Chapter 1
The Emergence of Decision-Centric Warfare

Bryan Clark

The US Department of Defense (DoD) increasingly focused its doctrine and capability development during the past decade on great power opponents such as the People's Republic of China (PRC) and Russian Federation or nuclear-armed regional powers like North Korea. The most stressing campaigns US forces could face against these adversaries dominated DoD planning, with the assumption that worst-case scenarios also capture the needs for "lesser-included" cases.[1] Recognizing DoD's focus on high-intensity warfighting, however, adversaries are methodically developing strategies and systems that circumvent the US military's strengths and exploit its vulnerabilities by avoiding the types of situations for which US forces have prepared.[2]

As part of their efforts to asymmetrically counter US military strengths, operational approaches being pursued by the PRC and Russian militaries share an emphasis on information and decision-making as the main battlegrounds for future conflict. Concepts such as the People's Liberation Army's (PLA) System Destruction Warfare or the Russian military's New Generation Warfare direct forces to electronically and physically attack an opponent's ability to obtain accurate information while introducing false data that erodes the defender's ability to orient. Simultaneously, the aggressor's military and paramilitary forces isolate or attack targets without escalating the conflict in ways that could provide a pretext for large-scale US and allied military retaliation.[3] The dilemmas posed by degraded information and an inability to employ traditional US military responses could enable aggressors to achieve their objectives without resorting to attrition as the primary success mechanism.

---

1 Eric Larson, "Force Planning Scenarios, 1945–2016: Their Origins and Use in Defense Strategic Planning," (Santa Monica, CA: RAND, 2017), https://www.rand.org/pubs/research_reports/RR2173z1.html.

2 Kilcullen, David. The Dragons and the Snakes: How the Rest Learned to Fight the West. United States: Oxford University Press, 2020.

3 James Derleth, "Russian New Generation Warfare: Deterring and Winning at the Tactical Level, *Military Review,* September/October 2020, https://www.armyupress.army.mil/Journals/Military-Review/English-Edition-Archives/September-October-2020/Derleth-New-Generation-War/.; Jeff Engstrom, *Systems Confrontation and System Destruction Warfare* (Santa Monica, CA: RAND, 2018), https://www.rand.org/pubs/research_reports/RR1708.html.

Decision-centric concepts like those pursued by the PRC and Russian governments will likely be a significant form of future conflict, especially as more confrontations occur outside the context of large-scale existential combat. When a government's survival is at stake, its leaders would be more likely to adopt attrition-based approaches in an attempt to avoid defeat. Although decision-making and information would remain important when a conflict becomes attritionary, the lethality and survivability of individual units could be equally decisive.

During the late Cold War, the US military's revolutionary approach to precision-strike warfare leveraged the then-new technologies of communication datalinks, stealth, and guided weapons. Similarly, decision-centric warfare may be the most effective way to militarily exploit artificial intelligence (AI) and autonomous systems, which are arguably today's most prominent technologies. An example of this approach is the Defense Advanced Research Projects Agency's (DARPA) Mosaic Warfare concept, which combines AI-enabled command and control (C2) with forces that achieve greater disaggregation than today's US military by incorporating a larger proportion of autonomous systems.

Mosaic Warfare's central idea is that disaggregated manned and autonomous units guided by human command with AI-enabled machine control could use their adaptability and apparent complexity to delay or prevent adversaries from achieving objectives while disrupting enemy centers of gravity to preclude further aggression.[4] This approach is consistent with maneuver warfare, and contrasts Mosaic Warfare with attrition-based strategies employed by Allied forces during the Second World War and by the US military during post-Cold War conflicts in Kosovo, Iraq, and Libya. Although Mosaic Warfare employs attrition as part of creating dilemmas for enemies, its primary mechanisms to achieve objectives are denying, delaying, or disrupting adversary operations rather than eroding an opponent's military power to the point where it can no longer fight effectively.

