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INTEGRATED C4ISR

INTEROPERABLE AND SECURE C4ISR USING ENTERPRISE INTEGRATION

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C4ISR'S CHANGING NATURE

Until recently, many C4ISR systems were designed to meet specific mission requirements. Traditional acquisition processes were well suited to develop such systems, which were not primarily designed to share information or interoperate seamlessly with systems outside of their mission space. As opportunities and requirements for collaboration grew, these systems were expanded and modified after they were fielded, typically by the OEMs that built them using proprietary technology.

This approach of using proprietary systems provided a very high degree of efficiency in achieving the original objective. However, because each C4ISR system was developed in relative isolation, each had a unique infrastructure, operating system software, software services (e.g., security, reporting), data, and custom mission-specific software. Moreover, as these systems were fielded and became more integrated into the operations of the military, expectations and demands on the systems grew significantly. The next logical step was to pursue options to integrate after-the-fact. Unfortunately, as efforts have been undertaken to better connect the individual systems, the challenges inherent in using proprietary systems came very clearly to the forefront.

Consequently, this approach to building and then integrating systems has proved to be inadequate for creating C4ISR that meets today's warfighting requirements. At the heart of the issue is the failure to take advantage of a concept known as the network effect. Under this concept, the value of a network to its users becomes significant after a certain size—known as critical mass—has been achieved. At the critical mass point, the value obtained from the service delivered by the network is greater than or equal to the price paid for the service.

In other words, as an IT-based weapons system, C4ISR is at its most effective when it is integrated. A unique characteristic of the military's C4ISR system is that the component parts of the network are present—they are just not configured in a way that capitalizes on the full network value of the components.

"We have systems that can show us volumes of data on fires, logistics, or friendly and enemy force locations, yet we don't have one system that brings the entire picture together. We have constantly evolving software, but some tools require too many clicks or permission levels for warfighters to actually find their best features. We have great communications systems inside combat and tactical vehicles, but they each come with their own monitors and other hardware, creating a challenge for operators in tight quarters," said Army Maj. Gen. Daniel Hughes, Army Program Executive Office for Command, Control, Communications-Tactical (PEO C3T), in describing the challenge.[1]

This siloed approach impedes mission performance in other ways as well. For example, the increasing sophistication of current cyber threats requires that C4ISR systems be protected with the highest levels of security; however, the creation of digital interfaces to integrate independent OEM systems can often introduce vulnerabilities that weaken cybersecurity. Another problem is that the insertion of new technologies into proprietary systems can be complex and difficult, especially after the systems are fielded. Consequently, the C4ISR systems used by warfighters often lack the latest technological capabilities, including those that may be

commercially available. The development of C4ISR systems in relative isolation also increases costs due to the duplicate investment to develop the same technology component, service, and/or application in multiple systems—often in closed, proprietary (or industry-owned) architectures.

Clearly, the traditional approach to C4ISR integration does not meet today's mission challenges. Integrating independent, proprietary systems in a one-off fashion after they are fielded hampers interoperability, inhibits technology insertion, diminishes security, and drives up costs with inefficiencies. "We can't continue down a path where we have proprietary hardware and software that causes us to spend a lot of money in post-production just to try to maintain connectivity and interoperability between proprietary systems," said Lt. Gen. Michael Williamson, principal military deputy to the Assistant Secretary of the Army for Acquisition, Logistics and Technology. "It's just unaffordable."[2]

ACHIEVING INTEGRATED C4ISR

We propose creating integrated C4ISR, in which each new system is conceived from the beginning with an eye toward its interdependent role in the larger C4ISR ecosystem, and existing systems are reengineered in the same context. Integrated C4ISR systems are designed, developed, and built with the understanding that they will interoperate with a wide range of mutually supporting C4ISR systems. Integration is organic, not an afterthought. Equally important, this organic method streamlines system development, facilitates insertion of emerging technologies throughout a system's lifecycle, strengthens security, and increases operator involvement to ensure systems meet operational requirements. Integrated C4ISR achieves these goals through five essential features:

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Government-owned, open architectures and standardized interfaces. Government and military organizations will shift away from proprietary, closed, vendor-owned C4ISR systems to an enterprise architecture that is standards-based, open, and government-owned to ensure system interoperability and data integration. The government will develop enterprise blueprints with detailed designs for intersystem interfaces and specifications for a modular, open, government-owned architecture. In addition, as part of their procurement packages, vendors will be required to deliver individual systems that integrate seamlessly into the overall enterprise environment.

