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Royal Canadian Air Force (RCAF) Future Air Operating Concept (FAOC) Functional Concepts

Advice and Example

Dr. Brad Gladman
Dr. Andrew Billyard
DRDC – Operational Research and Analysis Branch
Canadian Forces Aerospace Warfare Centre

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Prepared for: Commanding Officer Canadian Forces Aerospace Warfare Centre

Scientific Letter

RCAF FAOC Functional Concepts: Advice and Example

The purpose of this Scientific Letter is to address a question asked by the Commanding Officer of the Canadian Forces Aerospace Warfare Centre (CFAWC) on how best to develop the supporting functional concepts emanating from the Royal Canadian Air Force (RCAF) Future Air Operating Concept (FAOC). The OR&A Branch at CFAWC has looked at this problem and would offer the following pragmatic recommendations for the considerations in developing a FAOC functional concept (FC).

The FAOC FC should begin with an introduction that sets the appropriate context. It should include a brief summary of where the FC fits in the concept hierarchy—that it flows from the FAOC and its subordinate operational concepts which, in turn, set the tone for the FC.

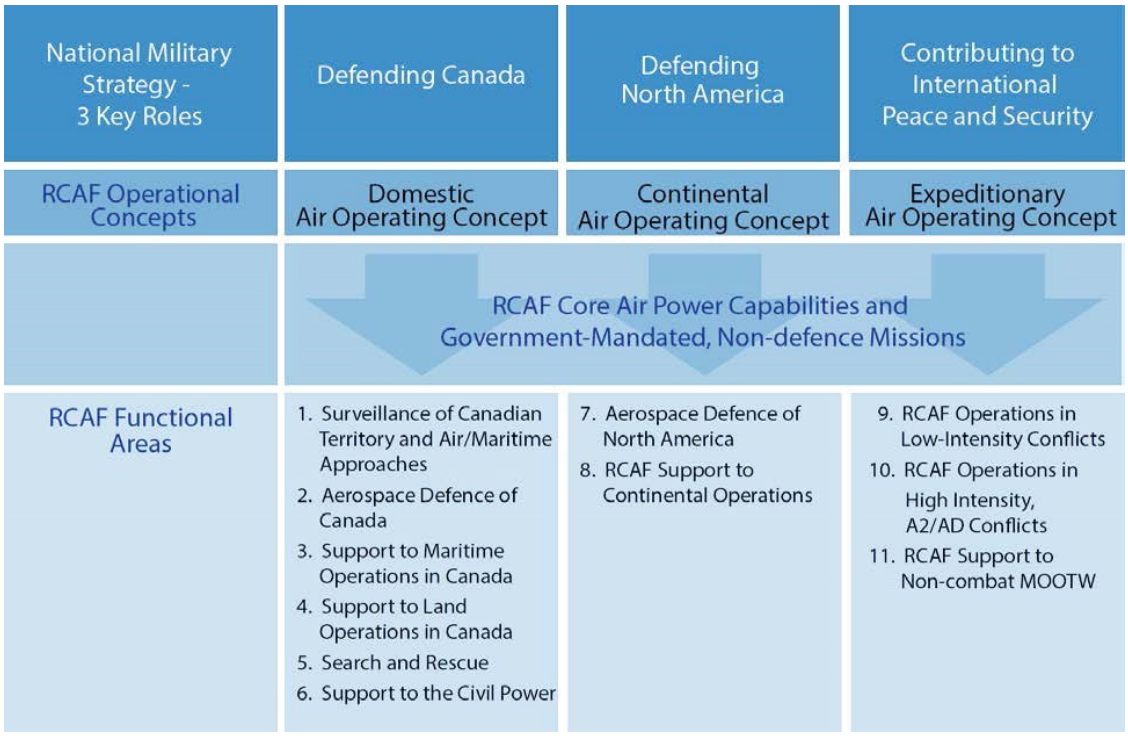

Figure 1: FAOC Concept Hierarchy.[1]

[1] Figure 1 is drawn from Royal Canadian Air Force, "Future Concepts Directive Part 2: Future Air Operating Concept," 14. 15 August 2016. http://www.rcaf-arc.forces.gc.ca/assets/AIRFORCE_Internet/docs/en

Canada

The first part of the FC should outline the broad operational context. Drawing from guidance from the FAOC and the appropriate operational concept (domestic, continental, expeditionary), the FC should provide more detail about the specific functional area. For example, in a FC dealing with RCAF operations in a high intensity anti-access area-denial (A2/AD) environment, the description of the operational concept should be derived from the best understanding possible of the challenges posed. It should identify exactly how adversaries are planning to use technology and operational methods to create advanced A2/AD environments, and to what end. In the case of Russia, for example, the intent is to ensure its influence in regions in its near-abroad where it feels vulnerable, or where it feels it must have a presence. Similarly, the Chinese wish to establish a predominant position over their territory and as far out as the second island chain. Each set of desired goals will cause different technologies and methods to be pursued, and thus the detailed understanding of the means with which an enemy will challenge access and freedom of manoeuvre in its region, how it will use terrain and other features to its advantage, and its preferred method of fighting are all factors that should be included in the FC description of the military problem. Determining the state actors and the challenges that they bring would require a request for information from the Department of National Defence (DND); for example, either the intelligence community or strategic analysis.

Equally important is the orientation of important allies, the most important of which is the United States (US), in meeting these specific challenges. Thus, a level of collaboration with key allies is valuable to the development of an RCAF FC that will ensure it makes a meaningful contribution in any future operation of this nature. Some work in this area has already been done, and should be exploited.[2] As well, material derived from the Force Development Management Tool (FDMT) that will be a useful resource to exploit in the design of the RCAF FC and scenario to be wargamed, and which may be the start point to identifying enabling concepts coming from the FAOC FC wargames.

From all of this analysis would come a necessary understanding of the context upon which an RCAF FC should be based. Failing to set this context leads to a common practice of rushing right to the solution instead of following something known, in the words of historians Richard Neustadt and Ernest May, as "the *Goldberg Rule*." This maxim assists in focusing attention on the central and critical elements of any situation by asking '*what is the story?'*, rather than '*what is the problem?'* By doing the former, rather than the latter as is the norm, one sets an appropriate context around which the real problems in the functional area will be better illuminated.[3]

The RCAF FC should provide a detailed description of the context for the functional area, and use that to design a scenario (or scenarios) that could be wargamed. In so doing, it will be important to ensure to draw upon the resident expertise within the Department of National Defence (DND) and Canadian Armed Forces (CAF) by inviting the right people with the right expertise, and those who are empowered to speak on behalf of their organisations. In terms of the A2/AD FC, for example, cyber issues will be significant in the scenario design. Having the right personnel from, *inter alia,* the Director General of Cyber and the

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/cf-aerospace-warfare-centre/elibrary/future-concepts-directive-part-2-future-air-operating-concept.pdf (accessed 16 October 2017).

