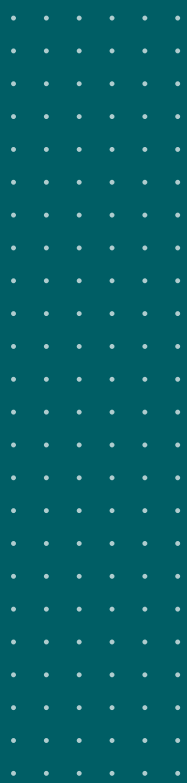




# ACCELERATING JADC2

THREE KEYS FOR DECISION ADVANTAGE



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# IMAGINE THIS SCENARIO:

**Your special operations unit is conducting a combat patrol.** You've just had contact with the enemy. You're regrouping and preparing to continue movement. You spot one of your unit's drones soaring from the north back to the Tactical Operations Center (TOC).

**Simultaneously from the TOC,** your battalion commander streams live data from the unit's drone using the resilient mesh network at the edge combined with brigade and higher national asset drone feeds. Using edge compute power, analysts skim off enough data to do artificial intelligence (AI) processing—light, fast, just enough to address the immediate threat.

**Your commander approves the recommendation** to move your unit southwest while planning and synchronizing resources for the next engagement. A message from the TOC appears in your headset: *"Enemy tank, 1K North in desert camo vic grid GJ 12345 67890. Move to interdict."*

**In the meantime, the edge network pushes** the full data into the data fabric for robust processing. Neural networks use the data to train existing algorithms to scan for a tank with desert camouflage. The open-architecture network uses open application programming interfaces (APIs) to upload new data to the Joint Operations Center (JOC) about the

enemy's appearance and position to sensors across the joint force—terrestrial, airborne, maritime, and satellite.

**Leaders send updates** to joint forces, allies, and partners across the federated data fabric. The networks have borrowed 5G spectrum for extra speed. By the time your unit arrives at its new position, warfighters across the joint force are reviewing an updated common operational picture. You receive an updated message from the TOC on your headset: *"You are cleared to engage enemy forces vic Grid GJ 01345 67890."*

**You act on the alert with confidence. Your intelligence is backed by the full power of JADC2.**



# THE FOUNDATION

## Building the Foundation: Three Keys


The United States faces continual threats from nimble adversaries who use information as a weapon to disrupt and destroy. AI-enhanced warfare, advanced cyber attacks, and hypersonic munitions are a few of the lethal capabilities that have accelerated the speed of war. We have reached a critical juncture. The United States must act to protect its information and maintain decision advantage over adversaries.


Joint All-Domain Command and Control (JADC2) is a transformative initiative launched by the U.S. Department of Defense (DOD) to synchronize efforts across the joint force and dominate the [digital battlespace](#)—in data, human enterprise, technology, nuclear command and control (C2), and the mission partner environment.

Accelerating JADC2 requires a new level of innovation and integration across the joint force. DOD has begun tackling essentials to break down silos and enable multidomain operations. These include agile software development, advanced AI, and a cross-service digital architecture.

Booz Allen drives innovation and mission support in three areas, which we call keys to accelerate JADC2:

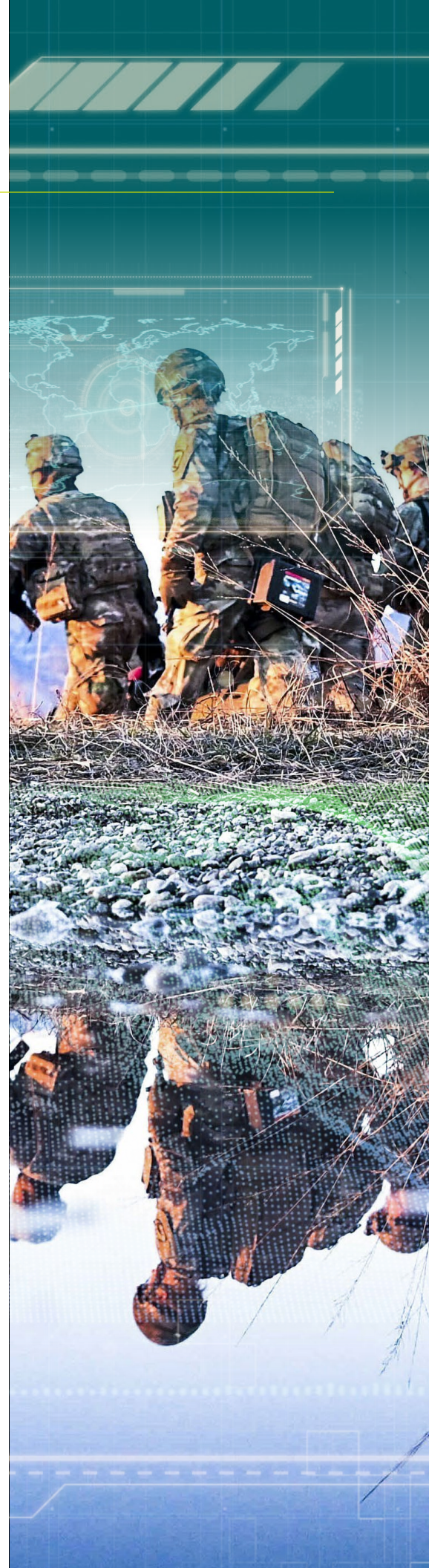
- 

1 Resilient networking, compute, and communications
- 

2 A unified data fabric
- 

3 An AI-powered C2 decision framework

If you are furthering the future of all-domain operations, chances are your work relates to one of these key elements. This publication is for you. Booz Allen translates innovation in each of these keys into mission-ready capabilities. Since our teams build with open architectures and open APIs, we ensure that DOD maintains complete ownership and control over the mission as it evolves. Read on to explore JADC2 implementation challenges, advancements in these three key elements, and critical implications for your work as the digital battlespace evolves at a breakneck pace.



# Overcoming the Obstacles: Three Challenges



In our work supporting DOD across the services, we've seen three major areas that need to be addressed for joint operations across the digital battlespace. Here's a summary.



**DATA GOVERNANCE AND SHARING:**

Rigid data ownership results in siloed data analysis, isolating users at the edge from critical information. The concept of data ownership must evolve to one of data stewardship, where commands and suborganizations receive guidance on protecting individual data assets. Despite efforts to emphasize jointness, services still typically set requirements and make acquisitions independently. Only enterprise-level management can achieve the complex functional and technical alignments required for true interservice collaboration.



**JOINT DECISION-MAKING:**

AI offers the promise of delivering faster insights, but only if analytics platforms can receive relevant data, analyze it, and deliver rapid recommendations. In the same way, warfighters can take faster action, but only if they are connected to networked communications and systems. Flexible innovations are needed to integrate sensors, data, devices, and effectors to enable a common course of action to be developed in near-real time.



**CONNECTED, OPEN ARCHITECTURES:**

Implementing JADC2 will require data platforms and other technical infrastructures built on modular open architectures. Proprietary software, APIs, and hardware interfaces drive up development costs and take longer to upgrade and modify. Government-owned APIs and open-architecture approaches are two key ways to free the government from vendor lock-in.

As we dive into the three keys to accelerating JADC2, we will address how the government can overcome these challenges to empower the future force. Resilient networking, a unified data fabric, and a streamlined C2 decision framework will connect our forces from sensor to effector. Open architectures will enable flexible development and continuous innovation. Let's explore those solutions now.



# THE THREE KEYS

## 1 Resilient Networking, Compute, and Communications



To connect the battlespace from enterprise to edge and sensor to effector, DOD needs a cloud-based, vendor-agnostic network with solutions built on [government-owned open architectures](#). A cloud-based network will offer increased data storage, resilience to server crashes, increased flexibility in data access, and faster data transmission. All these benefits work together to accelerate warfighter safety on the front lines and mission success across conflicts and campaigns.

