# Air Superiority in the Twenty-First Century

## *Lessons from Iran and Ukraine*

CSIS BRIEFS

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## THE ISSUE

*Russia has not achieved air superiority over Ukraine in more than three years of fighting, but Israel seized air superiority over Iran in less than four days. Despite the vastly different circumstances and strategic objectives facing each nation's forces, this CSIS comparison of the two campaigns holds lessons for countries seeking to achieve air superiority in modern conflicts—or to deny it to their adversaries. Israel succeeded where Russia failed by building and equipping an organization that fit an offensive air superiority doctrine, preparing the battlefield with special operations forces, and taking full advantage of its intelligence edge. Ukraine succeeded where Iran failed in taking advantage of dispersion and mobility to prevent its suppressed air defenses from being destroyed.*

## INTRODUCTION

Before Russia invaded Ukraine, its Aerospace Forces (VKS) and missile forces were considered likely to play a major role in forcing Ukraine's rapid collapse.[1] But as Russia's offensive unraveled in early 2022, commentators declared Russia's air force to be "missing" and its performance to be "perplexing."[2] In contrast, the Israeli Defense Forces (IDF) achieved air superiority over Iran in less than four days, an achievement made more impressive by the fact that Tehran is nearly 1,000 miles from Israel's nearest airbase.

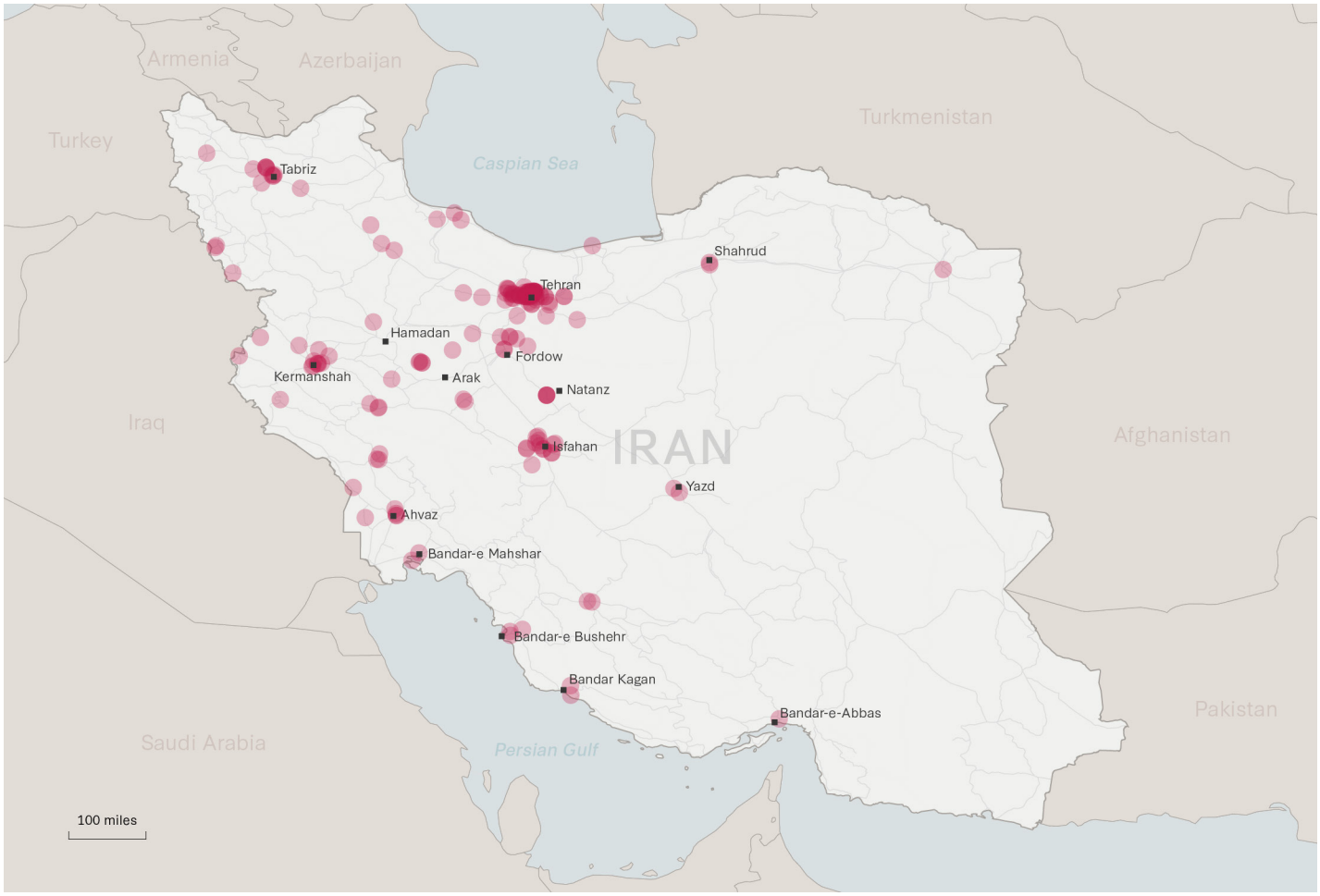
To better understand air war in the twenty-first century, this analysis compares Israeli, Russian, Iranian, and Ukrainian performance across several dimensions. Few of the lessons are novel; Israel's success and Russia's failure reinforce old lessons about pursuing qualitative superiority in technology and training, operational flexibility, accurate and timely intelligence, and effective use of combined arms. The most important new development is the increasing ability to strike ground-based air defense (GBAD) systems from threats within their lethal envelopes, the three-dimensional space in which air defenses can kill incoming threats, along with the corresponding need to defend against such attacks. Israel's use of Mossad special operations forces to conduct unmanned aerial system (UAS) and missile strikes against Iranian air defense systems from within Iran demonstrate the risk that small precision-strike assets can pose to a country's air defenses. Unconventional attacks—such as those conducted by Mossad against Iran and by Ukraine against Russia in Operation Spider's Web—are repeatable because these or other states could conduct similar attacks in the future.[3] Although this type of attack involves significant preparation and cannot be repeated without rebuilding the networks that enabled them, they represent an ongoing threat to air defenses and strategic assets that air defenders must respect.

Due to the differences between the Russian and Israeli air campaigns, this analysis compares Operation Rising Lion with only a narrow slice of the Russian campaign. At the beginning of its 2022 invasion, Russia prioritized attacks against Ukrainian air defenses, and its plan to rapidly seize Kyiv and decapitate the Ukrainian government required airborne insertion of forces near the capital—and therefore required suppression or destruction of Ukraine's air defenses.[4] This analysis therefore directly compares the 12-day Israeli campaign, throughout which the Israeli Air Force (IAF) was able to operate freely over Iran, with the first two weeks of the Russian operation. During this period, Russia sought and, in several locations, achieved air superiority. But by the ninth day of Russian operations, Ukraine had partially reconstituted its air defense network and Russian control of the skies was lost, although Ukraine took several more weeks to fully deny the VKS the ability to operate over its territory.

## SUCCESS AND FAILURE IN THE SKIES

Israel's strikes against Iran and Russia's invasion of Ukraine differed in their goals, assumptions, and requirements. Operation Rising Lion incorporated special forces, cyber, and informational elements, but air and missile forces were always going to provide the decisive capabilities—the operation depended on seizing and maintaining air superiority long enough to degrade Iran's nuclear infrastructure. In contrast, Russia's 2022 invasion of Ukraine was primarily a ground operation. The Russian military did not assume that success depended on air superiority in the way the Israeli operation clearly did.

