The PLA, A2/AD and the ADF: Lessons for Future Maritime Strategy

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Over the past two decades the PLA has developed an operational concept designed to deny US naval forces use of vast areas of ocean. Dubbed Anti Access/Area Denial (A2/AD), this operational concept leverages technological developments in long range anti-maritime weapons, networking and sensors to target naval forces, with precision, over a large portion of the western Pacific. Utilising a case study of the methods, systems and organisation the PLA has wielded to forge such a formidable A2/AD capability over the past two decades, this article contends that A2/AD offers Australia significant opportunities to offset the naval superiority the PLA holds over the ADF, and is thus a desirable, effective and achievable method of operations upon which the nation's wider maritime strategy can be founded.

A2/AD and the ADF's Future Maritime Strategy

This article argues that A2/AD is both a desirable and achievable concept of operations for the Australian Defence Force (ADF), and could well serve as the foundation for a wider strategic doctrine designed to deal with the threat of high intensity, great power conflict in East Asia. Essentially an evolution of current 'Sea-Air Gap' doctrinal concept, A2/AD shifts the emphasis from the denial of sea control in areas close to the Australian littorals to an area encompassing most of the Indonesian archipelago. This both prevents hostile naval formations from standing off and hinders manoeuvre by denying vast areas of strategically and operationally significant geography to enemy amphibious and strike forces.

From an operational viewpoint the ADF and People's Liberation Army (PLA) face nearly identical challenges, and thus the leverage of technological trends to locally offset aggregate naval superiority, as exemplified by the Chinese, is a low cost and low risk approach to ensure the ADF is capable of defending Australia against a superior opponent. Additionally, achieving a formidable A2/AD capability is neither cost prohibitive, considering the elements already in place, nor does it require a drastic force structure alteration. Indeed, with the foundational elements of the kill chain implemented, reasonably large portions of the ADF could theoretically still undertake expeditionary warfare and allied operations in other areas or even theatres, without compromising the defensive system.

Australia is part of an Asian security architecture which has been regionally dominant for over seventy years. As a treaty ally of the United States, Australia enjoys the benefits of an indirect link to a wider security network via a number of US mutual defence arrangements, which include Thailand, the Philippines, South Korea, Taiwan and Japan. Australia is a member of the Five Power Defence Arrangements committing it to security cooperation with Malaysia and Singapore, and enjoys a close bilateral security relationship with Japan. Thus, although only two of these bilateral treaty commitments include mutual defence clauses,[195] given Australia's deep integration with virtually all of South East Asia, and our close alliance with the world's premiere maritime power, the question may arise as to why the ADF even needs an independent maritime strategy. If the likelihood of direct armed attack on Australia, especially in a bilateral context, is low, why should the Australian people devote time, energy and resources to countering such an unlikely threat?

Unfortunately, the geostrategic environment Australia has enjoyed over the past seven decades is rapidly changing. For the first time since 1945, a significant naval power has emerged in East Asia which is not integrated into the US-led regional security architecture.[196] Additionally, this power is a strategic competitor of the United States. This 'major power adversary' is the PLA. The ADF now has to contend with the possibility of confronting a major maritime power, with bilateral naval superiority, operating in our northern approaches. In terms of pure military capability, it is the greatest threat the Australian military has had to contend with since the fall of Imperial Japan. Obviously, given the numerous treaty commitments and security architecture with which Australia is engaged, it is unlikely that the ADF should expect to face such a threat alone. However, in the event of a general conflict, clearly it is the government's expectation that the ADF is capable of providing sufficient capability to independently defend the Australian theatre in all *reasonable* contingencies:

> The first Strategic Defence Objective is to deter, deny and defeat any attempt by a hostile country or non-state actor to attack, threaten or coerce Australia. The Government is providing Defence with the capability and resources it needs to be able to independently and decisively respond to military threats, including incursions into Australia's air, sea and northern approaches.[197]

[195] Australia has mutual defence treaty (ANZUS) which includes the United States and New Zealand.

[196] Estimates put total PLA(N) strength at some 85 Destroyers and 85 Frigates, all of modern design, by 2020. See Ronald O'Rourke, *China Naval Modernization: Implications for U.S. Navy Capabilities—Background and Issues for Congress*, CRS Report, RL33153, Congressional Research Service, 17 June 2015.

[197] Department of Defence, *2016 Defence White Paper* (Canberra: Commonwealth of Australia, 2016), p. 17.

Indeed, the 2009 Defence White Paper clearly stated that even in the event of a general regional conflict the defence of Australia would primarily rely on sovereign capabilities.[198] This is not an uncontroversial objective,[199] and clearly not something which would apply in the extreme cases of nuclear attack or drastic bilateral overmatch.[200] If the Australian Government is serious about the above commitment as, arguably, it should be, given the potential limitations of allied capability to assist in the early stages of any conflict, then a clear operational concept must be formulated in order to impose severe costs on that 'major power adversary', should they initiate operations against Australia.

Such a drastic shift in the geostrategic landscape with which Australia must contend poses fundamental challenges to long-established Australian strategic doctrine, and the ADF's core military doctrine which underpins wider national strategy. Australia has experienced five dominant doctrinal paradigms, at the strategic level, since Federation.[201] Each of these strategic eras reflects a particular threat, conflict or wider geostrategic circumstance which dominated Australian planning and strategy. The watershed between these eras is often the termination of a conflict or the emergence of a new threat. This process is clearly evident in the transition from forward defence to 'Defence of Australia' as outlined in the 1976 Defence White Paper,[202] released at the conclusion of the decade-long Vietnam War. The strategic doctrine of forward defence, which had been dominant since the Korean War, was designed to counter the threat of revolutionary communism destabilising South East Asia and installing unfriendly governments in the region.[203] The end of the Vietnam War, combined with the revolution in western relations with China, fundamentally shifted Canberra's strategic outlook, practically removing the threat of communist subversion from Australian strategic calculus. What emerged from that transition was a strategic doctrine which emphasised self-reliance in the provision of fundamental Australian security.[204] Since 1975, it has been a core assumption of Australian defence planning that it is both Australia's responsibility and within the nation's resources to provide for its own defence in all but the most extreme of circumstances, as is evidenced by a series of White Papers.

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[198] Department of Defence, *Defending Australia in the Asia Pacific Century: Force 2030* (Canberra: Commonwealth of Australia, 2009), p. 65.
[199] Paul Dibb, '2016 Defence White Paper: Solid Policy with Funding to Match', *The Australian*, 11 March 2016.
[200] Department of Defence, *2016 Defence White Paper*, p. 50.
[201] Peter Edwards, *Learning from History: Some Strategic Lessons from the 'Forward Defence' Era*, ASPI Strategy series (Barton: Australian Strategic Policy Institute, 2015), p. 5.
[202] Department of Defence, *Australian Defence* (Canberra: Commonwealth of Australia, 1976), p. 10.
[203] Edwards, *Learning from History,* p. 5.
[204] Department of Defence, *Australian Defence*, p. 10.