[2] See Brad Gladman, *The Future of Allied Air Power: The United States Air Force* (Ottawa: DRDC-RDDC-2014-R82, 2014); Brad Gladman, *The Future of Allied Air Power: The Royal Australian Air Force,* Ottawa: DRDC-RDDC-2015-R212, 2016; Brad Gladman and Andrew Billyard, "The Implications of the US Third Offset Strategy for the RCAF of the Future," DRDC-RDDC-2017-L272, 2017.

[3] Richard E. Neustadt and Ernest R. May, *Thinking in Time: The Uses of History for Decision-Makers* ,New York: The Free Press, 1986, 235.

Canadian Forces Intelligence Command (CFINTCOM) that are able to speak intelligently and authoritatively on the current state of the domain, plans for the future, and perceived challenges to be addressed is essential; so too is ensuring those individuals are prepared and able to speak with authority. These scenarios (which likely will have to be classified appropriately) will look at the problem through the lens provided by RCAF strategic guidance documents, currently Air Force Vectors which identifies four vectors (Agile, Integrated, Reach, and Power) whose meaning for the RCAF of the future will bring an appropriate focus to discussion of future capability. How the attributes of the RCAF's vision will evolve across the core air power functions (control of the air, attack, surveillance and reconnaissance, and air mobility) will be explored in each FC.[4]

Out of these wargames will fall a series of enabling concepts – and may include capability options to best meet scenario requirements. These enabling concepts will, after all FAOC FC are completed, identify key areas and priorities for the research and development groups supporting the RCAF, as well as informing its own internal force development community. For instance, a future fighter 'concept' may not be the result of any one particular functional concept, but rather one of these key areas that results as the amalgam of several enabling concepts across the FC spectrum. It is not recommended to pre-suppose any such cross-cutting concepts until a few FC have been sufficiently developed.

These key areas will influence the FD community by describing how a new method or technology supports each specific FC, and these should be used as the intellectual foundation upon which the RCAF should establish research priorities and better direct the FD and S&T communities in support of the RCAF of the future.

Conclusions and Recommendations

As directed by the RCAF campaign plan, the development of RCAF enabling concepts should flow from the full development of the supporting operational and functional concepts. It is recommended that the CFAWC Concept Development and Experimentation (CD&E) and Operational Research and Analysis (OR&A) branches work collaboratively to develop an appropriately robust means of developing the functional concepts as described in this paper, as well as an effective way to wargame those concepts and analyse the results to produce a series of enabling concepts. These enabling concepts will, in turn, serve as the basis upon which the RCAF can better influence the S&T support it receives, and a main means to inform RCAF FD efforts.

The OR&A branch recommends the following steps which ought to be applied to each FC:

1. Determine which FC should be next considered. The priority will be determined by allied activities (such as upcoming international wargames), Commander RCAF's priorities and FC refresh rates (applicable once all FCs have been developed and need to be updated).
2. Solicit from the appropriate expertise in the department (e.g., CFINTCOM, DRDC as noted above) the context necessary to frame the FC.
3. Draft a FC document which has the background material from point 2 above fleshed out in detail; found in the Introduction section, the "Brief Literature Review / Background Research" section and parts of the "Time Horizon, Assumptions and Risks" section of the FC (see Annex A for a sample FC format). After an internal review, disseminate to the wargame community as part of the necessary reading package.

[4] Royal Canadian Air Force, "Future Concepts Directive Part 2: Future Air Operating Concept," 6. 15 August 2016

4. Convene the wargame to determine the enabling concepts necessary in order to appropriately realize the FC. The wargame should identify assumptions and risks as well as identify the enabling concepts. The assumptions and risks will be captured in the "Time Horizon, Assumptions and Risks" portion of the FC, the challenges and gaps should be identified in the "Concept Synopsis" section of the FC and the enabling concepts should be identified in the "Conclusions" section.

Finally, the OR&A branch does not recommend a prescribed length for each FC. Rather, the nature and complexity of the functional area will dictate the length of the corresponding FC. For instance, the A2/AD presented in the Annex requires a thorough understanding of the adversaries at play and the strategies being adopted. Consequently, it demands a rich background discussion. Conversely, many of the government mandated non-defence missions (for example, search and rescue) are sufficiently prescribed by the government that they do not require a detailed background discussion. This pragmatic approach will ensure the timely delivery of all RCAF FAOC functional concepts.

Prepared by: Dr Brad W. Gladman and Dr Andrew Billyard (DRDC – Operational Research and Analysis Branch).

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Neustadt Richard E., and Ernest R. May. *Thinking in Time: The Uses of History for Decision-Makers.* New York: The Free Press, 1986.

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Annex A An Example of a Future Air Operating Concept Functional Concept Paper: RCAF Operations in High Intensity Anti-Access and Area Denial Conflicts

Introduction

This Future Air Operating Concept (FAOC) functional concept "RCAF Operations in High Intensity A2/AD Conflicts" is subordinate to the expeditionary operational concept (see figure 2).[5] Its purpose is to describe a specific air power function within the defined operational context, allowing further definition of that operational concept and leading directly to a set of enabling concepts needed to inform RCAF capability development.

