Army Soldiers assigned to 5th Squadron, 73rd Cavalry Regiment, 3rd Brigade Combat Team, 82nd Airborne Division, experiment with Integrated Visual Augmentation System during Project Convergence at Camp Talega, California, October 14, 2022 (U.S. Army/Osvaldo Fuentes)

# Mission (Command) Complete
## Implications of JADC2

By Joseph M. McGiffin

As one of the fundamental warfighting functions, command and control (C2) has changed little in nature over the course of American military history:

*Command and control encompasses the exercise of authority, responsibility, and direction by a commander over assigned and attached forces to accomplish the mission. Command at all levels is the art of motivating and directing people and organizations into action to accomplish missions. Control is inherent in command. To control is to manage and direct forces and functions consistent with a commander's command authority. Control of forces and functions helps commanders and staffs compute requirements, allocate means, and integrate efforts.*[1]

This definition was formulated the same way as every other element of doctrine: using the best practices gleaned from history as precedent. However, in the complex threat environment posed by the future characteristics of warfare, unprecedented assets will be used at every level with little regard to domain: artificial intelligence and machine learning (AI/ML), hypersonic precision-guided weapons, and autonomous weapons platforms,

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to name a few of the higher profile innovations. As with war, while C2 as a fundamental principle will persist, the characteristics of how it is exercised will be new, dynamic, and uncertain—and the joint force must prepare for this.

The current effort to modernize the U.S. military's C2 apparatus is Joint All-Domain Command and Control (JADC2): "The JADC2 Strategy provides a vision and an approach for identifying, organizing, and delivering improved Joint Force C2 capabilities, and accounts for adversaries who have closed many of the capability and methodology advantages we depend upon for operational success."[2] The more notable indicators of this modernization effort have been a suite of new software and hardware networks, leaving observers to herald JADC2 as a "once-in-a-generation modernization of [the military's] approach to commanding [its] forces" that will mesh all the sensor and communications assets of the respective military Services into a single network.[3] Assuming the consolidation is successful, does it stop at linked command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) assets? Or will it address the conceptual implications of a faster, more lethal, less human future force and its C2 requirements? Available open-source information indicates that it is not the pervasive revolution in warfare that its name implies.

The purpose of this article is to identify points of friction in transitioning joint force C2 networks to support the JADC2 concept. The question that drives this project is: As network upgrades iteratively increase the ability for commanders to exercise JADC2, should the military concurrently explore JADC2-optimizing organizational and doctrinal changes, and what might those look like? This article examines the relevant technologies under development and their projected utilities and contrasts them against current military doctrine to illuminate points of friction that must be addressed in the planning and iterative implementation of JADC2. The findings indicate that mission command, the current C2 concept, will need to be modified to enable the full capabilities of the JADC2's desired endstate.

This article has six sections. The first two provide the concept of the battle network as a framework for the discussion of JADC2 and a condensed summary of the program's development up to the present. The third and fourth sections identify the strategic- and tactical-level implications of JADC2 in relation to the battle network frame. The fifth section discusses friction points between JADC2 and mission command, the prevailing C2 approach for the joint force. The article concludes with some suggestions to help direct future research on completely integrating this new C2 concept to optimize the joint force for future conflict.

## The Battle Network

The battle network, or "kill chain," is a model for understanding what the command and control warfighting function entails. There are five essential steps between identifying a threat and effecting a solution: sensors that collect information on a threat or situation, communicators that relay information between network nodes, processors that analyze the information, a decider node that elects a course of action, and effector nodes that execute the decision.[4] Each of these is a necessary component for the network to function, and therefore each constitutes an exploitable vulnerability. Conventionally, the United States has sought to maximize the outputs of these components and the cost of protecting them by reducing the number of platforms, or nodes, required to complete the network.