The collapse of governance in East Timor and the emergence of global Islamic extremism, in 1999 and 2001 respectively, brought an end to Defence of Australia as a strategically dominant doctrinal paradigm. The contribution to the Global War on Terror repositioned Australia as a globally relevant military actor when engaged in coalition with the United States.[205] Additionally, the violence and political instability in Dili during the 1999 independence referendum exposed the divergence of Australian and US interests in the region,[206] and the need for Australia to act independently in the 'arc of instability' throughout Oceania.[207] These operations illustrated the need to move to a hybrid strategic model, one which emphasised the capability for expeditionary warfare—unilaterally within the region and in concert with the United States and other partners globally—in addition to the foundational security provided by the ADF in the Australian theatre. This shift in strategic doctrine has produced a drastic increase in the ADF's ability to project power, with what is now a regionally dominant amphibious capability and a much more flexible and deployable army.[208]

We are almost certainly in the midst of another strategic watershed in 2016. The end of the Global War on Terror, in combination with the emergence of the PLA as a regional competitor to US naval dominance, has challenged the fundamental strategic assumptions upon which the current hybrid model was formulated. A realistic appraisal of Australia's strategic environment over the last forty years reveals a relatively benign region, integrated into a stable geopolitical order and utterly dominated by US naval power. However, this metric will drastically shift over the next three decades. The Australian strategic community now has to contend with the prospect of a major naval power in East Asia which, through a combination of Anti-Access/Area Denial capabilities and blue water naval assets, has the potential to pose a strategically significant conventional threat to the Australian mainland, even whilst engaged in a general conflict with the United States. Clearly, considering the US alliance and the stated US expectation of active Australian participation in any serious conflict,[209] the ADF and wider Australian strategic community must formulate a new strategic doctrine—underpinned by a concurrent concept of operations—designed to successfully engage in a high intensity conflict in the Asia Pacific, including our northern approaches, against an enemy which may

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[205] Robert Hill, 'The War in Iraq ADF Operations in the Middle East in 2003', Department of Defence, 2004, <www.defence.gov.au/publications/lessons.pdf> [Accessed 5 October 2016], p. 10.

[206] For US reactions and support of the operation see Hugh White, 'The Road to INTERFET: Reflections on Australian Strategic Decisions Concerning East Timor, December 1998-September 1999', *Security Challenges*, vol. 4, no. 1 (Autumn 2008), p. 83.

[207] Dennis Rumley, Vivian Forbes and Christopher Griffin, *Australia's Arc of Instability: The Political and Cultural Dynamics of Regional Security* (Dordrecht: Springer, 2006), p. 1-2.

[208] Ken Gleiman and Peter Dean, *Beyond 2017: The Australian Defence Force and Amphibious Warfare*, ASPI Strategy series (Barton: Australian Strategic Policy Institute, July 2015), p. 21.

[209] Jan Van Tol, *AirSea Battle: A Point-of-Departure Operational Concept* (Washington, DC: Center for Strategic and Budgetary Assessments, 2010), p. 51

enjoy local naval superiority. Thus the current 'deterrence'-based doctrinal model may need to shift to a 'defence'-based military doctrine, where we cannot expect current capabilities to effectively prevent hostile action by a great power within the context of a wider conflict, and thus must focus tactics, assets and capabilities towards the conduct of a high intensity, defensive naval campaign in our primary area of operations.[210]

Predicting the course of future conflict is a difficult task, one which is nearly impossible to achieve with perfect accuracy. However, an evaluation of the relationship between strategic objectives and relative capabilities reveals incentives which will likely restrict military actions. Such an evaluation of the strategic environment in the western Pacific reveals some very dangerous trends. Beijing's immediate strategic objectives rest in the domination of its near seas, including the long-term subjugation of Taiwan, as part of a wider goal of displacing US regional hegemony, which it clearly views as hostile to its long-term interests. In line with these longstanding strategic objectives the PLA is building substantial joint maritime capabilities which, by the mid-2020s, will not only provide Beijing with the credible option of achieving its strategic objectives by force, but may be in a position of regional overmatch over forward deployed US and allied forces. This is the first factor which will shape any regional conflict. The second is the aggregate superiority of US air and naval forces: the successful intervention of the US Third Fleet would drastically curtail the PLA's ability to operate along the first island chain, as would the deployment of substantial US Air Force strategic and tactical air power to the theatre. Thus, upon the opening of hostilities, these relative capabilities incentivise the following courses of action:

- The PLA will likely wage an aggressive, high intensity naval campaign to gain its strategic objectives while it enjoys local naval superiority.

- Allied basing capable of supporting significant US air power will be primary targets of Chinese air and naval operations in the opening days of any conflict.

- US battle forces—carrier strike groups—will be the targets of the PLA's joint A2/AD complex, rather than the focus of classic, main force encounters for which the PLA Navy (PLA(N)) is not optimised.

This broad analysis is consistent with the assumptions outlined in the US military's original AirSea battle concept, a doctrinal development designed to facilitate the effective delivery of combat capability into the western Pacific in

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210 For the dissociation between the three forms of military doctrine—'offensive', 'defensive' and 'deterrent'—see: Barry Posen, ***The Sources of Military Doctrine: France, Britain and Germany between the World Wars*** (Ithaca: Cornell University Press, 1984), p. 16.

the face of the PLA's A2/AD architecture. As stated by Benjamin Schreer,[211] one of the potentially decisive advantages Australia can provide the United States is access to high quality military facilities which are well placed to contest PLA(N) operations in the South China Sea. This reveals a confronting likelihood: in any regional conflict between the United States and China, Australia's northern basing infrastructure will most probably be a high priority target for the PLA, given the threat US strategic air power poses to its operations. Whatever the conflict's proximate cause, be it deliberate attack, miscalculation in the Ryukus or a formal Taiwanese declaration of independence, Beijing simply cannot ignore the possibility of potentially decisive amounts of US air power being staged from northern Australia. Additionally, given the above capability metrics, without large-scale forward deployed forces, primarily air power, the United States will possibly not be in a position to offer significant assistance during the first week of conflict. Obviously the threat to our northern basing is only magnified in any bilateral contingency, should the isolationist political trends personified by Donald Trump gain ascendency in United States, for example.

In the event of such a general regional conflict, Australia's maritime geography limits the major threats to Australian security to maritime forces, given the logistical constraints of land-based air power. Key Australian infrastructure is simply far beyond the effective reach of much the PLA Air Force's (PLA(AF)) strategic air power, as even when equipped with the long-ranged CJ-20 Air Launched Cruise Missile (ALCM),[212] the H-6M based at Hainan Island is only able to strike Darwin at maximum range, well beyond the capability of escorting fighters and overflying the Philippines and Indonesia. Thus, the only realistic means by which the PLA can project strategically significant power against Australia is by surface forces and submarines.[213] The PLA's submarine fleet is not currently optimised for land attack missions, although instalment of the CJ-10 on a limited number of nuclear attack units is certainly a possibility.[214] Thus the primary threat arises in the form of surface formations. The PLA(N) is currently testing its first operational aircraft carrier, the *Liaoning*, a 60,000 ton Kuznetsov class, which is apparently the basis for the PLA(N)'s indigenous aircraft carrier series, of which there is at least a single unit in production, possibly two. This indigenous series should rival the *Liaoning* in displacement and air wing size. Given the observed level of investment to date, a fair estimate of PLA(N) carrier strength in 2030-35 is four fleet carriers, and enough destroyers and frigates to form four carrier strike group equivalents, in

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[211] Benjamin Schreer, *Planning the Unthinkable War: 'AirSea Battle' and its implications for Australia*, ASPI Strategy series (Barton: Australian Strategic Policy Institute, 2013), p. 7.