Although they share a common foundation, Mosaic Warfare builds on maneuver warfare by proposing a force design and C2 process that would enable the US military to execute a larger and more diverse set of courses of action (COA) compared to an opponent. In a decision-centric confrontation, the force with such an "optionality advantage" would be more likely to impose an insoluble combination of dilemmas on

---

4 For more details on Mosaic Warfare, see Bryan Clark, Dan Patt, and Harrison Schramm, *Mosaic Warfare: Exploiting Artificial Intelligence and Autonomous Systems to Implement Decision-Centric Operations*, (Washington, DC: Center for Strategic and Budgetary Assessments, 2020), https://csbaonline.org/research/publications/mosaic-warfare-exploiting-artificial-intelligence-and-autonomous-systems-to-implement-decision-centric-operations.

the adversary.[5]

Mosaic Warfare would also differ with maneuver warfare in terms of its scope and timeframe. Whereas maneuver warfare is viewed as a tactical and operational-level military concept, Mosaic Warfare's force design and C2 approach would yield optionality advantages at the strategic level as well as in the development and fielding of new capabilities before a confrontation begins.

Force Design

The US military is already adopting many of the elements of mosaic force design. To increase optionality, mosaic force design would replace a portion of the US military's monolithic, self-contained platforms and units with a larger number of smaller, less-expensive, and less multifunctional units and systems. Although these smaller units may have less endurance, self-protection, or capacity than the elements of today's force, they could be deployed or escorted into theater by multimission platforms and considered attritable or expendable in combat. Figure 1 shows how a mosaic design approach could be implemented in the US Navy's force structure, which increases the overall number of vessels without growing procurement or sustainment costs.[6] The Navy and other US military services are already moving in the direction of more distributed force structures that are consistent with mosaic force design.[7]

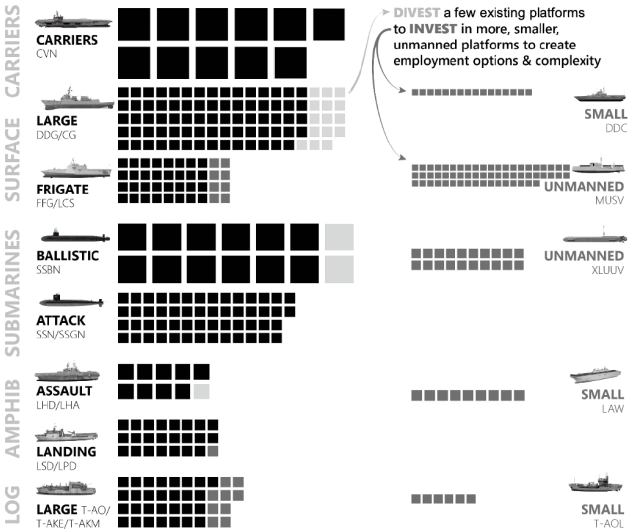
---

5 Robert Leonhard, The Art of Maneuver: Maneuver Warfare Theory and AirLand Battle (New York: Ballantine Books, 1991), pp. 66–74.

6 Bryan Clark, Timothy A. Walton, and Seth Cropsey, *American Sea Power at a Crossroads: A Plan to Restore the US Navy's Maritime Advantage*, (Washington, DC: Hudson Institute, 2020), https://www.hudson.org/research/16406-american-sea-power-at-a-crossroads-a-plan-to-restore-the-us-navy-s-maritime-advantage.

7 Ben Werner, "SECNAV Modly Says Nation Needs Larger, Distributed Fleet of 390 Hulls," *USNI News,* February 28, 2019, https://news.usni.org/2020/02/28/secnav-modly-says-nation-needs-larger-distributed-fleet-of-390-hulls.

Figure 1: Example of how the US Navy could be rebalanced to implement Mosaic Warfare force design principles



The current and proposed future force cost approximately the same amount to buy and operate, incorporating inflation.
Source: Adapted from Bryan Clark, Timothy A. Walton, and Seth Cropsey, *American Sea Power at a Crossroads: A Plan to Restore the US Navy's Maritime Advantage*, (Washington, DC: Hudson Institute, 2020), https://www.hudson.org/research/16406-american-sea-power-at-a-crossroads-a-plan-to-restore-the-us-navy-s-maritime-advantage

The greater number and diversity of units in a mosaic force would provide more potential combinations to commanders, allowing them to identify acceptable COAs faster and more easily select COAs that have a higher probability of success. The mosaic force's disaggregation would also enable commanders to calibrate the capacity and capability of force packages more precisely, which could allow a force to be spread over a larger number of simultaneous tasks compared with today's US military. From an opponent's perspective, the mosaic force's higher decision-making tempo, scale, and effectiveness compared to a traditional force would tend to foreclose more of the opponent's COAs, further strengthening the mosaic force's optionality advantage.

