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TRANSFORM GROUND SYSTEMS FASTER

3 Ways to Add Flexible Capabilities and Control Costs

3 WAYS TO SPEED GROUND SYSTEM CAPABILITIES

World events are moving faster than ever, as the Russian-Ukraine war and gray zone hostilities in the Indo-Pacific have repeatedly demonstrated. Space assets are essential to carry vital information to the U.S. and its allies, in addition to supporting commercial enterprises and civil missions like space exploration and climate study. Yet every day, space is becoming an increasingly contested, congested domain. Military and national security agencies need to develop interoperable systems for multiple goals—from protecting space assets to addressing Joint All-Domain Command and Control (JADC2) challenges.

Government leaders can build and modernize space systems rapidly using an approach that skillfully combines three key concepts: open systems architecture, flexible data frameworks, and rigorous DevSecOps. These three elements can be scaled for digital integration into any system—whether providing unprecedented capabilities to new systems or mitigating vulnerabilities in legacy ground systems.

Read on to discover how to rapidly create space ground systems that are resilient, smart, scalable, and secure.

IDENTIFYING SPACE CHALLENGES: AN URGENCY FOR SECURITY AND ADAPTABILITY

Open architectures should be the foundation of modern space systems, providing an interoperable framework for open data to be processed, analyzed, and shared. DevSecOps ensures the strategic decisions, agile processes, and automated checkpoints which enable the essential attributes of security and flexibility. Combining safety with the ability to rapidly modify or upgrade is essential for situations that change continually, especially those in space. Recent developments include:

More Competition: Rival nations have prioritized space as a warfighting domain. For years, the U.S. and other countries have been investing massive resources in developing sophisticated space-based capabilities, including counterspace weapons. However, the development of counterspace weapons does not protect the many U.S. satellites still in use today that were designed during the "space as a sanctuary" era, when space assets were not designed to survive on-orbit attacks. These satellites are therefore vulnerable to threats from counterspace weapons, which the Center for Strategic & International Studies (CSIS) categorizes into four areas:

+ kinetic physical—anti-satellite missiles
+ non-kinetic physical—directed energy technologies such as lasers
+ electronic—jamming and spoofing devices
+ cyber—digital tactics to infiltrate, damage, or disrupt

Information Overload: Military and national security organizations must accelerate space situational awareness for evolving threats. As technology speeds up the pace of communications and data transmission for actors across the board, the U.S. must stay a step ahead of its adversaries with more intelligent, coordinated space-based

information gathering. Information dominance is essential to evolve the integrated concept of command, control, communications, computers, cyber, intelligence, surveillance, and reconnaissance (C5ISR). Faster data sharing and advanced analysis that ensures U.S. information is more accurate, holistic and actionable than that of its competitors are crucial for the Department of Defense (DOD) and intelligence agencies to anticipate risks from competitor nations and insurgencies alike.

Space assets also play a pivotal role in DOD's concept of the integrated force of the future, Joint All-Domain Command and Control (JADC2). Satellite networks will need to deliver actionable information to warfighters in real time as they execute their missions, leveraging both space-based communication satellites and advanced analysis of data transmitted from or through space.

Overcrowding: More Assets Require Adavances In Space Traffic Management.
The modern world relies increasingly on space-based assets (SBAs) like the Global Positioning System (GPS) for everything from complex logistical operations to driving directions. That means both government and private-sector entities are filling low-earth orbit (LEO) with exponentially more SBAs annually, driving up the possibility of collision and the complexity of management. What's more, miniaturization of technologies has lowered cost to entry and prompted the proliferation of nanosatellites such as CubeSats—satellites tiny enough to be measured in centimeters.

+ More than 2,080 nanosats are estimated to launch in the period spanning 2022–2027.
+ Most of the artificial objects in space are in LEO, each completing at least 11.25 orbits each day.
+ There are currently more than 4,800 active satellites and more than 36,000 pieces of space debris greater than 10 centimeters orbiting the earth.

Greater Complexity: New concepts such as Proliferated LEO (P-LEO) promise new capabilities—and considerations.
Taking advantage of miniaturization of space assets and low launch costs, government and commercial entities are planning large constellations of small satellites projected to provide global coverage with low latency. While distributed SBAs offer greater coverage, their sheer numbers greatly complicate management of assets and maneuvers in the space domain.

