

## Air Power

# Air Defence Insights From the Ukraine-Russia Conflict

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This paper analyses Ukraine's air defence capabilities during the current Ukraine-Russia conflict to derive lessons applicable to the Australian Defence Force (ADF). It explores the evolution of Ukraine's air defence capabilities from 2014 to 2025, highlighting how preparedness, mobility, integration and Western support enabled Ukraine to counter a multifaceted aerial threat. Comparing Ukraine and Australia's strategic environments identifies similarities, including multi-faceted strategic threats and advanced long-range missile threats, and differences, particularly Australia's geographic isolation and lower risk of invasion. From this comparison, the paper identifies five key insights for the ADF's Integrated Air and Missile Defence (IAMD) system: the need for domestic manufacturing of air defence munitions; the importance of agile and broad system integration; the imperative to defend civilian infrastructure; the limitations of purely defensive systems; and the strategic value of offensive strike capabilities in complementing air defence. These insights underscore the importance of IAMD to Australia's defence, and suggest ways to improve this capability in preparation for any future regional conflict scenarios.

## 1. Introduction

Ukraine's ability to defend against aircraft and missiles has played a key role in countering Russia's invasion. This offers the ADF an opportunity to identify valuable air defence insights, despite the conflict occurring in a very different strategic context from Australia's.

Australia's 2024 National Defence Strategy and 2023 Defence Strategic Review emphasise the importance of Integrated Air and Missile Defence (IAMD) systems to protect Australia and its interests. The proliferation of long-range precision strike weapons in Australia's region has eliminated the protection previously afforded by our geographical isolation (Department of Defence, 2023). Australia's strategic concept of National Defence expands the ADF's responsibility for countering these threats. An ADF IAMD system must therefore prevent adversaries from using these weapons to threaten Australia or its interests (Department of Defence, 2023).

This paper will examine Ukraine's air defence system and review how Russian threats and Ukrainian responses have evolved. It will then assess the Ukrainian experience from an Australian perspective, comparing the strategic environments and their implications for defending against air and missile threats. Finally, it will present insights from the Ukraine-Russia conflict relevant to the ADF. This paper focuses specifically on military air defence systems and does not examine broader civil defence measures, which merit separate study.

## 2. Air defence in the Ukraine-Russia Conflict

### 2.1. Ukraine readies air defences in depth

When Russia invaded Ukraine in February 2022, Ukraine boasted a well-equipped, ready and relatively well-maintained air defence capability. This was a significant improvement on their capability eight years earlier when Russian forces occupied the Crimean Peninsula. In 2014, Ukraine's air defences had suffered from years of neglect. Their predominantly Soviet-era equipment had low operational readiness and inadequate logistics, and their personnel were poorly trained. This led to low levels of readiness, which the Russians exploited in 2014 (Sankaran, 2024). However, in 2014 the foundations were in place for Ukraine to establish a potent air defence system. Importantly, Ukraine's armed forces retained a Soviet-style structure, incorporating more ground-based air defence capabilities than a Western military of similar size (Kofman, 2024).

Russia's occupation of Crimea prompted significant improvements in Ukraine's military capabilities and national defence enterprise. Ukraine's air defence system benefitted from these improvements in three ways. First, increased resourcing led to better training and critical maintenance and repair work. This brought air defence capabilities to high levels of readiness (Roblin, 2021). Second, enhancements to Ukraine's military industry and capability acquisition led to the integration of new drones, munitions and networking software into air defence systems (Kuzmuk & Scarazzato, 2025). Third, the loss of Crimea led to significant Western military aid to Ukraine. Initial support was predominantly non-lethal, but included a crucial data sharing agreement with the US (Mills, 2022). As Russia continued threatening

Ukraine's eastern regions, this support expanded to include military capabilities. Western partners provided air surveillance and command and control systems, along with support to integrate these capabilities with Ukraine's existing air defence equipment (Mills, 2025).

By February 2022, Ukraine's air defence system was large, partially modernised and at a high degree of readiness. Long- and medium-range surface-to-air missiles (SAM) provided coverage over almost all of Ukraine's eastern airspace at medium to high altitudes (Sankaran, 2024). Man-portable air defence systems (MANPADS) and anti-aircraft artillery (AAA) could threaten low-flying aircraft and helicopters (Bronk et al., 2022). Early warning radars could track Russian aircraft, and command and control systems could coordinate air defence responses (Ministry of Defense of Ukraine, 2020).

