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The Air Littoral: Another Look

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ABSTRACT: Assessing threats to the air littoral, the airspace between ground forces and high-end fighters and bombers, requires a paradigm change in American military thinking about verticality. This article explores the consequences of domain convergence, specifically for the Army and Air Force's different concepts of control. It will assist US military and policy practitioners in conceptualizing the air littoral and in thinking more vertically about the air and land domains and the challenges of domain convergence.

For the first time in more than six decades, the US military no longer dominates the skies over battlefields. In the largest battle of the last decade—the fight to recapture Mosul from the Islamic State in 2016–17—the adversary was able to access and exploit the air domain closer to the ground, even as US and coalition warplanes flew unimpeded in the skies high above the battlefield. Small, cheap commercial drones loaded with light explosives—effectively, tiny bombers—killed or wounded dozens of Iraqi soldiers.¹ The enemy air threat became so serious it nearly brought the Iraqi offensive “to a screeching halt,” when, according to General Raymond Thomas, the US Special Operations Forces commander, the enemy’s drones were “right overhead and underneath our air superiority.”² Battlefields in Nagorno-Karabakh, Syria, Ukraine, Yemen, and elsewhere have seen combatants employ small, cheap unmanned aerial systems to combat an adversary’s advantages in the air.³

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1. Joby Warrick, “Use of Weaponized Drones by ISIS Spurs Terrorism Fears,” *Washington Post*, February 21, 2017, https://www.washingtonpost.com/world/national-security/use-of-weaponized-drones-by-isis-spurs-terrorism-fears/2017/02/21/9d83d51e-f382-11e6-8d72-263470bf0401_story.html.

2. David Larter, “SOCOM Commander: Armed ISIS Drones Were 2016’s ‘Most Daunting Problem,’” *Defense News*, May 16, 2017, <https://www.defensenews.com/digital-show-dailies/sofic/2017/05/16/socom-commander-armed-isis-drones-were-2016s-most-daunting-problem/>.

3. Don Ressler, *The Islamic State and Drones: Supply, Scale, and Future Threats* (West Point, NY: US Military Academy Combating Terrorism Center, 2018), <https://ctc.usma.edu/wp-content/uploads/2018/07/Islamic-State-and-Drones-Release-Version.pdf>; John Wendle, “The Fighting Drones of Ukraine,” *Air & Space Magazine*, February 2018, <https://www.airspacemag.com/flight-today/ukraines-drones-180967708/>; Ben Hubbard, Palko Karasz, and Stanley Reed, “Two Major Saudi Oil Installations Hit by Drone Strike, and U.S. Blames Iran,” *New York Times*, September 14, 2019, <https://www.nytimes.com/2019/09/14/world/middleeast/saudi-arabia-refineries-drone-attack.html>; and Tom Kington, “Libya Is Turning into a Battle Lab for Air Warfare,” *Defense News*, August 6, 2020, <https://www.defensenews.com/smr/nato-air-power/2020/08/06/libya-is-turning-into-a-battle-lab-for-air-warfare/>.

The airspace between ground forces and high-end fighters and bombers is quickly emerging as the more challenging and important contest for air control.⁴ Termed the air littoral, this airspace generally located below 10,000 feet is defined as the “area from the Coordinating Altitude to the Earth’s surface, which must be controlled to support land and maritime operations and can be supported and defended from the air and/or the surface.”⁵ Just as the emergence of the submarine, the self-propelled torpedo, and mines during the early-twentieth century added subsurface threats in the contest for sea control, small autonomous drones, low-flying missiles, and loitering munitions increasingly present a threat to air control from below the altitudes of conventional air superiority.⁶ Put simply, relatively cheap and easy-to-access technologies are exponentially increasing the number of actors with access to the air littoral and the military capabilities to dispute its control.⁷

Addressing this threat demands more than technological solutions; it requires a paradigm change in American military thinking about verticality. Adding a third dimension, that of vertical space, to conceive of both the air and land domains as volumes, we propose a three-dimensional concept of air control in time, planar distance, and altitude.

A volumetric concept of air control directs attention to critical differences between the “blue skies,” where high-end air assets typically operate, and the air littoral. Bringing the air war closer to the ground fight will not only resurrect past Army–Air Force disputes about service roles and missions, it will also place the Army and Air Force’s different concepts of control in conflict. Whereas the Army is more likely to strive for control of the air littoral through localized persistent occupation, the Air Force is likely to pursue control through responsive, if fleeting, presence. Adversaries are certain to exploit the gap between these differing

4. See Jules “Jay” Hurst, “Small Unmanned Aerial Systems and Tactical Air Control,” *Air & Space Power Journal* 33, no. 1 (2019): 19–33.