Rebalancing US forces toward a larger number of smaller platforms and formations creates operational benefits. The more disaggregated mosaic force would be better able to mount feints, probes, and other high-risk, high-payoff operations that would not be worth the potential loss of a monolithic, multi-mission platform or formation.

Disaggregation would also enable more force package options that can proportionally counter gray-zone or sub-conventional aggression. In contrast, today's US gray-zone responses either employ small numbers of expensive platforms at high risk of being overwhelmed adjacent to an adversary's territory, or larger formations that can protect themselves but are likely disproportionate to the situation.[8]

Across a longer competition, the smaller, less-multifunctional units in the mosaic force could more easily incorporate new mission systems and technologies compared to their monolithic, multimission counterparts. As a result, the mosaic force could adapt more quickly compared to today's military by promptly fielding new sensors, radios, weapons, or electronic warfare systems as they emerge from research and development instead of waiting for costly and time-consuming integration.[9]

C2

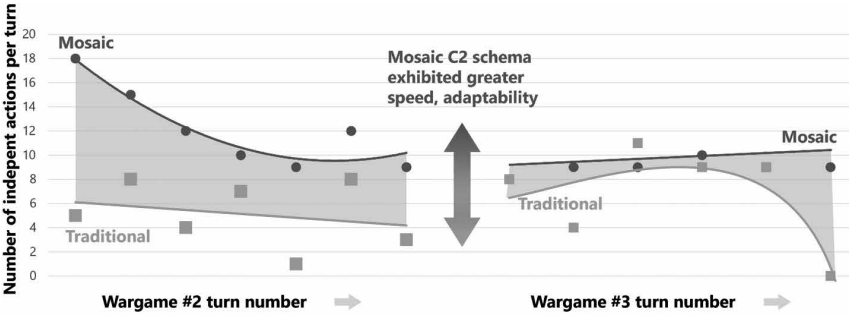
The staff-managed and doctrine-driven C2 process of today's military is too slow and lacks the capacity to rapidly develop COAs that integrate a large number of disaggregated units in performance of changing missions. The mosaic C2 approach addresses the shortfalls of staff-driven planning by combining human command with machine control, in which human commanders identify tasks, set constraints and priorities, and identify forces available for use; machine-enabled decision support systems then develop proposed COAs that support the commander's intent. Together, a more disaggregated force and a machine-enabled C2 process would enable faster decision-making at scale, as evidenced in the wargame performance of mosaic teams shown in Figure 2.

---

8 Zachary Cohen and Ryan Browne, "US B-52 bomber flies near contested islands in South China Sea," CNN, March 5, 2019, https://www.cnn.com/2019/03/05/politics/us-b-52-bomber-training-south-china-sea/index.html; Geoff Ziezulewicz, Two US aircraft carriers are operating in the South China Sea; Air Force B-52 joins them." July 6, 2020, https://www.navytimes.com/news/your-navy/2020/07/06/two-us-aircraft-carriers-are-operating-in-the-south-china-sea-air-force-b-52-joins-them/.

9 These benefits are detailed in Bryan Clark, Dan Patt, and Harrison Schramm, *Mosaic Warfare: Exploiting Artificial Intelligence and Autonomous Systems to Implement Decision-Centric Operations*.

Figure 2: Comparison of task completion between mosaic forces and traditional military forces in recent wargames



Wargames suggest that a Mosaic C2 approach combined with a more disaggregated force structure can yield faster, more adaptable operations.
Source: Bryan Clark, Dan Patt, and Harrison Schramm, Mosaic Warfare: Exploiting Artificial Intelligence and Autonomous Systems to Implement Decision-Centric Operations.

Human command and machine control would also support the US military concept of mission command, in which subordinate leaders rely on their own initiative and creativity to pursue the intent of senior commanders when communications are lost.[10] As US forces become more disaggregated or distributed, junior commanders will be less able to creatively employ units and systems under their control without planning staffs. As a result, junior commanders cut off from headquarters could fall back on habit or tactics that are predictable by the enemy. Decision support systems would avoid this loss of optionality by enabling junior commanders to effectively improvise and create unexpected COAs when communications are degraded.

