Future Air Battles Envisioned by China

What Is the People's Liberation Army Learning from the Russo-Ukrainian War?

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Chapter 2

War with New and Old Characteristics

Fighter jets flying in formation with an aerial refueling aircraft (VCG/Getty Images)

The Russo-Ukrainian War, initiated on February 24, 2022, has run contrary to most expectations. Russia, a military power, has struggled to gain the upper hand against Ukraine, and the conflict has turned into a war of attrition. It is generally understood that in modern warfare the success or failure of the initial air battle largely influences the subsequent course of the war. Indeed, the inability of the Russian Aerospace Forces (Vozdushno-Kosmicheskiye Sily, VKS) to gain the necessary control of the air[1] had consequences for the Russian military's overall operations.[2] VKS aircraft were shot down in large numbers and continued to take losses, due in part to aviation accidents of their own causing.[3] Furthermore, a series of incidents have revealed a lack of coordination within the Russian military, including the downing of aircraft by Russian surface-to-air missiles (SAMs) in friendly fire[4] and the accidental bombing of the Russian city of Belgorod by an Su-34 fighter-bomber.[5] The notably poor performance of the VKS has been attributed to a complex combination of factors, including a limited military budget, outdated weapons, insufficient pilot flight hours, low

1) According to the latest U.S. Air Force doctrine, air superiority is "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" (U.S. Air Force, *Air Force Doctrine Publication 3-01: Counterair Operations* (June 15, 2023)). The VKS has succeeded in a partial air invasion of Ukraine and gained air superiority temporarily. It is in this context that the wording, "necessary control of the air," is used. In this article, the terms "control of the air" and "air superiority" are distinguished in conformity with the U.S. Air Force doctrine. See Yanagida Osamu, "'Control of the Air' and 'Air Superiority' in the American Military," *Briefing Memo* (June 2020).

2) Aita Moriki, "China's Perspective on the Use of Russian Airpower: What Lessons Is the People's Liberation Army Learning from the Air Battle in Ukraine?," *NIDS Commentary* (June 22, 2023).

3) Phil Stewart and Idrees Ali, "What Happened to Russia's Air Force? U.S. Officials, Experts Stumped," Reuters, March 2, 2022.

4) Joe Barnes, "Downed Russian Jets 'Almost All' Taken Out by Kremlin's Own Air Defence," *The Telegraph*, December 30, 2022; "Friendly Fire: Russian Air Defense Strikes Own Helicopters Down," Defense Express, May 13, 2023.

5) Mary Ilyushina, "Russia Bombed Its Own City, Defense Ministry Says," *Washington Post*, April 21, 2023.

operational readiness of aircraft, uncoordinated command, and a shortage of precision-guided weapons.[6]

The war began to fall into a stalemate in early 2023, with the VKS unable to gain the "necessary control of the air," and also with the defending Ukrainian Air Force (UkAF) unable to maintain full control of the air.[7] On why neither forces can gain or maintain control of the air, General James Hecker, commander of U.S. Air Forces in Europe, explains, "The problem is both of the Russian as well as the Ukrainian success in integrated air and missile defense (IAMD) have made much of those aircraft worthless."[8] As a result of the two armies' SAMs being crowded together in the war zone, aircraft from both armies are having difficulty entering the airspace.

In light of these air battles in the war in Ukraine (hereinafter, "the air battle in Ukraine"), there has been a debate in the United States about the nature of air battles. Those who attach importance to conducting joint operations while gaining air superiority explain that the conditions of the Ukrainian theater are unfavorable for achieving air superiority. Conversely,

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6) Justin Bronk et al., "The Russian Air War and Ukrainian Requirements for Air Defence," Royal United Services Institute, November 7, 2022; Mykola Oleshchuk, Viacheslav Shamko, and Artem Antonov, "Air Power in the Russian-Ukraine War: Myths and Lessons Learned," *The Journal of the JPACC* (February 2023); Rafael Ichaso, "Russian Air Force's Performance in Ukraine: Air Operations: The Fall of Myth," *The Journal of the JPACC* (February 2023); Aita Moriki, "Digital Transformation of the Chinese Air Force: Initiatives Observed in the PLAAF's Introduction of a New Maintenance Management System," *Security & Strategy*, no. 4 (January 2024), 89–108.

7) In a situation where Ukraine has not completely lost control of the air, stating that Ukraine has been unable to maintain air superiority would be inappropriate, and therefore, the phrase "control of the air" is used. According to the U.S. Air Force doctrine, air superiority is achieved outside one's control of the air, such as over international waters that is no one's territory and enemy-controlled airspace. Stating that "Ukraine is unable to gain air superiority" over its own territory is inappropriate as long as Ukraine retains a certain degree of control of the air (U.S. Air Force, *Air Force Doctrine Publication 3-01: Counterair Operations*). In Japan, however, "air superiority" has been explained to mean "control of the air" by Defense Agency Director General Nakasone Yasuhiro at the Diet in 1970, causing complications in understanding these concepts (Response by Defense Agency Director General Nakasone Yasuhiro, 63rd Diet session, House of Representatives plenary session, no. 13 (March 26, 1970) https://kokkai.ndl.go.jp/simple/detail?minId=106305254X01319700326&spkNum=33#s33). At the time, "control of the air" was associated with offensive operations surpassing operations for exclusive self-defense ("Seiku- seikai-ken wo kakuritsu" [Establishing control of the air and sea], *Asahi Shimbun*, March 18, 1970).

8) Christopher Woody, "Fighter Jets Are 'Worthless' over Ukraine, and It's a Sign of What US Pilots and Troops May Face in Future Battles," Business Insider, March 17, 2023.

those who emphasize denying air superiority to the enemy argue for the layered deployment of SAMs to build a robust IAMD system.[9] Araki Jyunichi, a former lieutenant general of the Japan Air Self-Defense Force, while explaining the debates unfolding in the United States, critiques the latter argument for using the word "deny" inappropriately, noting that the act of denial should not be compared with or discussed along the same lines as air superiority, which indicates the level of advantage. Araki posits that a fundamental understanding of air superiority and similar concepts is needed to accurately understand and draw lessons from the air battle in Ukraine.[10]

As one can easily imagine, such discussions related to the air battle in Ukraine are becoming increasingly controversial, especially among military officials from around the world. What about the Chinese People's Liberation Army (PLA)? What are its views, and what has it been discussing? How would the lessons drawn by the PLA impact the prevailing air force strategy of "integrating air and space capabilities as well as coordinating offensive and defensive operations" [空天一体, 攻防兼备]? The opinions of PLA experts on these questions could potentially be reflected in strategies and tactics of future warfare. Therefore, they carry more weight than comments by Chinese diplomats and others on the war in Ukraine. However, articles in the PLA's official newspaper, the *PLA Daily*, frequently use vague language and avoid references to specific terms, making it challenging to extract explicit lessons on the Russo-Ukrainian War.

Yet, by deepening our understanding of the air battle in Ukraine, examining the content of these Chinese sources, reading them in conjunction with global trends, and inferring what is missing by supplementing it with Western arguments, it is possible to read the lessons that the experts of the PLA are trying to convey to all the generals through the *PLA Daily*. The insights of PLA experts could eventually influence China's military buildup and, by extension, have rippling effects on the security environment in East Asia, particularly around the Taiwan Strait.

This article illustrates China's vision for future air battles by illuminating the perspectives held and arguments presented by Chinese military experts

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9) Maximillian K. Bremer and Kelly A. Grieco, "Air Denial: The Dangerous Illusion of Decisive Air Superiority," Atlantic Council (August 2022).

10) Araki Jyunichi, "Reiwa jidai no 'koku yusei' wo kangaeru" [An examination of "air superiority" in the Reiwa era], *Gunji Kenkyu* 59, no. 1 (January 2024): 90–101.

and officials on the air battle in Ukraine. This research primarily draws on the insights of air force members and other experts from China, the United States, the United Kingdom, and Ukraine, and is based on a review of mainly Chinese sources, statements made by Chinese military members, and PLA literature. The situation of the Russo-Ukrainian War was examined by carefully reading materials from the National Defence University of Ukraine to discern the overall progression of the conflict, supported by media reports as needed.

The Air Battle Previously Envisioned by the PLA

A Forward-Looking Air Force Strategy—"Integrating Air and Space Capabilities as well as Coordinating Offensive and Defensive Operations"

The Gulf War, particularly Operation Desert Storm launched in January 1991 by the U.S. forces-led coalition, had a critical impact on Chinese military strategy. The U.S. military's airpower, notably, high-tech weapons such as the F-117 stealth attack aircraft, precision-guided munitions (PGMs), and Tomahawk cruise missiles, inflicted heavy damage on Iraqi forces. Shocked by the U.S. military's overwhelming airpower, Jiang Zemin, chairman of the Central Military Commission (CMC), instructed the development of high-tech airpower. In 1999, he proposed transforming China's air force from a homeland air defense type into one capable of offensive and defensive operations. Since then, the PLA has continued to study future air battles and began to build up airpower for penetrating enemy air defenses effectively and destroying enemy bases and operational infrastructure.[11] In 2004, the PLA officially approved the "integrating air and space capabilities as well as coordinating offensive and defensive operations"[12] strategy that calls for the

11) 田越英 [Tian Yueying] and 王建华 [Wang Jianhua], "江泽民空军军事思想" [Jiang Zemin's military thought on the Air Force], 中国空军百科全书 [China Air Force Encyclopedia], vol. 1 (Beijing: Aviation Industry Press, 2005), 15.