5. This definition draws from the Joint doctrinal definitions of the maritime littorals. See Joint Chiefs of Staff (JCS), *Joint Maritime Operations*, Joint Publication (JP) 3-32 (Washington, DC: JCS, 2018), I-5, https://www.jcs.mil/Portals/36/Documents/Doctrine/pubs/jp3_32pa.pdf.

6. Milan Vego, *Maritime Strategy and Sea Control: Theory and Practice* (New York: Routledge, 2016), 136–53.

7. See Thomas L. Friedman, *The Lexus and the Olive Tree: Understanding Globalization* (New York: Picador, 2000), 47–51.

concepts of control unless the US military moves quickly to close this conceptual seam.

Air Superiority

Air control centers on preventing *prohibitive* or *effective* interference with air, land, and maritime operations, thus securing the Joint force's freedom to maneuver and attack. Current Joint doctrine acknowledges differing levels of air control. These range "from no control, to a parity (or neutral situation) wherein neither adversary can claim any level of control over the other, to local air superiority in a specific area, to air supremacy over the entire operational area."⁸ Air forces typically aim to achieve at least air superiority, whether a theater-wide and enduring condition or one localized in time and geography for the achievement of mission-specific objectives.

Joint Publication JP 3-01, *Countering Air and Missile Threats*, defines air superiority as "that degree of control of the air by one force that permits the conduct of its operations at a given time and place without *prohibitive* interference from air and missile threats."⁹ The highest level of control of the air is air supremacy, wherein the enemy is "incapable of *effective* interference within the operational area using air and missile threats."¹⁰ For decades, the United States has attained air superiority, if not supremacy, in almost all of its military conflicts. Today, however, this superiority is no longer a given.

The Eroding Foundations of US Air Superiority

With the renewed emphasis on great-power competition, academic and policy debates have centered on whether the United States is losing its military-technological advantages.¹¹ While addressing high-end capabilities is important, these debates run the risk of missing how low-cost technological innovations will significantly alter the character of war. The democratization of technology—the declining costs of

8. See JCS, *Joint Air Operations*, JP 3-30 (Washington, DC: JCS, 2019), I-1, https://www.jcs.mil/Portals/36/Documents/Doctrine/pubs/jp3_30.pdf.

9. JCS, *Countering Air and Missile Threats*, JP 3-01 (Washington, DC: JCS, 2018), I-4, https://www.jcs.mil/Portals/36/Documents/Doctrine/pubs/jp3_01_pa.pdf. Emphasis added.

10. JCS, JP 3-01. Emphasis added.

11. Robert O. Work and Greg Grant, "Beating the Americans at Their Own Game: An Offset Strategy with Chinese Characteristics," Center for New American Security, June 6, 2019, <https://www.cnas.org/publications/reports/ beating-the-americans-at-their-own-game>; James Maynika and William H. McRaven, *Innovation and National Security: Keeping Our Edge*, Independent Task Force Report No. 77 (New York: Council on Foreign Relations, 2019); and James Johnson, "The End of Military-Techno Pax Americana? Washington's Strategic Responses to Chinese AI-Enabled Military Technology," *Pacific Review* 34, no. 3 (2019): 351–78, <https://doi.org/10.1080/09512748.2019.1676299>.

computing power and the Internet's global reach, along with the dual-use nature of many current and emerging technologies—have made airpower available to a much broader range of state and nonstate actors.¹² In the past, financial, organizational, technological, and scientific hurdles limited the development and employment of air forces to major powers.¹³ Today, however, commercial drones repurposed for military use offer an affordable entry point into the air domain. These simple-to-operate systems have placed advanced capabilities in the hands of any adversary for a few thousand dollars or less, while the Internet has given millions of people easy access to information about how to repurpose commercial drones for military applications.¹⁴

America's strategic competitors also seek to exploit these developments. Both Russia and China have made large investments in high-end, asymmetric capabilities for exploiting the air littoral in future fights—whether they are conducting proxy wars or large-scale conventional conflicts.¹⁵ In 2019, Russia announced plans to add more than 300 short-range drones annually to its already large fleet to outfit its ground forces with small, cheap drones armed with miniature bombs.¹⁶ In eastern Ukraine, since 2014, Russian-backed fighters have used multiple drones, flying at different altitudes over target areas, to spot for artillery.¹⁷ Similarly, the Chinese have begun to integrate smaller, tactical drones into their tactical firepower targeting and damage assessments.¹⁸ Most worrying for the United States is the potential curtailing of the military's