[212] Ian Easton, 'The Assassin Under the Radar: China's DH-10 Cruise Missile Program', *Futuregram* 09-005, Project 2049 Institute, 2009, p. 1.

[213] Ballistic missiles are clearly a threat as well but, given the ranges involved, unless WMDs are utilised the PLA is unlikely to use ICBMs with the requisite mass to achieve the necessary effects with conventional warheads.

[214] O'Rourke, *China Naval Modernization*, p. 14.

addition to numerous surface action groups.[215] Additionally, the PLA has announced plans for a blue water amphibious capability, in the form of an indigenously designed landing helicopter dock (LHD), named the Type 081.[216] Reportedly, three are already under construction.[217] Consequently, the most likely threat the ADF could face in the event of a general conflict in East Asia will be PLA(N) carrier strike group equivalents operating against the RAAF's northern basing infrastructure and the port facilities in Darwin,[218] and amphibious strike groups[219] conducting amphibious operations to secure island bases in the Indonesian archipelago in order to defend maritime communications. Clearly Australia is unlikely to face the full weight of any great power's naval forces, given other commitments. Thus, a realistic objective is joint ADF forces having the ability to successfully engage a single formation equivalent to a carrier strike group and/or an amphibious strike group operating in our northern approaches.

A2/AD is an attractive concept of operations for such a defensive strategic doctrine. Combining wide area Intelligence, Surveillance and Reconnaissance (ISR) capabilities and long range weapons in a networked Command, Control, Communications and Computers (C4) complex, A2/AD is an operational concept designed to deny access and use of vast areas of operationally significant maritime geography to an opposing naval force. In principle, its core innovation is the dramatically increased range at which large naval formations can be effectively engaged by defensive missile forces. Ironically, the local naval superiority the PLA(N) is expected to enjoy in the opening phases of any conflict with the United States is a direct result of the PLA's vast A2/AD complex, which has significantly complicated the planned reinforcement of the Seventh Fleet from the continental United States. Indeed, the leverage of long range systems to deny access and disrupt the operations of forward deployed forces has been a key technological offset utilised by the PLA to counter overwhelming aggregate US naval superiority. In just two short decades China's A2/AD capability has generated drastic reappraisals of fundamental US naval doctrine from the American strategic community,[220] and even calls for the abandonment of the

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[215] Ibid., p. 21.

[216] The Type 081 should displace about 20,000 tons, and thus be roughly equivalent to the Mistral class LHD. 'Type 081 Aviation Assault Ship (LPH / LHA)', GlobalSecurity.org, <www.globalsecurity.org/military/world/china/type-81-lha.htm> [Accessed 3 October 2016].

[217] O'Rourke, *China Naval Modernization*, p. 36.

[218] Gleiman and Dean, *Beyond 2017*, p. 21.

[219] Susan Hutchins, William Kemple, David Kleinman and Susan Hocevar, 'Expeditionary Strike Group: Command Structure Design Support', 10th International Command and Control Research & Technology Symposium, Naval Postgraduate School, 2005, Monterey, p. 4. In the US Navy an Expeditionary (Amphibious) Strike Group is an autonomous naval formation designed to conduct amphibious operations, usually based around a USMC battalion landing team, amphibious warfare vessels, major surface combatants and a submarine.

[220] Seth Cospey, Bryan McGrath and Timothy Walton, *Sharpening the Spear: The Carrier, the Joint Force, and High-End Conflict* (Washington, DC: Hudson Institute, 2015).

Ford Class CVN.[221] Yet in no metric whatsoever is the PLA(N) close to being comparable to the US Navy (USN) in aggregate terms. The level of success the PLA has achieved in developing an A2/AD capability, the similar operational challenges which confront the PLA and ADF in the event of high-end conflict, and the leverage of long-term trends in wide area, land based surveillance and weapons systems to locally offset significant naval inferiority, all warrant significant attention given the strategic and operational challenges the ADF faces in the Asia Pacific.

Case Study: The Development of the PLA's A2/AD Complex in the Western Pacific 1995-2015.

The PLA's answer to the operational challenge posed by the entrance of US battle forces into the Taiwan Strait during the crisis of 1996, established over the last two decades, has been the development of an integrated A2/AD system.[222] This battle network is comprised of the combination of Anti-Ship Cruise Missile (ASCM) armed maritime strike aircraft, medium range ballistic missiles (MRBM), dedicated C4 facilities and a layered, wide area ocean surveillance system. This system leverages developments in long range precision weapons and wide area sensor networks to allow precision targeting of US and allied basing and maritime forces out to the second island chain, with the intent of deterring the entrance of US reserve forces from the continental United States in the event of a military confrontation, and restricting the operation of forward deployed forces.[223] It is the development of this A2/AD system which has provided the first real challenge to the operational mobility, and thus utility, of US carrier strike groups since the fall of the Soviet Union.

Over the last ten years the PLA has leveraged technological developments in two types of weapon systems to drastically increase the potential reach and lethality of the kinetic threat to US battle forces in the western Pacific. The weapon which has undoubtedly garnered the most public attention is the ballistic missile. A development of the DF-21C MRBM, which is designed to strike US basing on Okinawa and mainland Japan, the primary technological breakthrough the PLA has made in this arena is the DF-21D, Anti-Ship Ballistic Missile (ASBM). The ASBM is a key element in the development of the A2/AD concept, as the fielding of a weapon with an 800+ nautical mile (nm) range and a flight time measured in minutes has

[221] Noel Williams, 'The US Navy's Self-Imposed Blockade', War on the Rocks, 19 October 2015, <warontherocks.com/2015/10/the-u-s-navys-self-imposed-blockade/> [Accessed 3 October 2016].

[222] Annual Report to Congress, Military and Security developments Involving the PRC, Office of the Secretary of Defence, 2015, p. 78.

[223] The second island chain, as defined in Chinese naval strategy, is an arbitrary line running from northern Japan, through the Marianas to Guam and West Papua, see N. Li, 'The Evolution of China's Naval Strategy and Capabilities: From "Near Coast" and "Near Seas" to "Far Seas"', *Asian Security*, vol. 5, no. 2 (2009), p. 129.

considerably complicated US naval operations in the western Pacific, requiring the development of significant technological and tactical countermeasures.[224] The DF-21D was apparently tested against a land target in western China in 2013, though to date no successful engagement of a moving target at sea has been reported.[225] Perhaps of equal operational significance is the PLA's ASCM capability: the YJ-18 ASCM is currently being fielded on several destroyer and submarine classes in PLA(N) service.[226] When launched from subsurface platforms, the YJ-18 is designed to strike US naval formations from beyond the reach of their outer anti-submarine warfare (ASW) perimeter, with targeting cued from the wider battle network. The development of the YJ-12 ASCM has significantly improved the PLA(AF)'s maritime strike capability by allowing strike aircraft to achieve a launch range well beyond the defensive surface-to-air-missile (SAM) umbrella.[227] These weapons have drastically increased the reach and lethality of PLA anti-maritime forces, which at the very least will move the operational stations of USN battle forces further from Taiwan, and thus substantially degrade their ability to intervene given the limited range and persistence of USN tactical air power.

