JADC2 Culture at the Operational Level of War

Thomas L. Cantrell

Joint all-domain command and control (JADC2) represents a historical transformation in conducting warfare. The changes have manifested through technological advancements and resulting command-and-control reconfigurations, many of which are nascent. While these two levels of JADC2—technology and command and control—are still in development, the Air Force can prepare with changes to the organizational culture, the foundational layer underpinning both. Air components must foster a culture that is truly domain agnostic, engages partners meaningfully in operations, embraces the kill web, and executes daily tasks in a connection-rich environment.

The US Air Force is in the midst of a transformation as it readies itself for a potential great power conflict with a near-peer competitor. One of the most wide-ranging changes will be the implementation of Joint all-domain command and control (JADC2). The US military must consider the implications this change has for the operational level of war, which for the Air Force is embodied in its air components and its air operations centers (AOC).

JADC2 involves establishing a complex amalgam of connected sensors and machine-to-machine interfaces that will integrate service components, Ally and partner nations, and kinetic/nonkinetic domains of warfare. The resulting new asymmetric advantage will preserve US military superiority in the same way the 1980s precision revolution did in the post-Cold War era. As such, JADC2 dialogue has been overwhelmingly technical in nature and has focused on a future state when the architecture will be realized. What receives less attention is the vast human dimension to JADC2 and the cultural change required of Airmen and air components to make this asymmetric advantage a reality.

Air components must pay equal attention to cultural and technical changes within their organizations if JADC2 is to be successful at the operational level of warfare. Truly, JADC2 can be envisioned as a pyramid with the wizardry of promising technology featured at its top. Yet that technology rests firmly on two lower and broader layers: a middle layer of agile command and control (C2) and the critical foundational layer consisting of military personnel and their warfighting culture.

Organizational culture is the collection of values, expectations, and practices that guide and inform the actions of all team members. It must be addressed early for transformation to occur. As one analysis affirms, "it is necessary to educate Airmen early on new

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concepts in warfare that might require changes to organizational structure and culture, and as JADC2 matures, so should plans for instruction."[1] JADC2's technology may lie in the future, but preparing for this new concept of warfare is today's problem.

To be successful in JADC2, air components must foster a culture that embraces Joint capabilities, understands nonkinetic processes, and sees partner nations as solutions to problems. This is a culture that values horizontal collaboration at the lowest possible level and demands radical sharing of information, so the best shooter will have the best chance to strike the target. Moreover, this is a culture of curiosity, but a curiosity constantly searching for the best ways to ensare the enemy in its kill web.

A pyramid metaphor allows a further examination of JADC2 and its impacts to the air component. The top layer of the JADC2 pyramid represents technology and technological change. The middle layer represents the agile C2 element of JADC2 and how this poses an organizational challenge to air components and especially to their AOCs as they are currently configured.[2] The bottom layer represents the critical foundation of an optimized JADC2 culture.

Incidentally, the significance of this cultural layer is abundantly clear to the Air Force's Operational Command Training Program (OCTP). Part of the 505th Command and Control Wing, this program comprises a group of operational C2 subject matter experts who mentor and advise every air component around the globe via major exercises and real-world contingencies. The views in this article are based in part on conversations with hundreds of senior leaders and practical observations from these complex events that took place from 2019 to 2023.

The Technological Layer

The Department of Defense states that the purpose of Joint all-domain command and control is "to produce the warfighting capability to sense, make sense, and act at all levels and phases of war, across all domains, and with partners to deliver information advantage at the speed of relevance."[3] Put simply, JADC2 is a means to directly tie every sensor to every shooter irrespective of service, domain, or partner.

The Department of Defense highlights the ride-sharing service Uber as an analogy to describe its desired end state for JADC2.[4] In a similar manner that Uber matches riders to the best possible drivers using apps and algorithms, JADC2 will use apps and algo-

1. Timothy Marler et al., *What Is JADC2, and How Does It Relate to Training? An Air Force Perspective on Joint All-Domain Command and Control,* PE-A985-1 (Santa Monica, CA: RAND Corporation, 2022), https://www.rand.org/.

2. Frederick "Trey" Coleman, "Air Operations Center Evolution: A Roadmap for Progress," Wild Blue Yonder, March 14, 2022, https://www.airuniversity.af.edu/.

3. Department of Defense (DoD), *Summary of the Joint All Domain Command and Control (JADC2) Strategy* (Washington, DC: DoD, March 2022), 3, https://media.defense.gov/.

4. John R. Hoehn, "Joint All Domain Command and Control (JADC2)," In Focus 11493 (Washington, DC: Congressional Research Service (CRS), January 21, 2022), https://crsreports.congress.gov/.

rithms to match targets to the best possible weapons regardless of service, domain, or partner nation. The overall effect of JADC2 is to enable high-tempo observe, orient, decide, and act (OODA) loops for rapid C2 decisions, because in great-power conflict, speed and accuracy are paramount.

