A REVIVED COMMITMENT TO CONTROL OF THE AIR

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Air superiority remains vital for sustaining the joint force's military advantage. This article argues that a nuanced integration of emerging capabilities with adaptive airpower strategies, rather than platform supremacy alone, optimizes joint capability, offering the most effective approach for the United States and its Allies to maintain air dominance. This article explores the operational potential of collaborative combat aircraft, hypersonic weapons, and pulsed air operations as critical components of such an effective counterair strategy. Drawing on the authors' extensive operational expertise, institutional knowledge, and current research, the article challenges notions of air denial as the future of conflict, identifying the logistical, technological, and doctrinal adaptations necessary to preserve the effectiveness of airpower to address pacing threats, particularly in the Indo-Pacific.

The character of modern warfare is undergoing a profound transformation. The proliferation of anti-access/area denial (A2/AD) systems, drone swarms, and advanced missile technologies has disrupted traditional paradigms of air superiority, placing increasing pressure on legacy platforms and conventional doctrine. Against the backdrop of potential high-intensity conflicts with near-peer adversaries like Russia and China, the United States and its Allies face a pivotal question: Can air superiority still be achieved using conventional means, or must it be reimagined entirely?

Like a seasoned champion boxer facing a new generation of faster, more adaptive opponents, the joint force must decide whether to retire outdated strategies or radically evolve its approach. The answer likely lies in a deliberate transformation—one that blends innovation with operational realism and redefines what it means to control the skies.

Air superiority has historically been a cornerstone of successful military operations and campaigns and the prerogative of superpowers.[1] Yet, recent conflicts—most

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1. Peter Porkka and Vilho Rantanen, "Windows, Not Walls: Conceptualizing Air Superiority for Future Wars," *War on the Rocks*, 4 September 2024, https://warontherocks.com/.

notably Russia's war in Ukraine—underscore the increasing complexity of gaining and sustaining air control in contested environments. This article argues that future air superiority will not hinge on platform supremacy alone, but on integrated approaches optimizing joint capability. It examines the operational potential of collaborative combat aircraft (CCA), hypersonic weapons, and pulsed air operations as critical components of a reimagined approach to joint counterair strategy. Furthermore, this article identifies the logistical, technological, and doctrinal adaptations necessary to preserve the effectiveness of airpower in an increasingly complex battlespace. To maintain a decisive edge in twenty-first-century warfare, the joint force must embrace a weapon-centric, strategically adaptive approach to airpower—one that anticipates the demands of future battlefields and sheds legacy constraints.

Control of the Air: A Historical Requirement Reinforced by Ukraine

Some have asserted that the widespread use of drones—in this article, this term refers to small, one-way attack unmanned aerial vehicle systems—and A2/AD strategies has challenged the notion that superpowers can attain air superiority.[2] Some of the confusion surrounding this topic may stem from the ambiguous terminology used by academics and warfighters when discussing air superiority.

Air superiority exists along a spectrum of control of the air. At one end of this spectrum is *air parity*, in which opposing forces possess comparable strength, resulting in similar loss ratios. At the other end is *air supremacy*, where one force possesses overwhelming dominance, enabling total control of the air domain. Air superiority falls between these two extremes and refers to a state in which friendly air forces, supported by counterair missions, can operate without prohibitive interference.[3]

The air war during the Korean War provides a useful framework for understanding control of the air as a continuum, helping to clarify the distinction between different levels of aerial dominance. Controlling the air in Korea posed a significant challenge for the United States, as adversary forces outnumbered US forces and, in some cases, possessed superior technology, particularly with the introduction of the adversary MiG-15 in late 1950.[4] At certain points in the conflict, documented loss ratios were close to 1:1, indicating that neither side maintained a decisive advantage.[5] North Korean forces, supported by China and the Soviet Union, posed a significant threat to American bomber aircraft,

2. See, for example, Michael P. Kreuzer, "Beyond Air Superiority: The Growing Air Littoral and Twenty-First-Century Airpower," *Æther: A Journal of Strategic Airpower and Spacepower* [*Æther*] 3, no. 3 (2024), https://www.airuniversity.af.edu/.

3. Air Force Doctrine Publication 3-01, *Counterair Operations* (Curtis E. LeMay Center for Doctrine Development and Education, 5 June 2023), https://www.doctrine.af.mil/.

4. Douglas A. Birkey, *Air War over Korea: Lessons for Today's Airmen* (Mitchell Institute for Aerospace Studies [Mitchell Institute]), February 2022, https://www.mitchellaerospacepower.org/.