As much as the development of the PLA's missile arsenal has potentially changed the game in the western Pacific, it is only the last link in the A2/AD kill chain: weapons are useless without timely and accurate detection, location and classification of US battle forces. The Chinese Ocean Surveillance System (COSS) aims to achieve the necessary ISR capability by applying two echelons of sensors, each with multiple systems. The first echelon is designed to detect shipping by utilising a wide area search, the second to achieve precise classification and higher resolution track data to support the relevant missile forces.[228] Two primary systems constitute the PLA's first echelon sensors: a Synthetic Aperture Radar (SAR) and Electronic Intelligence (ELINT) satellite constellation and a Sky Wave radar network. The current foundation of the COSS's space-based ISR capability is the Yaogan constellation. Launched since 2006, it includes five SAR and

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224 Cospey et al., *Sharpening the Spear,* p. 57.

225 Robert Johnson, 'China's Successfully Tests "Carrier Killer" Missile In The Gobi Desert', Business Insider Australia, 26 January 2013, <www.businessinsider.com.au/chinas-carrier-killer-missile-test-proves-df-21d-lives-up-to-name-2013-1>

226 Michael Pilger, *China's New YJ-18 Antiship Cruise Missile: Capabilities and Implications for U.S. Forces in the Western Pacific*, US-China Economic and Security Review Commission, Staff Research Report, 28 October 2015, p. 2. The YJ-18 is a long range, sea skimming ASCM, with a 290 nm (530 km) range and a terminal attack speed of Mach 3. It is roughly equivalent to the SS-N-27B/SIZZLER ASCM, which is fielded on eight of China's twelve Russian-built Kilo class SSKs.

227 Ibid., p. 11. Essentially an enlarged Kh-31, the YJ-12 provides the PLA with a standoff capability approaching 200 nm (370 km).

228 Jonathan Solomon, 'Defending the Fleet from China's Anti-Ship Ballistic Missile: Naval Deception's Roles in Sea-Based Missile Defense', Master of Arts Thesis, Graduate School of Arts and Sciences of Georgetown University, 2011, p. 11.

fifteen ELINT satellites.[229] These satellites provide COSS with wide area, all weather surveillance: each cluster of ELINT satellites provides a passive sensor footprint of some 3,500 km, though these are inherently limited by target Emissions Control (EMCON) procedures. The five SAR Yaogan's make a sweep of the western Pacific roughly every four hours.[230] In combination, the SAR and ELINT constellations provide 24/7 surveillance of the western Pacific, which is, however, inherently intermittent. The other primary long range, wide area surveillance system is the PLA's Over The Horizon–Backscatter (OTH-B) radar system. The OTH-B system is located in the Guangzhou Military Region, has a 60 degree field of view and a rough footprint stretching from the south of Kyushu to Mindanao, projecting roughly 2,000 km into the western Pacific.[231] The combination of the five SAR satellites, the ELINT Yaogan clusters and OTH-B theoretically provide the PLA with a dense and redundant method of detecting shipping. However, none of these first echelon sensors can reliably provide target classification, or likely even generate or hold a track of sufficient resolution to allow a missile strike, hence the need for a second echelon of sensors which have much higher resolution, but a much smaller sensor footprint.

Second echelon sensors in COSS are divided into two classes, orbital platforms and aircraft. The orbital arm of the second echelon consists of five Electro Optical (EO) imaging satellites, each with orbital paths designed to take them over the western Pacific during daylight hours. The EO Yoagans provide COSS with target verification and classification, in addition to high fidelity track data which, in turn, improves the accuracy of OTH-B via Coordinate Registration. Combined with the BeiDou navigational satellite constellation, these EO satellites can achieve precise geo-location of an identified target whilst the orbital path permits. The other major arm of COSS second echelon sensors are Maritime Patrol Aircraft (MPA) and Unmanned Aerial Vehicles (UAVs). These systems provide several benefits in comparison to space-based systems in both persistence and responsiveness. Unlike satellites a terrestrial platform can maintain a track for extended periods, providing the central command with continual strike quality targeting data. Unlike satellites, however, these platforms are far more vulnerable to tactical air power and surface to air missiles.

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[229] S. Chandrashekar and Soma Perumal, *China's Constellation of Yaogan Satellites & the Anti-Ship Ballistic Missile – An Update* (Bangalore: International Strategic and Security Studies Programme, 2015), p. ii.
[230] Ibid., p. 2.
[231] Mark Stokes, 'China's Evolving Conventional Strategic Strike Capability: The Anti-Ship Ballistic Missile Challenge to U.S. Maritime Operations in the Western Pacific and Beyond', Project 2049 Institute, 14 September 2009 p. 19. The Chinese system is unlikely to be as advanced as comparable western radars, with an estimated tracking error of twenty to forty kilometres, compared to US OTHR accuracy of eight to thirty kilometres. Eric Hagt and Matthew Dunin, 'China's Anti Ship Ballistic Missile, Developments and Missing Links', *Naval War College Review*, vol. 62, no. 4 (Autumn 2009), pp. 92-94.

As can be seen this complex of overlaying sensors and platforms is necessary to achieve near real-time detection, track and classification of naval units within COSS's footprint. Each system has significant strengths and weaknesses, which necessitates the synergistic overlaying of multiple platforms. However, the large inflow of information such a system generates imposes a significant C4 burden on the PLA. This challenge is addressed by the use of a data fusion centre, which is likely located with the PLA Joint Theatre Command.[232] As each system is complementary, managing contacts from SAR, OTH-B and MPA, for example, and fusing the information into a coherent picture is a key element in COSS's role within the A2/AD operational concept, and is critical in allowing PLA command to strike transient targets. Although this centralised command provides significant benefits, it also entails significant vulnerabilities, as either hard or soft decapitation operations could have a drastic influence on the PLA's operational and tactical performance, as would any compromising of the wider C4 complex.

Key A2/AD Systems and Capabilities Developed over the Last Two Decades by the PLA:

- *Wide area, multi-layered, ocean surveillance system*: Two echelons of sensors, one optimised for wide area search and detection of shipping, the second optimised for classification and fire solution generation.

- *Integrated data fusion capability within a dedicated C4 complex*: The ability to manage data inflows from multiple systems and sensors at a centralised data fusion centre is critical in forming a coherent picture of the battle-space, as is the ability to network sensors, decision makers and missile forces.

- *Long range missile forces*: The development and introduction of successive generations of long range anti-ship missiles, staged from land, air, surface and subsurface launch platforms, with an effective engagement footprint projecting 1,000 nm from the Chinese littorals.

The ADF and Opportunities for A2/AD Development

Contesting the 'Sea-Air Gap' with combined naval and air forces has been a core operational objective for the ADF since 1976. Indeed, many of the low cost opportunities for A2/AD development in an Australian context exist because of the investment in the infrastructure and technologies developed in the post-Vietnam War era. However, when the infamous Defence of Australia white paper was being developed in the early 1970s, the only conceivable conventional surface threat existed in the submarine-heavy

[232] Solomon, 'Defending the Fleet from China's Anti-Ship Ballistic Missile', p. 11.