The Air Force has embraced the advanced battle management system (ABMS) concept to execute JADC2. This concept proposes using cloud environments and new communications methods to share data seamlessly, using artificial intelligence to enable faster decisions among an Internet of Things made of sensors, C2 systems, and shooters.[5] The Air Force has identified four key elements to make ABMS a reality: a sensing grid, advanced networking, decision-making, and authorities and delivery of effects.[6]

Sensing Grid

The sensing grid is envisioned as a network of sensors collecting vast amounts of platform-agnostic, all-domain data to gain and maintain decision advantage. The sensing grid is platform agnostic because it does not care what platform generates the data—it could be an intelligence, surveillance, and reconnaissance (ISR) aircraft, a Navy ship, or a social media account. The grid also is indifferent to the domain that generates the information; whether it is air, land, sea, space, cyber, human, or electronic warfare does not matter. The sensing grid swarm will consist of DoD platforms, willing partner nations, and relevant commercial sources.

Advanced Networking

JADC2 requires an agile and resilient network to transport data in real time across all components and domains. This network must be able to operate in a contested, degraded, and operationally limited environment. This environment will require multiple pathways to resist adversary network attacks, and if it cannot resist degradation, then it must be able to be healed quickly or at least brought to some limited capability. While the network (transport) is key, equally important is the data (content). Data standards are crucial to advanced networking. If nodes from all domains, services, and partner nations are to share warfighting-relevant information, their data must be structured in a way to make it universally compatible.

Decision-Making

This element relies on human-machine teaming to sort large volumes of data gathered by the sensing grid and present it in a way that makes decision-making easier. Joint all-domain command and control envisions reliance on artificial intelligence and machine

5. John R. Hoehn, "Advanced Battle Management System (ABMS)," In Focus 11866 (Washington, DC: CRS, February 15, 2022), https://crsreports.congress.gov/.

6. Headquarters, US Air Force (HAF), "USAF JADC2 Supporting Concept," July 8, 2021, 2.

learning (AI/ML) to enable this process. Some examples might be performing industrial tasks such as plotting real-time order of battle or matching kinetic platforms armed with optimized weapons to take out a dynamic pop-up target. JADC2 also envisions a global and all-domain common operating picture fused with a common intelligence picture to enable rapid decision-making and integration across all echelons supporting or executing the fight.

Authorities and Effects Delivery

The goal of authorities and effects delivery is to match the right weapon to the right target. In an all-domain environment, the right platform and weapon may be cyber, air, maritime, ground fires, or whatever makes the most sense from an effects-based perspective and whatever asset is most readily available given physical reach and connectivity status at that point in time. Mission authorities to leverage capabilities from other domains, services, and partner nations must exist for JADC2 to work. Establishing contracts and mission-type orders to enable these authorities is something that must be accomplished prior to conflict. And authorities also call into discussion how all-domain capabilities are to be controlled at the operational level of war, especially when dealing with Joint counterparts.

The Joint counterparts to the advanced battle management system—the US Navy's Project Overmatch and the US Army's Project Convergence—heavily emphasize common data standards in order to share the targeting data needed for convergent fires. The Navy and the Army are looking for ways to establish common data standards because data sharing continues to be a challenge within and between each service.

Project Overmatch is developing a new fleet architecture using artificial intelligence and manned/unmanned teaming for Distributed Maritime Operations.[7] The Navy is striving to build the Naval Operational Architecture in a way that will enable a common standard for every part of the fleet to exchange data and establish interoperability with other services.[8] Project Convergence is the Army's JADC2 concept designed to integrate artificial intelligence, robotics, and autonomy to improve battlefield situational awareness, connect sensors with shooters, and accelerate the decision-making timeline.[9]

The C2 Layer

The need to address all-domain authorities has emerged as a common theme during recent Tier 1 exercises, US Air Force wargames, and experiments. Joint all-domain command and control's lateral connectivity, where every sensor is connected to every shooter,

7. Hoehn, "JADC2."

8. John R. Hoehn, *Joint All-Domain Command and Control: Background and Issues for Congress*, R46725 (Washington, DC: CRS, January 21, 2022), https://crsreports.congress.gov/.

9. 505th Command and Control Wing Public Affairs, "Nellis' ShOC-N Supports Army Project Convergence Experiment," US Navy (website), December 7, 2022, https://www.navy.mil/.

begs the issue of command and control: Who makes the decision to shoot? When, where, and with what? Today's C2 construct puts each service component and domain into its own silo where they work in parallel as deconflicted by the Joint combatant or Joint Force commander. Yet this current C2 construct is seen as antiquated and too slow for the anticipated speed, range, and multidomain nature of a future great-power conflict. In an era where all services and domains are connected and speed is a priority, the question becomes, Who gets to command and control all-domain fires? The answer to this question has huge implications for air component Airmen.