5. Walter J. Boyne, foreword to *MiG Alley: The U.S. Air Force in Korea, 1950–53*, by Thomas M. Cleaver (Osprey Oxford UK, 2019).

such as the B-26 and B-29, forcing them to shift operations to nighttime missions or avoid certain areas entirely.[6] This situation exemplifies air parity, where neither side maintained a significant advantage due to prohibitive interference.

Yet other phases of the conflict saw much higher kill ratios—ranging from 10:1 to 12:1—particularly as the United States countered the MiG-15 with F-86s and refined its aerial combat tactics.[7] Over the course of a prolonged and costly campaign, the United States achieved a degree of air superiority, as evidenced by the limited ability of adversary aircraft to threaten American ground forces and the continuous execution of US air campaigns against enemy targets.[8] Air superiority thus should not be misinterpreted as an absence of aerial threats or a state that exists in perpetuity. Instead, air superiority is a temporal and often localized condition in which friendly aircraft can effectively accomplish their missions within an acceptable level of risk.

The integral role of air superiority in modern warfare is exemplified by Russia's war in Ukraine. As one study notes, "Perhaps the single most significant lesson learned from the Russia-Ukraine War is that air superiority is still an essential prerequisite to enable combined-arms maneuver."[9] Russia's inability to secure air superiority has hindered its ability to support ground forces advancing into Ukraine. Similarly, Ukraine's failure to achieve air superiority has prevented it from executing effective counteroffensive operations to repel Russian forces.[10] If Ukraine could establish control of the air at strategic times and locations, its forces could more effectively conduct airstrikes against Russian ground units.[11]

Some airpower analysts have conflated the effectiveness of drones with that of manned fighters and bombers. In Ukraine, these systems are used to defend against Russian aggression. Yet early lessons from Russia's war in Ukraine indicate that drones are not replacing traditional airpower but instead represent a tactical adaptation to trench warfare, where neither side has achieved air superiority.[12] Observations from Ukraine suggest that drones provide substantial intelligence, surveillance, reconnaissance, and precision-strike capabilities, and when employed in a limited strike or defensive capacity, they demonstrate considerable utility in targeting adversary ground forces.[13] Yet despite their tactical effectiveness, drones have not proven to be a decisive

6. John T. Correll, "MiG Alley," *Air & Space Forces Magazine*, 1 April 2010, https://www.airandspaceforces.com/.

7. Robert G. Angevine, "Adapting to Disruption: Aerial Combat over North Vietnam," *Joint Force Quarterly* 96, no. 1 (2020), https://ndupress.ndu.edu/.

8. Cleaver, *MiG Alley*.

9. Michael T. Hackett and John A. Nagl, "A Long, Hard Year: Russia-Ukraine War Lessons Learned 2023," *The US Army War College Quarterly: Parameters* 54, no. 3 (2024), https://press.armywarcollege.edu/.

10. Joe Goodwin, "Allied Air Command Lessons from Ukraine," *The Journal of the Joint Air Power Competence Center* 37 (May 2024), https://www.japcc.org/.

11. James B. Hecker, "Air Superiority: A Renewed Vision," *Æther* 3, no. 2 (2024), https://www.airuniversity.af.edu/

12. Hecker, "Air Superiority."

13. Hackett and Nagl, "Long, Hard Year."

factor in achieving military victory. Nevertheless, based on such observations in Ukraine and the enduring lessons of military history from major armed conflict since the Second World War, air superiority continues to be vital to support forces on the surface and achieve critical military objectives that lead to victory.[14]

Achieving air superiority against a highly capable adversary like Russia or China will be costly. During World War II, the Eighth Air Force suffered more combat fatalities than the entire US Marine Corps.[15] In Korea, the United States' grueling air battles against a numerically superior and technologically capable adversary resulted in the loss of over 2,700 aircraft—a thousand more tactical aircraft than the US Air Force has in its total inventory today.[16] During the Vietnam War, the US Navy famously commissioned the Ault Report to analyze declining loss ratios, leading to the establishment of the TOPGUN program to regain aerial combat superiority.[17] The historical record underscores that maintaining control of the air has always been difficult and costly. The relative ease with which the United States has controlled the air after Vietnam reflects specific circumstances rather than an inherent capability.

If the United States and its Allies seek to prevail in military conflict against adversaries such as Russia and China, controlling the air is a joint warfighting necessity. Without air superiority and the ability to support combined-arms operations, the US military risks encountering a combat environment reminiscent of that faced in World War I—a challenging situation analogous to the ongoing conflict in Ukraine, where the failure to secure air superiority has contributed to a protracted and costly ground war.