An open architecture system can readily utilize solutions from multiple vendors, as opposed to a proprietary system. Instead of purchasing a billion-dollar proprietary solution that could be obsolete in 5 years, the network can evolve with open-source solutions that adapt to changing mission needs. This enables DOD to execute a phased rollout of a scalable, context-aware environment that integrates new technology and adapts over time.

This future network must integrate with and capitalize on existing 5G and 6G networks to deliver speed, automation, and ubiquity, while being hardened against adversarial attacks and interference. Booz Allen data scientists are innovating in several critical areas to support a resilient network that is compatible across the joint force: network security, network resiliency, and edge computing.

### ESSENTIALS FOR INTEROPERABILITY

- + Government-owned open architecture framework
- + Ubiquitous 5G and 6G network
- + Cloud-based network
- + Zero trust security
- + Low latency, from enterprise to edge
- + AI-enabled self-healing network

## SECURITY: ZERO TRUST

[Zero trust security](#) has quickly arisen as a necessary minimum to protect critical networks across the joint force. Zero trust continuously verifies a user's attributes—identity, device, behavior patterns, endpoint hardware, geolocation, and more—before granting access to the network. To bolster its zero trust posture, DOD has developed a new identity, credentialing, and access management (ICAM) tool to limit data access to approved users even after they've entered the network. These solutions are critical for flexible and secure information sharing both across the joint force and in a [mission partner environment](#), where trusted international allies need to access and share information.

## NETWORK RESILIENCY: MESH NETWORKS AND AI

Complementing zero-trust networks in protecting against attack and improving resiliency are mesh networks—networks with multiple nodes that connect dynamically. Mesh networks provide breadth, stability, and flexibility. For example, if one node is impacted in an adversarial attack, it can simply be removed. The rest of the network will cooperatively compensate for the removal by rerouting data through other nodes.

Further improving network resiliency are advanced analytics and AI, which can rapidly identify threats to the network and provide insights into the entire attack surface. Within moments, AI can perform a threat inventory and then automate vulnerability scans, anomaly detection, and incident responses. While human-machine teaming will always be critical—particularly in life-or-death battlefield scenarios—advanced analytics pave the way for a self-healing network that can identify and eliminate adversarial threats without human intervention.

## EDGE COMPUTING: MADL, NETWORK SLICING, AND MULTI-ACCESS EDGE COMPUTING

No matter how robust the network, challenges—jamming attempts, cyber attacks, extreme weather events, remote environments, and more—can wreak havoc on joint force communication and time to critical insight. [Edge computing](#) is the key to giving warfighters full situational awareness in these scenarios. Data processing occurs at the point of collection, and connectivity remains intact in the absence of the cloud or the network.

The most advanced aircraft ever created, the F-35, uses an edge technology called multifunction advanced data link (MADL) to assess the environment, fuse data, and distribute a single picture of data across an F-35 fleet. As MADL technology expands to communicate with other weapons and platforms across the joint force, the benefits of edge computing and network resiliency become more visible.

[Chris Bogdan](#), a leader in Booz Allen's aerospace business, retired U.S. Air Force Lieutenant General, and former Pentagon Executive Officer for the F-35 Lightning II Joint Program Office, shared a powerful example. He witnessed how a naval ship shot down a missile using data from an Air Force F-35. The F-35 was flying beyond the ship's tracking system range, but MADL edge technology linked the F-35 and the ship. Edge computing connected the Navy and Air Force platforms and enabled real-time elimination of the threat.

Booz Allen researchers in our [5G lab](#) in Annapolis, Maryland are taking further strides to advance edge computing through innovation in network slicing and multi-access edge computing (MEC). Network slicing creates multiple virtualized networks over a multidomain infrastructure to reduce latency and enhance speeds for high-priority missions. MEC moves the computing of traffic and services from a centralized cloud to the edge of the network,

reducing latency and increasing performance on high-bandwidth jobs. Read on in our callouts to learn more about network innovations in the 5G lab.