12. T. X. Hammes, "Technologies Converge and Power Diffuses: The Evolution of Small, Smart, and Cheap Weapons," *Cato Institute Policy Analysis*, no. 786 (2016); T. X. Hammes, "Cheap Technology Will Challenge US Tactical Dominance," *Joint Force Quarterly*, no. 81 (2016): 76–85; T. X. Hammes, *Deglobalization and International Security* (Amherst, NY: Cambria Press, 2019); Audrey Kurth Cronin, *Power to the People: How Open Technological Innovation is Arming Tomorrow's Terrorists* (New York: Oxford University Press, 2019); and Audrey Kurth Cronin, "Technology and Strategic Surprise: Adapting to an Era of Open Innovation," *Parameters* 50, no. 3 (2020): 71–84. See also Alexander Boroff, "What Is Great-Power Competition, Anyway?" Modern War Institute, April 17, 2020, <https://mwi.usma.edu/great-power-competition-anyway/>.

13. Sebastian Ritchie, *Industry and Air Power: The Expansion of British Aircraft Production, 1935–41* (London: Routledge, 1997); and Ferenc Á. Vajda and Peter Dancy, *German Aircraft Industry and Production, 1933–1945* (Warrendale, PA: SAE International, 1998).

14. Anne Stenerson, "The Internet: A Virtual Training Camp?," *Terrorism and Political Violence* 20, no. 2 (2008): 215–33; and Marcus Schulzke, "Drone Proliferation and the Challenge of Regulating Dual-Use Technologies," *International Studies Review* 21, no. 3 (2019): 497–517.

15. Tyrone L. Groh, *Proxy War: The Least Bad Option* (Stanford, CA: Stanford University Press, 2019); and Andreas Krieg and Jean-Marc Rickli, *Surrogate Warfare: The Transformation of War in the Twenty-First Century* (Washington, DC: Georgetown University Press, 2019).

16. Patrick Tucker, "Russian Troops Will Be Getting Tactical Bomb Drones," *Defense One*, July 2, 2019, <https://www.defenseone.com/technology/2019/07/russian-troops-will-be-getting-tactical-bomb-drones/158179/>.

17. Phillip A. Karber, "Lessons Learned from the Russo-Ukrainian War: Personal Observations," Historical Lessons Learned Workshop, sponsored by Johns Hopkins Applied Physical Laboratory & US Army Capabilities Center (July 8, 2015), 12–16.

18. Elsa Kania, *The PLA's Unmanned Aerial Systems: New Capabilities for a "New Era" of Chinese Military Power* (Montgomery, AL: China Aerospace Studies Institute, 2018), 3–16.

ability to provide effective support to US, allied, and partner ground forces from the skies above.

Contesting the Air Littoral

By combining old and new technologies in innovative ways, adversaries will vie for control of the air littoral. Clusters of technological breakthroughs in nanotechnology, additive manufacturing (3D printing), materials science, robotics, and quantum computing will allow the employment of numerous small, cheap, smart, and highly lethal weapons.¹⁹ Beyond the power of sheer numbers, swarms of autonomous systems could confer qualitative advantages against lower numbers of exquisite US weapon platforms.²⁰

Swarm attacks complicate defenses because these systems disperse across the battlespace, quickly massing at chosen moments to strike, before swiftly breaking off and dispersing until the next attack. As Paul Scharre explains, “rather than fighting against a formation,” the defender “faces an insuppressible collection of targets that are, seemingly, everywhere and nowhere at once.”²¹ For example, swarms of lethal miniature aerial munitions, also known as loitering munitions, might “mine” the airspace, lying in wait to collide with high-value US weapons systems, like fighter jets and bombers.²²

The mere threat of collision could be enough to deny that airspace to expensive fifth- or sixth-generation fighters, which would allow the enemy to access and exploit the airspace to conduct quick strikes against military bases, airfields, and logistical rear areas.²³ The low profiles and small signatures of these systems will also make them hard to detect and track,

19. Klaus Schwab, *The Fourth Industrial Revolution* (New York: Crown Business, 2016), 1; and Hammes, “Cheap Technology,” 77–80.

20. Christian Brose, “The New Revolution in Military Affairs: War’s Sci-Fi Future,” *Foreign Affairs* 98, no. 3 (May/June 2019): 122–34; and Paul Scharre, *Robotics on the Battlefield, Part II: The Coming Swarm* (Washington, DC: Center for New American Security, 2014), 16–18. See also John W. R. Lepingwell, “The Laws of Combat?: Lanchester Reexamined,” *International Security* 12, no. 1 (1987): 89–134.

