick analysis. However, as previously described, the TSF necessitated onboarding a Parsons-owned and operated ground station. This means the planning system needs to be designed to handle technical astrodynamics as well as business rules. As a best practice, these requirements should be levers in the COTS product, rather than hard coded, to allow for configuration as mission priorities and cost evolved over time. If continued, the team would have utilized Parsons' Optimyz™ software to expand the network and manage priorities and demands.

In the end, the key drivers for network utilization and planning for POES EL fell down to the business rules for contacts driven by:

- Elevation impact to commanding: the series of activities scheduled for a pass has a specific minimum duration to be performed. That along with a planned buffer let the planners know what was possible for each pass based on the elevation for that contact.
- Downlink duration: Contract requirements for pass was dependent on data downlink. The SOW requirement was, "Perform a SMD Downlink once an orbit (~120 Minutes) for each POES Observatory" with specific SMD format types including GAC and HRPT. As both formats were being transmitted via the same antenna, this meant they had to run in series versus in parallel so passes take longer for the downlink portion.
- Command inhibit zones: for SVL, there were no transmit inhibit zones, however when utilizing ROOST there were some based on the topography of the site. An obscura file was built based on provided images. This is critical to understanding how the antenna operate and how useful that can be during a given pass.
- Commanding requirements: to meet commanding requirements to not trip to safe mode (occurs when NOOP command not sent to the s/c in >12 hours), the passes did not require a transmit at every pass. This meant ROOST could be used for TSF and data downlink prior to the transmit license. Additionally, this meant it was okay to skip transmitting for 2 – 3 passes when other activities took precedence, or other locations optimized cost plans.
    - Commanding requirements were defined in the SOW by, "Perform Encrypted Commanding within every 8 hours to the POES Observatories".
- Cost of antenna operations: as Parsons invests in and onboards more antennas across geographically diverse locations including several in Alaska, the cost as the prime to operate those locations will decrease resulting in a cost savings to government customers compared to the use of other commercial providers.
- Trade of locations: the trade of capabilities per location is key. One pass at ROOST would not offer the same opportunities as those in SVL or Alaska.

Business and government buyers need to have transparency and more technical discussions to optimize commercial utilization in the future. The proposal should include intent of antennas to use, with an approval process as necessitated by the security and risk posture of the assets to onboard additional locations and antennas; the implementation should enable the ability to use available minutes on any approved antenna. This would optimize cost savings and if desired, enable redundancy of data downlinks for primary operations.

2.8 Lean Documentation

Documentation is critical to communication as well as capturing decisions. An overly complex requirement on written documentation can also hinder progress when it is needing to be adapted to meet changes that could occur at every pass. Using some simplified capturing techniques, like the use of shared PowerPoint files, helped to meet the needs.

An example of this was when it came to developing the Shadow Operations Test. To move into this next phase, as with all stages of this project, there was a review. This review included the purpose, the entrance criteria (prerequisites, the test procedure and expected observations, the exit (success) criteria, and all documentation expected. Unlike a traditional review established through, for example NPR 7120.5F, the aspects of the review were not predefined. Leading up to the review, we met to confirm all the items necessary for each category of the review. Then, as we were approaching the review we would circulate this one slide to communicate progress alongside the daily reports. This lean documentation meant everyone knew where we were and helped to ensure all those preparing to attend review, were informed with not only what Team Parsons was doing but how the team was doing it.

The accelerated velocity of all sub teams, especially the engineering group, was running at needed loose processes, availability of knowledge (people), and intense collaboration between all stakeholders. This resulted in very lean documentation but a focus on documenting what was critical, and when possible, documenting items in advance of their need. As POES EL moved into operations, disposition, and classification of items such as bugs versus enhancements became fruitful in explaining priorities and managing expectations, and identifying where additional documentation would be beneficial.

2.9 Commercial GSaaS Challenges

There were several instances and learning opportunities related to using commercial GSaaS solutions. They can be summarized as antenna configurations, support service agreements, sharing previous lessons learned, diversification of assets, and building in redundancy in an efficient way.