Figure 1: Israeli Air Force Attacks in Iran, June 12–24, 2025




Source: CSIS analysis of data from Institute for the Study of War, "Interactive Time-Lapse: Israeli Strikes in Iran," June 30, 2025, https://storymaps.arcgis.com/stories/bd51aa4893724e1e893043881002fd92.

Nevertheless, the Russian and Israeli campaigns began in much the same way, with air and missile strikes against their adversaries' militaries—especially their air defense infrastructure. Israel's initial strikes, including the well-publicized Mossad operations of June 13, 2025, killed the leadership of Iran's strategic air defense and long-range strike unit, the Iranian Republican Guard Corps (IRGC) Aerospace Forces.[5] Over the next 24 hours, the IAF struck 100 targets with nearly 200 sorties of manned and unmanned aircraft, decimating Iran's integrated air defense system.[6] Russia also began its 2022 invasion with a strike campaign intended to degrade and destroy Ukrainian air defenses.[7] During the first week of the conflict, Russia launched more than 200 short-ranged ballistic missiles into Ukraine.[8] Russian combat aircraft also flew roughly 140 sorties per day, attacking more than 100 air defense targets in the first 72 hours of the invasion.[9]

Israel's success was comprehensive—the IDF announced that it had air superiority on the fourth day of the conflict—and while Russia's was not, the VKS did achieve air superiority in key locations.[10] In the first three days of the conflict, Russia managed to both insert a 34-helicopter air assault into Hostomel airport and conduct sorties up to 300 kilometers into Ukraine.[11] However, Russia did not expand or maintain its air superiority. Slow-moving Ukrainian Bayraktar TB2 UAS struck Russian ground forces when they should have been easily destroyed by Russian air or air defense forces. Russia was unable to defeat Ukraine's air forces, which fought the VKS until about March 3, 2022, when Ukraine's GBADs had recovered from Russia's suppression.[12] From that point onward, the VKS grew increasingly ineffective, and by early April 2022 it had effectively ceased attempts to penetrate Ukrainian airspace.[13] In the end, Israel did not lose a single manned aircraft or pilot—one F-16I navigator claims that Iran did not fire a single surface-to-air missile—while independent researchers confirmed the destruction of multiple Russian manned-combat aircraft in the opening weeks of the campaign.[14]

## HISTORY, DOCTRINE, AND ORGANIZATION

Israel has a long history of offensive air operations, but Russia does not. Due to Israel's limited strategic depth and its proximity to hostile nations and actors, IDF doctrine emphasizes the rapid achievement of air superiority to enable preemption, rapid escalation, and freedom of action.[15] The IAF does not merely support operations; Israeli officials see it as a critical enabler of Israel's national defense, designed to rapidly seize control of the air in support of ground forces and to impose strategic costs on adversaries. For more than 50 years, Israel has prioritized technological, operational, and doctrinal improvements to increase the IAF's ability defeat adversary air defenses.[16] Unlike many of its adversaries, the IAF emphasizes suppression and destruction of enemy air defenses as operational imperatives in air force doctrine, training, equipping, and operational employment.[17]

In contrast, Russia has no significant history of offensive air superiority operations. Russian air forces have been employed either in air defense or close air support missions for most of the country's history, and they have never been pitched against a sophisticated enemy air defense system like that of Ukraine.[18] Despite the combat experience its pilots gained in Syria, that campaign did not involve disrupting or defeating an adversary's air defense network.[19] Rather than attempting a U.S.- or IAF-style air superiority campaign in Ukraine, Russia appears to have sought only limited air superiority over corridors vital to its plan to quickly seize Kyiv and topple the Zelenskyy government.[20] This may be because, unlike Israel and the United States, Russia does not see air superiority as necessary to enable ground maneuver. Its ground forces rely much more on artillery than on airpower.[21]

As a result, struggling Russian ground commanders were not prevented from redirecting assets from the air superiority mission before Ukraine's GBADs had been destroyed and air superiority seized.[22] This was a critical limitation of the air superiority campaign; even in the absence of Russia's many other failings, the ground forces' redirection of air superiority assets alone would have made it difficult for the VKS to consolidate or expand its gains. Russia's subordination of the VKS to the ground forces has even drawn criticism within Russia, despite restrictions on negative speech about the war.[23]

Israel's emphasis on air superiority and Russia's corresponding de-emphasis led to different patterns of investments in materiel and training over the previous decades. For instance, the IAF's deliberate training against S-300s—the most effective air defense platform of the Iranian armed forces—began as early as 2007.[24] Furthermore, the IAF acquired and fielded the expensive F-35I platform despite significant domestic opposition, a key investment in air

capabilities.[25] In contrast, VKS training focuses on narrow tactical situations using small homogenous groups of aircraft rather than integrated strike campaigns, which limits its applicability to an air superiority campaign.[26] Russia has also underinvested in important air superiority equipment such as targeting pods and precision munitions, which are important for the dynamic targeting of mobile GBADs.[27]

## THE CONVENTIONAL BALANCE

Going into the conflict, Israel had overwhelming qualitative superiority over Iran. The IAF is one of the world's most capable air forces. The F-35 is one of the world's most advanced warplanes, with remarkable stealth and computing power that enables more effective use of Israel's less-advanced aircraft.[28] Israel also modifies its imported F-15I, F-16I, and F-35I aircraft with advanced electronic warfare (EW) capabilities, avionics, communications systems, weapons pods, and enlarged fuel tanks to increase interoperability, range, and lethality in contested airspace.[29] In contrast, Iran's air defenses were made up of a mix of Iranian, Soviet, and Russian systems that—where not obsolete—were poorly integrated.[30] While its air forces did not enter the fight, Iran's combat air fleet is ancient, consisting of U.S. aircraft produced before the 1979 Islamic Revolution.[31] There is little reason to believe that Iranian air forces would have posed much of a challenge to the IAF.

Russia's qualitative superiority was much more uneven. It had enormous technological superiority over Ukraine's air force, but Ukrainian pilots proved at least the equals of their VKS counterparts. Ukrainian pilots have reported that Russian aircraft "completely outclass" their Ukrainian counterparts from a technical standpoint, particularly in radar and air-to-air missile performance.[32] But Ukraine blunted the Russian campaign through aggression, pilot skill, and an apparent willingness to accept greater losses than Russia.[33] In addition, Russia's most advanced combat aircraft—the Su-57 fifth-generation multi-role fighter—was conspicuously absent from the air war over Ukraine.[34]

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Although the VKS was technologically superior to the Ukrainian air force, it did not exhibit the same level of superiority over Ukrainian GBADs. Russia's ISR aircraft already struggled to locate enemy radars during the 2008 Georgia war, and its development of advanced ISR assets since has lagged.[35] Its most modern ISR aircraft, the Tu-214R, was not fielded in Ukraine in significant numbers and may have fallen so short of VKS expectations that its production was cancelled.[36] The VKS seems to rely primarily on antiradiation missiles (ARMs) for suppression and destruction of Ukrainian GBADs, but Ukrainian GBAD operators have been able to counter ARMs by "blinking" their radars off and on.[37] The Ukrainian GBAD network was also much more advanced than that of Iran, meaning that the VKS had much less of a technological advantage over Ukraine than Israel did over Iran. After Russia's invasion of Crimea and the Donbas in 2014 and 2015, Ukraine invested significantly in its GBAD network. It modernized much of its S-300 inventory, developed modern replacements for Soviet-era surveillance and target-acquisition radars, and upgraded the hardware and software of its GBAD systems, adding components such as the Ukrainian-made 35D6M wide-area surveillance and targeting radar.[38]