12) It was not until 2015 that this phrase appeared in China's defense white paper (State Council Information Office of the People's Republic of China, 中国的军事战略 [China's military strategy], 中国政府网 [China Government Net] (May 2015)).

integration of the air force and space development.[13] The approval of an independent air force strategy in the Army-dominated PLA owes in part to the promotion to CMC member of Qiao Qingchen, the ninth commander of the PLA Air Force (PLAAF), in 2002, which enabled the PLAAF to express its views more easily than ever before.[14]

By 2005, Zhang Jiali and Min Zengfu at PLAAF Command College began asserting the indispensable role to be played by both airpower and space assets in air operations of future local wars conducted under informationized conditions. In anticipation of future air battles using anti-satellite weapons and fighter jets to disrupt, degrade, and destroy the enemy's space assets in a contest for "control of the air" and "control of the space," Zhang and Min advocated for the development of an "integrated air and space operations system" comprised of assets, such as lasers, directed energy weapons, stealth aircraft, drones, precision-guided weapons, and missile interception systems launched from land, sea, and air platforms.[15] At the Air Force Engineering University, Cai Fengzhen and Deng Pan similarly made the argument that the air force and space development are interconnected, and therefore, their integration is essential for future air battles.[16]

In this way, there was widespread discussion about the need to closely link together traditional airpower and space assets. However, this discourse did not develop into broader discussions about space operations and remained limited in scope. As evidence of this, *The Science of Integrated Air and Space Operations*, a PLA doctrine textbook published in 2006, focuses little on anti-space systems, with most of the content devoted to electronic warfare and traditional airpower.[17]

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13) 尚金锁 [Shang Jinsuo], 空军建设学 [Study of Air Force construction] (Beijing: PLA Press, 2009), 551–552.

14) Michael S. Chase and Cristina L. Garafola, "China's Search for a 'Strategic Air Force'," *Journal of Strategic Studies* 39, no. 1 (2016): 8–9.

15) 张加礼 [Zhang Jiali] and 闵增富 [Min Zengfu], "试论局部战争的空中化" [On extending regional war into the air and space], 中国军事科学 [China Military Science] 18, no. 1 (2005): 37–41.

16) 蔡风震 [Cai Fengzhen] and 邓攀 [Deng Pan], "空天战场与国家空天安全体系初探" [Exploration into air-space battlefields and national air-space security system], 中国军事科学 [China Military Science] 19, no. 2 (2006): 44–51.

17) 蔡风震 [Cai Fengzhen] and 田安平 [Tian Anping], 空天一体作战学 [The science of integrated air and space operations] (Beijing: PLA Press, 2006), 158–172.

Thus, while there are extensive narratives attempting to outwardly explain the air force strategy of "integrating air and space capabilities as well as coordinating offensive and defensive operations,"[18] these discussions are no more than "concepts" and do not delve into concrete operational matters, such as the actual conditions under which integrated air and space capabilities would be employed. The narratives did not detail concrete operational plans like those of the air forces of Western countries, and merely expressed the "posture" of the PLAAF that should be adopted in preparation for future warfare.

From "Integrated Air and Space Operations" to "Intelligentized Warfare"

Around the same time that the air force strategy of "integrating air and space capabilities as well as coordinating offensive and defensive operations" was approved in 2004, a new concept called "Integrated Joint Operation" (IJO) was introduced across all PLA services. Subsequently, the IJO discourse also began to explore how capabilities should be integrated across the PLA's services to perform operations in the space, cyberspace, and electromagnetic domains. Alongside IJO, its supporting concept of "information system-based systemic operational capability" was presented, under which "necessary capabilities," such as "integrated firepower strike capability," were defined in detail. Such capability-based military buildup continued to be considered, and eventually, the PLA came to emphasize "System of systems confrontation."[19]

In response to these trends, the PLAAF has also undergone a series of transformations: from mechanized to information-oriented, from a territorial air defense type air force to an offensive and defensive type air force, from an air force based on airpower to one integrating airpower and space capabilities, and from an air force that emphasizes "quantity" to one that emphasizes "quality."[20] Prioritizing alignment with the IJO concept, the PLAAF came to identify this concept as a critical component in the tactical

18) 薰文先 [Li Wenxian], 现代空军论 [Discussion on modern air forces] (Beijing: Lantian Publishing, 2005), 244–246.
19) Sugiura Yasuyuki, *China Security Report 2022: The PLA's Pursuit of Enhanced Joint Operations Capabilities*, English edition (Tokyo: NIDS, 2021), 12–19.
20) 蔡 and 田, 空天一体作战学, 2.

framework of "integrated air and space operations." Notably, however, the 2009 PLA doctrine textbook, *Study of Air Force Construction*, which explains "integrating air and space capabilities as well as coordinating offensive and defensive operations," lacks any mention of drones in the context of this strategy. In other words, as of 2009 when the doctrine was published, the PLA had not yet developed concrete ideas on the use of drones in operations.[21]

The understanding of this definition of "integrating air and space capabilities" [空天一体] has remained different according to various sources.[22] Among them, Kevin Pollpeter cites a PLA expert's following definition: "air forces, structure, and operational activities integrating aviation and space, air defense and space defense." According to this definition, "integrated air and space operations" envisioned by China refer to integrating airpower with space assets, such as satellites, orbital space stations, and spacecraft, in order to conduct simultaneous offensive and defensive operations using not only aircraft, cruise missiles, and ballistic missiles, but also a range of new concept weapons, including various types of SAMs, high power lasers, high power microwave weapons, and particle beam weapons.[23]

As the above definition illustrates, "integrated air and space operations" envisioned by the PLA anticipated air battles utilizing a variety of weapons, but the specific usage of drones remained unclear. Meanwhile, the prototype of the Wing Loong series of drones was unveiled at the China International Aviation & Aerospace Exhibition (Zhuhai Airshow) in 2004 and the prototype of the Cai Hong series of drones at the Zhuhai Airshow in 2006. These drones were improved to enable reconnaissance and strike missions via remote control using satellite communication. They were not only exported, mainly to the Middle East and Africa, but also rapidly introduced to the PLA.[24]

By 2017, along with emphasizing the significance of the military reforms over the previous five years, CMC Chairman Xi Jinping called for the enhancement of "joint operation capabilities based on network information

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21) 尚, 空军建设学, 537–559.
22) 薰, 现代空军论, 244–246.
23) Kevin Pollpeter, "The PLAAF and the Integration of Air and Space Power," in *The Chinese Air Force: Evolving Concepts, Roles, and Capabilities*, ed. Richard P. Hallion, Roger Cliff, and Phillip C. Saunders (Washington, DC: National Defense University Press, 2012), 165–190.
24) Aravind Levakumar, *Jane's All The World's Aircraft 2020/2021 Unmanned* (London: IHS Markit, 2020) 24–30, 33–35.

system" and "all domain operations capabilities." This "joint operation capabilities based on network information system" was introduced in *The Science of Military Strategy 2017*, edited by the PLA National Defense University, as an alternative to the "information system-based systemic operational capability" and became a new capability concept to support the IJO.[25] The operations under this capability concept are characterized by an emphasis on precision, stealth, and unmanned operations and attaining information dominance, and by the achievement of strategic goals through short decisive wars based on IJO.[26] In line with the strategic directive of "integrating air and space capabilities as well as coordinating offensive and defensive operations," the PLAAF built up strategic early warning capabilities necessary for nuclear deterrence[27] and rapidly modernized capabilities in missile defense, air operations, and strategic power projection.[28]

By 2019, China began to shift toward "intelligentized warfare," recognizing that the military application of advanced science and technologies, such as artificial intelligence (AI), quantum technology, big data, cloud computing, and the Internet of Things (IoT), would dramatically alter the security environment.[29]

China's Perceived Challenges of Modern Air Battle

The VKS's Failure to Gain Control of the Air in the Air Battle in Ukraine

In the Russian invasion launched in the early hours of February 24, 2022, Moscow's concept of operations was to employ special forces to eliminate Ukraine's political leadership in the capital of Kyiv, while invading forces

25) Sugiura, *China Security Report 2022*, 24–29.
26) Ibid.
27) 闻洪工 [Wen Honggong] and 薰玉江 [Xun Yujiang], 信息时代的空天防御 [Aerospace defense in the information age] (Beijing: Lantian Publishing, 2013), 17–26.
28) State Council Information Office of the People's Republic of China, 新时代的中国国防 [China's national defense in the new era] (Beijing: Foreign Languages Press, 2019), 7–10.
29) Sugiura, *China Security Report 2022*, 26–31.

drew the Ukrainian military's ground forces to the east and southeast.[30] The VKS was tasked with degrading Ukraine's air defense capabilities and gaining control of the air.[31] Nevertheless, at the outset, the VKS did not actively employ tactics such as electromagnetic attacks to disrupt UkAF radars, nor did it use drones as decoys to identify the locations of UkAF SAM launchers.[32] The VKS used fighter-bombers and long-range cruise missiles to strike approximately 100 UkAF air defense-related facilities from multiple directions, including air force bases, radars, SAM launchers, anti-aircraft batteries, and command-and-control systems.[33] Furthermore, the VKS was unable to promptly locate the dispersed Ukrainian air defense forces, revealing Russia's poor battle damage assessment (BDA) capabilities.[34] That being said, as Ukraine's air defense forces were also in disarray, for a while only the UkAF's fighter jets were used for interception operations.[35] In the VKS's air invasion, combat aircraft averaged about 140 sorties per day, penetrating into Ukrainian territory to depths of roughly 150 nautical

30) David A. Deptula and Christopher J. Bowie, "The Significance of Air Superiority: The Ukraine-Russia War," Mitchell Institute Policy Paper 50, 4.