The Future Role of CCA in Counterair Missions

There is considerable debate in the United States and Western defense circles regarding the future of aerial combat. Assertions like that of SpaceX founder Elon Musk, who stated that "idiots are still building manned fighter jets like the F-35," significantly impact the defense industrial base, leadership within the Pentagon, and the national security community.[18] This notion is not novel; in 2020, Musk presented similar ideas at the Air Force Association's Air Warfare Symposium, positing that autonomous drones augmented with artificial intelligence (AI) would represent the future of

14. Hecker, "Air Superiority."
15. "Author and Historian Donald L. Miller," Layfayette.edu, accessed 10 March 2025, https://sites.lafayette.edu/.
16. "Korean Air Battles," Defense POW/MIA Accounting Agency, accessed 10 March 2025, https://dpaa-mil.sites.crmforce.mil/.
17. Angevine, "Disruption."
18. See, for example, Jesus Mesa, "Why F-35 Fighter Jets are 'Obsolete' According to Elon Musk," *Newsweek*, 25 November 2024, https://www.newsweek.com/; Peter Porkka and Vilho Rantanen, "Windows, Not Walls: Conceptualizing Air Superiority for Future Wars," *War on the Rocks*, 4 September 2024, https://warontherocks.com/; and Maximilian Bremer and Kelly Grieco, "Air Denial: The Dangerous Illusion of Decisive Air Superiority," Atlantic Council, 30 August 2022, https://www.atlanticcouncil.org/.

warfare, rendering platforms like the F-35 obsolete.[19] CCAs and unmanned technology will be part of the future joint force—the question is not if it will happen, but rather when CCAs will be ready to provide capability to the joint force in combat, to what degree, and how that should change the overall joint force structure.

Long before such unsubstantiated assertions by Musk and others, the US Air Force had already been investigating and developing concepts under the Low-Cost Attritable Aircraft Technology initiative, which aimed to develop and build low-cost autonomous aircraft in large numbers. This program also encompassed the Low-Cost Attritable Strike Demonstrator program. The former initiative evolved into the Skyborg program within the Air Force Research Laboratory and is foundational for current Air Force CCA efforts.[20] The XQ-58A Valkyrie demonstrator first flew in 2019, just one week after Boeing unveiled its Australian Loyal Wingman drone, now known as the MQ-28 Ghost Bat. These developments marked critical milestones and a shift in narrative, drawing attention from Air Force leadership, the broader defense industrial base, and tech investors eager to enter the defense sector.[21] In the latter part of the 2010s and early 2020s, funding for autonomous aircraft research and development was relatively modest, amounting to less than $500 million per year. Yet the fiscal year 2025–2029 budget request for these programs has surged to $9 billion, with expectations for continued growth.[22]

The key appeal of CCAs lies in their potential for both cost savings and enhanced capability. If CCAs can be developed at a lower cost than manned fighters and provide comparable or superior capability, the Department of Defense could open a pathway to cost-overmatch against its adversaries in the air domain. If CCAs do not achieve a comparable military capability of manned fighters, they could be additive to the US military's manned fighter inventory if cost-effective. CCAs would help address a chronic fighter pilot shortage, particularly in the Air Force and Navy. The problem with this narrative is that if CCAs fail to produce capability, and the Department hedges its air superiority force structure on CCA technology, nothing less than joint military effectiveness is at risk.

The ongoing pilot shortage in the Air Force and Navy shows no sign of resolution in the coming decade. While the defense industry has frequently discussed the challenges of replacing lost aircraft in combat, the more pressing issue lies in the depletion

19. Rachel S. Cohen, "The Fighter Jet Era Has Passed," *Air & Space Forces Magazine*, 1 April 2020, https://www.airandspaceforces.com/.

20. Gregory C. Allen and Isaac Goldston, *The Department of Defense's Collaborative Combat Aircraft Program: Good News, Bad News, and Unanswered Questions* (Center for Strategic & International Studies [CSIS], 6 August 2024), https://www.csis.org/.

21. Tyler Rogoway, "Air Force's Secretive XQ-58A Valkyrie Experimental Combat Drone Emerges After First Flight," *TWZ* [*The War Zone*], 6 March 2019, https://www.twz.com/.