A large obstacle as the team moved through development into operations was a struggle with getting the EUMETSAT antenna information at SVL. The lack of this information to refine configurations was causing noise in the downlink, resulting in initial degraded data quality. Through coordination with OSPO, Team Parsons was able to engage NOAA antenna experts at their GOGO Wallops and their GOCO Fairbanks site to understand what they did differently. This TIM was critical to understanding antenna post-processing. Additionally, KSAT engaged their US based expert engineer who started applying filters and figured out a quick resolution. As was found out later, this same configuration challenge had presented itself during the CRADA and that knowledge would have reduced this testing phase by an order of days to weeks.

As we moved toward operations, another key aspect was the difference in support between KSAT and KSATLite. KSATLite has a very different business model of support and engagement, which is also how they can provide their service at a significantly lower cost. Their support team works SVL business hours and days, with escalation for ground system outage. The time difference as well as the expected self-service model proved challenging when we went into testing with the antennas. While this business model was understood upon contracting their service, the obstacles to integrate these older s/c were not, and thus additional support was needed. As the entire team was committed to making this happen, enacting shift support for pass testing including development engineers during KSATLite's business day was enacted. Additionally, it was requested to have a support service agreement for a specified number of hours to support the POES EL testing with an on-console engineer from KSAT who could help with antenna changes in real-time.

Parsons is investing in building out a US-built, US-based, US-operated antenna network. Using more of these antennas in the future is a planned cost savings for OPS in addition to having the support in house; any issues with the antennas could be resolved between Parsons and their antenna vendor immediately, not requiring additional shifts or delays.

The cloud architecture and planned multi-location operations makes a commercial GSaaS reliable, having planned redundancy, and leads to smoother operations. This program experienced a weekend where this was required; during a weather event in Colorado, local operations were unavailable due to a network outage. By having a geographically diverse operator team, Team Parsons was able to reassign the shift and support was provided from Pennsylvania and Washington during the outage. The only unavailable lost during this transition was access to the sim that was physically located in Colorado. If a new procedure would have been needed, there would have been a risk; however, as all high and moderate pneumonics had already been run through the sim, this risk was minimized as much as possible. While not all risks can be fully eliminated, this cloud solution eliminates as much as possible for this and future programs.

2.10 Project Management Rigor

As a part of the requirements, an emphasis on management was essential to delivering the successful program. To this point, the SOW obligated task management and oversight of all activities performed to satisfy the requirements identified including, but are not limited to, cost, schedule, and risk management as well as status reporting.

A novel approach to this program was set in the bid: the contractor program manager would be part of the prime (Parsons) team whereas the contractor deputy program manager would be part of the teammate's staff (ASRC Federal). This implementation capitalized on previous experience in this sector and with this customer. Parsons provided a PMP certified program manager with experience providing commercial GSaaS solution in the defence sector. This resource knew how to efficiently produce status reports, engage with the Parsons leads to drive the schedule, and provide the PP&C rigor on internal Parsons departments. ASRC Federal provided an engineer with extensive experience in the program planning and control areas for NASA communication services programs, including understanding of similar NASA-built, NOAA-operated systems. Experience working with NPRs including 7120.5F and 7120.8A proved helpful in building reporting mechanisms and implementing risk management aligned to previous experience of the NOAA stakeholders. Parsons had excellent experience with other programs and ASRC Federal had experience with POES, so working together and being transparent helped bridge known gaps. Additionally, being open with the government to status and challenges enabled Team Parsons to find resources to support this effort.

In addition to fulfilling all SOW requirements, the team employed innovations into their management reporting, enabling this to be a true pathfinder for everyone involved. One item was the performance requirements tracking and utilization of specific antennas. The team was able to report on processes to identify trends, flagging an antenna as less successful in meeting pass objectives and how they brought them back into the rotation after a ramp up of testing; this is critical when the antenna utilization is tied to available minutes rather than a dedicated antenna asset. The reporting also captured the integration of operations through the DevOps coordination; tracking showed how bug fixes and system enhancements improved operational performance, especially during automation. This transparency helped to highlight the focus on the meaningful activities, while still working other requests as resources allowed.