The Abrams tank and Bradley Fighting Vehicle, for instance, are self-contained networks. They have optics to detect the enemy; crews that communicate among the commander, loader, driver, and gunner; targeting computers and a seasoned gunner for processing and analyzing a threat; a vehicle commander who decides to engage; and the main gun to create effects. The network is conveniently condensed and armored for increased protection and could even be linked with other platform-networks via radio and other communications equipment to magnify the effects. The F-35 is another example, although sophisticated computers and algorithms take on much of the sensing and processing requirements to relieve the pilots of some requirements and allow them to focus on key decisions.

However, communicating among various platforms and network nodes introduces several significant inefficiencies, causing dangerous lag in the engagement process. For instance, developed separately by the respective Services, both F-35s and landpower assets have stovepiped communications and sensory networks. Thus, the Army's platforms cannot effectively share information or network with the Air Force's to achieve an even greater unified effect. There are multiple intermediary nodes and communications networks required to put the platforms in contact.

To enable even moderate interoperability, the F-35s must be patched via workarounds. There have been several patches throughout history that establish the inter-Service workaround technique as an institutionalized expectation. Two current examples are U-2s with specialized communications payloads to connect F-22s and F-35s,[5] and the Battlefield Airborne Communications Node that must be installed on certain platforms in order to bridge gaps between aircraft and ground users through tactical data links.[6] The assets in development that will enable JADC2 aim to reduce these obstacles and enhance interoperability among the assets of the different Services, enabling a cohesive system-of-systems network.

## JADC2 Development

To date, the literature on JADC2 has two primary focuses: the Services' innovative acquisitions approaches and the proposed network's potential as a commander's decision support tool. For its part, the acquisitions process has showcased a game-changing approach to the lamentably lethargic system of contracting, developing, and fielding military systems that are more agile and cost-effective. However, other experts question whether the approach is sufficient for reaching its modernization

efforts, concerned that it might instead continue the existence of legacy shortfalls. The second topic, though, should be a far more nuanced discussion but has not yet developed beyond JADC2's potential for improved information-sharing and the potential benefits of machine-enabled strategic analysis.

Heralded in press releases and professional journals, JADC2 is a needed endeavor for modernization of the joint force. With antiaccess/area-denial assets shifting combat to happen faster and at greater distance, reducing latency between steps of the decisionmaking process becomes mission critical. Commanders need more accurate, timely information to neutralize threats. Development efforts promise to deliver that capability through a combination of AI/ML supported by an integrated cross-Service C4ISR network to create as close to a real-time common operating picture as possible with machine-augmented analysis and recommendations to expedite the decisionmaking process.[7]

Put concisely, the "JADC2 strategy organizes its approach for improving Joint Force C2 through (1) the need for Joint Force Commanders to 'sense,' 'make sense,' and 'act' in the operational environment, and (2) the use of five functional areas of focus, or LOEs [lines of effort], to guide the development and implementation of improved C2 Joint Force capabilities."[8] The physical components that will support JADC2 are a series of parallel projects that separate entities within the Department of Defense (DOD) are developing independently:[9]

- Fifth-generation information communications technologies: The DOD Chief Information Officer is the lead proponent.
- Fully networked command, control, and communications: The Office of the Under Secretary of Defense for Research and Engineering's mid- to long-term vision of a C2 system unifying the force at three levels: physical, networking, and application.
- Mosaic warfare: A series of projects under development by the Defense Advanced Research Projects Agency (DARPA) that intends to integrate Service branch networks and platforms that are traditionally noninteroperable. This includes a few abilities from linking sensor and shooter platforms, nesting radio protocols, airspace control, and imposing "multiple overlapping dilemmas on enemy forces that disrupt their operations and thus prevent them from reaching their objectives in time."[10]
- Advanced Battle Management System (ABMS): The Air Force's contribution to JADC2 and the central hub for the system-of-systems architecture. This project is directed at improving informational awareness for commanders through real-time data availability and AI-supported predictive analysis through six product lines: sensor integration, data, secure processing, connectivity, applications, and effects integration.
- Project Convergence: The Army's flagship modernization program that seeks to streamline command and control to meet the increasingly fast-paced threats of the operating environment by using AI to analyze information and augment the Army network: "a culmination of numerous preceding exercises, experimentations, and events, it provides a critical venue to identify and refine recommendations necessary to transform the Army and ensure future war-winning readiness."[11]
- Project Overmatch: The Navy's endeavor to "enable a Navy that swarms the sea, delivering synchronized lethal and nonlethal effects from near-and-far, every axis, and every domain."[12] It aims to create an integrated naval operational architecture that will enable JADC2 and support enhanced distributed maritime operations.[13]