22. Jennifer DiMascio, *U.S. Air Force Collaborative Combat Aircraft*, In Focus (IF) report 12740 (Congressional Research Service [CRS], 22 January 2025), https://crsreports.congress.gov/.

of pilots—currently at historic lows—unless pilots are no longer necessary.[23] Training fighter pilots is an expensive endeavor, costing approximately $11 million per pilot for fifth-generation platforms like the F-35 and F-22.[24] Additional benefits of unmanned platforms include reduced risk to human life, shorter training cycles, and the disaggregation of combat mass.

The Defense Department, however, must navigate these opportunities carefully, balancing them against proven capabilities. The US military cannot choose the time or nature of its conflicts, and relying solely on the promise of unmanned technology presents significant risks. If this technological shift fails to deliver, and the US military hedges its force structure on the promise of technology, the US military's joint combat effectiveness will be severely compromised. Therefore, it is crucial to approach CCAs as a complementary force, gradually integrating them alongside human-piloted aircraft while acknowledging the challenges ahead.

Autonomous systems face well-documented obstacles in performing tasks that humans can execute with relative ease.[25] Training CCAs to match or exceed the capabilities of current manned fighter jets will require extensive data, immense computational resources, and a thorough understanding of adversary tactics—resources that the Defense Department currently lacks in sufficient quantities.[26] Demonstrations such as AlphaDogfight and the X-62 have largely sidestepped the issue of autonomous agent perception and real-time decision-making, making claims of CCA parity with human pilots in dogfighting scenarios somewhat misleading.[27] The autonomous perception of an air combat environment remains inadequately demonstrated in an operationally relevant environment that includes extensive degradation, denial, and disruption of Allied communication, sensors, and battlefield situational awareness. Although live-flight tests are planned to further explore this capability, previous DOD experiments in robotic perception within complex military settings have yielded mixed results.[28]

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23. Heather R. Penny, *Want Combat Airpower? Then Fix the Air Force Pilot Crisis* (Mitchell Institute, January 2025), https://www.mitchellaerospacepower.org/.

24. Beth J. Asch et al., *The Relative Cost-Effectiveness of Retaining Versus Accessing Air Force Pilots* (RAND Corporation, 2019), https://www.rand.org/.

25. See, for example, Ashley Roque, "Frustrations Mount over Army's Robotic Combat Vehicle Autonomy, Acquisition Approach," *Breaking Defense*, 22 July 2024, http://breakingdefense.com/; and Katherine Tangalakis-Lippert, "Marines Fooled a DARPA Robot by Hiding in a Cardboard Box While Giggling and Pretending to Be Trees," *Business Insider*, 29 January 2023, https://www.businessinsider.com/.

26. Bleddyn E. Bowen and Cameron Hunter, "We'll Never Have a Model of an AI Major-General: Artificial Intelligence, Command Decisions, and Kitsch Visions of War," *Journal of Strategic Studies* 47, no. 1 (2023), https://doi.org/.

27. Gary Hatch and Mary Kozaitis, "SecAF Kendall Experiences VISTA of Future Flight Test at Edwards AFB," US Air Force (USAF, website), 3 May 2024, https://www.af.mil/; and Adrian P. Pope et al., "Hierarchical Reinforcement Learning for Air-to-Air Combat," arXiv, The 2021 International Conference on Unmanned Aircraft Systems, last revised 11 June 2021, http://arxiv.org/.

28. David Jeans, "How a Grisly Injury Threw a $5 Billion Drone Startup Off Course," *Forbes*, 13 March 2025, https://www.forbes.com/; Roque, "Frustrations"; and Tangalakis-Lippert, "Marines."

Since its inception, the CCA operational concept has shifted from envisioning a fully autonomous platform to one tethered to human control while retaining the ability to perform autonomous tasks.[29] This tethered model introduces vulnerabilities, as both human operators and the controlling algorithms may be compromised, thereby diminishing the system's operational effectiveness. Regardless of whether CCAs operate under human supervision or autonomously, they remain exposed to many of the same threats faced by manned aircraft. If the objective is to develop a less exquisite, expendable, or attritable platform, cost becomes the central consideration. Defense contractors must prove they can deliver a platform that is both operationally effective and significantly more affordable than manned fighters.