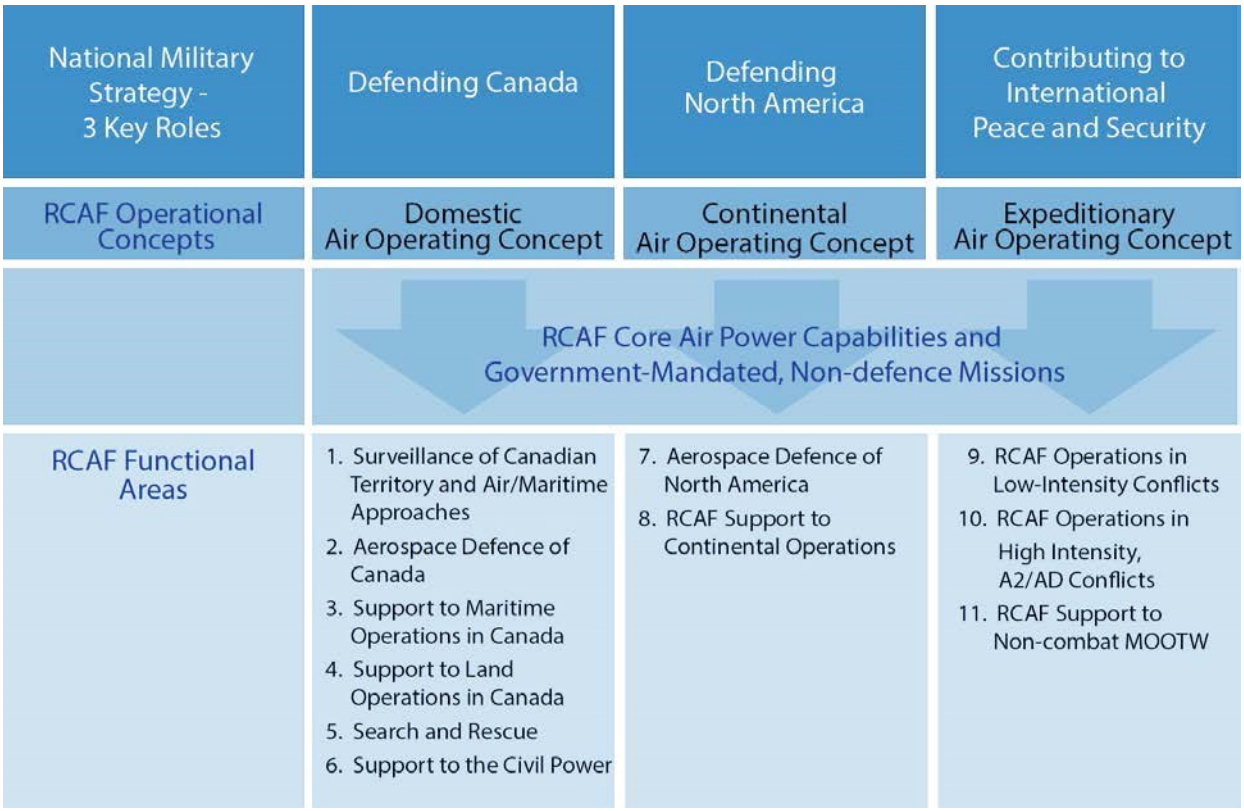

Figure 2: FAOC Concept Hierarchy.

[5] This FC is intentionally incomplete, as the section on the enabling concepts will emerge from a suitable wargame.

The Military Problem: The Anti-Access/Area-Denial Challenge

The term anti-access (A2) refers to action "intended to slow deployment of friendly forces into a theater or cause forces to operate from distances farther from the locus of conflict than they would otherwise prefer. A2 affects *movement* to a theater."[6] Area-denial (AD) refers to action "to impede friendly operations within areas where an adversary cannot or will not prevent access. AD affects *maneuver* within a theater."[7] Neither of these ideas is new. The attempt by an adversary to prevent reinforcement and limit manoeuvre is as old as warfare. One of many examples can be seen in the North African campaigns where the British forces sought, through the Royal Air Force (RAF) in North Africa and the Royal Navy (RN) in Malta, to prevent the flow of supply from Italy to Tripoli and thence to the front.[8] Rather, the character of these ideas is changing in response to technological advance and its proliferation, allowing regional powers around the world to challenge the military pre-eminence of the US and its allies. Recent advances in missile technology, from ballistic, cruise, and air-to-air and surface missiles with improved accuracy, range, and destructive power are combining with new sea mines, stealth fighters and submarines, and technologies to challenge space and cyberspace environments. All of these technologies are being directed at challenging the key advantages of the US military and its key allies. The reliance of these forces on space and cyberspace capabilities for communications, intelligence and surveillance, and targeting information makes them an obvious target and fundamentally threatens the accepted model whereby the US and its allies are able to seize air supremacy, project power over distance, and manoeuvre at will. These developments have serious consequences for deterrence efforts, regional and global stability and the free flow of trade around the world upon which it depends.

Literature Review and Background Research

Through its recent Third Offset strategy, or whatever moniker is adopted for this effort by the new US administration, the US is seeking to counter the erosion of its military advantages to avoid the loss of access to vital areas of the world by ceding control to adversaries. It has acknowledged that its near monopoly in precision-strike ushered in by the Second Offset strategy begun in the late 1970s has started to slip away. A few specific adversaries have developed their own reconnaissance-strike brands and integrated air and missile defences to challenge the pillars of US power projection – its in-theatre bases, constellation of satellites upon which so much depends, aircraft carriers and other surface combatants, and non-stealthy aircraft that are now increasingly vulnerable to enemy integrated air defences.

It is expected that the challenge to the US ability to ensure operational access will continue, and that might well be the most difficult operational challenge its forces will face over the coming decades.[9] It further identifies the military problem developing a way to project military force into a disputed area and to sustain it "in the face of armed opposition by increasingly capable enemies when U.S. overseas defense posture is changing and space and cyberspace are becoming increasingly important and contested domains."[10] Most literature focuses attention on two key adversaries, China and Russia, while admitting that A2/AD strategies are or may be adopted by other potential opponents like Iran. Each of these countries is modifying this general strategy to meet its own particular regional requirements, with

[6] "Air-Sea Battle: Service Collaboration to Address Anti-Access & Area Denial Challenges" (Washington D.C.: Air-Sea Battle Office, May 2013), 2. Emphasis in original.
[7] *Ibid.* Emphasis in original.
[8] See Brad W. Gladman, *Intelligence and Anglo-American Air Support in World War Two: The Western Desert and Tunisia, 1940-43* (London: Palgrave Macmillan, 2009).
[9] *Joint Operational Access Concept* ,Washington D.C.: Department of Defense, 17 January 2012, ii.
[10] *Ibid.*

capability implications for the US military and its allies. This section will outline the broad military challenge faced by A2/AD strategies of Russia and China, and these should provide the context needed to design a series of scenarios with which to focus the RCAF's FAOC wargame.

Chinese 'Counter-Intervention' Strategy

It was almost inevitable that the US and many of its allies would rediscover the Western Pacific as an essential theatre. The flow of goods through this region make it one into which the US cannot afford to lose its ability to project power. Indeed, the Western Pacific Theatre of Operations (WPTO) may well be the most challenging operational environment, given the distances involved and the recent development of the Chinese military while the US and its allies were distracted with the Middle East. China now has the ability and likely the resolve to pose a formidable A2/AD challenge, through what the Chinese refer to as a 'counter-intervention' strategy.[11] Some authors have argued that a conflict with China in the WPTO is inevitable, and while its recent activity is a source of concern the potential for conflict must be balanced against the internal problems China is facing with a slowing economy and attempts to develop a more sustainable economic model. In fact, some authors argue that China's actions are "mainly bluster and puff" aimed mainly at a domestic audience and that it actually is acting in both the East and South China seas from a weak position.[12] It certainly is a regional power but at the moment it simply cannot contend with a coalition that includes the United States, something that has resulted in a series of confrontations "that serve domestically in China to keep the nationalistic spirit at a high volume in order to reinforce the sense of rising Chinese power – something particularly necessary for the leadership during a time of slowing economic growth."[13] It stands up to the US without provoking a conflict it cannot yet win. That having been said, US military planners cannot afford the luxury of hoping potential enemies will remain behind them in military power. Indeed, the trends point in the opposite direction.