[10] Mission Command: C2 of Army Forces, US Department of the Army, 2020, https://armypubs.army.mil/epubs/DR_pubs/DR_a/pdf/web/ARN19189_ADP_6-0_FINAL_WEB_v2.pdf.

Implementing Decision-Centric Warfare

DoD's C3 efforts today are organized under its Joint All-Domain C2 (JADC2) strategy,[11] which includes the US Air Force's Advanced Battle Management System (ABMS),[12] the Army's Project Convergence,[13] and the Navy's Project Overmatch.[14] System development under JADC2 has largely focused on communications to connect a greater variety of disparate units via ABMS, but gaining a decision-making advantage will require that commanders go beyond merely connecting forces to also develop COA and compose force packages faster or more effectively than their opponents.[15]

Although JADC2 should help commanders communicate with a more diverse and dynamic set of forces, the current staff-driven US military planning approach will be unable to review the growing range of possible COAs at an operationally relevant tempo. To speed up planning, staffs are likely to fall back on doctrine or habit that an enemy would more easily predict, reducing the decision advantage of US forces.

Some new technologies are needed to enable DoD's emerging force designs, such as autonomous vehicle controls, network management systems, and small form-factor sensors or effectors. However, these efforts are well-supported and reaching a high level of maturity. Given DoD's progress on fielding more disaggregated forces, C2 should be the focus of technology development for decision-centric warfare in general and Mosaic Warfare in specific. The technology for human command and machine control is already emerging from DoD initiatives designed to support specific military missions such as air-to-air combat or missile defense.[16] C2 technology development will need to build on these programs and enable management of an entire force across multiple missions

---

[11] Theresa Hitchens, "Exclusive: J6 Says JADC2 Is A Strategy; Service Posture Reviews Coming," *Breaking Defense,* January 4, 2020, https://breakingdefense.com/2021/01/exclusive-j6-says-JADC2-is-a-strategy-service-posture-reviews-coming/.

[12] Theresa Hitchens, "ABMS Demo Proves AI Chops For C2," *Breaking Defense*, September 3, 2020, https://breakingdefense.com/2020/09/abms-demo-proves-ai-chops-for-c2/.

[13] Mark Schauer, "Project Convergence a generational shift for Army," US Department of the Army, October 7, 2020, https://www.army.mil/article/239770/project_convergence_a_generational_shift_for_army.

[14] David Larter, "The US Navy's 'Manhattan Project' has its leader," *C4ISRNet*, October 14, 2020, https://www.c4isrnet.com/naval/2020/10/14/the-us-navys-manhattan-project-has-its-leader/.

[15] John Hoehn, "Joint All Domain C2 (JADC2)," Congressional Research Service, September 28, 2020, https://fas.org/sgp/crs/natsec/IF11493.pdf.

[16] DARPA, "AlphaDogfight Trials Go Virtual for Final Event," DARPA, August 6, 2020, https://www.darpa.mil/news-events/2020-08-07; Jen Judson, Inside Project Convergence: How the US Army is preparing for war in the next decade," Defense News, September 10, 2020, https://www.defensenews.com/smr/defense-news-conference/2020/09/10/army-conducting-digital-louisiana-maneuvers-in-arizona-desert/.

against adversaries that are actively attempting to undermine US decision-making.

In contrast to the playbooks and tactics used in today's operational planning, realizing the greater optionality inherent in the mosaic force design will require decision support systems that can rapidly analyze numerous potential COAs and adversary responses, providing commanders an assessment of each COA's likelihood of success and how it may impact the opponent's decision space. Perhaps most importantly, C2 tools for decision-centric warfare will need the ability to develop and consider COAs outside the bounds of previous engagements or doctrine to surprise an opponent with an unexpected action or respond to an unlikely enemy operation. Some DoD programs are already pursuing the algorithms needed to support this approach to "changing the game" on an opponent.[17]

Over a longer conflict, C2 tools will also need to help commanders understand how they can orchestrate individual engagements to implement their strategy and maintain an optionality advantage. For example, a commander can initially use a large number of simultaneous operations, including numerous feints and probes, to overwhelm enemy decision-making and narrow decision space. Using the information gained from their opening actions, US forces could then execute a focused set of attacks against primary targets while pursuing suppression operations against enemy forces using attritable units with a high likelihood of loss. The US commander could close the mission by mounting a series of unexpected COAs against remaining targets to constrain the enemy's options and keep it off balance until the US force accomplishes its objectives. A decision-centric C2 tool should aid commanders in considering a series of COAs like these against a range of enemy responses.