The Air Force transformation includes a change to its mantra. No longer do operational-level warriors tout "centralized control and decentralized execution" as their doctrine but instead offer "centralized command, distributed control, and decentralized execution" as the way forward.[10] The introduction of distributed control is meant to disassociate control from command—indeed, some have taken to calling it "control and command"—as a means to better operate in a JADC2 environment where single C2 nodes are degraded or destroyed and control can actually occur in a multitude of places.[11] Distributed control makes sense where multiple control nodes share a ubiquitous common operating picture/common intelligence picture; where AI/ML assists the matching of targets to weapons; where a single, concentrated C2 node makes for an inviting target; and where speed is of the essence.

The Doolittle Games and Chennault war games executed since 2018 represent an effort to better understand all-domain operations and the associated implications for control and command. That is where new concepts such as agile control and integrated command have been discussed.[12] Agile control leverages multiple nodes to exert air battle management across the operational environment, not just the air operations center or a platform-centric C2 node such as an E-3 Sentry aircraft. Integrated command explores how Airmen could assume authorities over all-domain fires—such as cyber, space, and maritime—at the operational level to prosecute a critical time-sensitive target in the battlespace.

These and similar concepts will turn Airmen from thinking in an airpower-centric way to an airpower-optimized way, a distinction that looks to other domains to achieve airpower goals. Looking at practical means to implement integrated command has led to new organizational concepts such as the all-domain operations capability (ADOC) and to the use of the Common Mission Control Center (CMCC).[13]

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10. Department of the Air Force (DAF), *The Air Force*, Air Force Doctrine Publication (AFDP) 1 (Maxwell AFB, AL: Curtis LeMay Center for Doctrine Development and Education [LeMay Center], March 10, 2021), 13, https://www.doctrine.af.mil/.

11. HAF, Deputy Chief of Staff for Strategy, Integration, and Requirements (A5/7), *Doolittle 2022: Command and Control Concept Primer* (Washington, DC: HAF, February 2022), 3.

12. HAF, Doolittle 2022 – C2 Workshop and TTX, April 2022, 10.

13. HAF, A5/7, *U.S. Air Force Concept Exchange: Enabling Concept for Integrated Command* (Washington, DC: HAF, June 2022), 10; Miranda Priebe et al., *Multiple Dilemmas: Challenges and Options for All-Domain Command and Control,* RR-A381-1 (Santa Monica, CA: RAND Corporation, 2020), 92, https://www.rand.org/; and Air Combat Command, *Common Mission Control Center (CMCC) Concept of Operations*, December 2022.

In 2021 and 2022, air components experimented with the ADOC concept. For example, Exercise Keen Edge 21—a US Indo-Pacific Command exercise—engaged this concept by standing up the air operations center as an all-domain operations capability to see how an air component could synchronize Joint functions in forward locations.[14] Other air components have explored scenarios where the AOC would become the ADOC and command and control all-domain fires for a specific phase of a Joint operation, such as the takedown of enemy air defense systems during a campaign's opening phase.

Defining future control and command authorities will be critical in identifying ADOC form and function since its ability to direct multidomain and multiservice capabilities will be central to its existence. As both Keen Edge and the Chennault games demonstrated, a solid definition of ADOC structure, its several roles, and its placement within AOC echelons will be important discussion points. For example, will the ADOC merely take the place of the theater commander's Joint operations center? Or could all-domain operations capability be a distributed capability with nodes stretching from the forward edge of battle all the way to sanctuary in CONUS? If control shifts throughout the C2 structure, then how and when control is shifted requires more gaming and testing.[15]

An example of command and control from CONUS is the Common Mission Control Center located at Beale AFB, California. The CMCC was highlighted in recent exercises as a JADC2 enabler, most notably during US Indo-Pacific Command's biennial Joint field training exercise, Valiant Shield 2022. The CMCC is an advanced tactical battle management C2 prototype designed for use in a contested, degraded environment and intended to become a member of the theater air control system, the Air Force's mechanism for commanding and controlling airpower. During Valiant Shield, the center provided capabilities for improving critical C2 and battlespace awareness functions—including maintaining over-the-horizon target custody across distributed C2 nodes, decreasing the time required for electronic order of battle updates, and rapidly disseminating enemy locations to enable convergent fires.[16]

The Common Mission Control Center's access to higher security communication pathways enables it to leverage all-domain capabilities from the US Space Force and US Cyber Command with greater transparency than the AOC or, presumably, a forward-edge ADOC. As such, the CMCC could be a capability working for the air component to task space and cyber in conjunction with air maneuver and launder higher classification information derived from space and cyber in order to integrate it into the lower classification tactical fight as needed.