The Chinese 'counter-intervention' strategy is developing what some have called *shashoujian* or 'assassin's mace' weapons, referring to ancient Chinese hand maces that could concealed and used without warning. Modern versions are designed to deter entry of US or allied forces into the second and first island chains, what China views as its own territory.[14] It growing fleet of diesel-electric and nuclear submarines, a variety of ballistic, anti-ship, and cruise missiles, advanced and capable intelligence, surveillance and reconnaissance (ISR) aircraft and fourth and fifth generation fighters, and its anti-satellite and offensive cyber capabilities, the Chinese could attempt to sever US access to the area, presenting the US with the unenviable choice of ceding control of the region to China or fighting a costly campaign to re-establish access.[15] The purpose at this time is not to confront the US directly, but rather to combine Eastern strategic thought with Western technology into a potent counter-intervention strategy.

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[11] Benjamin Shreer, *Strategy: Planning the unthinkable war, 'Air Sea Battle' and its implications for Australia* (Canberra: Australian Strategic Policy Institute, April 2013), 8.
[12] Robert Kaplan, "Why Is China Really Provoking Its Neighbors?" http://www.realclearworld.com/articles/2014/02/13/why_is_china_really_provoking_its_neighbors.html, (accessed 4 October 2017).
[13] *Ibid.*
[14] The second island chain extends from the Japanese island of Honshu, through the Marianas islands to the tip of New Guinea, while the first island chain includes a series of disputed islands off the coast of Japan, Taiwan, the Philippines, Malaysia, and Vietnam. See Andrew F. Krepinevich, *Why AirSea Battle?* (Washington D.C.: Center for Strategic and Budgetary Assessments, 2010), 13-14. Also see Brad Gladman, "The future of allied air power: The United States Air Force" DRDC-RDDC-2014-R82, November 2014, 29.
[15] Andrew Krepinevich, "Strategy in a Time of Austerity" *Foreign Affairs*, Vol. 91, Issue 6, (Nov/Dec 2012).

In the event of a conflict over Taiwan or some other WPTO contingency, Chinese planners expect the US military to follow its traditional model from other recent campaigns, by starting operations with a missile and air campaign while its forces, supplemented by key allies, and networks are built up in the theatre.[16] The Chinese likely would counter this campaign by targeting key features of the US way in warfare using *shashoujian* weapons. Likely beginning without warning, one could expect cyber and kinetic strikes against US and allied forces in-theatre, the latter striking directly at alliance cohesion. As Colonel Yuan Zelu of the People's Liberation Army has said, "The goal of a space shock-and-awe strike is to deter the enemy, not to provoke the enemy into combat…This will shake the structure of the opponent's operational system of organization and will create a huge psychological impact on the opponent's policymakers."[17] These attacks likely also would be directed against the constellation of US satellites combined with "neutralizing the uplinks and downlinks of space-based systems through diverse forms of cyberattack [sic]."[18] Since the majority of US precision weapons are dependent on Global Positioning System (GPS) satellite information for their targeting, and some "US unmanned aerial vehicles, such as the Predators, are incapable of operating in the absence of satellite data links to their remote controllers", the effect of such measures should not be underestimated.[19] Moreover, the "US military's Time-Phased Force and Deployment Data (TPFDD), essential to deploying forces in a timely and efficient manner, is highly dependent upon myriad data links bringing together information from a range of sources."[20]

Supplementing attacks on US and allied networks, the Chinese would likely use its range of ballistic missiles (capable of carrying both conventional and nuclear weapons) to threaten US bases at Guam and possibly even Australia or the second island chain. Moreover, those technologies, in the form of anti-ship ballistic missiles having reached initial operational capability (IOC), pose a grave threat to US surface combatants and aircraft carriers.[21] In particular, the so-called "carrier-killer" or DF-21D is of particular concern to US Navy planners, since it is "designed to hit ships at ranges beyond the unrefueled range of a carrier strike group"[22], most notably its aircraft carriers which are central to US power projection.[23] The recent development of a "special submunition warhead for the missile with clusters of non-explosive flechette penetrators designed to damage a carrier by kinetic impact, and a high-power microwave warhead designed to disable naval radars with electromagnetic pulses" offers the potential for the Chinese to render impotent a main means by which the US projects power.[24] Combined with newly developed maritime surveillance systems designed to detect and target US warships at extended ranges, capable maritime patrol aircraft, and a rapidly improving fleet of diesel-electric and nuclear powered submarines to 'shadow' and possibly engage US carrier battle groups at distance or inside the theatre, the Chinese have developed what appears to be an effective way at denying the US and its allies the ability to access

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[16] *Ibid.*
[17] Larry R. Moore, "China's Antisatellite Program: Blocking the Assassin's Mace" *Asian Perspective* Vol. 38 Issue 1 (2014), 163.
[18] *Ibid.,* 168.
[19] Andrew F. Krepinevich, *Why AirSea Battle?,* 16.
[20] *Ibid.*
[21] Stew Magnuson, "Navy Program at Center of Drone Survivability Debate", *National Defense* (September 2014), http://www.military.com/daily-news/2014/09/17/navy-program-at-center-of-drone-survivability-debate.html (accessed 4 October 2017).
[22] *Ibid.*
[23] See Harry Kazianis, "Behind the China Missile Hype", *The Diplomat* (January 20, 2012), http://thediplomat.com/2012/01/behind-the-china-missile-hype/ (accessed 4 October 2017). Michael S. Chase, Andrew S. Erickson, and Christopher Yeaw, "Chinese Theater and Strategic Missile Force Modernization and its Implications for the United States," *The Journal of Strategic Studies,* (February 2009), 67-114.
[24] Andrew F. Krepinevich, *Why AirSea Battle?*, 19. Also see See Robert Hewson, "Dragon's Teeth – Chinese Missiles Raise Their Game," *Jane's Navy International*, February 2007, 22.

what it views as its region, as well as the freedom of manoeuvre US and allied forces have taken for granted for decades.[25]

Air supremacy is another feature of modern operations the US and its allies have come to expect, but recent developments can be expected to challenge this assumption. The PLA air force (PLAAF) includes long-range bombers such as the H-6K, a substantially modernized and longer-ranged copy of the Soviet-era Tupolev Tu-16 armed with sea-skimming anti-ship missiles and anti-radiation missiles aimed at targets like the US Airborne Warning and Control System (AWACS), and the US Navy SPY-1 and E-2 Hawkeye.[26] The PLAAF has also recently acquired fourth generation fighters like the Sukhoi Su-30MKK2, raising "the specter of combined fighter and bomber attacks against US aircraft carriers – a threat not encountered since World War II."[27] These fourth generation fighters and other advanced aircraft will soon be complemented by the fifth-generation fighters such as the J-20, demonstrating the Chinese intent to produce its own fighter with "stealth attributes, advanced avionics, and supercruise-capable engines over the next several years."[28] With its own airborne warning and control aircraft, ISR and maritime surveillance aircraft, aerial refueling tankers, an impressive array of upgraded Russian SAM systems like the S-300 PMU1 and PMU2, and close to five hundred fourth and soon fifth-generation fighters and attack aircraft, the PLAAF will soon be able to challenge the assumption of US and allied air supremacy, and make control of the air the costly business it has normally been.[29]