Questions of quantitative superiority are impossible to resolve because there is a lack of data on Iran's air defense network. Israel operates around 240 combat aircraft, while Russia employed about 350 in its 2022 invasion of Ukraine.[39] On the defenders' side, Ukraine operated about 250 M-300PS/PT systems, 72 9K37M Buk M1 systems, and about 100 short-range systems, most of which were 9K33 Osa systems.[40] Meanwhile, Iran operated at least 10 S-200 and 32 S-300 long-range systems, about 50 medium-range Mersad systems, and at least 250 FM-80 and 29 9K331 Tor short-range air defense systems. However, Iran also operated an unknown number of medium-range 3rd Khordad, 15th Khordad, and Talash systems and a variety of point-defense systems, making it impossible to compare the numerical balance between Russia and Ukraine with the balance between Israel and Iran.[41]

## SPECIAL OPERATIONS

Special operations were critical to both Israeli and Russian planning, but Israel dedicated its special operations to the air superiority effort while Russia targeted Ukraine's command and control systems. Crucially, Israel's special operations forces targeted Iranian GBADs in a way Iran did not

expect and against which its GBADs had no defense: from within Iran itself.

Israeli special operations consisted of at least two key lines of effort. The first was the infiltration of precision weapons systems—missiles and drones have been publicly revealed to have been used—into hidden bases within Iran, which were then used to strike key Iranian air defense and missile systems from short range.[42] The second consisted of an effort to kill Iranian military leaders in the early moments of the campaign.[43]

These efforts were central to Israel's achievement of air superiority. The IDF chief of staff stated that the IDF's air superiority campaign was "made possible, among other things, thanks to full coordination and deception by air and ground commando forces" operating deep within Iran.[44] The UAS attacks almost certainly targeted air defense systems from within the defenses' lethal envelopes: while a long- or medium-range air defense system can target an aircraft seeking to engage it, it is helpless against a swarm of drones launched from close range.[45] Meanwhile, the killing of Iran's IRGC commanders likely paralyzed strategic decisionmaking within its centralized air defense command, because the people who were supposed to make those decisions had been killed.

In contrast, Russian special operations efforts did not specifically target Ukrainian air defenses. Instead Russia's special operations campaign was intended to achieve the surrender of Ukraine's armed forces and the collapse of the Zelenskyy government.[46] As a result, the campaign primarily consisted of a series of information operations conducted against Ukraine's military leadership, frontline commanders, and communities, along with cyberattacks against Ukrainian state communications and assassination attempts against Ukrainian leadership.[47] Specifically, Russia sought to isolate frontline units from Kyiv using cyberattacks and undermine cohesion through personalized appeals to specific commanders.[48] There is no reason to believe that Russia conceived of its information operations as pertinent to the air superiority effort. One comprehensive analysis concluded that such an effort would likely have been futile given Russia's theory of victory: "[T]he one part of the Russian invasion plan where obstruction, isolation and negotiated capitulation could not be achieved in theory was the Ukraine air defence system."[49]

Israel's special operations did not aim for "obstruction, isolation and negotiated capitulation." Its efforts were destructive first and psychological second. Although successful assassinations of Ukraine's political leaders might have triggered the collapse of the Ukrainian armed forces, predicting the psychological effects of new information on an adversary is extremely difficult. In contrast, killing an entire layer of a military hierarchy and removing critical nodes of its defenses can more reliably be assumed to have a significant effect on the organization's ability to operate. Russia would have benefited from comparable efforts enabling deliberate intelligence, operational preparation, and advanced force operations within Ukraine to focus on destructive effects to achieve air superiority.

## BATTLEFIELD INTELLIGENCE

Both Israel and Russia had extensive targeting information at the beginning of their campaigns, but only Israel effectively exploited it. In November 2024, Israeli intelligence and air force officials worked in tandem to develop a comprehensive list of military targets, including equipment and persons, in order to decapitate, paralyze, and destroy Iranian air defenses.[50] Over the ensuing months, Israeli intelligence maintained effective surveillance of their intended targets through human and technical intelligence collection, providing actionable intelligence for rapid decisionmaking and dynamic targeting.[51] According to one former Mossad official, the majority of information collection for Israel's initial operation was done through cyber- and signals-based intelligence, with its long-range precision strikes enabled by cutting-edge Israeli technology and almost certainly with U.S. intelligence support.[52]

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Russia had also been developing human source networks inside Ukraine for years. These networks were expected to play a major role in the aforementioned information operations, but Russia's human sources also provided extensive targeting information prior to and during the invasion.[53] Most of Russia's long-range missile strikes targeted air defense sites that had been identified in the months leading up to the invasion, and Russia focused on

quickly destroying fixed radar, surface-to-air missile, and command sites in the opening phase of the conflict.[54] Russia managed to strike more than 75 percent of Ukrainian air defense sites in the first few days of the invasion, although the destructive effects were limited.[55] Russia does not appear to have sufficiently updated its target lists before the strikes began: Many of its missiles struck locations from which Ukrainian mobile GBADs, ammunition stockpiles, and aircraft had already been moved. Sometimes the movement immediately preceded the strike and was triggered by U.S. warnings, but in other cases, the assets had been moved years before, demonstrating that Russia failed to maintain timely target lists.[56]

Russia's information problem persisted beyond the opening salvos. Targeting plans were created every 24 hours—much too slow to destroy Ukraine's mobile systems following successful suppression.[57] In addition, targets appear to have been prioritized based on the order in which information was received, and old locations of the same target were sometimes not removed, further undermining the reactivity and efficiency of Russian forces.[58] Adding to the intelligence issues, battle damage assessment, the process by which militaries determine the level of damage done by a particular attack, was ineffective.[59] Without rapid and accurate battle damage assessment, follow-up strikes to finish a suppressed or damaged but undestroyed target cannot be ordered in time. Rather, the Russian military appeared to assume that every strike was effective, allowing suppressed GBADs to survive.[60] Had Russia developed a comprehensive multi-intelligence approach to its targeting, it would have been more likely to successfully exploit its numerical superiority in aircraft and long-range missiles to destroy Ukraine's mobile air defense systems.