DOD envisions a "system-of-systems" network capable of generating a common operating picture for a given commander by completely integrating joint force C4ISR assets to create a connected battlespace.

Still in the early stages of development, these programs have demonstrated impressive agility when compared to the acquisition of other major platforms in recent history. Part of the reason for this is the nature of the desired products. Most of the JADC2 network components are militarized versions of cutting-edge technologies that are already available through the commercial sector. These include "lighter, cheaper, and higher fidelity sensors; increases in data throughput capacity and coverage from cellular, fiber, and satellite communications networks; massive cloud computing and data storage centers; and big data analytics, ML, and AI systems."[14]

Additionally, acquisitions leaders within each Service have tailored their approaches toward flexible partnerships with the commercial sector. By design, the offices supervising developments have been kept at comparatively low levels for major acquisitions endeavors, resulting in less central oversight and much more agility in budget use.[15] The JADC2 portfolio programs are monitored at the joint level by a joint cross-functional team (CFT). This does allow for coordination across the Services but leaves the programs directly reportable to each branch. This approach comes with the substantial risk of failing to achieve the intended comprehensive network of joint sensors.[16] While restructuring might be a necessity in the future, at present the CFT has been effective at coordinating these initial efforts toward the common vision of the JADC2 strategy.[17]

As the Government Accountability Office has already advised regarding ABMS, this approach could also result in an inefficient use of resources as Services fund redundant programs or potentially produce products that lack full interoperability, requiring more hardware or software patches to be funded to create workarounds.[18] JADC2, in essence, would be a partially interoperable amalgamation of Service all-domain C2 systems.[19] That said, these programs are in an early development period, and the CFT structure could be revised as these programs mature to exercise centralized development as needed in the coming years.[20]

Master Sergeant Paul Thompson, left, 621st Contingency Response Support Squadron (CRSS) operations standards and evaluation superintendent, and Technical Sergeant Kevin Koenig, 621st CRSS tactical radio communications section chief, provide communication from Nomad GCS Tactical Control Vehicle during exercise on Nellis Air Force Base, Nevada, September 3, 2020 (U.S. Air Force/Cory D. Payne)

## Strategic-Level Impacts

While network development efforts are decentralized, the JADC2 concept is a top-down effort that emphasizes a strategic-level goal to support combatant commanders.[21] In relation to the battle network model, these applications focus on the sensor-processor and processor-decider nexus through a combination of AI/ML, improved sensor platforms, and completely interoperable communications. These functions manifest as algorithmic warfare and a next-generation C4ISR network capable of providing a complete operating picture to a commander and with rapid, accurate analysis to enable timely and effective decisionmaking.

JADC2, as a decision support asset, takes on the guise of algorithmic warfare. As AI becomes more sophisticated, programmers can train it to analyze data, unsupervised, to various degrees in a process referred to as *deep machine-learning*.[22] After rigorous conditioning, AI/ML innovations produce autonomous programs that can collect and analyze data and then make or recommend decisions to the commander they support. With deep learning, machines can achieve an understanding of far more complex issues and process results much faster than even the most competent headquarters staff.[23]

These decision-support innovations have already been validated in a limited trial by fire. From his perspective as the supported commander, General Terrence O'Shaughnessy, USAF, U.S. Northern Command and North American Aerospace Defense Command commander during the initial COVID-19 response, described JADC2 as "decision superiority" achieved by authoritative data from near-zero latency sources, a shared cloud-based data pool, and machine-enabled insights that support the commander through AI/ML.[24]

Cumulatively, this template enables an operational- or strategic-level commander to make effective decisions with more clarity than ever imagined for C2 doctrine.