For instance, if a CCA costs $10 million per unit—substantially less than some publicly cited estimates—but lacks the survivability or mission capability of a manned fighter in contested counterair operations, its utility may more closely resemble that of existing decoy systems than traditional combat aircraft.[30] The ADM-160 Miniature Air-Launched Decoy (MALD), for example, is an unmanned, autonomous platform capable of simulating various aircraft signatures for electronic warfare and is priced at several hundred thousand dollars. While CCAs offer greater potential than systems like MALD, their unit cost must be substantially lower than $10 million, especially if they lack survivability, to ensure a lower cost per effect compared to manned alternatives.[31]

Military personnel are primarily concerned with mission success, and they deserve the best possible capabilities to accomplish their objectives regardless of cost. If unmanned CCAs prove to be effective in operationally relevant counterair missions, warfighters will undoubtedly advocate for their inclusion in the arsenal. Yet, for CCAs to fulfill this role, they must demonstrate the ability to execute the core missions of current fighter aircraft—destroying, or significantly disrupting, enemy fighters, bombers, special mission aircraft, and high-value surface-to-air missile systems that threaten coalition forces. Of these target sets, fast-moving fighters and bombers are the most challenging to destroy.

The challenge of targeting fast-moving, high-altitude adversaries remains formidable, and developing fire control systems and weaponry capable of reliably performing these tasks against adversaries actively challenging one's capabilities is expensive. Designing a platform that can achieve high speeds and carry weaponry is one challenge; ensuring it can deliver that capability effectively in chaotic, unpredictable combat conditions is another. When CCAs are tested in operational environments by warfighters who confirm that they are additive, superior, or vital to counterair missions, how CCAs will integrate in the future joint force structure will become apparent.

29. Jon Harper, "Air Force Preparing for 'Tethered' and 'Untethered' CCA Drone Operations," *DefenseScoop*, 27 March 2023, https://defensescoop.com/.

30. DiMascio, "Collaborative Combat Aircraft."

31. Alex Hollings, "Images Surface of Secretive US MALD Flying Decoy Used in Ukraine. But What Is MALD?," SANDBOXX, 15 May 2023, https://www.sandboxx.us/; and Tyler Rogoway, "Recent MALD-X Advanced Air Launched Decoy Test Is a Much Bigger Deal Than It Sounds Like," *TWZ*, 25 August 2018, accessed 10 March 2025, https://www.twz.com/.

Until the operational utility of CCAs in counterair missions is better understood, assessments of their value should focus primarily on mission effectiveness rather than projected cost savings or force multiplication. A more comprehensive understanding of CCA performance will enable more informed evaluations of broader strategic value. As CCA technology continues to mature, the Defense Department should also prioritize the integration of hypersonic weapons into both manned and unmanned counterair platforms, as these systems are likely to exert the most immediate influence on the evolving character of warfare.

Hypersonic Weapons: A Potential Game-Changer for Control of the Air

Hypersonic weapons represent a fundamentally different class of counterair capabilities compared to conventional systems currently in the US military arsenal. Defined by their ability to travel at speeds exceeding Mach 5—five times the speed of sound, or approximately one mile per second—these weapons offer unprecedented reach and responsiveness. Although flight times vary by system, a representative benchmark illustrates their speed: a hypersonic weapon could travel from New York to Los Angeles in under 20 minutes. This range and velocity are comparable to the distance from China's eastern coast to Guam, or from Russian territory to the United Kingdom—demonstrating a performance more than 10 times greater than that of traditional supersonic weapons.

While intercontinental and regional ballistic missiles also achieve hypersonic speeds, hypersonic weapons differ fundamentally in their maneuverability and altitude of operation. Unlike traditional ballistic missiles, which follow a predictable, high-arching trajectory, hypersonic weapons can alter their flight path mid-course, complicating interception efforts. Additionally, they travel at lower altitudes and may remain undetected by air defense systems until they are near their targets, significantly reducing reaction time. The combination of high velocity, maneuverability, and low-altitude flight renders existing missile defense systems inadequate for reliably intercepting these threats.[32]

The rapid advancements in hypersonic technology raise critical strategic and defense considerations. Military analysts and defense scholars debate whether hypersonic weapons represent the next major military offset or merely an asymmetric advantage. The proliferation of these weapons challenges conventional air defense systems, particularly those integrated into A2/AD networks deployed by adversarial states. The United States, recognizing the strategic implications of hypersonic weapons, has initiated the "Golden Dome for America" initiative, aiming to enhance its missile defense capabilities.[33] From both US and adversarial perspectives, the ability of

32. Kelley M. Sayler, *Hypersonic Weapons: Background and Issues for Congress*, R45811 (CRS, 11 February 2025), https://crsreports.congress.gov/.