### *Booz Allen 5G Lab Develops AR and VR Training for Soldiers*

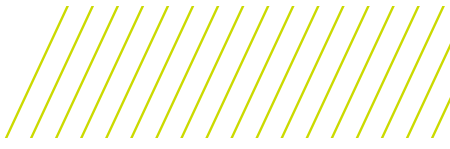
Booz Allen is taking an open, yet secure system architecture approach to developing augmented reality (AR) and virtual reality (VR) applications that leverage the latest technologies and integrate across various mixed reality (MR) headsets. Open, secure digital frameworks allow the military to integrate AR and VR training, mobile intelligence, and networked weapons to get to the future force faster. Our MR solutions provide an immersive tactical environment to give military personnel a realistic experience anywhere, anytime. *Pictured: Microsoft HoloLens 2*



### *Innovating with AI to Share 5G Spectrum*

Booz Allen developed the R.AI.DIO software to optimize artificial neural networks in a signal processing software stack. This technology helped the Air Force equip airborne radar systems to dynamically share spectrum with 5G cellular services. Using our R.AI.DIO signal processing algorithms, Booz Allen created a spectrum sensing application to enable a seamless connection with these powerful, high-capacity networks.

## 2 A Unified Data Fabric



The battlespace of the future depends on information advantage. Data is the spinal cord that connects the joint force and ensures mission success. But in the current state, data is siloed, and warfighters have insufficient information. The military needs a federated data platform, integrated via a common reference architecture, to ensure seamless connectivity across domains.

While much of the data the warfighter needs already exists in various repositories, actionable intelligence is rarely shared between different services' networks and databases and is frequently undiscoverable due to the lack of a common reference architecture. Although policies and protocols need to be updated before data can be truly sharable, a unified data fabric would solve the technical challenges to cross-domain information integration.

Currently, information is largely stored in siloed databases or at the edge, where sensors receive live input. As noted previously, connecting sensor data and processing it in real time has lifesaving benefits for warfighters. However, these benefits are not readily available across DOD. A federated data fabric will provide one cohesive platform to connect data across domains.

This ecosystem will enable trusted data sharing and advanced analytics from the enterprise to the tactical edge, connecting sensor to effector for faster action. Advanced analytics and AI can be quickly integrated via open architectures and platforms made adaptable to mission needs.

### THE POWER OF END-TO-END CONNECTIVITY

- + Real-time, trusted data delivered end to end
- + Data shared seamlessly across domains
- + Security ensured across federated platforms
- + Innovations and efficiencies integrated rapidly
- + Response time accelerated using mission-specific platforms



## DATA SHARING ACROSS THE JOINT FORCE

A data fabric is the next evolution of data platforms connecting data across databases and sensors. It provides a unified architecture—an integration of data and analytics across joint force environments, enabling DOD to manage data efficiently. The data fabric experience is seamless—agnostic of environment (whether hybrid or multicloud), technology differences, or data source. A unified data fabric will unlock the power of the joint forces on every mission by giving warfighters rapid access to the right data, regardless of where it is in the organization.