As stated earlier, from an analysis of Chinese military writing it is assumed that at the outset of any conflict in the WPTO the PLA would engage in pre-emptive attacks with *shashoujian* weapon systems to blind and damage US and allied forces in the theatre, while concurrently disrupting US command and control networks through cyber or kinetic attacks, and crippling "US operational logistics by destroying major supply nodes and the relatively few US logistic ships."[30] The strategy would seek to delay and keep US power-projection forces beyond effective range of the WPTO, or defeat them when they came within range.[31] The strategy's ultimate purpose is aimed at demonstrating the inability of the US to defend its regional allies, and by inflicting substantial damage and loss on US and allied forces very quickly, to make it clear they could either accept Beijing's *fait accompli"* or pay a very high price to reverse the situation.[32] This A2/AD strategy strikes at the US military's long-held assumptions about the invulnerability of its forces, sensors, and the connectivity binding them together.

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[25] Andrew F. Krepinevich, *Why AirSea Battle?*, 19. Brad Gladman, "The future of allied air power: The United States Air Force", 28.
[26] *Ibid.,* 21.
[27] *Ibid.* Richard Fisher, Jr., "Growing Asymmetries in the China-Japan Naval Balance," *International Assessment and Strategy Center,* November 22, 2005, https://www.sinodefenceforum.com/growing-asymmetries-in-the-china-japan-naval-balance.t948/ (accessed 4 October 2017).
[28] Robert P. Haffa Jr., "Full-Spectrum Air Power: Building the Air Force America Needs," (Washington D.C.: The Douglas and Sarah Allison Center for Foreign Policy Studies Special Report No. 122, 12 October 2012), 7.
[29] Andrew F. Krepinevich, *Why AirSea Battle?*, 21. Also see Carlo Kopp and Peter A. Goon, "Inquiry into Australian Defence Force Regional Air Superiority," *Air Power Australia*, (February 2006), 55-56; Roger Cliff, Mark Burles, Michael S. Chase, Derek Eaton, and Kevin L. Pollpeter, *Entering the Dragon's Lair: Chinese Antiaccess Strategies and Their Implications for the United States* (Santa Monica: RAND Corporation MG524, 2007), 85.
[30] Jan Van Tol, Mark Gunzinger, Andrew Krepinevich, and Jim Thomas, *AirSea Battle: A Point-of-Departure Operational Concept*, xii.
[31] Andrew F. Krepinevich, *Why AirSea Battle,* 15.
[32] *Ibid.*

Russian A2/AD in Europe and the Arctic

The resurgence of Russia under Vladimir Putin, something enabled in part by the distraction of the US and its allies in the Middle East for the past sixteen years, has brought with it a modernisation of its military as a tool with which to re-establish control in its periphery not seen since the end of the Cold War. The current conflict between Ukraine and Russia, in which Russia sponsored Crimea's succession vote from Ukraine and subsequently annexed it and parts of eastern Ukraine in 2014, has forced the US and its allies to once again think about containing Russia and limiting its ability to exert control over the nations in its periphery.[33]

One cannot understate the effect of geography on the Russian perception of the world. Its lack of defensible rivers, mountains, oceans or other features upon which to secure its defence has defined Russia over its history. Its core, defined by the former region of the Grand Principality of Muscovy is simply indefensible. It has found itself invaded over its history along one or two main routes. The first is along the North European Plain, which both Napoleon and Hitler used as their invasion route in 1812 and 1941 respectively. The second is along the southern plains that link central Asia to Russia, a route used by the Mongols when they invaded the Kievan Rus state in the 13th century.[34] The only option open to the Russians in each case was to trade distance for time and to use Russia's harsh climate and attacks on logistics to lessen invading forces through attrition. These experiences, especially the invasion by Germany in 1941, are still central to Russian thinking, and have influenced heavily their perception of the world and Russia's place therein. While some might argue that it is unthinkable that anyone would invade Russia, the unthinkable happens to Russia "once or twice a century."[35]

Throughout its history, Russia has sought either a controlling influence or outright occupation of certain territories on its periphery. In particular, they have sought to anchor themselves as far west as possible on the North European plain, and to secure the southeastern frontier by controlling key areas of the Caucasus, Central Asia, and especially Ukraine, the latter being part of the North European plain along the Black Sea has been a natural invasion route from Europe.[36] They have also sought to anchor themselves on the Baltic Sea, which brings them into direct conflict with NATO members Latvia, Lithuania, and Estonia, and other Arctic countries. It is insecurity in these areas that makes Russia feels particularly vulnerable, and which motivates their thinking and their actions. It is in these regions where Russia feels compelled to develop advanced A2/AD environments.

Whether one refers to Russian strategy as A2/AD or a deep defensive zone, its intent is clearly to reassert itself as a Great Power and to deny or limit US military access to what it views as its region of the world. The Black Sea and eastern Ukraine represents a concrete example of an A2/AD environment aimed at keeping the US and the North Atlantic Treaty Organization (NATO) forces out and to convince them that establishing a presence in it's near abroad and seeking to manoeuvre would be prohibitively expensive. This approach, and the capabilities it is developing and fielded, will be used elsewhere including the Arctic if not countered effectively. The US is seeking to do so through its Third Offset strategy and the

[33] Justin A. Evison, "MIGs and Monks in Crimea: Russia Flexes Cultural and Military Muscles, Revealing Dire Need for Balance of Uti Possidetis and Internationally Recognized Self-Determination," *Military Law Review* 220, June 2014, 91; *The National Military Strategy of the United States of America 2015* (Washington DC: Joint Chiefs of Staff, 2015), 1, 2, and 4.
[34] "The Geopolitics of Russia: Permanent Struggle," *Stratfor Analysis*, 11/1/2011; U.S. Department of State Dispatch 10517693, "Russia at a glance," *Supplement Economic Summit* 5, 2 July 1994.
[35] "The Geopolitics of Russia".
[36] *Ibid.*

Joint Concept for Access and Maneuver in the Global Commons (JAM-GC), which is a continuation of its Air-Sea Battle concept under a new moniker.