## 2.2. Survive to deny: Ukraine's air defences stay in the fight

Ukraine's improved air defence system foiled Russia's attempts to gain air superiority in the initial phase of the conflict, surprising many observers. This prevented Russia from providing air support to its ground forces, negating Russia's plans for a quick victory (Zabrodskyi et al., 2022). Ukraine also had some success in protecting Ukrainian forces and infrastructure from the initial Russian air and missile threat (Bronk et al., 2022). The survivability and resilience of Ukraine's air defences when faced with Russia's initial attacks was crucial to these successes.

Russian air forces conducted a missile bombardment, accompanied by air strikes, to support the initial land invasion of Ukraine. Their goal was to destroy Ukraine's air defence capabilities and achieve air superiority over Ukrainian airspace. They targeted airfields, SAM sites and early-warning radars. However, the Russian air forces were not doctrinally prepared to conduct a Western-style suppression of enemy air defence (SEAD) campaign, and the strikes were poorly planned, lacking the necessary scale and concentration of force (Sankaran, 2024). The Ukrainians also knew the invasion and accompanying strikes were imminent, thanks to American intelligence. This allowed them to disperse their air defence capabilities, further limiting the effectiveness of the Russian strike campaign. While 75% of Ukraine's air bases were struck, only around 10% of their mobile air defence assets were attacked in the first 48 hours of the conflict (Zabrodskyi et al., 2022).

Within 3-4 days of the initial invasion, Ukraine was able to re-establish basic air defence operations using mobile SAMs and early warning radars (Sankaran, 2024). They then rebuilt their command and control network, and began sharing targeting information and integrating electronic warfare measures. They kept their SAM systems moving and reduced the electronic signature of both SAM and radars to increase their survivability (Bronk, 2023). MANPADS and AAA were integrated, threatening Russian aircraft at low altitudes. Together, these measures imposed steep costs on the Russian air force and prevented it from operating freely over key areas of Ukrainian airspace (Plopsy & Bronk, 2024).

While denying Russia freedom of action, Ukraine could not achieve air superiority. Long-range Russian SAM located in both Russia and captured Ukrainian provinces targeted Ukrainian aircraft over eastern Ukraine (Layton, 2025). Within weeks of the Russian invasion, a state of mutual air denial was established in eastern Ukraine – a situation that has continued for crewed aircraft on both sides ever since.

## 2.3. The defensive obligation: responding to new Russian tactics and targeting

Russia seized the initiative in the air war after its initial failures by changing tactics and targets. With Ukrainian airspace deemed too dangerous for crewed aircraft, the Russian military began prioritising missile and drone attacks. As their hopes for a quick victory faded, they began targeting civilians. Ukraine's air defence systems were forced to respond, changing both how they defended and what they defended (Gibbons-Neff et al., 2023).

Russia launched massive, coordinated attacks of drones and missiles at Ukrainian targets. Multitudes of relatively cheap, disposable drones were integrated with less numerous but more dangerous cruise and ballistic missiles. These mass strikes presented Ukrainian air defences with three problems. First, the mass strikes often overwhelmed Ukraine's air defence capabilities, with many, but not all, threats often being defeated (Bronk et al., 2022). Second, Ukraine was forced to find more economical ways to defeat low-cost drones. Third, Ukraine needed to distinguish between the different types of threats, allowing its defences to prioritise the highest threats.

Russia's military began focusing air and missile attacks on civilian targets in the northern winter of 2022. While strikes on Ukrainian forces continued, air attacks were expanded to target water distribution facilities, petroleum processing facilities, and electricity generation and distribution infrastructure (Harmash, 2023; Reuters, 2023).

This shift in tactics and targeting imposed new challenges on Ukraine's air defence systems. They needed to be able to rapidly discriminate drones from cruise and ballistic missiles, share that targeting information, and assign the most appropriate air defences to each target type. They learned that some threats needed to be targeted multiple times to ensure they were defeated, complicating an already complex air defence plan. Most challenging of all, they now had to defend both civilian infrastructure and military forces, constantly prioritising between the two; all while managing a constrained supply of air defence munitions and expendables (Watling & Reynolds, 2025).

