Hudson Institute

DECEMBER 2025

Pickets, Pouncers, and Protectors

How the Australian Defence Force Can Use Uncrewed Systems for Twenty-First-Century Deterrence

BRYAN CLARK AND DAVID BYRD
CENTER FOR DEFENSE CONCEPTS AND TECHNOLOGY, HUDSON INSTITUTE

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Cover: Royal Australian Navy officers and sailors stand at ease on board HMAS *Choules* during their port visit to Hobart, Tasmania, in May 2025. (Australian Department of Defense)

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EXECUTIVE SUMMARY

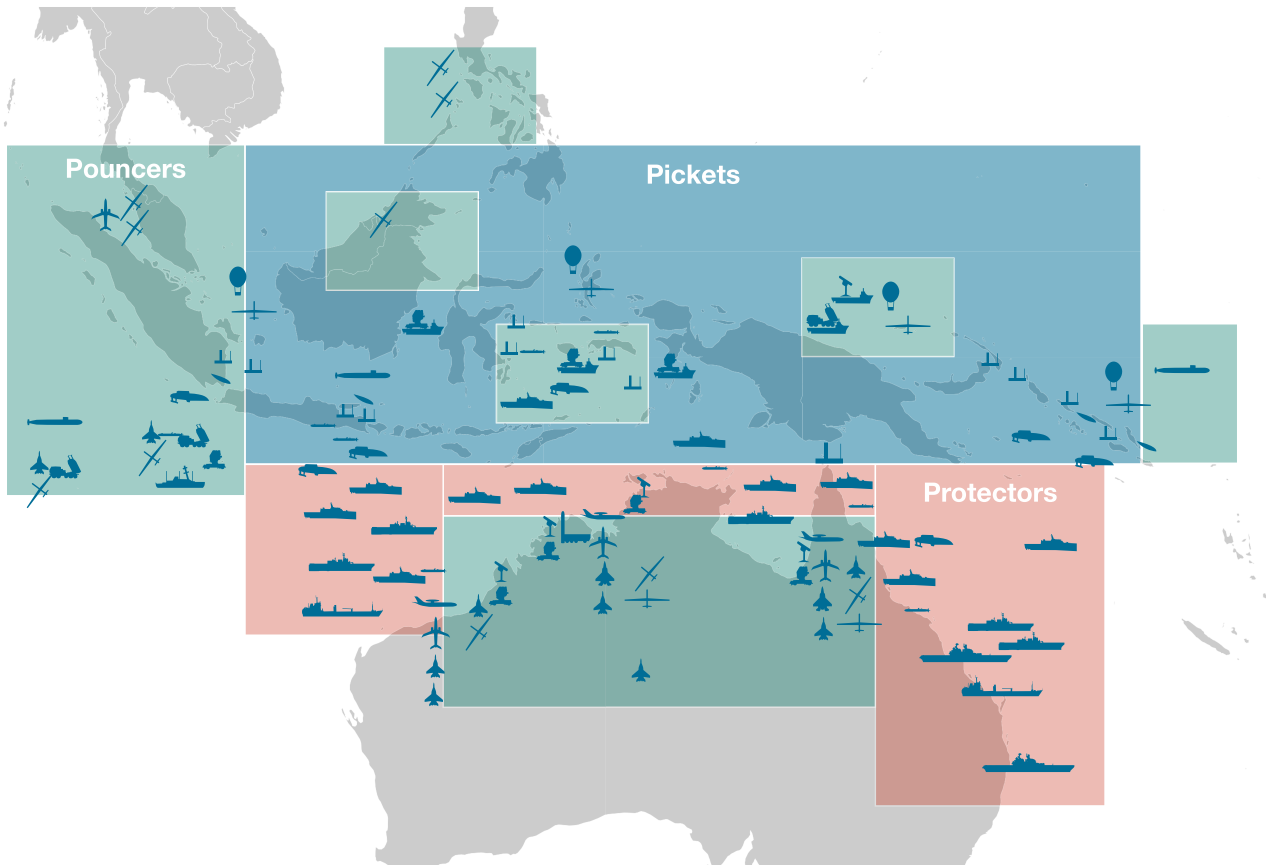
For more than 80 years, Australia has relied upon its isolation and peaceful relations to protect its interests. But technology proliferation and a multipolar environment have created conditions that encourage revisionist governments to use military force in pursuit of territory and influence. The Australian Defence Force (ADF) therefore needs to be able to defend the homeland again.

In its most recent defense strategy, the Australian Department of Defence (ADoD) argued that it would pursue a strategy of denial to deter aggression. However, the ADF lacks the size or capabilities to implement this strategy under realistic budget and personnel constraints. Potential aggressors will likely deploy larger forces than the ADF and view denial as out of reach for Canberra.

Outright denial may not be feasible, but the ADF could deter aggression through a strategy of cost imposition that would threaten an attacker with the prospect of unacceptable losses or delay. This approach is especially advantageous for Australia, which is unlikely to be an essential or existential interest for an aggressor. An attack on Australia will likely seek to coerce Australia regarding economic or security policy or keep ADF forces occupied during military actions against other countries in the region. If an aggressor believes that operations against Australia would lead to unacceptably high losses or protrac-

Photo: Australian Army soldiers launch an Integrator tactical uncrewed aerial system at Shoalwater Bay training area in Queensland as part of preparations for Exercise Talisman Sabre 2025 in July 2025. (Australian Department of Defense)

Figure ES.1. Proposed ADF Posture



Pickets

- Broad area ISR using high-altitude UAS and sail USVs, in addition to satellites, OTHR, and other broad-area sensors
- 100T MUSV and LUUV/XLAUV conducting ASW and ISR, and acting as hosts for smaller UxS
- Forward-deployed SRGBAD/MRGBAD ashore on MUSVs
- Patrol boats and OPVs carrying UxS and operating as local C2 nodes

Pouncers

- SSKs and SSNs operating near likely enemy transit areas with sub-launched ASCMs and HWTs
- Long-range kill chains of CCA, fighters, HALE/MALE UAS, and E-7s operating out of Tindal/Darwin, Townsville, and bare base Learmonth
- Forward-deployed offensive missile batteries, including those on 300T MUSVs
- Long-range kill chains of CCAs and MALE UAS deployed to Cocos (Keeling) and Christmas Island
- MALE UAS operating out of Indonesia, Malaysia, and Philippines for targeting

Protectors

- High-value assets held in reserve in lower threat density areas
- Majority of surface combatants pulled back to northern approaches with small and medium combatants to protect sea lanes
- GBAD protecting critical targets in Australia

Source: Author.

tion, they could pursue other paths to their objective without reputational risk.

The challenge with a cost-imposition strategy is understanding which avenues of attack the aggressor is considering and what costs will be unacceptable. Canberra will need a campaign that uses signaling and operations to help policymakers estimate enemy leaders' risk tolerance while in parallel establishing a defensive posture that can guard the country's northern approaches.

The current ADF is not well-suited to implement either of these tasks. While it can effectively protect Australia from attacks in limited geographic areas, the ADF's relatively small number of multimission ships, aircraft, and ground formations cannot address all the most likely avenues of attack. The ADF also has too few crewed multimission ships and aircraft to posture or adapt in novel or unexpected ways that could elicit responses that reveal adversary leaders' risk tolerances.

This study used a series of tabletop exercises (TTXs) to develop operational concepts that could deter conflict and defend Australia within the ADF's fiscal and personnel limits. These concepts relied predominantly on uncrewed systems organized into hedge forces that conduct distant anti-submarine warfare, offensive counter-air operations, and anti-surface warfare to prevent threats from approaching Australian territory during conflict. Crewed ships and aircraft that are the bulk of today's ADF would focus on peacetime responses and acting as a last line of defense in war.

To support these concepts, teams in the TTXs developed a posture that organized the ADF into *pickets*, *pouncers*, and *protectors* as shown in figure ES.1. Uncrewed pickets detect and respond to threats; a mix of crewed and uncrewed pouncers delay or stop threats; and crewed protectors surge to augment pouncers or defend high-priority locations such as cities or military installations.

This study translates the concepts and posture developed during TTXs into a new force design that could sustain a deterrence campaign, summarized in figure ES.2. This design is affordable, assuming that the ADoD can redistribute the AUD 12.8 billion it earmarked for uncrewed systems between 2025 and 2035 to a new combination of crewed and uncrewed systems.

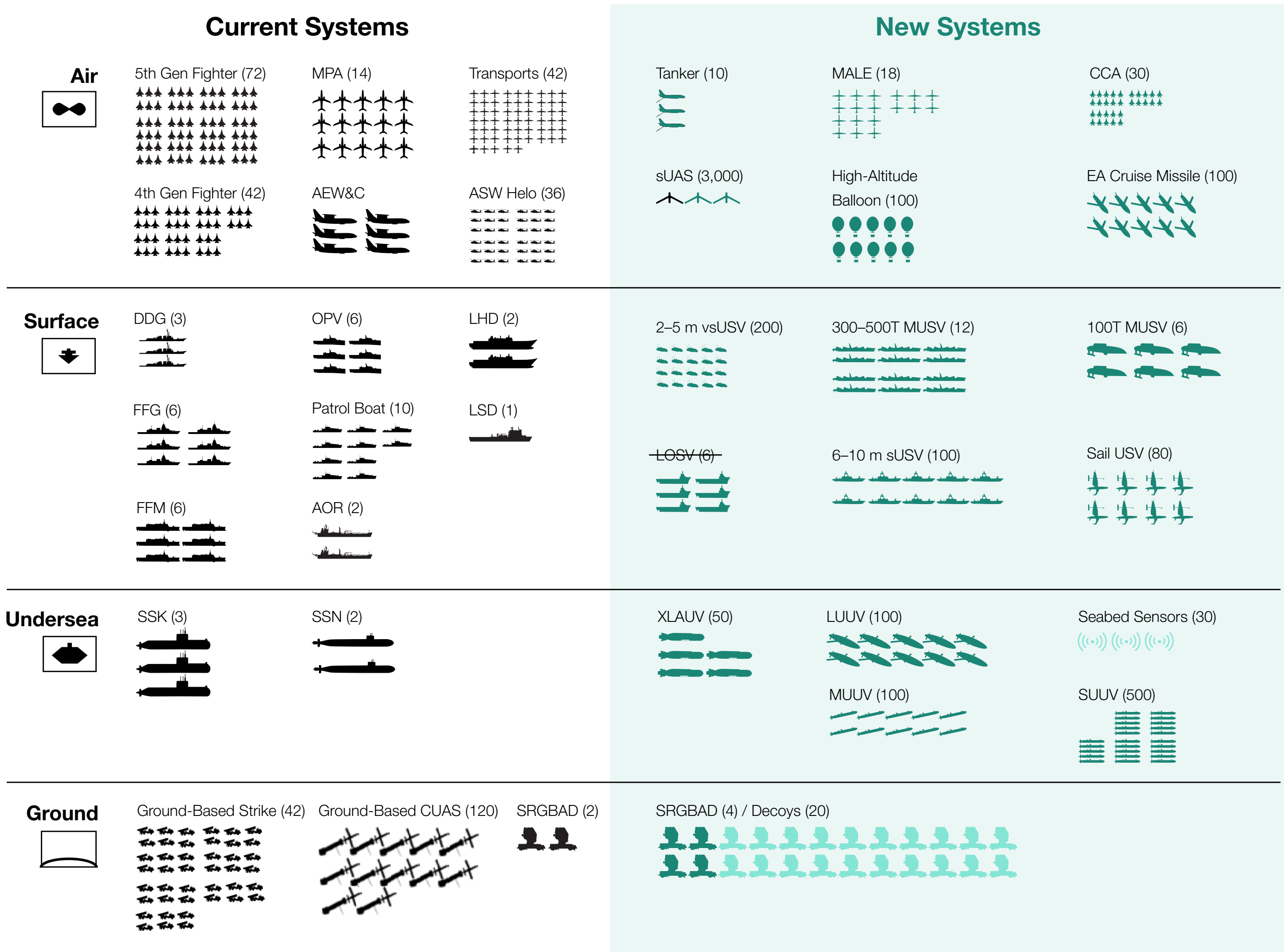
The force design only proposes modest changes in crewed units. Fiscal and industrial base constraints preclude growing crewed forces substantially while economic concerns prevent eliminating larger programs, such as in shipbuilding, that provide sizable employment. As shown in figure ES.2, the force design eliminates the Large Optionally Crewed Surface Vessel and adds short-range ground-based air defenses and aerial refueling aircraft.

The proposed force design makes almost all of its changes to the uncrewed system portfolio, primarily because they offer the scale and adaptability to address the ADF's need for a distributed force that can defend the northern approaches while mounting a deterrence campaign against likely opponents.

Australia needs a new, more realistic defense strategy and a rebalanced force design to implement it. The strategy of cost imposition proposed by this study would seek to deter aggression by increasing enemy losses in a conflict and raising the likelihood of protraction. Facing the prospect of an embarrassing inability to quickly bring Australia to heel, adversary leaders may forgo military action and choose other avenues to pursue their interests against Canberra.

In addition to being affordable within the ADoD's existing spending plans, the changes recommended by the force design are implementable largely through domestic manufacturing and assembly. Although the ADoD may initially need to purchase some uncrewed systems from suppliers in allied countries like the United States, it can quickly pivot to building them in Australia.

Figure ES.2. Proposed Force Design



Source: Authors.

In addition to promoting economic development, this approach would allow the ADF to draw on a common allied industrial base and supply chain.

Of course, this study's proposed force design is probably not the exact right answer. Systems will require rigorous assessment and testing, and some concepts may prove too challenging to execute in practice. The concepts and programmatic recommendations of this report are intended to give force planners an idea of the challenges and opportunities in building the future force and the possibilities within the ADF's likely fiscal and personnel limitations. While the ADF's challenges are substantial, it can still field an effective force during the next decade. But to realize this vision, the Australian government will need to act now while budgets enable the ADF to embrace the potential in uncrewed systems and other new technologies.

1. A STRATEGY IN DENIAL

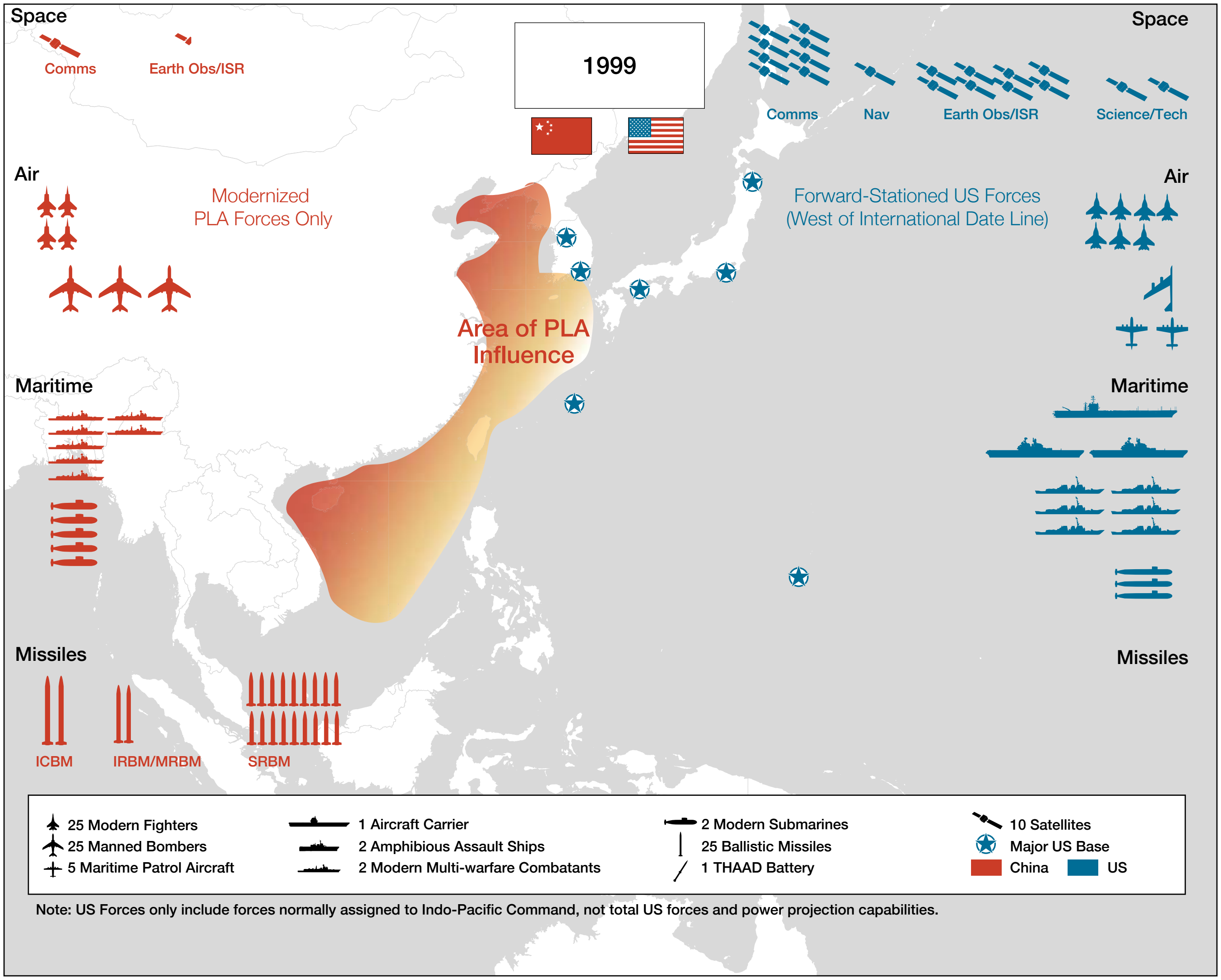
Australia has enjoyed more than 80 years without an attack on its territory thanks to its isolation and lack of natural enemies. But the Lucky Country's fortunes may be starting to turn. Technology proliferation and a multipolar environment have created conditions that encourage revisionist governments to use military force in pursuit of territory and influence.[1]

Australia has long depended on allies to bolster deterrence, but that may no longer be a reliable assumption. The US Department of War (DoW) considers China to be its pacing threat, but as shown in figure 1.1, the People's Liberation Army (PLA) outnumbers US and allied forces in the Western Pacific.[2] The US government is unlikely to devote substantial forces to defending Australia if such operations might reduce US deterrence against Beijing in Northeast Asia. And although the DoW plans to surge up to four times the capacity shown in figure 1.1 during a conflict, those forces will take weeks or months to arrive.[3]

Recent trends in US defense strategy and economic policy also undermine reassurance. Despite advocating an approach of peace through strength, the US Congress and the Trump administration are, like Australia's government, planning for only modest increases in defense spending over the next decade.[4] The Trump administration has further argued that US security guarantees to allies are contingent on them investing more in their own defense and rebalancing their trading relationships to buy more US exports.[5] And although the Indo-Pacific remains the Pentagon's priority theater, President Donald Trump and other national security officials have not committed to defending Taiwan against Chinese aggression.[6]

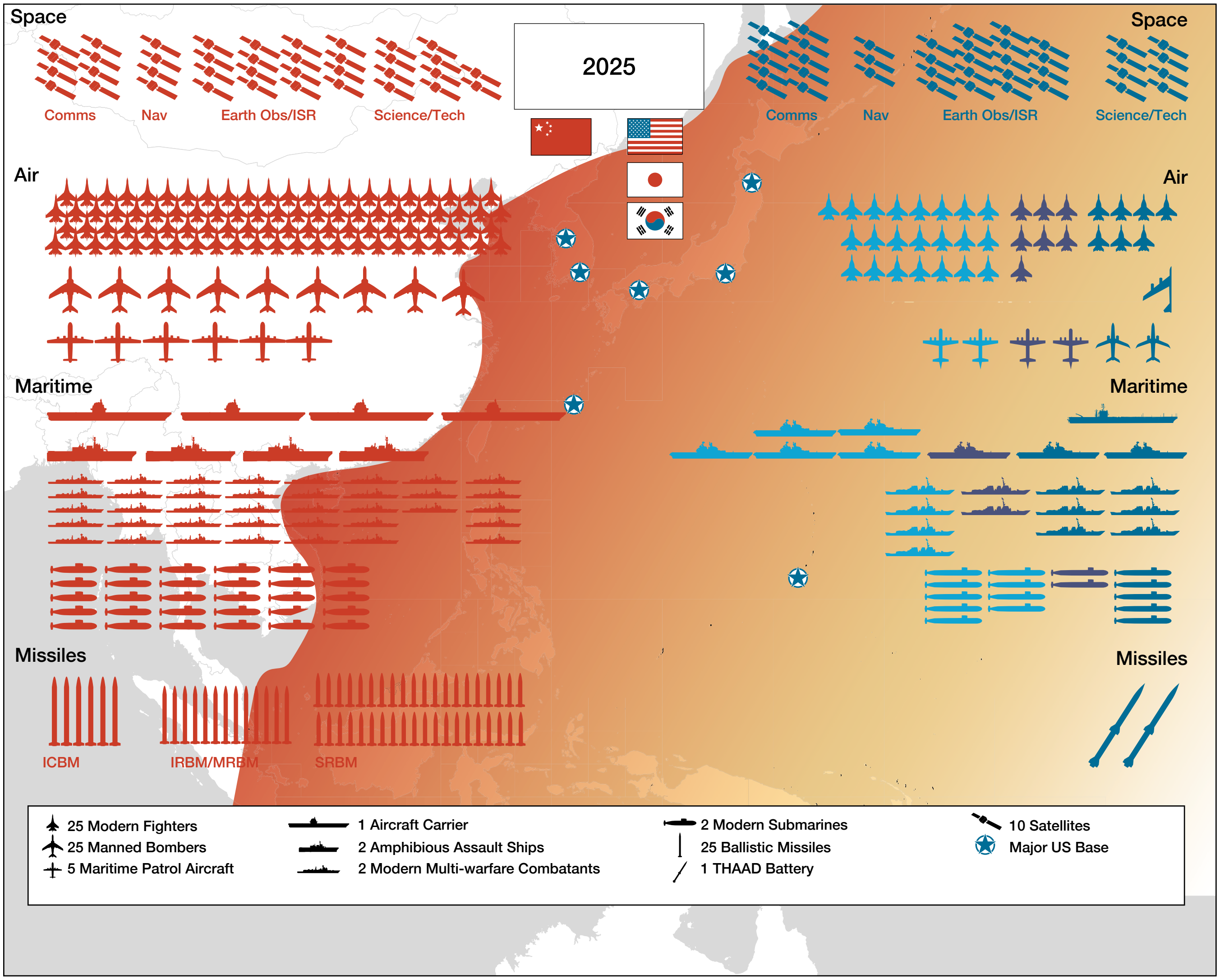
Photo: An Australian Army National Advanced Surface to Air Missile System fires an AIM-120 missile during Exercise Talisman Sabre 2025 at Bradfield Training Area in July 2025. Image was digitally altered for security purposes. (Australian Department of Defense)

Figure 1.1. Comparison of PLA and Allied Force Postures in 1999 and 2025



Source: Brian Everstine (@beverstine), ".@GenCQBrownJr shares this slide comparing US and China weapons platforms, but adds USAF Airmen are the 'force multiplier' that make the difference," Twitter (now X), September 14, 2020, https://x.com/beverstine/status/1305512270571745282.

An adversary could also attempt to convince allied leaders that they should not come to Australia's aid. In addition to economic or diplomatic coercion, an aggressor and its proxies could attack Japanese, British, or US territory and compel those governments to keep their forces home for domestic defense. For example, drone attacks, counter-shipping operations, or undersea cable disruptions could cause US leaders to divert troops to protect America's military installations and economy. Under these conditions, Australia could find itself facing an attack essentially alone, with support only from forces the US has already deployed in the region.



A Return to Self-Reliance

Until recently, Australia's post–World War II military was largely designed to support overseas operations rather than to defend Australia. Under the early Cold War approach of forward defense, Australian Defence Force (ADF) units expected to combine with those of the United States and United Kingdom to counter Soviet aggression in Europe or Northeast Asia. The Australian government adopted more self-reliant strategies through the late 1970s and 1980s following the US withdrawal from Vietnam and reduced its presence in East Asia. However, as the 1987 Defence White Paper articulated, the Australian government viewed homeland attacks as a low-level concern and considered substantial threats to be a decade or more in the future.[7]

Subsequent white papers sustained these assumptions through the 2010s. The 2016 Defence White Paper was the first to highlight that the ADF should prioritize Australia's northern approaches to protect the nation. But it assessed overall that "there is no more than a remote chance of a military attack on Australian territory by another country."[8] The 2020 Defence Strategic Update followed suit by prioritizing nonmilitary efforts to influence events in Australia's region over defense or deterrence against potential attacks.[9]

Political leaders sometimes opposed the paradigm of focusing the military on overseas actions and relying on nonmilitary influence near home, arguing that the Australian Department of Defence (ADoD) should place greater emphasis on protecting Australian territory.[10] However, substantial threats to the homeland did not materialize, and uniformed officials valued overseas operations as a way to remain proficient and justify continued defense investment.

The Australian government shifted course in its 2023 Defense Strategic Review (DSR). Whereas previous reviews emphasized cooperation and stability in the region, the DSR explicitly prioritized defense of Australian territory, especially the country's northern approaches, against immediate and substantial threats. Moreover, the DSR identified that the ADF would pursue deterrence through denial, which would require capabilities that would prevent an aggressor from succeeding. Beyond deterring and defending against attacks on Australian territory, the DSR's main objectives were protecting Australia's global economic connections, contributing to collective regional security, and maintaining a rules-based global order.[11]

In conjunction with the DSR's more muscular approach to defense policy, the Australian government pledged to spend more on defense. As described in the 2025–26 Portfolio Budget Statement (PBS), the government plans to increase defense spending by an average of 6 percent per year.[12] This translates into about 3 percent of actual growth given Australia's current inflation rate of about 2.6 percent.[13] The 2025 landslide reelection of Labor Party leaders suggests this growth trajectory is likely to continue.[14]

But these relatively modest budget increases may not be enough to achieve the DSR's objective of deterrence by denial. Revisionist nations continue to press ambitious—and generally extralegal—territorial claims. If an adversary dedicated a substantial portion of its forces against Australia, the ADF alone would be unable to protect Australian territory from air and missile attacks. And a relatively modest naval force would be sufficient to exploit Australia's dependence on sea lanes by interdicting shipping going to and from the country's ports.

With US support no longer assured, the Australian government will need to close the gap between the 2023 DSR's aspirations and the ADF's current capabilities. In the 2024 National Defence Strategy and Integrated Investment Program (IIP), the ADoD argues it will improve Australia's defense mainly through the following efforts:

- Acquiring conventionally armed, nuclear-powered submarines through the Australia, United Kingdom, and United States agreement (AUKUS)
- Developing the ADF's ability to precisely strike targets at longer range and manufacture munitions in Australia
- Improving the ADF's ability to operate from Australia's northern bases
- Improving the growth and retention of a highly skilled defense workforce
- Incorporating disruptive new technologies in close partnership with Australian industry

- Deepening diplomatic and defense partnerships with key partners in the Indo-Pacific[15]

These initiatives would strengthen the ADF and improve Australia's ability to deter and defeat aggression. However, each line of effort could consume a substantial portion of the ADoD budget without realizing the ADoD's strategy of denial. The ADF will need to reframe its strategy around achievable objectives and prioritize the initiatives and investments that can best achieve them.