Underlying the five functions of a battle network and how AI/ML augments a commander's capabilities is the decisionmaking process itself. One of the most effective yet plain models is John Boyd's "observe, orient, decide, act" (OODA) loop: observe a potential threat, orient oneself to the threat (processing and analyzing based on known variables), decide on a course of action, and then act to achieve a desired effect.[25] It is a process done in iterations, folding back time and again, until a desired end-state has been reached.

The earlier analogy of the tank crew illustrates this idea as it is manifested in the battle network. The commander and his or her staff would exhibit this same model in a more abstract sense during the joint planning process and military

Air Force MQ-9 Reaper fires missile over Nevada Test and Training Range at Nellis Air Force Base, Nevada, August 30, 2023 (U.S. Air Force/Victoria Nuzzi)

decisionmaking process.[26] What the OODA loop does not show, though, is the communications function of the battle network. When applying the model to individuals, it is relatively unimportant. However, communications are a limiting factor on timeliness for decisions because sharing information and collaborating between nodes require more time. Paired with a commander, AI/ML reduces the required time for processing and communications.

## Tactical Implications

To set conditions for achieving and maintaining military superiority in the future, JADC2's decisionmaking implications must be assessed for the complete battle network. The above discussed JADC2's strategic impacts of algorithmic warfare on C2 that are already manifesting. This section explores the changes at the tactical level. AI/ML promises a nested revolution in decisionmaking through dramatic changes to the kill chain by enabling a connected battlespace. JADC2 would integrate the platforms of each Service branch into a cohesive network to create better tactical options—that is, one platform could identify a threat and a different platform could be directed to respond to it, rather than the threat-identifying platform being obligated to respond regardless of its positioning or suitability.

The two segments of the battle network functions with the highest and likeliest major changes are the orientation and decision nodes: who decides to act, and how long it takes to gather and analyze information to make the decision. As Todd Harrison, a senior fellow for the Center for Strategic and International Studies, describes it, this connected battlespace does not just improve the sensor-shooter connection, or kill chain, but enables a kill "web": multiple nodes to achieve omnidirectional alignment and significantly greater threat response capabilities.[27]

JADC2 capabilities offer revolutionary advantages through improving information flow and situational awareness and providing superior analysis for a commander. In fact, it has the potential to change one of the fundamental assumptions of warfare: the human role. JADC2 has the potential to enable autonomous weapons systems in a manner that was previously thought of as the realm of science fiction: hypersonic missiles, directed-energy weapons, and

autonomous drone swarms. As these weapons reach maturity and become viable military force candidates, JADC2 can manage their scaled integration if the changes to doctrine, ethics of conduct for the use of autonomous weaponry, and task organization of the future force are anticipated and already planned.

Defense media outlets produce new headlines daily covering successful tests of technology that was once pure science fiction. Drone swarms have been tested even longer for their tactical use on the battlefield.[28] Robot gun trucks have been used to augment troops during exercises.[29] The United States and China are competing to perfect hypersonic missile technology, weapons that fly faster than humans can observe, decide, and act to counter.[30] However, there is little public discussion on how DOD should or will plan to merge these technologies into the theoretical JADC2 architecture, or how JADC2 should be scaled and iterated to receive these technologies as they prove viable. Feasibility aside, the implementation of these systems on the battlefield spurs more questions on who is making engagement decisions and at what level that should take place.