33. Exec. Order No. 14186, 90 Fed. Reg. 8767 (27 January 2025).

hypersonic weapons to bypass even the most advanced air defense systems poses a significant challenge. If deployed in sufficient numbers, these weapons could overwhelm defenses, striking critical components of adversary A2/AD networks and rendering previously resilient systems vulnerable.[34]

The development and deployment of hypersonic weapons also introduces complex policy and security concerns, particularly regarding warhead ambiguity. A hypersonic missile could carry either a conventional or nuclear payload, and given the extreme speeds involved, targeted nations would have minimal time to determine the nature of the attack before formulating a response. This uncertainty significantly increases the risk of unintended nuclear escalation. Additionally, the exceptional speed of hypersonic weapons exacerbates strategic instability. For example, a hypersonic missile capable of traveling 2,000 miles in approximately 15 minutes spends much of its flight below the radar horizon, making timely detection and counteraction nearly impossible. Without sufficient early warning systems, the unpredictability of missile targets further complicates threat assessment and escalation management. If multiple nuclear-armed states possess hypersonic weapons in significant quantities, and those weapons are employed from systems with conventional and nuclear capability, the potential miscalculation and rapid escalation could have catastrophic consequences.[35]

The United States currently advances multiple hypersonic weapons programs across its military branches. The US Navy develops the Conventional Prompt Strike (CPS) system and the Hypersonic Air-Launched Offensive Anti-Surface Weapon, while the US Army advances the Long-Range Hypersonic Weapon (LRHW). The US Air Force pursues the Air-Launched Rapid Response Weapon (ARRW) and the Hypersonic Attack Cruise Missile. These programs impose substantial financial burdens. Estimates indicate that each CPS unit costs about $50 million, each LRHW missile costs approximately $41 million, and each ARRW-class missile range between $15 million and $18 million.[36]

While total unit costs vary depending on procurement quantities and other factors, the overall financial investment remains significant. If each service branch continues developing its hypersonic arsenal independently, cost management and program sustainability will pose critical challenges. To maintain a competitive advantage against peer adversaries, the Department of Defense must prioritize partnerships with emerging defense companies focused on developing more cost-efficient propulsion systems and manufacturing techniques essential to sustaining US military capabilities and national security.

Multiple nations have operational or developing hypersonic weapons programs. Russia has deployed three primary systems: the Avangard, the Tsirkon, and the Kinzhal. China has developed several systems, including the DF-17, DF-21, DF-26,

34. James M. Acton, "Hypersonic Weapons Explainer," Carnegie Endowment for International Peace, 2 April 2018, https://carnegieendowment.org/.

35. Corinne Kramer et al., *U.S. Hypersonic Weapons and Alternatives* (Congressional Budget Office, January 2023), https://www.cbo.gov/.

36. Kramer et al., *Hypersonic Weapons*.

DF-27, DZ-F, and the Starry Sky-2. These programs incorporate both hypersonic glide vehicles and hypersonic missile technologies, with payload capabilities that include both conventional and nuclear warheads. Beyond Russia and China, other nations actively pursuing hypersonic weapons include India, Germany, France, South Korea, North Korea, Japan, Iran, Israel, and Brazil.

Senior US defense officials have expressed significant concern over the rapid pace of hypersonic development by adversarial nations. In 2020, General Terrence O'Shaughnessy, then-commander of US Northern Command, testified before the Senate Armed Services Committee that China was testing a nuclear-capable intercontinental-range hypersonic glide vehicle designed to evade US missile warning systems. The increasing deployment of hypersonic weapons poses a significant challenge to US national security, and countering adversarial hypersonic capabilities will likely remain a core defense priority for the foreseeable future. Simultaneously, Western defense strategists are exploring operational use cases for hypersonic weapons to enhance deterrence and combat effectiveness.[37]

A primary advantage of conventional hypersonic weapons lies in their ability to extend the reach of precision strikes. Hypersonic weapons have the potential to counter adversary A2/AD systems designed to deter and stop US forces. China and Russia's A2/AD strategies rely on advanced missile systems that extend their engagement zones, aiming to deter US air and naval assets from approaching contested regions. The fundamental objective of these defense postures is to deny US forces the ability to project power into highly defended areas. Yet, the introduction of conventional hypersonic weapons has the potential to undermine this strategic calculus. Adversarial surface-based assets, which once operated securely within the protection of A2/AD defense umbrellas, could become vulnerable to hypersonic weapons. If the United States successfully develops cost-effective hypersonic weapons capable of intercepting moving air and surface targets, it could achieve a strategic, operational, and tactical advantage that would be exceedingly costly for adversaries to counter.[38]

The widespread development and deployment of hypersonic weapons is reshaping global security dynamics. Their exceptional speed, maneuverability, and sustained flight within the atmosphere challenge existing missile defense systems and generate significant strategic uncertainty. Effective integration of hypersonic technologies into counterair operations—enabling the engagement of enemy fighters, bombers, and critical support aircraft—will transform conventional aerial combat. While CCAs represent important advances in modern warfare, the large-scale deployment of hypersonic weapons capable of precisely striking high-value aerial targets promises a far more disruptive strategic impact. Given the technological complexity and substantial financial investment required to develop and field these systems, the United States and its Allies must carefully calibrate their offensive and defensive strategies and critically assess the long-term effects of hypersonic warfare on global stability and deterrence.