Soviet Pacific Fleet, which posed a remote threat to continental Australia. Then, as now, Australia's South East Asian neighbours are not major maritime powers, and even in coalition lack even the potential capability to establish the requisite sea control to begin amphibious operations in Australia's north. Thus, within that context, a range limited maritime strike capability founded on platforms like the F/A-18A Hornet and Harpoon missile was more than adequate.[233] As outlined in earlier sections, the development of blue water naval capabilities by the PLA(N) has rendered the tactical and operational rationale behind the current concept of operations practically obsolete. Put simply, the current maritime strike system is not optimised to engage integrated naval formations with organic fighter cover, Airborne Early Warning (AEW), defensive vessels as formidable as the Type 52D Destroyer, and long range strike systems. Strike radius is the key weakness in Australia's ability to defend our northern basing infrastructure—arguably one of the nation's physical centres of gravity in any major conflict—at both the tactical and operational levels.

Long Range Missile Forces

As discussed in the previous sections one of the main technological developments the PLA has leveraged to further its A2/AD capability is advances in longer range weapons. The increased reach of maritime strike platforms and land based missile forces are key enablers in restricting access of US battle forces to optimum operational positions. The ADF's primary ASCM is the AGM-84C Harpoon Block II missile. The Harpoon is a lightweight, subsonic, relatively short-range weapon, which utilises a low altitude attack profile to approach target vessels from below the radar horizon.[234] Its tactical utility is, however, being significantly eroded by the increasingly capable surface formations with which the Harpoon will have to contend, and the future development of active homing SAM systems. For the first time since the missile's introduction into active service, western navies face a potential challenge of striking naval formations with organic fighter cover and AEW: the proliferation of AEW helicopters such as the Z-18J and Ka-31[235] has considerably increased the target formation's radar horizon,[236] which in combination with organic fighter support drastically complicates the tactical employment of Harpoon class ASCMs. The deployment of fixed wing naval AEW will only increase the target's sensor

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233 The F-111 provided much greater range than the F/A-18A, but was both relatively low in numbers and vulnerable to fighter defences.

234 For information on the Harpoon, see Randy Jackson, 'Harpoon Block II', *Boeing Backgrounder,* 2013.

235 See 'China Has Developed a New Military Transport Helicopter Z-18', Defence Blog, 6 January 2015, <defence-blog.com/news/china-has-developed-a-new-military-transport-helicopter-z-18.html> and 'Chinese Military Aviation: Helicopters III', <chinese-military-aviation.blogspot.com.au/p/helicopters-iii.html> [Accessed 5 October 2016].

236 A Z-18J on station at 4,000 m altitude would provide the PLA(N) with a radar horizon of 273 km, well beyond the Harpoon's maximum launch range providing ample opportunity for defending fighters to intercept inbound strike formations.

footprint. In addition to the technological and force structure factors which are eroding the Harpoon's tactical viability, its range also limits its value at the operational level when being utilised in an A2/AD operational concept.

The RAAF's seventy-one Classic Hornets will be replaced by the F-35A between 2016 and 2022, and with their departure the Harpoon will be limited to the F/A-18F (and P-8), which will be removed from service by 2030.[237] The Harpoon will not be integrated on the F-35A.[238] Hence, whether the ADF adopts A2/AD as an operational concept or not, the RAAF needs a new missile. Given the significant cost of integrating a weapon onto a tactical fighter,[239] the ADF is very unlikely to select a system that other F-35 users are not utilising. This leaves three realistic possibilities. The first is the AGM-154C1 Joint Stand-Off Weapon (JSOW).[240] The AGM-154C1 adds a moving target capability to the already operational AGM-154C by integrating Link 16 and improving its seeker software, to include shipping.[241] Although the AGM-154C1 has several advantages in terms of cost, scale and currency in the RAAF, it imposes significant tactical limitations. As the weapon is not internally powered, in order to achieve Harpoon-like ranges the launch platform must remain at high altitude, leaving itself, and the JSOW, reasonably vulnerable to defensive fighters and semi-active SAM systems, many of which, like the HQ-9, have comparatively larger engagement footprints.

The second realistic option is the Norwegian Joint Strike Missile (JSM). Based on the currently operational Naval Strike Missile, the JSM is a joint venture between Raytheon and the Norwegian defence contractor Kongsberg.[242] The combination of a very small frontal profile, frontal RCS (Radar Cross Section) reduction, low infra-red emissions from the 'microturbo' turbojet engine and passive seeker give the JSM minimal electromagnetic and infra-red signatures, making the missile difficult for shipboard defences to counter. The RAAF has apparently investigated a

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[237] Andrew Davies, *ADF Capability Snapshot 2015: Part 1—RAAF*, ASPI Strategic Insight (Barton: Australian Strategic Policy Institute, 2015), p. 8.

[238] Doug Hayward, 'F-35 Weapon System Overview', Distribution Statement, Lockheed Martin, 2010, p. 12.

[239] Lance Halvorston, 'The F-111C Aircraft for Australia', *Wings*, Summer 2010, p. 18; Nigel Pittaway, 'ADF Weapon Project: JASSM to Enter Service this Year', *Australian Defence Magazine*, 1 November 2011, <www.australiandefence.com.au/archive/adf-weapons-project-jassm-to-enter-service-this-year-adm-july-2012> [Accessed 5 October 2016]

[240] For general JSOW information see 'AGM-154A Joint Standoff Weapon [JSOW]', Federation of American Scientists, <fas.org/man/dod-101/sys/smart/agm-154.htm>.

[241] 'AGM-154 Joint Standoff Weapon (JSOW)' Raytheon, <www.raytheon.com/capabilities/products/jsow/> [Accessed 5 October 2016].

[242] The JSM is a 400 kg, subsonic ASCM, with a 120 kg titanium warhead. It has a 180 km range. The weapon is specifically designed to fit within the F-35A's internal weapons bay, maintaining the aircraft's Very Low Observability (VLO). See 'Kongsberg's NSM/JSM Anti-Ship & Strike Missile Attempts to Fit in Small F-35 Stealth Bay', Defence Industry Daily, 12 November 2015, <www.defenseindustrydaily.com/norwegian-contract-launches-nsm-missile-03417/> [Accessed 5 October 2016] for a full description of the NSM and JSM development and testing.

joint venture with the Royal Norwegian Air Force in integrating the JSM onto the F-35A.[243] The third potential option is Lockheed Martin's Long Range Anti-Ship Missile (LRASM). The LRASM is a development of the Joint Air-to-Surface Standoff Missile (JASSM) family currently operational with the RAAF and USAF/USN. Leveraging the JASSM-ER variant, the LRASM will have an air launched engagement range of between 500 and 600 nm (930-1,100 km).[244] Critically, the LRASM is designed to leverage advances in autonomous targeting, allowing the missile to operate in heavy EW (electronic warfare) environments, where satellite data-link performance is impaired. The missile is reportedly capable of making approach vector alterations based on defensive dispositions and independent target selection and discrimination.[245]

Obviously the selection of a specific weapon for a tactical fighter is multifaceted process, and all too often research articles and pundits fall into the trap of backing pet projects and systems. Cost, allied interoperability, sustainment, the confidence in resupply, development options and partner collaboration are often as important as tactical capability in making selections. Thus, the analysis made in this paper focuses only upon the rival weapons' utility in an A2/AD operational concept as described above. Given the general utility of the AGM-154C1 in both land and maritime strike, its service with the USN (and probably RAAF) and lack of integration cost, it is very likely said weapon will be operational with RAAF F-35As, whether another ASCM is purchased or not. However, given the weapon's limitations in range and attack profile, it is unsuited to employment against well defended surface formations. Tactically both the JSM and LRASM address the challenge presented by organic fighter and AEW support. However, given the context of this article the LRASM clearly has greater application in any A2/AD system. The LRASM–F-35A combination would allow the RAAF strike naval formations as far as 1,200 nm from its bare bases. The JSM–F-35A combination would provide roughly half the strike radius, and thus does little to leverage the ADF's massive sensor footprint. Additionally, LRASM is designed to be utilised by naval vessels, which would increase the reach of RAN frigates, destroyers and potentially submarines by an order of magnitude. Preventing access to operationally significant areas of ocean is a key objective in A2/AD, which only becomes more critical as naval surface forces increase the range at which they pose a threat to Australian

[243] 'Norway and Australia to Cooperate on JSM-Development', Government.no, 26 February 2015, <www.regjeringen.no/en/aktuelt/norge-og-australia-enige-om-jsm-samarbeid/id2397609/> [Accessed 5 October 2016].