Adopting a Cost-Imposition Strategy

The goal of deterrence by denial, which the 2023 DSR and 2024 NDS advanced, is a classic military strategy in which the defender prevents an attacker from realizing the benefits of its aggression.[16] In most interpretations, a military pursuing a strategy of deterrence by denial would mount a defense that could credibly prevent an attacker from succeeding.[17] This approach creates vulnerabilities, as historical examples like France's World War II Maginot Line demonstrate. Unless the defending military is the dominant force, it will need to devote most of its capabilities to a so-called goal-line defense that could stop an offensive from reaching its objective. As in the World War II case, the attacker could circumvent a goal-line defense using new operational concepts or technologies. Or, in the case of Russia's annexation of Crimea in 2014, the aggressor could achieve many of its objectives by operating in the gray zone short of war.[18]

The US strategy for defending Taiwan reflects this interpretation of deterrence by denial. Taiwanese and US forces would counter a PLA invasion of the island by using uncrewed systems (UxS) and Taiwanese troops along the Taiwan Strait, coupled with long-range fires from US ships and aircraft in the region. If the two countries organized and orchestrated this approach effectively, it could prevent PLA forces from gaining a lodgment on the island or landing enough troops ashore to succeed.[19] However, as recent operations by People's Republic of China (PRC) maritime forces show, this goal-line defense does not address other scenarios like a blockade. It also allows the PRC to continue its gray-zone harassment of Taiwan.[20]

Another interpretation of deterrence by denial is that the defender—or the defender's allies—will reverse the attacker's actions and thereby negate the benefits of the attack. This approach could work, but few historical cases highlight its effectiveness. For example, the history of both world wars and Operation Desert Storm suggests that the potential for a counteroffensive by the defender's treaty allies, or even the presence of allied troops in the defended country, may not dissuade a determined aggressor.[21]

The difficulty of implementing deterrence by denial led the United States and Soviet Union during the Cold War to eventually adopt a strategy of deterrence by punishment. Each nation reserved the right to use nuclear weapons if its government was imperiled or it was at risk of losing a military confrontation. This strategy certainly contributed to the lack of major conflict between the US and USSR during the Cold War, and it probably constrains the scale of confrontations today between nuclear-armed Pakistan, India, and China.[22]

Deterrence by punishment was likely effective in preventing major-power war because each side could credibly threaten existential nuclear attacks on its opponent. However, this strategy has failed to prevent smaller conflicts in which neither side, or only one side, possessed nuclear weapons. Russia's invasion of Ukraine in 2022 proceeded even though the US and its allies both threatened and realized economic and diplomatic sanctions that subsequently damaged Russia's economy.[23] PRC forces have skirmished with Philippine Coast Guard and Navy units although the Republic of the Philippines is a US treaty ally.[24] And Iran directly or through its proxies has attacked Israel and US forces multiple times during 2023–25 although Israel is reportedly a nuclear-armed state.[25]

For Australia, deterrence by punishment is probably not an option. As a middle power, it lacks the economic heft to threaten sufficient sanctions or trade constraints to influence opposing leaders. And with a relatively small, conventionally armed military, Australia is unlikely to exact enough damage on an opponent to deter its leaders, even after Canberra obtains nuclear submarines under the AUKUS agreement.

But the ADoD's stated strategy of deterrence by denial may also be out of reach. If the ADF were able to mobilize and position forces in time, it could prevent an adversary from seizing outlying territories, like the Christmas or Cocos Islands, and stop landings on Australia's mainland. But the ADF's current force lacks the capacity and persistence to sustain these operations or conduct them in multiple locations.

Aggressors could also attack Australia to coerce Canberra regarding trade and economic policies or dissuade Australian leaders from supporting allies or partners in conflicts across the Western Pacific or Indian Oceans. In support of coercion, an opponent could mount air strikes on northern Australia, assaults on shipping, or cyber and EW operations against Australian defense and commerce. The ADF will be hard-pressed to prevent these attacks from succeeding.

Outright denial may not be feasible, but the ADoD could deter aggression by reframing its goal as cost imposition. In this strategy, the defender increases the aggressor's difficulty in achieving its goals. Facing the prospect of unacceptable losses or delay in accomplishing an operation, the aggressor chooses another path or waits for a better opportunity to emerge.[26]

Some proponents of deterrence by denial argue that deterrence by cost imposition is just a lesser included case of denial. Under this theory, a defender that cannot render an attack infeasible could still deter an attack by making it difficult enough.[27] This is flawed reasoning. Denial is a binary condition—the action is either feasible or infeasible. But for a military to deter through not-quite-denial requires understanding what the aggressor considers "too difficult."

Consider the case of Australia. As a middle power, it lacks the resources to deny more than one (or maybe any) of the realistic paths available to an opposing military. For example, the ADF would need to substantially grow its current fleet of fighters, aerial refueling tankers, and airborne early warning and control (AEW&C) aircraft to deny an attack on Australia using bombers. That investment in equipment and personnel would prevent Australia from expanding or improving other elements of the ADF. A similar dynamic would occur when countering other threats, like submarines, surface combatants, or ballistic missiles. As a result, in each case the attacker would lose one option while other courses of action would become easier to execute.

In contrast to attempting denial, a military applying a strategy of cost imposition would focus its efforts on the scale and type of defenses that would create unacceptable losses or delay for the aggressor. A middle-power defender like Australia could stretch its modest pool of funding and personnel across the most likely forms of aggression by mounting sufficient defenses in each mission. For example, the ADF could complicate bomber attacks enough to make the mission too impractical for adversary leaders by using real and decoy air-defense systems at sea around the Indonesian archipelago.

The challenge with a cost-imposition strategy is understanding which avenues of attack the aggressor is considering and what costs will be unacceptable. A strategy of denial relies on the aggressor calculating that an attack cannot succeed based on the defender's posture, demonstrations, or statements. A strategy of cost imposition requires the defender to predict the level and type of protection sufficient to dissuade the aggressor. But as recent conflicts in Ukraine or Kashmir show, defenders often underestimate the costs an aggressor is willing to accept in pursuit of an objective.[28]

One advantage of adopting a cost-imposition strategy is that likely aggressors will not consider conflict against Australia as a core interest. The stakes are existential for Russia in Ukraine;

almost any cost is worth bearing if the alternative is collapse of the regime or the country. A country or non-state group will likely intend for an attack on Australia to coerce leaders in Canberra regarding economic or security policy, or keep ADF forces occupied during military actions against other countries in the region. If the losses or protraction of operations against Australia seem too high, the aggressor can pursue other paths to its objective without reputational risk.

The Cost-Imposition Campaign

The Australian government will need to build a feedback mechanism to better estimate the costs an aggressor is willing to accept in aggression against Australia. But the ADoD cannot wait for that analysis to begin attempting deterrence by cost imposition. It will need to pursue both initiatives in parallel—establishing the posture, concepts, and capabilities to counter the most likely attacks while using those efforts to elicit responses from potential aggressors that suggest their risk tolerance and cost thresholds.

A previous Hudson Institute study by Bryan Clark and Dan Patt describes this approach.[29] Consistent with the ADF concept of integrated campaigning, deterrence by cost imposition requires a long-term, interactive process of messaging, fielding new capabilities, posture, and exercises designed to generate unguarded responses from a potential aggressor. The campaign would need to incorporate all instruments of national power, but this study will focus on the military's role in fielding and operating a force that can support the overall campaign.[30]

The campaign assessment process is shown in figure 1.2. Using the terms in ADF doctrine, the ADF (Blue) initially applies open-source and government intelligence information to *understand* the aggressor's (Red) potential modes of attack and hypothesize what defenses may be most effective within the ADF's capability and capacity limitations. The ADF then *orchestrates* public signals, such as exercises that gauge the aggressor's concerns about the ADF's operating areas or proficiency. The ADF can also generate *effects*, such as cyber or EW operations, designing them so that only the aggressor perceives them and so that they signal potential threats to the aggressor. The ADF would apply insights from analyzing the aggressor's responses to develop the next set of public and private signals and *sustain* the campaign.[31]

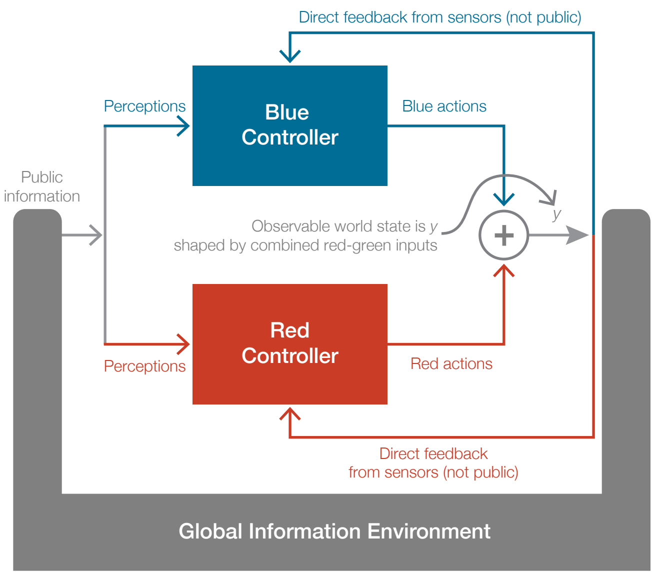
To accurately estimate the aggressor's risk tolerances, the defender will need to iteratively refine its actions based on previous responses. This requires a wide variety of potential new actions and capabilities. Moreover, the defender will need to conduct unexpected actions to elicit genuine, rather than pro forma, responses from the aggressor.

The ADF's current force design will be unable to implement the deterrence campaign of figure 1.2 in two main ways. First, the ADF needs to mount an initial defense in the absence of feedback from potential aggressors. While it can effectively protect Australia from attacks in limited geographic areas, the ADF's relatively small number of multimission ships, aircraft, and ground formations lacks the distribution to address all the most likely avenues of attack. And perhaps more importantly, the ADF is not recomposable enough to reorient against adversaries' preferred forms of aggression when they are revealed.

Second, the ADF cannot provide sufficiently diverse or unexpected signals to develop an assessment of an aggressor's priorities, pain points, and risk tolerances. The ADF's crewed multimission ships and aircraft are too few in number to organize or posture in novel and unexpected ways and are not easily modifiable to incorporate new features or capabilities that generate surprising signals for the opponent.

The ADF will need a larger number of small platforms or units with only one or two functions to generate sufficient scale and adaptability to implement deterrence by cost imposition. This approach would bring two other benefits: First, it would reduce the consequences of any individual defensive

Figure 1.2. An Assessment Process to Support Deterrence by Cost Imposition



Source: Authors.

engagement because the units involved would be smaller and predominantly uncrewed. Second, a more distributed and recomposable force design would enable the ADF to reallocate forces against threats as they materialize during combat against a larger opponent.

Raising AUKUS's Second Pillar

The ADF could use the AUKUS initiative to evolve its force design. In the near term, under AUKUS Pillar I, the allies will establish by 2027 a rotational force of up to five US and UK nuclear attack submarines (SSNs) operating from Australia's west coast. Over the medium term, the ADoD will purchase up to three US *Virginia*-class SSNs starting in 2032. Over the long term, Australia and the UK will develop the SSN-AUKUS to replace the Royal Navy (RN) *Astute*-class SSNs and remaining Royal Australian Navy (RAN) *Collins*-class conventional submarines, which they will field in the 2040s.[32]

The allies have made steady progress along the "optimal pathway" of AUKUS Pillar I. Australian sailors and officers are already graduating from US and UK nuclear propulsion training pipelines and will join Royal Navy and US Navy SSN crews until Australia has its own SSNs.[33] US SSNs have operated from HMAS *Stirling* in Western Australia and conducted maintenance at an Australian facility.[34] And several US SSNs will visit Australia during 2025, with one completing a three-week maintenance period.[35]

Allied and Australian SSNs will surely improve the ADF's ability to deter aggression. To attack Australia, an opponent would need to rely on naval forces or long-range missiles and aircraft. With unlimited submerged endurance and superior stealth, RAN SSNs could engage enemy ships well before they reach weapon range of Australia. And although SSNs may not be able to attack aircraft, they could strike the air bases that host them.

But SSNs are not a solution to all the potential threats facing Australia. An attacker could use unmarked ships to carry missiles and one-way attack drones within reach of Australian territory before RAN SSNs can interdict them. Several countries' submarines are relatively quiet and could avoid RAN SSNs to conduct missile attacks against Australian territory. And as recent operations by Russia demonstrate, ballistic or hypersonic missiles could also reach Australia from an opponent's protected interior.

The ADoD will need to raise AUKUS's second pillar of emerging technologies to address the full range of enemy attack options and create a more distributed and recomposable force that can support a deterrence campaign. Most AUKUS Pillar II activity focuses on six technology areas, each with its own working group:

1. Undersea capabilities
2. Quantum technologies
3. Artificial intelligence (AI) and autonomy
4. Advanced cyber

5. Hypersonic and counter-hypersonic capabilities

6. Electromagnetic warfare[36]

While Pillar I is proceeding apace, the allies have made uneven progress in fielding new technologies under Pillar II. They moved most quickly on undersea capabilities, including integrating the UK Swordfish torpedo and new AI-enabled sonar algorithms on P-8A maritime patrol aircraft.[37] The US and Australian navies have also conducted multiple rounds of experimentation with maritime autonomous systems, some of which they are incorporating into their forces.[38]

The allies have made less headway on other Pillar II technologies. For example, the ADoD and the Pentagon established the Hypersonic Flight Test and Experimentation (HyFliTE) Project Arrangement in 2024, more than three years after signing the AUKUS agreement.[39] The allied nations also did not complete the first AUKUS Pillar II prize competition, focusing on EW, until late 2024.[40] A second prize competition, focusing on undersea autonomy and communications, started in spring 2025.[41]

The allies' modest results in AUKUS Pillar II capabilities beyond undersea systems are largely due to a lack of focus. The US military has a wide variety of investments relevant to AUKUS Pillar II technology areas and has shared many of those technologies with the other AUKUS allies. However, it has not adopted a formal program around any Australian or UK Pillar II technology efforts. As a result, UK Ministry of Defense and ADoD AUKUS Pillar II projects generally fall short of fieldable military capabilities.

The AUKUS allies recently established the International Joint Requirements Oversight Council (I-JROC) to ensure they allocate funding and leadership attention to the most important AUKUS Pillar II programs. Modeled on the DoW's JROC, the I-JROC includes the vice chiefs of defense of each AUKUS ally, who lead their respective militaries' force design activities.[42]

However, a potential limitation of the I-JROC model is that each ally has different operational problems to address. Australia's challenges center on extended-range homeland defense, whereas the US military is mainly an expeditionary force designed to project power in defense of allies. The UK's defense priorities encompass both mission sets due to air and naval threats from Russia and the need to defend UK interests and citizens in the Mediterranean Sea and Indian Ocean.

Given the allies' lack of focus in AUKUS Pillar II, the ADoD should prioritize its own defense technology efforts to address the key operational problems in implementing deterrence by cost imposition. For example, the ADF faces the following operational problems in its three more important homeland defense missions:

- **Anti-surface warfare (ASUW).** Crewed aircraft, ships, and SSNs could conduct most ASUW operations around Australia thanks to an uncontested air and surface environment. However, the ADF's relatively small fighter and surface combatant fleets would be unable to cover the full reach of Australia's northern approaches and sea-lanes. They may also need third-party targeting from uncrewed systems anywhere from the seabed to space to update weapons in transit.
- **Integrated air and missile defense (IAMD).** Enemy fighters or bombers could attack northern Australia using cruise missiles from outside the range of land-based Royal Australian Air Force (RAAF) fighters. With aerial refueling, RAAF aircraft could engage small numbers of bombers before they launch cruise missiles, but only in narrow geographic areas. And the RAN's three air-defense destroyers may be insufficient to protect critical Australian targets from ballistic missiles or boost-glide hypersonic weapons.
- **Anti-submarine warfare (ASW).** As with ASUW, the permissive air and surface environment around Australia would allow ADF ships and aircraft to conduct ASW. However, the ADF lacks the capacity to cover all relevant areas with to-

day's crewed ships and aircraft. The relatively short ranges of most ADF ASW sensors and weapons exacerbate this problem.

The ADoD could apply the full range of AUKUS Pillar II technologies to these gaps. For example, it could apply new undersea capabilities to ASUW and ASW sensing and engagement gaps and use hypersonic weapons against enemy surface forces or bases from which adversary bombers operate. It will need hypersonic defenses to protect Australian territory from advanced missile attack. Most importantly, UxS and AI could offer Australia's military the scale and adaptability it needs to deter and defeat aggression.

A Changing Value Proposition

Australia is not alone in pursuing uncrewed and autonomous systems. Militaries around the world are quickly adopting UxS as a substantial portion of their forces. This trend accelerated

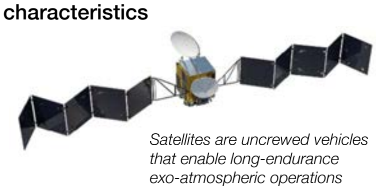
Figure 1.3. The Changing Value Proposition for Uncrewed Systems

Most military uncrewed systems are used because of their system-level characteristics

Enables operational risk-taking

- Can afford risk of loss
- Can use for probes and feints
- Use for *dangerous* missions

Offers unique performance characteristics



- Long endurance
- No need for life support
- Use for *dirty* missions

Reduces costs

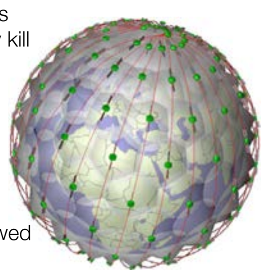
- Cheaper to buy and maintain due to simplicity
- Cheaper to operate due to fewer operators per platform
- Use for *dull* missions

But new generation systems can support each element of kill chains from find to engage to assess

Enables scale

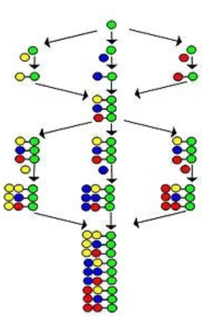
Vast future operating areas and third-party kill chains require distributed operational concepts

Only viable with more, smaller, uncrewed systems

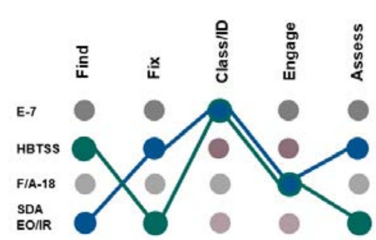


Creates more options (more dilemmas)

More building blocks enables more rapid discovery and refinement of distributed systems-of-systems



Enables adaptability/resilience



Coupled with software, permits rapid evolution of systems-of-systems

Source: Authors.

during the last five years due to rising compensation costs, the availability of militarily relevant commercial technology, and the demonstrated success of drones during the Russia-Ukraine War and Houthi attacks on Red Sea shipping. These forces have reshaped themselves around UxS as the primary battlefield weapon, confining traditional cruise and ballistic missiles and aircraft to niche missions.[43]

The value proposition of UxS is changing, as shown in figure 1.3. Uncrewed systems are now used for every link in military kill chains instead of being treated as adjuncts to the traditional crewed force for "dirty, dull, and dangerous" missions. Humans remain in the loop to make decisions about which targets to attack, but they increasingly rely on UxS to make their own decisions about how to reach a target, precisely when to attack it, and which effects to use in prosecuting the attack.[44]

This changing value proposition allows militaries to do more than simply lower risk to humans or achieve greater reach and persistence. Because they can contribute to any link in the kill chain, UxS can dramatically increase a force's scalability, complexity, and adaptability. The force that better exploits the new value proposition for UxS can create more dilemmas for opponents, which would need to prepare for a wider variety of potential threats.

The ADF could also dramatically reduce future personnel requirements by adopting UxS to perform a larger portion of Australia's military missions. Using automation, the ADF could reduce the crews needed for each ship, aircraft, or ground unit and improve the efficiency of support functions like logistics or administration. But crewed ships or aircraft require sustained upkeep even when at home base and need to operate regularly to keep their crews proficient.

Uncrewed systems offer a more effective way to reduce personnel needs compared to automation. A military can grow the number of UxS faster than the associated increase in the number of required personnel because a single operator and support crew can operate multiple vehicles simultaneously. When UxS are not needed, they can be stored with only minimal maintenance, and their operators can stay proficient using simulators.

A Path to Strategic Solvency

To its credit, the ADF's plans incorporate UxS across each domain and in many cases treat its new autonomous systems as independent actors rather than merely adjuncts to crewed platforms and units. However, the planned number and mix of UxS in the ADF does not support Australia's current strategy or a strategy of cost imposition. And other AUKUS Pillar II technologies, such as hypersonic attack and defense, will likely need more resources to protect Australia's northern approaches.

This study will assess the security challenges facing Australia and propose an alternative path to achieve the ADoD's goal of deterring and defeating aggression within realistic fiscal and personnel constraints. The next chapter will describe the study approach, which used a combination of tabletop exercises (TTXs) and interactive workshops to develop a proposed force design for the ADF in 2035. Chapters 3 and 4 will describe those assessments and proposed forces in detail, and Chapter 5 will provide conclusions and recommendations for the ADF.

2. STUDY FRAMEWORK

Hudson Institute used a combination of TTXs, workshops, and academic research to assess ways the ADF could implement a strategy of deterrence by cost imposition within its fiscal and personnel constraints by the mid to late 2030s. The study framework was structured to address a set of research questions regarding ADF force design:

- What are the main strategic challenges facing Australia and the ADF in 2035–40?
- How should the ADoD equip and posture the ADF in 2035–40 to implement its strategy, considering realistic fiscal and personnel limitations?
- How should ADF units conduct warfighting operations in the mid-2030s to take advantage of emerging technologies?
- How could US military contributions impact the needed ADF force design?

The study assumed the main constraints on ADF force design would be funding and personnel. The AUKUS agreement would likely make almost all relevant allied technologies available to the ADF, and the combined allied industrial base would likely be able to deliver equipment and systems in quantities the ADoD could afford.

Budget

The study assumed ADoD budgets through 2035 will remain consistent with current Australian government plans. The ADoD's planned budget as described in the 2025–26 PBS grows at an annual rate of about 3 percent above inflation from 2024–25 through 2028–29. The study assumed this 3 percent rate of

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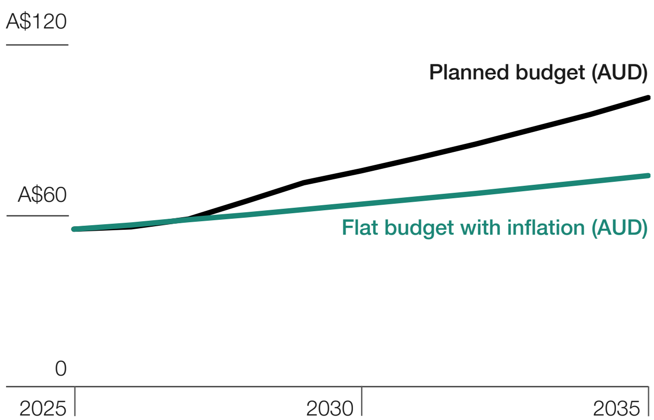
Photo: Remote pilot warfare officers conduct training with the Shiebel S100 Uncrewed Aerial Vehicle at Jervis Bay Airfield in May 2023. (Australian Department of Defense)

Figure 2.1. Assumed Spending Levels Used in the Study



Source: Authors, using ADoD data.[47]

real growth continues until 2035, as shown in figure 2.1. This assumption is likely to be optimistic, considering that the Australian government has not begun to grow defense spending in line with the 2024 NDS and IIP. It has deferred much of the decadal investment those documents describe to start in the late 2020s.[45]

Within the overall defense budget, the study assumed that funding for new capabilities would remain consistent with the 2024 IIP. In that document, the Australian government established a goal of v 330–430 billion for procurement and for research and development (R&D) during 2024–34. However, it has approved only about AUD 92 billion of that investment spending.[46] The slow implementation of the 2024 NDS and IIP suggests the ADoD may not be able to achieve its planned total investment budget.

The study assumed the ADoD can realistically reallocate only a portion of its planned investment funding to implement its proposed fleet design. For example, government investments in crewed ship construction provide essential employment and workforce training. Other investments—such as improvements to base, housing, or information technology infrastructure—are likely already at the minimum level to support current operations. These cannot be reduced without creating new vulnerabilities. And some investments, such as space and cyber capabilities, are classified, so this study cannot adequately assess or explain proposed changes.

To address these limitations, the study assumed that planned investment in UxS is the primary fiscal tradespace for a new fleet design. As described in chapter 1, uncrewed and autonomous systems will be the primary means to achieve the scale and adaptability ADoD needs to implement deterrence by cost imposition. Investments in crewed shipbuilding, cyber and space capabilities, and infrastructure will not be in the tradespace. The study proposed adjusting other planned investments, but on a limited basis that minimizes the need to analyze impacts on personnel and sustainment.

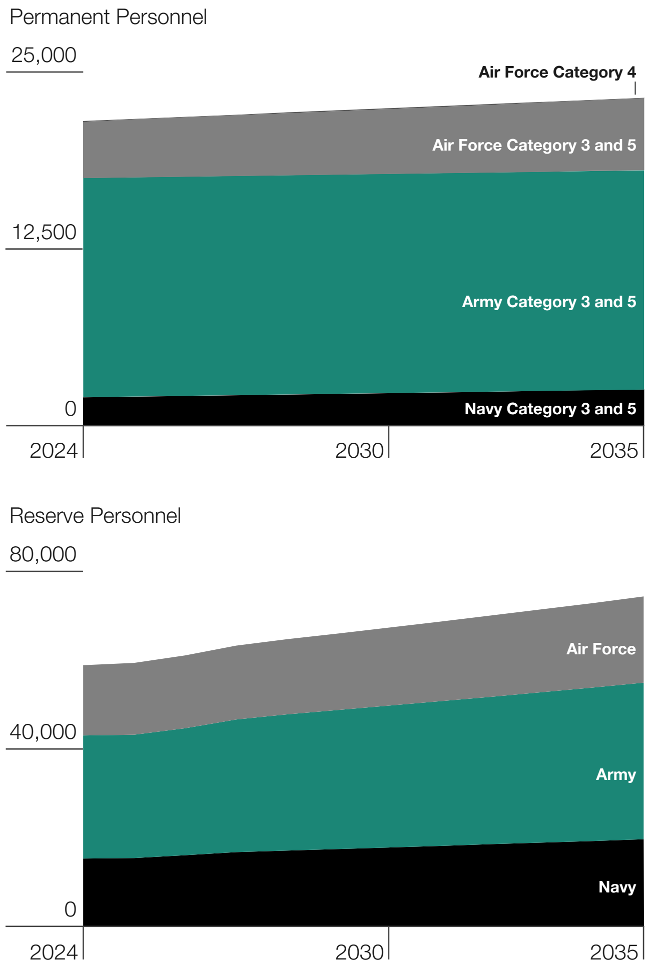
The 2024 IIP identifies a planned investment of about AUD 12.8 billion in UxS between 2025 and 2035. The government has approved only a fraction of this funding, but the study assumed it would eventually achieve this funding level. Of that, the study assumed the ADoD could devote about 70 percent, or AUD 8.5 billion, to UxS procurement, and the rest to R&D and fielding costs.

In general, the study assumed that reallocating investment would result in a commensurate realignment of personnel and sustainment spending to ensure the new capability mix is supported. It further assumed that the operations and support costs of the new capability mix will be within the planned spending on personnel and sustainment. This is a conservative assumption. As described in chapter 4, the proposed force design rebalances the ADF toward more uncrewed and autonomous systems and away from crewed platforms, which reduces the number of necessary personnel in the ADF and likely lowers sustainment costs relative to the current IIP plan.

Personnel

The Australian government plans to grow the ADF to about 69,000 permanent uniformed personnel by the early 2030s and about 100,000 permanent uniformed and civilian personnel by

Figure 2.2. Assumed Personnel Levels in the Study



Source: Authors, using ADoD data.[49]

2040, according to the 2024 Defense Workforce Plan.[48] The ADF would need to grow at about 2 percent per year to reach those levels. The study assumed personnel levels in the ADF will grow at that rate annually through 2035, as shown in figure 2.2.

Like the budget assumptions above, these personnel assumptions may be optimistic. The ADF has not met its recent recruiting targets, missing by 20 percent in 2024.[50] The ADoD's outsourcing of recruiting operations to a contractor is complicating its efforts to address this shortfall. The ADoD can penalize the contractor for failing to meet targets, but this is only retrospective and does not help fill today's gaps in ships, aircraft squadrons, or ground formations.

Developing the 2035 Force Design

Within the budget and personnel constraints described above, the study used a series of TTXs and workshops to assess how the ADF force design should evolve between 2025 and 2035 to implement the ADoD's strategy. Hudson Institute conducted two TTXs with a group of military officers and defense civilians from the US, Japanese, and Australian militaries, complemented by selected industry technical experts. The first TTX was held in Japan, and the second in Australia. Hudson Institute conducted workshops before each TTX to familiarize players with the capabilities to be used and after the TTX to discuss the TTXs' implications for force design.

Scenario

The TTXs used a scenario set in 2035. In it, an ongoing conflict takes up all available US (Purple) and Japanese (Green) forces. As a result, they are unable to support Australia's (Blue) homeland defense missions.