Russia was further hampered by underinvestment in airborne command and control or intelligence, surveillance, and reconnaissance (ISR) assets. Russian military commentators have identified that shortages in airborne early warning and control system (AEW&C) aircraft, ISR, drones, signals intelligence, and integrated command and control likely contributed to the VKS' struggle to establish air superiority in Ukraine.[61] The VKS operates 15 AEW&C of the A-50 family, with perhaps half (or even fewer) in working condition.[62] Given the age of the fleet, these platforms fall significantly short of the capabilities offered by their Western counterparts.[63]

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In contrast, Israel clearly places a much greater emphasis on these platforms than does Russia. The IDF possesses four AEW&C aircraft, all of which were developed in the twenty-first century and are in working order, giving the IDF roughly twice as many AEW&C aircraft per combat aircraft as the VKS.[64] Israeli AEW&C aircraft are also almost certainly of higher quality than Russia's, given the latter's acknowledged neglect of its AEW&C systems. In addition, Israeli F-35Is operated in an ISR role as part of an integrated strike package in Operation Rising Lion, and the lack of Russian Su-57s in Ukraine deprived the VKS of anything approaching that capability.[65] Although Iran represented a much easier target than Ukraine, even Russian Defence Minister Andrey Belousov acknowledged Russia's need to deliver more EW and ISR systems to the battlefield in 2024.[66]

## FORCE EMPLOYMENT

Force employment is how a military behaves in combat—especially the way in which a force coordinates fire and movement across different units and weapons—and is frequently used to explain battlefield success.[67] Accordingly, the specific techniques, tactics, and procedures employed in an offensive air (or air denial) campaign by military forces and their enablers can significantly influence their ability to achieve operational objectives, often regardless of technological or numerical advantages. In this regard, force employment helps explain Israel's success and Russia's failure across three main tactical behaviors: (1) the attacker's employment of heterogenous strike packages, (2) effective integration of multidomain effects, and (3) the defender's employment of GBADs in dispersed mobile units. Israel's ability to employ its forces more effectively than Russia was likely further increased by the higher level of training received by Israeli pilots.

Coordinating multiple types of weapons allowed Israel to mass effects rapidly from ground-based long-range missiles and aerial attack platforms. Israeli strike packages seem to have at least sometimes employed one F-35I in an ISR role flying ahead of one or more F-15I or F-16Is.[68] The IAF also employed a mix of precision-guided glide bombs and air-launched missiles, including ballistic missiles.[69] Specific weapon-to-target pairing for the IAF during the campaign is somewhat speculative, but varying loadouts have been identified, with a plethora of GPS- and laser-guided munitions reflecting a desire for flexibility and the potential of Israeli ground-based target designation.[70] Furthermore, the employment of EW via airborne jammers and electronic attack systems (designed to confound adversary radars) is essential to enabling destructive strikes by supporting aircraft. The IDF's airborne EW platforms are hard to identify, but its F-35I and F16I are known to carry domestic EW systems, and Israel is known as a world leader in EW defense technology.[71] In contrast, Russian EW pods are often operated in an autonomous mode that only provides protective jamming rather than electronic suppression of enemy GBADs.[72]

On the other hand, the VKS did not demonstrate that it combined suppressive weapons, like ARMs, with weapons better suited to destroying the target—especially precision-guided munitions. Russian aircraft were observed using a variety of ARMs from the Kh-31 series launched primarily from Su-35S multi-role fighters, Su-30SM multi-role fighters, and Su-34 strike fighters. At the level of the individual aircraft, Russian airframes were rarely observed loaded with both ARMs and other air-to-surface weapons, reflecting an insufficient weapons combination for both suppression and destruction of adversary GBADs.[73] In addition, Russian aircraft frequently flew without EW pods during the first three days of the conflict.[74] Russian strikes were primarily conducted by single aircraft, which is consistent with the VKS's combat experience in Syria but limits an air force's ability to combine suppressive and destructive effects.[75]

Russia's ability to combine arms was further limited by problems of fratricide, a sign of ineffective command and control. Russian EW caused so many problems with communications between poorly equipped Russian ground forces that Russia was forced to scale back its EW efforts against Ukrainian GBADs.[76] Russian fratricide also reflects a difficulty coordinating the activities of different combat arms, a vital task for modern force employment. Russian pilots were repeatedly shot down by their own GBADs.[77] In contrast, suffering ground-to-air friendly fire prompted Ukraine to adapt its force employment by placing Man-Portable Air-Defense Systems (MANPADS) operators in its mobile air defense teams, which integrated them into air force and air defense planning cycles and communication networks and reduced fratricide by MANPADS operators.[78]

Underlying many of these differences in force employment are likely major differences between IAF and VKS training, as previously discussed. Russian pilots receive far less training than their Israeli counterparts. VKS pilots fly fewer than 100 training hours per year, while Israeli pilots likely fly at or above the NATO minimum of 180 flight hours per year.[79] Russia's training is also less realistic than Israel's, focusing on simple tasks rather than complex operations.[80]

Ukrainian adaptation also played a role. Ukraine's employment of a mobile, dispersed GBAD force allowed it to deny Russia air superiority. Ukraine rapidly relocated most of its mobile air defense systems shortly before the first round of Russian long-range strikes.[81] It then dispersed its Buk units, which had previously operated as divisions, into small air defense teams. Ukraine's dispersal and mobility allowed it to employ new "shoot-and-scoot" tactics with its mobile Buk systems, deploying them as individual "pop-up threats" rather than as batteries.[82] Integration of Ukrainian MANPADS operators into the air-defense teams also allowed the Ukrainians to force Russian pilots to choose between flying high and being targeted by radar-based GBADs or flying low and facing Ukrainian MANPADS missiles.[83]

This mobility allowed Ukraine's GBADs to survive and eventually recover, playing a role in the Russian failure to convert suppression into destruction: Ukraine was able to disperse its mobile systems in the hours before Russian strikes began, saving about 90 percent of them from destruction.[84] Ukraine's dispersed force employment required tradeoffs—Buk units were cut off from their battalion-level surveillance and targeting assets—but the new force structure allowed for greater geographic coverage and survivability.[85] Ukraine's Buks quickly emerged as the backbone of the Ukrainian air defense system, deploying near the front lines to push the VKS out of Ukrainian airspace.[86]

## IMPLICATIONS

This section outlines lessons for military forces seeking to achieve air superiority or denial. Most lessons merely reinforce enduring principles of war, but Israel's use of special

operations to disrupt and destroy Iranian GBADs has novel operational implications.

## COMBINED ARMS

Both examples reinforce the importance of combined arms at the strategic, operational, and tactical levels. Combined arms work in two ways: (1) the strengths of one system compensate for the weaknesses of another, and (2) enemies trying to evade one system become targetable by another.[87] Ukraine benefited from the first effect when its combat aircraft took over the air defense mission from its GBADs during the first few days of the conflict. Iran, with its ancient and incapable air force, did not. Ukraine also benefited from the second effect when it integrated its MANPADS operators into air defense teams with mobile Buk systems: Russian pilots sought to avoid radar targeting by flying low, which exposed them to targeting by MANDPADS missiles.[88]

Israel likely also benefited from combined arms, albeit more clearly at the tactical level. Israeli weapons loadouts and investments in EW systems suggest that it combined multiple modes of attack in which kinetic and electronic systems took advantage of different weaknesses of Iranian systems.

Similarly, Russia began to benefit from the effects of combined arms and long-range artillery as it integrated Orlan-10 UASs into its efforts, but by then it was too late to take full advantage of the initial suppression of Ukraine's GBADs.[89]

## QUALITATIVE SUPERIORITY

The quality of technology and personnel differed across the campaigns, and both likely made a big difference. Israel almost certainly benefited from enormous technological superiority over Iran, particularly in its ISR, EW, and PGM capabilities.[90] Ukraine also probably benefited from its significant investments in upgrading its GBADs. However, a lack of granular data on what systems were used and how they performed on the battlefield limit the conclusions that can be drawn regarding technological superiority.