+ P-LEO advantages: enabling persistent coverage, advancing C5ISR and remote sensing, and increasing resilience by eliminating a single point of failure.
+ P-LEO risks: complicating navigation, collision avoidance, and threat identification.

MEET THE CHALLENGE: BUILD OPEN-ARCHITECTURE SYSTEMS FOR CHANGING MISSIONS

Recognizing the need for secure, adaptable space systems, the national security community is requiring organizations to modernize systems and processes. For example, DOD's September 2023 Space Policy directive prioritizes streamlining space architecture efforts for better integration and speed of delivery; the U.S. Intelligence Strategy emphasizes the need for modernized systems and standards; and DOD mandates modular open-system approaches for rapid information sharing across missions and domains.

In addition to providing interoperability, built-in cyber protection and agile processes, open architectures offer modular advantages that increase security and adaptability. "Open frameworks allow us to introduce microservices and small components—building in flexibility for new systems and allowing changes for existing systems as missions and priorities change," says Josh Perrius, a leader in Booz Allen's space business.

His teams help defense, intelligence, and NASA clients move their space technology forward. They implement an open-architecture approach using a convergence of technologies that have only recently become possible—such

as bringing advanced cyber, cloud, and artificial intelligence (AI) together. By creating scalable tools and partnering with providers from Amazon Web Services to NVIDIA, they ensure clients receive the advantage of Silicon Valley advances along with industry-leading cybersecurity.

TOTAL TRANSFORMATION

A holistic approach is required to receive the full benefits of new technologies—from the network level down to the critical application programming interfaces (APIs) that enable disparate software components and resources to interact. This is important not only to implement new capabilities, but also to modernize the legacy systems that support them.

To achieve this, the mission must remain central to the approach. A detailed understanding of a program's goals and how it's likely to evolve, coupled with a digital engineering approach that keeps all stakeholders informed and aligned, saves time, rework, and costs.

EVOLVING GROUND SYSTEMS

Terrestrial ground stations play a leading role in modern space architectures, as new technologies give control centers flexibility to mitigate threats and expand capabilities in both new and existing systems. "When designing a new system, we build in adaptability to respond to unknown challenges," says Josh. "For example, we recommend using digital models and modular architecture so we can test and mitigate threats in the ground layer and entry points for new capabilities. The ground system can be equipped with software and algorithms allowing for assessment of anomalies, for example, with smart analytics alerting operators to potential attacks."

VIRTUAL GROUND SYSTEMS

For space leaders ready for a transformative solution, virtual ground systems provide a powerful combination of flexiblity and resiliency.

Using the latest cloud technologies, we develop virtual systems for "hosted-anywhere" operations. And we apply AI and cyber innovation to engineer automated and secure command and control, sensor mission management, and data processing and dissemination—for taskings (directives) that take seconds.

After launch, the space layer is beyond physical reach. However, the ground layer remains accessible to add software, algorithms, and AI to add new functionality or correct problems. This allows for even a decades-old system to implement some of the latest innovations.

This approach also allows the re-use of technology, an agile principle that simplifies projects while increasing speed and lowering costs.

THE POWER OF FREE DATA

Industry has often outpaced government in the development of new technology. That imbalance has left many government buyers susceptible to buying products whose use and even designs they cannot always control. But this doesn't have to be the case. "Instead of creating proprietary solutions, we use standard APIs, store them in industry-standard formats, and maintain them on the secure cloud infrastructure so any partner can access them," says Josh. "You get to a place where the data stays free. That means the government can open the conversation to anyone with a great idea."

Open architectures make modifications or additions easy. They can be built quickly and made adaptable for changing missions and priorities. Systems built with open architectures allow the military to modernize at scale while providing advantages like cloud capabilities and data aggregation for AI and analytics.

MACHINE LEARNING AND AI-POWERED ANALYTICS

Microservices architecture is a powerful example of innovation accelerated by combining multiple advanced technologies such as AI and machine learning (ML). By arranging applications as loosely coupled services, microservices allow modularization to support new approaches to space mission management and cyber protection. Preliminary data tagging and normalization enables algorithms for inbound and outbound data, allowing the government to obtain new solutions quickly while staying in control of the technology.