31) Ibid.

32) Mykhalo Zabrodskyi, Jack Walting, Oleksandr Danylyuk, and Nick Reynolds, *Preliminary Lessons in Conventional Warfighting from Russia's Invasion of Ukraine* (London: RUSI, 2022), 29–33.

33) National Defence University of Ukraine, *Lessons Learned of Russian-Ukrainian War* (Ministry of Defence of Ukraine, 2023), 99.

34) Because the UkAF had dispersed its aircraft shortly before the war broke out, the majority of its aviation and air defense forces were able to survive the initial attacks by the VKS (Zabrodskyi et al., *Preliminary Lessons in Conventional Warfighting from Russia's Invasion of Ukraine*, 21).

35) While the intercepting Ukrainian side fielded approximately 50 MiG-29 fighter jets, 32 Su-27s, and around 40 aircraft, such as the Su-24 and Su-25 attack aircraft, it was a much smaller and less capable force compared to Russia's (刘杨 [Liu Yang], "从俄乌冲突看: 乌空军战力" [Seen from Russia's invasion of Ukraine: Ukrainian air power], 航空知识 [Aerospace Knowledge], no. 621 (January 2023): 50–51); The UkAF fighter jets responded immediately and intercepted VKS aircraft advancing at high altitudes. However, due to the hasty dispersal of Ukrainian air defense forces, the UkAF was unable to conduct systematically coordinated air defense in the initial phase of the conflict (Deptula and Bowie, "The Significance of Air Superiority," 4).

miles (approximately 280 km) at medium altitudes.[36] However, the VKS entered in formations of no more than one to six aircraft each time. Never were they large-scale invasions by numerous aircraft like those of the U.S. military during the 1991 Gulf War. Ground attacks consisted mainly of unguided bomb and rocket strikes launched from Su-25 fighter-bombers.[37] In the early stages, the Russian forces attempted to gain control of Antonov Airport north of Kyiv, but several VKS transport aircraft carrying airborne forces were shot down. While some assault forces managed to land at the airport, the Ukrainian Army had preemptively destroyed the runway, preventing follow-on transport aircraft from landing. Moreover, the VKS did not provide air cover for the airborne forces that had landed at the airport. The isolated assault forces were mopped up by the Ukrainian Army and annihilated within a few days.[38]

From the start of the war, the VKS, with its overwhelming airpower, was assumed to swiftly gain control of the air. However, three days into the conflict, the VKS had only managed to gain temporary and localized air superiority, falling short of gaining the "necessary control of the air."[39] Although systematic air invasions by the VKS gradually declined, it continued isolated air operations as the Russian forces advanced toward Kyiv. The VKS began to terminate systematic air invasions because the decapitation strike had failed. Subsequently, Russian ground battles were bogged down, and the VKS was called upon to provide immediate air cover. This forced a

36) During the first three days of the conflict, Russian fighter jets, such as the Su-35 and Su-30, conducted combat air patrol (CAP) at medium altitudes to provide cover for attack aircraft, shooting down UkAF aircraft, including the MiG-29, Su-27, Su-24, and Su-25. As the threat posed by Russia's advanced SAMs and Su-35s increased, the UkAF was gradually forced to shift to low-altitude operations in order to evade these threats (刘, "从俄乌冲突看: 乌空军战力," 53–54).

37) 曹励云 [Cao Liyun], "教训与启示: 俄罗斯军事问题专家姜永伟谈俄乌沖突空防武器系统应用" [Lessons and insights: Jiang Yongwei, an expert in Russian military issues, discusses the application of air defense weapons systems in Russia's invasion of Ukraine], 现代兵器 [Modern Weaponry], no. 534 (October 2023): 26–31.

38) "俄乌冲突一周年, 暴露了哪些问题? 金一南解读" [What issues have been exposed on the first anniversary of the Russia-Ukraine conflict? Jin Yinan explains], 上观新闻 [Shanghai Observer], February 24, 2023.

39) Air superiority is achieved by aircraft and missiles to provide a temporary advantage to carry out a specific operation and is not the objective of an operation (U.S. Air Force, *Air Force Doctrine Publication 3-01*).

shift in VKS policy from prioritizing control of the air, to providing close air support (CAS) while gaining localized air superiority.[40]

Even under these circumstances, the VKS conducted repeated missile strikes against the UkAF's radars, bases, and infrastructure to break through Ukraine's integrated air defense system (IADS).[41] The VKS may have gained air superiority had it continued its offensive counter air (OCA) operations. However, the VKS had been unable to conduct effective suppression of enemy air defenses (SEAD) operations. Nor was it capable of performing BDAs swiftly. Above all, VKS pilots lacked sufficient flight training. As a result, they were not trained to carry out air invasions in multi-aircraft formations, making it impossible to sustain large-scale air operations.[42]

The PLA Revisited the Definition of "Control of the Air"

PLA-affiliated media remained silent on the Russo-Ukrainian War for some time after its outbreak. But, from May 2022, they began to frequently publish commentaries that seemed mindful of the air battle in Ukraine. One was a *PLA Daily* commentary from May 12, which hinted that the concept of control of the air was under reconsideration.[43] Derek Solen at the China Aerospace Studies Institute (CASI) of the U.S. Air Force suggested that China was reconceptualizing its definition of control of the air to conform to the U.S. Air Force doctrine, which classifies control of the air into three states: parity, air superiority, and air supremacy.[44] The same *PLA Daily* commentary emphasizes that the means of gaining control of the air are evolving from a single-domain air battle to multi-domain joint operations.[45] As these signs of reconceptualization indicate, China is believed to be independently reviewing its concepts of control of the air and air superiority and optimizing operational blueprints. The concepts appear to be modeled on the U.S. Air Force doctrine, which has been revised based

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40) Deptula and Bowie, "The Significance of Air Superiority," 5.
41) Particularly in the northern areas around Kyiv, the VKS launched anti-radiation missile strikes from the Su-35S and limited strikes employing PGMs from the Su-24.
42) Aita, "China's Perspective on the Use of Russian Airpower."
43) 柴山 [Chai Shan], "飞掠百年, 制空权有何新变化" [A century in flight: What's new in the evolution of control of the air?], 解放军报 [PLA Daily], May 12, 2022.
44) Derek Solen, "The PLA Reconceptualizes Control of the Air," *China Brief 23*, no. 13 (July 2023).
45) 柴, "飞掠百年, 制空权有何新变化."

on extended missile ranges and the characteristics of space, cyberspace, and electromagnetic domains in a multi-domain environment.

The *PLA Daily* commentary then depicts the air battle in Ukraine as follows. The era of securing absolute control of the air is over. In the modern era, the advent of advanced aircraft and SAMs has fragmented the battlespace, triggering competition in each altitude block. The emergence of armed helicopters and "low-altitude, low-speed, and small-sized" drones has accorded importance to low altitudes equivalent to the "height of trees," and air defense systems to counter them have become multilayered with various engagement ranges. In struggles for control of the air under these circumstances, actions must be taken hierarchically, from long to short range and from high to low altitudes. Even if an enemy's air defense systems are destroyed, its mobile field air defense systems and man-portable air defense systems (MANPADS) remain significant threats, as demonstrated by the recent localized wars abroad. With the advent of the information era, struggles for control of the air employ long-range precision strike systems; space-, cyber-, and electromagnetic-based systems; drones; and cognitive domain weapons. New means are emerging, such as attacks from outside the enemy's range, exploiting blind spots in air and space, network blackout, missile warfare, electromagnetic suppression, cyberattacks, drone swarms, and cognitive warfare. The commentary explains that in informationized and intelligentized wars, it is essential to formulate systematic operation plans that take into account the characteristics of each altitude range in the theater and to carry out more targeted suppression. It further argues that control of the air should be gained not all at once but through repeated and sustained operations.[46]

The argument that "necessary control of the air" should be gained through joint operations across various domains by multiple military services was likely intended to convey to all generals the legitimacy of the PLA's pursuit of securing control of the air through IJO.[47] Additionally, another intention was to convey to all generals the difficultness of gaining even a certain degree of air superiority in future air battles of the PLA, instead of simply attributing the VKS's failure to secure necessary control of the air to poor performance.

46）Ibid.

47）Sugiura, *China Security Report 2022*, 12–31.