Human capital, however, clearly proved critical. Russia's technological superiority was insufficient to overcome training deficiencies, and aggressive Ukrainian pilots were able to blunt the efforts of their better-equipped but under-trained VKS counterparts. Ukraine's GBAD operators also proved capable of operating independently as pop-up threats, which required confidence and initiative that can only be effectively taught through realistic training.

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## FLEXIBILITY

Ukraine's dispersion of its mobile Buk systems likely made them more survivable, although Russia's failure to employ large, heterogenous air strikes or order rapid follow-on strikes makes attributing Ukraine's success entirely to its force employment impossible. Operating its Buk launchers as individual pop-up threats may have failed against larger formations that employed a greater mix of strike and countermeasure assets, like those employed by Israeli forces. Against the types of formations envisaged by Western air superiority doctrine, a more traditional integrated air defense system may have performed better. Militaries can hedge against this uncertainty by prioritizing the development and acquisition of mobile systems that can operate either in a coordinated battery or as pop-up threats and training their crews to operate in both modes.

This type of flexibility requires investment. Ukraine's ability to disperse its Buk systems depended in part on the Buk's use of transporter erector launcher and radar (TELAR) vehicles. TELARs incorporate targeting and launch capabilities into a single vehicle, whereas other types of launchers cannot operate without accompanying radar vehicles. Many militaries—like Taiwan's, for example—operate no long- or medium-range TELARs, which limits the operational flexibility of their GBADs[91].

Flexibility also matters for attackers. Israel's use of mixed strike packages suggested a desire for flexibility. In contrast, the VKS demonstrated little operational flexibility. Russia's apparent practice of striking targets in the order received and corresponding lack of dynamic targeting increased the effectiveness of Ukraine's dispersed pop-up tactics. VKS pilots did not demonstrate that they were able to react effectively on the fly to the sudden emergence of a new threat or opportunity.

The VKS also proved inflexible in another important way: Russia's command structure limited its ability to pursue its air superiority mission to the greatest extent possible. Sub-

ordinating air units to ground command and the priority given to close air support in Russian practice diverted VKS resources from the air superiority mission when Ukraine's air defenses were at their weakest. The priority given to ground operations also forced the VKS to limit its use of EW against Ukrainian systems, reducing the effect of combined arms.

### *INTELLIGENCE*

Effective air superiority requires aggressive, continuous intelligence collection and responsive dissemination of target data, most notably in terms of threat assessments for the supported operational assets.[92] Russia's failure to update its intelligence during the lead-up to the attack likely limited the efficacy of its initial strikes. In contrast, Israeli intelligence maintained effective custody of these targets through a variety of intelligence sources, further preparing the operational environment to overwhelm their opponents.

Suppression of enemy air defense must always be followed by rapid cycles of battle damage assessment and follow-up strikes until they are confirmed destroyed or contact with the enemy is lost, although this need is not unique to air superiority operations. Russia's failure to conduct follow-on strikes when Ukrainian GBADs were suppressed allowed Ukrainian air defenses to reconstitute after a few days. Rapid cycles of intelligence processing for air or missile strikes require pushing analysis capability and targeting authority down the chain of command.

Closely related to the importance of intelligence is the importance of surprise. The United States warned Ukraine of Russia's intent to invade, allowing the Ukrainian armed forces to relocate its mobile GBADs before Russian strikes arrived on target.[93] Israel achieved complete surprise over Iran, which did not mount any effective defense. While hardly a novel lesson, the two conflicts reinforce the desirability of achieving surprise, the need to maintain operational security, and the value of warning intelligence.

### *SPECIAL OPERATIONS*

Special and intelligence operations have a surprisingly large role to play in modern air superiority operations. Israel effectively demonstrated that these operations can attack an air defense system from unexpected and poorly defended directions, thus enabling conventional forces. Air planners should coordinate with organizations responsible for covert and clandestine operations, which will require overcoming bureaucratic barriers in many militaries. As they are integrated into conventional air superiority plans, irregular operations should not depend solely or primarily on psychological measures to suppress or disrupt adversaries' air defense (or more general military and political) systems. While information operations or the psychological effects of violence can support destructive or suppressive operations, they cannot replace them.

Air defenders cannot ignore these types of operation. GBADs must be protected from close-in attacks by special operations forces. Drone attacks such as those conducted by Israel against Iran are repeatable, meaning that other countries can replicate them to an extent, even if the networks and systems they require are used up in the attack. Local counter-UAS bubbles will be a vital part of integrated air defense systems in the future. However, these attacks are unlikely to be limited to precision weapons: Irregular forces could also conduct EW attacks, plant cyberweapons, or engage in old-fashioned sabotage to suppress or destroy air defense systems. Counterintelligence will play a major role in defending against these types of operation, but relying entirely on detecting covert operations puts too many eggs in one basket and will likely prove increasingly vulnerable as advancements in artificial intelligence reduce the need for human involvement in UAS operations. Individual air defense sites should be hardened against cyber, electronic, and physical attacks originating within the system's lethal envelope.

## CONCLUSION

Despite the differences between the Ukrainian and Iranian contexts, several lessons for air defense and air superiority efforts are evident from Israel and Russia's air campaigns. Israel succeeded where Russia failed because it let its air forces maintain their focus on achieving and maintaining air superiority, effectively integrated destructive special operations into its preparation of the environment, rapidly updated its battlefield intelligence, and procured, planned, and trained for offensive air superiority operations for years. Ukraine also contributed to its own success through the courage and aggression of its fighter pilots and the adaptability of its GBAD systems. ■

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Photo Source: JACK GUEZ/AFP via Getty Images

# ENDNOTES

1 For example, see Dara Massicot, "Ukraine Needs Help Surviving Airstrikes, Not Just Killing Tanks," Rand, *Commentary*, January 19, 2022, https://www.rand.org/pubs/commentary/2022/01/ukraine-needs-help-surviving-airstrikes-not-just-killing.html.

2 Justin Bronk, "The Mysterious Case of the Missing Russian Air Force," Royal United Services Institute, February 28, 2022, https://www.rusi.org/explore-our-research/publications/commentary/mysterious-case-missing-russian-air-force; Phil Stewart and Idrees Ali, "What Happened to Russia's Air Force? U.S. Officials, Experts Stumped," Europe, Reuters, March 2, 2022, https://www.reuters.com/world/europe/what-happened-russias-air-force-us-officials-experts-stumped-2022-03-01/; and "The Curious Case of Russia's Missing Air Force," The Economist, March 8, 2022, https://www.economist.com/interactive/2022/03/08/curious-case-russias-missing-air-force.

3 The authors owe this insight to a comparison between Israel's non-repeatable pager operation against Hezbollah and Ukraine's repeatable Operation Spider's Web made during a discussion held under the Chatham House Rule in Basin Harbor, Vermont, on June 11, 2025.

4 Mykhaylo Zabrodskyi et al., *Preliminary Lessons in Conventional Warfighting from Russia's Invasion of Ukraine: February-July 2022* (London: Royal United Services Institute, 2022), 17, https://www.rusi.orghttps://www.rusi.org.

5 Natalie Treloar, "Special Operations by Israel and Ukraine Were Immediate Tactical Successes. Their Strategic Impact Will Take More Time to Assess," Bulletin of the Atomic Scientists, June 30, 2025, https://thebulletin.org/2025/06/special-operations-by-israel-and-ukraine-were-immediate-tactical-successes-their-strategic-impact-will-take-more-time-to-assess/.