AI and ML can then be inserted into workflows and data sets using graphics processing unit (GPU) technology for results like these:

+ Applying deep reinforcement learning (RL) to enhance satellite collision avoidance in LEO.
+ Explore using ML for satellite scheduling optimization. Our engineers used deep RL models to optimize compute cluster scheduling. As this problem is closely related to collection resource allocation, it showed the viability of a deep RL approach.
+ Multi-source data fusion from open frameworks can fuel GPU-generated algorithms powerful enough to increase accuracy for space tracking and predictions—for example, drag models that can factor in solar effects for SBAs traveling in the upper ionosphere.

ADVANTAGES OF ADAPTIVE, SECURE SPACE SYSTEMS

Open architectures allow government to tap into the marketplace of ideas and integrate those ideas into systems right away, rather than having to wait months or years for a prototype. National security organizations can therefore take advantage of increasingly sophisticated solutions to obtain benefits like these:

GOVERNMENT-OWNED TECHNOLOGY

Open data platforms running on interoperable systems allow intelligence and military leaders to end vendor lock-in. Moreover, government-owned APIs allow DOD to integrate technology from both traditional vendors and Silicon Valley innovators.

FASTER DEVELOPMENT

Open architectures enable modular services which automate capabilities and can easily adapt to new missions.

+ Agile delivery through disciplined DevSecOps provides efficiencies and accuracy through automation and rigorous processes.
+ Continuous integration and continuous deployment (CI/CD) enables rapid changes as missions evolve.
+ Cloud services enable re-use of tools and accelerate application migration from months to days.

INTEGRATED INTELLIGENCE

Through modular microservices, AI/ML can be easily inserted wherever needed in a mission workflow:

+ At data ingestion—so ground systems can process data directly off the satellite feed
+ In analytics—from domain awareness to decision-making analysis
+ With mission algorithms—allowing the system to continuously learn to deliver greater insights
+ Through smart dissemination of data—automatically updating relevant stakeholders in real time

To optimize efficiencies, we choose asynchronous microservice technologies. These enable faster, more flexible functionality via one-to-many communication so a software client can message multiple services at once.

ADVANCED SPACE CYBER DEFENSE

The space ecosystem is a high-stakes environment—a compromised space asset can endanger the lives of citizens and warfighters alike. Open-source solutions and secure cloud technologies ensure security is integrated from the start, with features like:

+ Standardized approaches to ensure data provenance and integrity.
+ Encryption that protects communications at rest and in transit, on network connections and data.
+ Zero trust security architectures that reduce human error and add resilience from cyber attack.

+ Automated capabilities such as attack assessment and self-healing architectures for resilience, enabling the space mission to continue even after an attack occurs.
+ Cyber protection for the intersection between IT and the satellite system, addressing the special vulnerabilities of operational technology.

HOW WE HELP GOVERNMENT ACHIEVE FASTER RESULTS

Booz Allen has partnered with government space clients for decades, from the nation's first missile defense program to tomorrow's DevSecOps platform. Now, we are combining our expertise in new technologies with our mission understanding from long-term partnership with government, allowing us to help tackle some of the toughest problems in the modern space age. Clients trust our track record of delivering new, secure, adaptable ground systems and modernizing legacy capabilities on time and as promised.

APPLYING INGENUITY

+ We offer ready-made tools and solutions in addition to strategic approaches informed by long-term knowledge of the mission.
+ Silicon Valley partnerships allow us to adopt new best practices quickly, and tech scouting—identifying promising startups or technologies—enables us to bring clients the best emerging technologies.
+ Our cloud expertise in AWS, C2S and Azure brings secure capabilities with the latest efficiencies in cloud or hybrid computing.
+ Our extensive cybersecurity expertise ensures sophisticated, proactive approaches and tactics.