In integrated C4ISR, the government will own the architecture, the system, and the data, thus reducing vendor lock-in and helping eliminate inefficiencies. In addition, the government will create modular architecture with open, interoperable, and well-defined interfaces to plug in new technologies when they become available, fostering innovation and reuse across the enterprise. The government will gain access to the most innovative companies, which will vie to "appify" cutting-edge C4ISR

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capabilities that can plug and play within the existing, standardized infrastructure.

This approach corresponds with the views of many senior military leaders. "It is essential, in my view, that the government take the most important technical standards and authorities and pull them back and control them," said Vice Adm. David Dunaway, Commander, Naval Air Systems Command (NAVAIR), in an interview advocating that the Navy end the practice of outsourcing responsibility for the integration of complex systems.[3] Rather than integrating individual stovepiped systems, the Navy should engineer systems in an integrated fashion from the beginning, he said.[4]

"Then, industry can plug into a common standard, and that goes to things like open architecture, modularity, plug-and-play," he said. "We've all talked about these things for a long time, and it might have been a bridge too far in the past. But the technology is here today. In NAVAIR, we've integrated more than 20 [electrooptical/infrared] sensors in the past 10 years in a point-to-point, proprietary fashion. That's just crazy. It's money that's just lost to the system. It should be an open architecture with a minor integration effort for every new sensor."

Agile, incremental delivery of modular systems with integrated capabilities. Government and military organizations will shift away from the big-bang acquisition approach in which large, monolithic systems are delivered all at once, often after years of development, by a single vendor team comprised of a primary contractor and a handful of subcontractors. Instead, they will acquire smaller, modular systems with common interface specifications delivered incrementally by the full industry base and inject new innovations into the integrated C4ISR solution as soon as they are invented. This will yield an agile, evolutionary capability that expands the competitive industrial supply base to bring new innovations quickly into the networked environment.

This approach aligns with current Pentagon efforts to spur innovation and speed technology insertion. For example, DoD's Better Buying Power 3.0 initiative expresses a "growing concern that the United States' technological superiority over potential adversaries is being threatened today in a way that we have not seen for decades."[5] Among its recommendations, Better Buying Power 3.0 advocates that acquisition programs emphasize technology insertion and refresh in program planning, increase the use of prototyping and experimentation, and use modular, open systems architecture to stimulate innovation.[6]

Some of the key concepts in Better Buying Power 3.0, such as "technology insertion" and "refresh," are not new but "need to be emphasized," said Frank Kendall, US Defense Undersecretary for Acquisition, Technology, and Logistics, who is leading the effort.[7] "We have pushed for modular, open systems for a long time," he said. "We've had mixed success with that. I think a lot of it has to do with successful management of intellectual property and managing design interfaces."

Collective forums that bring together operators, acquisition professionals, and engineers to support agile development of solutions tailored to operational and technical requirements. For example, a strong government laboratory system is essential to implementing agile development that can continuously incorporate emerging technologies and capabilities into integrated C4ISR systems. Vibrant labs will have the resources to bring together engineers and operators to test new and refined technologies through agile development. Wargames, tabletop exercises, hackathons, and other similar activities can also ensure that the operators' perspective informs systems development. In an environment of open architectures, interfaces, and infrastructures, stakeholders from the engineering realm can bring in their solutions to evaluate how well they interoperate with existing C4ISR platforms, assess how well they meet the real-world operational needs of warfighters, and determine the best options for maintaining quality standards while rapidly fielding the capabilities.

"There are a lot of technologies that are moving more quickly in the commercial world than they are in the military-unique technology world. We want to be able to capitalize on them as much as we can," Kendall said.[8] In fact, one of the major goals of Better Buying Power 3.0 is to improve the return on investment in DoD labs, which process about $30 billion in spending each year.[9] Labs that can provide a robust forum for engineers and operators to develop and test new technologies in agile development could help deliver the innovation needed to maintain US warfighters' technological advantage.

Designed-in cybersecurity to infuse solutions with organic, unified, and multilayered defense. The cybersecurity approach used for independent C4ISR systems is necessary but not sufficient, as the military moves toward an integrated system. Protecting an expansive network calls for the incorporation of different techniques and technologies compared to a stand-alone system. Early engagement of security issues in the design process, along with control over security standards and interfaces, will enable system developers to make cybersecurity an organic feature of each integrated system. Similarly, because systems will be designed to interoperate through interfaces with common (and secure) standards, they will not be linked by insecure—and often jerry-rigged—interfaces created when independent systems are integrated after fielding.