China's Reaffirmation of the Importance of Air Operations Planning

The VKS's Inconsistent Air Operations Planning in the Air Battle in Ukraine

In late March 2022, the Russian military's attempt to capture Kyiv ended in failure, and the Ukrainian forces began to reclaim territory in northern Kyiv and Kharkiv. In turn, the Russian forces began concentrating their strength in eastern and southeastern Ukraine and subsequently launched major offensives in those regions. Historically, the former Soviet military attached an extremely important role to "air defense missions." As such, both the Russian and Ukrainian militaries have traditionally formed large-scale air defense forces. When the two sides engaged in air battle, it inevitably led to the establishment of dense air defense networks by both sides.[48]

The VKS continued its air strikes employing drones as decoys to weaken Ukraine's IADS. When the UkAF activated radars in response to these drones, Su-30 and Su-35 fighter jets fired anti-radiation missiles (ARMs). Coordinated SEAD operations began to be observed at the VKS at last. As a result, Ukrainian air defense forces gradually lost combat power and were forced to withdraw from the front lines, while VKS aircraft steadily improved their ability to conduct high-altitude air operations.[49] The VKS made gradual gains, albeit facing challenges in SEAD operations, whereas the UkAF's defensive counter air (DCA) operations were increasingly at a disadvantage.

The Ukrainian forces conducted strikes against the southeastern front lines, utilizing the U.S.-made High Mobility Artillery Rocket System (HIMARS) delivered in June. Russian land forces became subject to precise strikes and faced an increasingly severe situation. In response, the VKS began providing CAS from the sky to protect its land forces. In this way, the VKS, affected by the circumstances of the Russian military's ground forces, engaged in inconsistent air operations. In July, the VKS as a whole ceased

48) Christopher Woody, "Fighter Jets Are 'Worthless' over Ukraine, and It's a Sign of What US Pilots and Troops May Face in Future Battles," INSIDER, March 17, 2023.

49) Deptula and Bowie, "The Significance of Air Superiority," 6.

deep penetrations with fighter-bombers into Ukrainian airspace and instead shifted to striking with stand-off weapons and long-range missiles.[50]

PLA Experts Recognize the Importance of Air Operations Planning

On April 11, 2023, around one year into the Russo-Ukrainian War, the *PLA Daily* published a commentary predicting that "non-contact" air operations would become mainstream in the future.[51] The authors—Bao Zhenfeng, Li Geng, and Qu Min at the PLAAF Command College—explain that the use of medium- and long-range air-to-air and air-to-ground missiles has rose dramatically in recent local wars, while SAM ranges on the intercepting side have extended to several hundred kilometers. They analyze that this has forced the offensive side to carry out air-to-ground strikes from nearly 1,000 kilometers away, and forecast that "non-contact" air operations referred to as "ultra-long-range air defense" and "out-of-area strikes" will become mainstream in the future. Bao Zhenfeng, Li Geng, and Qu Min further point out that if both sides are equipped with large numbers of long-range weapons, their long-range combat capabilities in the air will be mutually deterred, resulting in the cancellation of each other's superiority in range (distance).[52] They predict that securing control of the air through traditional means would become even more difficult, and in air battles, control of the air would often be denied by medium- to long-range SAMs fired from outside the combat zone. Additionally, they anticipate that attack aircraft performing CAS will face threats from SAMs of the enemy's air defense forces, and ground and naval operations would confront a chaotic

50) As ground battles intensified from autumn 2022, the ground became densely concentrated with powerful air defense forces from both sides. As a result, VKS and UkAF aircraft could not easily intrude into the airspace. Even at low altitudes where they are not easily detected by radars, the large number of MANPADS possessed by both Russia and Ukraine posed a lethal threat to penetrating aircraft (Deptula and Bowie, "The Significance of Air Superiority," 7).

51) 鲍振峰 [Bao Zhenfeng], 李耕 [Li Geng], and 屈敏 [Qu Min], "紧盯高新技术应用给空中作战带来的新变化" [The focus on new changes brought about by high-tech air operation applications], 解放军报 [PLA Daily], April 11, 2023.

52) It is necessary to compare the enemy's posture with that of our own forces and to comprehensively deploy the operational forces of each sector, establishing favorable conditions to maximize the strength of our own forces at the time and place where it is most needed and in the appropriate environment, and combining their respective strengths. (Ibid.)

operational environment under a state of parity. Therefore, they assert that the strategy for securing control of the air in a future war must shift toward gaining air superiority in specific airspace zones whenever necessary.[53]

In another commentary published in September of the same year, Bao Zhenfeng and Li Geng note that, in order to coordinate overall operation plans and missions and integrate operations, it is essential to establish operation goals and ensure consistency across the plans.[54] These strategists at the PLAAF Command College argue that air operations within joint campaigns should not merely involve assembling air forces from different military services, but also employ their airpower in an integrated manner to achieve victory in war. If air operations were to become detached from joint operational objectives, air operations would lose strategic direction and lack comprehensive perspective. They warn that this would lead to a narrow vision limited to only certain military services, units, or spaces, resulting in the inability to conduct "systemic combat" under a centralized operational command.[55]

In February 2023, in an interview with *Shanghai Observer*, retired PLA Major General Jin Yinan commented on the VKS's performance in the air battle in Ukraine. *Shanghai Observer* is not the *PLA Daily* or another PLA-affiliated media, and Jin is a retired officer. As such, his views do not necessarily represent the official views of the PLA but are still worthy of reference. Jin criticizes the Russian military's low-quality air operations as an inevitable outcome:

> The Russian military not only exposed the weakness of its airpower, but also inflicted serious consequences on Russia's entire special military operations. Had Russia been able to gain control of Antonov Airport, land over 70 Il-76 transport aircrafts without issue, and airlift heavy weaponry smoothly, it could have swiftly occupied Kyiv and decisively turned the tide of the war in its favor. Because a Ukrainian heavy brigade stationed near Antonov Airport destroyed the runway, VKS transport aircraft were unable to land, forcing the Russian

53) Ibid.

54) 鲍振峰 [Bao Zhenfeng] and 李耕 [Li Geng], "联合空中作战与指挥的内在机理" [The internal mechanisms of joint air operations and its command], 解放军报 [PLA Daily], September 5, 2023.

55) Ibid.

> forces to drastically revise its initial operation plan. As this reveals, they were clearly ill-prepared and their airpower was inadequate.[56]

Known as a hardliner in the PLA, Jin's personality is strongly reflected in his assessment. It is nonetheless rare for a retired PLA officer to publicly criticize the VKS to such an extent.[57] It is a fact, however, that intrusions by PLA aircraft into Taiwan's Air Defense Identification Zone (ADIZ) have increased each year since the outbreak of the Russo-Ukrainian War, and that there has been a growing trend for intrusions by multiple diverse aircraft.[58]

Hence, learning from the failures of the VKS's sporadic air operations, the PLA may be training for air invasions involving formations of multiple aircraft of different types. In any case, the arguments illustrate the PLA's critical view of the Russian military's outdated operation plans. It follows that the intention behind the arguments was to convey to all generals that the PLA's efforts to conduct IJO had been legitimate.[59]

China's Positive Assessment of Long-Range Stand-off Strikes

Offensive and Defensive Operations Using Air Defense Missiles and Hypersonic Missiles in the Air Battle in Ukraine

Over the first three months of the war, around 2,000 cruise missiles and around 240 ballistic missiles, averaging around 24 missiles per day, were fired by all Russian services combined.[60] Nonetheless, the VKS was unable to adapt to the rapidly changing battlespace, failing to weaken Ukraine's IADS and bolster the momentum of Russia's ground invasion. As a result, in order to avoid Ukraine's air defense network, VKS aircraft and helicopters were

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56) "俄乌冲突一周年, 暴露了哪些问题? 金一南解读."
57) Aita, "China's Perspective on the Use of Russian Airpower."
58) Aita Moriki, "Chinese PLA Intrusions into Taiwan's ADIZ (2): The "System" that Enables Multi-Aircraft Formation Intrusions," *NIDS Commentary* (September 28, 2023).
59) Sugiura, *China Security Report 2022*, 12–31.
60) Justin Bronk, Nick Reynolds, and Jack Watling, *The Russian Air War and Ukrainian Requirements for Air Defence (*London: RUSI, 2022), 25.

forced to operate at low altitudes, repeatedly launching unguided rockets in daily sorties. Because these air strikes were conducted for consecutive days following predictable flight routes,[61] they increasingly became targets for Ukraine's vast stockpile of MANPADS.[62]

To penetrate deep into Ukrainian territory, the VKS began to deploy many drones, cruise missiles, and ballistic missiles and refrained from flying manned aircraft as much as possible.[63] As of May 2023, the Ukrainian forces had been intercepting about 90% of Russia's cruise missiles and drones and nearly 80% of air- and ground-launched ballistic missiles throughout Ukraine. In areas protected by the U.S.-made Patriot Advanced Capability-3 (PAC-3) air defense system, nearly 100% of Russian ballistic missiles were being shot down.[64] Consequently, the VKS became reluctant to use manned aircraft to break through the robust air defense network of the Ukrainian forces. In May 2023, as ground battles intensified in Bakhmut in eastern Ukraine, a showdown unfolded in the skies over Kyiv between the UkAF's PAC-3 missiles and the VKS's Kinzhal air-launched ballistic missiles fired from MiG-31 fighter jets. The UkAF's air defense forces successfully intercepted the first wave of incoming Kinzhals. In the subsequent second wave, however, Kinzhal missiles fired from MiG-31s were

The VKS's MiG-31 carrying a Kinzhal (Anadolu/Getty Images)

61) The VKS sometimes lost as many as eight fighter jets in a single week. In an effort to reduce losses, the VKS even switched to conducting nighttime ground attacks along the front lines using some of its Su-34 aircraft.