The reality of a contested, degraded, and operationally limited environment and the capability of new distributed C2 nodes mean the air component now needs to plan for

14. "USAF B-52 Bomber Conducts Simulated Hypersonic Kill Chain Employment," Air Force Technology, May 11, 2021, https://www.airforce-technology.com/.

15. HAF, Doolittle 2022 – C2 Workshop and TTX, April 2022, 10.

16. Air Force News, "Air Force Units Support Navy Valiant Shield Exercise," *Aerotech News* (blog), updated August 9, 2022, https://www.aerotechnews.com/.

C2 as deliberately as it plans for offensive counterair or ISR. The notion of distributed control, sensor-to-shooter connectivity, and integrating cyber and space with kinetics augurs for a reimagination of air operations center functions. Greater attention must be paid to C2 downstream from the AOC and the center's relationship not only to these distributed control nodes, but also to forward-edge Joint and partner-nation capabilities. Joint efforts at common data standards make a Joint integrated fire control network a reality where multiple fires can converge or deconflict at the speed of sensing.

With all this potential capability, it is tempting for many to dismiss the AOC and the operational level of war in favor of envisioned tactical omniscience. While this thinking is shortsighted in the context of a theater campaign plan, it is clear the air operations center has to change with the new environment. Operational-level C2 needs greater emphasis on commander's intent and conditions-based authority. In such an environment, the air component must give significant thought on how to plan C2 deliberately to operationalize distributed control.

AOC Challenges

Critics have pointed to the air operations center as being antiquated and poorly constructed when it comes to its incorporation of JADC2 and distributed control.[17] This line of criticism extends to the air tasking order (ATO) with its 72-hour timeline, often characterized as too slow, inflexible, and a model more fit for the late-twentieth-century Desert Storm fight than the twenty-first-century South China Sea operating environment. While many of these criticisms do not take adequate account of the inherent flexibility resident in the AOC's dynamic targeting and ad hoc tasking methods as well as the foundational importance of operational-level planning, the air operations center does have structural and cultural challenges that must be addressed as the United States embraces a JADC2 future.[18]

Kinetic bias. Air operations center and air component personnel have a bias toward bombs. While nonkinetic targeting certainly occurs today—and improves all the time—the comparative scale of thinking, planning, targeting, and weaponeering in today's AOCs is heavily weighted toward kinetics.[19] The deck is stacked against nonkinetic effects with culture, personnel, doctrine, and processes all weighing in favor of kinetic weapons delivered from air platforms.

Air component leaders are largely selected from fighter backgrounds, which compounds the bias under which knowledge and comfort with space, cyber, and other nonkinetics take

17. Hannah Terino, "Why the AOC Cannot Execute JADC2," Over the Horizon, July 19, 2021, https://overthehorizonmdos.wpcomstaging.com/.

18. David A. Deptula, "A New Battle Command Architecture for Joint All-Domain Operations," *Æther: A Journal of Strategic Airpower and Spacepower* 1, no. 1 (Spring 2022), 53, https://www.airuniversity.af.edu/.

19. *Chennault 2.0 After Action Report: Air Operations Centers and the Targeting Process in the United States Air Force* (Maxwell AFB, AL: LeMay Center, 2020), 4.

a backseat to the kinetic experience that shaped a leader's formative years. Being good at kinetic effects is not a bad thing, but in the context of evolving into an all-domain force, having leaders with such a strong domain bias is a challenge that must be addressed.

Battle rhythms. The kinetic bias is reinforced by the 72-hour air tasking order cycle, which was of course designed with aircraft firmly in mind. All-domain capabilities like cyber, space, and information operations do not necessarily conform to that 72-hour cycle and in most cases have planning timelines that extend well beyond this time frame. For example, the Chennault war games have considered how an eight-day nonkinetic effects (NKE) planning cycle might be merged with the ATO cycle.[20] This type of battle rhythm mismatch contributes to NKE being overlooked and usually not well integrated into air component planning and execution. When one considers Joint, interagency, and partner-nation planning timelines, the challenges of integration and utilization grow exponentially. Alignment of disparate planning processes and timelines will be a crucial task in moving JADC2 forward.

Airpower-centric. Air operations center personnel rarely have the knowledge and expertise to ask questions about Joint, all-domain, and partner-nation capabilities much less how to plan and coordinate their integration. Many Airmen come into the AOC with no Joint experience, and some are junior or even first-term Airmen. Their Joint thinking often consists of how to integrate service or partner aircraft and usually does not stray, for example, into how maritime or ground force operations could be used in lieu of airpower or in support of air maneuver. As a result, understanding of how nonairpower capabilities can achieve airpower goals is often not present or advocated within today's air components.