TTX Teams and Forces

The TTXs compared three potential future ADF force designs to assess a range of ways the ADoD could address future operational needs within its fiscal and personnel constraints. Hudson Institute based the number of crewed units in each force design, shown in table 2.1, on the 2024 IIP. The ADoD is unlikely to change its shipbuilding or aircraft production plans substantially due to the industrial base and economic impacts described above. Because analyzing such changes was unnecessary, Hudson Institute assigned each force design the same number and type of crewed units.

Hudson Institute assigned each force design a different mix of UxS to assess which systems and associated operational con-

Table 2.1. Crewed Forces Assigned to Each Blue Team

TYPE	CLASS	TTX INVENTORY
Nuclear-Powered Submarine	*Virginia*-Class SSN	2
Conventional Submarine	*Collins*-Class SSK	3
Guided Missile Destroyer	*Hobart*-Class DDG	3
Guided Missile Frigate	*Hunter*-Class FFG	6
Multi-Mission Frigate	*Mogami*-Class FFM	6
Patrol Boat	Evolved *Cape*-Class Patrol Boat	10
Offshore Patrol Vessel	*Arafura*-Class Patrol Vessel	6
OSV	Large Optionally Uncrewed Vessel	6
Tanker	*Supply*-Class Replenishment Oiler	2
Assault Ship	*Canberra*-Class LHD	2
Landing Ship	LSD	1
Watercraft	Army Watercraft	24
Air Defense	SRGBAD Battery	2 (24 launchers)
Air Defense	MRGBAD Battery	0
Air Defense	CUAS System	120
Long Ranged Ground Launch	HIMARS	42
Short/Medium Ranged Ground Launch	Loitering Munition Battery	50
Hypersonic Launcher	Hypersonic Battery	4
MPA	P-8	12
AEW&C	E-7	6
Land-Based Fighter	F-35A	72
Refueling Aircraft	KC-30 MRTT	7
Land-Based Fighter	F-18F	24
Land-Based EW	EA-18G	18
ASW Helicopter	MH-60R	36
Ground Attack Helicopter	Apache	29
Transport Helicopter	Blackhawk	40
Transport Helicopter	Chinook	14
Transport Aircraft	C-17	8
Transport Aircraft	C-130	24
Transport Aircraft	C-27	10

Source: Authors.

Notes: AEW&C = airborne early warning and control, ASW = anti-ship warfare, CUAS = counter uncrewed aerial system, DDG = guided-missile destroyer, EW = electromagnetic warfare, FFG = frigate, FFM = multi-mission frigate, HIMARS = High Mobility Artillery Rocket System, LHD = landing helicopter dock, LSD = landing ship dock, MPA = maritime patrol aircraft, MRGBAD = medium-range ground-based air defense, MRTT = multi-role tanker transport, OSV = offshore support vessel, SRGBAD = short-range ground-based air defense, SSK = diesel-electric submarine.

Table 2.2. Uncrewed Systems Assigned to Each Team with Notional Examples

DOMAIN	TYPE	EXAMPLE	TEAM 1 (LARGE)	TEAM 2 (SMALL)	TEAM 3 (HYBRID)
Surface	300T MUSV	US Navy Ranger	8		6
	100T MUSV	US Navy Sea Hunter	15		10
	6-12m sUSV	US Navy CUSV		325	200
	2-5m sUSV	Saronic Spyglass		800	400
	Sail sUSV	Ocius Bluebottle		100	90
Air	HALE	US Navy MQ-4	8	0	0
	MALE	JMSDF MQ-9B	24		12
	CCA	Boeing Ghost Bat	36	0	36
	6” sUAS	Anduril Altius-600		15,000	10,000
Undersea	XLAUV	Anduril Ghost Shark	10		8
	LUUV	C2 Robotics Speartooth	50		30
	MUUV	US Navy Razorback		120	100
	SUUV	US Navy Lionfish		630	500

Source: Authors.

Notes: These systems were chosen by Hudson Institute and are not reflective of ADF plans. CCA = collaborative combat aircraft, CUSV = common uncrewed surface vessel, HALE = high-altitude long endurance, LUUV = large uncrewed underwater vessel, MALE = medium-altitude long-endurance, MUSV = medium uncrewed surface vessel, MUUV = medium uncrewed underwater vessel, sUSV = small uncrewed surface vessel, SUUV = small uncrewed underwater vessel, XLAUV = extra-large autonomous underwater vessel.

cepts were most beneficial in addressing Australia's future operational challenges. A different team played each force design, as described below:

- **Blue Team 1.** Large UxS: Emphasized multimission UxS with long endurance and organic weapons.
- **Blue Team 2.** Small Systems: Emphasized tactical, single-function UxS.
- **Blue Team 3.** Hybrid Force: Incorporated a mix of large and small UxS.

Hudson Institute constrained each UxS force list with the assumptions that funding for UxS would remain at about AUD 8.5 billion for procurement based on the 2024 IIP and that only about 7,500 personnel would be available for UxS operations, about half the new personnel added to the ADF from 2025 to 2035. Table 2.2 shows the UxS assigned to each Blue team.

A White cell comprising Hudson Institute personnel played the forces of other countries, whose actions were largely scripted in advance of the TTXs. Non-ADF forces did not interact with the Blue teams in the TTXs under the assumption that they focused on other operations. For example, the exercise assumed that the US force was attempting to break the blockade of Taiwan and that the Japanese force was defending Japan and attempting to close the First Island Chain across the Nansei Islands.

Three Red cells of two experts each played the aggressor force, with one cell opposing each Blue team. Hudson Institute scripted the Red forces' actions but allowed each Red cell to deviate from the script when appropriate. The TTX scenario assigned each Red team the same forces, shown in table 2.3.

Table 2.3. Red Forces Used in TTXs

TYPE	NUMBER
Corvette	25
Guided Missile Destroyer	22
Frigate	24
Minesweeper	7
Maritime Militia	21
Amphibious Task Group	5
Conventionally Powered Aircraft Carrier	2
LUSV	2
Conventional Submarine	18
Nuclear-Powered Guided Missile Submarine	10
XLUUV	10
LUUV	10
Minefield	15
Fighter	14
ASW Helicopter	12
LUAS	11
MPA	15

Source: Authors.

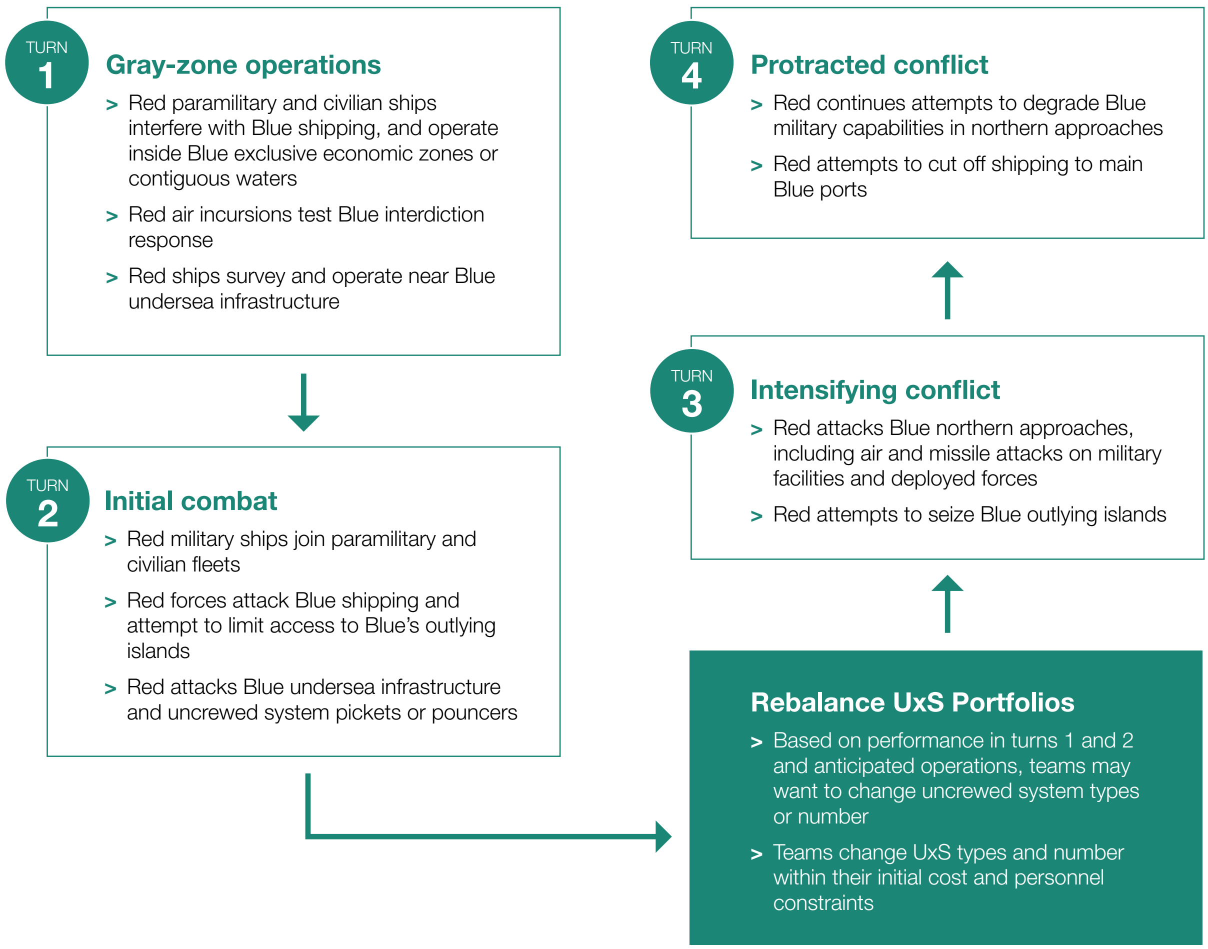
The Red force included only larger uncrewed systems, such as long-endurance large uncrewed air systems (LUASs), large uncrewed surface vessels (LUSVs), and larger uncrewed undersea vehicles (UUVs). The Red force would likely integrate small UxS with crewed units or larger UxS to carry them the long distances to Australia and coordinate their operations.

TTX Mechanics

The TTXs used four main turns, shown in figure 2.3, to play through the scenario. It started with gray-zone actions against Blue, then escalated over nine months of game time through Red attacks on the Blue homeland. Teams were provided an opportunity to adjust their UxS portfolios midway through the TTXs based on insights from the first two turns.

Rules of engagement (ROE) changed during the TTXs consistent with the level of escalation. During Turn 1, Blue could not

Figure 2.3. TTX Methodology



Source: Authors.

engage Red forces except in self-defense. This resulted in a protracted gray-zone operation between Red and Blue forces. The ROE changed in Turn 2 to also allow Blue forces to engage Red forces attacking shipping or uncrewed pouncers. And in Turn 3, Blue forces were allowed to engage Red anywhere because Red had begun attacks on Blue's deployed forces and homeland.

During each turn, Blue teams conducted two tasks, summarized in figure 2.4.

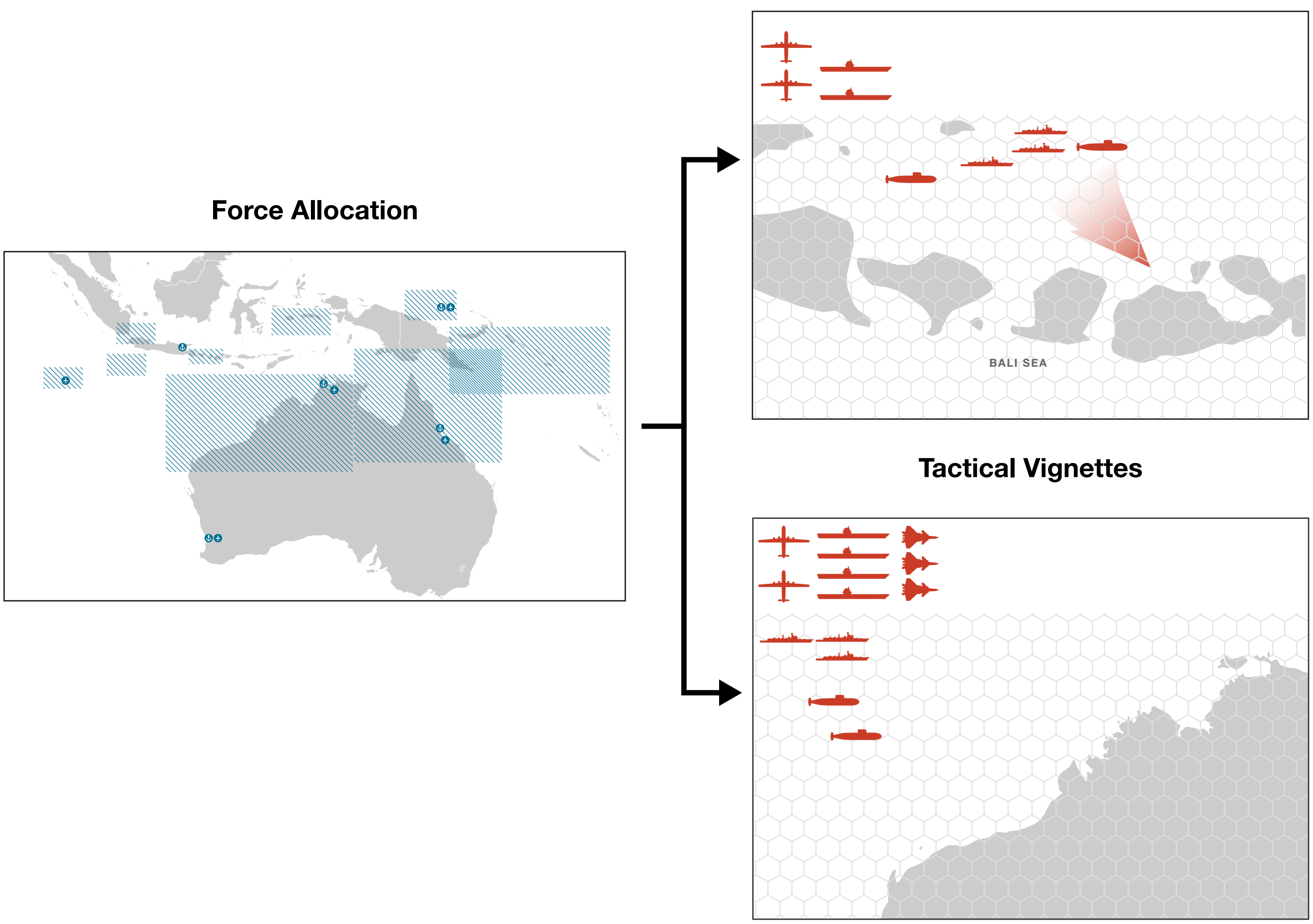
- **Force allocation.** Each team allocated its entire available force across the missions and geographical areas they were concerned could be subject to Red attack.[51] This task provided insights regarding the necessary number of each type of ship, aircraft, troop formation, or UxS. Teams used a physical chart and tokens to deliberate on their force allocation and a computer-based spreadsheet to track and record the results.
- **Tactical vignettes.** Each team engaged Red during tactical vignettes, shown in figure 2.4, to inform which capabil-

ities were beneficial or identify gaps that required new or different capabilities. Due to time constraints, Blue teams played only two or three vignettes of the nine total vignettes per turn, although they allocated forces to all the potential vignette operating areas. Vignettes addressed a range of missions appropriate to the setting, such as counterinvasion and air defense in the Cocos Islands or ASW in the Bali Sea. Hudson Institute used a computer-based adjudication tool to determine the outcomes of engagements during vignettes.

Blue teams built plans for tactical engagements that identified each element required to compose the associated effects chains, from finding targets to assessing results. To ensure realistic plans, the computer adjudication tool constrained teams' selected kill chains based on the physical characteristics and performance of the systems.

The TTX scenario assumed that commercial and military space-based sensors provided situational awareness but that Australia continued to lack space-based targeting, and US targeting was

Figure 2.4. Blue Team Tasks During the TTXs



Source: Authors.

not in position to support engagements around Australia due to other tasking. Therefore, the TTX mechanics and adjudication tool required teams to establish a tactical targeting source for each engagement. To capture the sensor, processing, and communications constraints of tactical targeting platforms like uncrewed surface vessels (USVs) or medium-altitude, long-endurance uncrewed air systems (MALE UASs), the adjudication tool limited the number of targets each sensor could maintain in custody.

The computer adjudication tool also automatically operated protective capabilities, such as air defenses and EW systems or decoys, that would respond to Red attacks. The computer tool adjudicated interactions of kinetic and non-kinetic effects stochastically rather than using a physics-based model, but it used parameters that were informed by detailed physical modeling where available.

Limitations and Areas for Further Study

This study does not reflect a comprehensive assessment of all the factors that could and should affect the ADF force design, such as alternative scenarios, logistics and communications constraints, and variations in Red force design. These factors, detailed below, should be addressed in subsequent analyses.

Scenarios

The proposed 2035 force design is based largely on a conflict in which US and Japanese forces are not available and the Red force is constrained as shown in Table 2.3. Other scenarios may result in a different or larger Red force or could allow the US military to devote more capacity to defending Australia. The ADoD could further refine the 2035 force design by assessing it against a wider variety of potential scenarios. This would enable it to establish a range of capacity necessary in each platform type and help identify which platforms or systems are useful across multiple situations.

Logistics

The TTXs conducted for this study did not address in detail the long-term sustainment of the force. The TTX mechanics and adjudication tool considered requirements to refuel ships and aircraft, but not repairs or maintenance. The game design also did not stress the logistics necessary to operate and maintain UxS deployed in expeditionary environments or at sea for extended periods. Because their endurance is generally lower than crewed platforms, uncrewed systems will demand more frequent refueling and maintenance than crewed platforms, even if they are operating close to Australia. The ADoD could address these considerations through detailed analysis of a more protracted scenario.

Communications

The 2035 TTXs did not address in detail the communication architectures and bandwidth necessary to enable effective intelligence, surveillance, reconnaissance, and targeting (ISR&T) or command and control (C2). They also did not model the impact of communications jamming, which could increase the need for redundant networks or communication relays. Further studies could assess the operational concepts in the 2035 TTX using communication models that analyze the bandwidth and latency necessary for each kill chain and could incorporate the impacts of EW. This analysis would highlight where new capabilities or additional communication capacity may be necessary to improve throughput or resilience.

Laydown

The study did not address the infrastructure necessary to support the future fleet or ideal basing locations for its elements. The study team made this choice because Australia has a large number of existing bases and facilities that can host military units, and the ADoD can relocate units to address the changing strategic environment. However, the study's recommended rebalancing of the force toward uncrewed systems would introduce requirements for facilities that can store and maintain large numbers of uncrewed vehicles.

Further research could address the changing infrastructure needs of the ADF as it evolves the force away from larger crewed platforms. For example, the ADF could reduce the number of active air bases it needs, allowing those facilities to become dual-use civilian and military airfields or transitioning them to host uncrewed aircraft.

Red Force Design

The 2035 TTXs did not consider a variety of Red force designs that could emerge during the next 10–20 years. Based on lessons from the war in Ukraine, adversaries could rebalance their forces toward uncrewed systems to address demographic challenges or to exploit autonomous capabilities that remove the uncertainty of relying on junior commanders to execute plans. Although a more uncrewed Red force would likely be more numerous and challenging from a capacity perspective, it could also have vulnerabilities that the ADF could exploit in its own force design. For example, autonomous systems relying on AI-enabled perception algorithms may be more susceptible to counter-C5ISR (command, control, communications, computers, cyber, intelligence, surveillance, and reconnaissance) capabilities than a system with an operator in the loop.

Further studies could test the proposed 2035 force design against a variety of Red force designs. For example, a replay of the 2035 TTX could place a common Blue team against three Red force designs, each with different mixes of crewed and uncrewed systems and different levels of vehicle autonomy. The TTX could reveal elements of the 2035 ADF force design that should change depending on the adversary's evolution, as well as which ADF elements are robust across a range of potential opposing forces.

3. CAMPAIGNING AND FIGHTING

To deter aggression, the ADF needs the ability to conduct wartime operations that increase an opponent's risk of protraction and military losses. However, because the ADF cannot completely deny most forms of attack, the ADoD and Australian government need to conduct operations in peacetime to assess the risk tolerance of adversary leaders. The TTXs and workshops conducted for this study found that a single ADF force design could perform both of these major strategic tasks.

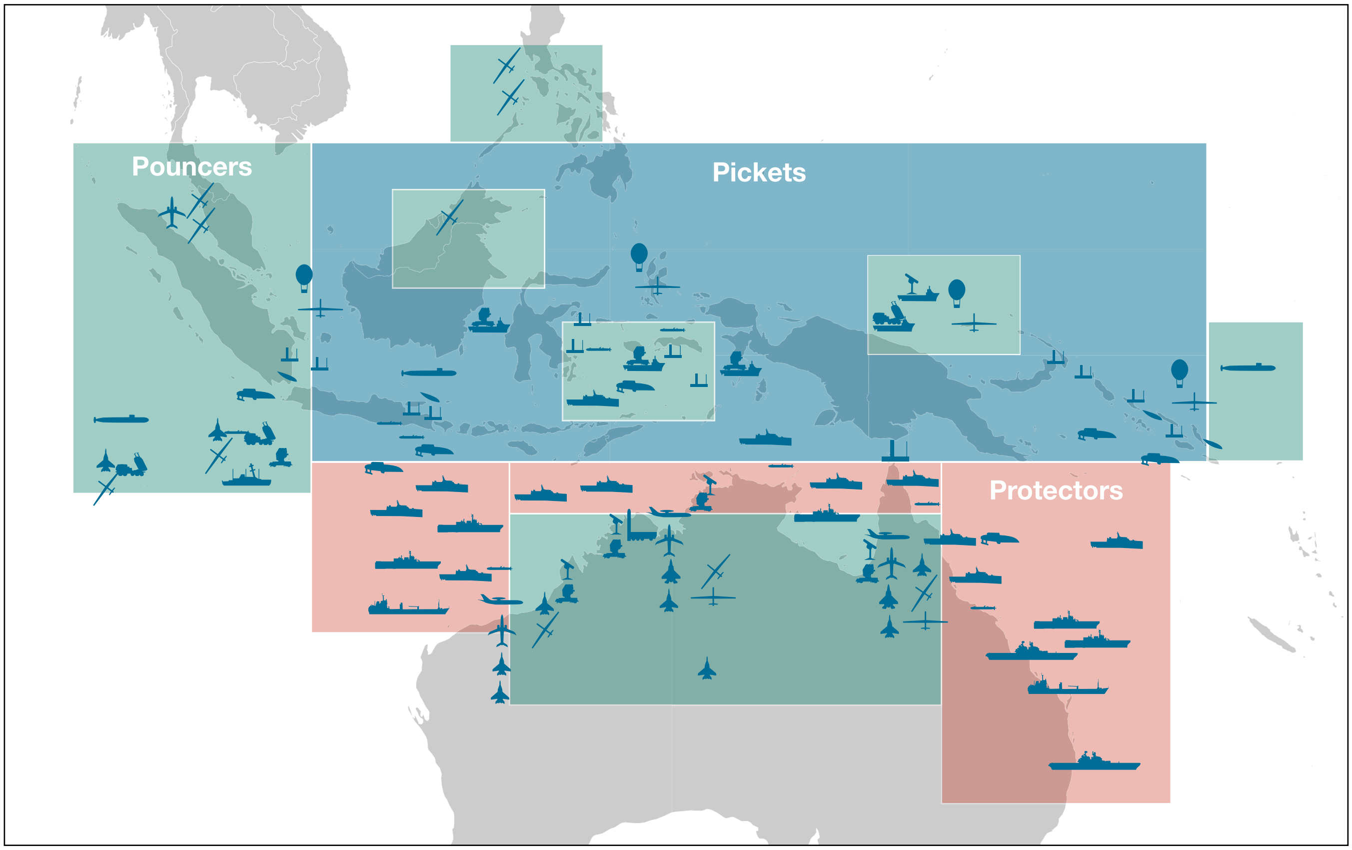
Because of Australia's vast geography and small military, the ADF will also need highly distributed capabilities that can respond to and hold threats at bay until a concentration of forces can arrive. This suggests a basic construct like that shown in figure 3.1, with uncrewed *pickets* that detect and respond to threats; a mix of crewed and uncrewed *pouncers* that delay or stop threats; and crewed *protectors* that can surge to augment pouncers or defend high-priority locations such as cities or military installations.

The construct shown in figure 3.1 would also support an ADF campaign to probe and assess adversary leaders' risk tolerance and preferred attack scenarios. And because the individual units involved would be mostly small or uncrewed pickets and pouncers, the consequences of losses suffered in these probing activities would be reduced.

As described in chapter 1, the ADF force design should enable flexibility in posture, tactics, and force composition to pose novel and unexpected challenges against an enemy's various avenues of attack. The reaction to ADF operations may yield insights about which attack plans adversaries prefer and which ADF concepts are most concerning to potential aggressors. By

Photo: HMAS *Toowoomba* conducts a live fire gunnery serial while sailing through the Western Australian Exercise Area in March 2025. (Australian Department of Defense)

Figure 3.1. Force Design Construct Developed in TTXs and Workshops



Source: Authors.

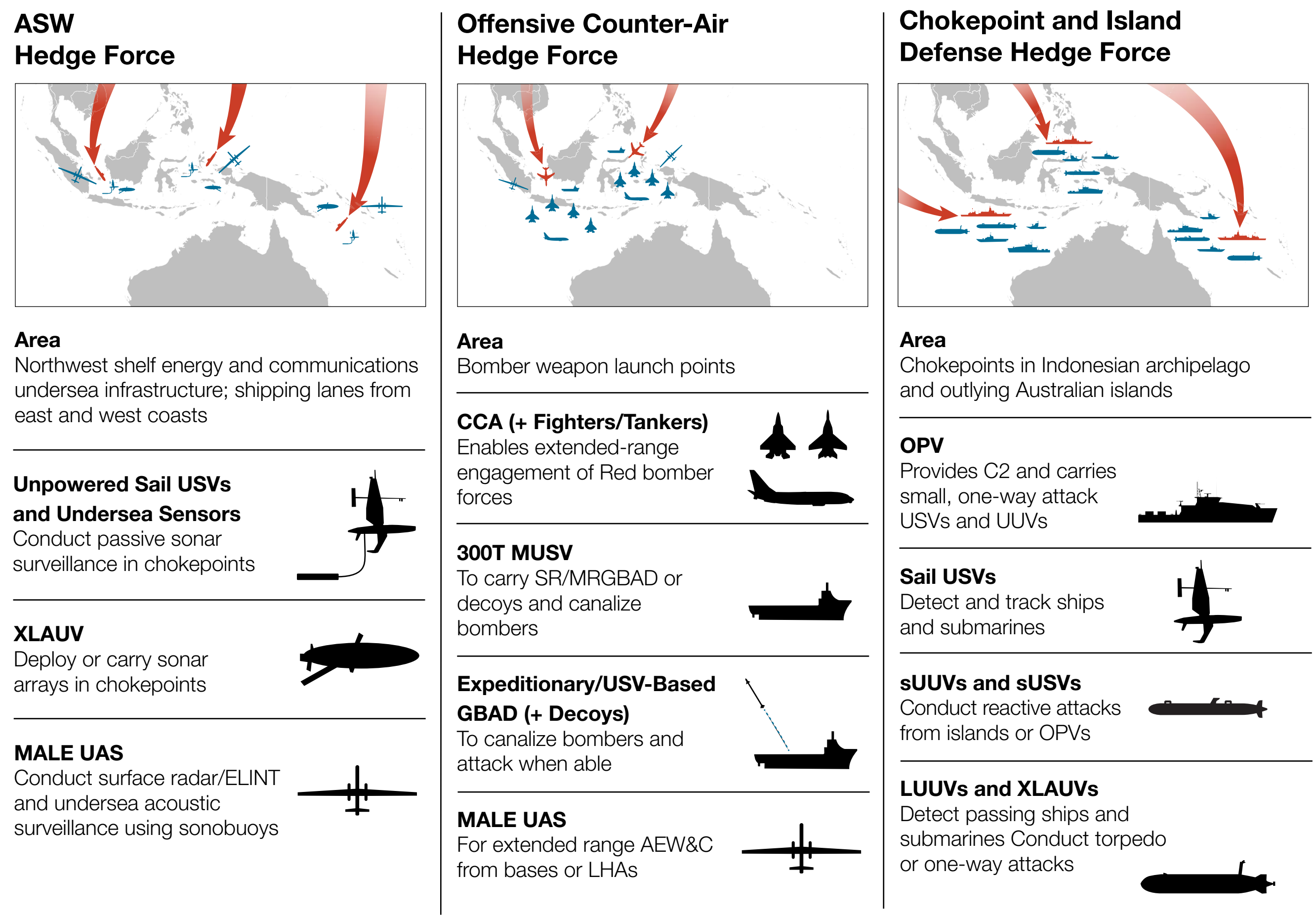
expanding the ADF's reliance on modular uncrewed systems, the force design of figure 3.1 provides the capacity and recomposability to support a changing and diverse array of dispositions and operational approaches in a deterrence campaign.