62) 曹励云 [Cao Liyun], "俄乌冲突空防武器系统实战应用观察: 专访俄罗斯军事问题专家姜永伟" [Observation of the application of air defense weapons system for actual combat in Russia-Ukraine combat: An interview with Jiang Yongwei, an expert in Russian military issues], 现代兵器 [Modern Weaponry], no. 533 (September 2023): 14–17; National Defence University of Ukraine, *Lessons Learned of Russian-Ukrainian War*, 119.

63) 老虎 [Lao Hu], "俄乌战争一年祭" [One year of the Russo-Ukrainian War], 航空知识 [Aerospace Knowledge], no. 623 (March 2023): 20–23.

64) Ian Williams, "Russia Isn't Going to Run Out of Missiles," Center for Strategic and International Studies (June 2023).

accompanied by other weapons fired simultaneously from different directions: Kalibr sea-launched cruise missiles fired by the Black Sea Fleet, Iskander M ground-launched missiles and S-400 long-range air defense missiles fired by ground forces, and multiple Shahed-131 and Shahed-136 Iranian-made suicide drones.[65] The UkAF's air defense forces became swamped with interceptions, and their SAM stockpiles were gradually depleted.[66]

PLA Experts Recognize the Utility of Long-Range Stand-off Weapons

The fact that the VKS, which failed to weaken Ukraine's IADS, began frequent use of the long-range Kinzhal missile from March 2022 is drawing attention in China.[67] The Chinese military magazine *Aerospace Knowledge* published a feature on the confrontation between the U.S.-made PAC-3 missiles and Russia's Kinzhal missiles, detailing the course of the combat as follows.

From May 2023, the air operations of the VKS began targeting the PAC-3 systems of the UkAF. The first "missile duel" between the PAC-3 and the Kinzhal occurred at around 2:40 a.m. on May 4, concluding with the Ukrainian forces successfully shooting down a Kinzhal for the first time. In the second engagement at around 3:30 a.m. on May 16, the Ukrainian forces' counter air combat successfully intercepted six Kinzhal missiles, nine Kalibr missiles launched from the Black Sea, three missiles launched from land (either Iskander or S-400), and numerous Iranian-made drones.[68] The magazine article notes that Russia's objective in striking with a large number of stand-off weapons was to destroy or wear out the expensive PAC-3 systems being continuously supplied to Ukraine and make Western countries disinclined to support Ukraine.[69]

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65) National Defence University of Ukraine, *Lessons Learned of Russian-Ukrainian War,* 177–179.
66) 王鑫邦 [Wang Xinbang], "'爱国者' 血战 '匕首'" ["Patriots" and "Kinzhal" in a bloody battle], 航空知识 [Aerospace Knowledge], no. 627 (July 2023): 56.
67) "中华版匕首" [The Chinese version of the Kinzhal], 兵工科技 [Ordnance Industry Science Technology], no. 23 (2022): 79–83.
68) 王, "'爱国者' 血战 '匕首,'" 56.
69) Ibid., 57.

According to the detailed account in *Aerospace Knowledge*, the Russian military operation was structured in three phases. In the first phase, inexpensive Shahed drones were used for widespread air raids to activate conventional air defense systems deployed in Kyiv and trigger their interception responses. In the second phase, the Russian forces targeted air defense systems whose locations were revealed by the feint operation, and launched Kalibr missiles from the sea and Iskander missiles from land to destroy the air defense systems. In the third and final phase, when the UkAF activated its PAC-3 system, the VKS's MiG-31 fighter jet, which had been loitering in the skies, fired a Kinzhal missile in an attempt to eliminate the PAC-3 missile.[70]

While acknowledging the PAC-3 system's excellent interception capabilities, the Chinese military expert points out their limitations, explaining that while the PAC-3 is designed to intercept missiles weighing 140 kilograms, the Kinzhal has a total weight of 4 tons and a warhead weighing 1 ton. He argues that, because of the Kinzhal's extremely high terminal velocity and resulting large kinetic energy, a Kinzhal missile, even if it were intercepted at close range by a PAC-3 system, can still land near its target due to inertia and cause damage.[71] The reports of the PAC-3 system shooting down Kinzhals were often based on Ukrainian claims. According to the Hong Kong-based newspaper *South China Morning Post*, some analysts praised the Kinzhal's ability to travel at high speed and penetrate air defense networks.[72] A PLA official, speaking on condition of anonymity, stated that Ukraine had launched at least 36 PAC-3 missiles and intercepted just two Kinzhal missiles. He noted that considering there were at least 1,200 ballistic missiles targeted at Taiwan in mainland China, PAC-3 systems are hardly cost-effective even if they are deployed on Taiwan.[73]

On a China Central Television (CCTV) program broadcast on October 1, 2024, Wang Mingzhi, an expert at the PLA, praised the usefulness of the

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70) Ibid., 57–58.

71) Ibid., 58–59.

72) Song Zhongping, a former PLA instructor and military analyst, was skeptical about Ukraine's claims, explaining that the Kinzhal was not necessarily a hypersonic missile: "Strictly speaking, the air-launched Kinzhal missile couldn't be defined as a hypersonic missile, but more a ballistic missile because its speed drops if it is launched from a fighter jet such as the MiG-31." Minnie Chan, "Could the US Missile Defence System Used by Ukraine Help Taiwan?," *South China Morning Post*, May 19, 2023.

73) Ibid.

Kinzhal missile that attempts to penetrate an enemy's air defense network at high speed and destroy its IADS. At the same time, he indicated that the United States is newly developing a similar missile, expressing concern that such new hypersonic weapons will become a trend and will be used by the U.S. forces in China's periphery.[74]

In a situation where both Russia cannot gain the necessary control of the air in Ukraine and the Ukrainian forces cannot maintain control of the air through DCA operations, Wang Mingzhi predicted that the AGM-154 Joint Stand-off Weapon (JSOW), which the United States supplied to the Ukrainian military, would be effective in penetrating the Russian military's air defense networks. Wang explained that, while the JSOW is a stand-off weapon that has been in development for years, it will serve as a precision-guided bomb well suited to the ongoing air battle in Ukraine.[75]

Hence, given that many Chinese military experts are focusing on hypersonic weapons and precision-guided bombs launched from outside the enemy's air defense range, it is highly likely that long-range stand-off weapons will come into frequent usage in future air battles envisioned by China. It follows that the intention behind the above views was to convey to all generals the legitimacy of pursuing "firepower strike capability," which falls under "system warfighting capability based on information systems" that the PLA had emphasized for the conduct of joint operations.[76]

74）"《防务新观察》20241001 以军宣布在黎南部展开'有限地面行动'美军研发高超音速武器拦截器" [Defense review: October 1, 2024 The Israeli military announces a "limited ground operation" in southern Lebanon; The U.S. military develops a hypersonic weapon interceptor], 中视网 [CCTV Net], October 1, 2024.

75）While Wang Mingzhi does not explicitly state that neither side has gained air superiority, he explains that precision-guided bombs that penetrate from outside air defense ranges are extremely useful (Ibid.).

76）Sugiura, *China Security Report 2022*, 20–24; 董连山 [Dong Lianshan], ed., 基于信息系统的体系作战研究 [Research on system warfighting based on information systems] (Beijing: National Defense University Press, 2012), 50–54.

China's Positive Assessment of Deepening Drone Operations and the Evolving Form of Warfare

Rapid Expansion of Drone Use in the Air Battle in Ukraine

Facing continued difficulties in gaining control of the air, the Russian military began striking Ukraine using the Shahed suicide drone in September 2022.[77] Shaheds fly at low altitudes at a slow speed of 115 knots (approximately 210 km/h) and deliver 50 pounds (approximately 23 kg) of explosives. They are relatively low cost at approximately $30,000 but still have a long range of 700 to 800 nautical miles (approximately 1,300 to 1,480 km), making it difficult for Ukraine to locate launch sites and conduct interceptions.[78] Furthermore, the Russian military's Shahed tactics have evolved over the years.[79] At times, Russia openly flew Shaheds in groups to distract the Ukrainian forces and secure attack routes for long-range missiles, attempting to shift the tide of the war in its favor.[80]

Ukraine followed in October, launching suicide drone attacks on Tu-22M3 supersonic bombers at the Shaykovka Air Base in Russia, located about 200 kilometers from their border, and damaging two bombers.[81]

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77) "Ukraine Claims Shooting Down Iranian Drone Used by Russia," CNN, September 13, 2022.

78) The Shahed drone, launched from the bed of a truck using a booster rocket, has a fuselage made of composite materials, and is powered by a small gas engine driving a wooden propeller. It flies using either a satellite guidance or inertial navigation system, and is used as a long-range attack drone. Iran began developing drones around 40 years ago during the Iran-Iraq War. During this period, it struggled to maintain its combat air assets and suffered heavy losses. Today, Iran manufactures and exports a range of reconnaissance, surveillance, and strike drones, including the Shahed. Iran has supplied Shahed drones to Russia during the Russo-Ukrainian conflict, and Russia now produces thousands of improved variants (Uzi Rubin, "Russia's Iranian-Made UAVs: A Technical Profile," RUSI, January 2023).