Enterprise-oriented culture. The connectedness, interdependency, and adaptability of integrated C4ISR will be reflected in the enterprise approach adopted by leaders and their people. In an enterprise-oriented culture, stakeholders do not think of their roles simply from a functional perspective (i.e., as a technologist, an operator, an acquisition professional), but instead from an enterprise perspective that moves them from a siloed view of the issues to coordinated decision making. An enterprise approach calls for much greater stakeholder collaboration—horizontally across the joint services (US Army, Air Force, and Navy/Marine Corps) and vertically across strategic, operational, and tactical levels—to prioritize requirements and ensure that cross-organizational mission needs are met. Ultimately, an "integrated" mindset will permeate in the enterprise.

At a practical level, acquisition officials will need to consider the need to create a Program Executive Office (PEO), or similar leadership governance function, to ensure that C4ISR programs adhere to common standards and interfaces, and help programs maintain an enterprise perspective. As an example, the Naval Air Systems Command has established the Integrated Warfighting Capability (IWC) Enterprise Team to help carry out the Navy's

Integration and Interoperability Charter. The IWC goal is to ensure the technical aspects of warfighting capability work together across platforms, weapons, networks, and sensors from the initial planning stages until delivery to the fleet."[10] The IWC Enterprise Team serves as an "integration agent" and promotes an enterprise perspective by developing and enforcing mission-level technical standards to support integrated solutions that interoperate seamlessly and meet operational requirements. The effort includes Rapid Response initiatives that address urgent capability gaps and speed improvements to the fleet using spiral upgrades. The Navy expects the IWC initiative to reduce costs, increase efficiencies, and help combatant commanders accomplish their missions.

In addition to creating a PEO or similar enterprise sponsor to oversee Enterprise Integration efforts, government and military organizations should also consider establishing reward structures to encourage adherence to common standards, resource sharing, and an enterprise perspective among program managers.

These five characteristics are mutually reinforcing. For example, open architectures and interfaces are needed to support agile development. A robust lab system will also support agile development. An enterprise-oriented culture is needed to sustain these areas, but, at the same time,the establishment of open architectures and innovative labs will help build the desired culture. Successes in one area will fuel successes in the others, thus providing momentum to help organizations build integrated C4ISR.

USING ENTERPRISE INTEGRATION TO BUILD INTEGRATED C4ISR BY COMBINING ENGINEERING, OPERATIONAL, AND ACQUISITION EXPERTISE

Government and military organizations can develop and field integrated C4ISR through an Enterprise Integration approach that manages the acquisition of C4ISR systems. Enterprise Integration creates integrated C4ISR by incorporating each of its five major features into the acquisition process. Although this will introduce changes into the traditional big-bang acquisition approach, Enterprise Integration does not require major reform of acquisition regulations or laws. Precedent for this approach can be found in other DoD programs, such as missile defense. When government and military leaders have had urgent need to deploy systems rapidly to support warfighters in the field or apply agile development to incorporate new technologies in developing systems, acquisition rules have allowed them to do so. As previously noted, many Pentagon leaders are advocating government-owned, open architectures, modular designs, and related innovations.

Some programs have already adopted many of the essential features of Enterprise Integration. To cite one example, the Army's Distributed Common Ground System-Army (DCGS-A) Standard Cloud program operates in an open architecture environment with inter-system interfaces. As a result, DCGS-A integrates 13 different U.S. Army ISR programs into one virtual, interoperable system. Vendors develop systems for "plug and play" within the broader DCGS-A infrastructure, and they use the Army's System Integration Labs for vendors to test their systems to ensure interoperability before fielding. In addition, the labs enable operators to test and shape new technologies to enhance their usability and mission capabilities. As a result, the Army has improved integration, strengthened its

analytic capabilities, and streamlined the process of getting intelligence and analysis to commanders and warfighters, while also reducing the overall costs to support DCGS-A Enterprise Integration introduces an expanded role for acquisition organizations. To manage Enterprise Integration effectively, government organizations will need to significantly enhance and link capabilities in three primary disciplines:

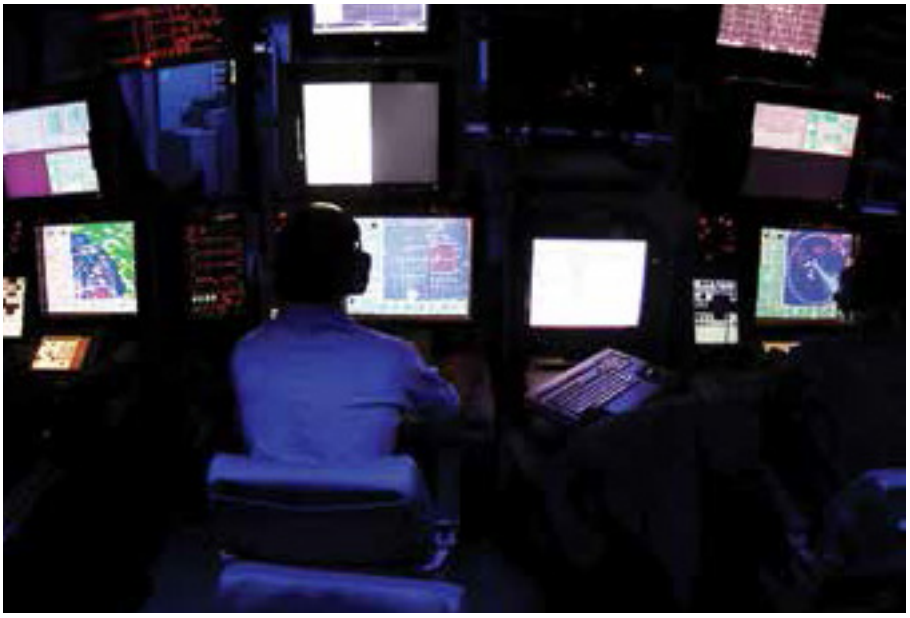
- **Engineering.** Engineering and technical skills are needed to ensure that standards, interfaces, and infrastructure are well architected to enable interoperability among systems, as well as to allow emerging technologies to plug into developing and existing systems.
- **Operations — Strategic and Tactical.** Technologists need to understand how warfighters will actually use their solutions. Operational knowledge and experience is required when developing new systems and upgrading existing systems to ensure that C4ISR solutions are user friendly and tailored to battlefield realities.
- **Acquisition Policies and Processes.** In-depth knowledge of acquisition policies and processes is needed to coordinate C4ISR acquisitions among numerous stakeholders in the program and operator communities, while also ensuring compliance by all parties with common standards, sharing of common components, etc. Such knowledge will also be important to guide programs through agile and rapid development, and to make sure the programs adhere to the myriad rules and regulations governing DoD acquisitions.

To manage Enterprise Integration effectively, government organizations will need to significantly enhance and link capabilities in three primary disciplines: Engineering, Operations and Acquisition.

These three skill sets are not entirely new or absent from the current programs, but Enterprise Integration demands a much higher level of expertise and cooperation than most acquisition efforts currently possess. Consequently, government and military organizations will likely need to supplement their own capabilities with industry expertise.

Reaping the Benefits of Enterprise Integration

The Enterprise Integration approach will deliver on C4ISR's full potential by addressing current challenges with the systems and laying the foundation for integrated C4ISR. It will help break down silos among systems to enable rapid communications and sharing of large amounts of data in real time. In turn, this will enhance the military's ability to exploit big data analytics to improve the processing, exploitation, and dissemination (PED) in the wake of the explosion of ISR data. Collaboration among intelligence teams and warfighting units will also be strengthened. The ultimate payoff will be enhanced situational awareness and decision making.



Enterprise Integration will also facilitate the rapid insertion of new technologies throughout the lifecycles of C4ISR systems. The establishment of open, common standards and interfaces will allow vendors to plug-and-play new technologies within a common operating infrastructure. The standardized infrastructure will also facilitate agile development for incorporating new technologies into developing systems. A robust lab system will bring operators and engineers together to ensure that solutions meet warfighters' requirements. And the reliance on common standards and interfaces will simplify the operating environment to make C4ISR systems easier to use, particularly in battlefield conditions.

Two other important benefits will also accrue. Enterprise Integration will strengthen cybersecurity because interoperability and security will be designed into systems from the beginning. This will preclude the need for the complex integration of systems after they are developed and fielded, which can introduce vulnerabilities into the system-of-systems interfaces. In addition, Enterprise Integration will reduce acquisition costs. The common operating architecture will enable reuse and sharing of common components among C4ISR systems, and the plug-and-play environment will streamline acquisition and give warfighters wider access to commercial technologies. The expanding industrial base will spur even greater competition and innovation among vendors to lower costs, while increasing mission capabilities.