Hedge Forces

Another feature of the posture model of table 3.1 is that it enables uncrewed systems to reduce the risk associated with high-consequence but low-probability scenarios facing Australia. Picket and pouncer forces are essentially hedge forces that provide the scale and persistence necessary for situations that are beyond the capacity of the crewed ADF and that would demand a substantial force restructuring to otherwise address.[52] For example, the ADF would need a dozen FFGs or DDGs and nearly 100 fighters to counter an air campaign against the northern approaches when taking operational availability into account. This would tie up the entire surface combatant and fighter fleets, leaving Australia vulnerable to other threats.

Using uncrewed systems in hedge forces allows crewed ships, aircraft, and troop formations to provide C2, prepare for higher-probability scenarios like border protection or interference with shipping, and back up hedge forces as part of the protector force. Because they address challenging threats that will rarely material-

Figure 3.2 Hedge Forces for the ADF



Source: Authors.

ize, the ADF would benefit most from using hedge forces for ASW, offensive counter-air (OCA), and chokepoint and island defense operations, as shown in figure 3.2. These hedge forces would free crewed ADF units to focus on more common day-to-day missions and would enable a more dynamic defensive posture to undermine adversary planning as part of a deterrence campaign.

This chapter starts by describing concepts developed in the study that underpin the basic force design construct shown in figure 3.1 and the hedge forces of figure 3.2. The chapter then analyzes implications of these concepts for command, control, and communications (C3) and uncrewed system portfolios. Chapter 4 describes how the proposed ADF posture and operational concepts translate into a force design that fits within the ADoD's fiscal and personnel constraints.

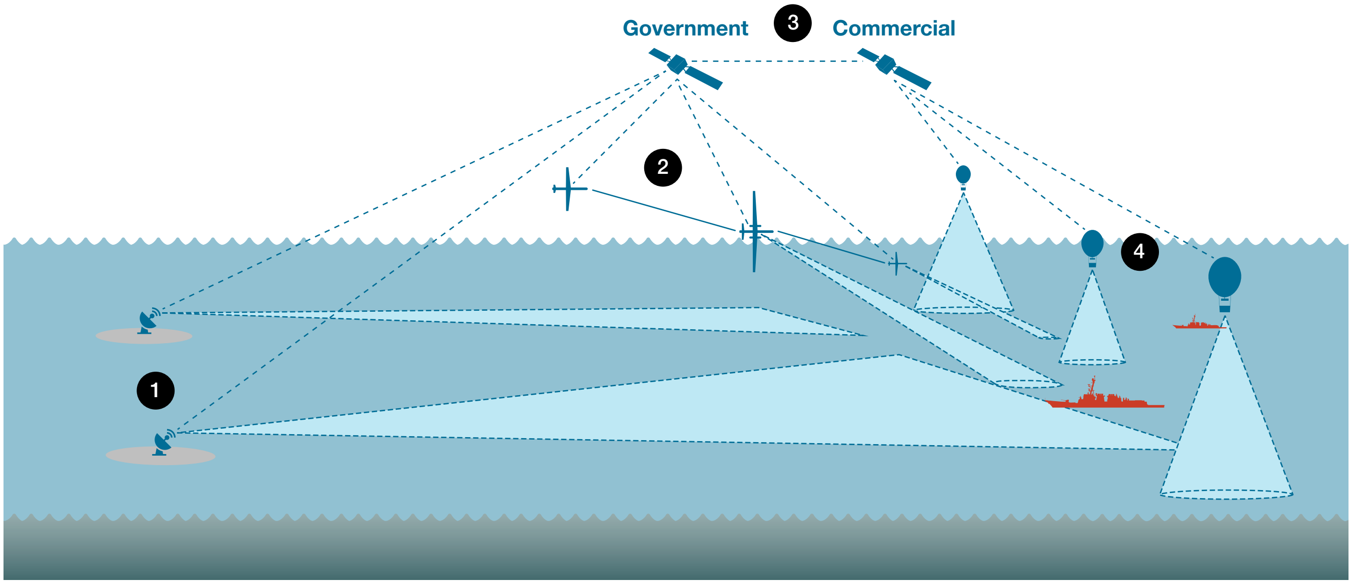
Operational Concepts

One of the main research questions for the study was how the ADF would operate and fight in the 2035–40 time frame. However, the ADF cannot wait more than a decade to implement new concepts like these. It will need to begin fielding them in the next several years to begin a deterrence campaign against adversary aggression. The following sections detail operational concepts developed by Hudson Institute for ISR&T, C3, IAMD, OCA, ASW, and strike/surface warfare missions.

Intelligence, Surveillance, Reconnaissance, and Targeting

Military planning and operations start with ISR. In 2035–40, the ADF will be able to employ the wide variety of sensing approaches summarized in figure 3.3. Perhaps the most important new source of ISR is commercial space sensing,

Figure 3.3. Wide-Area ISR Concepts



1

JORN OTH Radar

- Shore-based detection
- Cue other assets
- Links: MILSATCOM
- Latency: **Long**
- Data Intensity: **Low**

2

Long-Range ISR

- Cued by other assets
- Higher fidelity sensors
- Assets acting as edge processing and C2 nodes
- Links: LOS, MILSATCOM
- Latency: **Long**
- Data Intensity: **Medium**

3

SATCOM

- Passing cues from long-range sensors
- Passing rich sensor data from search assets
- Integration with commercial SATCOM
- Latency: **Long**
- Data Intensity: **High**

4

High-Altitude Balloons

- Low-fidelity ISR
- Local C2 node for other assets
- Links: LOS, COMSATCOM
- Latency: **Long**
- Data Intensity: **Medium**

Latency

Maximum delay in C2 link to avoid bottleneck

Long: Many minutes
Moderate: <1 minute
Short: <1 second

Data Intensity

Required bandwidth or onboard processing

Low: B/sec
Medium: KB/sec
High: MB/sec+

C2 Links

— Line of Sight (LOS)
- - - SATCOM
···· Other Comms

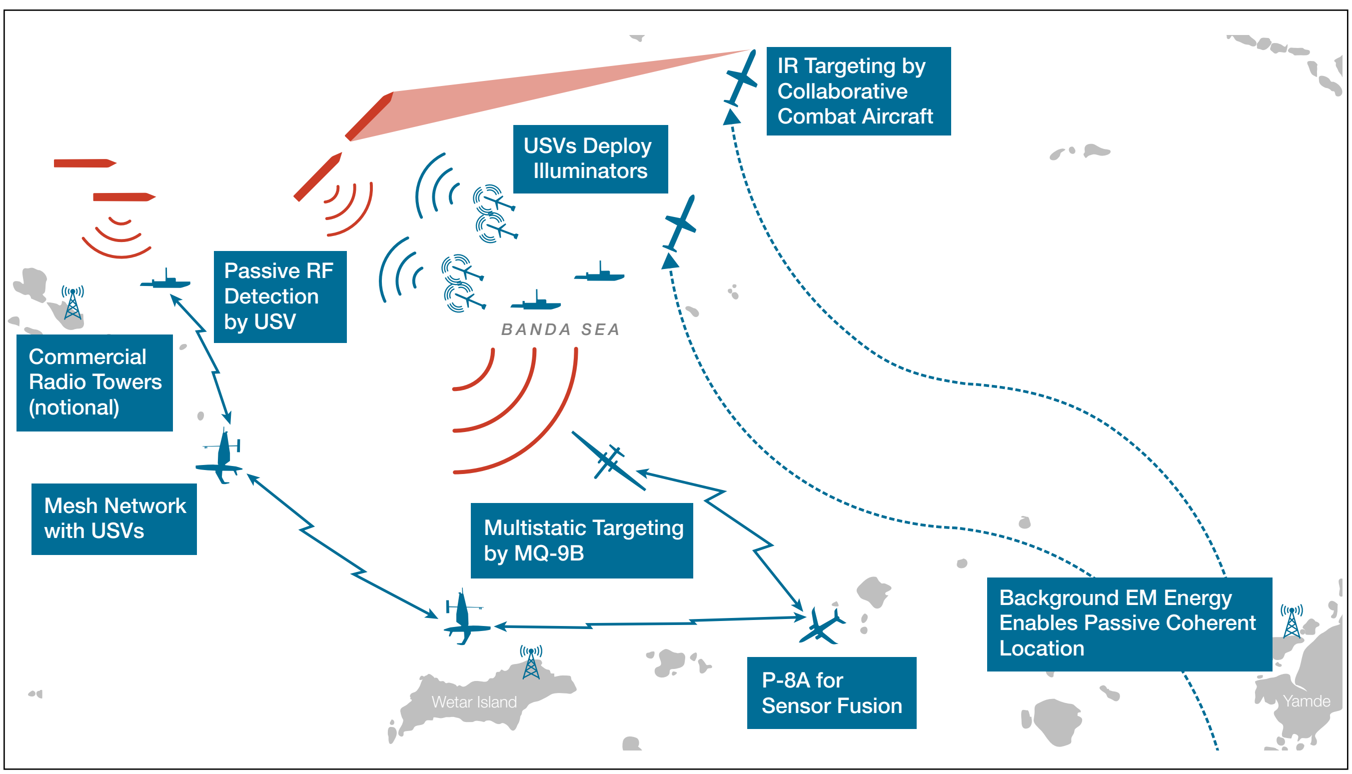
Source: Authors.

which has dramatically improved all militaries' ability to maintain situational awareness of their region and provide warning of possible attacks. Countries close to a potential aggressor, like Ukraine, cannot exploit commercial satellite capabilities for warning because their attackers can quickly launch a large-scale assault. However, for the ADF, the relatively long distances from potential aggressors would enable commercial space sensing to provide adequate warning of enemy forces' arrival.

A constraint on the ADF's ability to exploit commercial space sensing is reduced coverage at lower latitudes. Most commercial low-earth orbit constellations are optimized to provide the densest coverage and shortest revisit rates in the mid-latitudes. This will support ISR over the northern approaches but will result in higher latency and lower accuracy along Australia's southern approaches.[53]

The United States and other allied nations field pole-orbiting satellites to improve coverage at higher and lower latitudes, but these constellations do overfly Australia. For its part, the Australian government does not operate surveillance satellites, although it is pursuing a low-earth orbit constellation as part of a consortium to provide communications and space domain awareness.[54] The US Space Force is addressing limitations of US military satellite coverage through initiatives like the Tactical Surveillance, Reconnaissance, and Tracking Program, which combines military and commercial space capabilities to provide

Figure 3.4. Proposed Passive and Multistatic Targeting Concepts



Source: Authors.

surveillance data to allies and partners.[55] This program could provide ISR data for ADF operations.

Australian forces can augment space-based ISR with the Jindalee Operational Radar Network (JORN), a set of high-frequency (HF) over-the-horizon radars (OTHRs) positioned across the northern half of Australia. Australia is the world leader in OTHR technology, and the ADF has refined its sensing concepts during three decades of JORN operation to detect ships and larger aircraft more than 1,000 nm away.[56]

Between commercial and military space capabilities and JORN, the ADF has sufficient ISR capabilities to build a regional operational picture. The ADF's challenge, however, is translating that picture into the target-quality information it needs to launch long-range weapon attacks. Commercial satellites and JORN generally do not provide the precision or fidelity necessary to place a long-range weapon in the right location to see the target when its seeker turns on. And even if they do, the ADF cannot provide in-flight updates from commercial space services or JORN to weapons that could be in flight for hours before reaching their targets.

ADF forces will generally need a separate, local sensor to track targets and provide in-flight updates to weapons. Australia is far from most aggressors and will not experience the intense, large-scale missile fires that Ukraine endures. However, active monostatic radars would easily reveal an ADF unit's location and identity, and anti-ship and anti-air missiles with ranges of more than 1,000 nm could strike a targeting sensor as soon as it emits.[57] To manage counter-detection risks, ADF ISR&T concepts should limit radar use to crewed air-defense platforms such as guided missile destroyers (DDGs) and AEW&C aircraft that operate far from enemy forces as part of the posture construct shown in figure 3.1.

With radar too risky to use in most situations, ADF forces would turn to passive and multistatic sensors for targeting, as shown in figure 3.4. These approaches take advantage of the ADF's need to field more uncrewed systems as part of a distributed defense and deterrence campaign. Passive sensors like radiofrequency receivers and electro-optical/infrared (EO/IR) sensors have inherently shorter ranges than radar since the target can reduce its signature through emissions control, camouflage, or jamming and obscuration. Moreover, passive techniques require multiple sensors to geolocate the target through triangulation because these sensors generally cannot obtain range information. Expendable or attritable uncrewed systems can overcome these disadvantages by approaching targets more closely and deploying at the scale necessary to geolocate contacts.

Integrated Air and Missile Defense

One advantage of the new posture construct in figure 3.1 is that it shifts most forward operations to uncrewed systems that require minimal or no protection from air threats. As a result, crewed pouncer units or protector forces stationed around Australia and its outlying islands would conduct nearly all ADF IAMD operations.

In its IAMD concepts, the ADF should apply recent lessons that US and allied militaries have learned in real-world air-defense operations. For example, US naval forces in the Red Sea have been preferentially using short-range air defense systems, such as guns or Evolved Sea Sparrow Missiles (ESSMs), that cost less and that they can carry in greater numbers than long-range surface-to-air missiles (SAMs) like the SM-3 or SM-6.[58] The US Navy is also beginning to use EW more frequently to defeat drone and missile threats by confusing their seekers or jamming their satellite navigation signals.[59]

In ground combat, Ukrainian forces are employing similar approaches that rely on high-capacity, lower-cost defenses like short-range surface-to-air missiles (SAMs), guns, or EW and reserving sophisticated, long-range SAMs like the Patriot and PAC-3 to counter Russian hypersonic and ballistic missiles.[60] As part of this approach, Ukraine is fielding a range of ad hoc air-defense

Figure 3.5. Metinvest Radar Decoy Under Construction in Ukraine

Source: Metinvest.

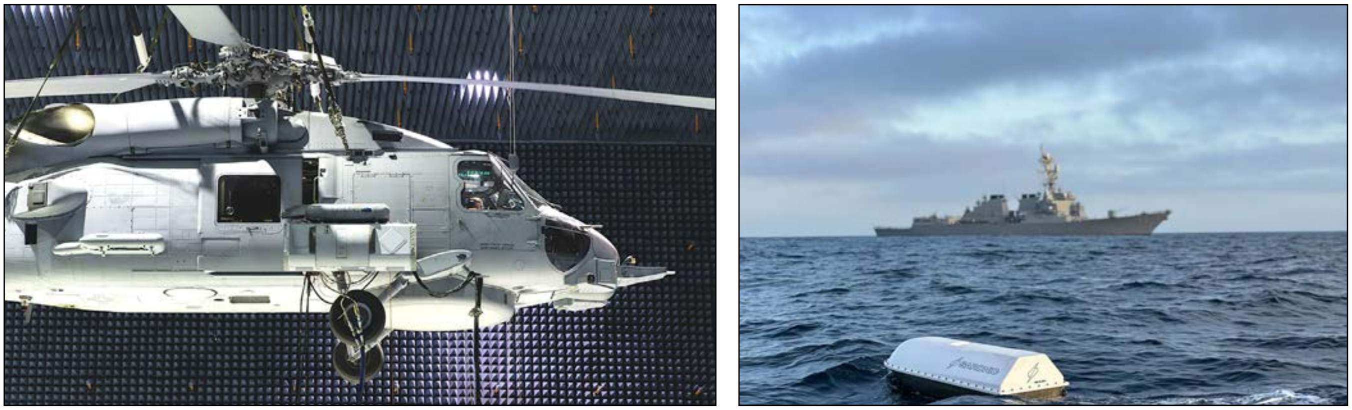
systems that repurpose infrared-guided short-range air-to-air missiles (AAMs) to defeat missiles or larger drones.[61] Reportedly, these systems have also been deployed on expendable USVs to provide an offensive anti-air capability in otherwise denied areas.[62]

Recent US and Ukrainian operations also highlight the growing diversity of counter-UAS concepts and capabilities. In addition to radar-guided cannon-based air defenses (CBADs), US and allied ground troops are using drones like the Coyote to down adversary UASs and using EW to jam drone control signals and sensors. New systems that can engage UASs at longer ranges or greater scale are now joining these capabilities. For example, existing 5-inch guns can launch General Atomics' Long-Range Maneuvering Projectile (LRMP), which forces could employ against drones at longer ranges than traditional artillery rounds.[63] And high-energy microwave (HEM) systems like the Epirus Leonidas can defeat drone swarms and some cruise missiles at dozens of kilometers by damaging or resetting their onboard electronics.[64]

Decoys, which fell out of favor in the years following the Cold War, have also proven themselves in Ukrainian and US air-defense operations.[65] Ukrainian ground system decoys like the simulated radar shown under construction in figure 3.5 can often emulate the visual, RF, and infrared signature of the real system. Because an inexpensive, expendable system will be too small to simulate a modern warship's visual signature, maritime decoys would rely primarily on radiofrequency and infrared signals to seduce incoming weapons away from protected platforms. For example, the US Navy Airborne Offboard EW (AOEW) decoy system in testing today is designed to draw incoming weapons away from a defended ship by emulating the radar return a missile would expect from the defended ship. A small USV, like the Saronic Spyglass shown in figure 3.6, could carry and power the AOEW payload to create a persistent air-defense decoy.[66]

xPersistent ADF ground and maritime decoys will likely lack the fidelity to deceive adversary sensing and sensemaking capabilities for more than a few hours. However, these decoys would be more effective against cruise and ballistic missiles, whose seekers are less sophisticated than ship, space, or aircraft sensors. And because of the reduced space and airborne communication coverage around Australia, enemy missiles may not be able to quickly compare seeker data with data from space

Figure 3.6. US Navy AOEW Decoy (left) and Saronic Spyglass USV (right)



Source: Lockheed Martin and DVIDS.

or airborne sensors. As a result, decoys could draw incoming weapons away from defended forces and reduce the number of weapons that real ships, aircraft, and ground units need to engage with air-defense systems.

Guns, EW, short-range SAMs, HEM systems, and decoys offer high air-defense capacity at low cost. But they have a significant downside: They require commanders to let threats more closely approach defended forces. However, with advancements in predictive AI-enabled models, IAMD C2 systems can help commanders determine which threats to engage at long range, which to engage at short range, and which to ignore because they will miss defended targets.[67] IAMD battle management systems can also help operators identify which air-defense systems are best suited to counter which incoming threats.

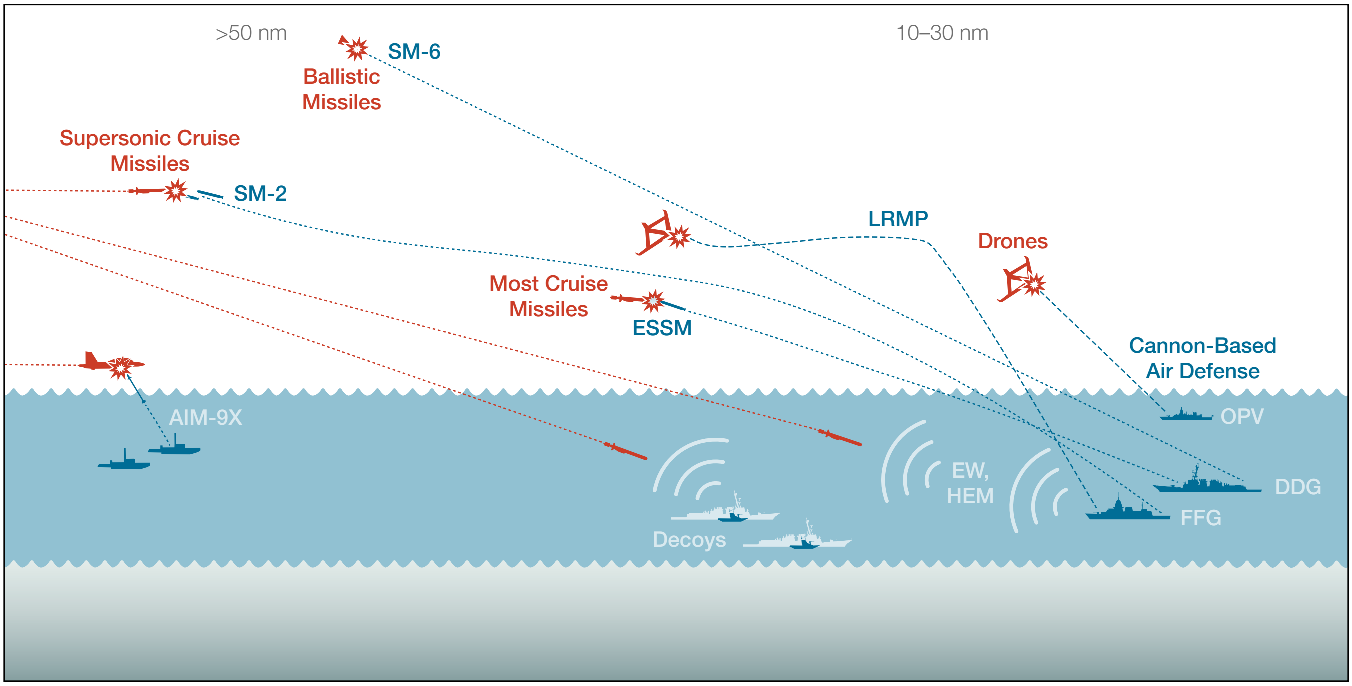
The ADF is pursuing improved IAMD C2 capabilities through its Air6500 program, which seeks to provide broad-area airspace awareness and battle management for air defense of the northern approaches.[68] These decision-support capabilities will be valuable in defending Australia, which has large areas that may not require protection and has a small force that must use its air-defense systems efficiently.

Figure 3.7 summarizes the IAMD concept for ADF units to protect themselves and nearby areas. This approach would shift most air-defense operations to shorter-range systems and increase the ADF's reliance on non-kinetic capabilities such as decoys, HEM systems, and EW jammers. The concept also relies more on uncrewed systems to draw weapons away from defended forces.

Although it represents a naval application, the principles and capabilities shown in figure 3.6 are equally relevant to ground operations. The ADoD is fielding two National Surface-to-Air Missile System (NASAMS) ground-based air defense (GBAD) batteries, which will provide the ADF with six firing units of three launchers each. NASAMs can conduct short-range GBAD (SRGBAD) using AIM-9X Sidewinder missiles or medium-range GBAD (MRGBAD) using AIM-120 missiles.[69] However, the ADF will need to add more firing units, complemented by new HEM systems and cannon-based defenses, to protect deployed forces across the northern approaches and support the OCA concepts described later in this chapter.

Another insight from the war in Ukraine is the growing prevalence of ballistic and hypersonic weapons. Through the Air6502

Figure 3.7. Proposed New Air Defense Concept for Deployed ADF Forces



Source: Authors.

program, the ADoD is pursuing a dedicated MRGBAD solution that could include a system like Patriot and can defeat ballistic and hypersonic threats, but it is not funded in the 2024 IIP.[70] The RAN's three *Hobart*-class DDGs could conduct hypersonic and ballistic missile defense (BMD) using their Aegis Weapon System and SM-3, SM-6, or PAC-3 interceptors. The *Hunter*-class guided missile frigates (FFGs) may also incorporate this capability. This is, in part, why the force design includes these crewed warships in the protector forces stationed around Australia. From these operating areas, DDGs and FFGs can help defend units that the ADF has deployed on bases in northern Australia and intercept attacks against population centers, including Brisbane, Perth, and Sydney.

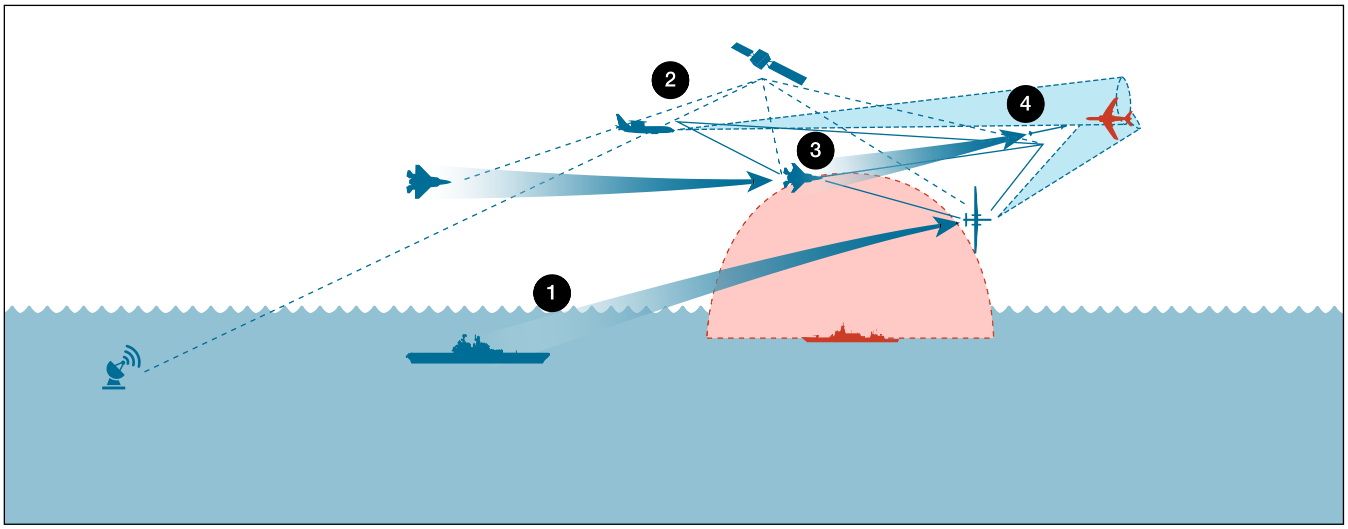
A potential weakness of this IAMD approach is that it consigns multimission warships to small operating areas close to the coast, where they may not be able to contribute to ASW or strike and surface warfare. To keep these protector platforms close to home, the proposed force design shifts most of their missions outside of air defense to UxS, as described in the sections below.

Offensive Counter-Air Operations

New IAMD concepts will improve the ADF's ability to protect itself and civilian targets from missile attack, but the ADF will lack the capacity to sustain a purely defensive effort past the first few salvos. To present adversary leaders with a risk of unacceptable losses and delay, the ADF will need the ability to engage the sources of air and missile attacks—to shoot the "archers" before they can release their "arrows."

ADF units conducting OCA operations can attack enemy aircraft either on the ground or in the air. Enemy fighters and fight-

Figure 3.8. Proposed ADF OCA Hedge Force Concept



1

MALE UAS

- Launched from shore or LHA
- Uses radar or ELINT to target bomber (radar lowers endurance)
- Links: LOS; MILSATCOM
- Latency: **Short**
- Data Intensity: **High**

2

Third-Party Targeting

- Passes targeting information to CCA
- Third-party guidance for weapons
- AEW&C for active targeting
- MALE UAS for passive or active targeting
- Links: LOS, MILSATCOM
- Latency: **Short**
- Data Intensity: **High**

3

CCAs

- Air-launched from fighter
- Optional one-way employment
- Links: LOS, MILSATCOM
- Latency: **Moderate**
- Data Intensity: **Low**

4

In-Flight Weapons

- Fired from CCA
- Guided by third party
- Links: LOS, MILSATCOM
- Latency: **Short**
- Data Intensity: **Medium**

Latency
Maximum delay in C2 link to avoid bottleneck

Long: Many minutes
Moderate: <1 minute
Short: <1 second

Data Intensity
Required bandwidth or onboard processing

Low: B/sec
Medium: KB/sec
High: MB/sec+

C2 Links

— Line of Sight (LOS)
---- SATCOM
···· Other Comms

Source: Authors.

er-bombers will be unable to reliably reach Australia due to long distances and a lack of aerial refueling. As a result, the main air threats to Australia are long-range bombers or theater and intercontinental ballistic missiles.