ADVANCING EFFICIENCY

Our integrated approach gives clients higher functionality in less time:

+ For new builds, we integrate systems engineering with cybersecurity and digital engineering rather than creating separate workflows, timelines and budgets—providing cost savings and delivering a better product faster.
+ For both development and modernization projects, our experts employ a proven software method, our Solutions Delivery Platform, rooted in Agile and DevSecOps.
+ Our teams develop specialized solutions—for example, our software framework for the OPIR space-based missile warning system and Clairvoyant, a machine learning operations (MLOps) program for the intelligence community (IC).

SNAPSHOT CASE STUDY

PGMM: OPIR CONSTELLATION MISSION MANAGEMENT

The Air Force needed a common software development environment and open framework for the OPIR satellite constellation. We developed the Persistent GEOINT Mission Manager (PGMM)—a fully containerized architecture solution with interservice communication provided by message broker software APIs that conform to the flexible REpresentational State Transfer (REST) architecture.

Benefits for defense:

+ Allows for sharing of common capabilities
+ Enables faster development of new capabilities
+ Prevents vendor/integrator lock-in
+ Provides smooth hand-off between contractors

SNAPSHOT CASE STUDY

CLAIRVOYANT: MLOPS FOR INTELLIGENCE MISSIONS

An intelligence agency wanted a solution to help get machine learning developed and deployed into operations for mission-critical national systems. But the IC's complex

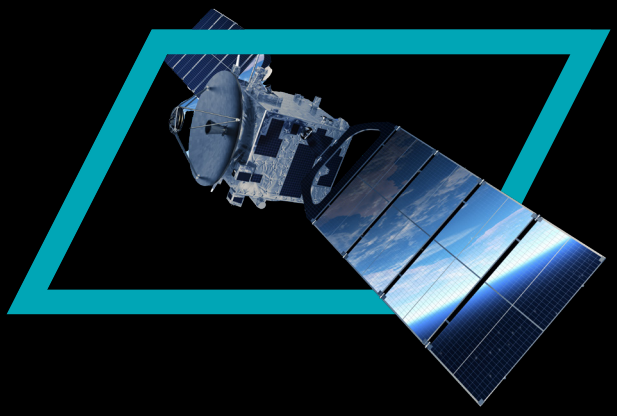
operational environment had made progress difficult. In addition, each application needed to be custom-developed by cloud deployment experts and was subject to accreditation requirements.

We provided a DevSecOps tool suite including:

+ A deployment framework that includes Kubernetes clusters for hosting containerized software, a continuous integration and continuous deployment (CI/CD) pipeline integrated with security checkpoints to automate security accreditations, and program health monitoring and metrics.
+ An integrated data platform that combines data warehousing, query tools, discovery tools, and streaming services.
+ A solution that allows data scientists to leverage the power of Amazon SageMaker via a secure portal so they can collaboratively build, train, and deploy machine learning models for their mission use cases.

Benefits for intelligence:

+ Enables secure exploitation of ML models.
+ Accelerates mission timelines via rapid deployment.
+ Delivers new insights into exponentially increasing data.



TRUE DEVSECOPS

There's more to DevSecOps than checklists and good intentions. True DevSecOps is a disciplined, coordinated approach leveraging strategic innovations for repeatable results.

Explore the difference below; download the full infographic here.

Pretend "DevSecOps"	TRUE DevSecOps
Daily builds often broken	Daily, tested builds for **infrastructure confidence**
Slow, text-based process open to error	Automated deployments for **close to 100% uptime**
Environments configured via console (siloed)	Standardization for **environment parity with efficiency**
Pre-deployment scans address critical issues only	Automated scans for **less risk at lower cost**
Bugs accidentally deployed are fixed manually	Fast fixes for **accelerated progress with lower risk**

ABOUT BOOZ ALLEN

Trusted to transform missions with the power of tomorrow's technologies, Booz Allen Hamilton advances the nation's most critical civil, defense, and national security priorities. We lead, invest, and invent where it's needed most—at the forefront of complex missions, using innovation to define the future. We combine our in-depth expertise in AI and cybersecurity with leading-edge technology and engineering practices to deliver impactful solutions. Combining 110 years of strategic consulting expertise with the perspectives of diverse talent, we ensure results by integrating technology with an enduring focus on our clients. We're first to the future—moving missions forward to realize our purpose: **Empower People to Change the World®**.

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