Another aspect of this program was cost management. The development task order was time and material which required management of cost controls for all parties contributing to stay within budget. Additionally, the utilization of the COTS products was important given the stable baseline and then modifications tailored for the program. The operations task however was firm-fixed-price which required a different type of management. The COTS products, their maintenance and sustainment are known. Additionally, pricing based on the bid to use KSATLite for the maximum of every pass every day was known. The s/c anomalies, the ability to reduce manual augmentation to the automation plan, and other activities were unknown, so risk had to be planned into the pricing model.

Dealing with the unknowns at the beginning of the transition made FFP difficult. Now that the program has been operational for well over a year, costs have come down and are steady. Realizing that the beginning of any activity like this – especially one seen as a pathfinder and changing legacy OPS – is likely to have a significant number of issues requiring investigation and work by highly compensated engineers or senior personnel can eat up the budget quickly.

In addition to risks, opportunities for the program were identified as part of the risk management process. This methodology allowed the stakeholders to see what was possible if there was time to implement it. It is recommended that this communication medium be used more in programs to understand trades and see the benefits of taking an alternative path or enabling innovations on a program.

3. Lessons from Operations

Being agile in development and operations was key to program success. Envisioning solutions with Tier-2 engineers began the evolution of the program's operations phase as pass planning turned into a symphony, from the array of activities performed to the dedication of the operators, increasing OPS performance quarter-after-quarter by building their own self-forming teams and roles.

3.1 Original CONOPS

Maintaining the s/c operations in a new paradigm involved changing cultural norms and understanding requirements., To do this, the team determined the baseline operational activities and timing during a pass, day, and week. The proposed CONOPS included hands-on operations occurring Monday through Friday, during traditional business hours (9 hours/day, 5 days/week), by two operators. To ensure success, the team extended operations support

Monday through Friday from 6am-6pm Eastern with checks around 11pm nightly and every ~8 hours on the weekends and holidays.

The 8-hour check-in ensured compliance with the contract requirement to not trip the onboard encrypter into safe mode. To do this, a NOOP command is sent to the s/c once every 12 hours. Therefore, 8-hours was the ideal duration to guarantee that if several passes did not meet this commanding requirement through automation, there would time for manual intervention for 1 – 2 revolutions to restart services or send the command manually, thus not triggering the safe mode. This was an example of pivoting from traditional operations to more efficient, lean automation – remembering that automation is helpful, and to meet the performance goals, the system still required these check-ins.

Another operational switch included moving from a 30-hour SCT load to a 5-day load, which changed fundamental, labour-intensive operations. This was accomplished at the suggestion of a senior aerospace engineer; through estimating the real storage possibilities, assessing what could be adequately transmitted, confirming the operational plans, and understanding how willing the customer was to try this new opportunity. These operations changes could have been implemented previously, but the risk posture of the mission at that time did not prefer this type of experimentation. This is one way to see how extended operations promotes an efficiency for the government and offering new innovations from the existing workforce.

A high-level comparison of what occurred in the legacy operations model versus the final POES EL operations schedule is found in Table 1.

Table 1. Activity Planning During Legacy POES Operations vs. POES EL Operations

Activity	POES Legacy	POES EL
Operations Support	24x7, minimum 1 dedicated person for each contact	Extended hours Monday - Friday, automation with checks every 8 hours on nights, weekends, and holidays
SCT & EPHEM load generation	Offline schedulers generated	Operator generated
SCT Load	Daily Load = 30 hours	2x a week, on Tuesdays and Friday Load = 5 days
Weekly Ephemeris load	Tues night – backup computer Wednesday day – prime computer	Both computers Thursday, separated by 1 orbit
Contacts scheduled	Prime s/c – every REV – 1 GAC per REV Others 7-9 REVs a day – 1 to 3 GACs a REV	Every REV for each s/c (except for weekly maintenance period, 0-2 REV)
Stations	NOAA CDAS EUMETSAT SVL	KSATLite SVL Parsons ROOST, PAK
System Maintenance	Quarterly patching during natural blinds	Every Weds from 15:00-19:00 UTC For small patches, done during quiet periods between passes
Contact Activity	Required operator intervention for each contact	Automation does not require operator intervention
Anomaly Notification	Manually completed by operators via phone calls and emails	Automation by system via text messages, follow-up and escalation via phone and email if needed
Transmitter Usage	1 Transmitter for HRPT – L-Band Other transmitters for data dumps	1 S-Band transmitter used for real-time commanding and data dumps resulting in real-time telemetry loss during each contact for ~3 mins, less commanding time