## 2.4. Ukrainian advances and Western aid

Ukraine needed to improve and expand their air defence capabilities to address these new challenges. They also needed to reduce the resources required to counter each Russian threat to ensure their air defences were sustainable. Ukraine addressed these challenges through a combination of local defence innovation, Western military aid and a focus on force integration.

Ukraine's military industry has enabled constant improvements to air defence systems throughout the war, building on pre-war foundations. Soviet-era SAM systems have been modified to fire either Ukrainian air-to-air missiles or Western missiles, allowing more readily available munitions to be used (Di Mizio & Gjerstad, 2025). New systems were also developed, built and introduced into service. This included automated artillery systems for targeting drones, and jamming systems to counter drone control signals and the guidance systems used by Russian cruise missiles (Watling & Reynolds, 2025). These systems were cheaper and more sustainable options for defeating drones and missiles, complementing existing SAM systems. Developing these systems in Ukraine also enabled rapid and responsive system updates as the threat continued to evolve (Kuzmuk & Scarazzato, 2025).

Multiple international partners began delivering Western air defence systems as military aid from late 2022 (Mills, 2025). These systems added capacity and provided different types of capabilities to the Soviet-era systems employed by Ukraine. More military and civilian assets could be protected, and the newer, more effective systems could be used against the most dangerous threats, increasing engagement success (Di Mizio & Gjerstad, 2025). The importance of these systems to Ukraine's defences against Russian air threats cannot be overstated, as reflected in Ukraine's continued requests for more such systems (Reuters, 2024).

Ukraine integrated these new systems with their existing ones by combining Western support, domestic industry solutions, and fixes identified by military operators and technicians (Yaffa, 2022). Quick, simple solutions were prioritised, and distributed rapidly throughout the force (Hakmeh, 2025). Commercially available technologies, including satellite bearers, phone-based chat applications and internet protocol-based communications, were integrated whenever they provided the best solution (Bondar, 2025). Civilian authorities were also integrated, providing air raid warnings and coordinating emergency responses (Malyasov, 2025). These efforts were crucial to fully maximising the capabilities of both new and existing systems, increasing the efficiency and effectiveness of the air defence system as a whole.

### 2.5. Offence is the best defence

The most recent, and perhaps most significant, change to Ukraine's air defence system is an increased effort to negate Russian air and missile threats before they launch. In November 2024, the United States (US) administration authorised Ukraine to strike targets in Russia with US-made weapons (Stone & Pamuk, 2024). Shortly after, Ukraine launched its largest strikes on targets in Russia, integrating US-made Army Tactical Missile System (ATACMS) ballistic missiles, United Kingdom (UK)-made Storm Shadow cruise missiles and Ukrainian-made strike drones. Several similar strikes have followed, targeting oil refineries, ammunition plants, air bases and aviation fuel distribution infrastructure. These strikes have directly impacted Russia's ability

to launch and sustain aircraft, and to launch missiles at Ukraine (Reuters, 2025).

Ukraine has also extended their strike range into Russia through less-conventional means. In May 2025, six Russian airbases, some thousands of kilometres from Ukraine, were simultaneously struck by commercial drones smuggled into Russia (Ryan, 2025). The damage caused by the strike remains unconfirmed. However, initial reports describe the destruction of Russian strategic bomber and strike aircraft. These aircraft had launched cruise missiles from beyond Ukraine's air defence coverage and are irreplaceable in the near term. Their destruction represents a significant reduction in the Russian air threat (Collett-White et al., 2025).

These strikes demonstrate a shift in Ukraine's air defence strategy towards a more offensive approach. This is reflected in Ukraine's recent priority requests for both air defence and strike systems (Poznansky & Wohlforth, 2025). This shift can also be viewed as a continuation of efforts to counter Russian air threats in the most efficient way. Destroying Russia's fuel and airbase infrastructure, or their aircraft before they launch, reduces Russia's threat far more significantly than simply destroying drones and missiles once they are airborne (Ryan, 2025).