21. Scharre, *Robotics on the Battlefield*, 29. See also Paul Scharre and Michael D. Horowitz, *An Introduction to Autonomy in Weapon Systems* (Washington, DC: Center for New American Security, 2015); M. L. Cummings, *Artificial Intelligence and the Future of Warfare*, research paper (London: Chatham House, 2017); Paul Scharre, *Army of None: Autonomous Weapons and the Future of War* (New York: W. W. Norton & Company, 2018); and Benjamin M. Jensen, Christopher Whyte, and Scott Cuomo, “Algorithms at War: The Promise, Peril, and Limits of Artificial Intelligence,” *International Studies Review* 22, no. 3 (2020): 526–50.

22. Leslie F. Hauck III and John P. Geis II, “Air Mines: Countering the Drone Threat to Aircraft,” *Air and Space Power Journal* 31, no. 1 (2017): 28; and Ashley May, “Drones Can Do Serious Damage to Airplanes, Video Shows,” *USA Today*, October 17, 2018, <https://www.usatoday.com/story/travel/nation-now/2018/10/17/drones-crashing-into-airplanes-quadcopters-damage-video/1657112002/>.

23. J. Noel Williams, “Killing Sanctuary: The Coming Era of Small, Smart, Pervasive Lethality,” *War on the Rocks*, September 8, 2017, <https://warontherocks.com/2017/09/killing-sanctuary-the-coming-era-of-small-smart-pervasive-lethality/>.

complicating defensive efforts.²⁴ China is actively pursuing such capabilities, having recently tested a swarm of 48 so-called “kamikaze drones” loaded with high-explosive warheads and launched from a truck and helicopter.²⁵ Possession of these capabilities is not limited to near-peer competitors. The commercial development of low-cost, lightweight advanced sensors and the spread of AI surveillance technology and small drones will place these systems within the reach of most combatants.²⁶

These threats will converge at the boundary between the ground and the blue skies, where high-end air assets typically operate, and transform what Giulio Douhet referred to as the “coastline of the air” into a “contested zone,” where adversaries can dispute control of the air.²⁷ This area of convergence and contestation constitutes the air littoral.²⁸

A New Paradigm in Air Superiority

To address these threats successfully, military planners must reconceptualize air control as a “volume rather than a flat bounded plane.”²⁹ In the past, control of the air was won or lost in the blue skies: obtaining superiority over the theater of operations generally amounted to control over all the altitudes. But air control was never absolute. For example, even after the Allies gained air superiority over Europe in 1944–45, the German Luftwaffe still managed to cause tactical problems for ground troops. The overall effect, however, was negligible.³⁰ US doctrine has traditionally reflected these realities, conceiving the degree of air control as a simple function of time and lateral space. Such characterizations are increasingly outmoded; control of the air littoral is rapidly decoupling from that of the blue skies.³¹ Accordingly, the concept of air control must evolve into a

24. Alexis C. Madrigal, “Drone Swarms Are Going to Be Terrifying and Hard to Stop,” *Atlantic*, March 7, 2018, <https://www.theatlantic.com/technology/archive/2018/03/drone-swarms-are-going-to-be-terrifying/555005/>.

25. David Hambling, “China Releases Video of New Barrage Swarm Drone Launcher,” *Forbes*, October 14, 2020, <https://www.forbes.com/sites/davidhambling/2020/10/14/china-releases-video-of-new-barrage-swarm-drone-launcher/?sh=3121d6892ad7>.

26. Steven Feldstein, *The Global Expansion of AI Surveillance* (Washington, DC: Carnegie Endowment for International Peace, 2019), <https://carnegieendowment.org/2019/09/17/global-expansion-of-ai-surveillance-pub-79847>.

27. Giulio Douhet, *The Command of the Air*, trans. Dino Ferrari (Washington, DC: Office of Air Force History, 1983), 17. The term contested zone comes from Barry R. Posen, “Command of the Commons: The Military Foundation of U.S. Hegemony,” *International Security* 28, no. 1 (Summer 2003): 22–24.

28. This definition draws from the Joint doctrinal definitions of the maritime littorals. See JCS, *Joint Maritime Operations*, JP 3-32 (Washington, DC: JCS, 2018), I-5, https://www.jcs.mil/Portals/36/Documents/Doctrine/pubs/jp3_32pa.pdf.

29. Alison J. Williams, “Reconceptualising Spaces of the Air: Performing the Multiple Spatialities of UK Military Airspaces,” *Transactions of the Institute of British Geographers* 36, no. 2 (2011): 256.

30. Thomas Hughes, *Over Lord: General Pete Quesada and the Triumph of Tactical Airpower in World War II* (New York: Free Press, 1995).