Bombers could launch missions against Australia from bases beyond the reach of ADF strike-fighters. However, the ADF could attack enemy aircraft on the ground using hypersonic missiles like the US Army's Dark Eagle. The RAN could also use its future *Virginia*-class SSNs to launch missile attacks on bases to destroy enemy aircraft and their support infrastructure.

The ADF's other approach to OCA will be to attack bombers in the air before they can launch their cruise missiles. Air-launched cruise missiles generally have ranges of more than 1,000 nm, allowing bombers to launch attacks outside the reach of ADF strike-fighters, which have combat radii of about 600 nm.[71] ADF fighters could go farther using aerial refueling, but the RAAF can likely operate only five of its seven KC-30 tankers at a time and will need to devote them primarily to keeping combat air patrols and AEW&C aircraft in the air. ADF fighters will therefore need a different approach to engage enemy bombers before they reach their launch points.

Figure 3.8 describes the OCA hedge force concept developed during the TTXs conducted for this study. In it, ADF fighters remain on alert on northern bases such as Darwin and Tindal or fly continuous combat air patrols if an attack is likely. The fighters, equipped with smaller collaborative combat aircraft (CCAs) like the US Defense Advanced Research Projects Agency (DARPA) Longshot, launch when long-range sensors like JORN detect bombers. Larger CCAs, like the MQ-28 Ghost Bat, can accompany them.[72] Fighters would launch their onboard CCAs when they approach their maximum range, which aerial refueling from KC-30s can extend; these refuelers would already be supporting E-7 Wedgetail AEW&C aircraft orbiting in the northern approaches. The E-7s or—if the range is too far for the E-7 to reach within RAAF tanker capacity—short take-off and landing MQ-9B UASs launched from amphibious assault ships (LHAs) guide CCAs into the vicinity of incoming bombers. The CCAs would attack bombers with AAMs like the AIM-120D medium-range missile or AIM-9X short-range missile.[73]

The kill chain shown in figure 3.8 demands a substantial portion of RAAF force structure. For example, an AEW&C orbit requires two or three aircraft total, each fighter combat air patrol requires three or four, and the fighters need about eight CCAs per orbit. The RAAF KC-30 fleet would also be fully occupied with keeping the force airborne. The ADF will lack the capacity to establish this kill chain in each possible bomber attack lane across Australia's northern approaches, which could demand a dozen or so force packages like that shown in figure 3.7.

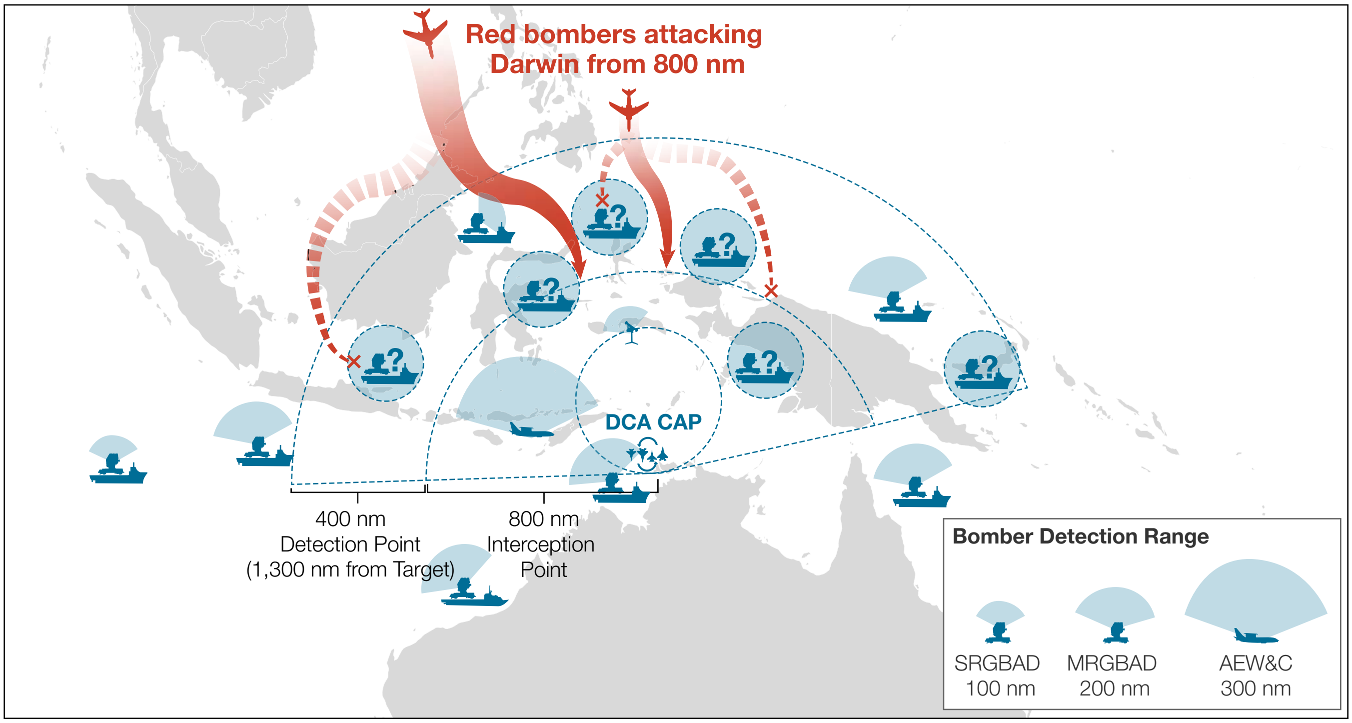
The ADF could use deception and an extended air-defense concept to constrain bomber attack lanes and reduce the capacity necessary to defeat them. For example, the concept shown in figure 3.9 would create a complex and dynamic air-defense network by deploying a small number of real SRGBAD launchers, such as NASAMS, and a larger number of decoy air-defense systems on medium uncrewed surface vessels (MUSVs). This extended air-defense scheme should force bombers into a subset of open lanes, where the RAAF can concentrate its OCA operations.

The use of NASAMS aids the deception scheme of figure 3.9 because it can employ a variety of interceptor missiles, from AIM-9X Sidewinders with a range of about 10 nm to AIM-120D missiles that could reach targets more than 100 nm away. Without knowing which missiles the NASAMS are deploying, enemy planners would have to assume each system covers 100 nm in each direction, complicating strike planning and helping to herd bombers toward RAAF OCA "kill boxes."

The ADF's planned approaches to ASW—primarily using crewed platforms such as FFGs and P-8A Poseidon maritime patrol aircraft—lack the capacity to cover the northern approaches and important sea-lanes. The ADF's 12 P-8As are too few to counter growing adversary fleets of nuclear, conventional, and air-independent submarines. And the ADF's planned force of 17 Hobart and Tier 2 FFGs would likely be too vulnerable conducting ASW against submarines that carry anti-ship missiles (ASMs) with ranges of more than 150 nm.[74]

The proposed hedge force concept addresses these capacity shortfalls and the vulnerability of using crewed P-8A or FFGs

Figure 3.9. ADF Extended Air-Defense Concept



Source: Authors.

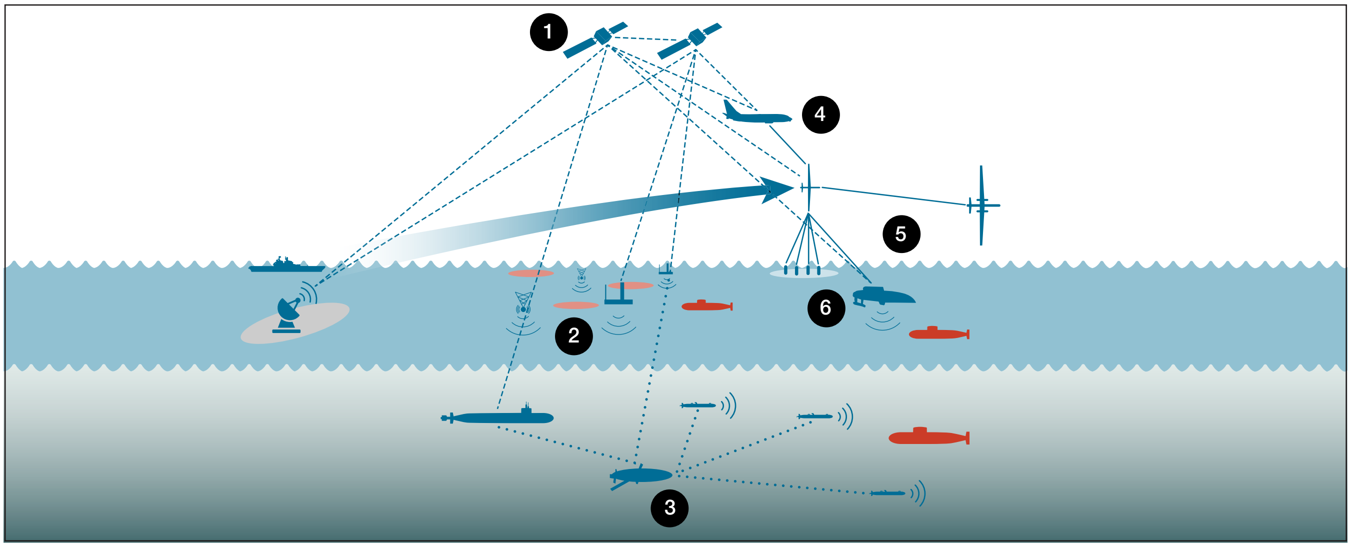
for ASW. As shown in figure 3.10 and consistent with the posture model of figure 3.1, these concepts would use P-8As primarily for C2 and as a backup method of weapons delivery. Uncrewed systems would provide all other parts of the ASW effect chain as described below for each phase of the ASW operation. Placing operators in theater with uncrewed ASW systems would mitigate the impact of enemy jamming by enabling line-of-sight communications. Local command would also reduce the load on central C2 nodes like the ADF's Joint Operations Command (JOC).[75]

Search and Track

To find submarines, the ADF ASW concept would use deployable seabed or floating sonar arrays like the US Navy's Transformational Reliable Acoustic Path Sensor (TRAPS) or Ultra Maritime's Sea Spear in chokepoints or likely submarine transit lanes.[76] Bottom-anchored vertical line arrays like TRAPS detect submarines in a cone above the array with a radius of 10–20 nm; horizontal arrays like Sea Spear can detect targets dozens of miles away, depending on how noisy they are.[77] Both types of arrays use buoys to connect with other ASW forces via commercial satellite communications. Multiple platforms could deploy the arrays, including extra-large autonomous undersea vehicles (XLAUVs) like the Anduril Ghost Shark, MUSVs, support ships, or aircraft.

In shallow water or in areas where currents, dredging, or fishing could disturb portable seabed arrays, sail-type USVs towing passive sonar arrays would fill gaps in coverage. These systems are already in experimental use by both the US and Australian

Figure 3.10. Proposed ADF ASW Hedge Force Concept



1

SATCOM

- Node between JOC and local command
- Primary non-LOS datalink for weapons
- Latency: **Long**
- Data Intensity: **High**

2

Persistent Sensors

- For cueing at chokepoints
- Deployable undersea sensors and long-endurance sail drones
- Links: COMSATCOM
- Latency: **Long**
- Data Intensity: **Medium**

3

UUVs

- XLAUV and LUUV acting as motherships
- S/MUUVs for search or attack missions
- Links: ACOM, COMSATCOM
- Latency: **Long**
- Data Intensity: **Medium**

Source: Authors.

4

MPA C2

- C2 for ASW operations after cueing
- Provide additional sonobuoy and weapons capacity
- Links: LOS, MILSATCOM, COMSATCOM
- Latency: **Moderate**
- Data Intensity: **High**

5

MALE Patrols

- C2 from JOC or local commander and MPA after a cue is obtained
- Deploy and/or monitor sonobuoy fields when cued by persistent sensors
- Pounce with CRAW
- Links: LOS, MILSATCOM
- Latency: **Moderate**
- Data Intensity: **High**

6

100T MUSVs

- Long-endurance detection and track in open ocean
- Deploy smaller systems and cue pouncers
- Links: LOS, ACOM, MILSATCOM
- Latency: **Long**
- Data Intensity: **Medium**

Latency
Maximum delay in C2 link to avoid bottleneck

Long: Many minutes
Moderate: <1 minute
Short: <1 second

Data Intensity
Required bandwidth or onboard processing

Low: B/sec
Medium: KB/sec
High: MB/sec+

C2 Links

— Line of Sight (LOS)
---- SATCOM
···· Other Comms

navies, such as in the recent collaboration between Ocius with its Bluebottle vehicle and ThayerMahan's sensors and sonar processing.[78] The ADF would also use sail-type USVs to patrol shipping lanes, protective zones around undersea infrastructure, and other areas where submarine operations are likely or would pose a higher threat to Australia's security.

Uncrewed passive sonars would use automated target recognition algorithms, increasingly augmented with machine learning, to identify specific submarine frequency tonals amid the overall ocean noise. TRAPS, Sea Spear, and other sonar sensors employ these techniques today, enabling them to process sonar information onboard and to send short contact messages only to other ASW forces and commanders.[79]

The newest generation of SSNs and many SSPs may be too quiet to reliably track with only passive sonar. The ADF could instead use active sonar against these targets, although doing so reveals the location of the sonar and requires more electrical power than a battery or solar-powered system could provide. To reduce the risk to crewed units and provide adequate power, the concept would use a multistatic approach combining a 100-ton or larger MUSV carrying the transmitter and uncrewed passive sonar arrays receiving the returns.

To maximize their reach, MUSVs would tow low-frequency active (LFA) variable-depth sonars (VDSs). Operating between 100 and 1,000 Hz, LFA sound can enable detection ranges of more than 100 nm in deep water and dozens of miles in shallow water.[80] A VDS enables vertical placement of the LFA transmitter in the water column, where it can use the ocean's temperature profile to further improve sound transmission quality or range.[81] Most passive sonar arrays could receive LFA sonar returns.

MUSVs with active sonars are too expensive to position near every port, chokepoint, and piece of critical infrastructure to detect quiet submarines. The concept would instead deploy them as a backup to passive arrays or in areas where they can use their active sonars to deter submarines from approaching, like shipping lanes.

ASW Attacks

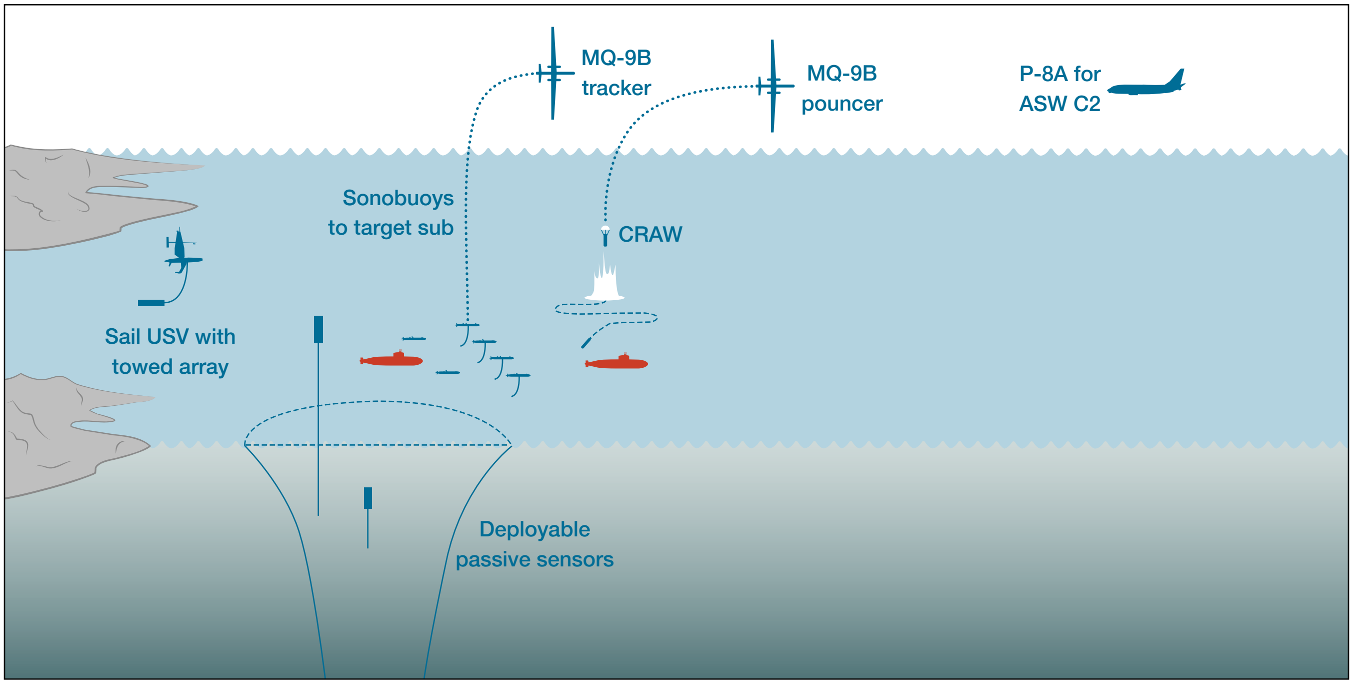
During wartime, ADF units will need to quickly translate sonar detections into ASW attacks. However, the ADF's small fleet of 12 P-8As will not be able to promptly engage a dozen or more enemy submarines across the northern approaches. The submarines could then disappear from ADF sensors and become unlocated threats around Australia. Air ASW attacks also have a notoriously low probability of kill.[82]

The ADF's limited air ASW capacity and low lethality suggest a different ASW attack approach, shown in figure 3.11. In this strategy, chokepoint passive sensors or MUSVs operating in shipping lanes (not shown) detect an enemy submarine. A MALE UAS like the MQ-9B Sea Guardian orbiting in the region deploys sonobuoys to continue tracking the contact. A second MQ-9B carrying small torpedoes, like the US Navy Compact Rapid Attack Weapon (CRAW), transits to the location and attacks the submarine.

Small torpedoes like the CRAW do not have enough energy to search for a submarine, but they can force it to stop its operation and leave the area because submarines lack the self-defense systems of a surface combatant or the speed of an aircraft.[83] By focusing on suppression rather than destruction of submarines, the ADF can exploit the endurance and scale possible with UASs while accomplishing the main objective of ASW: preventing the submarine from threatening Australian forces or security. Moreover, as it evades, the submarine will likely improve opportunities for tracking. P-8As would manage the ASW operation locally and stand by with additional sonobuoy and CRAW capacity if necessary.

The ADF ASW concept would complement submarine suppression with attacks using larger, more lethal weapons. ADF SSNs could exploit the noise generated by an evading enemy submarine to prosecute and sink it. Or the ADF could position

Figure 3.11. Proposed ADF Submarine-Suppression Attack Concept



Source: Authors.

torpedo-bearing XLAUVs in chokepoints or ahead of naval formations to attack enemy submarines at close range, where they can achieve higher lethality.

Mine warfare is another approach to ASW detection and engagement. Given Australia's location and geography, mining would be most advantageous in chokepoints. Teams did not employ this option during TTXs for this study, and the ADF would be unlikely to use it in wartime. In addition to host nation concerns about the deployment of mines in its exclusive economic zone, ADF MUSVs may need to operate in the same waters for OCA operations, as described below.

Extended Track and Trail

In wartime, the ADF could use uncrewed systems to achieve the scale necessary to promptly engage enemy submarines after detecting them. However, it will need the ability to track enemy submarines for potentially weeks during peacetime or for several hours during a conflict if MALE UASs or P-8s are not in position to attack. Track-and-trail operations using crewed ships and aircraft are costly, take these units away from other missions, and may put them at unnecessary risk. An uncrewed system of systems like that shown in figure 3.12 could monitor adversary submarines at a lower cost and with more scalability compared to crewed platforms.

For overt trail, a MUSV towing an LFA VDS and sail USVs towing passive sonar arrays could monitor adversary submarines from tens of miles away, passing periodic or continuous reports to commanders via satellite communications or aerial relays. Although the submarine would be aware of the trail, the standoff range of the MUSV would not suggest an imminent attack, reducing the likelihood of escalation. For covert track-and-trail, schools of sail USVs towing passive sonar arrays could trail adversary submarines from up to a dozen miles away, depending on the target's noisiness. To regain contact if the submarine's signal begins to fade, the ADF could combine them with land-based UASs carrying sonobuoys.

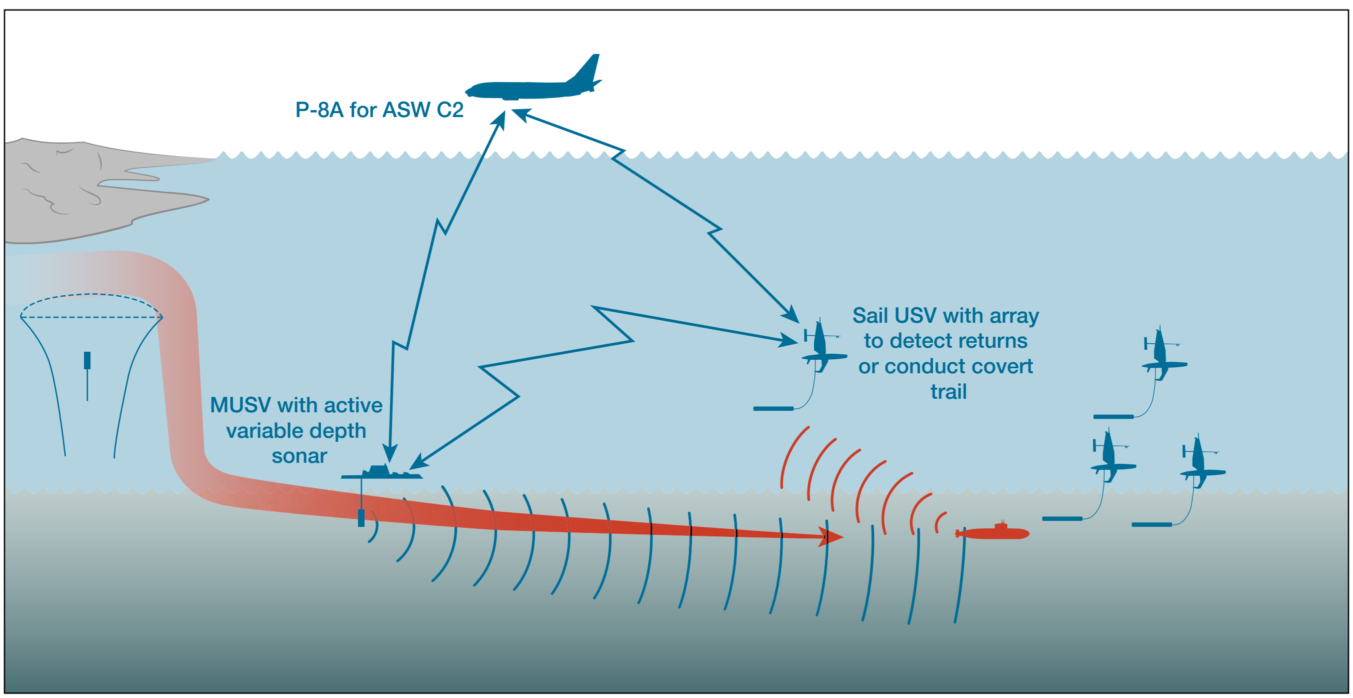
Defensive ASW

ADF ASW operations should focus on concepts like those described above that keep adversary submarines busy evading rather than attacking Australian targets. When offensive operations are unsuccessful or submarine numbers overcome them, however, military and civilian maritime formations need the ability to preemptively disrupt an enemy submarine's attack.

The most challenging aspect of defensive ASW operations is the range of submarine-launched anti-ship cruise missiles. These are likely to reach 1,000 nm within the next decade, consistent with the range of the US Navy's Tomahawk missile. Enemy submarines will generally need third-party targeting to attack surface ships from more than a few dozen miles away. Naval forces could use EW to prevent submarines from receiving targeting information and use ASW operations to find submarines, disrupt their attacks, and force them to evade.

In the defensive ASW scheme depicted in figure 3.13, land-based or LHD-deployed MALE UASs conduct EW in suspected enemy submarine operating areas on common enemy SATCOM frequencies. Along shipping lanes and around naval operating areas, the concept uses MUSVs with LFA VDS to search for enemy submarines or deter their approach. Sail USVs, FFGs, and DDGs with passive towed arrays would listen for returns from LFA sonars.

Figure 3.12. Proposed ADF Concept for ASW Trail



Source: Authors.

If a sonar detects an enemy submarine in shipping lanes or outside naval operating areas, MALE UASs or P-8As would deploy CRAWs to disrupt the submarine's operations and force it to evade. If surface combatants detect the submarine, they will engage it with anti-submarine rockets (ASROCs) that combine a rocket booster with a lightweight torpedo. The rockets should disrupt the submarine's approach and compel it to evade, and MQ-9Bs and P-8As could continue prosecuting the submarine until it is out of range of naval forces. Although today's short-range ASROCs cannot stop a submarine from getting within anti-ship missile range, the US Navy and RAN are working on new ASROCs that use CRAWs and SAM boosters to extend their reach.

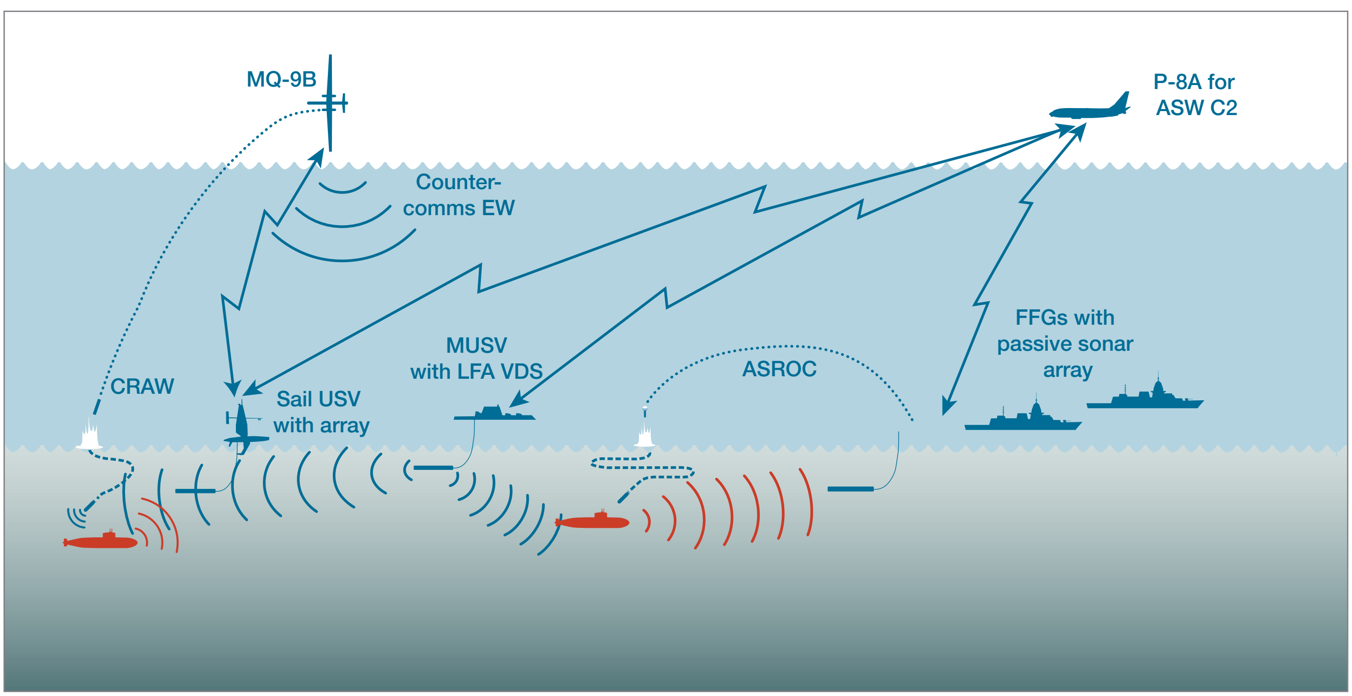
Strike and Surface Warfare

The ADF will need two main approaches for land and maritime strike to mitigate its capacity constraints and exploit the opportunities of uncrewed systems. During the TTXs in this study, teams built these concepts to keep crewed surface combatants and aircraft outside enemy missile range while using uncrewed systems for targeting and attacks inside the enemy's weapons envelope.