79) Fabian Hinz, "Iranian Missile Deliveries to Russia: Escalating Military Cooperation in Ukraine," *Missile Dialogue Initiative*, September 18, 2024.

80) Impressed by the usefulness of the Shahed, Russia constructed a drone factory to annually produce approximately 6,000 Shaheds (which Russia has renamed "Geran-2") in Tatarstan, located approximately 500 miles (805 km) east of Moscow (Kristen D. Thompson, "How the Drone War in Ukraine Is Transforming Conflict," *Council on Foreign Relations*, January 16, 2024).

81) Howard Altman and Tyler Rogoway, "Ukrainian Kamikaze Drone Attacks Bomber Base Deep in Russia (Updated)," War Zone, October 7, 2022.

As the air defense forces of both sides became densely deployed, forming an extremely robust air defense network, Russia was unable to gain the necessary control of the air in Ukraine. Nor was the Ukrainian military able to maintain control of the air through DCA operations. As a result, both initiated the use of long-range suicide drones to preemptively eliminate each other's airpower. In 2023, Ukraine fielded over 100,000 drones of various types to the front lines[82] and started using long-range suicide drones to strike Moscow and air bases.[83] By August, the offensive and defensive operations of the two militaries began to fall into a stalemate. Struggling with counteroffensive operations on land, the Ukrainian military shifted tactics to shooting Russia's high-value military targets and used drones as its means. In August, the Ukrainian military, whose supply of weapons and ammunition from Western countries had begun to run dry, employed long-range drones to destroy Il-76 transport aircraft and other aircraft parked at a Russian airbase 430 miles (approximately 690 km) from the Ukraine border,[84] as well as a Tu-22 bomber parked at a Russian airbase 400 miles (approximately 640 km) from the border.[85] In September, Ukraine also commenced attacks on SAMs (S-400 and S-300) deployed in Crimea.[86] By the end of September 2023, Ukraine had conducted a total of approximately 190 long-range drone strikes, with the aim of destroying key functions that support the VKS, including fuel facilities, airbases, and the Kremlin in the capital.[87]

Despite the impressive achievements of long-range drone strikes, the Ukrainian forces on the front lines remained in a precarious position. On top of that, the counteroffensive carried out from summer to fall 2023 ended in failure, and the arrival of military supplies from Western countries was delayed. Affected by these developments, the Ukrainian military rapidly

82) Tom Balmforth, "Ukraine to Produce Thousands of Long-range Drones in 2024, Minister Says," Reuters, February 12, 2024.

83) Stacie Pettyjohn, *Evolution Not Revolution: Drone Warfare in Russia's 2022 Invasion of Ukraine* (Washington, DC: Center for a New American Security, 2024), 16.

84) Howard Altman, "Moment of Drone Strike That Destroyed Russian Il-76s Seen in Infrared Image," *War Zone*, August 31, 2023.

85) Graeme Baker, "Ukrainian Drone Destroys Russian Supersonic Bomber," BBC News, August 22, 2023.

86) Mark Jacobsen, "Ukraine's Drone Strikes Are a Window into the Future of Warfare," Atlantic Council (September 2023).

87) 华迪 [Hua Di], "俄方说乌克兰企图用无人机攻击克里姆林宫 乌方否认" [Russia says Ukraine attempted to attack the Kremlin with drones; Ukraine denies the claim], 新华网 [Xinhua Net], May 4, 2023.

depleted its reserves of personnel, ammunition, and SAMs for its air defense forces.[88] Even amid these challenges, the Ukrainian military used the U.S.-supplied Army Tactical Missile System (ATACMS) in actual combat for the first time on October 17. Attacks were launched against Russian troops stationed in Berdyansk and Luhansk in Russia, destroying helicopters, ammunition depots, air defense systems, and other equipment.[89]

Conversely, the Russian military attempted to suppress the Ukrainian military's air defense networks by deploying the expensive Kinzhal, Kalibr, and other missiles.[90] However, as their stockpiles dwindled, Russia was forced to shift tactics and increasingly used the cheaper Shahed drone and the domestically made Lancet loitering suicide drone.[91] The Russian military's tactic of fielding large numbers of suicide drones was aimed at striking Ukrainian infrastructure.[92] In November 2023, even while ground battles still resembled World War I trench warfare, the conflict entered a new phase of Russian and Ukrainian drones loitering in the sky.[93] By the end of the year, the Russian military conducted an airstrike on Odesa using 44 drones. Although 34 were intercepted, the surviving 10 hit Ukraine's power generation facilities, disrupting electricity supplies for approximately 1.5 million people.[94] Both sides have utilized not only military drones but also various commercial drones, large and small, for a variety of purposes.[95] This has been particularly pronounced on the Ukrainian side. Alongside accelerating innovative development of drones for land, sea, and air, Ukraine

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88) C. Todd Lopez, "Air Defense Remains Top Priority at Meeting on Ukraine Defense," DoD News, September 19, 2023.

89) Robert Greenall and Chris Partridge, "Ukraine Uses US-supplied ATACMS for the First Time, Says Zelensky," BBC, October 18, 2023.

90) 曹, "俄乌冲突空防武器系统实战应用观察," 33.

91) Max Hunder, "Cheap Russian Drone a Menace to Ukrainian Troops and Equipment," Reuters, June 28, 2023.

92) National Defence University of Ukraine, *Lessons Learned of Russian-Ukrainian War*, 177.

93) In a November 3, 2023 article, Lyle Goldstein and Nathan Waechter point out that Chinese military strategists are closely watching and drawing lessons from the effective use of loitering drones by both the Russian and Ukrainian forces (Lyle Goldstein and Nathan Waechter, "Chinese Strategists Evaluate the Use of 'Kamikaze' Drones in the Russia-Ukraine War," *The Diplomat* (November 2023)).

94) "Three Killed in Russian Drone Attack on Ukrainian City of Odesa," *Wall Street Journal*, June 10, 2023; "Ukraine Says Downs Russian Drones Targeting Odesa Port," Reuters, January 17, 2024.

95) Stacie Pettyjohn, *Evolution Not Revolution: Drone Warfare in Russia's 2022 Invasion of Ukraine* (Washington, DC: Center for a New American Security, 2024), 16–28.

established the Unmanned Systems Forces in February 2024.[96] Their ideas for drone use are indeed sweeping and extensive, and Ukraine's anti-drone electromagnetic pulse guns continued to evolve.[97] Drone use extended beyond battlefield surveillance and direct attacks. Operators wearing first-person view goggles flew drones mounted with small explosives directly into the Russian military's armored vehicles, bunkers, and trenches.[98] In this way, the form of drone combat evolved rapidly.

PLA Experts Recognize the Utility of Robotics and Autonomy

According to the above-mentioned *PLA Daily* commentary from April 11, 2023 by Bao Zhenfeng, Li Geng, and Qu Min at the PLAAF Command College, rapid advances in intelligentized military technologies are driving the transformation of drones from a supporting to a central role in air battles. The use of large-scale and different types of drones became commonplace, especially after the Nagorno-Karabakh conflict in 2020. The roles of drones are rapidly expanding from simple aerial reconnaissance to swarm tactics and all-weather support operations. The authors predict that, with the support of joint operation systems, drones will conduct long flights in future air battles, allowing them to execute not only communications, jamming, precision strike, and BDA missions, but also more complex missions such as air interdiction and intelligentized air battle.[99] In fact, a CCTV program on July 23, 2022 showed a PLA Naval Air Force fighter unit at the Southern Theater Command testing the use of drones in air battle. During a live-fire air-to-air missile exercise, drones were flown in high-threat airspace and attempted to transmit target firing data to missile-launching fighter jets flying

96) David Ingram, "Ukraine Creates a Branch of its Armed Forces Specific to Drone Warfare," NBC News, February 7, 2024; Mykola Bieliesko, "Outgunned Ukraine Bets on Drones as Russian Invasion Enters Third Year," Atlantic Council (February 2024).

97) 曹励云 [Cao Liyun], "电磁频谱战场的一次真实较量: 俄军事问题专家姜永伟谈俄乌军队电子战系统作战应用与启示 (中)" [Competition in electromagnetic spectrum warfare: Jiang Yongwei, an expert in Russian military issues, discusses the electronic warfare systems' applications toward operations in the Russian and Ukrainian militaries and insights (Part 2)], 现代兵器 [Modern Weaponry], no. 541 (May 2024): 61–66.

98) Tom Cotterill, "Death from Above: Ukraine's New Suicide Drones Are the Start of a 'Terrifying' Arms Race British Military Chiefs Fear Could Create the Next 'Weapon of Mass Destruction'," *Daily Mail*, February 4, 2024.