6 "Israel Carries out Strikes Targeting Iran's Nuclear, Military Sites," Al Jazeera, June 13, 2025, https://www.aljazeera.com/news/2025/6/13/sounds-of-explosions-heard-in-irans-capital-tehran.

7 Justin Bronk et al., *The Russian Air War and Ukrainian Requirements for Air Defence* (London: Royal United Services Institute, 2022), 26, https://www.rusi.org/explore-our-research/publications/special-resources/russian-air-war-and-ukrainian-requirements-air-defence.

8 Mykhaylo Zabrodskyi et al., *Preliminary Lessons in Conventional Warfighting from Russia's Invasion of Ukraine*, 41. During the first month, Russia launched more than 2,000 cruise missiles; see Justin Bronk et al., *The Russian Air War and Ukrainian Requirements for Air Defence,* 25.

9 Justin Bronk et al., *The Russian Air War and Ukrainian Requirements for Air Defence*, 7–8.

10 David Isaac, "IDF Announces It Has Complete Aerial Superiority over Tehran," Jewish News Syndicate, June 16, 2025, https://www.jns.org/idf-we-have-complete-aerial-superiority-over-tehran/.

11 Sebastien Roblin, "Pictures: In Battle for Hostomel, Ukraine Drove Back Russia's Attack Helicopters and Elite Paratroopers," 19FortyFive, February 25, 2022, https://www.19fortyfive.com/2022/02/pictures-in-battle-for-hostomel-ukraine-drove-back-russias-attack-helicopters-and-elite-paratroopers/; and Justin Bronk et al., *The Russian Air War and Ukrainian Requirements for Air Defence*, 7–8.

12 Justin Bronk et al., *The Russian Air War and Ukrainian Requirements for Air Defence*, 14.

13 Justin Bronk et al., *The Russian Air War and Ukrainian Requirements for Air Defence*, 35.

14 Stijn Mitzer et al., "Attack On Europe: Documenting Russian Equipment Losses During The 2022 Russian Invasion Of Ukraine," Oryx, May 1, 2022, https://web.archive.org/web/20220501034436/https://www.oryxspioenkop.com/2022/02/attack-on-europe-documenting-equipment.html. The nature of air combat makes open-source data extremely difficult to gather. For more on this point, see Justin Bronk, *Russian Combat Air Strengths and Limitations: Lessons from Ukraine* (Arlington, VA: Center for Naval Analyses, 2023), 1-2, https://www.cna.org/analyses/2023/05/russian-combat-air-strengths-and-limitations.

15 David Rodman, "The Role of the Israeli Air Force in the Operational Doctrine of the Israeli Defense Forces: Continuity and Change," *Air & Space Power Journal* 29 (2000): 2-3, https://www.airuniversity.af.edu/Portals/10/ASPJ/journals/Chronicles/rodman.pdf.

16 Michael Starr, "What Lessons Did the Israel Air Force Learn from the Yom Kippur War?", *Jerusalem Post*, October 5, 2023, https://www.jpost.com/israel-news/article-761809.

17 Udi Etsion, "Inside Israel's Secret 20-Year Plan to Strike Iran: Advanced Weapons Unveiled," *Jerusalem Post*, October 16, 2024, https://www.jpost.com/israel-news/article-824803. Israel's defense strategy cites "freedom of action in the air" as a fundamental principle for the use of force, see "Israel Defense Forces Strategy Document," Belfer Center for Science and International Affairs, December 16, 2024, https://www.belfercenter.org/research-analysis/israel-defense-forces-strategy-document.

18 Phillips Payson O'Brien and Edward Stringer, "The Overlooked Reason Russia's Invasion Is Floundering," The Atlantic, May 9, 2022, https://www.theatlantic.com/ideas/archive/2022/05/russian-military-air-force-failure-ukraine/629803/.

19 Dmitry Adamsky, "Russian Lessons from the Syrian Operation and the Culture of Military Innovation," *Marshal Center Security Insight 47* (February 2020), https://www.marshallcenter.org/en/publications/security-insights/russian-lessons-syrian-operation-and-culture-military-innovation.

20 Mykhaylo Zabrodskyi et al., *Preliminary Lessons in Conventional Warfighting from Russia's Invasion of Ukraine*, 25. For more on Russia's flawed strategic assumptions, see Jack Watling et al., *Preliminary Lessons from Russia's Unconventional Operations During the Russo-Ukrainian War, February 2022-February 2023*(London: Royal United Services Institute for Defence and Security Studies, 2023), https://rusi.org/explore-our-research/publications/special-resources/preliminary-lessons-russias-unconventional-operations-during-russo-ukrainian-war-february-2022; and Sam Cran-

ny-Evans and Sidharth Kaushal, "The Intellectual Failures Behind Russia's Bungled Invasion," Commentary, Royal United Services Institute, April 1, 2022, https://www.rusi.org/explore-our-research/publications/commentary/intellectual-failures-behind-russias-bungled-invasion.

21 Michael Kofman, "Russian Airpower in Context: The First Year of the War," *in The Air War in Ukraine: The First Year of Conflict*, ed. Dag Henriksen and Justin Bronk (Oxfordshire: Routledge, 2024), 16; and Sean M. Wiswesser, "Potemkin on the Dnieper: The Failure of Russian Airpower in the Ukraine War," *Small Wars & Insurgencies 34*, no. 7 (2023): 1210–11, https://doi.org/10.1080/09592318.2023.2187201.

22 Mykhaylo Zabrodskyi et al., *Preliminary Lessons in Conventional Warfighting from Russia's Invasion of Ukraine*, 45.

23 "Эксперт Рассказал о Критической Проблеме Российских ВКС [Expert talks about critical problem of Russian Aerospace Forces]," Charter'97, April 8, 2025, https://charter97.org/ru/news/2025/4/8/636170/.

24 Toi Staff, "Israel, US Send Secret Delegation to Ukraine to Train against S-300 - Report," Times of Israel, October 16, 2018, https://www.timesofisrael.com/israel-us-send-secret-delegation-to-ukraine-to-train-against-s-300-report/.

25 Mitch Ginsburg, "Could Israeli F-35s Turn the Tables on Iranian S-300 Missiles?," Times of Israel, April 19, 2015, https://www.timesofisrael.com/could-israeli-f-35s-turn-the-tables-on-iranian-s-300-missiles/.

26 Lieutenant Colonel Rafael Ichaso, SP AF, "Russian Air Force's Performance in Ukraine," *Transforming Joint Air and Space Power 35* (February 15, 2023), https://www.japcc.org/articles/russian-air-forces-performance-in-ukraine-air-operations-the-fall-of-a-myth/; Justin Bronk, Russian Combat Air Strengths and Limitations, 12–13.

27 Justin Bronk, "Developments in Russian Combat Air Spending and Likely Operational Implications," in *Russian Concept of War, Management and Use of Military Power: Conceptual Change*, ed. Pentti Forsström (Washington, DC: National Defense University, 2022), 92; Matthew Galamison, *The Failures of the Russian Aerospace Force in Ukraine* (Newport, RI: Naval War College, 2023), 5–8, https://apps.dtic.mil/sti/trecms/pdf/AD1206107.pdf; and Jaganath Sankaran, "The Failures of Russian Aerospace Forces in the Russia-Ukraine War and the Future of Air Power," Journal of Strategic Studies 47, nos. 6–7 (2024): 867–68, https://doi.org/10.1080/01402390.2024.2345899.