Russia has many tools at its disposal to prevent US and NATO forces from attempting to take back the Crimea or Eastern Ukraine, or indeed in any attempt by Russia to expand its influence in it's near abroad through direct military action. While unlikely, the possibility exists that the Russians might seek to invade parts of Poland or the Baltic states of Latvia, Lithuania, and Estonia and establish an advanced A2/AD environment before NATO could react and then seek a negotiated settlement enabling them to consolidate their influence over what they view as key territories for their own security.[37] While in overall strength the Russians cannot compete with the potential military might of the US and NATO, it is the local correlation of forces where their advantage exists. Their aim would be to destroy enemy forces in the region and prevent follow-on forces from flowing into Europe before their goals could be attained. A series of deep defenses would be created to present NATO and the US with the choice of accepting the Russian *fait accompli* or conducting a costly campaign to reclaim lost territory.

A key pillar of recent Russian military modernisation has been its navy, and in particular its submarine fleet. It recently has added a new Boreal-class Ship, Submersible, Ballistic, Nuclear (SSBN) submarine to its fleet.[38] This new boat, capable of nuclear and conventional launch capabilities through its Bulava (RSM-56) missiles, is very adept at anti-submarine warfare, making it a key part of Russian anti-access strategy.[39] Added to this is the Russian navy's newest nuclear powered attack submarine, the Yasen-class Kazan, armed with advanced torpedoes and long-range Kalibr cruise missiles.[40] In total, the Russian navy has at least 40 nuclear powered submarines, including 13 strategic missile boats. It has a further 30 diesel-electric submarines, as well as eight cruisers, 14 destroyers, seven frigates, 4 corvettes, 27 anti-submarine warfare ships, 46 fast attack craft, 54 mine warfare vessels, and an aircraft carrier spread across its various fleets.[41] All of these would be used in an anti-access role to prevent the insertion of follow-on forces from North America or the UK, or to prevent freedom of manoeuvre in waters associated with the conflict area.

A recent development in Russian air and space domains reflects an evolution in Russian military thinking. In August 2015 Russian Defence Minister Sergey Shoigu declared the unification of Russia's air and space forces into an 'Aerospace Forces Command.[42] This change from the Cold War structure where Soviet air and space forces were under the command of different branches of the Soviet military was prompted by what Shoigu referred to as a "shift in the combat 'center of gravity' toward the aerospace theater."[43] These arrangements continue the 2011 merger between Russia's space and air defence forces into the Aerospace Defence Forces, whose purpose was to defend Russian airspace from air and space attack. The Aerospace Forces Command significantly streamlined the command and control of Russian

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[37] S.G. Chekinov and S.A. Bogdanov, "The Nature and Content of a New-Generation War" *Military Thought.* October–December 2013, 23.
[38] Franz-Stefan Gady, "Putin's 'Red October': Russia's Deadliest New Submarine," *The Diplomat*, 4 March 2015.
[39] *Ibid.*
[40] Loulla-Mae Eleftherious-Smith, "Russia launches most powerful nuclear attack submarine yet," *The Independent,* 5 April 2017, http://www.independent.co.uk/news/world/europe/russia-nuclear-attack-submarine-yasen-class-tass-kalibr-cruise-missiles-east-europe-severodvinsk-a7667511.html (accessed 5 October 2017).
[41] "Janes' World Navies: Russian Federation – Navy," https://janes.ihs.com/WorldNavies/Display/1322754 (accessed 16 October 2017).
[42] Matthew Bodner, "Russian Military Merges Air Force and Space Command," *The Moscow Times*, 3 August 2015, https://themoscowtimes.com/articles/russian-military-merges-air-force-and-space-command-48710 (accessed 5 October 2017).
[43] *Ibid.*

Long-Range Aviation (LRA), tactical aviation, air and space ISR assets, and potentially anti-satellite weaponry possibly targeting US and coalition space-based ISR and communications.[44] When combined with Russian cyber-attack capability targeting uplink and downlink of space-based systems, the potential for kinetic attack against US and allied military satellites is a serious concern. The US Time-Phased Force and Deployment Data (TPFDD) system is dependent upon myriad data links bringing together information from a range of sources and would be a prime target at the outset of a conflict.[45] The streamlining of command and control of the Russian Federation Aerospace Forces (RFAF) will enhance its ability to support Russia's A2/AD strategy.

The threat posed by Russian LRA to the assembly and deployment of forces to oppose Russian military operations, and its deterrent value are significant. Recent efforts to modernise its TU-95 Bear H, TU-160 Blackjack, and Tu-22M Backfire bombers has added new lethality to these Cold War aircraft, although the modernisation programmes are "progressing at a snail's pace."[46] Upgrades to avionics to improve precision, survivability, as well as enhancing command, control and communications functions add to their overall effect. So too do developments with precision strike weapons, in particular the KH-101 and 102 Air Launched Cruise Missiles with their reduced radar cross-sections and improved range and accuracy will enhance the efficacy of Russian LRA once reliability and serviceability matters are resolved.[47] As well, in September 2010 Vladimir Putin announced the development of the next generation Russian strategic bomber, known as the Prospective Aviation Complex for Long-Range Aviation (PAK-DA).[48] The broad specifications for this aircraft are for it to be a 'flying wing' low-observable design cruising at subsonic speeds, capable of carrying a range of precision-guided munitions including long-range hypersonic air-to-surface missiles with both conventional and nuclear payloads.[49] Currently under development, this aircraft will not be in service for some time, but it represents Russia's desire to once again be seen by the world as a Great Power.

Russian fighters are an integral part of its area-denial strategy. While its Soviet-era fighters are showing their age, the newer 'fourth and fourth-plus generation' fighters like the SU-34 Fullback and SU-35 Super Flanker (part of the long-standing SU-27 family) are quite capable. Moreover, some older Soviet-era fighters are being upgraded. For example, the Sukhoi Su-27 Flanker's latest variant, the SU-27 SM3, was delivered in 2011.[50] Equipped with new and more reliable engines, avionics, and weapons, these aircraft are capable multi-role platforms. Moreover, with more than 1000 multi-role and attack aircraft in service, even considering the questionable serviceability and pilot training levels the airspace above a conflict zone will be contested. It is not at all certain that, when combined with capable surface-to-air missile systems, air superiority is achievable and certainly not to the level the US and its

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[44] *Ibid.*
[45] Andrew F. Krepinevich, *Why AirSea Battle?* 16.
[46] Matthew Bodner and Aaron Mehta, "Heightened Ops Tempo Reveals Russian Air Force Vulnerabilities," *Defense News, 13* July 2015.
[47] Defense Intelligence Agency, "Russia Military Power: Building a Military to Support Great Power Aspirations," DIA 11-1704-161, http://www.dia.mil (accessed 5 October 2017); Sebastien Roblin, "Russia's TU-95 Bear Bomber: Everything You Need to Know", *The National Interest,* 4 May 2017, http://nationalinterest.org/blog/the-buzz/russias-tu-95-bear-bomber-everything-you-need-know-20484?page=2 (accessed 11 October 2017).
[48] Franz-Stefan Gady, "Russia Moves Ahead With Future Strategic Stealth Bomber Project," *The Diplomat*, 2 March 2017, https://thediplomat.com/2017/03/russia-moves-ahead-with-future-strategic-stealth-bomber-project/ (accessed 5 October 2017.
[49] *Ibid.*
[50] "New Multi-Role SU 27 SM(3) Fighters Delivered to the Russian Air Force," *Defence Talk*, 29 January 2011, http://www.defencetalk.com/new-multi-role-su-27sm3-fighters-delivered-to-the-russian-air-force-39215/ (accessed 5 October 2017).

allies have come to expect. Numbers do matter, and the latest generation of Russian fighters and their armaments are of a high quality.