Forces conducting decision-centric warfare will require a complex set of C2 and communications capabilities to fully exploit the optionality possible with a more disaggregated force design and narrow the COAs available to opponents. These mission integration capabilities are described in the next section.

Integrating heterogeneous military forces

Advancements in communication technology, modularized electronics, and software-defined systems are propelling explosive growth and specialization across most sectors

---

[17] DARPA, "Gamebreaker AI Effort Gets Under Way," DARPA.mil, May 12, 2020, https://www.darpa.mil/news-events/2020-05-13.

of the US economy. Driven by technology companies' business models, consumers can obtain increasingly tailored products and services, often delivered directly to their homes. Although accelerated by 2020's coronavirus pandemic and the exigencies of remote work, these developments reflect underlying trends that are inexorably leading toward a future of diverse products and services being delivered to rapidly expanding markets.[18]

Military forces are also evolving toward a combination of heterogeneity and scale. The DoD is pursuing greater resilience through distributed force structures intended to grow the number of targets an enemy would need to engage and expand the variety of ways US forces could conduct offensive operations.[19] In a fiscally constrained environment, further distributing the US military will necessarily increase its heterogeneity. If today's US joint force was distributed into a larger number of units having approximately the same capability and capacity, either the overall US military would be too small because each unit would be a costly multimission platform or formation, or DoD would lack needed high-end capabilities such as air defense or long-range fires that are too expensive to be carried by every unit. Therefore, compared to the current US military, DoD's future force design will likely be more disaggregated and heterogeneous, combining fewer large, multi-mission platforms and troop formations with a larger number of smaller, more specialized, units.

In addition to the improved resilience arising from distribution, a more heterogeneous US force will likely be more effective in confrontations where success results increasingly from information and decision superiority rather than attrition. For example, the Mosaic Warfare concept contends a military able to exploit heterogeneity at scale could gain a decision-making advantage over opponents by affording commanders greater adaptability and creating more complex presentations for the enemy to assess,

---

[18] Scott Galloway, Post-Corona, (New York, NY: Penguin/Random House, 2020), pp. 16-24.

[19] Office of the Chief of Naval Operations, Deputy Chief of Naval Operations (Warfighting Requirements and Capabilities - OPNAV N9), "Report to Congress on the Annual Long-Range Plan for Construction of Naval Vessels," (Washington, DC: US DoD, 2020), p. 9, https://media.defense.gov/2020/Dec/10/2002549918/-1/-1/1/SHIPBUILDING%20PLAN%20DEC%2020_NAVY_OSD_OMB_FINAL.PDF; Charles Q. Brown, "Accelerate Change, Or Lose," US Department of the Air Force, August 2020, https://www.af.mil/Portals/1/documents/csaf/CSAF_22/CSAF_22_Strategic_Approach_Accelerate_Change_or_Lose_31_Aug_2020.pdf; Headquarters, US Marine Corps, "Force Design 2030," US Department of the Navy, March 2020, https://www.hqmc.marines.mil/Portals/142/Docs/CMC38%20Force%20Design%202030%20Report%20Phase%20I%20and%20II.pdf?ver=2020-03-26-121328-460; Jen Judson, "US Army's $7 billion wish list would boost multidomain units and wartime funding," *Defense News*, February 21, 2020, https://www.defensenews.com/smr/federal-budget/2020/02/21/armys-7-billion-wish-list-would-boost-mutlidomain-units-and-wartime-funding/.

understand, and defend.[20]

A contemporary example of mosaic-like force design is US Special Operations Forces (SOF), which consist predominantly of small, specialized units supported by a few multimission platforms or troop formations. However, the SOF model for training, equipping, and planning would be too expensive and time-consuming to apply across the entire US military. Enabling greater adaptability and composability by DoD's general-purpose forces within likely fiscal and organizational constraints will require new approaches to force management and preparation that balance scalability with the goal of providing more options to commanders.