### 3. A comparison of strategic environments and threats

Ukraine's successes suggest there are valuable air defence insights for the ADF. To identify insights that are relevant, the similarities and differences between Australia's strategic environment and that of the Ukraine-Russia conflict must be understood. Relevant insights can then be identified, and inform the ADF's realisation of an air defence capability, which is critical to defending Australia and its national interests (Department of Defence, 2023).

Both Europe and the Pacific region are characterised by competition across the economic, military, strategic and diplomatic spheres (Department of Defence, 2024a). Even before Russia's invasion of Ukraine in 2022, Russia was conducting cyberattacks on Ukrainian institutions and causing unrest in Ukraine's eastern provinces (Anghel & Spatafora, 2025). After the invasion, European countries quickly imposed significant economic sanctions on Russia, while initially still purchasing large quantities of natural gas (Sorge, 2023). This highlighted the multi-faceted relationships and dependencies between countries in the region.

Australia's strategic environment is similarly complex and competitive. Nations in Australia's region have demonstrated the will and ability to coerce other countries and challenge the existing rules-based order (Department of Defence, 2023). These efforts have included economic, military and diplomatic measures. China's imposition of trade restrictions on Australia in 2020, leveraging their economic might, is one such example (Edmonstone, 2024), and has parallels with Russia's leverage over its European gas customers. These challenges are accompanied by an unprecedented military build-up in the region, conducted without any strategic reassurance or transparency (Department of Defence, 2023). Despite these similarities, there are also

significant differences between the threats faced by Australia and Ukraine in their respective environments.

The most significant difference between Australia and Ukraine is Australia's much lower risk of invasion. The 2024 National Defence Strategy (NDS) stated that such an invasion remains only a remote possibility (Department of Defence, 2024a). Australia's lack of land borders, geographic separation from potential adversaries, size and sparse infrastructure, particularly in the north, all make it difficult to invade. There is also no motive for any nation to invade Australia that is comparable to Russia's desire to 'reunite' Russia and Ukraine.

An invasion of Australia is unlikely, and it is also unlikely that Australia would be forced to defend against a missile threat alone. Instead, Australia may become involved in the escalation of one of several regional flash-points, or a great power confrontation between China and the US, or both (Department of Defence, 2024a). These situations may see Australia targeted directly. But in no case would Australia face a regional threat alone, unlike Ukraine's defence against the Russian threat.

Although Australia may not be at risk of invasion, it is at risk of coercion. Countries in the region possess military capabilities, including modern cruise and ballistic missiles, that can overcome Australia's geographic isolation and threaten Australia. The Chinese Naval Task Group that recently exercised around Australia provides an instructive example of this threat. The cruiser in that task group can carry up to 112 cruise or ballistic missiles, all with a range exceeding 1,500 km (US Army Training and Doctrine Command, 2025). Strike and bomber aircraft in the region can carry missiles able to strike targets in northern Australia, while both intermediate-range and inter-continental ballistic missiles in the region can reach Australia (US Department of Defense, 2024). These missile threats provide a means of influence, and even deterrence, that Australia must be able to counter. The 2023 Defence Strategic Review recognised this, describing an all-domain IAMD capability as a critical capability for the ADF (Department of Defence, 2023).

Ukraine faces a similarly advanced cruise and ballistic missile threat. But it must also defend against mass strikes integrating these missiles with large numbers of cheap, disposable drones. Australia does not face an equivalent threat due to its geographic separation. Cheap, disposable drones cannot generally be launched from ships or aircraft, and lack the range to reach Australia from mainland bases in the region (Hollenbeck et al., 2025). The scale of the missile threat in Australia's region also differs from the Russian threat to Ukraine. Unlike Russian strikes on Ukraine, potential adversaries would need to rely heavily on sea and air-launched missiles to strike Australia. This reliance on sea- and air-launched missiles limits the ability to launch such raids against Australia night after night, over months to years, as Russia has done in Ukraine (Center for Strategic and International Studies, 2025). As lethal as these missiles are, ships and aircraft must return to base to reload. Transporting missiles from a nation's industrial base to air and

naval bases, through a potentially contested environment, is a major logistical challenge.