In 2011 the Russians displayed their Sukhoi T-50 Prospective Aviation Complex for Frontal Aviation (PAK-FA) fifth-generation fighter. Constructed mainly from carbon plastic, half as heavy as aircraft aluminum and four times stronger than steel, this aircraft represents a significant development sure to complicate US and allied air operations. It is not on the same level as the F-22 Raptor, which has a much smaller radar cross-section, but it is far less visible to radar than any other Russian design.[51] It will be equipped "with a dual-band (X- and L- band) radar which should provide it with certain tactical advantages over the F-35."[52] It will be armed with the full range of increasingly sophisticated air-to-air, air-to-surface, and cruise missiles will give Russian aviation improved stand-off range with the prospect of increasingly precise engagement. Further enhancing the area-denial strategy is Russia's long history with radars and surface-to-air missiles, the next generation of which may be quite effective against the USAF's greatest advantage – its low-observable aircraft.

The main technological advantage of the US and its allies is its global aerial power projection capability. The speed, responsiveness, and precise effect of aircraft such as the B-1, B-2, and the F-22 and F-35, to name just a few, have seen air power become the first choice of political and military leadership. Against Russian integrated air defences, these aircraft may be somewhat less effective. As some authors have written, the "theoretical capabilities of military hardware do not always translate into real-world effectiveness. It is therefore important to consider the opposing force – the air-defence assets in the future operating environment."[53] With a motto of "Don't Fly, Don't Let Others Fly", the Russian National Air Defence troops have been equipped with the latest Russian radars and SAMs that might prove quite capable even against low-observable aircraft. The combination of SAM systems like the S400 Triumph, along with the development of the S-500 expected to be operational around 2020, with low-band radars like the Track Tall (55Zh6U) with its publicly advertised error box of less than 60 metres, makes for a potent combination.[54] Along with these technologies comes the Russian Concept of Operations (CONOPS) for their use whereby the low-band radar is used to guide a SAM to the vicinity of the stealth target, after which the SAM is flown in a curved approach to seek the target from "aspects in which its radar cross-section is higher…thus increasing the probability of the SAM seeker successfully locking onto the target."[55] Given the willingness of the Russians to sell these air-defence technologies, along with their CONOPS and technical training, to a range of countries around the world, they are likely to pose a serious challenge to US and allied air power until countermeasures are developed.

The physics behind the employment of SAMs with low-band radars "is based upon the fact that the emission-absorbent materials used by the modern low-observable aircraft are only marginally effective against meter-band emission, while the shape of the aircraft is too small to conceal it from the meter-wavelength radar signals." Thus, the F-35 is more liable to detection by these radars than the F-22 or B-2, but the latter aircraft are detectible by decametre-band 1,200 kilometre range Rezonans-NE radars, which the Russians also possess.[56] When combined with capable and numerous Russian fighters

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[51] Franz-Stefan Gady, "Russia to Receive 2 Fifth-Generation Stealth Fighter jets in 2017," *The Diplomat,* 7 June 2017, https://thediplomat.com/2017/06/russia-to-receive-2-fifth-generation-stealth-fighter-jets-in-2017/ (accessed 5 October 2017).
[52] Igor Sutyagin, "The Limits of Stealth" *RUSI Defence Systems*, 9 September 2014.
[53] Sutyagin, "The Limits of Stealth.".
[54] Defense Intelligence Agency, "Russia Military Power: Building a Military to Support Great Power Aspirations," 80.
[55] Sutyagin, "The Limits of Stealth."
[56] *Ibid.*

and their increasingly advanced air-to-air missiles, Russian integrated air defences are going to be very costly to penetrate and more so to gain even a degree of air superiority.

One possible Russian strategy related to operations aimed at seizing part of a NATO member's territory is the so-called 'strike, pause, and win' strategy. Using its advantage in local correlation of forces, Russia would seize part of a NATO member's territory, pause while NATO seeks to mobilise its forces, and simultaneously seek to win by undermining European will to retake the lost territory. This strategy follows from a Russian assessment of NATO's willingness to fight, and its capacity to respond quickly. Air power is essential to convincing them otherwise, from detecting the build-up before hostilities commence through to interdicting and blunting and movement in the opening stages, something that may reinforce alliance will and resolution. This would only be possible through the development of capabilities able to survive in advanced A2/AD environments that no doubt would be established around any potential axis of advance. Given the developments in Russian air and space capabilities, and the expectation that both kinetic and cyber-attack would be part of this strategy, the sooner solutions are found for each pillar of Russian military strength, the better.

All of these capabilities are being deployed in and around Russia's near abroad, but also in the Arctic. This is a concern of all Arctic nations, including Canada, and may be something that will increase in importance with the possibility of the Arctic opening to year-round naval traffic and the already increasing air traffic. The free movement of goods safely by ship through this region will be a priority if the Arctic waters are able to be navigated for some or all of the year. Recent Russian investments in military capabilities in the Arctic could threaten freedom of navigation. These include the development of new bases and airfields in the Arctic, unifying command of these forces under a Northern Joint Strategic Command, and plans to deploy new radar sites and SAM systems possibly of the types described earlier further complicates this situation.[57] While some authors argue there is no Russian intent to threaten the Arctic, it has long been an area in which pressure on Canada and the US has been placed and these developments are another example of that long-standing trend.[58]

Russia's recently assertive behaviour in the Arctic is a source of concern for all Arctic nations. Norway intercepted 74 Russian warplanes in or near its airspace in 2014. This represents a 27% increase over the previous year and close to seven times as much as 2004. In March of 2015, Russia responded to a Norwegian military exercise of 5,000 personnel with an unannounced one of its own involving 45,000 forces "and some forward deployed nuclear forces."[59] Moreover, there is suspicion that Russian submarines have been operating in the territorial waters of Finland, Sweden, and other Arctic nations. Indeed, in 2015 Finland "dropped depth charges against a suspected foreign submarine within its territorial waters."[60]