Ultimately, the open architectures and standard interfaces within the military services will serve as building blocks for standard interfaces among the services, thus supporting interoperable, joint warfighting. "In standards compliance, the use of military and industry standards - versus proprietary interfaces—is mandatory for digital interoperability,"

said Marsha Mullins, a systems engineer in the Joint Fires Division of the Joint Staff J-6 Deputy Directorate for C5 Integration.[11] Mullins' observation underscores the need for government and military leaders to abandon their hands-off approach that places the responsibility on OEMs to integrate proprietary systems after fielding and, instead, assume responsibility for establishing the standards and interfaces for integrated C4ISR systems.

BOOZ ALLEN: YOUR ESSENTIAL PARTNER IN INTEGRATED C4ISR

Booz Allen is uniquely positioned to bring the skill sets together that will enable Enterprise Integration. Our single profit and loss (P&L) center allows for rapid and seamless integration of diverse skill sets and, as a result, we operate with an enterprise mindset. In addition, we have an organizational structure that allows us to collaborate on technical innovation, operations expertise, and acquisition acumen for integrated C4ISR. Other benefits:

- **Booz Allen has been a leader in innovative C4ISR for decades.** Booz Allen has a long history of working in the C4ISR arena—our projects have focused on innovative improvements to technical systems and operational enhancements. We have always taken a holistic view of C4ISR challenges, and have brought our engineering-focused consulting skills to bear on the most complex and challenging issues our clients have faced.
- **The addition of Booz Allen Hamilton Engineering Services is turbo-charging our already powerful C4ISR capabilities.** Recognizing the increasingly critical role that C4ISR systems will play in military operations, we have been steadily expanding our supporting capabilities. With the acquisition of Booz Allen Engineering Services in 2012, we expanded an already solid engineering base to include many specialized capabilities crucial to an integrated approach to C4ISR.
- **Integrated prowess: engineering + operational + acquisition expertise.** The 2014 Quadrennial Defense Review (QDR) highlights the inherent tension between capacity, capability, and modernization in developing military systems today, particularly C4ISR. To manage this tension, at an acceptable level of risk and performance, means that technical engineering actions associated with C4ISR need to be directly informed by operational requirements and acquisition realities.
- **Deep technical expertise.** Today's integrated approach to C4ISR creates a multidimensional challenge, which requires the highest level of technical expertise. We offer highly qualified personnel who possess deep experience with government and industry, and who are providing the thought leadership and innovation that is driving innovation in the C4ISR space.

NOTES

1. *Rosenberg, Barry, "Command Conversation: BG Daniel Hughes, Army PEO C3T," C4ISR & Networks, October 3, 2013.*
2. *Jared Serbu, "For DoD, open architectures turn from a nice idea to a budget imperative," Federal News Radio, November 5, 2014.*
3. *Jared Serbu, "Navy looks to overhaul acquisition processes for aviation systems," Federal News Radio, April 10, 2014.*
4. *Ibid.*
5. *Kendall, Honorable Frank, Better Buying Power 3.0: Interim Release, September 19, 2014, p. 2.*
6. *Ibid., p. 6.*
7. *Erwin, Sandra L., "Better Buying Power 3.0: New Pentagon Procurement Rules Seek to Create a Culture of Innovation," National Defense, September 19, 2014.*
8. *Ibid.*
9. *Kendall, Honorable Frank, Better Buying Power 3.0: Interim Release, September 19, 2014, p. 5.*
10. *Navy Aviation Enterprise, Naval Aviation Vision 2014-2025, p. 3.*
11. *Mullins, Marsha, "Joint Force Digital Interoperability Remains Elusive," Signal, October 1, 2014.*

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Greg Wenzel is a Booz Allen Hamilton Executive Vice President in the firm's Strategic Innovation Group (SIG) Digital initiative, which focuses on the Internet of Things (IOT) delivering modular agile solutions that integrate mission and systems development with the latest technologies in social, mobile, and cloud computing. He is focused on the consumer/interactive aspects of creating new solutions for Digital Citizen (G2C), Warrior (C4ISR), and Workforce (Health) clients. Wenzel has a proven track record of applying emerging technologies and a deep understanding in the DoD Command, Control, Intelligence, Surveillance, Reconnaissance (C2/C4ISR) mission area, as well as Enterprise Integration.

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