Lack of authorities. Lack of tasking authority over Joint, all-domain, and partner-nation capabilities is often the reason given for AOC kinetic bias, air-centric battle rhythms, and poor Joint perspective. Air operations center professionals often think in terms of "what is my ALLOREQ (allocation request)?" which comprises those sorties allocated to the air component from other services and partners for tasking on the air tasking order. This line of thinking is of course a single-domain dead end.

But it is certainly a fair point that AOCs should examine what authorities they need to be truly all-domain and where their relationship with nonairpower capabilities could be mission enhancing, given proper planning and synchronization. Many air component Airmen feel they must control something to employ it, but this self-limitation should be minimized. Borrowing authorities from the combatant command for a limited period or engaging in supported/supporting contracts with cyber- or maritime-enabling capabilities

20. *Chennault Event 4: Joint All Domain Operations: Integrated Tasking Order Design and Execution After Action Report* (Maxwell AFB, AL: LeMay Center, 2020), 20.

may be the avenue for greater AOC awareness, understanding, and authorities as the military grows into the JADC2 era.

Human-in-the-loop heavy. Much like the rest of the Department of Defense, the AOC has specialty systems with very few machine-to-machine connections. As a result, there are many humans-in-the-loop who must move information manually from application to application to enable the find, fix, track, target, engage, and assess (F2T2EA) process. This construct is a major contributor to friction and lack of speed in executing time-sensitive activities like dynamic targeting.

New AOC weapons system tools like Kessel Run have enabled the machine-to-machine transfer of data among its own library of applications, but it remains unable to ingest data from non-Kessel Run systems. Data from intelligence-related apps and air-mobility-related systems, all critical to AOC functions, have no machine-to-machine ties to Kessel Run. This gap necessitates human-in-the-loop entry of critical data, a process that is slow and prone to mistakes. The key to making JADC2 a reality will be developing Joint common data standards that allow "single input, multiple outputs." In other words, data is entered once and then proliferated to where it is needed across the system-of-systems via machine-to-machine connection vice human-in-the-loop data entry.

YESFORN. Machine-to-machine issues are further compounded by security and classification. The AOC lives on the Secret computer system, but many all-domain capabilities require the Top Secret or Special Technical Operations (STO) access of the Common Mission Control Center. This exacerbates the problem of integrating capabilities and planning cycles, contributing to what the Chennault series characterizes as "non-kinetic malfunctions."[21] Add partner-nation security, system requirements, and sharing, and the problem becomes exponentially more difficult.

At a minimum, AOCs need to communicate at a Secret-Releasable level to integrate their respective partner nations. As Commander, Air Combat Command General Mark Kelly says, we need to replace NOFORN (no foreign access) with YESFORN.[22] With security and classification there is no elegant or easy solution, but AOCs must strive to deliver a balance.

The Foundational Culture Layer

Joint all-domain command and control is so sweeping and ambitious that it can be overwhelming. The technological top of the pyramid seeks to change sensors, machine-to-machine interfaces, and data structuring, leading to an alteration of the pyramid's middle layer by changing the very nature of operational command and control as it is known. Many air components are well invested in ongoing ABMS technical develop-

21. *Chennault 2.0*, 1.
22. General Mark Kelly, USAF, conversations with author.

ment and working machine-to-machine information flow through a bevy of operational warfare applications. Equally critical will be ensuring the foundational layer by preparing Airmen cognitively and experientially to master the demands of JADC2. Air components can bring their organizations closer to this vision by focusing on people and fostering a JADC2 culture.

Cultural Basics

Organizational culture is the foundational layer to any transformation, including that of the air component. At its heart, JADC2 is intended to embrace Joint and partner-nation capabilities through lateral connectivity that enables practitioners to sense, make sense, and act as a unified whole. The necessity for this is not new. Joint and partner-nation integration was also important in the 2003 invasion of Iraq. But 20 years of low-intensity conflict have ossified conventional forces and created low-tempo stovepipes. The need for Joint and partner-nation integration is as important today as it was in 2003. The only difference now is without truly radical integration, the risk involves not just losing a regional conflict of choice but also losing a great-power war of necessity.

The recommendations below are neither radical nor revelatory when taken separately, but the whole is greater than the sum of its parts and represents a significant shift in approach. The Air Force's Operational Command Training Program often finds organizational excellence is not an act of discovery but one of remembering. Organizations need to be reminded to apply the basics in changing culture. This involves leadership emphasis, training, and a frank commitment to repetition that builds muscle memory.

In particular, the Air Force should focus on building the cultural basics, namely the values, expectations, and practices of the organization. For JADC2, values, expectations, and practices should center on 1) partnering airpower and nonairpower teams and organizations; 2) building all-domain relationships; and 3) conducting frequent battle drills to turn these teams, organizations, and relationships into processes that enable a well-rehearsed kill web. In this way, air components can begin to truly integrate nonairpower capabilities such as space, cyber, and information, as well as Joint and partner-nation capabilities.