31. Hurst, “Small Unmanned Aerial Systems,” 28.

more complex understanding, as a volume, localized in time, equidistant plane, and altitude.³²

This reconceptualization shows the urgent need to modify the air tasking order. The 72-hour tasking and planning cycle of the Air Operations Center will be too slow and inflexible to define operations effectively in a highly dynamic environment. The increasingly contested air littoral will require closer cooperation and coordination at lower echelons of command across all services and forces, necessitating the delegation and dispersion of Air Operations Center and air tasking order responsibilities authorities.

Importantly, conceptualizing air control as a volume highlights critical differences between the blue skies and the air littoral in four key areas: vertical and temporal compression, airspace congestion, theater- and operational-level assessment and planning, and domain convergence. First, compared to the blue skies, the air littoral is a relatively narrow flight corridor, confined by terrain and other vertical obstacles posing unique operational challenges.³³ Flying at low altitudes places aircraft within range of ground-based attacks and renders them more vulnerable by restricting the field of vision and making it harder to detect incoming threats. Further, the compressed size of the littoral offers little reaction time, as the short vertical distances within the littoral critically reduce the window for deploying evasive countermeasures to battlefield threats, such as loitering swarms of mini-drones launched from backpacks.³⁴ Significantly, the high speeds and long-turn radii typical of fifth- and sixth-generation fighters and bombers reduce their maneuverability and agility in confined airspaces like the air littoral, rendering them less effective and thus exposing a critical gap in US air superiority.³⁵

Second, compared to the blue skies, the air littoral is a high-density threat environment. As US air assets fly at lower altitudes over enemy-held territories, the airspace will approximate an “aerial minefield.”³⁶ The small size and proximity of the airspace to the land domain will enable adversaries to mobilize and coordinate a defensive response, much as the maritime littoral confers a home-court advantage to coastal defenders. Operating in the air littoral will require US forces to maintain a constant, all-domain, and

32. JCS, *Joint Air Operations*, I-1.

33. JCS, *Joint Urban Operations*, JP 3-06 (Washington, DC: JCS, 2013), I-3, https://www.jcs.mil/Portals/36/Documents/Doctrine/pubs/jp3_06.pdf.

34. H. G., “Ruffling Feathers: Why Drones Could Pose a Greater Risk to Aircraft Than Birds,” *Economist*, January 26, 2018, <https://www.economist.com/gulliver/2018/01/26/why-drones-could-pose-a-greater-risk-to-aircraft-than-birds>.

35. Federal Aviation Administration, *Pilot's Handbook of Aeronautical Knowledge*, FAA-H-8083-25B (Oklahoma City, OK: US Department of Transportation, 2016), 14–41.

36. Posen, “Command of the Commons,” 22–30.

multidimensional state of alert.³⁷ Moreover, coordination challenges will intensify. Enemy threats and the increasing frequency with which other services, allies and partners, and commercial actors operate in and through the air littoral will complicate the operational environment. As the categorical distinction between unmanned aircraft and cruise missile vanishes, the military will need more than increasingly complicated procedural control measures for coordinating airspace control and joint fires support. Large numbers of manned and unmanned aerial systems will require real-time integration and deconfliction with numerous ground-based assets capable of massing large volumes of long- and mid-range fires. To better coordinate both tactical airspace and cross-domain fires, the United States may well need to expand the Joint Air-Ground Integration Center, including the Air Support Operations Center, down to the battalion or even company level.³⁸

Third, the absence of a fixed enemy order of battle will complicate theater- and operational-level assessment and planning. During the Cold War, the United States could build a reasonably accurate enemy order of battle and assume adversaries would become less effective over time as their capabilities degraded and they were forced to focus more on defense and rebuilding their capabilities. However, as adversaries begin to use 3D printing to regenerate small aerial drone and other weapons capabilities quickly and field them as fast as the rate of attrition, these assumptions will no longer hold. In this operating environment, a linear air superiority doctrine—the axiomatic belief in the need for a dedicated air superiority campaign to seize and maintain control of the skies before executing other missions—will be ineffective. Instead, the US air superiority paradigm must adapt to a real-time and localized model of air control, capable of achieving a protective bubble around ground forces and manned air assets at critical battlefield moments.

Finally, the air littoral, in traversing the air and land domains, increases interactions and interdependencies between those domains. Traditionally, each military service has focused on achieving dominance in its primary warfare domain. The Army sought to occupy and control territory through land actions, the Navy to command the high seas through fleet engagements, and the Air Force to gain air supremacy through offensive air operations. The challenge from the start was that no domain was wholly distinct from the others, such that each service sought to expand its reach into the other domains, albeit part of a single-domain orientation. The Army might use the air domain to employ

37. For a similar argument about the maritime littoral, see Yedidia Ya'ari, "The Littoral Arena: A Word of Caution," *Naval War College Review* 48, no. 2 (1995): 3.