[244] It employs the same 1,000lb BROACH warhead and advanced signature reduction methods as the JASSM — Bryan Clarke, *Commanding the Seas: A Plan To Reinvigorate U.S. Navy Surface Warfare* (Washington, DC: Center for Strategic and Budgetary Assessments, 2014), p. 25.

[245] Lockheed Martin, 'LRASM', <www.lockheedmartin.com.au/us/products/LRASM.html> [Accessed 5 October 2016].

infrastructure.[246] Given the probable operational life of such a system will be measured in decades, whether the LRASM is the specific weapon for the task or not, if the ADF wants to emulate the PLA's advances in this method of operations, long range systems are clearly where the appropriate investment should be made.

Wide Area Surveillance: JORN and the Need for Orbital ISR

The ADF's primary 'first echelon' sensor is the Jindalee Operational Radar Network (JORN). JORN is an integrated network of three sky wave OTH radars, located in Longreach, Queensland; Alice Springs, Northern Territory; and Laverton, Western Australia.[247] The combined footprint of this array encompasses Papua New Guinea north to Manus Island, the majority of the Indonesian archipelago and a broad swath of Indian Ocean roughly the size of the Bay of Bengal. Much like OTH-B, JORN achieves its massive sensor footprint by bouncing radar beams off the ionosphere. Sky wave radars operate different scan techniques to microwave systems: the radar's footprint is divided into Dwell Interrogation Regions (DIR), which are made up of rectangular range-azimuth resolution cells determined by the total aperture, beam number and frequency. Achieving precise locations within these cells is difficult,[248] and although these inherent resolution limitations are being improved by JP 2025 Phase 6 which will include the application of advanced signal processing technology,[249] JORN should still be considered a first echelon sensor.

Powerful synergies exist between OTH radar systems—such as JORN—and orbital ISR. Despite their massive footprint, sky wave radars face significant resolution problems. Classification of ships by sky wave systems is nearly impossible and as evidenced by Chinese efforts, background clutter is a major challenge.[250] These problems have been addressed in the COSS architecture by the synergistic layering of long range radar and ELINT systems with high-resolution Earth Observation (EO) satellites. The 2009 Defence White Paper declared the government's desire for a dedicated satellite imaging capability,[251] although a sovereign military capability was all

[246] The Type 055 Cruiser/Heavy Destroyer is reportedly under construction for the PLA(N), with a displacement exceeding 10,000 tons and 128 VLS cells, including the YJ-1000 long range ASCM. 'Chinese TV Details Plans for Type 055 Destroyer', <www.janes.com/article/48738/chinese-tv-details-missile-plans-for-type-055-destroyer>

[247] The Longreach and Alice Springs systems cover a 90 degree arc, the Laverton array covers a much larger 180 degrees, providing coverage from nearly 90E/30S to the equator between Borneo and Sulawesi and terminating several hundred kilometres off the east coast of Queensland in the Coral Sea at around 152E. See Giuseppe Fabrizio, 'High Frequency Over the Horizon Radar', IEEE Lecture, Atlanta Georgia, May 2012, p. 24.

[248] Ibid., p. 28.

[249] Department of Defence, *Defence Capability Plan, 2012* (Canberra: Commonwealth of Australia, 2012), p. 97.

[250] Fabrizio, 'High Frequency Over the Horizon Radar', pp. 59-61.

[251] Department of Defence, *Defending Australia in the Asia Pacific Century*, p. 105.

but abandoned in 2016 White Paper: "Defence's imagery and targeting capacity will be enhanced through greater access to allied and commercial space-based capabilities, strengthened analytical capability and enhanced support systems".[252]

Clearly the ADF enjoys significant access to the US EO satellite constellation; however, these systems are not optimised for counter maritime operations.[253] Given JORN's technological sophistication and massive, equatorial footprint, even greater synergies than the PLA achieved can be leveraged by just a single imaging satellite in ADF service, as the advantages of equatorial orbital mechanics allow a single satellite to make multiple passes per day, up to ten in a twenty-four-hour period.[254] There has been some question as to whether a SAR or EO system would best suit the ADF's needs. The selection of these systems stems directly from the role the satellite is intended to fulfil, and given the broad area maritime search capability delivered by JORN, wide area search is not a high priority. Classification and resolution of targets identified by JORN is the key capability satellite ISR can provide the ADF in terms of A2/AD. A basic EO satellite would not be prohibitively expensive.[255]

Second Echelon ISR: High-Altitude Long-Endurance UAVs and Maritime Patrol Aircraft

The MPA is a core element in most Naval Ocean Surveillance Systems (NOSS). As discussed previously, the MPA provides an additional layer of second echelon sensors, allowing persistent tracking of maritime targets and the potential for visual or electromagnetic classification at long range. The RAAF's AP-3C fleet are to be replaced by fifteen P-8A Poseidon aircraft and seven MQ-4C Triton HALE UAVs, though the order for the Tritons has currently not been placed.[256] Although the P-8A will be extremely useful as a long-endurance ELINT platform, in any general conflict these precious aircraft will have ASW tasking, limiting their role in ASuW (anti-surface warfare) operations. This leaves the ADF with the MQ-4C as the primary

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[252] Department of Defence, *2016 Defence White Paper*, p. 87.
[253] This access may be restricted in a high intensity conflict simply due to higher allied priorities.
[254] For an explanation of equatorial orbital mechanics see Toto Marnanto Kadri, *Developing an Equatorial Earth Observation Satellite System*, National Institute of Aeronautics and Space – LAPAN Indonesia, COSPAR/IAF Symposium, Vienna, Austria, 12-23 February 2007, p. 8. Davies outlines the geographical advantages Australia enjoys in terms of satellite surveillance: Andrew Davies, 'Around the World in Ninety Minutes: What an Australian Satellite System Could Do', ASPI *Policy Analysis*, Australian Strategic Policy Institute, 21 May 2009, p. 5.
[255] France's Pleiades system cost ~$950 million (650 million Euros) for two units, delivers a 1.5 m resolution and a 60 km wide swath. Though, obviously this does not include the costs of establishing ground stations and an air force squadron to operate the system. See Peter B. de Selding, 'Soyuz Launches French Pleiades Imaging Satellite', SpaceNews, 7 December 2012, <spacenews.com/soyuz-launches-french-pleiades-imaging-satellite/> [Accessed 5 October 2016].
[256] Department of Defence, *2016 Defence White Paper*, p. 94.