Where must a human remain in the decision loop? Assuming consistent or even disruptive technological progress is made, these platforms and enablers all have ethical implications of decisionmaking. The Nagorno-Karabakh conflict illustrated the devastating potential of unmanned aerial vehicles and long-range precision weaponry.[31] The more that the speed and range of engagements increase, the more pivotal that machine augmentation becomes to accelerate the decisionmaking process. As machines become more capable of making decisions in accordance with a commander's desired outcome, they gradually take a greater share of the decision loop, reducing the presence required by humans. Speculation of where the human element will remain in the loop is a critical ethical issue that exceeds the scope of this article.[32] It is addressed here to point to the dearth of conceptual development and long-range planning for the iterative deployment of JADC2 over time.

## End of Mission Command?

There are conceptual changes that DOD must reconcile to employ JADC2 to its fullest potential as supporting networks and assets continue to develop. While the physical nodes of JADC2-enabling technologies occupy the lion's

Unmanned surface vessel Sea Hunter transits underneath Sydney Harbor bridge as part of scheduled port visit during Integrated Battle Problem 23.2, October 24, 2023 (U.S. Navy/Pierson Hawkins)

share of unclassified discussion, the concept requires a fundamentally different battle network organization than what the United States has used since its founding. Historically, because the command and staff (decider and processor) were too remote from the reconnaissance and available troops or naval vessels (sensors and effectors) in various concurrent engagements, command authority had to be pushed down the chain to leadership closer to the decisive points of an operation. This technique is called *mission command*, defined as:

*the conduct of military operations through decentralized execution based upon mission-type orders. It empowers individuals to exercise judgment in how they carry out their assigned tasks and it exploits the human element in joint operations, emphasizing trust, force of will, initiative, judgment, and creativity. . . .* [Leaders] *delegate decisions to subordinates wherever possible, which minimizes detailed control and empowers subordinates' initiative to make decisions based on understanding what the commander wants rather than on constant communications.*[33]

However, AI/ML is revolutionizing the process of C2, reducing the lag between elements of the OODA loop without a commander's need to delegate more authority. As Todd Harrison observed, major changes have disrupted the legacy process through the "information-ization of warfare." That is, the amount of information, combined with the speed and depth at which AI/ML programs can process, creates opportunities for major tactical advantages through dominant battlespace knowledge and maneuverability: "In this 'new way of war,' advantage accrues to those that can see farther and clearer and act faster and at greater range—and deny the other side the ability to do the same."[34] Conceptually, these capabilities introduce new ways to exercise C2 that had never been feasible before.

Given these changes, the potential loss of relevance for mission command as a C2 paradigm for the future of combat must be assessed. Mission command was optimal for achieving unity of effort in complex operations because it enabled decentralized execution to achieve a single endstate.[35] It overcame the issue of timeliness in the decisionmaking process by reducing the reliance and latency of communications between nodes and consolidating the sensing, deciding, processing, and affecting functions of the battle network as close to the decisive point as possible. The degree of efficacy that mission command could achieve was contingent on seven principles:

- Competence: tactical and technical competence of subordinates, which sets the limits to which they can be trusted for decentralized operation
- Mutual trust: shared confidence between a commander and subordinates that they can be relied on to accomplish a mission
- Shared understanding: generating a common operating picture of a

mission's purpose, problems, and approaches to solving problems for mutual support and awareness among all team actors
- Commander's intent: a clear, concise expression of the purpose and desired endstate of an operation that synchronizes the efforts of decentralized operations without the need to reach back for more guidance in between objectives or when presented with new data
- Mission orders: directives to subordinates that focus on the desired effects, not how to achieve them
- Disciplined initiative: the freedom for subordinates to exercise sound judgment to achieve their commander's intent as guided by the mission order
- Risk acceptance: framing and mitigating the potential danger that decentralized execution will pose in relation to the importance of the objective and the time available to prepare for and achieve it.[36]

As indicated in the language of the definitions, mission command provided conditional freedoms to subordinate units in relation to explicit roles they were expected to play during a specific operation. However, the characteristics of future combat are trending away from the decentralized operations template that these principles support to become faster, farther, and more lethal.