Australia should, like Ukraine, be prepared to counter an adversary willing to target civilian infrastructure. Russia has forced Ukraine's air defence system to protect both critical civilian infrastructure and military forces (Gibbons-Neff et al., 2023). Any regional nation aiming to coerce the Australian Government could achieve this by threatening missile strikes on civilian infrastructure. Such threats may be more effective than threats against military targets. As shown in Ukraine, the aggressor, rather than defender, can often seize the initiative through their targeting decisions.

## 4. Key insights

This comparison of Australia and Ukraine's strategic environment allows insights to be drawn from Ukraine's ability to defend against Russian air threats. Five such lessons have been identified:

- Australia must manufacture air defence munitions domestically.
- Integration of the ADF's air defence systems must be broader and more agile.
- The ADF must be able to defend civilian infrastructure.
- The ADF IAMD system will not defeat all missile threats.
- A strike capability must complement the defensive capabilities of an IAMD system.

### 4.1. Domestic manufacturing of air defence munitions is essential

Australia needs to be able to manufacture air defence munitions within Australia to ensure a reliable supply of these munitions during any conflict. Australia currently has no ability to manufacture the sophisticated munitions used by the ADF's air defence capabilities (Blenkin, 2024) and would struggle to replenish stocks of these munitions during a conflict. Ukraine's inability to manufacture missiles for its Soviet-era launchers has made it reliant on existing stock and donations from supporting countries. This limitation has forced careful rationing of a finite resource throughout the conflict and constrained their air defence systems (Watling & Reynolds, 2025).

The strategic context of any Australian conflict would make it even more difficult to resupply air defence munitions. Supporting countries have donated military equipment to Ukraine without having to consider their own needs in conflict. Yet they have still been reluctant to donate capabilities that may be needed in the future, or to significantly reduce their weapons stockpiles (Bayer et al., 2022). In contrast, the ADF would likely be expending air defence munitions as part of a regional conflict. The US, the primary supplier of Australia's air defence munitions, would probably be involved in such a conflict. Would the US be willing to resupply the ADF with the same air defence missiles they themselves are relying on at the time? Even if they were, their ability to transport these missiles to Australia, through a probable conflict zone, is far from assured.

The ADF cannot plan to rely on US resupplies of these weapons during a conflict.

The 2024 NDS and Australian Guided Weapons and Explosive Ordnance Plan describe the need to establish a domestic guided weapons and explosive ordnance manufacturing capability (Department of Defence, 2024b). Currently, this plan only establishes domestic manufacturing of strike weapons. While these weapons clearly contribute to Australia's strategy of deterrence, the Ukraine-Russia conflict has shown that a continuous supply of air defence munitions is critical to defending the nation. Domestic production of these air defence munitions must be incorporated into this plan.

#### **4.2. Integration of the ADF's air defence systems must be broader and more agile**

The ADF must better integrate its air defence systems and make its integration processes more adaptive. The ADF's IAMD system currently excels at digitally sharing tactical data between sensor, C2 and weapon platforms. Operational headquarters can receive space-based early warning of missile launches in the region (Australian Defence Magazine, 2024), and integration with other government agencies and civilian authorities has been demonstrated in whole of government activities (Australian Civil-Military Centre, 2024). However, it takes years to introduce and integrate new elements into the ADF's IAMD system (Rhodes, 2024). An air defence threat to civilian infrastructure would require closer, and potentially more automated, integration with civilian authorities and first responders than has been demonstrated to date.

The Ukrainian Air Force has shown the benefits of an adaptive, wide-ranging integration approach. Under the pressure of combat they have rapidly integrated Western and Soviet military equipment to maximise the capabilities of the air defence system as a whole (Yaffa, 2022). They have incorporated US-sourced strategic intelligence into their targeting procedures (Mills, 2022). They have rapidly received and integrated improvements to their air defence systems from the domestic military industry (Kuzmuk & Scarazzato, 2025). They have also prioritised commonly available commercial technologies over bespoke military solutions where they provide the best option (Bondar, 2025). And they have established links with civilian authorities that provide air raid warnings and coordinate emergency responses (Malyasov, 2025). Integration of an air defence system is not a new concept (the I in IAMD gives this away). The force-multiplying effect of a rapid and flexible integration approach has been demonstrated by Ukraine, as has the importance of close integration with civilian authorities. The ADF's IAMD system should be guided by both.