Decision-centric warfare implies two levels of competition. Operationally, militaries will need the ability to exploit the adaptability possible with more distributed and heterogeneous forces by recomposing and integrating forces in the field. Institutionally, militaries will need to compete by evolving capabilities over time through the adoption of new technologies and concepts that exploit emerging opportunities or address new threats and challenges.

Heterogeneity at scale would improve the US military's composability, but decision superiority will depend as much or more on C3 capabilities that integrate units and coordinate their operations. In addition to the difficulty of organizing more numerous and diverse military units, today's planning and management processes are likely to be overwhelmed by the complexity created by the greater variety of possible force compositions and effects chains inherent in a more disaggregated force. New C3 organizations, processes, and systems will therefore be needed to implement decision-centric warfare regardless of the level of heterogeneity eventually achieved by the US military.

Framed another way, merely establishing machine-to-machine communications across the existing force is unlikely to deliver an asymmetric advantage against adversaries. And while networking everything all the time is a noble long-term goal it is impractical for the foreseeable future. A more fertile competitive field will be managing the timing and orchestration of force combinations possible with the units that commanders can communicate with to pursue immediate, focused military objectives. Decision support tools could help commanders understand their communications availability and harness

---

[20] Bryan Clark, Dan Patt, and Harrison Schramm, *Mosaic Warfare: Exploiting Artificial Intelligence and Autonomous Systems for Decision-Centric Operations* (Washington, DC: CSBA, 2020), https://csbaonline.org/research/publications/mosaic-warfare-exploiting-artificial-intelligence-and-autonomous-systems-to-implement-decision-centric-operations.

the complexity of a more heterogeneous force that embodies a greater variety of potential force packages and COAs. The US military is already expanding its use of computer based C2 aids, some of which employ artificial intelligence (AI), to speed the development and improve the effectiveness of COAs using modeling and simulation and the results of previous operations.[21]

The construct DoD normally uses to assess needs associated with new operational approaches considers doctrine, organization, training, material, leadership, personnel, and facilities (DOTMLPF). Because the doctrine for Mosaic Warfare, JADC2, and the joint warfighting concept are already under development, this study will focus on the remaining DOTMLPF elements, organized into three main categories: mission integration, operational infrastructure, and institutional processes.

Mission Integration

Today force composition is largely performed by the military services, which organize, train, and equip units that are then deployed to Combatant Commanders (CCDR) and their domain-specific service component commanders.[22] DoD's reliance on services to create force packages, however, can constrain the variety of compositions to those using a single service's capabilities. Moreover, services are incentivized to limit the variety of force packages they create to contain costs associated with preparing and certifying units before deployment.

To exploit the potential of a more heterogeneous and recomposable military, CCDRs will need mechanisms in theater to recompose and integrate forces from multiple services and domains. However, identifying when recomposition is warranted will require ongoing assessment of current force packages' effectiveness and adaptability across a range of potential situations the CCDR could need to address. Integrating new force packages in theater will also incur costs in terms of operational infrastructure such as logistics, protection, transportation, and C3 capabilities. To manage the scope and cost of their assessments and recomposition efforts, CCDRs could focus on a small set of operational challenges that must be tackled to enable their plans for deterrence and warfighting preparation. A mission integration cell on the CCDR staff could continuously

---

[21] Mallory Shelbourne, "Services Looking for 'Synergy' in JADC2 Efforts," *USNI News*, November 13, 2020, https://news.usni.org/2020/11/13/services-looking-for-synergy-in-jadc2-efforts.

[22] The joint force component commanders associated with most combatant commanders are air, maritime, and land.

evaluate the ability of available forces to address the CCDR's operational challenges and direct the recomposition of forces in theater when the improvement in effectiveness and adaptability outweighs the costs associated with operational infrastructure.