3.2 Training Operators

As the unionized civil servant workforce began supporting other missions, they were unable to train the POES operators; it was not a part of their work assignments. To make up for this knowledge gap, ASRC Federal hired a retiree with extensive POES operations experience to ramp up the operators on the s/c's personalities. Additionally, the other two operators brought their own experience - one was a military SATCOM operator and the other had a mathematics background – and combined, this crew brought ingenuity and the agility needed to be successful.

Despite the bid for two operators, it was quickly realized that at least three would be required for sick leave or vacation relief. Additionally, during the initial manual augmentation phase, this operator provided support during testing and shadow operations for POES EL as on-console operations were supported 16 hours a day by the primary POES operators with augmentations from another Parsons program for passive observations. This retiree's experience with operations was invaluable for the run up to the operations transition. The integral assistance that NOAA OPS had been offering for years was a missing element to the understanding of operations. His training and tricks for routine issues was yet another key to the success of this mission – a bonus was his location on the West Coast that gave the Parsons team more diversity on working hours.

Operators training started with the Tier-1 engineers, those with extensive POES s/c and instrument knowledge, hosting chalk talk presentations to explain the fundamentals of each s/c and their instrument suite. Next, the operators were provided more POES 101 material to learn and understand the jargon used at both Parsons and NOAA. They were then acclimated to the Parsons COTS products and were able to observe passes on other programs. The operators utilized the sim to train on POES EL specific procedures before going into shadow observations. Additionally, being a part of the testing was beneficial in training the operators. To monitor progress and maintain proficiency on activities, personnel that would cover any operator shift completed a certification. This also helped to know capabilities when assignments were needed or staff augmentation during overlapping passes, requiring multiple on console operators.

3.3 Integrating Operators Throughout Development, with Engineering

During the development cycle, the operators worked on pneumonics V&V and sometimes, this front-end engagement excluded them from discussions on programmatic schedule milestones and expectations of success at each stage. This internal lesson learned will change in future programs and overall, it is recommended to all programs to engage operations in all aspects of development, as they are key contributors to mission success.

Operators on POES EL researched and tracked items they personally identified as potential impacts to performance. If further details were needed, they notified the DevOps Coordinator who would help with the investigation and documentation. In the end, the identification of items provided by the operators were one of the biggest drivers of improved operational performance – and that is the quantitative measurements for the program. Holding sessions with the operators kept continuous improvement at the forefront of the team and they were recognized when they helped the program in this way.

POES EL enabled automated alerts via text messages, but even during automation phase those had to be reviewed and dispositioned by operators. Communication via texts is convenient, but it can also be overwhelming to the point of being ignored, especially by the on-call engineers who would look at these only when it was escalated. As someone with experience and authority to disposition escalations was needed (e.g., asking the question can it wait until Monday?), we chose to keep these on for that Tier-2 group and use them to triage support. Fine tuning this capability would be advantageous to communications and escalation in future operations.

Creating a clear way to communicate daily operations in a way that enabled NOAA to notify their data users was critical. Simplified reporting, Excel based, worked extremely well and as additional requests arose throughout the operations period, the reporting could be easily modified by the operators.

3.4 Operator Scheduling During Lights-Out

By understanding the pass plan, the maintenance windows, and overall, how the program works, the operators have evolved into a team. They are working amongst themselves to develop balanced schedules that are allowing all three of them to work toward degrees. Different holidays have different meanings culturally, they may celebrate another holiday entirely, and each of their families prioritize those differently; this crew negotiated internally who works which federal holiday. This balancing helped the individual operators feel supported to meet their personal, educational, and professional commitments while ensuring excellent support to the program.