Building relationships with those all-domain counterparts, understanding their capabilities and timelines, and practicing how to meld those fires must be done now during precrisis. Attempting to do this as crisis or war develops is simply too late. A JADC2 culture is one that places a premium on curiosity, learning, and engagement with those outside the organization. JADC2 requires air components to be value-embracing and domain-agnostic partners, focusing on the kill web and seeking machine-to-machine connection.

Being culturally partner focused and domain agnostic for JADC2 means first having a Joint outlook. The air component is the Air Force's Joint interface. Despite the importance of this connection, it is rare to find air component Airmen who have Joint experi-

ence.[23] This commonly results in staff cultures that think almost solely in terms of Air Force capabilities and kinetic bias. JADC2 demands practitioners think in a multidomain manner, similar to a Joint task force. Airmen must understand Army, Navy, Special Operations, and other capabilities and the tasking processes associated with their platforms, fires, intelligence, communications, targeting, and other aspects:

> Practitioners of [operational-level] C2 must be able to think beyond their tactical "family of origin" weapons systems and understand how the various joint and coalition forces can fit together into a coherent scheme of maneuver. Air planners in the [AOC] are specifically trained in the joint operation planning process for air but also support the parallel joint operation planning process performed by JTF headquarters. Thus, they must be familiar with multiple joint and functional operational-art concepts, doctrine, and terms.[24]

Fostering a culture of JADC2 means fostering a Joint task force culture where land, cyber, and maritime capabilities come to mind just as easily as airpower when working to solve problems. This emphasis must demand face-to-face interaction and relationship building with Joint counterparts; understanding of each other's capabilities and processes; and finding ways, at the lowest possible level, to integrate and synergize together. This could mean establishing dynamic targeting drills, planning multidomain ISR campaigns, or assigning officers from other services to air component billets.

And once Airmen find those points of integration and synergy with nonairpower partners, they should conduct frequent Joint battle drills to build muscle memory among the staffs. The importance of these frequent battle drills conducted alongside Joint partners cannot be overemphasized. Thinking like a Joint task force during precrisis, connecting Joint teams, and having relationships of trust forged over frequent battle drills is a precondition for JADC2 success.

Partner Nations

Being culturally partner focused means embracing key Allies and partners that share US objectives. Partner nations may bring exquisite capabilities and enabling authorities that allow them to achieve common goals easier and faster than the air component. As with Joint counterparts, Airmen must be educated on partner capabilities, understand their tasking (or asking) processes, and build personal relationships that become stronger with frequent battle drills.

Beyond aircraft, air component Airmen should be knowledgeable of partner-nation specialties and accesses, whether that be cyber, human intelligence, maritime, or publicly

23. Adam J. Hebert, "USAF Evaluating When Joint Experience Should Equal Command Experience," *Air and Space Forces Magazine*, September 20, 2017, https://www.airandspaceforces.com/.

24. Dave Lyle, "The Rest of the C2 Iceberg," *Air & Space Power Journal* 28, no. 4 (Summer 2014), https://www.airuniversity.af.edu/.

available information. Building this precrisis relationship, however, is complicated by additional challenges of technical interoperability and foreign disclosure. The team building that comes from frequent integration is commonly hampered by inadequate means to collaborate.[25]

Air components should strive to have robust video teleconference and chat connectivity with partners, in addition to common systems, partner networks, and voice lines. Yet having robust communication networks is not merely a checklist item. Those communications must be relevant and used frequently. These partner communication nodes should be persistently energized by Airmen in pushing integration to the lowest level during day-to-day operations and not just during exercise events.

Compounding the problem of partner integration is the difficulty of foreign disclosure. During every single crisis, the imperative to share with partner nations is paramount. Yet the number of foreign disclosure officers and prearranged, fast-moving sharing arrangements are often lacking in such crises.[26]

JADC2 culture will demand radical sharing with partner nations, and this means attacking the sacred barriers that well-meaning security professionals emplace—something that may be prosecuted best when the sharing demand signal emerges locally. The portrayal of Top Secret/Sensitive Compartmented Information on the AOC operations floor with partners working alongside US Airmen, for example, may have been unthinkable in previous times, but this situation will likely become a necessity if the United States is to win a future great-power conflict. The Air Force must thus insist on robust and technically redundant communications that make partner-nation communication routine, low level, and preferably face-to-face.

Domain Agnostic

Nonkinetic effects. The imperative to connect teams, build relationships, and drill battle operations applies especially to the integration of nonkinetic effects. The timelines and authorities for NKE are significantly different than those involved with kinetic effects. Familiarity and practice with these processes must occur in precrisis to be ready for war. Building a platform-agnostic culture familiar with cyber and information warfare requires employing and planning those fires as part of today's real-world, great-power competition, and not just notionally or during exercises.