28 Alex Hollings, "Why the F-35 Fighter Jet Is Such a Badass Plane—And Has Such a Giant Price Tag," Popular Mechanics, September 21, 2023, https://www.popularmechanics.com/military/aviation/a35281371/f-35-history/; and Howard Altman, "Israeli F-16I Navigator Opens Up About Striking Iran," The War Zone, July 24, 2025, https://www.twz.com/air/flying-and-fighting-in-the-israeli-air-forces-f-16i-sufa.

29 Maya Carlin, "Iran Is Learning to Fear Israel's Top Fighters," National Interest, June 21, 2025, https://nationalinterest.org/blog/buzz/iran-is-learning-to-fear-israels-top-fighters.

30 Aaron Mehta, "Iran's air defenses around Natanz nuclear site More 'brittle' than expected: Exclusive analysis," Breaking Defense, May 15, 2025, https://breakingdefense.com/2025/05/irans-air-defenses-around-nuclear-site-more-brittle-than-expected-exclusive-analysis/.

31 Jasim Al-Azzawi, "From Rust to Rockets: The Battle to Modernise Iran's Legacy Air Force," Middle East Monitor, August 1, 2025, https://www.middleeastmonitor.com/20250801-from-rust-to-rockets-the-battle-to-modernize-irans-legacy-air-force/; and Harrison Kass, "Why Is Iran's Air Force Such a Mess?", The National Interest, June 29, 2025, https://nationalinterest.org/blog/buzz/why-irans-air-force-such-mess-hk.

32 Justin Bronk et al., *The Russian Air War and Ukrainian Requirements for Air Defence*, 9. For a more extended discussion of Russia's qualitative superiority, see Justin Bronk, *Russian Combat Air Strengths and Limitations*, 6–7.

33 Justin Bronk et al., *The Russian Air War and Ukrainian Requirements for Air Defence*, 11–12.

34 Brandon J. Brandon Weichart, "Russia's Su-57 Felon Fighter Nightmare Has Just Begun to 'Drop,'" National Interest, August 4, 2024, https://nationalinterest.org/blog/buzz/russias-su-57-felon-fighter-nightmare-has-just-begun-drop-210798.

35 Matthew S. Galamison and Michael B. Petersen, "Failures of the Russian Aerospace Forces in Ukraine," *Air & Space Operations Review 2*, no. 3 (2023): 8, https://www.airuniversity.af.edu/Portals/10/ASOR/Journals/Volume-2_Number-3/Galamison_Petersen.pdf.

36 Matthew S. Galamison and Michael B. Petersen, "Failures of the Russian Aerospace Forces in Ukraine," 8–9.

37 Matthew S. Galamison and Michael B. Petersen, "Failures of the Russian Aerospace Forces in Ukraine," 11.

38 Justin Bronk, "How Ground-Based Air Defences Have Shaped the Air War over Ukraine," *in The Air War in Ukraine*, 146.

39 International Institute for Strategic Studies, "Chapter Six: Middle East and North Africa," *The Military Balance* 125, no. 1 (2025): 347, https://doi.org/10.1080/04597222.2025.2445478; and David Deptula, "Air Superiority and Russia's War on Ukraine," Air & Space Forces Magazine, July 26, 2024, https://www.airandspaceforces.com/article/air-superiority-and-russias-war-on-ukraine/.

40 International Institute for Strategic Studies, "Chapter Five: Russia and Eurasia," The Military Balance 123, no. 1 (2023): 203, https://doi.org/10.1080/04597222.2023.2162717.

41 International Institute for Strategic Studies, "Chapter Six: Middle East and North Africa," The Military Balance, 337–42.

42 ניר דבורי [Nir Davori], "תיעוד: הכוח המבצעי של המוסד פורס את מערכות התקיפה בלב איראן [Documentation: Mossad's Operational Force Deploys Attack Systems in the Heart of Iran]," N12, June 13, 2025, https://www.mako.co.il/news-military/f239747af17c5910/Article-497d0f5ac086791026.htm?pId=173113802; and Dov Lieber, "Inside 'Operation Narnia,' the Daring Attack Israel Feared It Couldn't Pull Off," Wall Street Journal, June 26, 2025, https://www.wsj.com/world/middle-east/israel-iran-attack-operation-narnia-a2c38ace.

43 Lieber, "Inside 'Operation Narnia.'"

44 Emanuel Fabian, "Israeli Commandos Operated inside Iran during War, IDF Chief Says," Times of Israel, June 25, 2025, https://www.timesofisrael.com/liveblog_entry/israeli-commandos-operated-inside-iran-during-war-idf-chief-says/.

45 Neil Renic, "Air Power by Small, Low-Cost Drones: Implications for Future Warfare," *The Air Power Journal*, 2024, https://theairpowerjournal.com/air-power-by-small-low-cost-drones-implications-for-future-warfare. According to one analysis, Ukraine operated the second-densest GBAD system in Europe behind only Russia. See David A. Deptula and Christopher J. Bowie, "The Significance of Air Superiority: The Ukraine-Russia War," The Mitchell Institute Policy Papers, no. 50 (July 2024), 4, https://www.mitchellaerospacepower.org/app/uploads/2024/07/Ukraine_Control_of_the_-Air_Policy_Paper_50.pdf.

46 For a detailed discussion of Russia's special operations campaign, see Jack Watling et al., *Preliminary Lessons from Russia's Unconventional Operations During the Russo-Ukrainian War*.

47 Spetsnaz (Russian special operations forces) units were frequently employed in more conventional tasks like air assault and battlefield reconnaissance. This was part of a broader pattern of Russia using irregular forces for conventional missions. See Jack Watling et al., *Preliminary Lessons from Russia's Unconventional Operations During the Russo-Ukrainian War*, 18, 27-30.

48 Jack Watling et al., *Preliminary Lessons from Russia's Unconventional Operations During the Russo-Ukrainian War*, 15–16.

49 Jack Watling et al., *Preliminary Lessons from Russia's Unconventional Operations During the Russo-Ukrainian War*, 17.

50 Lieber, "Inside 'Operation Narnia.'"

51 Treloar, "Special Operations by Israel and Ukraine Were Immediate Tactical Successes."

52 Rami Igra, "Former Mossad Official Details How Israel Eliminated Iran's Military Elite," July 5, 2025, Video, http://bbc.com/news/videos/ckglkxl2d25o.

53 Jack Watling et al., *Preliminary Lessons from Russia's Unconventional Operations During the Russo-Ukrainian War*, 31–32.

54 Justin Bronk et al., *The Russian Air War and Ukrainian Requirements for Air Defence*, 26.

55 Justin Bronk, *Russian Combat Air Strengths and Limitations*, 4.

56 Mykhaylo Zabrodskyi et al., *Preliminary Lessons in Conventional Warfighting from Russia's Invasion of Ukraine: February-July 2022*, 24.

57 Bronk et al., *The Russian Air War*, 28. In a later analysis, Watling notes that some short-ranged ballistic missiles struck with much lower latency, although he offers no hypotheses on why. Jack Watling, "Long-Range Precision Fires in the Russo-Ukrainian War," in The Air War in Ukraine, 70.