While the POES EL primary operators are all ASRC Federal team members, Parsons respects and implements a badgeless environment. The Parsons OPS Director hosts an "Ops Rally" every other week to engage all operators, in across the organization from all locations including the ASRC Federal team member. This example of teaming between a prime and their subcontracting teammate is often proposed but seeing it in action is a true testament to this strong partnership and broader dedication to program success.

4. Results

As of the 10th quarterly report submitted in March 2025, and since the transition to operations in November 2023, the POES EL program has supported over 23,000 passes with a 98% pass success rate. Additionally, fully successful passes have increased over time, where Team Parsons is achieving all objectives on 97% of passes. As described earlier, this includes exceeding the data delivery with a median time of 3 minutes and 55 seconds, compared to the latency requirement of 13-minutes.

4.1 Themes for Success

More than quantitative measurements, this program was a success because of the people. Everyone was motivated and excited to see this succeed. All Team Parsons and NOAA stakeholders were open and honest with what was needed and what could be done. Heroic efforts really made this program, especially those by the developers and operators, enabling early successes to keep the momentum going. The experienced s/c and instrument engineers provided key insights that helped to implement efficiencies and translate the systems between legacy and commercial.

In summary, key themes of this pathfinder program include:

- Commercial GSaaS is a feasible option for s/c operations and an efficiency for the government.
- A balance between documentation and SMEs is needed for all functions and roles.
- Being reasonable is important; showing a true partnership (between the teaming organizations, as well as with the government) accelerates success.
- Transparency builds trust and improves the likelihood of meeting the key objectives.
- Innovation doesn't end with development - continuous improvement including a willingness to relook at old practices, take risks, and empower experienced engineers to try new things, invigorates team members to be creative.
- Lessons learned as an operator enhances individual impact, whether they were an operator on this program or on other programs like many of the Parsons functional and engineering leads.
- The remote operations model is incredibly powerful and a great opportunity to support business more efficiently at all times.
- Automation enables OPS at a lower cost due to a more "on call" nature of support needed, with prioritization of efforts required during business hours.

4.2 Recommendations for Future RFPs

There are two key items, in hindsight, that would be beneficial for future transitions of legacy ground systems to a modern architecture for the acquisition strategy by the government. A retrospective is recommended to provide feedback to those writing the SOWs to better communicate nuances and requirements. This technical and specific activity could be a benefit to contracts of all types – by directly engaging the vendor and their partners at the opportune stage of the lifecycle, the correct people in a wide variety of roles could be engaged to provide the government with the information it needs to improve future procurements. This could prove challenging if multiple vendors are selected, but it would still prove fruitful if the foundation of honesty - as outlined in the success of this program - was also established.

Similarly, engaging with technical SMEs for each area covered in the transition would help to the assessors and SOW authors understand complexities from the start. This would lead to richer conversations at kick-off, and even enable more questions during a draft RFP phase in the procurement cycle. Spending the time, in detailed conversations, with each bidder, could be very time consuming for the SMEs. But having these conversations as early as possible, after picking a contractor, is necessary. Sometimes each side doesn't know what questions to ask or even what data is important to share. This is where trust and full honesty, in numerous tag-ups, would be the only way to get the data exchanged.

5. Conclusions

Commercial GSaaS works – even on a legacy program – enabling an opportunity for the government to extend the life of the capital investment for a fraction of the traditional OPS cost. The data of these legacy missions still provide value, and it is a benefit to the taxpayer to find a more efficient way to continue to receive returns for the investment.

Converting a legacy system is not easy, especially as you transition missions that have already exceeded several extensions in operations. However, as seen throughout the POES EL program, Parsons had a sustained corporate commitment to make this a success. In choosing ASRC Federal as their partner, the team was well matched to meet the needs of this program. Teams Parsons helped be that pathfinder for NOAA and other agencies to follow the lead for more commercial utilization in the future.

Acknowledgements

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