Consistent with the overarching construct in figure 3.1, the ADF's first line of defense is the chokepoint and island defense hedge force arrayed at the periphery of the northern approaches and around Australia's outlying islands. The ADF would use these units to conduct local, short-range attacks against enemy surface forces, as shown in figure 3.14. In addition to one-way attack small USVs (sUSVs), the hedge force would include XLAUVs and large uncrewed undersea vehicles (LUUVs) carrying small torpedoes.

Because the ADF would pre-position them in chokepoints and likely enemy transit lanes, hedge force units would rely

Figure 3.13. Proposed ADF Defensive ASW Concepts



Source: Authors.

largely on their organic sensors to target enemy forces. However, they could receive support from high-altitude, long-endurance (HALE) UASs like the MQ-4C or from MALE UASs such as the MQ-9B that could remain outside enemy SAM range. C2 nodes operating on small warships like FFGs or offshore patrol vessels (OPVs) would locally manage picket forces while remaining outside enemy ASM range. To accommodate the geographic span necessary for pickets, C2 nodes and UxS would communicate using commercial satellites. These networks would reduce the load on Australia's small military satellite communications capacity and lower the consequences if enemy forces capture UxS or their radios.

The TTX results showed that hedge force units could effectively slow or stop surface combatants in island or chokepoint defense operations. This was important in the TTXs because Blue teams deployed forces on outlying territories to increase their reach and ability to protect shipping lanes or Australian military installations. In this regard, the TTXs found similar results to those of Hudson Institute's recent hedge force study, which assessed the viability of an uncrewed force to defend Taiwan.[84]

However, hedge force units are useful only for short-range attacks against enemy ships or submarines that drive into reach. In some cases, enemy vessels will be able to circumvent or absorb the pickets' relatively modest attacks and continue their approach to Australia.

The ADF would also need long-range pouncers to sustain the fight against enemy surface forces that evade the chokepoint and island defense hedge force, as shown in figure 3.15. In this standoff concept for surface attacks, crewed targeting and weapon launch platforms would attempt to remain outside the enemy's weapon range or under the protection of ADF ship- or shore-based air defenses. The ADF could launch anti-ship or strike attacks in three main ways:

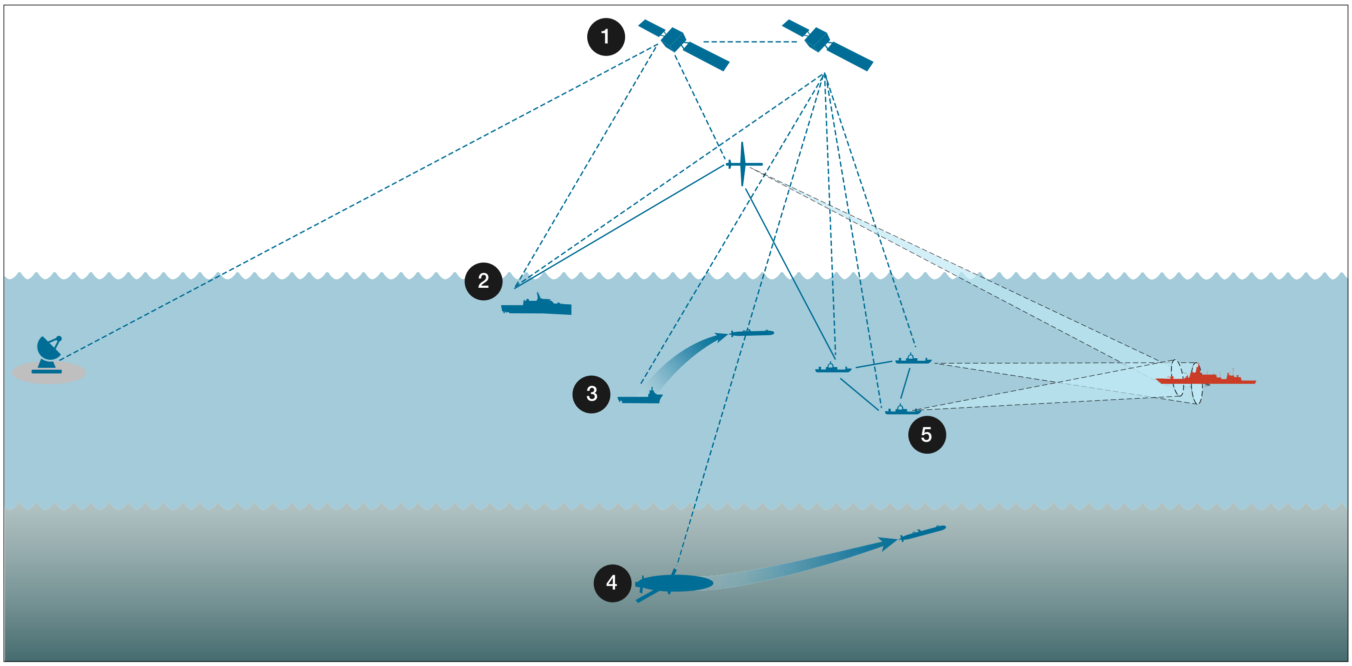
1. Australian Army units could engage enemy forces using Precision Strike Missiles (PrSMs) carried by High-Mobility Artillery Rocket System (HIMARS) launchers ashore.[85]
2. RAAF fighters could conduct attacks from just outside enemy air-defense range with missiles like the Long Range Anti-Ship Missile, the Advanced Anti-Radiation Guided Missile, and the hypersonic SCiFIRE—or at even longer ranges by using CCAs to shuttle anti-ship missiles.[86]
3. RAN *Collins*-class SSs or *Virginia*-class SSNs could engage enemy surface units with Tomahawk missiles.

A disadvantage of relying on long-range attacks is the ADF's small number of long-range strike weapon platforms. As noted above for ADF IAMD concepts, the RAN's surface combatants will need to focus primarily on air defense against ballistic missiles and submarine- or bomber-launched cruise missiles. Beyond its surface fleet, the RAN has only six SSs and should have two SSNs by 2035. In the mid-2030s, the RAAF plans to field about 100 F-35A and F-18 E/F strike-fighters, the majority of which may be needed for OCA.

The largest increase in ADF strike capacity will be through the ground force. The ADF plans to field 42 to 84 HIMARS launchers by 2035, each of which could carry four PRsM weapons. However, the PrSM may not have the reach to engage ships outside the range of enemy weapons.[87] To enable these launchers to fire effectively first, the pouncer force includes MUSVs carrying HIMARS or similar launchers for PRsMs. These uncrewed launchers would not be expendable, per se, but the ADF could deploy them around maritime chokepoints closer to potential enemy surface formations and lose them to enemy fire without causing casualties.

Standoff engagements by pouncers also reduce the stress on ADF C3. In contrast to short-range attacks that could overwhelm small, forward-deployed C2 nodes, the more robust staff at the ADF JOC could manage long-range attacks because it

Figure 3.14. Proposed ADF Chokepoint and Island Defense Concepts



1

SATCOM
- Node between JOC and local command
- Primary non-LOS datalink for weapons
- Latency Possible: **Moderate**
- Data Intensity Possible: **Medium** to **High**

2

OPV
- Provides local C2
- Links: MILSATCOM, COMSATCOM
- Latency: **Short**
- Data Intensity: **High**

3

MUSV
- Supporting pickets with longer-range ASMs
- Links: MILSATCOM, ACOM
- Latency: **Moderate**
- Data Intensity: **Low**

4

XLAUV or LUUV
- Prepositioned at chokepoints
- Operating near surface to receive radio direction
- Links: MILSATCOM, ACOM
- Latency: **Long**
- Data Intensity: **Low**

5

sUSVs
- Local swarming
- Passing back targeting
- Coordination by JOC and local command
- Links: LOS, COMSATCOM
- Latency: **Moderate**
- Data Intensity: **High**

Latency
Maximum delay in C2 link to avoid bottleneck

Long: Many minutes
Moderate: <1 minute
Short: <1 second

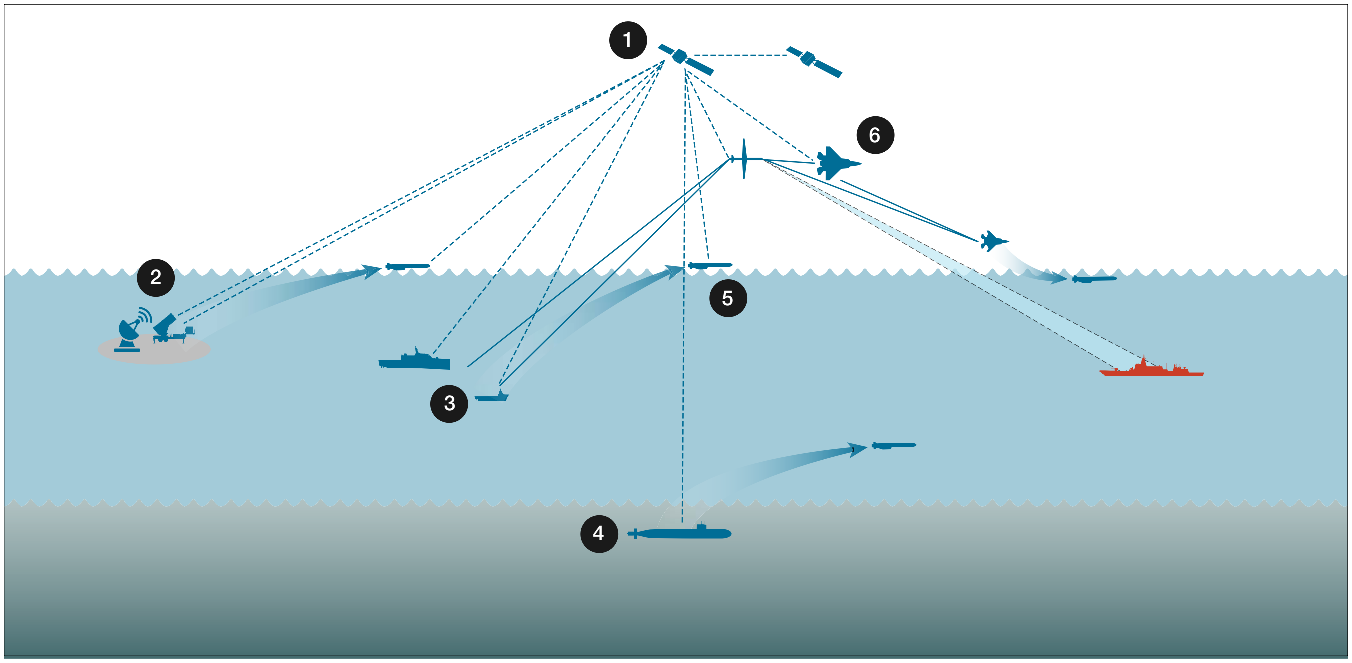
Data Intensity
Required bandwidth or onboard processing

Low: B/sec
Medium: KB/sec
High: MB/sec+

C2 Links
— Line of Sight (LOS)
---- SATCOM
···· Other Comms

Source: Authors.

Figure 3.15. Proposed ADF Long-Range Surface Attack Concepts



1

SATCOM

- Node between JOC and local command
- Primary non-LOS datalink for weapons
- Latency Possible: **Moderate**
- Data Intensity Possible: **Medium** to **High**

2

Ground launchers

- Operating as pouncer
- Links: MILSATCOM, ACOM
- Latency: **Short**
- Data Intensity: **Low**

3

MUSV

- Operating as pouncer
- Links: MILSATCOM, ACOM
- Latency: **Short**
- Data Intensity: **Low**

4

SSN

- Coordination infrequent to maintain operational security
- Links: MILSATCOM, ACOM
- Latency: **Long**
- Data Intensity: **Low**

5

In-Flight Weapons (MST, etc.)

- Coordinating approach to targets
- Receiving targeting updates
- Links: LOS, MILSATCOM
- Latency: **Moderate**
- Data Intensity: **High**

5

Fighters and CCAs

- Coordinating CCAs
- Links: LOS, MILSATCOM
- Latency: **Moderate**
- Data Intensity: **High**

Latency

Maximum delay in C2 link to avoid bottleneck

Long: Many minutes
Moderate: <1 minute
Short: <1 second

Data Intensity

Required bandwidth or onboard processing

Low: B/sec
Medium: KB/sec
High: MB/sec+

C2 Links

— Line of Sight (LOS)
---- SATCOM
···· Other Comms

Source: Authors.

would need to coordinate a smaller number of targeting platforms and shooters. With fewer participants, most of which are crewed or relatively capable platforms like CCAs and MUSVs, the long-range-attack C3 architecture would rely mainly on military satellite communications.

Command, Control, and Communications

ADF commanders will need new C2 capabilities to manage the diverse array of uncrewed systems and distributed crewed units necessary for the above concepts. Ukrainian and Russian forces already use AI-enabled software to assess intelligence, build plans, and close kill chains that combine drones, artillery, and non-kinetic effects like EW.[88] The DoW and NATO are also pursuing AI-enabled C2 systems for theater-wide planning as well as for specific missions, such as aerial refueling, logistics, and strike warfare.[89]

Figure 3.16 depicts a general C2 concept the ADF could apply as part of its emerging force design.[90] This approach could be useful as an element of the existing ADF Military Appreciation Process, with the C2 tool acting as an adjunct to reduce the workload for planning staff. And while in theory C2 tools like those that companies including Anduril and Palantir are developing could operate at any level of war, they are likely to be most useful at the tactical level, where they could be part of the Combat Military Appreciation Process (CMAP).[91]

An analytic decision-making process like CMAP may be too slow for modern warfare, but C2 tools could help battlefield leaders more quickly assess a variety of tactical courses of action (COAs) that achieve the mission's objective. To exploit these tools, commanders and their staffs would still need to scope and frame the mission, including providing the C2 tool with an estimate of the likely threat, the crewed and uncrewed capabilities available for tasks, and relevant ROE.[92]

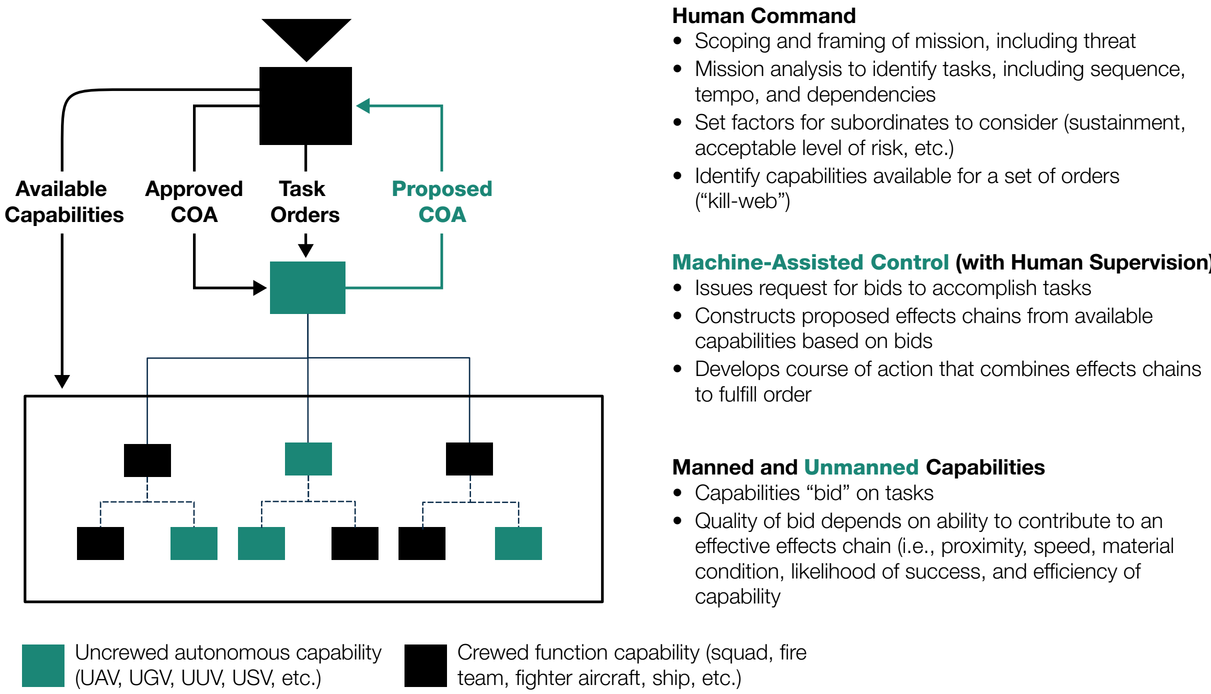
This is not to say the intuitive decision-making approach that experienced commanders often use has no place in future ADF C3. C2 tools will not be omniscient and cannot set an acceptable level of risk. Commanders will need to use their intuition and judgment to estimate adversary force capabilities and disposition, assess proposed COAs from C2 tools, decide how to orchestrate tactical missions toward an operational objective, and define the acceptable likelihood of casualties or collateral damage.

Based on the commander's direction, the C2 tool would follow a multistep approach to assess the various combinations of forces that could accomplish the mission. Initially, the tool could use an auction-like process similar to ride-sharing applications, in which participating drivers *bid* on ride requests and the algorithm presents the most appropriate bids to the rider.[93] Or C2 tools could use a specialized large language model that developers have trained on reports of previous and historical operations.[94] The tool would then assess the most promising COAs using modeling and simulation to better understand their likelihood of success, potential risks, and impacts on logistics and sustainment.

Based on its assessment, the C2 system would propose a set of the most effective COAs for the commander and staff to consider. The commander would either choose one of those plans or direct the tool to rerun the analysis with different inputs or constraints, such as an updated intelligence assessment, an adjusted set of capabilities, or new logistics or ROE considerations. After approving a plan, commanders or their staff would send orders to the crewed and uncrewed units involved.

In addition to enabling ADF leaders to manage their larger, more heterogeneous force, a C2 concept like that shown in figure 3.16 can help address other challenges. First, human command and machine-assisted control could help reduce the size of operational staffs. The ADF will need its personnel to focus on operating and maintaining uncrewed systems and crewed platforms. Decision-support systems can develop COAs in shorter times than a traditional staff process and free up personnel for more important tasks.

Figure 3.16. C2 Approach for Distributed Manned-Unmanned Teams



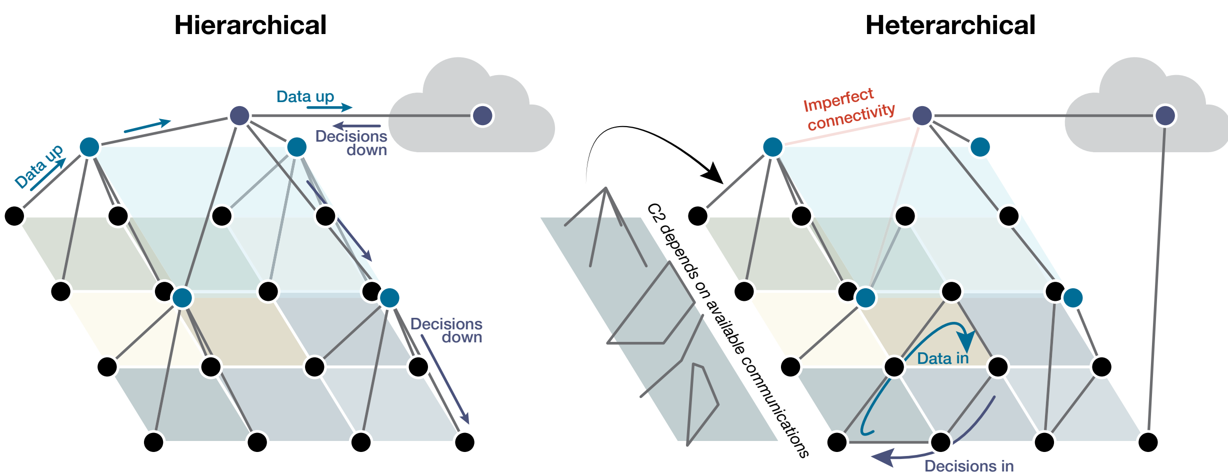
Source: Authors.

Second, decision-support tools designed for broader strategic activities can help manage the deterrence campaign. As described in chapter 1, the ADF is likely unable to completely deny aggression or impose intolerable punishment on an attacker. To mount a strategy of cost imposition, ADF commanders and Australian government leaders will need help predicting which potential defensive schemes adversaries are likely to view as the most challenging. Decision-support tools could also help Australian leaders and commanders gauge adversary government reactions and propose subsequent COAs to increase an opponent's perceived costs of aggression.[95]

Third, AI-enabled C2 tools can help mitigate the impact of communications constraints that are likely in a conflict against China. The ADF's predominant C2 approach relies on the JOC and its command center to coordinate nearly all operations around Australia. The JOC passes down orders, resources, and authorities to enable agile control by deployed forces.[96] This hierarchical C2 structure works well when communications are generally available over the commander's area of responsibility and are of sufficient throughput to transmit sensor data, analytics, orders, and feedback.[97]

However, when communication shortfalls prevent reliance on staffs at the JOC, C2 tools like those shown in figure 3.16 could enable junior leaders to continue executing missions. This model reverses the normal C3 construct of designing communications requirements to support an intended C2 relationship. Instead, C2 tools like those in figure 3.16 allow the force to adapt its C2 rela-

Figure 3.17. Comparison of Hierarchical and Heterarchical C3 Architectures



Hierarchical		Heterarchical
Universal joint standard for communication, data	**Communications and interoperability**	Diverse communications and on-demand interoperability
Forecast joint force and mission threads, enforce standards compliance	**Design approach**	Architectural principles, but evolutionary/emergent design
Optimized directive control based on global picture	**C2 approach**	Local decision making based on opportunity
Attrition-centric	**Warfighting concept**	Decision-centric

Source: Authors.

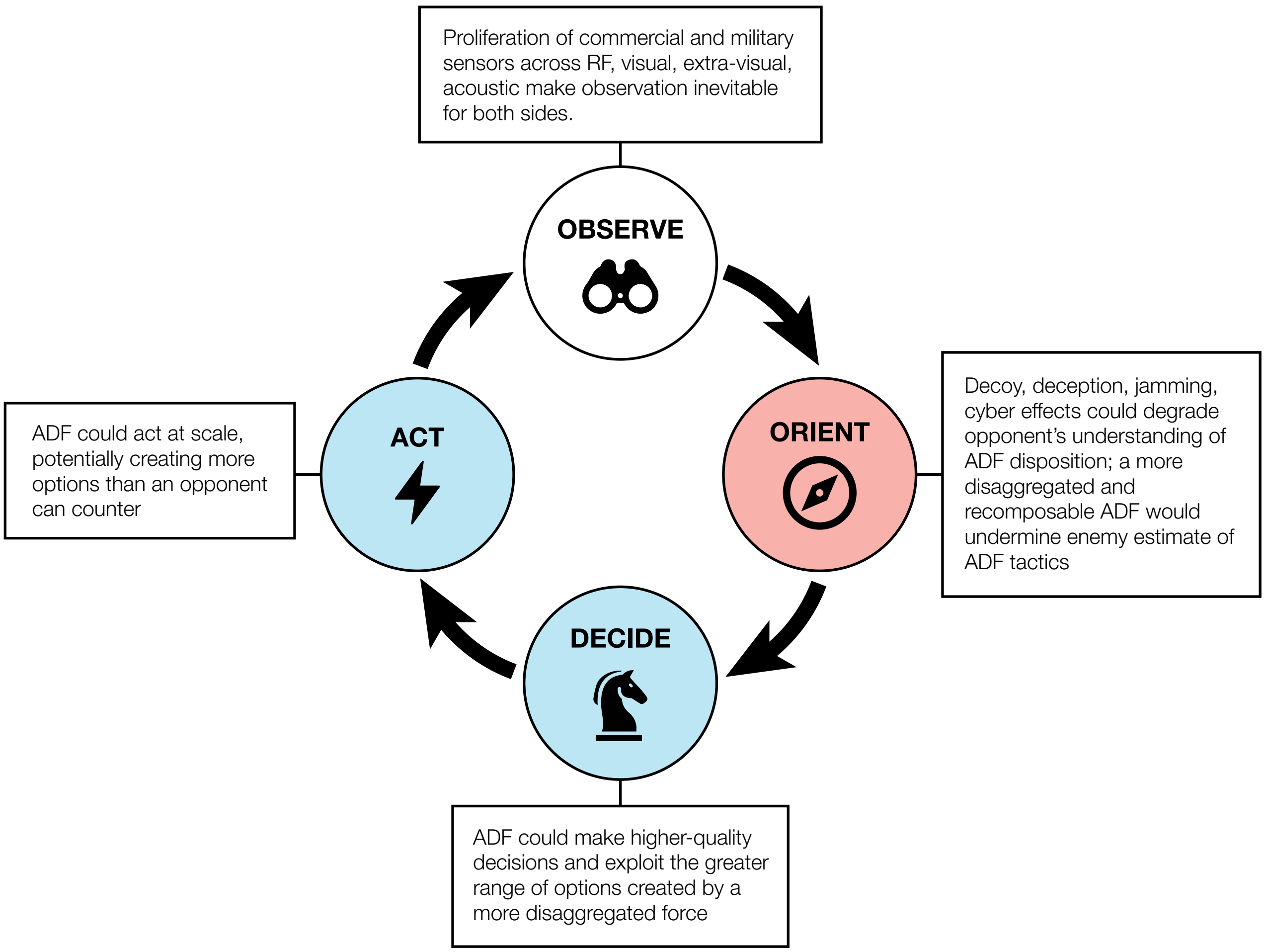
tionships based on communications availability. One may characterize this C3 architecture, shown in figure 3.17, as *heterarchical*.

A fourth benefit of this C3 approach is that it enables the ADF to gain a decision-making advantage in specific operations or as part of a deterrence campaign. US Air Force colonel John Boyd captured this dynamic in his classic observe, orient, decide, act (OODA) loop for military operations. Although analysts often interpret it as an argument for faster decision-making, Boyd's writings on the OODA loop focus more on how to degrade the enemy's decision cycle.

The ADF could undermine an adversary's decision-making by creating uncertainty in the validity of its plans, as described in figure 3.18. The proliferation of commercial and military sensors may prevent either side in a conflict from gaining an edge in observation.[98] To degrade the enemy's ability to orient, ADF uncrewed systems could employ cyber and EW effects against adversary sensors to create false or misleading contact information. Although their sensors would still observe ADF units, adversary commanders would not be able to confidently make sense of their sensor data and understand what the ADF units are preparing to do.

ADF commanders could further complicate enemy orientation by deploying disaggregated forces in ways that could execute a wide variety of COAs.[99] However, an opponent

Figure 3.18. Opportunities for Decision-Making Advantage in a Heterarchical C3 Model



Source: Authors.

may have its own AI-enabled C2 systems that can predict which COAs an ADF commander is likely to choose. ADF commanders will need to occasionally employ some unexpected COAs, even if they are less effective, to confuse these predictions and create uncertainty regarding enemy plans. ADF commanders can also defer their down-selection of a COA until the enemy force seems to commit to a defensive scheme and then choose COAs that circumvent the opponent's approach.

Access, Basing, and Overflight

The operational concepts described above are executable without access, basing, and overflight (ABO) in the Indonesian archipelago, but are significantly more difficult and costly if the ADF must conduct them from sea. During the TTXs, teams deployed uncrewed GBAD systems and small USVs or UUVs on MUSVs. However, this took a large portion of their USV fleet and impacted the ADF's ability to conduct open-ocean ASW or engage enemy surface combatants at extended ranges from

Australian territory. Teams also used OPVs to carry GBAD and small USVs or UUVs, which enabled personnel to more easily maintain and exert C2 but also placed crewed platforms at higher risk.

The ADF will need more maritime host platforms as ABO is not assured in locations like Indonesia, where the ADF would establish pickets and pouncers to defend the northern approaches. The ADF could pursue two MUSV variants to reduce the impact of using MUSVs as host platforms. It could design a smaller variant for long-endurance, highly distributed open-ocean sensing, counter-sensing, ASW, or small-scale anti-ship attack. The other variant would be larger to host a variety of systems that it could containerize and carry on its mission deck.

Conclusion

The ADF will need to implement new operational concepts for key missions of ISR&T, IAMD, ASW, surface and strike warfare, and C3 to counter increasingly capable opponents. These new approaches will demand a larger and more disaggregated Australian military, which the ADoD cannot achieve within its fiscal and personnel limits unless a much greater portion of the ADF is uncrewed. The next chapter proposes a force design that would support the concepts described above within the ADoD's planned budgets.