58 Jack Watling et al., *Preliminary Lessons from Russia's Unconventional Operations During the Russo-Ukrainian War*, 32.

59 "Marine Corps Warfighting Publication (MCWP) 3-22.2: Suppression of Enemy Air Defenses (SEAD)," Department of the Navy, May 18, 2001, 1-12, 4–4.

60 Mykhaylo Zabrodskyi et al., *Preliminary Lessons in Conventional Warfighting from Russia's Invasion of Ukraine: February-July 2022*, 25; Justin Bronk et al., The Russian Air War and Ukrainian Requirements for Air Defence, 17.

61 Boroda. "Чего Не Хватает ВКС России Для Завоевания Стратегического Господства в Воздухе? [What Does the Russian Aerospace Forces Lack to Gain Strategic Air Superiority?]." Альтернативная История, July 12, 2025. https://alternathistory.ru/chego-ne-hvataet-vks-rossii-dlya-zavoevaniya-strategicheskogo-gospodstva-v-vozduhe/.

62 Boroda. "Чего Не Хватает ВКС России Для Завоевания Стратегического Господства в Воздухе? [What Does the Russian Aerospace Forces Lack to Gain Strategic Air Superiority?]."

63 Boroda. "Чего Не Хватает ВКС России Для Завоевания Стратегического Господства в Воздухе? [What Does the Russian Aerospace Forces Lack to Gain Strategic Air Superiority?]."

64 "The Military Balance 2025," 347; "Chapter Five: Russia and Eurasia," The Military Balance 122, no. 1 (2022): 201–2, https://doi.org/10.1080/04597222.2022.2022930.

65 Howard Altman, "Israeli F-16I Navigator Opens Up About Striking Iran"; Alex Hollings, "Why the F-35 Fighter Jet Is Such a Badass Plane."

66 Иван Петров [Ivan Petrov], "Министр Обороны РФ Проверил Боевую Работу Авиации в Зоне СВО [Russian Defense Minister Reviews Aviation Combat Operations in the SVO Zone]," Российская Газета [Rossiyaskaya Gazeta], June 14, 2024, https://rg.ru/2024/06/14/ministr-oborony-rf-proveril-boevuiu-rabotu-aviacii-v-zone-svo.html.

67 Stephen Biddle, *Military Power: Explaining Victory and Defeat in Modern Battle* (Princeton University Press, 2006).

68 Howard Altman, "Israeli F-16I Navigator Opens Up About Striking Iran."

69 Ibid.

70 Graham Scarbro, "Iran-Israel Conflict: A Quicklook Analysis of Operation Rising Lion," U.S. Naval Institute, June 2025, https://www.usni.org/magazines/proceedings/2025/june/iran-israel-conflict-quicklook-analysis-operation-rising-lion. *Proceedings of the U.S. Naval Institute* 151, no. 6 (June 2025), https://www.usni.org/magazines/proceedings/2025/june/iran-israel-conflict-quicklook-analysis-operation-rising-lion.

71 Ibid.

72 Matthew S. Galamison and Michael B. Petersen, "Failures of the Russian Aerospace Forces in Ukraine," 10.

73 Guy Plopsky and Justin Bronk, "Russian SEAD Efforts during the Air War in Ukraine," in *The Air War in Ukraine*.

74 Mykhaylo Zabrodskyi et al., *Preliminary Lessons in Conventional Warfighting from Russia's Invasion of Ukraine: February-July 2022*, 26.

75 Justin Bronk et al., *The Russian Air War and Ukrainian Requirements for Air Defence*, 8; Justin Bronk, *Russian Combat Air Strengths and Limitations*, 5; and Justin Bronk, "Is the Russian Air Force Actually Incapable of Complex Air Operations?," Royal Unit-

ed Services Institute, March 4, 2022, https://www.rusi.orghttps://www.rusi.org. The homogeneity of Russian air groups should not be overstated. Strike aircraft were supported by a variety of support aircraft, but synchronization of effects by combat aircraft remained limited. See Plopsky and Bronk, "Russian SEAD Efforts during the Air War in Ukraine," 118.

76 Justin Bronk et al., *The Russian Air War and Ukrainian Requirements for Air Defence*, 13.

77 Sean M. Wiswesser, "Russian VKS Operational Planning for Ukraine, Hybrid War, and the Role of the Russian Special Services," in *The Air War in Ukraine*.

78 Bronk, "How Ground-Based Air Defences Have Shaped the Air War over Ukraine," 148.

79 David Roza, "Why the Skies over Ukraine Have Proven so Deadly for Russian Pilots," Task & Purpose, March 17, 2022, https://taskandpurpose.com/news/russian-aircraft-shoot-down-ukraine/; Algemene Rekenkamer [Netherlands Court of Audit], "Our criticisms of the ministry of defence's calculations," https://english.rekenkamer.nl/topics/joint-strike-fighter/the-netherlands-as-a-purchaser-of-the-jsf/operational-aspects/our-criticisms-of-the-ministry-of-defence's-calculations; and Howard Altman, "Israeli F-16I Navigator Opens Up About Striking Iran."

80 David Roza, "Why the Skies over Ukraine Have Proven so Deadly for Russian Pilots."

81 Justin Bronk et al., *The Russian Air War and Ukrainian Requirements for Air Defence*, 26.

82 Justin Bronk et al., *The Russian Air War and Ukrainian Requirements for Air Defence*, 14, 27.

83 Justin Bronk et al., *The Russian Air War and Ukrainian Requirements for Air Defence*, 14–15.

84 Mykhaylo Zabrodskyi et al., *Preliminary Lessons in Conventional Warfighting from Russia's Invasion of Ukraine: February-July 2022*, 24.

85 Justin Bronk, "How Ground-Based Air Defences Have Shaped the Air War over Ukraine," 148–49.

86 Mykhaylo Zabrodskyi et al., *Preliminary Lessons in Conventional Warfighting from Russia's Invasion of Ukraine: February-July 2022*, 26.

87 Jonathan M. House, *Combined Arms Warfare in the Twentieth Century*, Modern War Studies (Lawrence, KS: University Press of Kansas, 2001), 4–5.

88 Justin Bronk et al., *The Russian Air War and Ukrainian Requirements for Air Defence*, 14–15.

89 Justin Bronk et al., *The Russian Air War and Ukrainian Requirements for Air Defence*, 16–17; "How Ground-Based Air Defences Have Shaped the Air War over Ukraine," 155–56.

90 Although the F-35I is also a stealth asset, there is no evidence that its low observability made much of a difference given the degradation of already weak Iranian radar capabilities—one Israeli pilot told a reporter that not a single surface-to-air missile was even fired. See Howard Altman, "Israeli F-16I Navigator Opens Up About Striking Iran."

91 "Chapter Five: Asia," *The Military Balance* 125, no. 1 (2025): 302, https://doi.org/10.1080/04597222.2025.2445477.

92 Air Land Sea Application Center, "J-SEAD: Multi-Service Tactics, Techniques, and Procedures for Joint Suppression of Enemy Air Defenses (ATP 3-01.4, MCRP 3-31.3, NTTP 3-01.42, AFTTP 3-2.28)," Department of Defense Air Land Sea Application Center, 2022, 27.

93 Mykhaylo Zabrodskyi et al., *Preliminary Lessons in Conventional Warfighting from Russia's Invasion of Ukraine: February-July 2022*, 24.