38. Headquarters, Department of the Army (HQDA), *The Joint Air Ground Integration Center*, Army Techniques Publication (ATP) 3-91.1/Air Force Tactics Techniques Procedures (AFTTP) 3-2.86 (Washington, DC: HQDA, April 2019).

rockets and artillery to wear down an adversary's ground defenses. Similarly, the Air Force might attack enemy air bases and ground-based radar systems to suppress sortie generation.³⁹ Even as the concept of "jointness" was born to better coordinate such actions, the boundaries between the domains and the domain-centric service structures remained firmly intact.⁴⁰ The historical exception was the seam between the land and sea domains, where the Army and Navy meet in the maritime littorals, leading the Marine Corps to specialize in this trans-domain environment.⁴¹

The Army and Air Force adopted a different solution, based on differentiating the roles and missions of each service. As codified in the Key West Agreement, the Army retained organic air assets such as helicopters, surface-to-air missiles, and antiaircraft artillery, while the Air Force gained control of all strategic air assets and fixed-wing tactical air support.⁴² This uneasy compromise has often been a source of interservice friction. Increased interactions and interdependencies between the Army and the Air Force lay bare the fiction of domain separation in the air littoral. Although the solution is not a new Air Littoral Force, akin to the Marines in the maritime littoral, the Navy and Marine Corps concept of composite warfare has significant applicability to the air littoral, particularly as an alternative model for addressing Army–Air Force jurisdictional problems.⁴³

Vertical Reciprocity or Rivalry?

Exploiting the "vertical reciprocity" between the air and ground will confer significant operational and tactical advantages. But it is also certain to resurrect past Army–Air Force disputes about service roles, missions, and doctrine.⁴⁴ By exploiting the air littoral, land forces will be able to attack from multiple directions and threaten adversaries with vertical envelopment.⁴⁵ This ability to maneuver in the air littoral will increase the defensive challenge for ground forces, who will confront a "spherical challenge," with threats in both the horizontal and vertical

39. Everett Carl Dolman, *Pure Strategy: Power and Principle in the Space and Information Age* (New York: Frank Cass, 2005), 30–35.

40. William Dries, "Some New, Some Old, All Necessary: The Multi-Domain Imperative," *War on the Rocks*, March 27, 2017, <https://warontherocks.com/2017/03/some-new-some-old-all-necessary-the-multi-domain-imperative/>.

41. The authors thank Lieutenant Colonel Michael Kreuzer for suggesting this term.

42. Kenneth W. Condit, *History of the Joint Chiefs of Staff: The Joint Chiefs of Staff and National Policy, Volume 2 – 1947–1949* (Washington, DC: Office of Joint History, Office of the Chairman of the Joint Chiefs of Staff, 1996), 95–96.

43. Department of the Navy, *Composite Warfare: Maritime Operations at the Tactical Level of War*, Navy Warfare Publication (NWP) 3–56 (Washington, DC: Department of the Navy, December 2015).

44. Peter Adey, *Aerial Life: Spaces, Mobilities, Affects* (London: Wiley-Blackwell, 2010), 2.

45. George M. Dougherty, "Ground Combat Overmatch through Control of the Atmospheric Littoral," *Joint Forces Quarterly* 94, no. 3 (2019): 54–73; and Jules Hurst, "Robotic Swarms in Offensive Maneuver," *Joint Forces Quarterly* 87, no. 4 (2017): 105–11.

dimensions.⁴⁶ Brigadier General Walter T. Rugen, director of the US Army's Future Vertical Lift Cross Function Team, asserts the Army's exploitation of the "lower tier of the air domain" could well be "decisive" in future wars, allowing Army aviation to "hide in the clutter, show up at the time and place of our choosing to really create chaos in the enemy's decision cycle."⁴⁷

With adversaries seeking these same advantages, however, US ground forces may well come under aerial attack. US Air Force Chief of Staff General Charles Q. Brown Jr. reminds, "For decades, American, allied, and partner warfighters have felt safe with top cover and strategic deterrence our air forces have provided . . . These assumptions no longer hold true today."⁴⁸ An increasingly accessible and contested air littoral stands between the ground and the blue skies, threatening to eliminate effective Air Force top cover.

With US aircraft operating in the blue skies, the Air Force will become less responsive to the needs of land forces.⁴⁹ Anticipating this prospect, the Army has begun to expand its air and missile defenses, growing the number of short-range air defense battalions, adding missile-hauling Stryker vehicles, and assigning Stinger teams to support maneuver units.⁵⁰ At the same time, the Army seeks to develop long-range, land-based missiles, such as precision-strike missiles, long-range hypersonic weapons, and "Strategic Long-Range Cannon[s]."⁵¹ Every indication is that the Army seeks to operate in and contest the air littoral as a secondary line of effort to preserve freedom of movement. As the Army incorporates more

46. Kobi Barak, "The Sky is No Longer the Limit: The Need for a Ground Forces UAV Fleet and Multi-Dimensional Warfare Capabilities," *Dado Center Journal*, 11-12 (2017): 38–60, 40.