4. A PROPOSED FORCE DESIGN FOR DETERRENCE AND DEFENSE

The ADF's current force design does not present adversaries with sufficient risk of losses or protraction to deter aggression. Australia's small air and naval fleets leave multiple avenues for attack along the northern approaches or shipping lanes and cannot threaten enemy forces at sufficient range to interrupt standoff missile attacks. A more distributed force with greater reach could dissuade opponents who want to avoid heavy losses or delays in an operation that is likely not essential or existential. More importantly, a more distributed force could provide Australian leaders with the variety of military options they need to test, assess, and undermine enemy plans as part of a deterrence campaign.

Ground-based fires and uncrewed systems are the ADF's best options for achieving a more distributed and recomposable military. Within planned budgets, the ADoD would need to make dramatic cuts in naval and ground forces to procure, sustain, and crew more RAAF fighters or to field a bomber force—as some have proposed.[100] Alternatively, the ADoD could grow the RAN beyond its current efforts to field *Hunter*-class FFGs, Tier 2 FFGs, and *Virginia*-class SSNs. But expanding the fleet further under planned budgets would demand substantial reductions in ground and air forces.

Another concern in whether to grow the ADF's crewed air or naval forces is the industrial base. Australia lacks the capacity to ramp up ship or aircraft production substantially. For exam-

Photo: A MQ-28A Ghost Bat takes off during Exercise Carlsbad at RAAF Base Tindal in April 2025. (Australian Department of Defense) ple, Mitsubishi Heavy Industries will build the ADoD's first three Tier 2 frigates in Japan to allow time for the industrial base to prepare.[101] In contrast, companies within Australia could manufacture or assemble almost all the uncrewed systems included in this study or under consideration by the ADF.

Unlike the RAN or RAAF, the Australian Army is already designed to operate in a distributed manner with weapons systems that it can recompose into a variety of effects chains. Most of its current systems are not highly relevant to defending the northern approaches or shipping lanes. However, the Australian ground force is fielding a significant number of surface-to-surface and surface-to-air missile launchers that it can deploy forward on shore or on uncrewed vessels, which provides an alternative to buying more crewed warships or fighters. With a modest redistribution of funding from other portfolios, the ADoD could rebalance the Army's fires units toward capabilities necessary for the concepts described in chapter 3 without impacting the ADF's combatant ship or aircraft fleets. These investments are highlighted at the end of this chapter.

Uncrewed Capabilities

The ADF will need uncrewed systems to build a larger and more adaptable force that can implement new operational concepts and sustain a deterrence campaign. Because they are more expendable and numerous than their crewed counterparts, the ADF should incorporate uncrewed systems predominantly in the picket and pouncer forces described in chapter 3. Table 4.1 summarizes the UxS needed for the concepts in chapter 3.

Pickets

Picket forces are designed primarily to detect, target, and identify adversaries far from Australian territory in concert with wide-area sensors such as JORN or satellite constellations. Secondarily, these forces can conduct reactive non-kinetic or kinetic attacks to slow or deter an enemy's advance. For example, during gray-zone operations, sUSVs could harass enemy ships and aircraft by jamming navigation systems, communications, or sensors. In combat, small or very small USVs (vsUSVs) and UUVs could attack enemy forces attempting to pass through narrow chokepoints or seize islands.

As shown in table 4.1, picket forces would include larger uncrewed platforms, such as MALE and HALE UASs, LUUVs, and XLAUVs, that have the endurance for sustained ISR&T operations. If the ADF cannot gain access ashore, larger UxS like these as well as MUSVs may be needed to carry small one-way attack vehicles such as sUUVs or vsUSVs.

Picket forces can automatically conduct their sensing and targeting mission but should require orders to launch reactive attacks. As noted in chapter 3's discussion of C3 concepts, the ADF will likely be unable to centrally manage the scale of these operations. It should plan to deploy crewed units, such as OPVs, as part of picket forces to provide local C2. These crewed units can also carry small UxS for reactive attacks.

Pouncers

Pouncer units conduct responsive attacks against enemy forces. In contrast to pickets that mainly conduct close-quarters attacks, pouncers are designed to stop enemy advances at standoff ranges, allowing a small number of systems to cover a wide area. Though pickets cue them, pouncer forces include organic targeting platforms and sensors to enable effects chains after an enemy is beyond the range of picket force sensors. To enable rapid response across the northern approaches, pouncer units are forward-deployed on outlying Australian islands, afloat across the northern approaches, and on bases in northern Australia.

Most pouncer units are uncrewed because maintaining a forward presence with crewed units would demand a large rotational force structure. However, the pouncer force includes crewed fighters and support aircraft and SSNs because they require human operators to provide sustainment or C2. And although pouncers would normally be crewed, the ADF could automate and deploy ground-based missiles like PRsMs, Tomahawk cruise missiles, or hypersonic boost-glide weapons on MUSVs or outlying islands to give them greater standoff from defended territory.

Protectors

The protector force is designed to provide higher-capacity defenses on or near Australian territory. Uncrewed systems support crewed protector units by providing offboard targeting. For example, 100-ton MUSVs can conduct ASW or ASUW patrols or increase the survivability of crewed units, such as air or surface decoys that confuse incoming missiles.

Within its budget constraints, the ADoD cannot afford to outfit each force with a set of uncrewed systems. Although UxS could increase the protector force's capacity, they offer more value forward with pickets or pouncers, where they can remain

Table 4.1. UxS in the Proposed ADF Posture Construct

ROLE	MISSION	EXAMPLES	FAVORED ATTRIBUTES	
Picket (sustained ISR&T and reactive attack)	Wide area surface/ air targeting	• Stratospheric balloon • HALE • MALE	• >12-hour endurance	• Wide area-of-regard
	Wide area undersea detection	• 100T MUSV	• Onboard data processing	• >5,000 nm endurance • >20 knot sprint speed
	Chokepoint targeting and reactive attack	• Sail USV • sUUV/vsUSV (hosted by OPV, LUUV, XLAUV, MALE UAS) • LUUV	• Long on-station time • Low cost relative to targets	• Onboard data processing OR comms bandwidth
	Sensor or effector deployment	• LUUV • XLAUV	• >1,000 nm endurance • Payload capacity/modularity	• Ability to act as comms relay
Pouncer (responsive attack)	Persistent targeting	• HALE UAS • MALE UAS	• High-resolution sensors • Low-latency comms	• Long endurance OR high speed
	Chokepoint responsive attack	• 6–15 m sUSV • MUUV	• >6-hour endurance at 200 nm • Modular payloads	• High sprint speeds • Easy recovery and resupply
	Air defense	• Automated GBAD and decoys	• Distribution • Low cost (if SRGBAD)	
	Offensive counter-air	• CCA	• Low cost	
	C5ISR disruption	• EW UAS/missile	• Low cost	• >4-hour endurance
	Air defense and ASuW	• 300T MUSV	• Modular payloads • >3,000 nm endurance	• Low latency comms
	ASW pouncer	• MALE	• Onboard sensor processing	• Organic weapons
Protector (defensive operations)	Sea lane patrol	• MUSV (300T & 100T)	• Long endurance	• Undersea sensing
	Decoy	• 2–5 m vsUSV • sUAS	• Low cost • Rapid deployment	

Source: Authors.

on station longer than a crewed unit and provide expendable detection and response capabilities. If enemy threats appear able to overwhelm protector forces, the ADF could redeploy uncrewed picket and pouncer units to provide additional offensive capacity.

Uncrewed Capacity

The TTXs conducted for this study included a rebalancing exercise to assess the number of UxS necessary to implement the concepts and posture described above and in chapter 3. The three Blue teams in each TTX started with different UxS portfolios: Team 1 had a portfolio weighted toward larger UxS; Team 2's portfolio focused on small UxS; and Team 3 started with a mix of large and small UxS. After two turns of gameplay, teams could buy a different mix of systems within the same budget and personnel constraints. The rebalancing exercise results, shown in table 4.2, converged around a UxS portfolio that prioritized larger UxS, complemented by a relatively modest number of smaller systems.

This result supports the posture and concepts of chapter 3, which rely on MUSVs, sUSVs, MALE UASs, XLAUVs, and LUUVs to operate at standoff range from Australia as part of picket and pouncer forces. Larger UxS or crewed platforms generally

Table 4.2. UxS Portfolio Rebalancing Exercise Results

DOMAIN	TYPE	TEAM 1		TEAM 2		TEAM 3		AVERAGE
		FINAL TOTAL	CHANGE	FINAL TOTAL	CHANGE	FINAL TOTAL	CHANGE	FINAL TOTAL
Surface	300T MUSV	4	-1	15	15	11	4	10
	100T MUSV	8	-3	0	0	10	5	6
	6–12 m sUSV	30	30	120	-120	300	120	150
	2–5 m vsUSV	50	50	300	-330	50	-250	133
	Sail sUSV	75	75	100	0	90	0	88
Undersea	XLAUV	5	0	0	0	3	0	3
	LUUV	0	-10	40	40	10	5	17
	MUUV	0	0	120	0	100	0	73
	SUUV	245	245	0	-630	500	0	250
Air	HALE UAS	11	-1	4	0	0	-4	5
	MALE UAS	24	0	12	12	20	8	19
	CCA	30	-30	30	18	50	-10	37
	sUAS	2,000	2,000	4,000	-6,000	5,000	0	3,667
	EA Cruise Missile	40	40	200	200	0	0	80
	High-Altitude Balloon	100	100	40	40	0	0	47

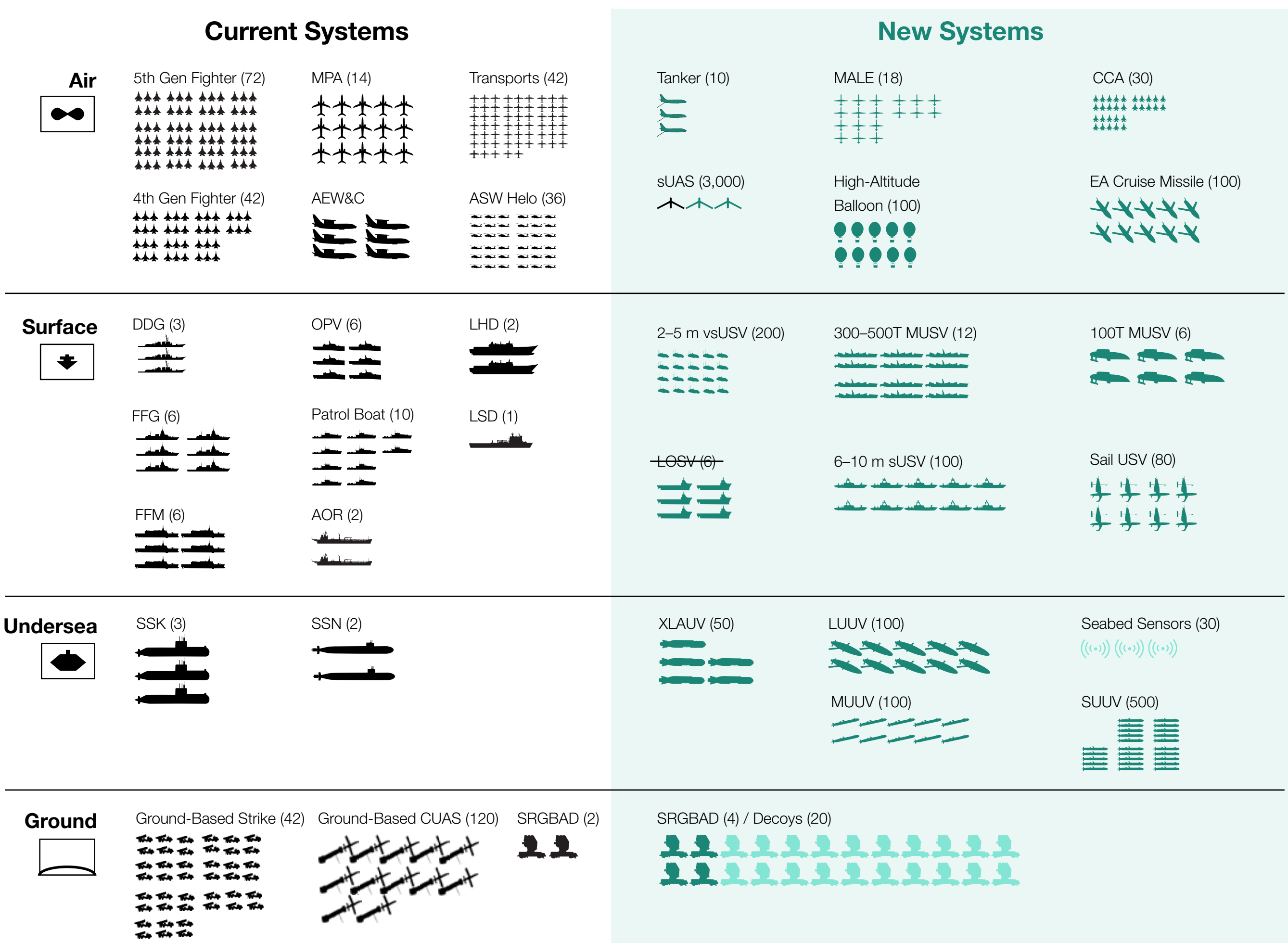
Source: Authors.

carry smaller UxS, which lack the endurance to sustain picket or pouncer operations on their own. Note that the numbers in table 4.2 are intended to be directionally accurate but not quantitatively precise. The costs of many uncrewed systems are not defined yet and will likely be lower in production than assumed in the rebalancing exercise. Teams concluded they would buy more XLAUVs, CCAs, and MUSVs if their costs were lower or if more funding was available.

The Proposed Force Design

Using the results of multiple TTXs and rebalancing exercises and postgame analysis, Hudson Institute developed a proposed force design for the ADF, circa 2035–40, summarized in figure 4.1. In addition to defending Australia's northern approaches, shipping lanes, and territory, the proposed force design provides the adaptability and distribution needed for a deterrence campaign.

Figure 4.1: Proposed ADF Force Design



Source: Authors.

As noted in chapter 2, the force design assumes the AUD 12.8 billion that the IIP earmarked for uncrewed systems between 2025 and 2035 can be reallocated and that the ADoD could devote about 70 percent of it to procurement (and the remainder to R&D). The force design also assumes it is not possible to reduce crewed ship and aircraft inventories below those planned in the IIP and PBS due to a combination of industrial base concerns in shipbuilding and existing contract arrangements for aircraft.

Crewed Platforms

The proposed force design makes modest changes in the crewed force, described below, to support the operational concepts of chapter 3, including the hedge force concepts for OCA, ASW, and ASUW. The specific changes do not include ground units that are mainly relevant to expeditionary or internal operations, such as rotary-wing aircraft, infantry, counter-UAS, or armor units. The force design assumes these capabilities would remain as planned.

Eliminate the Large Optionally Uncrewed Surface Vessel (LOSV)

The LOSV provided little utility during the TTXs because it was considered too expensive to be expendable and lacked the inventory to be distributed in concepts for IAMD, ASUW, or strike warfare. Moreover, the US Navy canceled a similar program, eliminating the ADF's ability to leverage US military investment to develop and field the LOSV. The ADoD should use this funding to procure MUSVs, which the US Navy is pursuing under the Modular Attack Surface Craft (MASC) program. These offer a combination of expendability, distribution, and the capacity to carry missile launchers like HIMARS or NASAMS as part of distributed air-defense or strike concepts.[102]

Increase SRGBAD Inventory

The OCA hedge force concept requires a larger number of SAM launchers and radars than the two NASAMS batteries that the ADoD is currently procuring. Although decoys can help increase the effective scale of air defenses, the concept will demand deployment of at least a half-dozen real launchers and one or two real radars during periods of heightened tension. Northern bases in Australia will also need more defenses to counter the impact on sortie generation of enemy missiles that get past the OCA hedge force. The study found that four additional NASAMS batteries would meet needs for both extended and northern base air defense, including establishing a rotation base to allow for maintenance and training. And because NASAMS can also carry medium-range AIM-120 missiles, they could meet some of the ADF's requirement for MRGBAD under the AIR6502 program.[103]

Increase Aerial Refueling Capacity

The OCA concept described in chapter 3 reduces the need for aerial refueling by using CCAs to extend the reach of fighter aircraft and sea-based MQ-9Bs to support AEW&C. However, the ADF will still need more aerial refueling capacity to enable airborne combat patrols when ramp alert does not provide sufficient response. It will also need them to support E-7 operations when MQ-9Bs cannot reach the area or LHDs cannot reach appropriate launch points due to other mission needs.

The ADoD could reduce other crewed forces to further rebalance the ADF toward a more distributed and adaptable force. However, these units have utility in missions that this study does not address. For example, SSNs are most valuable in offensive missions as part of a conventional deterrent against aggression, and ground forces are necessary to support Australia's interest in alliance operations or stability in neighboring regions.

Uncrewed Units

The proposed force design makes almost all of its changes in the ADF uncrewed system portfolio. This is in part a practical decision because the ADoD is generally not procuring these systems yet. But the force design emphasizes uncrewed systems primarily because they offer the scale and adaptability to address the ADF's need for a distributed force that can mount a deterrence campaign.

As described in chapter 1, Australia's defense strategy of deterrence by denial is infeasible with its current force structure and is likely unachievable even under current ADF plans. The ADF's fundamental budget and personnel constraints preclude it from growing to the point where it could present a risk of failure to most aggressors. Therefore, the ADF should pursue a strategy of cost imposition that seeks to raise the risk of losses and protraction to enemy leaders as a way of dissuading them from military attacks against Australia's northern approaches, shipping lanes, or population centers.

This study proposes the uncrewed system portfolio summarized in table 4.3 to implement a strategy of cost imposition through the concepts described in chapter 3. As noted in the right column of the table, these systems either are already fielded in allied or partner militaries, are available from industry, or are being fielded by AUKUS allies and could be brought into the ADF under AUKUS Pillar II.

Australia-based companies are already producing some of the vehicles in table 4.3, such as the Ocius Bluebottle USV, An-

Table 4.3. Proposed ADF Uncrewed Force Structure

DOMAIN	TYPE	PORTFOLIO DEVELOPED IN TTXS	PROPOSED CA. 2035 INVENTORY	REFERENCE SYSTEM
Surface	300–500T MUSV	10	12	"Baseline" MASC USV being fielded by US Navy that can host 2 MK-70 launchers carrying 8 strike-length missiles
	100T MUSV	6	6	"Single payload" MASC USV fielded by the US Navy (US Navy Sea Hunter or Seahawk)
	6–12 m sUSV	150	100	US Navy GARC, Saronic Corsaire, Saildrone Voyager
	2–5 m vsUSV	133	200	Saronic Spyglass, HavocAI Rampage
	Sail sUSV	88	80	Ocius Bluebottle, Saildrone Explorer
Undersea	XLAUV	2	50	Anduril Drive-XL, Boeing Orca
	LUUV	17	100	C2 Robotics Speartooth, Anduril Drive-LD
	MUUV	73	100	US Navy Razorback, HII Remus 600, Anduril Copperhead 500
	SUUV	250	500	US Navy Lionfish, Remus 300, Anduril Copperhead 300
	Undersea Sensors	30	30	US Navy Transformational Reliable Acoustic Path System (TRAPS), Ultra Sea-Spear
Air	HALE UAS	5	4	US Navy MQ-4C Triton
	MALE UAS	19	18	US Marine Corps MQ-9A, Japan Maritime Self-Defense Force MQ-9B
	CCA	37	30	MQ-28 Ghost Bat, GA-ASI Longshot, Anduril Fury
	sUAS	3,667	3,000	Anduril Altius-600
	EA Cruise Missile	80	100	US Air Force Miniature Air-Launched Decoy (MALD), Anduril Hammerhead
	High-Altitude Balloon	47	100	Aerostar Thunderhead

Source: Authors.

Note: These systems were selected by Hudson Institute and do not reflect those being considered or procured by the ADF.

Table 4.4. Budgetary Impact of the Proposed ADF Force Design

DOMAIN	RECOMMENDATION	NUMBER	COST PER UNIT ($AUD)	TOTAL ($AUD)
	Planned investment in uncrewed systems per 2024 Integrated Investment Plan			**12.80 Bn total** **Assume 8.7 Bn (70%) for procurement and 4.1 Bn (30%) for integration and fielding**
Surface	Decline to pursue LOSV (US Navy canceling program in favor of MUSV)		250.00 M	**+ 1.50 Bn**
Undersea	No changes			**-**
Air	Increase refueling tankers from 7 to 10 (included here as enabler for air defense hedge force)		333.00 M	**- 1.00 Bn**
Ground	Buy 4 additional SRGBAD systems (NASAMs batteries; 12 launchers each) and 20 SRGBAD decoys (included here as part of air defense hedge force)			**- 1.30 Bn**
Uncrewed Systems	300–500T MUSV	12	90.00 M	**1.60 Bn**
	100T MUSV	6	50.00 M	**0.30 Bn**
	6–12 m Class sUSV	100	9.00 M	**0.90 Bn**
	2–5 m Class vsUSV	300	1.60 M	**0.48 Bn**
	Sail sUSV	80	1.10 M	**0.09 Bn**
	XLAUV	50	40.00 M	**2.00 Bn**
	LUUV	100	3.20 M	**0.32 Bn**
	Seabed Sensor	30	0.80 M	**0.24 Bn**
	MUUV	100	4.80 M	**0.48 Bn**
	SUUV	200	8.00 M	**0.16 Bn**
	HALE UAS	0	290.00 M	**0.00 Bn**
	MALE UAS	18	48.00 M	**0.87 Bn**
	CCA	30	32.00 M	**0.97 Bn**
	sUAS	3,000	0.16 M	**0.48 Bn**
	EA missile	100	0.50 M	**0.48 Bn**
	High-Altitude Balloon	100	1.60 M	**0.16 Bn**
			Net:	**+445.00 M**

Source: Authors.

Note: These systems were selected by Hudson Institute and do not reflect those being considered or procured by the ADF.

duril Dive-XL and Dive-LD AUVs, and C2 Robotics Speartooth LUUV. With their simpler designs and less-exquisite supply chains, companies in Australia could easily build or assemble other UxS in table 4.4.

Funding

The ADoD could pay for the changes described in tables 4.3 from within its planned uncrewed system investment per the 2024 IIP. The costs associated with the new force design are detailed in table 4.4 and would come in well under the overall AUD 12.8 billion the IIP expects to spend on uncrewed systems, even if only 70 percent of that funding is available for procurement.

Because it derives uncrewed capability and capacity needs from an analysis of missions and posture, this proposed uncrewed portfolio enables a more strategic approach to changing defense budgets compared to the domain- or service-centric approach in the 2024 IIP. For example, if adversaries expand their naval deployments around Australia but do not threaten air attacks, the ADoD could apply additional funding to increase purchases of the MUSVs and MALE UASs needed for ASW and surface warfare concepts. Or, if budgets decrease, ADoD leaders could reduce spending on UxS associated with concepts that are the least likely to be needed or those in which the ADF can accept more risk.

This approach to program management essentially makes uncrewed systems the adjustable portion of the force and keeps crewed systems for structures largely fixed per existing plans. By minimizing changes to crewed ship, aircraft, vehicle, and launcher programs, the ADoD can better maintain a dependable demand signal for traditional Australian defense suppliers, an industry that lacks the size to weather boom and bust cycles as ADF strategy and operational concepts change. Uncrewed system manufacturers and assemblers should be better able than their traditional counterparts to adapt their vehicles, build new ones, or shift to commercial products in response to the ADF's evolving needs.

5. CONCLUSION

The ADF faces an array of personnel, fiscal, and operational challenges during the next 10–15 years. Although Australia's population is growing, the ADF has often had difficulty reaching its recruiting goals during the last decade due to competing opportunities for young people and the stringent requirements for entering military service. Defense budgets are rising, but slowly and largely to support the SSN programs associated with AUKUS Pillar I. And rising revisionist powers are seeking to change international borders and relationships by force, if necessary.

The ADF cannot afford to field a force of predominantly crewed units that can scale only in proportion to its number of servicemembers and cost of hundreds of millions of dollars each. Moreover, the ADoD's strategy of deterrence by denial is bankrupt. Today's ADF has the capacity neither to defend against a concerted enemy assault nor to degrade the ports, airfields, and bases that are the sources of attacks.

Australia needs a new, more realistic defense strategy and a rebalanced force design to implement it. The strategy of cost imposition proposed by this study would seek to deter aggression by increasing enemy losses in a conflict and raising the likelihood of protraction. Facing the prospect of an embarrassing inability to quickly bring Australia to heel, opposing leaders may forgo military action and choose other avenues to pursue their interests against Canberra.

The current strategy of denial implicitly assumes US forces would come to Australia's aid and defeat aggression. As a strong treaty ally, the US would likely support Australia if it came under attack. However, if simultaneously defending other allies

Photo: Ghost Shark "Alpha"—the first prototype co-developed by Defence Science and Technology Group, the Royal Australian Navy, and Anduril Australia—is unveiled at Garden Island in Sydney in April 2024. (Australian Department of Defense) encumbers the US military, Australia may be on its own for a time. A strategy of cost imposition, informed by a deterrence campaign to assess adversaries' risk tolerance, would better prepare the ADF to defend Australia by itself.

The proposed force design of this report would enable the ADF to mount a strategy of cost imposition. In addition to being affordable within the ADoD's existing spending plans, the changes recommended by the force design are implementable largely through domestic manufacturing and assembly. Although the ADoD may initially need to purchase some uncrewed systems from suppliers in allied countries like the United States, it can quickly pivot to building them in Australia. In addition to promoting economic development, this approach would allow the ADF to draw on a common allied industrial base and supply chain.

Of course, the force design proposed in this study is probably not the exact right answer. Systems will require rigorous assessment and testing, and some concepts may prove too challenging to execute in practice. However, the concepts and programmatic recommendations of this report are intended to give force planners an idea of the challenges and opportunities in building the future force and the possibilities within the ADF's likely fiscal and personnel limitations.

While the ADF's personnel, fiscal, and operational challenges are substantial, it can still field an effective force during the next decade. But to realize this vision, the Australian government will need to act now while budgets enable the ADF to embrace the potential in uncrewed systems and other new technologies.