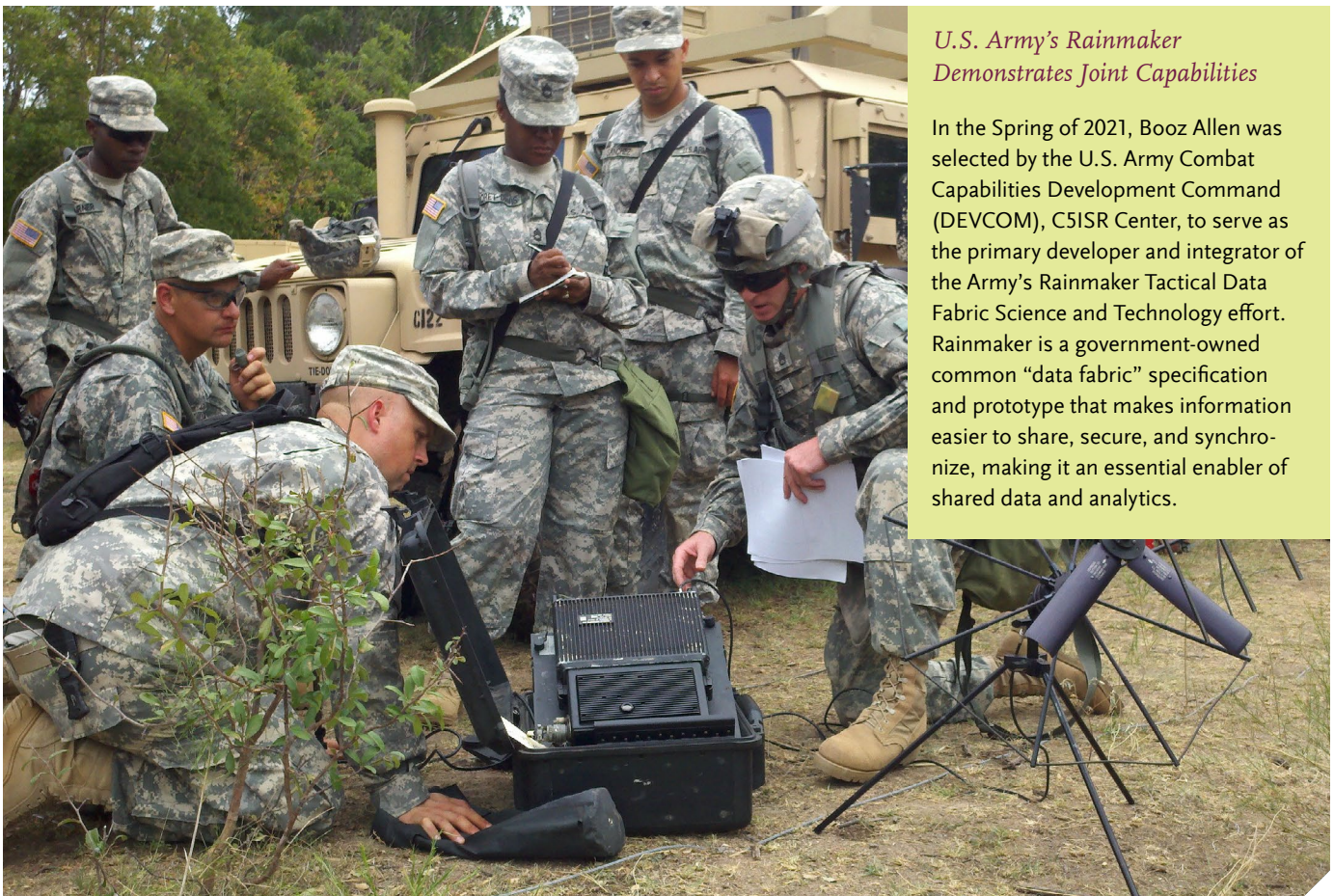
Here are the top four ways that a data fabric will unite the joint forces and accelerate JADC2.

**BUILT-IN CYBERSECURITY:** Integrated data fabrics provide a game-changing benefit: Cybersecurity solutions are built directly into the platform, not bolted on later. Integrated data architectures are modular, enabling cyber protections to be continually upgraded as the mission changes.

**INTERSERVICE INTEROPERABILITY:** Current approaches of moving data from one service to another—from the Navy to the Air Force, for example—require a chain of approvals and often rely on outdated methods to move data across classification levels and networks. Updated policies and permissions for data sharing in combination with a federated, open-architecture solution, paired with updated policies and data governance, will make interservice connections seamless.

**RAPID MODERNIZATION:** An open-architecture approach provides the foundation for uniting data from diverse systems; government-owned APIs provide the connectivity. APIs also enable rapid integration of new AI capabilities and modular tools. Combat networks can therefore integrate data sources rapidly, making information immediately accessible to all domains, without needing a full overhaul of their systems.