For example, air operations centers that develop specific offensive cyber operation concepts of operation (CONOPs) during precrisis must assign caveats to their work because air components do not have the authority to approve cyber fires. This authority is retained by US Cyber Command and its subordinate elements and is coordinated through the

25. Lucas Thoma, "There's a Big Problem Limiting US Interoperability with Allies: Here's How to Fix it," Modern War Institute, February 18, 2021, https://mwi.usma.edu/.

26. David Ellison and Daniel Vardiman, "Ukraine Lessons for Naval Intelligence's Next War," *Proceedings* 148, no. 10 (October 2022), https://www.usni.org/.

theater combatant command.[27] Despite this, AOCs that develop offensive cyber CONOPs can create an education tool for air component personnel, a focal point for kinetic and NKE planners, an expected plan of action for combatant commands, and a clear intent for functional elements within the cyber fires chain—all of which will likely result in a cyber capability more readily integrated with air maneuver.

Another example would be air component personnel employing real-world multidomain ISR packages or multidomain flexible deterrence options alongside Joint and partner-nation cyber or information warfare planners during precrisis competition activities. This would build the practical experience and organizational relationships that can be leveraged in wartime. Seeking battle drills in the use of NKE and embedding with partner-nation cells for real-world planning and execution will create well-worn paths for domain-agnostic fires in wartime.

Globally integrated operations. Joint all-domain command and control demand for an all-domain outlook will encourage Airmen to seek solutions to airpower problems outside of the air component and even outside of theater geographical boundaries. Airpower targets may reside in the cyber and space domain, outside the physical reach of airpower kinetic effects, or beyond an area of responsibility. As such, the target may not be prosecutable on that AOC's air tasking order. Many legacy-minded Airmen conclude that just because a target cannot be serviced by their ATO, it is not their job. But in this era of globally integrated operations, all combatant commands (and their air components) work together to target the enemy despite geography or domain.

In the JADC2 culture, an air component working a target of interest that it cannot action by itself will still invest in the detailed analysis of that target's critical vulnerabilities, if only to effectively lobby for its inclusion on another combatant command's or partner nation's Joint target list. JADC2-cultured Airmen will instinctively reach into the realm of globally integrated operations and understand the reach and capability of US Cyber Command or US Space Command as they seek any means necessary to deliver effects to the enemy.

Kill Web

Embrace it. The point of being culturally partner focused and domain agnostic is to obtain greater efficiency and effectiveness in killing the enemy. Embracing the kill web means embracing intelligence, surveillance, and reconnaissance, which for air components means the distributed common ground system (DCGS). Until a few years ago, the DCGS was solely focused on the exploitation of raw intelligence gathered by airborne ISR. In January 2020, the 480th Intelligence Wing launched "DCGS Next Gen," which

27. DAF, *Cyberspace Operations*, AFDP 3-12 (Maxwell AFB, AL: LeMay Center, February 1, 2023), https://www.doctrine.af.mil/.

emphasizes platform-agnostic deep analytical support to the air component.[28] This support comes in the form of analyst exploitation teams that focus on air component intelligence problems requiring deep expertise.

DCGS has leaned into the advanced battle management system and JADC2 writ large by focusing on data services and enabling common intelligence picture and common operating picture capabilities that contribute to rapid OODA loops. The DCGS is also heavily invested in the sensing grid. The system is developing intelligence applications for rapid targeting and long-range kill-chain concepts, making it the fusion engine for JADC2 as the key enabler speeding decisions associated with the kill web. Thus, JADC2-cultured Airmen will be more knowledgeable of DCGS activities and will seek its inclusion in major exercises, battle drills, and flexible response options.

Drill it. Connecting organizations, building relationships, and battle drilling together form the sinews of Joint all-domain command and control. If these are done purposefully and habitually, muscle memory will form and the processes that enable fighting at speed and scale in all domains will come into sharper relief. JADC2 technical development traces the flow of machine-to-machine information from application to application and sensor to shooter. The JADC2 human dimension, however, needs to trace the flow of kill-web information through those processes. By frequently conducting battle drills together, Airmen with all-domain teammates will better identify the most effective paths and flows to integrate the all-domain kill web.

Finding the best paths and flows should be done from the bottom up, but Airmen need repetitions to discover them. Dynamic targeting experiential training, for example, is obtained via Blue Flags or the Neptune series' exercises. But these events are few and far between, taking place every 18 to 24 months. This is too infrequent to build organizational muscle memory. JADC2 cultures are created by air components that develop their own process for frequent battle drills and genuinely test their kill webs. An example of this is the F2T2—find, fix, track, target—which is the first part of the Air Force kill chain F2T2EA, minus the engage and assess. These are self-generated drills that practice an actual, not simulated kill web conducted with, for example, maritime and ground surface fires, partner nations, and all-domain capabilities like cyber.