47. Garrett Reim, "US Army to Exploit Crucial Weaknesses in Russian, Chinese Air Defences," *Flight Global*, September 24, 2020, <https://www.flightglobal.com/helicopters/us-army-to-exploit-crucial-weakness-in-russian-chinese-air-defences/140311.article>.

48. Charles Q. Brown Jr., *Accelerate Change or Lose* (Washington, DC: US Air Force, 2020), 3, https://www.af.mil/Portals/1/documents/2020SAF/ACOL_booklet_FINAL_13_Nov_1006_WEB.pdf.

49. See Kamal J. Kaaoush, "The Best Aircraft for Close Air Support in the Twenty-First Century," *Air and Space Power Journal* 30, no. 3 (2016): 39–53, https://www.airuniversity.af.edu/Portals/10/ASPJ/journals/Volume-30_Issue-3/F-Kaaoush.pdf.

50. US Army, *Army Air and Missile Defense 2028* (Huntsville, AL: US Army Air and Missile Defense Integration Division, 2019), https://www.smdc.army.mil/Portals/38/Documents/Publications/Publications/SMDC_0120_AMD-BOOK_Finalv2.pdf; and Gary Sheftick, "Army Rebuilding Short-Range Air Defense," *Army News Service*, July 3, 2019, https://www.army.mil/article/224074/army_rebuilding_short_range_air_defense.

51. Sydney J. Freedberg Jr., "Army Building 1,000-Mile Supergun," *Breaking Defense*, October 11, 2018, <https://breakingdefense.com/2018/10/army-builds-1000-mile-supergun/>; and L. Neil Thurgood, "Hypersonics by 2023," *Army AL&T Magazine*, September 4, 2019, <https://asc.army.mil/web/news-alt-ond19-hypersonics-by-2023/>.

organic air assets, however, it will surely resurrect past disputes with the Air Force about service roles and missions.⁵²

More fundamentally, it will place the Army and Air Force's different concepts of control in conflict, specifically notions of persistent occupation versus responsive presence. Military theorists and practitioners have long recognized the land and air domains have different operational advantages and limitations. In the land domain, the primary objective is to conquer and control territory, with armies still the main instrument for achieving that end. Indeed, armies are unique from navies and air forces, in that they are the only service able to provide a permanent occupation force in their primary domain.⁵³ In the words of Clausewitz, armies can "stand fast, as it were, rooted to the ground." To be sure, armies still must move and maneuver—what Clausewitz termed "the essence of attack"—but terrain, topographical features, and logistical networks impose significant constraints on speed, mobility, and maneuverability.⁵⁴ Control of the land domain is thus a function of the persistent occupation of territory, conferring to the Army battlefield advantages while simultaneously denying adversaries freedom of movement across the same ground.

In contrast, the Air Force concept of control in the air domain centers on responsive presence, not persistent occupation. Unlike armies, air forces cannot live in their primary domain, as aircraft and crews must eventually land to rest, refuel, and refit; the occupation of airspace may occur for a time, but it is ephemeral.⁵⁵ What airpower offers instead are rapid and lethal presence and the ability of aircraft and other airborne systems to bypass terrain that would otherwise impede the movements of ground forces for the quick delivery of effects across great distances.⁵⁶ Control of the air domain is thus mainly a function of the ability of air forces to access and

52. Valerie Insinna, "Air Force General Says of Army's Long Range Precision Fires Goal: 'It's stupid,'" *Defense News*, April 2, 2021, <https://www.defensenews.com/air/2021/04/02/air-force-general-says-of-armys-long-range-precision-fires-goal-its-stupid/>; Robert Brown, "AUSA Fires Back at Air Force: Long-Range Missiles Aren't 'Stupid,'" *Breaking Defense*, April 6, 2021, <https://breakingdefense.com/2021/04/ausa-fires-back-at-air-force-long-range-missiles-arent-stupid/>.

53. Julian S. Corbett, *Some Principles of Maritime Strategy*, reprint (Annapolis, MD: US Naval Institute Press, 1988), 16.