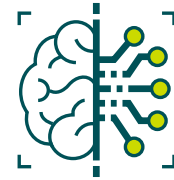
**INFORMATION SUPERIORITY:** With a unified data fabric, trusted users can more easily discover and access the information they need to share. Warfighters gain access regardless of domain, without needing to know parameters like data formats, locations, or originating platforms. Coalition partners can act in coordination, informed by regional updates while connected by data that delivers a shared global awareness of what is happening in real time.



### *U.S. Army's Rainmaker Demonstrates Joint Capabilities*

In the Spring of 2021, Booz Allen was selected by the U.S. Army Combat Capabilities Development Command (DEVCOM), C5ISR Center, to serve as the primary developer and integrator of the Army's Rainmaker Tactical Data Fabric Science and Technology effort. Rainmaker is a government-owned common "data fabric" specification and prototype that makes information easier to share, secure, and synchronize, making it an essential enabler of shared data and analytics.

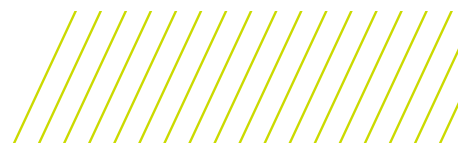
### 3 A Streamlined C2 Decision Framework



Operators need access to AI/ML algorithms at the tactical edge. Analytics at the point of need will allow warfighters to process information and turn it into actionable insights in real time.

DOD created the AI and Data Acceleration initiative (ADA) to speed JADC2 development by ensuring the right data is in place to create algorithmic models needed for rapid decision-making. This is a strong step toward developing robust AI programs for DOD, which will expedite data collection, delivery, and analysis.

As a [DOD](#) partner in advancing [AI](#), we are developing and operationalizing analytic capabilities for use across the military. New algorithms and automated processes are propelling AI-enabled decision-making that adapts to changing missions and conditions at machine speed.



#### THE GAME CHANGER: FAST, DECISIVE ACTION

- + Decision advantage achieved using AI/ML
- + Cross-domain connections maintained securely
- + Data synchronized for a common operating picture
- + Operators' time freed to focus on critical missions
- + Algorithms updated with precision across the joint force
- + Mission adaptability ensured by a flexible innovation engine

## MLOPS

Our [machine learning operations](#) (MLOps) approach accelerates speed to actionable insight by enabling teams across the joint force to standardize, scale, and reuse AI models. MLOps manages AI models throughout the lifecycle, tracks and monitors performance to identify and correct errors, and implements security in every phase.

### *Our MLOps Pipeline*

- Allows models to be managed throughout the lifecycle
- Monitors performance and corrects errors
- Offers built-in security
- Establishes a repeatable workflow
- Automates rebuilding of algorithms as missions change

Unlike AI requiring supervised training using exact inputs, our models use reinforcement learning to compute the best decisions. The models can therefore compute the best solution in a dynamically changing situation without constant intervention.

The AI models can also be adapted to the form factor—for example, adjusted for device-specific power and compute needs. This ensures:

- Warfighters will be able to access AI/ML on any device, anywhere
- Frontline teams and operators will know their models are up to date
- The MLOps infrastructure will provide these benefits efficiently and at scale

Most decisions can be automated, allowing rapid response to changing tactical conditions. Advanced algorithms can also enable human-in-the-loop identification of outliers, reducing the cognitive burden on mission teams. This will increase scalability and free up time for specialists to focus on operations.



### *Modular System Speeds Decisions*

C2 systems are critical at the tactical edge, but equipment takes time to set up and transport vehicles can become a target. Booz Allen worked with the Michigan National Guard and technical innovators to develop a better approach to C2 equipment: a modular detachment kit (MDK) that scales from a single laptop to a suite that can handle theater-level responsibility. Providing the most comprehensive military operational picture to forces anywhere in the world, MDK may become a key technology for the Air Force's Advanced Battle Management System (ABMS).