With AI/ML, JADC2's connected battlespace would place timely and accurate information directly in the hands of a commander and headquarters staff with machine-executed analysis to expedite a decision. The implications for command and control are apparent and must be addressed before these innovations mature and become integrated without a revised C2 approach. Both the Navy and Marine Corps have announced transitions to a distributed operations paradigm that requires force restructuring to project naval power more effectively over time and distance.[37] The conflict in Ukraine has illustrated similar issues with sustaining large-scale combat operations with noncontiguous, nonlinear operations, which the United States can anticipate in future scenarios.[38]

The largest implication for implementing JADC2 is the decreased reliance on intermediary command nodes. The mission command–enabling force structure uses tiered commands to support a theater's military operations. As previous conflicts were typically viewed as linear progressions of operational campaigns, this was a suitable approach. However, because of the connected battlespace framework, these structures are now extraneous and cumbersome; tactical command nodes need more freedom than mission command typically permits (that is, beyond the scope of a single campaign), and strategic commanders have near-immediate access to information and requirements of their decisive points of a conflict. As the joint force operationalizes the JADC2 concept, it will cause friction for existing C2 doctrine and practices, resulting in diminished performance for the reorganized military Services and a struggle to achieve unity of effort as the new C2 concept envisions.

Beyond simply restructuring the force to facilitate JADC2-enabled distributed operations, some researchers argue for a more extensive overhaul of the U.S. warfare paradigm. One study that focused on DARPA's mosaic warfare project suggests that the entire military's warfighting paradigm would need to change from attrition-focused, defeating the enemy military physically, to decision-centric warfare, which would aim to weaponize the AI/ML system itself: "Instead of destroying an adversary's forces until it can no longer fight or succeed, a decision-centric approach to warfare would impose multiple dilemmas on an enemy to prevent it from achieving its objectives."[39] This paradigm would fully embrace the informationization of warfare mentioned earlier and provide guidelines for future acquisitions programs. While the claim seems a radical step forward, in practice, decision-centric warfare is another option that JADC2 would provide the force by virtue of revolutionizing the C2 warfighting function.

## Conclusion

One of the largest impediments to addressing the concerns of this article will be resistance from the organization's culture. According to Christian Brose, "Rather than thinking in terms of buying new battle networks that could close the kill chain faster than ever, they [the U.S. military] thought in terms of buying incrementally better versions of the same platforms they had relied upon for decades—tanks, manned short-range aircraft, big satellites, and bigger ships." Brose identifies a severe deficit of creativity in the planning and acquisitions process. There is a bias toward improving legacy systems instead of finding new, more effective means of integrating present and future joint warfighting capabilities.[40] JADC2 relies on a collection of synced improvements to the C4ISR network, but if it is overlaid on the current mission command–oriented network without deliberate doctrinal and organizational reconfiguration, the force runs the risk of not achieving a major advantage in creating unified efforts in future conflict.

In addition to rethinking communications networks, JADC2's full, effective implementation will require planning, and redesign will also broach the issue of autonomous platforms sooner rather than later. These may begin replacing subordinate units in the battle network, shifting C2 back up the chain of command without sacrificing agility or precision in the decisionmaking process. While developing an interoperable C4ISR network is a momentous first step in preparing for future conflict, it should not be considered an endstate but rather the first phase of an ongoing operation.

To regain and maintain a decisive competitive advantage in future conflicts, JADC2 must be developed fluidly from the top down across the strategic, operational, and tactical levels of war. It must be viewed as an evolution of a historic warfighting function as well as a completely integrated C4ISR network. Furthermore, that network must be scalable—that it, it must be agile enough to accept new, potentially disruptive innovations into any part so that its core decision-support function can incorporate each new iteration seamlessly. This will require a refined concept for the

decisionmaking model underlying the battle network, an objective review of the relevance of mission command as a C2 technique, and contingency planning for major technological assets in development, including autonomous platforms and quantum computing. **JFQ**

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