54. Clausewitz, *On War*, 285.

55. Phillip S. Meilinger, "Ten Propositions about Airpower" (student paper, Washington, DC: Air University, 1995), 2.

56. Douhet, *Command of the Air*, 7–9.

exploit the domain at a required time and place while denying those same advantages to the adversary.⁵⁷

These differing Army and Air Force concepts of control will inevitably come to the fore as the air littoral grows more congested and contested. Put simply, in responding to the threat, the Army is more likely to strive for control of the air littoral through localized persistent occupation, while the Air Force is more likely to pursue control through rapid presence to provide time-bound denial and fires. Thus, the Army is likely to expand its organic air defense capabilities to create a persistent air umbrella over its ground forces. By deploying drone swarms as an occupying force in the air littoral, the Army could gain localized air superiority and persistent aerial cover. General Kobi Barak, the former chief of Israeli Defense Force's ground forces, envisions "a type of mission-specific Iron Dome that could provide tactical protection for assembly areas, for forces preparing for an assault and for forward command centers and others."⁵⁸ A continuous aerial umbrella could also create kinetic and non-kinetic effects from the air, including persistent close-air support for ground forces.

Indeed, the Army is urgently developing a future system, Air-Launched Effects, which will launch swarms of mini-drones to blanket the battlefield with lethal and nonlethal fire.⁵⁹ Short of the Air Force ceding the air superiority mission in the air littoral to the Army, the growing mission overlap will cause a clash of air-centric and land-centric concepts of control. Closing this seam before adversaries can exploit it is imperative. The future contested environment demands the development of novel operational concepts.

Conclusion

This new and unprecedented littoral challenge to US air superiority calls for more than technological solutions. It requires a profound paradigm change in US military thinking about the air domain. To this end, we propose the US military update concepts of air control to account for a third dimension, that of vertical space, thus localizing air control in time, lateral space, and altitude. This reconceptualization directs attention to critical differences between the blue skies and the air littoral, including

57. JCS, *Joint Air Operations*, I-I.

58. Barak, "Sky No Longer the Limit," 41.

59. Jared Keller, "The Army Is Going All In on a Drone Swarm to Back Up Its Next-Generation Helicopters," *Task and Purpose*, August 25, 2020, <https://taskandpurpose.com/news/army-drone-swarm-air-launched-effects-contracts/>.

temporal and spatial compression, airspace congestion, theater- and operational-level assessment and planning, and domain convergence. With the air littoral traversing the air and land domains, the Army and the Air Force urgently need to close the gap between air-centric and land-centric concepts of control.

The first requirement should be the development of a roles and missions commission to conduct a comprehensive review of existing service roles and missions. The 1948 Key West Agreement (defining roles and missions) and the 1986 Goldwater-Nichols Department of Defense Reorganization Act (delineating service and regional combatant command responsibilities) helped contain interservice rivalry and built jointness. These roles and mission compromises, however, are increasingly misaligned with the emerging trans-domain operational environment. The commission should focus on capability gaps and battlespace seams associated with zones of domain convergence, such as the air littoral, and better delineation of responsibilities for long-range fires, air defense, and cross-domain command, coordination, and control.

The second requirement should be the development of Joint doctrine for the air littoral. Military leadership should clearly identify different types of air littoral operations and schemes of vertical maneuver and explore new organizational structures based on functional commands, such as composite warfare. Presently, the services are focused on technological solutions, specifically countering unmanned aerial systems. Gaining a competitive advantage in the air littoral, however, will also require reconciling the Army and Air Force's different concepts of control—whether the air littoral requires persistent occupation or a responsive presence capable of achieving localized air superiority at critical battlefield moments.

Above all, both services must think more vertically. For nearly four decades, both services have primarily concentrated on the horizontal plane or the lateral distance from the enemy. Recent discussions of the anti-access and area-denial challenge in the Indo-Pacific region follow a similar pattern.⁶⁰ The contemporary operating environment, however, requires an expanded multidimensional framework. The anti-access and area-denial threat aims to push American power projection forces outside their combat effective ranges, both laterally and vertically. The

60. Stephen Biddle and Ivan Oelrich, "Future Warfare in the Western Pacific: Chinese Antiaccess/Area Denial, U.S. AirSea Battle, and Command of the Commons in East Asia," *International Security* 41, no. 1 (2016): 7–48.

democratization of the air littoral represents the core vertical challenge, as it significantly expands the battlespace from the US and allied perspective.

For ground forces, the close battle now includes not only the area immediately in front of ground troops, but also the area immediately above them. Similarly, the deep battle is the area well ahead and well above the most forward-deployed ground forces. For air operations, the fundamental challenge is no longer rapidly closing the distance to conduct effective operations; it is vertical mobility and cross-domain fires. Visualizing either the ground or air fights laterally is no longer adequate. The military services must develop a new Joint all-domain framework grounded in both horizontal and vertical spaces.

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