99) Therefore, the authors argue that the importance of drones in modern warfare is likely to grow daily (鲍, 李, and 屈, "紧盯高新技术应用给空中作战带来的新变化").

far behind the drones.[100] Another CCTV program aired on September 30, 2022 showed deepening coordination between drones and the PLA Rocket Force during ballistic missile strikes.[101] These footages suggest that the environment is becoming more conducive to the heavy use of drones in future air battles envisioned by China.[102] This clear shift in the PLA's approach to drones became apparent immediately following U.S. House Speaker Nancy Pelosi's visit to Taiwan in August 2022, as has been made evident by the frequent broadcast of the PLA's drone activities from the following month.[103]

Alongside this trend, theoretical research at the PLA has also evolved. On May 4, 2023, a commentary exploring hybrid manned and unmanned aircraft formations was published in the *PLA Daily*. The authors, Jiang Yan and Liu Zhengyuan, proposed flexible interactions between humans and AI to precisely control combat formations combining manned aircraft and drones—a concept they call "intelligentized operations." They argue that this will enable the integration of human experience-based judgment, rapid data processing of machines, and accurate logical reasoning, making it possible to maximize the strengths of humans and machines while fully merging their respective intelligence.[104] In addition, drones capture targets while conducting aerial reconnaissance, whereas manned aircraft are responsible for shooting down targets from the rear. The authors contend that mutual collaboration between drones and manned aircraft can create new complementary advantages.[105]

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100) "直击演训场 · 空战 万无一失 保障单元密切协同显硬功" [From the air war training ground: Flawless execution, support units demonstrate solid capabilities through close coordination], 中视网 [CCTV Net], July 23, 2022.

101) PLA News Media Center, "《强军一席话 (第三辑)》第四集 建设一支强大的现代化火箭军" [Military strengthening (third series), episode 4: Building a powerful and modern rocket force], 中国军网 [China Military Online], September 30, 2022.

102) Aita Moriki, "Chinese Drone TB-001 May Have Been Involved in Ballistic Missile Impact," *NIDS Commentary* (October 4, 2022); Aita Moriki, "Chinese PLA Intrusions into Taiwan's ADIZ (1): The Past Two Years," *NIDS Commentary* (November 17, 2022).

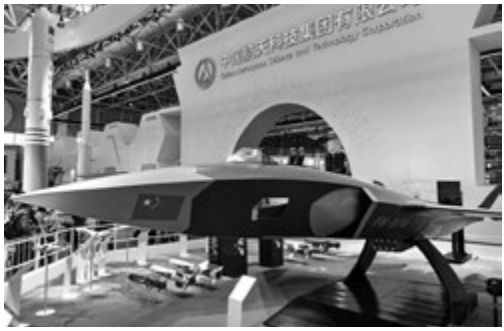
103) "记者探访空军无人机部队 组建之初 无经验 无教材 无范本" [A reporter visits an Air Force UAV unit: No experience, no teaching materials, and no precedents at the time of its formation], 中视网 [CCTV Net], September 20, 2022.

104) 蒋艳 [Jiang Yan] and 刘争元 [Liu Zhengyuan], "前瞻智能化作战编成设计" [Forward-looking intelligentized operations formation design], 解放军报 [PLA Daily], May 4, 2023.

105) 蒋 and 刘, "前瞻智能化作战编成设计."

Considering China's active research and employment of drones, the PLA scholar Elsa B. Kania is right in pointing out that the use of drones on the battlefield in the current Russo-Ukrainian conflict has been relatively successful, and that this can be taken as evidence that the PLA is gaining confidence in the utility of robotics and autonomy.[106]

Furthermore, attempts to integrate AI into drones to generate revolutionary advancements can be observed within the PLA. On July 16, 2024, the *PLA Daily* published a commentary asserting that combat effectiveness should be enhanced while using AI to optimize combat command, looking ahead to a future where advances in AI give machines the ability to think, make decisions, and act like humans.[107] The author, Yang Lianzhen, posits that managing combat through AI can accelerate decision-making in future warfare. Arguing that AI combat management systems must inform commanders of the enemy's activity zones, strike targets, and tactical options and help commanders make quick decisions,[108] Yang emphasizes that such systems will demonstrate their true value particularly in situations requiring agile firepower strikes. In short, intelligentized combat management is the idea of bringing together "command and control nodes, sensors, weapon platforms, and logistics support" to effectively conduct "systemic combat" and thereby optimize combat power.



An FH-97 drone displayed at the Zhuhai Airshow in 2024 (China News Service/Getty Images)

106) Elsa B. Kania, "Designing Deterrence: The PLA's Outlook on Disruptive Technologies and Emerging Capabilities," in *Modernizing Deterrence: How China Coerces, Compels, and Deters,* ed. Roy D. Kamphausen (Washington, DC: The National Bureau of Asian Research, 2023), 128.

107) 杨莲珍 [Yang Lianzhen], "前瞻智能化作战管理" [Forward-looking intelligentized operations management], 解放军报 [PLA Daily], July 16, 2024.

108) Through specific models and programs, AI effectively combines data processing and objective predictions with human common sense experience and intuition using intelligent technology to give commanders powerful decision-making capabilities (杨, "前瞻智能化作战管理").

Yang explains the importance of managing combat while creating an efficient "kill chain"—the process of clarifying combat tasks, selecting striking methods, determining priority tasks, formulating combat plans, issuing strike orders, and conducting battle assessments.[109]

Hence, given that many military experts are focusing on the integration of drones and AI, future air battles envisioned by China are anticipated to newly include AI-enabled drones. It follows that the intention behind the above views was to convey to all generals the legitimacy of the PLA experts' continual pursuit of the new military doctrine of "intelligentized warfare."[110]

New Ideas for Intelligentized Warfare

Pursuing Penetrating Counterair (PCA) Operations

On July 19, 2022, Ma Quan, an editor for the PLAAF journal, *Military Academics of Air Force*, published an article in the *PLA Daily*'s military forum, stating to the effect that PCA operations will become increasingly important.[111] Ma is a particularly noteworthy figure, having served as the chief editor for several PLAAF doctrines and authored numerous commentaries on the future of the PLAAF.

Ma Quan has translated a summary of the U.S. Air Force's *Air Superiority 2030 Flight Plan* (released in 2016) and published an article in the November 21, 2021 *Guangming Daily* on the PCA operations concept being considered by the U.S. Air Force.[112] It was a mystery as to why the U.S. Air Force's discussion on PCA operations from 2016 was cited in the *PLA Daily* in July 2022. Derek Solen at CASI analyzes that Russia's unexpectedly difficult struggle to gain control of the air in the air battle in Ukraine may have prompted the PLAAF to reassess its strategies and tactics for a potential invasion of Taiwan, and model them on the U.S. Air Force's concept of PCA

109) 杨, "前瞻智能化作战管理."
110) Sugiura, *China Security Report 2022*, 29–31.
111) 马权 [Ma Quan], "穿透性制空: 空中作战新趋势" [Penetrating control of the air: A new trend in air operations], 解放军报 [PLA Daily], July 19, 2022.
112) "穿透性制空: 一个全新空中作战概念" [Penetrating control of the air: A new air operations concept], 光明网 [Guangming Net], November 21, 2021.

operations.[113] Solen brings attention to Ma Quan's argument for exploiting the advantages offered by System of systems to build an integrated, real-time battlefield situational awareness network, also known as "common picture."[114]

Ma's concept of PCA operations, as described in the *PLA Daily*, revolves around striking a blow to the enemy by combat forces that are stealthy in all directions and domains, and have excellent information processing capabilities to break through the enemy's heavily fortified air defense systems. He posits that PCA operations become feasible by winning the information war in the "System of systems" confrontation. This requires a cycle of achieving a breakthrough against the enemy's robust air defense systems through a command and control system based on superior situational awareness, an information transmission system, and strike forces coordinating across domains; launching rapid strikes while providing timely target information to other weapon systems; and conducting follow-on operations.[115] He explains that overall capabilities are demonstrated with the support of System of systems, and that this requires the employment of autonomous drones and intelligentized drone swarms. Ma argues that the "System of systems" for PCA operations will upgrade the traditional linear "kill chain" into a dynamically interconnected "kill network." He envisions combat assets in all domains being able to enter the "operational System of systems" simultaneously, dramatically enhancing the system's overall combat capabilities. With this image in mind, Ma emphasizes the importance of differentiating between soft-kill and hard-kill methods and utilizing non-kinetic means, such as electronic warfare, to ensure the success of PCA operations.[116]

Ma Quan envisages future air battles where the PLA disperses assets across multiple domains, pursues collaboration between manned and

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113) Derek Solen, "A Translation of 'Penetrating Counterair Operations: A New Trend in Air Operations'," *China Aerospace Studies Institute* (September 2022).

114) For example, an "equipment System of systems" refers to a military equipment and weapons system complex that forms an integrated whole. "Air defense System of systems" consists of airborne early warning aircraft, ground-based radar, patrol fighter jets, surface-to-air missiles, among other components. The PLA views modern warfare as a contest between System of systems, and they are often collectively referred to as "operational System of systems" (Solen, "A Translation of 'Penetrating Counterair Operations").

115) 马, "穿透性制空: 空中作战新趋势."

116) Ibid.

unmanned aircraft, and conducts strikes using hypersonic stand-off weapons and ultra-stealth aircraft to penetrate the enemy's IADS. The intelligentized PCA operations he has conceived seem to not only deploy high-end manned stealth aircraft but also make frequent use of cheaper drones.