The process of mission integration will also yield insights that should be applied to future capability development. Through their assessments, mission integration cells may discover potential new capabilities that would yield a substantial improvement in effectiveness or adaptability compared with current approaches to an operational challenge. To act on these opportunities, DoD will need to leverage a federated model of capability development encompassing service program offices, rapid capability organizations, and "mission factories" such as Navy and Air Force warfare centers.[23]

Operational Infrastructure

Realizing the greater potential optionality of a more heterogeneous future force will depend on changes to the nature and provisioning of military transportation, protection, logistics, energy, C2, and communications infrastructure. Smaller specialized units such as patrol vessels, unmanned aircraft, or troop formations at the battalion level and below will often need to be carried into theater and afforded more inorganic support and protection than larger self-contained multimission platforms and formations. In some cases, multimission units could operate in concert with smaller, more specialized forces to provide protection and support. When operating independently, less-multifunctional troop formations and manned or unmanned platforms may need more disaggregated support infrastructure and logistics forces compared to today's efficient, but centralized, supply and fuel depots, aircraft, and ships.

Military capabilities that are less geographically constrained, like space-based sensing and communications systems or information and cyber tools, will also need to be integrated by CCDRs into recomposed force packages. Like smaller, more specialized platforms and formations, these capabilities may also depend on operational infrastructure; cyber tools may need transportation for physical access to targets or a commercial satellite sensor may depend on interoperability software to connect with an unmanned military surface vessel.

---

[23] See US Air Force, U.S. Air Force Warfare Center, Nellis Air Force Base, October 26, 2016, https://www.nellis.af.mil/About/Fact-Sheets/Display/Article/284150/us-air-force-warfare-center/; US Navy, "Warfare Centers," US Naval Sea Systems Command, https://www.navsea.navy.mil/Home/Warfare-Centers/Who-We-Are/.

As noted above, mission integration cells will need to consider operational infrastructure in their analysis of new force compositions. The smaller, less multi-functional units in a more heterogeneous military force will not be able to meet all their own support requirements, necessitating operational infrastructure to be integrated into the new force packages that CCDRs create in theater.

DoD Institutional Processes

The forecast-based and supply-focused analysis, resource allocation, and capability development processes used today by DoD are ill-suited to realize the force design and C3 architectures needed to implement decision-centric warfare. Most significantly, a more recomposable force will not result in predictable system-of-system instantiations that can be used to identify capability gaps and deterministically define requirements for engineers to pursue through research and development (R&D). DoD will need new approaches to assess and satisfy its capability needs that reflect the greater optionality of a decision-centric force.

Today, the Joint Capabilities Integration and Development System (JCIDS) is designed to identify system requirements by forecasting the performance of planned capabilities in predicted future scenarios.[24] This approach depends on assumptions regarding the configuration of US forces, but as the US military becomes more recomposable, the specific combination of units and their tactics will be less certain. To assess the future US force's effectiveness, DoD could instead evaluate all the reasonable combinations of units that could be pursued in a realistic range of situations. The distribution of the force's effectiveness across configurations and scenarios can be represented as a statistical distribution, rather than the current point solution directed through JCIDS.

DoD is making some progress toward identifying requirements for composability through mission thread analysis and mission engineering.[25] The Office of the Secretary

---

[24] U.S. Joint Staff, "Charter of The Joint Requirements Oversight Council (JROC) and Implementation of The Joint Capabilities Integration and Development System (JCIDS)," CJCSI 5123.01H, 2018, pp. D-1–D-3, available at http://acqnotes.com/wp-content/uploads/2018/11/CJCSI-5123.01H-Charter-of-the-Joint-Requirements-Oversight-Council-JROC-and-Implementation-of-the-JCIDS-31-Aug-2018.pdf;

[25] See Statement by Ms. Barbara McQuiston to the U.S. Senate Appropriations Committee Subcommittee on Defense Innovation and Research April 13, 2021 or the DoD Mission Engineering Guide found at https://ac.cto.mil/wp-content/uploads/2020/12/MEG-v40_20201130_shm.pdf

of Defense (OSD), US Joint Staff, and military services are beginning to use this methodology. As applied today, mission thread analysis examines the information and data flows necessary to complete a specific kill chain against a target, which can expose gaps in data transfer and sharing that are not reflected in simplistic operational architecture illustrations. However, by assuming a static arrangement of force elements, DoD's current mission engineering efforts risk creating brittle systems-of-systems that only work in a single configuration. An asymmetric US advantage should flow from the ability to rapidly decompose and recompose forces and create new systems-of-systems combinations.