tool to fill this link in the surveillance system. Powerful synergies present themselves if JORN and the MQ-4C are used in combination. A track provided by Triton would instantly provide calibration information for JORN, drastically improving resolution and thus geo-location. Relying on ELINT as a reliable means of classification is only possible if the target vessels are transmitting electromagnetic energy in the form of radars, data-links and radios. Strict EMCON procedures can effectively blind ELINT based surveillance systems, evidenced in the failures of the Soviet *Krug* direction finding network induced by USN EMCON tactics,[257] and can be reliably deceived by emulating the emissions of high value targets.[258] However, the operation of naval formations within JORN's estimated footprint would severely limit the opportunity for total EMCON by requiring minimal defensive measures; JORN effectively prevents the most effective counter to wide area ELINT systems as second echelon sensors.[259] This ELINT capability is of greater importance if satellite imagery and JORN's performance are both inhibited by adverse weather. Triton is also equipped with an advanced MFAS AESA (Multi-Function Active Sensor Active Electronically Scanned Array) air to surface radar, which could be used to generate high quality tracks of surface targets, however, this would leave the MQ-4C potentially vulnerable to any forward deployed combat air patrol.

C4 Requirements

The ADF has already done much of the C4 work necessary to facilitate such a system. As part of plan Jericho the ADF in general and RAAF in particular have invested much into developing a networked and integrated force.[260] Although the ADF has endured persistent difficulties in fully utilising the WGS 6 satellite,[261] once these are resolved the ADF will have full access to wideband, secure satellite communications, which is a critical enabler in supporting very long range ASCMs such as the LRASM. Additionally the effort already ongoing under JP 2008 to facilitate WGS 6 in terms of ground based infrastructure and information dissemination will be foundational in any satellite ISR capability.[262] As described previously, a system of this complexity requires high levels of centralised data fusion, and again the RAAF has already laid the groundwork through the Vigilare C2 system, currently operational at RAAF Tindal. Vigilare fuses information from JORN,

[257] Solomon, 'Defending the Fleet from China's Anti-Ship Ballistic Missile', pp. 41-43

[258] See the use of the AN/ULQ-5 and AN/ULQ-6 blip-enhancers on minesweepers and destroyers in the 1960s. Ibid., p. 44.

[259] For basic information on the MQ-4C, see Hairston, *MQ-4C Triton Persistent Maritime Intelligence, Surveillance and Reconnaissance*, Distribution Statement A, 2013, San Diego, CA.

[260] Jericho Vision, *Plan Jericho Information Statement*, Royal Australian Air Force, 2015, p. 4.

[261] WGS (Wideband Global Satellite-Communications/SATCOM). Construction of a satellite management station near Geraldton in WA is now seriously behind schedule. See APDR, 'JP 2008—Heading for the Projects of Concern List', Asia-Pacific Defence Reporter, 1 April 2014, <www.asiapacificdefencereporter.com/articles/431/JP-2008-heading-for-the-Projects-of-Concern-list> [Accessed 5 October 2016].

[262] Department of Defence, *Defence Capability Plan, 2012*, p. 96.

E-7 Wedgetail AEW&C aircraft, civilian air traffic control radars, Army's AN/TPS-77 air search radars, RAN surface vessels and numerous other inputs into a single operational picture.[263] Along with Link-16, this system is a key enabler in facilitating network enabled operations throughout the joint force. However, Vigilare's current focus is air surveillance. In order to facilitate the kind of near real-time NOSS as utilised by the PLA, Vigilare needs to be built upon to provide the same data fusion capabilities across the spectrum of joint maritime operations, managing air, naval and potentially ground forces and threats. This will be critical in synergising JORN, Triton and orbital ISR for counter maritime operations, and thus should be located at the ADF's Headquarters, Joint Operational Command (HQJOC) in Kowen, ACT, as opposed to RAAF Tindal.

Conclusions and Recommendations

As can be seen, most of the core systems of a formidable A2/AD capability are already either in place or are somewhere in the acquisition pipeline, and all that is realistically required to achieve the said capability is focused investment in the key areas of long range missiles, ISR and C4. Current force structure plans for the RAAF and RAN do not require alteration for the successful adoption of the A2/AD concept of operations. JORN, Triton, an orbital imaging capability and LRASM have a powerfully synergistic relationship, as each amplifies the other's strengths and together dramatically complicates the tactical picture for a hostile naval formation: the detection of a naval formation by JORN would automatically cue an imaging pass by a satellite, resolving the formation into number and type of units, weather permitting. Depending on the exact resolution achieved by CR techniques, JORN could possibly provide track data for a strike package and submarine there and then. If not, then Triton's ability to linger at the very edge of the target's sensor footprint, either passively gathering signals intelligence or moving to slightly closer to make a maximum range radar scan, achieves both classification and high fidelity tracks. Critically the combination of JORN with a second echelon sensor resolves the geo-location problem, providing persistent strike quality track data, information which not only constitutes a firing solution on the formation but drastically reduces AOU limitations. A squadron-sized strike package of F-35As, each armed with two LRASMs, external fuel tanks and flying a low speed–high altitude attack profile should be able to reach a launch point well beyond the typical 590 nm combat radius,[264] achieving a total engagement footprint with a radius of well over 1,000 nm, roughly the same size as the ADF's sensor footprint. Additionally, a single RAN submarine would have an engagement

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[263] Karinne Logan, 'Air Vigilance: Boeing's Most Advanced Command and Control Solution Is Set to Revolutionize Global Air Defenses—and Comes from Australia', *Boeing Frontiers*, April 2009, p. 33.

[264] For performance parameters of the F-35A, see Jeremiah Gertler, *F-35 Joint Strike Fighter (JSF) Program*, CRS report, RL30563, Congressional Research Service, p. 50.

footprint with a comparable diameter. In combination these platforms, missiles and sensors constitute a truly formidable maritime A2/AD capability, comparable in geographical scale—though undeniably not in terms of mass—to the system the PLA has constructed in the western Pacific. Such a system would do much to offset the naval superiority the PLA(N) enjoys over the RAN, and provide an effective means of defending the ADF's northern basing infrastructure.

As stated above, the choice of military systems is about more than capability within a single operational concept: platforms and systems function across the spectrum of operations, and their applicability to high-end war fighting scenarios may not outweigh their lack-thereof in low intensity or disaster relief contingencies. Additionally, procurement and through life cost, risk, industry participation, allied interoperability, sustainment and competing operational priorities are all major influences upon procurement decisions. Therefore, the following recommendations only address opportunities for development of an A2/AD system, as revealed through the PLA's experience to date, and thus make the assumption that A2/AD is a strategically desirable operational concept for the ADF.