ABBREVIATIONS

AAM: air-to-air missile

ABO: access, basing, and overflight

ADF: Australian Defence Force

ADoD: Australian Department of Defence

AEW&C : airborne early warning and control

AI: artificial intelligence

AOEW: Airborne Offboard EW

ASM: anti-ship missile

ASROC: anti-submarine rocket

ASUW: anti-surface warfare

ASW: anti-submarine warfare

ATG: tktktk

AUKUS: Australia, United Kingdom, and United States

BMD: ballistic missile defense

C2: command and control

C3: command, control, and communications

C5ISR: command, control, communications, computers, cyber, intelligence, surveillance, and reconnaissance

CBAD: cannon-based air defense

CCA: collaborative combat aircraft

CMAP : Combat Military Appreciation Process

COA: course of action

CRAW: Compact Rapid Attack Weapon

CUAS: counter-unmanned aerial system

DARPA: Defense Advanced Research Projects Agency

DDG: guided missile destroyer

DEAD: destruction of enemy air defenses

DoW: US Department of War

DSR: Defence Strategic Review

ELINT: electronic intelligence

EO/IR: electro-optical/infrared

ESSM: Evolved Sea Sparrow Missile

EW: electromagnetic warfare

FFG: guided missile frigate

GBAD: ground-based air defense

HAB: high-altitude balloon

HALE: high-altitude, long-endurance

HEM: high-energy microwave

HF: high frequency

HIMARS: High-Mobility Artillery Rocket System

HyFliTE : Hypersonic Flight Test and Experimentation

I-JROC: International Joint Requirements Oversight Council

IAMD: Integrated Air and Missile Defense

IIP: Integrated Investment Program

ISR: intelligence, surveillance, and reconnaissance

ISR&T: intelligence, surveillance, reconnaissance, and targeting

JOC: Joint Operations Command

JORN: Jindalee Operational Radar Network

LFA: low-frequency active

LHA: landing helicopter assault (amphibious assault ship)

LHD: landing helicopter dock (amphibious assault ship)

LOSV: Large Optionally Uncrewed Surface Vessel

LRMP: Long-Range Maneuvering Projectile

LSD: landing ship, dock

LUAS: large uncrewed air system

LUSV: large uncrewed surface vessel

LUUV: large uncrewed undersea vehicle

MALD: miniature air-launched decoy

MALE: medium-altitude, long-endurance

MASC: Modular Surface Attack Craft

MPA: maritime patrol aircraft

MRGBAD: medium-range ground-based missile defense

MUSV: medium uncrewed surface vessel

MUUV: medium uncrewed undersea vehicle

NASAMS: National Surface-to-Air Missile System

OCA: offensive counter-air

OPV: offshore patrol vessel

OTHR: over-the-horizon radar

PBS: Portfolio Budget Statement

PLA: People's Liberation Army

PRC: People's Republic of China

PrSM: Precision Strike Missile

R&D: research and development

RAAF: Royal Australian Air Force

RAN: Royal Australian Navy

Ro-ro: roll-on/roll-off transport ship

ROE: rules of engagement

RoK: Republic of Korea

SAM: surface-to-air missile

SEAD: suppression of enemy air defenses

SRGBAD: short-range ground-based air defense

SS: ship submersible (general submarine)

SSGN: nuclear-powered guided missile submarine

SSK: ship submersible hunter-killer (nonnuclear-powered submarine)

SSN: ship submersible nuclear (nuclear-powered submarine)

SSP: ship submersible propulsion (air-independent propulsion submarine)

sUAS: small uncrewed air system

sUSV: small unit support vehicle

sUUV: small uncrewed undersea vehicle

TRAPS: Transformational Reliable Acoustic Path Sensor

TTX: tabletop exercise

UAS: uncrewed air system

ULE: ultra-long endurance

USV: uncrewed surface vessel

UUV: uncrewed undersea vehicle

UxS: uncrewed systems

VDS: variable-depth sonar

vsUSV: very small uncrewed surface vessel

XLAUV: extra-large autonomous undersea vehicle

ENDNOTES

1 Chris Buckley and Damien Cave, "China's Military Puts Pacific on Notice as US Priorities Shift," *New York Times*, March 3, 2025, https://www.nytimes.com/2025/02/28/world/asia/china-military-drills-pacific.html.

2 Thomas Novelly, "China Is 'Pacing Threat,' Army Secretary Says—While Backing Trump's Homeland Defense Push," *Defense One*, October 14, 2025, https://www.defenseone.com/threats/2025/10/china-pacing-threat-army-secretary-sayswhile-backing-trumps-homeland-defense-push/408806/.

3 Stew Magnuson, "SNA News: Navy to Test Plan to Surge Ships, Subs, Aircraft When Needed," *National Defense*, January 15, 2025, https://www.nationaldefensemagazine.org/articles/2025/1/15/navy-to-test-plan-to-surge-ships-subs-aircraft-when-needed.

4 Noah Robertson, "Trump Requests $892.6 Billion Base Defense Budget, a Real-Terms Cut," *Defense News*, May 2, 2025, https://www.defensenews.com/congress/2025/05/02/trump-requests-8926-billion-base-defense-budget-a-real-terms-cut.

5 Damien Cave, "How Trump Supercharged Distrust, Driving US Allies Away," *New York Times*, March 31, 2025, https://www.nytimes.com/2025/03/31/world/trump-foreign-policy-trust.html.

6 Trevor Hunnicutt, "Trump Declines to Answer Question about China and Taiwan," Reuters, February 26, 2025, https://www.reuters.com/world/trump-declines-answer-question-about-china-taiwan-2025-02-26.

7 Michael Pezzullo, "The Long Arc of Australian Defence Strategy," *The Strategist*, Australian Strategic Policy Institute, May 11, 2024, https://www.aspistrategist.org.au/the-long-arc-of-australian-defence-strategy.

8 *2016 Defence White Paper* (Australian Department of Defence [ADoD], 2016), https://www.defence.gov.au/about/strategic-planning/defence-white-paper.

9 *2020 Defence Strategic Update* (ADoD, 2020), 25, https://www.defence.gov.au/about/strategic-planning/2020-defence-strategic-update.

10 Thomas Durrell-Young, *Australian Defense Planning in the Post–Cold War World: Imperatives for Change*, Strategic Studies Institute Special Report (US Army War College, 1991), https://apps.dtic.mil/sti/tr/pdf/ADA231971.pdf.

11 *National Defence: Defence Strategic Review 2023* (ADoD, 2023), https://www.defence.gov.au/about/reviews-inquiries/defence-strategic-review.

12 "Portfolio Budget Statements (PBS)—Defence 2025–2026," Budget Related Paper No. 1.4A (ADoD, 2025), https://www.defence.gov.au/sites/default/files/2025-03/2025-26_Defence_PBS_00_Complete.pdf.

13 "Monthly CPI Indicator Rises 2.4% in February 2025," Australian Bureau of Statistics, March 26, 2025, https://www.abs.gov.au/media-centre/media-releases/monthly-cpi-indicator-rises-24-february-2025.

14 Charles Edel, "Australia's 2025 Election: Decisive Labor Majority amid Liberal Collapse," Center for Strategic and International Studies, May 5, 2025, https://www.csis.org/analysis/australias-2025-election-decisive-labor-majority-amid-liberal-collapse.

15 "2024 National Defence Strategy and 2024 Integrated Investment Program," ADoD, 2024, https://www.defence.gov.au/about/strategic-planning/2024-national-defence-strategy-2024-integrated-investment-program.

16 Robert Rushby, "Deterrence by Denial," Sea Power Centre Australia, Royal Australian Navy, March 2025, https://seapower.navy.gov.au/sites/default/files/2025-03/Deterrence%20by%20Denial.pdf.

17 Elbridge Colby, *The Strategy of Denial: American Defense in an Age of Great Power Conflict* (Yale University Press, 2022), https://yalebooks.yale.edu/book/9780300268027/the-strategy-of-denial.

18 Gwendolyn Sasse, "Revisiting the 2014 Annexation of Crimea," Carnegie Endowment for International Peace, March 15, 2017, https://carnegieendowment.org/posts/2017/03/revisiting-the-2014-annexation-of-crimea.

19 This approach is detailed in Bryan Clark and Dan Patt, *Hedging Bets: Rethinking Force Design for a Post-Dominance Era* (Hudson Institute, 2024), https://www.hudson.org/defense-strategy/hedging-bets-rethinking-force-design-post-dominance-era-bryan-clark-dan-patt.

20 The approach of using force design and posture to drive scenario preference is detailed in Bryan Clark and Dan Patt, *Campaigning to Dissuade: Applying Emerging Technologies to Engage and Succeed in the Information Age Security Competition* (Hudson Institute, 2023), https://www.hudson.org/defense-strategy/campaigning-dissuade-applying-emerging-technologies-engage-succeed-information-age-bryan-clark-dan-patt.

21 Janice Gross Stein, "Deterrence and Compellence in the Gulf, 1990–91: A Failed or Impossible Task?," *International Security* 17, no. 2 (Fall 1992): 147–79, https://doi.org/10.2307/2539171.

22 Beyza Unal, Yasmin Afina, and Patricia Lewis, eds., "Perspectives on Nuclear Deterrence in the 21st Century," Chatham House, April 2020, https://www.chathamhouse.org/sites/default/files/2020-04-20-nuclear-deterrence-unal-et-al.pdf.

23 Bettina Renz, "Was the Russian Invasion of Ukraine a Failure of Western Deterrence?," *Parameters* 53, no. 4 (Winter 2023): 8, https://doi.org/10.55540/0031-1723.3256.

24 Gordon G. Chang, "America's Failed Deterrence of China Has Left Us With Only Bad Options," *Newsweek*, October 30, 2023, https://www.newsweek.com/americas-failed-deterrance-china-has-left-us-only-bad-options-opinion-1839110.

25 Carrie A. Lee, "The Paradox of Israeli Deterrence," *Foreign Affairs*, November 19, 2024, https://www.foreignaffairs.com/united-states/paradox-israeli-deterrence.

26 Hal Brands and Tim Nichols, *Cost Imposition in the Contact Layer: Special Operations Forces and Great-Power Rivalry* (American Enterprise Institute, 2021), https://www.aei.org/wp-content/uploads/2021/07/Cost-Imposition-in-the-Contact-Layer.pdf.

27 A. Wess Mitchell, "The Case for Deterrence by Denial," *American Interest*, August 12, 2015, https://www.the-american-interest.com/2015/08/12/the-case-for-deterrence-by-denial.

28 Steven Honig and Natalie Caloca, "India and Pakistan: On the Brink of Conflict over Kashmir," Council on Foreign Relations, April 30, 2025, https://www.cfr.org/blog/india-and-pakistan-brink-conflict-over-kashmir.

29 Clark and Patt, *Campaigning to Dissuade*.

30 *Australian Military Power*, Edition 2 (Australian Defence Force, 2024), https://acmc.gov.au/sites/default/files/2024-10/ADF-C-0%20Australian%20Military%20Power-compressed.pdf.

31 The use of non-kinetic effects in a counter-sensing and sensemaking campaign is detailed in Bryan Clark, *Winning the Fight for Sensing and Sensemaking: Fielding Cyber and Electronic Warfare Capabilities at Scale* (Hudson Institute, 2024), https://www.hudson.org/national-security-defense/winning-fight-sensing-sensemaking-fielding-cyber-electronic-warfare-c5isr-bryan-clark.

32 *The AUKUS Nuclear-Powered Submarine Pathway: A Partnership for the Future* (Australia Submarine Agency, 2023), https://www.asa.gov.au/sites/default/files/documents/2024-10/00.%20Public%20Report.pdf.

33 Kellie Randall, "First Royal Australian Navy Enlisted Students Graduate Nuclear Power Training," US Navy Press Office, April 18, 2025, https://www.navy.mil/Press-Office/News-Stories/Article/4160817/first-royal-australian-navy-enlisted-students-graduate-nuclear-power-training.

34 Rick Moore, "Submarine Tendered Maintenance Period Complete, USS Hawaii (SSN 776) Departs HMAS Stirling," US Navy Press Office, September 10, 2024, https://www.navy.mil/Press-Office/News-Stories/Article/3900654/submarine-tendered-maintenance-period-complete-uss-hawaii-ssn-776-departs-hmas.

35 ADoD, "Virginia Class Submarine Moors in Australia for the First US Submarine Visit of 2025," press release, February 26, 2025, https://www.defence.gov.au/news-events/releases/2025-02-26/virginia-class-submarine-moors-australia-first-us-submarine-visit-2025.

36 Luke A. Nicastro, *AUKUS Pillar 2 (Advanced Capabilities): Background and Issues for Congress*, CRS Report R47599 (Congressional Research Service, 2024), https://www.congress.gov/crs-product/R47599.

37 Aaron Mehta, "P-8 'Trilateral Algorithm' to Hit Field This Year, as AUKUS Pillar II Eyes Quantum Clocks, AI Projects," *Breaking Defense*, May 29, 2024, https://breakingdefense.com/2024/05/p-8-trilateral-algorithm-to-hit-field-this-year-as-aukus-pillar-ii-eyes-quantum-clocks-ai-projects.

38 "'Maritime Big Play' in Pacific Demonstrates AUKUS Partner Compatibility," US DoD, October 24, 2024, https://www.defense.gov/News/News-Stories/Article/Article/3945520/maritime-big-play-in-pacific-demonstrates-aukus-partner-compatibility.

39 US DoD, "AUKUS Partners Sign Landmark Hypersonics Agreement," press release, November 18, 2024, https://www.defense.gov/News/Releases/Release/Article/3966986/aukus-partners-sign-landmark-hypersonics-agreement.

40 Defense Innovation Unit, "First Trilateral AUKUS Pillar II Prize Competition Completed," US DoD, September 26, 2024, https://www.diu.mil/latest/first-trilateral-aukus-pillar-ii-prize-competition-completed.

41 "AUKUS Maritime Innovation Challenge 2025: Undersea Communications and Autonomy," Advanced Strategic Capabilities Accelerator, March 31, 2025, https://www.asca.gov.au/current-activities/aukus-maritime-innovation-challenge-2025-undersea-communications-and-autonomy.

42 Madeline Mortelmans, "Defense Official Statement on AUKUS Pillar 2 and Exercise Maritime Big Play," press statement, US DoD, October 24, 2024, https://www.defense.gov/News/Releases/Release/Article/3945552/defense-official-statement-on-aukus-pillar-2-and-exercise-maritime-big-play.

43 Marc Santora et al., "A Thousand Snipers in the Sky: The New War in Ukraine," *New York Times*, March 3, 2025, https://www.nytimes.com/interactive/2025/03/03/world/europe/ukraine-russia-war-drones-deaths.html.

44 Chris Panella, "Artificial Intelligence Is Going to Make Drone Wars Much More Deadly. It's Already Started," *Business Insider*, March 7, 2025, https://www.businessinsider.com/ukraines-smart-drones-more-likely-hit-targets-2025-3.

45 Marcus Hellyer, "Australia's 2025–26 Defence Budget: $59 Billion, but the Government's Still Missing Its Moment," *Strategic Analysis Australia*, March 26, 2025, https://strategicanalysis.org/australias-2025-26-defence-budget-59-billion-but-the-governments-still-missing-its-moment.

46 "2024 National Defence Strategy and Integrated Investment Program."

47 *Portfolio Budget Statements (PBS)—Defence 2025–2026*, Budget Related Paper No. 1.4A (ADoD, 2025), https://www.defence.gov.au/sites/default/files/2025-03/2025-26_Defence_PBS_00_Complete.pdf

48 *Defence Workforce Plan* (ADoD, 2024), https://www.defence.gov.au/about/strategic-planning/defence-workforce-plan.

49 *Defence Workforce Plan* (ADoD, 2024), https://www.defence.gov.au/about/strategic-planning/defence-workforce-plan.

50 Noah Yim, "New ADF Recruitment Firm Falls 30 Percent Short of Target," *The Australian*, February 24, 2025, https://www.theaustralian.com.au/nation/defence/new-adf-recruitment-firm-falls-

30-per-cent-short-of-target/news-story/73ef678766e9a9fe6fee-a6e5fd8df625.

51 During turn 1, the TTX assumed peacetime availability of forces, which was generally 30 percent of all units. During turns 2 and 3, the TTX assumed wartime availability rates, generally 70 percent of all remaining units.

52 Clark and Patt, *Hedging Bets*.

53 "5 Misconceptions about Commercial Satellite Imagery for Everyone," Space and Airborne Systems Series, Geospatial Data Products Team, L3Harris, December 5, 2023, https://www.l3harris.com/newsroom/editorial/2023/12/5-misconceptions-about-commercial-satellite-imagery-everyone.

54 Rachel Jewett, "Australian Defence and Optus to Invest in LEO Satellite Project," Via Satellite, July 14, 2025, https://www.satellitetoday.com/government-military/2025/07/14/australian-defence-and-optus-to-invest-in-leo-satellite-project.

55 Lisa Sodders, "Space Force Leverages Commercial Data Analytics to Aid Combatant Commands in New Ways," US Space Force, May 29, 2024, https://www.spaceforce.mil/news/article-display/article/3793014/space-force-leverages-commercial-data-analytics-to-aid-combatant-commands-in-ne.

56 "Jindalee Operational Radar Network," Defence Science and Technology Group (DSTG), ADoD, 2025, https://www.dst.defence.gov.au/innovation/jindalee-operational-radar-network, DSTG, "The Story Behind Jorn: 'We Young Guns Were Going to Make This as Good as We Could,'"ADoD, March 21, 2023, https://www.dst.defence.gov.au/news/2023/03/21/story-behind-jorn-'we-young-guns-were-going-make-good-we-could'.

57 Stephen Chen, "Chinese Scientists Plan Surface-to-Air Missile with 2,000km Kill Range," *South China Morning Post*, March 28, 2024, https://www.scmp.com/news/china/science/article/3256914/chinese-scientists-plan-surface-air-missile-2000km-range; "DF-26," *Missile Threat* (blog), Missile Defense Project, Center for Strategic and International Studies, April 23, 2024, https://missilethreat.csis.org/missile/dong-feng-26-df-26.

58 Austin Rooney, "*USS Carney*: A Destroyer at War," US Navy, December 4, 2024, https://www.navy.mil/Press-Office/News-Stories/Article/3984206/uss-carney-a-destroyer-at-war.

59 Jake Epstein, "US Destroyers in the Red Sea Conflict Defeated Enemy Weapons Without Firing a Shot, Changing the Way Warships Fight," *Business Insider*, February 6, 2025, https://www.businessinsider.com/us-warships-defeated-drones-without-shooting-changing-how-they-fight-2025-2.

60 Giorgio Di Mizio and Michael Gjerstad, "Ukraine's Ground-Based Air Defence: Evolution, Resilience and Pressure," International Institute for Strategic Studies, February 24, 2025, https://www.iiss.org/online-analysis/military-balance/2025/02/ukraines-ground-based-air-defence-evolution-resilience-and-pressure.

61 Stephen W. Miller, "Raven Ad Hoc Air Defence System," *Armada International*, May 19, 2025, https://www.armadainternational.com/2025/05/raven-ad-hoc-air-defence-system-foc.

62 H. I. Sutton, "Ukraine Has World's First Navy Drone Armed with Anti-aircraft Missiles," *Naval News*, May 21, 2024, https://www.navalnews.com/naval-news/2024/05/ukraine-has-worlds-first-navy-drone-armed-with-anti-aircraft-missiles.

63 "Precision Guided Munitions," General Atomics, 2025, https://www.ga.com/advanced-weapons-technology/precision-guided-munitions.

64 Epirus, "Epirus Delivers ExDECS HPM Prototype to US Navy for Marine Corps Counter-Drone Swarm Capability," press release, April 29, 2025, https://www.epirusinc.com/press-releases/epirus-delivers-exdecs-hpm-prototype-to-u-s-navy-for-marine-corps-counter-drone-swarm-capability.

65 Stephen W. Miller, "Battlefield Decoys and Deception: Reaffirmed in Ukraine," *Armada International*, September 20, 2023, https://www.armadainternational.com/2023/09/battlefield-decoys-and-deception-reaffirmed-in-ukraine; Kyle Mizokami, "How US Destroyers Keep Shooting Down Houthi Anti-ship Missiles Without Fail," *Popular Mechanics*, January 23, 2024, https://www.popularmechanics.com/military/weapons/a46411702/how-us-destroyers-shoot-down-houthi-anti-ship-missiles.

66 Lockheed Martin, "United States Navy and Lockheed Martin Successfully Test Key Capabilities of Advanced Off-Board Electronic Warfare System," press release, December 23, 2023, https://news.lockheedmartin.com/2023-12-12-United-States-Navy-and-Lockheed-Martin-Successfully-Test-Key-Capabilities-of-Advanced-Off-Board-Electronic-Warfare-System.

67 Megan Eckstein, "Lockheed Martin Blends AI Decision Aide, Virtual Aegis Combat System in Drill near Guam,' *Defense News*, June 21, 2022, https://www.defensenews.com/naval/2022/06/21/lockheed-martin-blends-ai-decision-aide-virtual-aegis-combat-system-in-drill-near-guam.

68 "Joint Air Battle Management System," AIR6500, ADoD, February 2024, https://www.defence.gov.au/defence-activities/projects/joint-air-battle-management-system.

69 "Project Data Summary Sheet," LAND19 Phase 7B, in *Auditor-General Report No. 20 2024–25: 2023–24 Major Projects Report* (Australian National Audit Office, 2025), https://www.anao.gov.au/sites/default/files/2024-12/Auditor-General_Report_2024-25_20_PDSS_08.pdf.

70 "Medium Range Ground-Based Air Defence," AIR6502, ADoD, February 2024, https://www.defence.gov.au/defence-activities/projects/medium-range-ground-based-air-defence.

71 "DH-10 / CJ-10," Missile Defense Advocacy Alliance, January 2023, https://missiledefenseadvocacy.org/missile-threat-and-proliferation/todays-missile-threat/china/dh-10-cj-10.

72 Aaron Mehta, "General Atomics LongShot Drone for DARPA to Start Flight Tests in December," *Breaking Defense*, September

7, 2023, https://breakingdefense.com/2023/09/darpa-longshot-general-atomics-drone-flight-test-first-look; "Ghost Bat," Royal Australian Air Force, accessed August 14, 2025, https://www.airforce.gov.au/our-work/projects-and-programs/ghost-bat.

73 The ADF has already begun experimenting with Ghost Bat and E-7s to demonstrate this effects chain. See "Boeing, RAAF Show Teaming of MQ-28A with E-7A Wedgetail," *Airforce Technology*, June 17, 2025, https://www.airforce-technology.com/news/boeing-raaf-mq-28a/?cf-view.

74 *Military and Security Developments Involving the People's Republic of China* (US DoD, 2019), 47, https://apps.dtic.mil/sti/citations/tr/AD1077680.

75 "Headquarters Joint Operations Command," ADoD, accessed August 14, 2025, https://www.defence.gov.au/about/locations-property/base-induction/headquarters-joint-operations-command.

76 Joseph Trevithick, "Submarine Surveillance System That's Rapidly Deployable, Unpredictable Unveiled by Anduril," *The War Zone*, April 3, 2025, https://www.twz.com/sea/submarine-surveillance-system-thats-rapidly-deployable-unpredictable-unveiled-by-anduril.

77 Reid McCargar and Lisa M. Zurk, "Depth-Based Signal Separation with Vertical Line Arrays in the Deep Ocean," *Journal of the Acoustical Society of America* 133, no. 4 (April 2013): EL320–EL325, https://doi.org/10.1121/1.4795241.

78 "ThayerMahan and Ocius Christen Persistent USV in the US," *Australia Defence*, April 15, 2025, https://www.australiandefence.com.au/defence/sea/thayermahan-and-ocius-christen-persistent-usv-in-the-us.

79 "0204311N Integrated Surveillance System," RDT&E Budget Item Justification Sheet (R-2 Exhibit), US Department of the Navy, Navy Intelligence and Related Activities, February 1997, https://fas.org/irp/budget/fy98_navy/0204311n.htm.

80 Gordon D. Tyler Jr., "The Emergence of Low-Frequency Active Acoustics as a Critical Antisubmarine Warfare Technology," *Johns Hopkins APL Technical Digest* 13, no. 1 (1992): 145–59, https://www.jhuapl.edu/Content/techdigest/pdf/V13-N01/13-01-Tyler.pdf.

81 Since sound moves faster in warmer or deeper water, sound waves will bend away from the bottom and surface of the ocean; placing the VDS at an appropriate depth will allow the LFA transmitter to extend the sonar's range.

82 This is inferred from analysis of similar torpedoes launched by missiles. See Stephen Valerio, "Probability of Kill for VLA ASROC Torpedo Launch" (master's thesis, US Naval Postgraduate School, 2009), https://apps.dtic.mil/sti/tr/pdf/ADA497264.pdf.

83 This approach is detailed in Bryan Clark, Seth Cropsey, and Timothy A. Walton, *Sustaining the Undersea Advantage: Transforming Anti-submarine Warfare Using Autonomous Systems* (Hudson Institute, 2020), https://www.hudson.org/national-security-defense/sustaining-the-undersea-advantage-transforming-anti-submarine-warfare-using-autonomous-systems.

84 Bryan Clark and Dan Patt, *Hedging Bets: Rethinking Force Design for a Post-Dominance Era* (Hudson Institute, 2024), https://www.hudson.org/defense-strategy/hedging-bets-rethinking-force-design-post-dominance-era-bryan-clark-dan-patt.

85 ADoD, "2024 National Defence Strategy and Integrated Investment Program."

86 Ground forces in the TTXs were able to use ground-launched hypersonic weapons like the US Army's Dark Eagle, but the ADF does not have plans to develop or field boost-glide hypersonic weapons. US forces would need to deploy them, and they would not be part of the ADF force design.

87 "US Army Conducts First Anti-ship Ballistic Missile SINKEX Using PrSM," *Naval News*, June 23, 2024, https://www.navalnews.com/naval-news/2024/06/u-s-army-conducts-first-anti-ship-ballistic-missile-sinkex-using-prsm.

88 Sam Bendett, "Roles and Implications of AI in the Russian-Ukrainian Conflict," *Russia Matters*, Belfer Center for Science and International Affairs, July 20, 2023, https://www.russiamatters.org/analysis/roles-and-implications-ai-russian-ukrainian-conflict.

89 Patrick Tucker and Jenifer Hlad, "Pentagon to Build AI for War Planning in Europe and Asia," *Defense One*, March 5, 2025, https://www.defenseone.com/technology/2025/03/pentagon-build-ai-war-planning-europe-and-asia/403506; Sydney J. Freedberg Jr., "NATO Picks Palantir's Maven AI for Military Planning, amid Trans-Atlantic Tension," *Breaking Defense*, April 14, 2025, https://breakingdefense.com/2025/04/nato-picks-palantirs-maven-ai-for-military-planning-amid-trans-atlantic-tension.

90 This approach is detailed further in Bryan Clark, Dan Patt, and Timothy A. Walton, *Implementing Decision-Centric Warfare: Elevating Command and Control to Gain an Optionality Advantage* (Hudson Institute, 2021), https://www.hudson.org/national-security-defense/implementing-decision-centric-warfare-elevating-command-and-control-to-gain-an-optionality-advantage.

91 *Joint Military Appreciation Process: ADFP 5.0.1* (ADoD, 2019), https://theforge.defence.gov.au/sites/default/files/adfp_5.0.1_joint_military_appreciation_process_ed2_al3_1.pdf.

92 "Command," Edition 1, ADF Philosophical Doctrine, 0 Series (ADF-P-0 *Command*) (ADF, 2024), https://theforge.defence.gov.au/sites/default/files/2024-01/ADF-P-0%20Command.pdf.

93 Leonardo Y. Schwarzstein and Rafael C.S. Schouery, "Budget-Balanced and Strategy-Proof Auctions for Ridesharing," *Computers and Operations Research* 151 (2023): 106094, https://doi.org/10.1016/j.cor.2022.106094.

94 William Cabellero and Philip Jenkins, "On Large Language Models in National Security Applications," preprint, ArXiv, July 3, 2024, https://arxiv.org/pdf/2407.03453v1.

95 Michael J. Mazarr et al., *Disrupting Deterrence: Examining the Effects of Technologies on Strategic Deterrence in the 21st Century* (RAND Corporation, 2022), https://www.rand.org/pubs/research_reports/RRA595-1.html.

96 *ADF Concept for Command and Control of the Future Force* (ADF, 2018), https://theforge.defence.gov.au/sites/default/files/adf_concept_for_command_and_control_of_the_future_force_v.1_signed.pdf.

97 *Electromagnetic Spectrum Superiority Strategy* (US DoD, 2020), https://media.defense.gov/2020/oct/29/2002525927/-1/-1/0/electromagnetic_spectrum_superiority_strategy.pdf

98 Frans Osinga, *Science, Strategy, and War: The Strategic Theory of John Boyd* (Routledge, 2007).

99 This approach is detailed in Bryan Clark, Dan Patt, and Harrison Schramm, *Mosaic Warfare: Exploiting Artificial Intelligence and Autonomous Systems to Implement Decision-Centric Operations* (Center for Strategic and Budgetary Assessments, 2020), https://csbaonline.org/research/publications/mosaic-warfare-exploiting-artificial-intelligence-and-autonomous-systems-to-implement-decision-centric-operations.

100 Euan Graham and Linus Cohen, "Australia Should Talk to Washington about Buying B-2 Stealth Bombers," *Breaking Defense*, April 16, 2025, https://breakingdefense.com/2025/04/australia-should-talk-to-washington-about-buying-b-2-stealth-bombers.

101 "*Mogami*-Class Frigate Selected for the Navy's New General Purpose Frigates," ADoD, August 5, 2025, https://www.minister.defence.gov.au/media-releases/2025-08-05/mogami-class-frigate-selected-navys-new-general-purpose-frigates.

102 MASC includes three variants, two of which correspond to the 100-ton and 300-ton MUSVs used in this study. See US Navy, "Modular Attack Surface Craft (MASC)—Solicitation," SAM.gov, July 28, 2025, https://sam.gov/opp/8b9b32c898a64ddc9d7dcd-3d208cfb0e/view.

103 Malcolm Davis, "Building Integrated Air and Missile Defence for Australia," *The Strategist*, Australian Strategic Policy Institute, June 21, 2023, https://www.aspistrategist.org.au/building-integrated-air-and-missile-defence-for-australia.

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