The American Approach to A2/AD

Despite the challenges faced by Chinese and Russian A2/AD environments, the US and its allies are not without a response. The US Navy is by far the world leader in anti-submarine and surface warfare

[57] David Barno and Nora Bensahel, "The Anti-Access Challenge You're Not Thinking About," *War on the Rocks,* 5 May 2015, https://warontherocks.com/2015/05/the-anti-access-challenge-youre-not-thinking-about/ (accessed 13 October 2017).
[58] Levon Sevunts, "Do Russian bomber patrols in the Arctic threaten Canada's security and sovereignty?" *Eye on the Arctic,* 13 March 2017, http://www.rcinet.ca/eye-on-the-arctic/2017/03/13/do-russian-bomber-patrols-in-the-arctic-threaten-canadas-security-and-sovereignty/ (accessed 13 October 2017).
[59] Barno and Bensahel, "The Anti-Access Challenge You're Not Thinking About."
[60] *Ibid.*

abilities. Its submarine launched ballistic missiles (SLBM) are a powerful deterrent, complemented by the USAF ICBM and strategic bomber fleet, the replacement for the latter is currently being developed. The US is investing in specific new technologies to maintain it advantage, something articulated broadly in discussions of its Third Offset strategy.[61] The US armed forces are investigating their own advanced technologies with which to deal with A2/AD environments. The USAF, for example, is pursuing the development of the Next-Generation Strike Bomber, an advanced and stealthy ISR capability, advanced cyberspace attack and defence, the F-35, as well as emphasising 'stand-off' and long-range weapon systems and 'stand-in' resilience.[62] As well, it is exploring so-called 'game changing technologies' like hypersonic missiles and aircraft, directed energy weapons, and next generation unmanned and autonomous systems. As with the Russian SAM/low-band radar CONOP, the US is working these capabilities into what was initially called the Air-Sea Battle concept (now the JAM-GC concept).

The Air-Sea Battle concept (ASB) was first described in 1992 by then Commander (eventually Admiral) James Stavridis in a National War College paper.[63] Like the Air Land Battle doctrine, which was developed after the Vietnam War to counter a Soviet combined arms attack in Europe through the degradation of rear echelon forces before they could engage, ASB was also designed for an in-depth attack. It sought to develop networked, integrated forces which would attack in-depth across air, land, maritime, space, and cyberspace to "disrupt, destroy and defeat adversary forces", thus providing maximum operational advantage to friendly joint and coalition forces across all domains.[64] It also understood that the enemy would seek to influence all of these domains, and the concept included defensive elements to protect rear echelons to enable rapid reconstitution after attack. In other words, the "defensive aspect of ASB helps the Joint Force reduce risk in the face of increasingly longer range and more precise weapons which could affect our space-based platforms, land forces, airbases, capital ships, and network infrastructure."[65] The JAM-GC concept "keeps and enhances ASB's proven best ideas. It is now a joint concept built on the ASB 'chassis.'"[66]

All US services are taking action to implement the JAM-GC concept in the short-term, and are planning specific capabilities suitable for A2/AD environments in the longer-term.[67] Examples of short-term actions are the incorporation of contested and denied environments into service training and exercises, and conducting service and joint war games focusing on ASB application in a realistic scenario; continued exploration of the ASB concept for relevance in light of adversary developments; building conceptual alignment with partners and allies to strengthen relationships to assure regional access; analysing and experimenting in order to evolve the concept into Joint and Service doctrine; and reviewing and better integrating command and control structures to enable cross-domain operations.[68] Its main initiatives remain mitigating the missile threat to bases and maritime forces; developing "penetrating and stand-off long-range ISR and precision strike capabilities and capacities"; enhancing undersea operations

[61] Brad Gladman and Andrew Billyard, "The Implications of the US Third Offset Strategy for the RCAF of the Future," DRDC-RDDC-2017-L272, August 2017.
[62] Brad W. Gladman, *The Future of Allied Air Power: The United States Air Force* (Ottawa: DRDC-RDDC-2014-R82), 39-51.
[63] Commander James Stavridis, "A New Air Sea Battle Concept: Integrated Strike Forces" (Washington DC: National Defense University, 1992).
[64] Air-Sea Battle Office, "Service Collaboration to Address Anti-Access & Area Denial Challenges", 4.
[65] *Ibid.*, i.
[66] Michael E. Hutchens, William D. Dries, Jason C. Perdew, Vincent D. Bryant, and Kerry E. Moores, "Joint Concept for Access and Maneuver in the Global Commons: A New Joint Operational Concept," *Joint Forces Quarterly* 84, 1 (2017), 136.
[67] Brad Gladman, "The future of allied air power: The United States Air Force,"
[68] Air-Sea Battle Office, "Air-Sea Battle: Service Collaboration to Address Anti-Access & Area Denial Challenges", 4, 10–12.

by submarines, mines, and unmanned underwater vehicles; offsetting the vulnerability of spaced-based systems to include low-cost easily replaceable systems and "high-capacity airborne C3 relay networks"; enhancing cyber defence and cyber warfare offensive capabilities; and developing directed-energy weapons."[69] Many of these initiatives are central to the US Third Offset strategy.

Time Horizon, Assumptions and Risks

All of this should be included in a realistic scenario design which likely will be classified. One option for scenario design would be to put existing and planned RCAF capabilities through the scenario to identify capability gaps and enabling concepts to fill those gaps.

This section will be mostly result from the wargame in which it will be determined how exactly the RCAF will be expected to contribute to the coalition within this A2/AD context. After a gap analysis is done via the wargame, those aspects that will NOT be achieved by the RCAF, nor intended to be achieved by the RCAF, will be articulated here. Those aspects that are intended to be achieved, but cannot be by current capability will yield the genesis for the enabling concepts listed below.

Concept Synopsis

This section is devoted to summarizing the outcome of the wargame. For instance, it should begin with "In order for the RCAF to realize this functional concept…" and followed with a summary of the successful outcomes of the wargame.

Conclusions

This is a brief section which provides the list of enabling concepts required to fulfil the function concept. For example:

In order for the RCAF to play an effective role in a coalition operation within an A2/AD environment, it will need to fully explore the following enabling concepts:

1. *EC 1*
2. *EC 2*
3. *EC 3 …*

Furthermore, the wargame may identify aspects to be considered which are not necessary a direct enabler to the concept in question, but may be of value to enhancing the concept. For example:

Furthermore, although not crucial to realize this Functional Concepts, the following enabling concepts should also be considered as secondary factors:

1. *EC a*
2. *EC b*
3. *EC c …*

[69] Andrew F. Krepinevich, *Why AirSea Battle,* xv.

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Future Air Operating Concept, Functional Concept, Operating Concept, Force Development, RCAF, Air Force