Invest in the Far Left and Right of the Kill Chain

Several responses to the growing geopolitical challenges Australia faces in the Indo-Pacific have arisen over the past ten years. Professor Ross Babbage argued for a drastic increase in the size of the ADF to a frontline strength of either 300–400 F-35As or/and 20–30 advanced submarines, which presumably can only be funded by a commensurate increase in defence spending.[265] Professor Hugh White advocated the effective abandonment of a capable, though expensive, RAN surface fleet in order to focus investment on 'sea denial', allowing the acquisition of 24 submarines and 200 F-35As.[266] Undeniably these proposed paths would deliver the ADF significant conventional deterrence and a formidable defensive capability. However, their platform-centric nature imposes significant direct and opportunity costs, and are thus probably unlikely to be achievable given current global obligations and the government's commitment to spending 2% of GDP on defence. Nonetheless, even if these platform numbers are achievable or desirable, the lessons of the PLA's A2/AD development seem not to suggest investment in more platforms, but instead to leverage advances in maritime ISR, C4 and longer range missiles. By far these are the areas which would provide the ADF the greatest potential return on investment in terms of offsetting superior naval powers. Investing in the kill chain as a whole is foundational to the wider A2/AD capability, and improving the reach and depth of your sensors, your ability to fuse and

[265] Ross Babbage, 'Learning to Walk Amongst Giants: The New Defence White Paper', *Security Challenges*, vol. 4, no. 1 (Autumn 2008), p. 19.
[266] Hugh White, 'A Middling Power: Why Australia's Defence Is All At Sea', *The Monthly Essays*, *The Monthly Magazine*, September 2012.

disseminate information, and the reach of the platforms you have is far more important than total force numbers. If the ADF has the foundational elements of an A2/AD capability in place, in terms of sensors, networking, C2, weapons, logistics, doctrine and basing, total force levels can be raised if the geopolitical situation deteriorates.

HIGH-ALTITUDE LONG-ENDURANCE UAV AND ORBITAL ISR ARE KEY SYSTEMS

Though government has publicly stated an intention to acquire these systems, neither is ordered nor approved at the date of authorship. Current plans are for seven MQ-4Cs which,[267] if we apply the one-third rule,[268] would deliver two systems airborne in a high-end military contingency, assuming no mechanical failures or combat losses. Any reduction in those numbers, to say five units, would leave a mere one-and-a-half airborne on average. That force level seems sub-optimal, given the ADF's immense area of operations. Increasing the number of Tritons to either ten or twelve would significantly increase availability for operational tasking, freeing up the P-8 fleet for ASW. The desire for orbital ISR, so clearly communicated in 2009, has seemingly retreated in 2013 and 2016.[269] Given the relatively low cost of investing in this capability—probably around $1 billion AUD considering the Canadian RADARSAT[270] and French Pleiades examples—and the considerable synergistic benefits of combining such a system with JORN, sovereign orbital ISR should not be allowed to become a mere unfulfilled desire on the part of Defence. After the WGS integration is successfully completed, this should become a capability priority.

EMBRACE THE LONG RANGE WEAPONS REVOLUTION

A primary technological trend the PLA has exploited in formulating its A2/AD system is the rapid increase the range of anti-ship weapons, be they ASCMs or ASBMs. Whether LRASM is *the* missile for the ADF or not, clearly a weapon of its class is far more desirable than relatively short range, lightweight systems such as the JSM in an A2/AD operational concept. Acknowledging the increasing reach of threat surface formations driven by the regional proliferation of land attack cruise missiles not only requires long range ASCMs, but accepting the fact that geography alone will not provide the protection it once did to the ADF's northern basing. Thus, hardening the RAAF's bare bases by the improvement of aircraft shelters and underground bunkerage of munitions and fuel could substantially increase the system's resilience to kinetic attack. The 2016 Defence White Paper's stated intent to

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[267] Department of Defence, *2016 Defence White Paper.*

[268] The 'one-third rule' is a rough approximation of the level of capability a specific unit can sustain continually; typically one third of the total.

[269] Department of Defence, *Defending Australia in the Asia Pacific Century*, p. 105; Department of Defence, *Defence White Paper 2013* (Canberra: Commonwealth of Australia, 2013), p. 79. Department of Defence, *2016 Defence White Paper*, p. 87.

[270] The Canadian SAR satellite reportedly cost some $650m including R&D. See Davies, 'Around the World in Ninety Minutes', p. 6.

purchase a Ground Based Air Defence missile system is a welcome improvement in this regard.[271]

The LRASM, perhaps in combination with the dual use AGM-154C1 (and its later derivatives), offers the greatest capability within the operational concept outlined above. If it were to be purchased, serious consideration should be given to its role in RAN surface and subsurface forces. The proliferation of long range ASCMs on PLA(N) surface and subsurface platforms, such as the YJ-18, has dramatically increased both their lethality and responsiveness when operating within an A2/AD architecture. The inclusion of LRASM, particularly on the Collins replacement, offers a powerful capability enhancement which additionally compensates for the conventional submarine's lack of transit speed. It would also provide the surface fleet with a credible offensive role within said operational plan. The 2016 White Paper outlined the desire for the ADF to acquire land-based ASCMs.[272] However, given the size of the ADF's primary area of operations utilising a land based missile is not an optimal means of delivering long range fire: even a land based derivative of the LRASM would only provide roughly half the engagement footprint of an LRASM–F-35A combination. Thus, the only realistic method of utilising these systems in a defensive A2/AD system is their forward deployment into Indonesia, which is an inherently uncertain proposition. The need for short range, land based systems in a defensive contingency seems reasonably redundant if the ADF has the ability to strike naval formations at 1,000 nm from its bare bases. Consequently, this is arguably an unwise investment, unless the intent is to use these systems in conjunction with offensive amphibious operations: the limitations of land based systems, given Australia's geography, makes them more capable offensive tools.

Summary of Requirements for the Development of an A2/AD Capability by the ADF

- *Long range replacement for the Harpoon*: Whether the LRASM is the missile or not, investment in a long range missile for both the RAAF and RAN is a low risk, low cost, A2/AD opportunity.

- *Orbital ISR and Triton should be capability priorities*: An imaging satellite is a key link in the proposed kill chain and is by no means cost prohibitive, and given Triton's unique terrestrial ISR capability, up to twelve systems should be purchased.

- *The development of a new C4 system based on Vigilare*: Centralised data fusion is a key requirement for decision makers within a system which utilises such diverse sensors and platforms, and is critical in

[271] Department of Defence, *2016 Defence White Paper*, p. 96.
[272] Ibid., p. 94.

limiting Area of Uncertainty limitations, thus facilitating the effective use of missile forces.

Over the next fifteen years the ADF is well placed to deliver an A2/AD system comparable to the PLA's in geographical scope and more than commensurate with Australia's size and wealth, if the appropriate investments are made. The costs of such a system are by no means prohibitive, considering the elements which are already in place, and are certainly achievable given the current budgetary environment. This is of critical importance, as the opportunity cost of investing in these technologies—perhaps $3 billion of additional expenditure over fifteen years—is comparatively small, as low as 1 per cent of allocated funding in the ten-year period covered by the 2016 Defence White Paper. Thus, A2/AD does not preclude other investment options, such as a nuclear submarine capability for example, and does not require the abandonment of currently planned capabilities. The combination of JORN, Triton, orbital ISR, F-35A, LRASM and an improved C4 capability, founded on Vigilare and Link 16, in addition to the RAN's already formidable future force structure, would pose substantial challenges to any great power operating in our northern approaches, and require the application of disproportionate capabilities and force levels to counter. Additionally, once the bones of the system are in place, it can be scaled up with relative ease via the acquisition of more platforms, should the geopolitical situation deteriorate. Adopting A2/AD as a core operational concept offers the ADF an approach to the unthinkable—a general conflict in the Asia Pacific—which is both monetarily achievable and provides a realistic chance of offsetting Chinese naval superiority within our primary area of operations.

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