[Learn more about the mobile kit](#)

### *First AI Copilot*

Our AI team moved innovation from the lab to the skies in fewer than 40 days for a U-2 flight showing an algorithm successfully emulating control of sensor systems. We worked with the U.S. Air Force Air Combat Command's 9th Reconnaissance Wing U-2 Federal Laboratory to create the milestone, which marked the first time AI has teamed with a pilot for a complex mission. The feat required rapid delivery in diverse areas like model training, developing a web-based interface, and arranging for program office approvals.

[Learn more about the U-2 flight](#)



SECTION III:

# MOVING AHEAD FASTER

## Innovation Through Collaboration

The info-centric future of war requires a digital-first approach. It takes a new type of partner to help you get there faster—one that understands the imperatives of the joint force and has the expertise, partnerships, and perspective to create open-source solutions that put you in control of your technology. It takes a digital integrator.

```

// export the group_info to a user-space array
unsigned int count = group_info->ngroups;
for (i = 0; i < group_info->nblocks; i++) {
  unsigned int cp_count = min(NGROUPS_PER_BLOCK, count);
  unsigned int len = cp_count * sizeof(groupset);
  if (copy_to_user(groupset, group_info->nblocks, len))
    return -1;
}

int i;
unsigned int count = group_info->ngroups;
for (i = 0; i < group_info->nblocks; i++) {
  unsigned int cp_count = min(NGROUPS_PER_BLOCK, count);
  unsigned int len = cp_count * sizeof(groupset);
}

/* fill group_info from a user-space array - it must be already filled
static void groups_from_user(struct group_info *group_info,
                           void __user *groupset)
{
  int i;
  unsigned int count = group_info->ngroups;
  for (i = 0; i < group_info->nblocks; i++)
    unsigned
}

24/07/2017 Hacker Tyler
https://hackerone.com/513
return 0;
}

/* a simple Shell sort */
static

```

### THE GAME CHANGER: FAST, DECISIVE ACTION

- + Government-owned APIs for joint force interoperability
- + DevSecOps for rapid software development
- + Tech partnerships that translate commercial inventions to mission solutions
- + New acquisition paradigms for flexible system design
- + Navigating uncertainty with clarity to accelerate JADC2



Booz Allen is the digital integrator that furthers DOD transformation to achieve resilient networking, a unified data fabric, and an AI-enabled C2 framework with greater speed and security. Here are some of the ways we can connect your technology to tomorrow.

### MISSION FIRST: PROVIDING GOVERNMENT-OWNED APIS

DOD has a mandate to connect disparate solutions via a single unified, yet federated platform. We've stressed the importance of solutions built on government-owned open architectures to achieve this goal. Government-owned APIs are a critical enabler of this paradigm.

Embedded in DOD-owned architectures, government-owned APIs would enable data sharing across the federated platform. They would also provide interoperability—allowing military teams to plug in a new solution for an immediate trial run at a site across the globe, for example, instead of waiting for a proprietary interface to be supplied or modified for the experiment. Defense organizations could quickly replace or reuse services, data, infrastructure, and user experiences across the joint force.

### TRUE DEVSECOPS

To deliver on the promise of JADC2, DOD needs to speed software development. The military encourages adoption of DevSecOps, but only the most forward-looking teams across the services and commercial providers actually use it—and all too often [use DevSecOps in name only](#).

Our agile development frameworks quickly and continuously improve and update application code with automated infrastructure deployments, security checks, and compliance. This approach to secure software development enables the rapid creation of applications and software, while implementing zero-trust security.



### Platform One

Knowing warfighters' safety depends on deploying software updates ahead of the next threat, the Air Force decided to accelerate innovation with a new development platform. Booz Allen helped the Air Force design and develop Platform One, the federal government's first DevSecOps enterprise-level service. By employing an enterprise mindset, creating an open and modular infrastructure, and automating key delivery elements, the Air Force now fast-tracks production of high-value mission applications.