37. Sayler, *Hypersonic Weapons*.

38. Kramer et al., *Hypersonic Weapons*.

Pulsed Operations: Achieving Localized, Temporary Air Superiority

The US Air Force concept of operations that will achieve localized and temporary air superiority to allow opportunities for the rest of the force is defined as *pulsed operations*.[39] Effective pulsed operations depend on a sufficient stockpile of capable weaponry. While complete air supremacy against a peer adversary may be challenging, strategic objectives can be achieved with offensive counterair operations that enable air superiority and attacks against high-value targets.

Hypersonic weapons and other standoff munitions supporting pulsed operations can help achieve localized, temporary air superiority. Distances in the Pacific Theater, coupled with China's defensive capabilities, increase the risk and cost of achieving air superiority over long periods. Sustained attrition of the enemy's integrated air defense system (IADS) via pulses utilizing advanced weaponry may offer an opportunity to expand the geographic region of air superiority as well as to extend the duration of superiority. Pulsed operations could benefit from intelligently deployed drones that confuse adversary targeting, repel enemy ground forces, and attack critical defense systems to temporarily overwhelm an adversary like China or Russia. A limited number of air-refueling aircraft, however, means the assets that are chosen for these pulsed operations must be capable of quick, hit-and-run tactics, using advanced weapons to overwhelm the enemy defenses. It is important to recognize that if CCAs are built with limited weapons carriage capacity, a similar fuel requirement to traditional fighters, and a similar offensive and defensive suite to traditional fighters, that investment may not offer the capability or cost overmatch required to extend the duration and geographic coverage of pulsed air superiority.

Instead, the United States should first identify the most critical weapons required to win against China and Russia. Focusing on the weapon first and platform second will be a fundamental change in recent philosophy, but it may yield better results. The Air Force has not fielded a new air-to-air weapon since the AIM-120D reached initial operational capability in July 2015.[40] Part of the reason the United States seems slow to field new weapons is because its weapon systems testing program is more stringent than that of any potential adversary. America should not wholly reverse that precedent, but the Defense Department should accept some level of risk to expedite the development and fielding of advanced weapon systems like hypersonic weapons. While such rigorous testing is admirable, it represents an approach that should be adjusted since the Defense Department is falling behind potential US adversaries. The United

39. Charles Q. Brown Jr., "Air Force Future Operating Concept Executive Summary," USAF, 6 March 2023, https://www.af.mil/.

40. Jeffrey Sobel, *Selected Acquisition Report (SAR): AIM-120 Advanced Medium Range Air-to-Air Missile, as of FY 2017 President's Budget* (Defense Acquisition Management Information Retrieval, 23 March 2016), https://www.esd.whs.mil/.

States should provide an improved weapons capability for crisis and conflict today and reach the 100 percent solution later. This is what US warfighters are demanding.

Redefining the Battlefield: Beyond a Reliance on Fuel and Runways

Many strategic thinkers propose that the United States can achieve a third offset using a combination of CCAs and artificial intelligence.[41] It will not be possible to achieve a distinct military advantage with these technologies unless the United States' defense industrial base outpaces China in these areas. Today, it appears that the United States does not hold a distinct advantage over China regarding CCAs or AI as it applies to military technology.[42] Additionally, if current cost estimates for CCAs continue to grow, following the trend from other major defense acquisition programs, the value proposition of CCAs decreases.[43] CCAs might help the United States solve its mass problem of projecting airpower in Europe and Asia, but CCAs over the Pacific could be limited if they are runway dependent.