#### **4.3. The ADF must be able to defend civilian infrastructure and the population**

The ADF's IAMD system must be able to defend both civilian and military assets. This goes beyond the direction provided in the 2024 NDS, which describes 'missile defence

to protect critical Defence infrastructure, Defence facilities and the ADF from long-range and high-speed missile capabilities' as a capability priority in the coming decade (Department of Defence, 2024a). Russia's targeting of civilian infrastructure and population centres to achieve strategic and operational effects against Ukraine highlights the limitations of this focus on Defence infrastructure and facilities.

Unlike Ukraine, an air and missile threat to Australia is not likely to occur alongside a land invasion. Instead, it may aim to destroy key military capabilities. Or it may aim to force, coerce or deter the Australian Government from acting in the country's best interests. Protecting Defence assets, as currently directed by the NDS, only addresses the first of these threats. The threat of a missile strike on unprotected civilian population centres or infrastructure could change the Australian Government's decision-making calculus. Such a threat would negate an IAMD system that only protects Defence capabilities and highlight the shortfalls of the current NDS guidance.

#### **4.4. The ADF IAMD system will not defeat all missile threats**

The ADF's IAMD system will never be able to protect all critical Australian military and civilian infrastructure against the regional air and missile threat. Ukraine's air defence system, which is far more extensive than the ADF's, defending an area smaller than NSW, has been unable to completely negate the modern missile threat posed by Russia. Russia's cruise, ballistic and hypersonic missiles still defeat Ukraine's air defences, striking their targets and causing significant damage (Bronk et al., 2022). Few if any countries could defend their civilian population centres, critical infrastructure and national interests from the missile threat faced by Ukraine.

It is similarly unrealistic to expect the ADF to defend all of Australia's critical infrastructure from the regional air and missile threat. The Australian Government must accept that successful missile strikes on Australian military and civilian infrastructure are likely in any significant conflict. Both national strategic and military planning must therefore incorporate ways to mitigate this threat beyond an IAMD system, including emergency response, civil defence and national resilience. The Ukraine-Russia conflict presents insights that can inform such planning, and these deserve further examination.

#### **4.5. A strike capability is an essential part of integrated air and missile defence**

To complement a defensive IAMD system, the ADF requires a strike capability that can deter or disrupt potential threats. Ukraine has recently demonstrated that targeting launch platforms, or the infrastructure supporting those platforms, can more efficiently and effectively reduce Russia's air and missile threats (Collett-White et al., 2025). These strikes have forced Russia to change their air basing plan, reduced their ability to overcome combat losses, and

may decrease the size of missile raids that can be launched at Ukraine (Reuters, 2025).

ADF strike capabilities that can target warships, air bases and supporting facilities would contribute significantly to countering the regional air and missile threat. Any nation wishing to deter Australia with an air and missile threat would themselves be at risk, potentially changing their decision-making calculus. In conflict, such capabilities would degrade an adversary's air and missile threat and complement the defensive capabilities of an IAMD system.

## 5. Conclusion

The ADF has a significant opportunity to learn from how Ukraine has implemented its air defence system against Russian threats. Valuable and relevant insights can be identified by understanding how Ukraine has defended against this threat, and by comparing Australia and Ukraine's strategic environments.

Ukraine's air defence systems have slowed Russia's ground invasion and reduced the threat to Ukrainian forces. They have constantly adapted to new threats, integrated new technologies, and launched offensive operations when possible. Australia does not face the risk of invasion that

Ukraine does. But like Ukraine, Australia must be prepared to counter advanced air and missile threats. These threats may be used to coerce the Australian Government or may be realised in a regional conflict.

This paper has identified five insights relevant to the ADF's IAMD system. Australia must manufacture air defence munitions domestically. The ADF must expand the integration of its air defence systems and make its integration processes more adaptive. It must also be able to defend civilian infrastructure. The ADF's IAMD system will never be able to protect all critical Australian military and civilian infrastructure against the regional air and missile threat, and a strike capability must complement the defensive capabilities of an IAMD system. Not all these insights are new, nor will implementing them guarantee Australia's safety against the regional air and missile threat. However, the Ukraine-Russia conflict suggests they can improve the ADF's IAMD capability, and ensure it is ready to defend Australia should the need arise.

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