Some air components employ F2T2s by using multidomain ISR packages against real-world targets, and the intelligence obtained drives multidomain targeting processes. Operational and tactical C2, machine-to-machine data sharing, service component procedures, and all-domain planning considerations are all exercised against a real, breathing, moving target with a mind all its own. The F2T2 drill initiative described above is ingenious because it combines real-world requirements with actual Joint/Allied/all-domain targeting processes and can occur many times a year. This type of frequent battle drill

28. Kelly Borukhovich and Tyler Morton, "DCGS Next Generation: Accelerating Change to Deliver Decision Superiority," Over the Horizon, September 26, 2020, https://overthehorizonmdos.wpcomstaging.com/.

finds JADC2 kill paths that are intuitive. JADC2 technology should not drive these kill-web processes. The lower and middle echelons of the air operations center are perfectly able to determine the right path when informed by all-domain and partner-nation understanding, integration, and frequent battle drills.

Connection-Driven

The sensing grid of the fully formed JADC2 construct assumes machine-to-machine lateral connections sharing data between many platforms at speed and scale, but this is clearly not a reality today.[29] Despite this shortfall, it is critical for Airmen building a JADC2 culture to seek ways for machines to connect and bring down barriers to data sharing. For example, during Joint Task Force Haiti relief operations in the summer of 2021, the Air Forces Southern Joint air component coordination element connected the radar picture emanating from maritime vessels for display in the AOC. Several communicators from both the air and maritime domains had to work together, and within a day or so, the radar picture became completely integrated.[30]

When JADC2 fully matures, this will occur automatically, but today it may require senior leader emphasis in order to happen. It is important for leaders at all levels to set the expectation that Airmen must always strive to identify barriers and work ties with Joint and partner-nation members regardless the topic. Whether it be for radar feeds or intelligence collection, these connections will prove foundational to JADC2 success.

Red dot tests are useful tools that both Pacific Air Forces and US Air Forces in Europe have used to trace machine-to-machine connections in their F2T2EA kill chains. The red dot chart traces the flow of data from ISR sensor to tactical shooter and all the intelligence and operations applications in between. The chart displays every occurrence in which a human-in-the-loop must manually transfer information from one application to another, each annotated with a red dot.

Looking at the number of red dots on the kill web gives a quantitative list of data connections that need automation. Red dots get removed every time machine-to-machine connections are crafted by software developers. The red dot test is an effective mechanism to identify and quantify analog connections, enabling air professionals to think more clearly about the machine flow of their data. Because of this, "single input, multiple outputs" should become the focus for most JADC2 culture-savvy Airmen.

An air component culture that is partner focused, domain agnostic, kill-web embracing, and connection driven will offer the rich soil in which JADC2 can take root. Building culture means taking action, and leaders should focus on ensuring connections, developing relationships, and demanding battle drills as they form the necessary foundational

29. Greg Hadley, "ABMS Will Need 'Continuous Improvement,' Will Never Be a 'Shiny' Finished Product, General Says," *Air & Space Forces Magazine*, September 21, 2021, https://www.airforcemag.com/.

30. Observed by author during Operational Command Training Program mission supporting Air Forces Southern at Joint Task Force Haiti, Homestead ARB, Florida, July 2021.

layer of the JADC2 pyramid. Focusing on building that culture now will help guide development of JADC2 technology and deliberately plan agile command and control in a manner that is most beneficial to the kill web. And building the relationships, knowledge, and muscle memory with the Joint community, partner nations, globally integrated, operations-focused entities, and the distributed common ground system will posture the air component for success in any great power conflict.

Conclusion

Joint all-domain command and control is a pyramid with technology as the capstone. But JADC2 is more than a myriad of technological solutions. To be effective, the technology at the top must have a sturdy middle layer of command and control. This C2 may be both tactical and operational and must deliver agile control and integrated command where Airmen are not constricted to the air domain or tied to a single, platform-centric C2 node.

While these technological and C2 changes may come in the near future, the task the Air Force faces now is to build and mature the foundational layer of the JADC2 pyramid—that of culture. The organizational culture that underlies JADC2 is something Air Force leaders must address today. This change is underway, especially among younger members of today's air components who have generated innovations like F2T2s, all-domain CONOPs, publications that challenge doctrine, and new ways to structure the air operations center. Moving forward, it is incumbent upon the Air Force to build the air component organization in a way that will synchronize airpower with every other domain to make the collective set of OODA loops and associated effects generate in a manner that is markedly faster, flatter, and more efficient. ✈

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