Instead, redefining the battlefield by eliminating the United States' current dependence on runways, reducing reliance on fossil fuels, and minimizing its logistical footprint will allow the United States to move at a greater speed while executing pulsed operations that outpace an adversary in their backyard. The special operations community understands this limitation and has asked the Defense Advanced Research Projects Agency to partner with industry to develop a runway-independent aircraft capable of high-speed flight.[44] The fiscal year 2025 Pacific Deterrence Initiative will spend $9.86 billion in upgrades to infrastructure that supports combat operations, training, and test objectives in the US Indo-Pacific Command area of operations.[45] A significant portion of this money is required to shape the environment to allow assets with logistical limitations the ability to operate in the First and Second Island Chains—the first stretching from Japan through Taiwan to the Philippines and Indonesia, and the second spanning Japan through Guam to New Guinea.[46]

Given the current geopolitical environment, the pivot to the Pacific is the correct strategic course of action, but much of the spending is handcuffed by platforms and weapon systems that require archaic logistical footprints. Individual units are making

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41. James Hasik, "Beyond the Third Offset: Matching Plans for Innovation to a Theory of Victory," *Joint Force Quarterly* 91, no. 4 (2018), https://ndupress.ndu.edu/.

42. Sam Bresnick, "The Obstacles to China's AI Power," *Foreign Affairs*, 31 December 2024, https://www.foreignaffairs.com/.

43. DiMascio, "Collaborative Combat Aircraft."

44. Inder Singh Bisht, "Pentagon Seeks Next-Gen Runway-Independent Aircraft," *The Defense Post,* 6 March 2023, https://thedefensepost.com/.

45. Luke A. Nicastro, *The Pacific Deterrence Initiative*, IF 12303 (CRS, 25 November 2024), https://www.congress.gov/.

46. *Pacific Deterrence Initiative: Department of Defense Budget: Fiscal Year 2025* (Department of Defense, March 2024), https://comptroller.defense.gov/.

great strides to reduce this footprint, but the acquisition strategies of the Department of Defense need to continue to help define a future and vision where that footprint is significantly reduced.

Numerous strategic advantages emerge when runway independence is achieved. Without any offensive counterair interference, China could use its current inventory of long-range munitions and target US airfields and much more in the First and Second Island Chains.[47] If assets can operate from austere locations, or China's confidence in successfully targeting runways and airfields decreases, the adversary loses the capability to predict the launch point or threat axis of an incoming pulsed operation. Coupled with hypersonic weapons and strategically placed drones, a redefined battlefield would enable the United States to achieve air superiority at a cost overmatch.

Although it is difficult to compare the cost of US and Chinese systems for many reasons, including the cost of labor and materials used, it can be determined that advanced A2/AD systems are exquisite, expensive, and largely considered strategic assets. Russia's most advanced surface-to-air missile systems cost over $1 billion for a complete system.[48] If the United States can field hypersonic or even near-hypersonic weapons at a lower price point, the required investment to effectively counter a US weapons salvo could become cost-prohibitive to adversary A2/AD strategic approaches. Conversely, CCAs dependent on prepared runway surfaces have the same vulnerability as any other asset at those locations. The ability of manned aircraft to "pick up" and control CCAs from austere operating locations or naval assets like barges will reduce the logistical footprint and significantly complicate the enemy's targeting.

Conclusion: A Proposal for the Future of Air Superiority

Achieving and maintaining air superiority in modern warfare requires a dynamic and adaptive approach that accounts for evolving threats, particularly those posed by A2/AD systems and drone technology. Both historical precedent and current conflicts—such as Russia's war in Ukraine and Israel's conflict with Iran—affirm that control of the air remains an indispensable prerequisite for securing operational and strategic objectives.

While emerging capabilities such as CCA and hypersonic weapons offer considerable promise, their integration into counterair operations requires rigorous operational testing to determine their efficacy in delivering localized, temporal air superiority. Employing CCAs, hypersonic systems, and unmanned platforms in pulsed air operations presents a feasible framework for contesting airspace against technologically advanced adversaries.

To maintain strategic advantage, the US military must adopt a weapon-centric approach that prioritizes operational effectiveness over legacy acquisition models. Future platforms—manned and unmanned—must be purpose-built to support adaptive and

47. Kelly Grieco et al., *Creating Effects: Chinese Missile Threats to US Air Bases in the Indo-Pacific* (The Stimson Center, 12 December 2024), https://www.stimson.org/.

48. John V. Parachini and Peter A. Wilson, "Russian S-400 Surface-to-Air Missile System: Is It Worth the Sticker Price?," RAND [website], 6 May 2020, https://www.rand.org/.

resilient airpower strategies. Additionally, reducing dependence on fossil fuels and traditional runway infrastructure will be essential to enabling distributed operations and survivability in high-threat environments.

US national security depends on a credible, agile, and globally capable military. To preserve its strategic edge, the United States and its Allies must integrate technological innovation with operational pragmatism, ensuring that coalition airpower remains a deterrent and decisive instrument of military maneuver. Æ