Building a Satellite Constellation Communication Network

Footage from the Russo-Ukrainian War showing small Ukrainian drones flying over the battlefield and attacking fleeing Russian soldiers was circulated around the world, giving the world a new impression of warfare. A key reason such drone guidance became possible on the devastated Ukrainian battlefield was Starlink, the U.S.-made satellite communication system, which was provided to Ukraine from the war's inception. Steven Feldstein, who studies the impact of digital technology on wars at the Carnegie Endowment for International Peace, explains that the Ukrainian military's drone reconnaissance forces are using Starlink to support drone attacks.[117]

PLA experts saw Russian forces struggle on the battlefield without such capabilities,[118] and witnessed how satellite constellation-based communications have provided decisive advantages in modern warfare.[119] It likely taught the PLA's military leaders a lesson that having continual internet access on the battlefield to support various operations and troop deployments will be critical in future wars, such as an invasion of Taiwan. Therefore, Feldstein notes that the Chinese political leadership no doubt views the creation of an independent satellite internet system, free from U.S. control or interference, as indispensable to its military operations.[120]

Under these circumstances, China quickly began building a low Earth orbit (LEO) satellite communication network in January 2024. This initiative is led primarily by state-owned enterprises while the participation of private enterprises is also encouraged. It reportedly aims to launch more than

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117) Steven Feldstein, "Why Catching Up to Starlink Is a Priority for Beijing," Carnegie Endowment for International Peace (September 2024).

118) Aita Moriki, "Beigunshiki no guntai wo mezasu Chugoku jinmin kaihogun" [Chinese People's Liberation Army aiming for U.S.-style military], *BeiChu tairitsu to kokusai chitsujo no yukue: Kosa suru sekai to chiiki* [U.S.-China confrontation and the fate of the international order: A world and region in crossroads], ed. Igarashi Takayuki and Osawa Suguru (Toshindo, 2024), 254–256.

119) Feldstein, "Why Catching Up to Starlink Is a Priority for Beijing."

120) Ibid.

26,000 satellites over the next decade to provide global coverage and counter Starlink.[121] In August, an improved Long March 6 rocket carrying 18 "Qianfan constellation" satellites was launched from the Taiyuan Satellite Launch Center in China.[122] The rocket successfully placed the satellites into LEO at an altitude of 500 miles (approximately 800 km). According to the United States Space Command (USSPACECOM), however, the rocket's upper stage broke apart shortly thereafter into numerous fragments that continue to orbit Earth,[123] suggesting that China's effort is still a work in progress. Nevertheless, China has successfully completed its second satellite launch as of October 2024.[124]

The Chinese version of "Starlink" being built is expected to become an essential communications infrastructure in merging drones and AI. China's efforts to build a satellite constellation communication network and integrate drones and AI are witnessing growing cooperation in the political, industrial, scientific, and military sectors that embody the military-civil fusion strategy in particular. According to the *Guangming Daily* from August 1, 2024, professors at the PLA National University of Defense Technology have identified six military technologies that are critical to rebuilding the future balance of military power—namely, AI, unmanned combat systems, space technology, hypersonic technology, cyber warfare technology, and new materials technology. Considering global technology trends, the professors opine that these six military technologies may reshape the military balance in the future.[125]

Furthermore, in light of China's efforts to build a satellite constellation communication network and combine drones and AI, the professors

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121) "Chugokuban 'sutaarinku' 24-nen kara kochiku jinko eisei 2.6 man ki" [China to launch 26,000 satellites and start building its own version of Starlink from 2024], *Nihon Kezai Shimbun*, January 10, 2024.

122) Simone McCarthy, "China Launches Satellites to Rival SpaceX's Starlink in Boost for its Space Ambitions," CNN, August 9, 2024.

123) Mike Wall, "Chinese Rocket Breaks Apart after Megaconstellation Launch, Creating Cloud of Space Junk," *SPACE.com*, August 9, 2024.

124) "工信部加强频轨资源统筹协调 助力 '千帆星座' 02组卫星成功发射" [The Ministry of Industry and Information Technology strengthens coordination of frequency and orbit resources to support the successful launch of the "Qianfan Constellation" Group 02 satellites], 新华网 [Xinhua Net], October 18, 2024.

125) "这六大军事科技创新, 正在重塑军事力量平衡" [Six major military scientific and technological innovations are reshaping the balance of military power], 光明日报 [Guangming Daily], August 1, 2024.

cite the widespread use of intelligentized technologies on the cognitive "battlefield" in the Russo-Ukrainian War and predict that technologies will be employed in future wars to alter audio or video, issue fake orders, or otherwise manipulate human cognition to confuse the enemy and disrupt the operations themselves.[126]

Conclusion

The purpose of this article was to illuminate the perspectives held and arguments presented by Chinese military experts and officials on the air battle in Ukraine and thereby illustrate China's future vision for future air battles.

Experts at the PLA critique the VKS's sporadic and inconsistent air operations. At the same time, they took the invading Russian forces' inability to gain control of the air very seriously, and are keenly aware of the difficultness of achieving even certain air superiority as long as the enemy's air defense systems are robust. In the modern era, the emergence of advanced aircraft and SAMs has fragmented the battlespace, triggering competition in each altitude block. Therefore, systematic operation plans have to be formulated taking into account the characteristics of each altitude block in the theater, and more targeted suppression is needed. PLA experts recognized that control of the air should be gained not at once but through repeated and sustained operations. For this reason, they appear to have sought to redefine control of the

The PLAAF's H-6K bomber carrying a 2PZD-21 missile (under development) that resembles a Kinzhal (CFOTO/ Getty Images)

126) The experts pay particular attention to Russia's Kinzhal as a representative hypersonic weapon, praising its high strategic deterrence capability and effectiveness in surprise attacks due to its high speed ("这六大军事科技创新, 正在重塑军事力量平衡").

air, even by modeling it on the U.S. Air Force doctrine, and refine their operation concepts and plans for future air battles.

Furthermore, the experts of the PLA anticipate that future air battles may be dominated by SAMs with a range of several hundred kilometers and air-to-ground attacks launched from nearly 1,000 kilometers away. They also anticipate that air operations in the future may be "non-contact," characterized by "out-of-area strikes" and "ultra-long-range air defense." The PLA learned that, in informationized and intelligentized warfare, it is essential to gain control of the air through IJO involving all military services.

Long-range stand-off strikes in the air battle in Ukraine drew China's attention. Beijing highly values stand-off weapons, such as the Kinzhal that attempts to penetrate the enemy's air defense networks at high speed and destroy IADS. Even if such weapons were intercepted, China finds meaning in forcing the enemy to expend many of its costly SAMs. In addition, China has taken significant interest in the advancement of drones and the changing form of warfare. As noted earlier, China began accelerating its development and deployment of drones around 2015. At the same time, China appears to have drawn operational insights from observing the Nagorno-Karabakh conflict and the air battle in Ukraine, and is expected to increase its drone use more than ever before. Against this backdrop, the PLA, which pursues intelligentized warfare, is anticipated to accelerate both the development of AI-enabled drones and the creation of a satellite constellation communication network.

In future air battles envisioned by China, the PLA attaches vital importance to the PCA operation for breaking through enemy air defense networks. Accordingly, it is forecast that high-speed, hard-to-intercept stand-off weapons like the Kinzhal, as well as J-20 stealth fighter jets and accompanying stealth drones will be deployed, supported by China's "System of systems."

Of course, the discussions by the PLA experts are only the tip of the iceberg. Still, they reveal the general direction China is heading toward for air battles in the future.

As experts at the PLAAF have noted, the "air superiority" explanation is beginning to reach its limits in modern air battles. In air battles several decades ago, the area in which aircraft has influence was considered the same as the area in which air superiority was achieved. Control of the air used to be understood as the airspace protecting key targets, such as airbases.

Therefore, "control of the air" and "air superiority" were often regarded as synonymous, with largely overlapping areas. However, the scopes of "control of the air" and "air superiority" have gradually diverged with the rapid advancement of military science and technology, particularly the rapid expansion of the area of influence of aircraft and missiles, making it difficult to treat the two as the same. In light of this trend, the U.S. Air Force reassessed what should be protected in joint operations and cyber warfare scenarios and revised its doctrine to avoid inconsistencies. Specifically, it categorized control of the air into three concepts in preparation for future air battles.

If long-range stand-off weapons are to be used frequently, as in the ongoing air battle in Ukraine, the PLA, which pursues intelligentized warfare, may need to reconsider how far the boundaries of control of the air should extend and from where air superiority begins. By studying the air battle in Ukraine, the PLAAF likely chose to optimize its military doctrine for future air battles while openly modeling it on the U.S. Air Force doctrine. In short, previously developed concepts are being refined in response to the changing times, and in regard to military doctrines, it appears important to stay abreast of evolving trends.

Based on the above discussion, the PLAAF's heretofore strategy of "integrating air and space capabilities as well as coordinating offensive and defensive operations" is not anticipated to change significantly as an outcome of the air battle in Ukraine. Rather, the strategy will likely be supplemented with details on drones and satellite constellation communications and reinforced with theory. Along with adding these elements, the PLA is expected to further develop its vision for future air battles as an extension of its pursuit of IJO, with a strong emphasis on increased precision, stealth, and unmanned capabilities. PLA experts, watching the Russian forces struggling in the Russo-Ukrainian War, are no doubt gaining confidence that their "intelligentized warfare" efforts were not misguided.