[Learn more about Platform One](#)

## TECH PARTNERSHIPS

Mission advancement depends on the integration of niche partners and technologies, including nontraditional government players. Booz Allen forms strategic partnerships to deliver mission-first technology and results.

Many of our partnerships are with other technology leaders. For example, NVIDIA has empowered us to capitalize on major advances in ML and high-performance computing. We've teamed up with Amazon Web Services (AWS) to support critical missions by delivering cloud services. Our partnership with Databricks is helping federal agencies

scale ML workflows and accelerate AI initiatives. At the same time, we work with companies from startups to traditional defense contractors, seeking the expertise and technologies that will be the right fit for each mission.

Commercial innovation offers DOD a way to propel its capabilities ahead. Yet most commercial companies—especially the startups where much of the future is forged—don't understand DOD's mission, challenges, and requirements. We help bridge that gap. Whether helping [DOD double the size of the U.S. Navy for World War II](#), supporting the space and missile programs developed as a response to Sputnik, or [continuously pushing the leading edge of cybersecurity from the 1990s through today](#), we know how ingenuity and technology can create new answers for the hard problems. Booz Allen has an 80-year history of putting the mission first, translating commercial inventions to solutions that meet mission needs.

## NEW PARADIGMS

We have discussed how DOD can adjust its paradigms to enable the design and development of systems that are flexible enough to evolve at the same pace as threats, technology, and warfighter needs. Our recommendation is that DOD adopt [two new acquisition paradigms to support JADC2 capabilities](#):

- **Open, modular, scalable architectures:** Rather than focusing on siloed efforts with proprietary architectures, acquisition regulations must focus on a plug-and-play scenario allowing rapid updates and continual improvement across the lifecycle.
- **Flexible requirements:** Instead of establishing static requirements at the start of an effort, the military must accept that threats evolve and missions change. Tools such as DevSecOps and agile development allow system developers to adapt to this dynamism without the significant impacts to cost and schedule that revising rigid requirements would entail.

## NAVIGATING UNCERTAINTY WITH CLARITY

DOD is creating JADC2 to defend the nation in a future that's ever-evolving. We'll be here to accelerate transformation with principles that help illuminate the road ahead:

- Change will always be with us—and the pace of warfare is moving ever faster.
- Adopting flexibility and modularity will enable DOD to adapt.
- Blending speed, simplicity, and security is essential to achieve decision advantage.

JADC2 is the power achieved through joint force coordination. It's seamless data connection between sensors and shooters, across services and operating environments. It's information dominance. It's mission advantage. JADC2 is modern warfare.

Booz Allen is committed to working side by side with the military, industry, and thought leaders across intelligence, technology, and cybersecurity to accelerate JADC2—and ensure information dominance to protect our nation.



### The Digital Integrator: Connecting DOD to the Innovation Ecosystem

We connect military visionaries with innovators and Silicon Valley-style entrepreneurs, helping DOD access leading talent to collaborate on the tough problems. We recently invested in [Latent AI, Inc.](#), a rapidly growing company with a suite of software tools that enable adaptive AI and ML—optimizing compute, memory, and energy at the edge. These capabilities will be particularly critical for defense, where running AI in contested environments is critical to achieving situational awareness.

## About Booz Allen

Booz Allen is the premier digital integrator for the Department of Defense, blending decades of mission experience with state-of-the-art AI/ML, next-generation data solutions, networking, cyber, and advanced software development to help the department achieve decision advantage. We bring our defense clients the best emerging technology to help them quickly and easily modernize, achieve interoperability, and win. We design open architectures to avoid vendor lock, lower lifecycle cost, and maintain a technological edge. Our technologists work hand-in-hand with our domain experts to build solutions that deliver the warfighter mission-critical information in today's digital battlespace. We're accelerating innovation to help defend the nation.

**[BOOZALLEN.COM/JADC2](https://www.boozallen.com/jadc2)**