During the last decade, the US Congress and DoD established new acquisition processes that could improve the US military's ability to develop capabilities based on emerging technical opportunities and operational challenges rather than predictions of future needs.[26] However, DoD's ability to start, stop, or change course on capability development is fundamentally constrained by supply-based government budgetary structures and processes that are built around programs, rather than missions or demands, and require years to alter funding allocations. New budgeting mechanisms with more flexibility, such as mission-based budgeting or DoD's recent pilot on software appropriation, will be needed to address CCDR operational challenges by modifying or introducing new capabilities that assessments suggest could improve the force's effectiveness or adaptability.[27]

Conclusion and recommendations

Emerging technologies and new use cases are driving consumer products, services, and military forces toward a combination of heterogeneity and scale. In commercial applications, the Internet, mobile communications, modular products, and algorithm-enabled transportation are enabling the dispersion of tailored products and services to users. Military forces are able to similarly exploit networks, C2 tools, modular mission systems, and operational infrastructure to compose force packages that provide a

---

[26] Office of the Under Secretary of Defense for Acquisition and Sustainment, "DOD INSTRUCTION 5000.02: Operation of The Adaptive Acquisition Framework," January 23, 2020, https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodi/500002p.pdf?ver=2020-01-23-144114-093.

[27] Office of the Under Secretary of Defense for Acquisition and Sustainment, "Budget Activity (BA) "BA-08": Software and Digital Technology Pilot Program," Defense Acquisition University, September 28, 2020, https://www.dau.edu/cop/it/DAU%20Sponsored%20Documents/SW%20APPROPRIATION%20BA-08%20FAQ.pdf.

combination of effectiveness and adaptability to CCDRs.

Whereas many commercial technology companies built their businesses around the ability to deliver bespoke products and services to widely distributed customers, DoD has largely been a bystander to the trend toward heterogeneity at scale. Although the Pentagon established a growing variety of capability development organizations and acquisition pathways to field more diverse systems faster, the goal of these efforts was to get capabilities more quickly to the warfighter rather than change its force development paradigm to harness fundamental technology trends.

The US military needs operational and institutional decision-making advantages to effectively deter opponents such as the PLA or Russian Armed Forces. Operationally, achieving a larger decision space depends on having military units and decision support tools able to compose force packages that are effective in a wide range of situations. Strategically, DoD's institutional processes will need new metrics and analytic approaches, more agile resource allocation structures, and a more responsive defense industrial ecosystem to adapt its capabilities for operational advantage.

As a first step, DoD should more proactively exploit the evolution of defense technology by explicitly adopting a federated model for mission integration. Today's approach of services integrating deploying units and affording CCDRs little ability to recompose force packages in theater denies US commanders their most effective opportunity for adaptation and fails to leverage ongoing advances in networking and interoperability. In addition to yielding greater operational optionality, providing CCDRs the tools and operational infrastructure to compose forces would also enable feedback for capability developers that are already organizing along the lines of the mission factories, rapid capability organizations, and proposed in the section of Mission Integration.

To fully exploit the opportunities in heterogeneity at scale, DoD should go further and begin to reform some of its decision processes. By prioritizing adaptability and effectiveness as metrics for capability assessment, force planners could privilege systems that improve outcomes across a range of situations and base decisions on value instead of cost. Performing these assessments will require new methods and tools for analysis that can quickly examine many situations at a lower level of fidelity compared to today's deep analysis within a narrow set of canonical scenarios. And to provide CCDRs the operational infrastructure to integrate forces in theater or the new and modified capabilities needed to achieve acceptable effectiveness and adaptability, DoD will need budget categories with more flexibility than today's program element structure.

DoD will need to engage the defense industry as a partner in its effort to improve

operational and strategic agility. Technology and conceptual trends are driving commercial and defense ecosystems toward new models of delivering capability and engaging with the government as a customer. Measuring the utility of new capabilities based on value rather than cost, DoD may be able to incentive greater commercial contributions to defense capabilities.

The Pentagon should stop letting the evolution of technology pass it by. By embracing new models for capability development, integration, and decision-making, DoD could gain the organizational flexibility to compete effectively with its PRC and Russian counterparts. If it doesn't, the US military runs the risk of ending up like the IBM PC—a great capability for its time but disrupted into irrelevance by more agile competitors.